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PNX METALS

FOUNTAIN HEAD GOLD PROJECT

ENVIRONMENTAL IMPACT STATEMENT

01238D_1_V2

MAY 2021



PNX Metals Ltd

Fountain Head Gold Project

Environmental Impact Statement

01238D_1_v2, May 2021

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Key Project Terms

Term	Definition
Environmental aspect	An element of an organisation's activities, products or services that can interact with the environment
Environmental factor	Aspects of the environment, defined by the NT EPA, that provide a framework for EIA in the Northern Territory
Environmental impact	The change that takes place from occurrence of any given environmental aspect. A marked effect or influence. Negative or positive effect/s caused directly or indirectly by an event or activity, or by the release of a substance into the environment, causing a change in the biological, physical and/or socio-economic environment
Environmental value	An aspect of the environment that is important or serves an important function. An environmental value may require protection due to its importance, sensitivity, vulnerability and/or worth
Evaporation pond	The existing water storage dam located in the north east of the Project area, following remediation and expansion
Existing dam	Refers to the existing dam in the north east of the Project area
Fountain Head Lake	The body of water located to the west of the existing waste rock storage
Fountain Head pit	The existing pit located on site. Historically referred to as the Fountain Head Tally Ho Pit prior to the collapse of the wall between the Tally Ho and Fountain Head pits
Integrated Waste Landform	The landform constructed for co-disposal of waste rock and filtered tailings
Potentially Acid Forming Stockpile Runoff Dam	A dam designed and constructed to capture runoff from the temporary potentially acid forming waste rock stockpile
Project area	The Fountain Head Project Area, consisting of MLN4, 1020, 1034 and ML31124
Study area	Refers to the area surveyed for a particular study that may differ to the Project area, e.g., water quality site

1. Introduction

1.1 Overview

PNX Metals Limited ('PNX', or the 'Proponent') (ABN: 67 127 446 271) is proposing to develop the Fountain Head Gold Project (the 'Project' or 'Fountain Head'). PNX is a publicly listed, minerals exploration company (ASX: PNX) with a significant tenement portfolio in the Pine Creek region of the Northern Territory containing both base and precious metals. The Company's main focus is the development of two priority projects:

- The Fountain Head Gold Project, containing the Fountain Head gold deposit and the proposed location of the gold processing plant.
- The Hayes Creek zinc-gold-silver Project ('Hayes Creek'), comprising of 14 wholly-owned mineral leases including the Iron Blow and Mount Bonnie deposits.

In 2018, PNX acquired an additional four mineral leases (MLs) at Fountain Head (MLN4, MLN1020, MLN1034 and ML31124) to secure the processing plant and tailings facility site for the Hayes Creek Project.

1.2 Project Proponent

1.2.1 Previous Proposals and Developments

PNX is an active explorer and has made significant investments in the Northern Territory since 2014 where it entered into an agreement with Crocodile Gold to acquire Hayes Creek containing the Mt Bonnie and Iron Blow deposits, and a farm-in agreement over 19 exploration licenses (ELs) and 4 MLs. The earn-in was completed in 2018 and now holds 90% under joint venture with Kirkland Lake Gold.

The Company's 100% owned Mineral Leases host considerable Mineral Resources including:

- Mt Bonnie and Iron Blow – 238,000 oz of gold, 16.2 Moz silver and 177,000 t of zinc, 37,000 t of lead and 10,000 t of copper.
- Fountain Head – 156,000 oz of gold.

Also 100% owned are the Moline Project, and Glencoe gold prospect containing a further 79,000 oz of gold.

In parallel with the studies and permitting activities currently underway, PNX has implemented an exploration strategy with the aim of identifying and testing exploration targets to deliver a pipeline of gold mineral resources for processing at Fountain Head.

Large areas of the exploration tenements remain untested by drilling with the majority of previous work centred on known, outcropping gold deposits and their immediate areas. Exploration and near-mine drill programs are scheduled to continue in 2021.

In mid-2017 PNX published a Preliminary Feasibility Study (PFS) for the Hayes Creek Project which confirmed the project to be a high value, relatively low risk and a technically strong development opportunity for the Company. The PNX Board had resolved to proceed with a Definitive Feasibility Study (DFS) however a weak zinc market, significantly elevated concentrate treatment charges, and exploration success at Fountain Head guided PNX decision to focus on its gold development opportunities.

In December 2019, the Company made a strategic decision to accelerate evaluation activities at Fountain Head to define low-cost, scalable options to rapidly monetise, and generate early cashflow from the newly defined gold resources at Fountain Head. The development options looked to preserve the value of the Hayes Creek Project, and potentially enhance the economics and extend mine life as the mined-out Fountain Head pit would be available for use as tailings storage from subsequent processing of Hayes Creek ores.

PNX had submitted a notice of intent (NOI) to the Northern Territory Environment Protection Authority (NT EPA) for the Hayes Creek Project in February 2018. The final terms of reference (ToR) were issued on the 2 August 2019 and determined the Project would be assessed at the level of an Environmental Impact Statement (EIS). Due to exploration success at the Fountain Head PNX will be pursuing environmental approvals for the Fountain Head Gold Project (detailed in Chapter 2).

PNX contact details for the Project are provided in Table 1.1 and the company organisational structure is provided in Figure 1.1.

Table 1.1 – Proponent Contact Details

Contact	Phone	Email	Address
James Fox Managing Director	08 8364 3188	info@pnxmetals.com.au	Level 1, 135 Fullarton Road, Rose Park, South Australia 5067

PNX has engaged ERIAS Group to assist in coordinating the environmental approvals for the Project. Contact details for ERIAS Group are provided in Table 1.2.

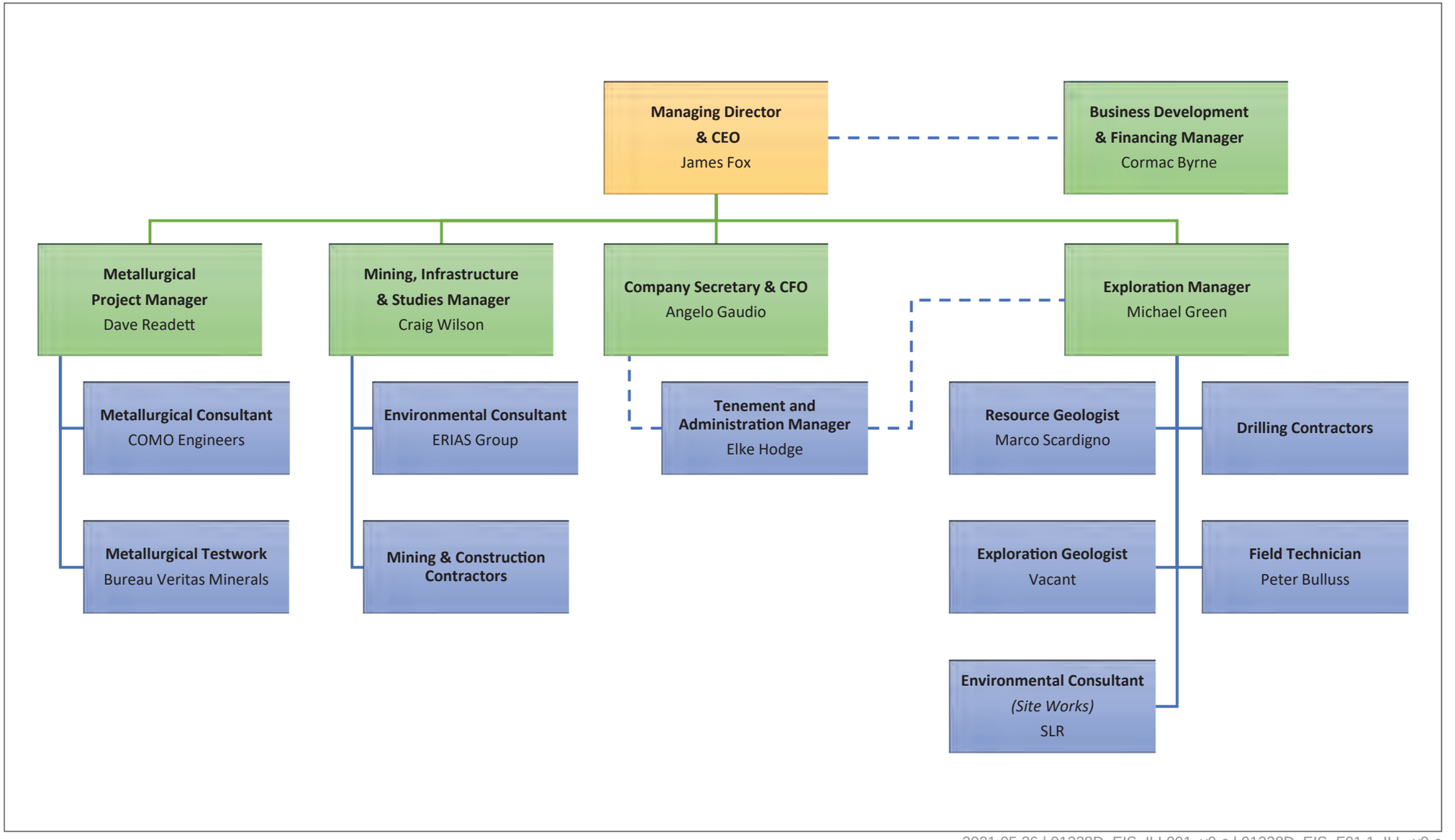
Table 1.2 – Consultant Contact Details

Contact	Phone	Email	Address
David Browne Principle	0419 012 698	david.browne@eriasgroup.com	22B Beulah Road, Norwood, South Australia 5067

PNX METALS ORGANISATIONAL STRUCTURE

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 1.1



1.3 Project Location and Overview

1.3.1 Project Location

The Fountain Head Gold Project leases are located on Ban Ban Springs Station, approximately 170 km south of Darwin in the Northern Territory, and approximately 13 km east of the Stuart Highway (Figure 1.2). Ban Ban Springs Station is an operating cattle station on pastoral lease (PL) 1111. The station covers an area of 1,873 square kilometres, with a carrying capacity of approximately 12,000 head of beef cattle for domestic and international markets. The land system consists of hilly and gently undulating terrain and vast plains interspersed with creek beds bordered by flood out country.

Coordinates of the site are provided below in Table 1.3 below.

Table 1.3 – Project Coordinates

Site	Latitude	Longitude
Fountain Head	13º27’58”S	131º30’15”E

Coordinates are in Latitude and longitude – Degrees, minutes, seconds.

The area surrounding the Project contains a number of historic, predominantly gold mines, some of which continue to be assessed by various companies regarding potential to recommence operations. Cosmo Gold Mine owned by Kirkland Lake Gold, located approximately 15 km to the west of the Project was the closest recently operating mine in the area. Ore from Cosmo Gold Mine was processed approximately 70 km south at Kirkland Lake Gold’s Union Reefs processing plant which recommenced operations in November 2019 after an approximate two-year period under care and maintenance. In March 2020, Kirkland Lake Gold made the decision to cease the Cosmo Gold Mine and Unions Reefs operations. Exploration by Bacchus Resources at the Woolwonga mine site approximately 6.5 km north of the Project area is the only other exploration or mining activity currently known in the immediate area.

Police (Territory) and Fire and Emergency (volunteer) services are located approximately 65 km from the Project area in the townships of Adelaide River and Pine Creek. Access to the Project site is off the Stuart Highway, via Ban Ban Springs Road, shown in Figure 3.3.

1.3.2 Project Overview

1.3.2.1 Project Activity

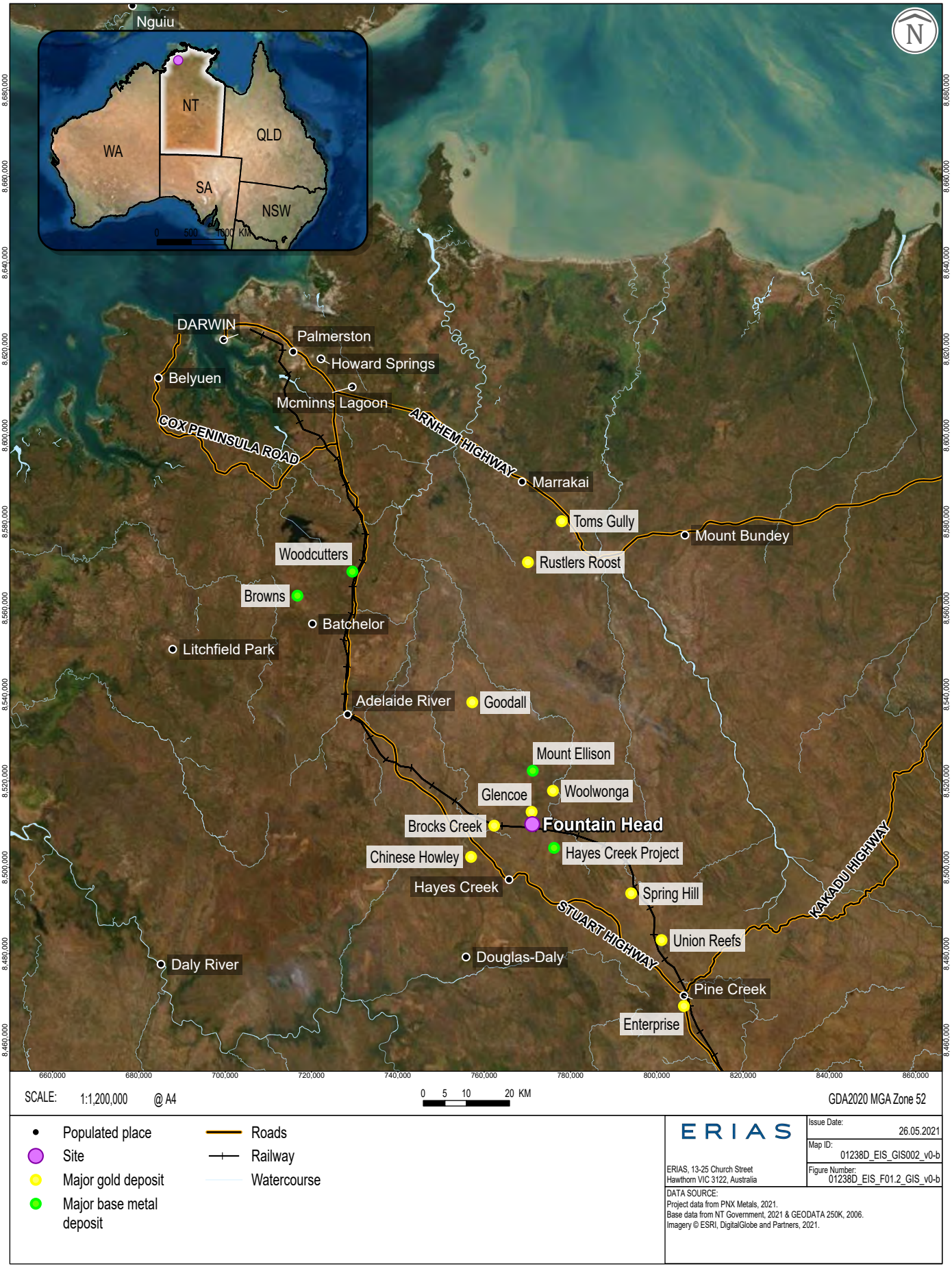
The Project involves recommencing mining of the Fountain Head pit and will include the following activities:

- Dewatering of existing open pit.
- Expansion of existing open pit.
- Construction of crushing facilities and gold processing plant.

PROJECT LOCATION

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 1.2



- Construction of supporting infrastructure (i.e. workshops, power station, roads, offices etc.).
- Construction and progressive rehabilitation of the integrated waste landform (IWL).
- Construction of surface water management features i.e., sediment and runoff dams and diversions.
- Ongoing dewatering of the evaporation pond.

The existing Fountain Head open pit has filled over time with ground water inflows, surface water runoff and rainfall since mining ceased in August 2008. The pit currently contains approximately 2064 ML of water that will need to be partially removed prior to the expansion of the pit (PNX Metals, 2019a). The proposed dewatering activity of the existing open pit is subject to a separate approvals process. In March 2021, PNX submitted a revised care and maintenance mining management plan (MMP) – the Fountain Head Tally Ho Mining Management Plan Amendment to the Department of Industry, Tourism and Trade (DITT), formerly the Department of Primary Industry and Resources (DPIR) addressing the dewatering activity. The MMP was subsequently approved on 19 March 2021. The dewatering activities include the following:

- Remediation and extension of dam walls for evaporation pond.
- Use of evaporators and pump system to dewater the pit void.
- Storage of pit water in the expanded evaporation pond for natural evaporation and retention.

Expansion of the Fountain Head open pit will be based on conventional drill and blast mining techniques. The expansion will involve a cutback of the existing open pit void, along with an extension to the existing void in a northward direction. Further detail on Project activity is provided in the Project description, Chapter 3.

1.3.2.2 Project Timeline

The key Project activity milestones are as follows:

- Evaporation of pit water – June 2021 to May 2022 (approximately nine months before the start of mining).
- Evaporation pond remediation and expansion – January to April 2022.
- Pumping of water from pit to evaporation pond – April to June 2022 (at the start of mining).
- Site preparation and construction – Early 2022.
- Mining – First half of 2022.
- Forced evaporation from the evaporation pond – Late 2022 to late 2024 (six months after mining commences to end of mine life).

- Closure activity commences – mid 2025.

1.3.2.4 The Environmental Impact Statement Report

The Fountain Head Gold Project Environmental Impact Statement report (this document) follows the structure advised by the NT EPA in the ToR and 'general guidance for proponents preparing an environmental impact statement' (NT EPA, 2019) and 'preparing an environmental impact statement – guidance for proponents' (NT EPA, 2021c) where appropriate. The report begins with introductory chapters that describe the proponent, the Project objectives, proposed schedule and Project alternatives. These chapters are followed by a description of the Project activity, existing environment, and assessment of impacts, where the latter identifies the predicted physical environment, biological, and socio-economic impacts taking into account the impact magnitude and sensitivity of the value that is affected. Cumulative impacts are also assessed where the Project may interact with impacts arising from the actions of third parties.

Specialist studies were commissioned to support the environmental impact assessment program of work for both the Hayes Creek Project and Fountain Head Projects, some studies characterise the environment in both locations. All studies reflect the current Project activity and potential impacts of the Fountain Head Gold Project and are listed in Table 1.4.

Table 1.4 – EIS Specialist Studies

Specialist Study	Report Name	Author
Air quality and greenhouse gas	Fountain Head Gold Project Air Quality and Greenhous Gas Assessment (Appendix 1)	Katestone Environmental Pty Ltd
Noise	Fountain Head Gold Project Environmental Noise Assessment (Appendix 2)	Sonus Pty Ltd
Hydrology and water quality	Fountain Head Gold Project Site Water and Solute Balance Modelling (Appendix 3)	CDM Smith Australia Pty Ltd
	Fountain Head Gold Project Flood Assessment and Surface Water Management Strategy (Appendix 4)	
	Fountain Head Gold Project Soil Infiltration and Solute Fate Assessment (Appendix 5)	
Geochemistry	Geochemical Characterisation of Waste Rock & Ore – Fountain Head (Appendix 6)	Environmental Geochemistry International Pty Ltd
	Geochemical Characterisation of Fountain Head CIL Tailings (Appendix 7)	
	Estimates of PAF Waste Rock Volumes at Fountain Head (Appendix 25)	
Flora and fauna	Hayes Creek Project Flora and Fauna Report (Appendix 8)	Low Ecological Services Pty Ltd
Aquatic ecology	Aquatic Baseline Characterisation Report – Fountain Head and Hayes Creek Zinc, Gold and Silver Projects (Appendix 9)	ERIAS Group Pty Ltd
Social and economic	Fountain Head Gold Project – Socio-economic Impact Assessment Report (Appendix 11)	
Cultural heritage	Archaeological Assessment of PNX Metals' Fountain Head Gold Project, 2019 (Appendix 10)	In Depth Archaeology Australia

Specialist Study	Report Name	Author
Traffic and transport	Fountain Head Gold Project – Traffic Impact Assessment (Appendix 12)	GHD Australia Ltd
	Fountain Head Gold Project – Traffic Management Plan (Appendix 13)	

The complete list of contributors to the EIS are listed in Appendix 14.

1.3.2.5 Spatial Boundaries

This report discusses the potential impacts associated with the Project in a range of spatial contexts, predominantly referring to the Project area within the Fountain Head tenements. Where appropriate, the report will also discuss aspects and impacts in relation to the local area of Pine Creek, regionally within the Northern Territory and on a national scale. The report will also, at times, refer to the study area, survey area or another specific spatial boundary applicable to a particular discipline and this will be shown clearly on Project figures for context.

1.4 Project History and Viability

1.4.1 Project Lease History

The Fountain Head leases are part of the Northern Territory Goldfields, a region that has been subject to extensive mining and exploration activity. The first mining boom in the broader region began when gold was first discovered circa 1871 during the construction of the Australian Overland Telegraph Line. Pine Creek became a busy mining town, with approximately 200 European and 4000 Chinese nationals working the goldfields.

The area has subsequently experienced a boom and bust economy that peaked in the 1880s, 1900s, 1930s, 1960s to 1970s (Jones, 1987), and the early 21st century. In addition to the township of Pine Creek, smaller settlements were also established in close proximity to the mines, including Brocks Creek, Bridge Creek, Hayes Creek, Burrundie, Mount Wells, Grove Hill, and Union Reef. While the region is known for gold, it has also been mined for a range of other minerals, including lead, tin, copper, silver and uranium (Donovan and Associates, 1995).

The Fountain Head mine operated intermittently between 1883 and 1951 and following a period of little activity a small open pit test pit was excavated by Dominion Mining in the 1990s. At the same time, Dominion worked the Glencoe and Yam Creek resources. Total recorded production from Fountain Head was 10,829 oz of gold, although a substantial proportion was from alluvial workings surrounding the mine.

Northern Gold acquired the leases in 2001 and then, in September 2005, GBS Gold International (GBS) announced that it intended to make an off-market takeover offer for Northern Gold. GBS mined the Fountain Head pit in 2008. GBS's mine plan (2007) for Fountain Head envisaged that some 666,000 tonnes of ore at 1.87 g/t with 39,884 oz. of contained gold would be extracted together with some 751,000 tonnes of waste. Waste rock was stored in a waste rock storage (WRS) constructed adjacent to the open pit, with ore stockpiled and transported by road to Union Reefs processing plant.

GBS were mining Fountain Head when they went into receivership in August 2008, which saw the site placed in care and maintenance. By this time, the WRS was enlarged along the edge of Fountain Head Lake, and since then, the pits (Fountain Head and Tally Ho) have flooded and are now adjoining over the central ramp.

Kirkland Lake Gold, formerly Newmarket Gold NT Holdings Pty Ltd (and Crocodile Gold Australia Pty Ltd prior) purchased the GBS leases in November 2009. The site has been in care and maintenance since that time, with past activity leaving the site highly disturbed.

1.4.2 Fountain Head Exploration Activity

1.4.2.1 Activity for the Year Ending February 2019

During the 2018 field season, exploration drilling was undertaken to determine additional gold resources at Fountain Head (PNX Metals, 2020a). The initial exploration at Fountain Head involved the use of 22 reverse circulation (RC) drill holes, three with diamond tails. The RC drills holes were drilled for 2,540 m and one diamond drill hole for 219 m to identify extensions to known mineralisation. Results from initial drilling indicated high-grade gold mineralisation along strike and down dip of the known mineralisation structures. These results indicated that mineralisation exists outside of the known zones and below historic mining (i.e., 60 m below surface).

New near-surface, high-grade gold was discovered to the northwest of the Fountain Head deposit, called the Banner prospect. A total of 10 RC holes were drilled and confirmed that the Banner prospect displays the same trend as the Tally Ho gold lode (1.5 km to the southeast). After successfully intersecting high-grade gold, another nine holes were drilled to target a high-grade intersection of 39.5 g/t Au. All drill holes returned significant gold mineralisation but failed to replicate the 39.5 g/t Au.

1.4.2.2 Activity for the Year Ending February 2020

A total of two additional RC drill programs were conducted in and around the existing deposits that involved 78 drill holes for 7,264 m. The programs infill existing drilling, extended mineralisation lodes beyond known occurrences and increased modern data density. Grades varied between drilling effort, ranging from 0.47 g/t Au to 45.51 g/t Au, but were still consistent with previous, high-grade results.

Two diamond drill holes were drilled down dip in the western part of Fountain Head for 138 m to obtain metallurgical samples for testing.

1.4.2.3 Activity for the Year Ending February 2021

Drilling

Two diamond holes were drilled in March 2020 for 336 m on the margins of the proposed open pit. They provided geotechnical information for input to mine design and captured new geological data from the south-eastern portion of the Tally Ho lode.

One hole intersected the southeastern end of the Tally Ho lode and geological logging identified occurrences of coarse visible gold from a down hole depth of 145 m to 188 m. Whole core

samples to include the visible gold zones were assayed and a number of sample repeats were taken.

Geotechnical logging during 2020 was prevented by the Northern Territory COVID-19 border closure and as a result, holes will need to be redrilled to obtain fresh core sample along with the remainder of the proposed geotechnical diamond drill holes.

Soil Sampling

A soil sampling program was undertaken across the historical alluvial mine coarse tailings to assess the potential for fine grained, low grade gold. A total 49 surface samples were taken. Assayed gold grades were found to be insufficient for further investigation.

Regional Exploration

PNX undertook an internal review of regional exploration options. Northeast trending regional structures were identified as potential offset structures to the mineralised lodes at Fountain Head and Tally Ho. A review of the drill hole data supported the regional interpretation. As a result of this, near mine targets representing potential offsets and extensions to the Fountain Head East and Tally Ho lodes were identified for follow up drilling.

1.4.2.4 Metallurgical Studies

Initial metallurgical testing was highly successful, with little reagent consumed in the process and excellent gold recovery. Using cyanide soluble (CN) gold, recoveries ranged from 89% to 97% with grades ranging from 0.24 g/t Au up to 24.05 g/t Au. These results were consistent with historical data from 1996, which also reported high CN soluble gold recoveries, predominantly in excess of 90%. Materials testing, including Crusher Work Index and Unconfirmed Compressive Strength testing, showed results indicative of ore with moderate strength, as expected.

PNX released a JORC 2012 mineral resource estimate (MRE) update on Fountain Head in June 2020, through independent mining consultants, CSA Global Pty Ltd. The MRE for Fountain Head and Tally Ho is 2.94 Mt at 1.7 g/t Au for 156,000 oz Au (PNX Metals, 2020b), shown in Table 1.5. The estimate was reported utilising a cut-off grade of >0.7 g/t Au which is consistent with the assumed open cut mining method.

Table 1.5 – Fountain Head and Tally Ho Mineral Resources by JORC Classification as at 16 June 2020

JORC Classification	Tonnage (Mt)	Au (g/t)	Ounces (Koz)
Tally Ho			
Indicated	0.94	2.0	59
Inferred	–	–	–
Total	0.94	2.0	59
Fountain Head			
Indicated	0.89	1.4	41
Inferred	1.11	1.6	56
Total	2.00	1.5	96
Total Fountain Head + Tally Ho			

JORC Classification	Tonnage (Mt)	Au (g/t)	Ounces (Koz)
Indicated	**1.83**	**1.7**	**100**
Inferred	**1.11**	**1.6**	**56**
Total	**2.94**	**1.7**	**156**

The update to the Fountain Head MRE (comprising the Fountain Head and Tally Ho deposits) is based on new geological information derived from analysis and interpretation of the most recent 2019 and 2020 diamond and RC drilling campaigns.

As a result of the outcomes of exploration activity, PNX has identified the Fountain Head Gold Project as the immediate priority, in order to generate early cashflow from the existing gold resources at this site.

1.4.3 Objectives

PNX's objective is to advance feasibility studies and approvals for the Fountain Head Project in order to generate early cashflow from the gold. The Project will add significant value to the Hayes Creek Project and improve the already robust case for its development. Opportunities also may exist for synergies between the two projects including tailings storage and processing options.

1.4.4 Benefits

The Project will provide economic benefits to the Federal and Northern Territory governments in the form of company taxes and royalties. The Project will also generate positive economic benefits through employment of the Project workforce and for suppliers, service providers and contractors. Personnel required for the mining and processing operations will first be sourced from the local areas of Pine Creek, Adelaide River and Darwin.

Whilst the Project has the potential to enable the development of other smaller deposits in the region, no assessment of these deposits is included in this EIS. Any future proposal to mine smaller deposits in the region and treat the ore at Fountain Head would be undertaken as part of a separate approval process.

2. Approvals and Regulatory Framework

2.1 Project Approvals Process

In the Northern Territory, environmental permitting of mining activities is regulated under the *Environmental Assessment Act 1982* (as in force 1 January 2013) and the *Mining Management Act 2001* (as in force 1 July 2015). The *Environmental Assessment Act* (*EA Act*) (and associated administrative procedures) is administered by the Department of Environment, Parks and Water Security (DEPWS), formerly Department of Environment and Natural Resources (DENR) and provides a framework for the assessment of the environmental effects of development proposals and for the protection of the environment. This Act and the environmental impact assessment process has been replaced by the *Environment Protection Act 2019* (*EP Act*) which commenced in June 2020. The NT EPA's assessment of the proposal was not completed prior to this time and transitional agreements have been established to allow for the environmental impact assessment to continue under the current *EA Act* with a modified process as defined in s. 296 of the *EP Act*.

The *Mining Management Act* is administered by the Department of Industry, Tourism and Trade (DITT) and provides the framework for the authorisation of mining activities, the management of mining sites, the protection of the environment on mining sites, the provision of economic and social benefits to communities affected by mining activities, and for related purposes.

The Project Notice of Intent (NOI) was submitted to the NT EPA on 20 December 2019 to determine the level of assessment required under the *EA Act*. On the 16 March 2020, the Statement of Reasons (SoR) were provided by the NT EPA, determining the Project would require assessment under the *EA Act* at the level of Environmental Impact Statement (EIS). The EIS (this document) has been prepared in accordance with the ToR issued by the NT EPA on 11 May 2020. Appendix 15 provides a list of the ToR requirements and where they have been addressed in the EIS.

In October 2020, PNX announced a change in the processing method from heap leach to carbon in pulp (CIP) processing. The NT EPA reviewed the transition arrangements according to the *EP Act* and advised that in accordance with section 296 of the *EP Act*, the proposal can continue to be assessed in accordance with the prior *EA Act* and the associated Environmental Assessment Administrative Procedures 1984 (EAAP). It was determined by ERIAS in consultation with the NT EPA that the Project change does not alter the environmental significance of the Project, and thereby the proposal can continue to be assessed under the existing Terms of Reference (ToR).

A summary of the key legislation relevant to the EIS and the Project's requirements under that legislation are provided in Table 2.1. Further detail is then provided in Sections 2.2 and 2.3.

Table 2.1 – Key Legislation Relevant to the Project

Legislation	Description	Permission Type
Northern Territory Legislation		
Environmental Assessment Act 1982; Environmental Assessment Administrative Procedures 1984	Ensures matters affecting the environment are adequately addressed	Preparation of an EIS (this document) in accordance with the Project ToR
Northern Territory Environment Protection Authority Act 2012	Details the objectives, functions and powers of the NT EPA	
Environmental Protection Act 2019	Replaces the environmental impact assessment process under the *EA Act* (June, 2020)	
Mining Management Act 2001	Authorisation under the Act is the key regulatory instrument used for approval and compliance monitoring of mining operations in the NT	Authorises the proposed mining operation under the Act
Pastoral Lands Act 1992	Applies to the clearing of native vegetation on pastoral land, and non-pastoral use of pastoral land (s. 86 of the Act)	*Mining Management Act* requirements supersede the *Pastoral Lands Act*. Approval not required under the *Pastoral Lands Act* (Section 2.2.5)
Planning Act 1999	Sets requirements for the appropriate planning of use and development of Northern Territory land	Not required (Section 2.2.5)
Crown Lands Act 1992	Enables the Minister for Lands and Planning to enter into development agreements and grant licences for developments on Crown Land	Not required (Section 2.2.5)
Water Act 1992	Provides for administration of water resources, including licenses to extract surface water and to discharge wastewater	Sewage effluent will be managed in storage tanks and disposed of offsite during construction and will be collected in subsurface septic tanks during operations, solids will be disposed at a licensed facility and wastewater will flow to a subsurface drainage field A license to discharge water under the *Water Act* will not be required as water is not proposed to be discharged off lease to water courses, such as rivers and streams
Waste Management and Pollution Control Act 1998	Requires licenses for certain activities	Not required (Section 2.2.7)
Territory Parks and Wildlife Conservation Act 1976	Establishes licenses to take or interfere with listed protected flora or fauna	Not required (Section 2.2.8)
Heritage Act 2011	Establishes a register of protected places to preserve the Northern Territory's natural and cultural heritage	Several archaeological places/objects have been identified as potentially requiring salvage. PNX will apply for

Legislation	Description	Permission Type
		permission for small-scale disturbance in accordance with the *Heritage Act* (Section 2.2.9)
Northern Territory Aboriginal Sacred Sites Act 1989	Provides location, recognition, description and protection of Aboriginal traditional sacred sites	PNX has engaged with the Aboriginal Areas Protection Authority (AAPA) and received an authority certificate for clearance under the *Northern Territory Aboriginal Sacred Sites Act* (Section 2.2.10) on 24 March 2021
Commonwealth Legislation		
Environment Protection and Biodiversity Conservation (EPBC) Act 1999	Requires assessment of developments that may have an effect on a matter of national environmental significance	An EPBC referral for the Hayes Creek Project which proposed to process ore from the Mt Bonnie and Iron Blow deposits was submitted on 25 February 2019. Following a period of public comment the Department of Agriculture, Water and the Environment (AWE) determined that the Project was not a controlled action, and did not require assessment under the *EPBC Act* (Section 2.3.1)
Aboriginal Land Rights (Northern Territory) Act 1976	Provides freehold ownership for certain lands to Aboriginal Land Trusts	Not required (Section 2.3.2)
Native Title Act 1993	Recognises the rights and interests of Indigenous people in Australia over land and water possessed under their traditional laws and customs	Not required (Section 2.3.2)

2.2 Key Northern Territory Legislation

2.2.1 Environmental Assessment Act and the Environmental Assessment Administrative Procedures

The environmental assessment process is administered under the *EA Act* taking into account the Environmental Assessment Administrative Procedures (EAAP). The *EA Act* ensures that each matter affecting the environment is examined and taken into account in relation to:

- Formulation of proposals.
- Carrying out of works and other projects.
- Negotiation, operation and enforcement of agreements and arrangements (including with authorities of the Commonwealth, the state and other territories).
- Making decisions and recommendations and incurring of expenditure.

2.2.2 Environment Protection Act 2019

As discussed in Section 2.1, the *EP Act* replaced the *EA Act* on the 28 June 2020. As a result, the Fountain Head Gold Project will be processed under a transitional arrangement received on the 12th of May 2020. The agreement states that the proposal will continue to be assessed under the *EA Act*, however the commencement of the *EP Act* will modify the timeframes and some public exhibition requirements in the assessment process that are specified in the EAAP. The assessment process for the Project is shown in Figure 2.1.

2.2.3 Northern Territory Environment Protection Authority Act 2012

The *NT EPA Act* details the objectives, functions and powers of the NT EPA, which includes determining the level of assessment required for proposals and providing advice to the Minister.

2.2.4 Mining Management Act 2001

The DITT oversees the approval and regulation of mining activities. The Fountain Head mining leases have been under care and maintenance since 2009. As such, no operational mining or processing activities have occurred since that time. Authorisation of the proposed mining operation outlined in this EIS is required under the *Mining Management Act*. To apply for authorisation, PNX will prepare a Mining Management Plan (MMP).

Authorisations for mining operations are granted by the Minister for Mines on the advice of DITT. For projects such as the Fountain Head Gold Project, that are assessed under the *EA Act*, the Minister may impose conditions relating to recommendations received from the NT EPA. Authorisations are granted following completion of the EIS assessment process. An authorisation is required before any activities can commence on the mining leases.

2.2.5 Pastoral Lands Act, Planning Act and Crown Lands Act 1992

The underlying tenure of the Project area is the Ban Ban Springs pastoral lease (PL) 1111, which is an active cattle station. The *Pastoral Land Act* applies to clearing of native vegetation on pastoral land, and non-pastoral use of pastoral land (s. 86 of the Act). The requirements of the *Mining Management Act* supersede those of the *Pastoral Land Ac*t for the Fountain Head Gold Project, and as such, formal approval from the NT Pastoral Land Board (within the DEPWS) is not required.

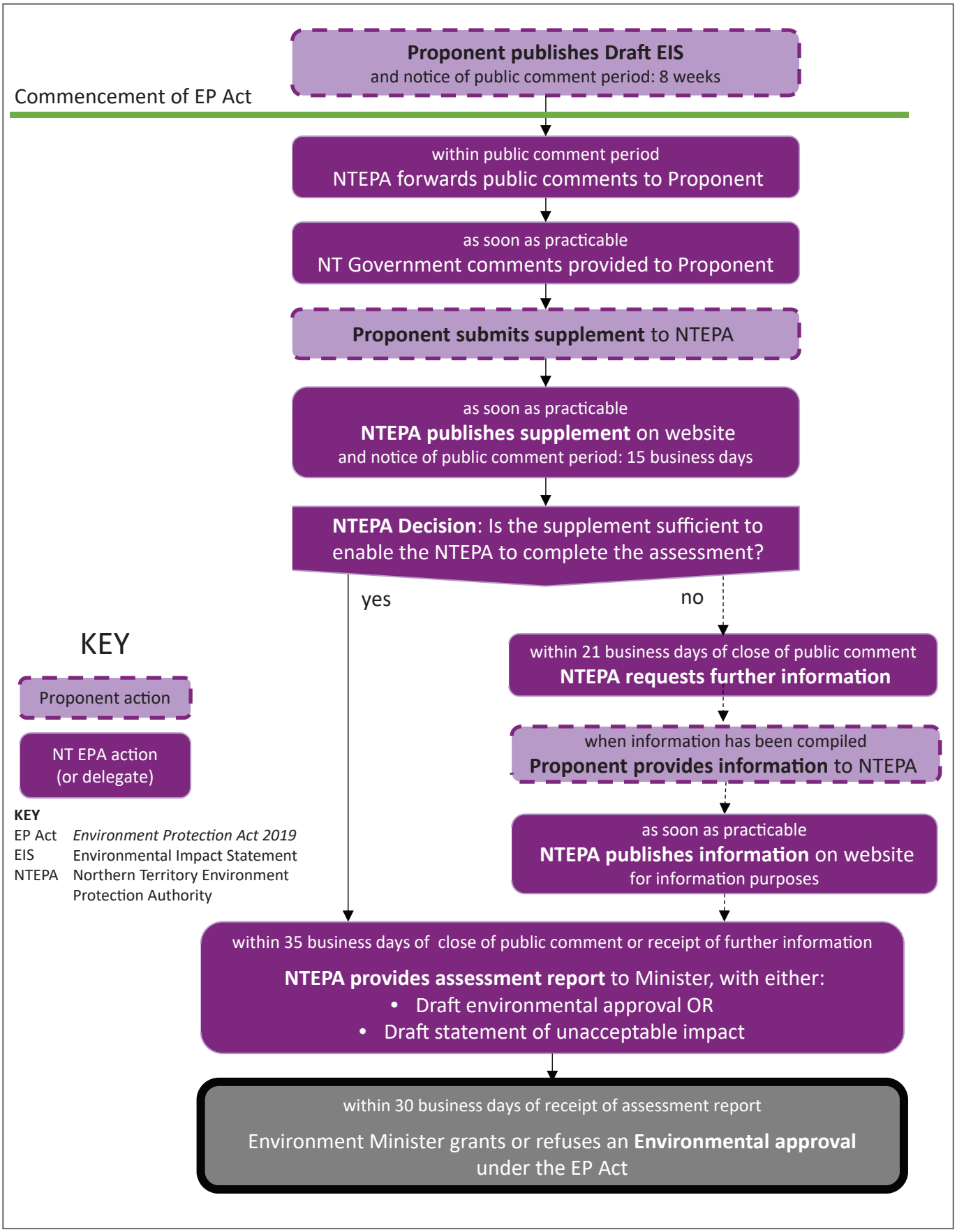
The *Planning Act* specifies requirements for the appropriate planning, use and development of Northern Territory land, however, it does not apply to land covered by the *Pastoral Land Act*. Similarly, while the *Crown Lands Act* (s. 24) enables the Minister for Lands and Planning to enter into development agreements and grant licences for developments on Crown Land, this does not apply to Crown Land that is under a pastoral lease.

The North Australia Railway easement passes directly to the south of the Project area and the Bonaparte Gas Pipeline (BGP) easement is adjacent to the Project area boundary on the south and passes through the mining lease on the east. The Amadeus Gas Pipeline easement is 2 km to the north and connects to the BGP (AEMC, 2020).

PROJECT IMPACT ASSESSMENT PROCESS FOLLOWING THE ENACTMENT OF THE *ENVIRONMENT PROTECTION ACT*

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 2.1



Source: NTEPA

2.2.6 Water Act 1992

2.2.6.1 Water Extraction

The Northern Territory *Water Act* and *Water Regulations* are administered by the DEPWS with assistance from the NT EPA. The *Water Act* provides for the administration of water resources in the Northern Territory, including the investigation, allocation, use, control, protection and management of surface water and groundwater resources.

The Act was amended in 2019 to fulfil a number of recommendations from the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, with a number of changes affecting mining projects as of July 2019. The key amendment in relation to this Project is that the extraction of surface water for mining activities now requires a licence under the Act, where it previously did not.

The definition of surface water under the Act does not apply to pits or dams because they are not considered to be waterways, and as such extraction from either of these sources on Ban Ban Springs Pastoral Station will not require a licence according to Project specific advice received in June 2019 from DEPWS.

No new groundwater bores are proposed to extract water for Project requirements. Drilling of a network of groundwater monitoring bores is proposed, to undertake measurements of water levels and water quality. A permit will be required to construct the monitoring bores, and the bores will be drilled in accordance with the conditions of the permit. The proposed network is discussed in the Project Water Management Plan (Appendix 16).

2.2.6.2 Discharge of Wastewater

In accordance with s. 7 of the *Water Act*, discharge of waste or wastewater to groundwater or waterways as a result of mining activities does not require a waste disposal or a waste discharge licence, provided that such waste or wastewater will be confined within the mining leases. If waste/wastewater with potential to pollute surface water or groundwater will not be confined to the leases, a license will be required.

PNX do not intend to discharge offsite and therefore do not plan on obtaining a discharge licence. All wastewater is planned to either be recycled e.g., through the process plant or retained on site within water storage areas such as the evaporation pond. Runoff (ANZECC/ARMCANZ (2000) compliant) from sediment dams around bunded hardstand areas and the IWL will be diverted to the Fountain Head Lake catchment or the evaporation pond catchment prior to release offsite.

Further, sewage from buildings (e.g., crib room or offices) will be collected in subsurface septic tanks. Solids will be removed and disposed of at a licensed facility, while wastewater will flow to a subsurface drainage field. Further detail on how sewage will be managed is detailed in Section 3.7.3.4.

2.2.7 Waste Management and Pollution Control Act 1998

The requirements of the *Waste Management and Pollution Control Act*, administered by the NT EPA, do not apply to the Project as the majority of waste disposal is not proposed on lease, with the only exception being grey water, which will be disposed within the mining lease area.

2.2.8 Territory Parks and Wildlife Conservation Act 1976

The *Territory Parks and Wildlife Conservation (TPWC) Act* and the Territory Parks and Wildlife Conservation By-Laws apply to listed threatened flora and fauna species that are protected within the Northern Territory. If a proposed project interferes with protected species, a Permit to Take or Interfere with Wildlife, issued under this Act, will be required. For the purposes of the Act, to 'interfere with' means to:

1 Harm, disturb, alter the behaviour of or otherwise affect the capacity of the animal or plant to perform its natural processes; or

2 Damage or destroy the habitat of an animal or plant.

No species listed under the *TPWC Act* were recorded during the 2017 and 2019 flora and fauna surveys undertaken by Low Ecological Services. The Merten's water monitor (vulnerable) was observed near the Fountain Head Lake during a routine site inspection. It is likely the monitor is opportunistically utilising the Fountain Head Lake, however seasonal water bodies are also located nearby, including a creek to the north of the Project area.

Nine species listed under the *TPWC Act* were identified as having a moderate to high likelihood of occurring in the Project area due to the presence of suitable habitat for these species. The Project area is highly degraded with areas of bare soil and a high density of weeds. The area is also adjacent to areas of suitable habitat and therefore the Project area is not considered significant habitat for threatened species (Section 7.7). Clearing activities are not expected to disturb any threatened species habitat, and no harm, disturbance or other interference with threatened species is anticipated, a 'Permit to Take or Interfere with Wildlife' is not expected to be required.

2.2.9 Heritage Act 2011

The *Heritage Act* provides a system for the identification, assessment, protection and conservation of the Northern Territory's natural and cultural heritage. The *Heritage Act* provides protection for any heritage places or objects (European or Aboriginal). Under the Act, if any archaeological places or objects are to be disturbed, permission must be sought for an approval (a work approval) to carry out work on a heritage place or object. An application can only be made with the consent of the owner of the place or object (the relevant Land Trust).

In Depth Archaeology undertook an archaeological assessment of the Project area in October 2019, the survey recorded six archaeological places and five archaeological objects, as defined under the *Heritage Act 2011*. Archaeological places will be avoided as far as practicable. Several archaeological places and objects have been identified as potentially requiring salvage in order to protect them from Project activity (Section 7.10), all other sites are either located outside of the proposed works or infrastructure is able to be repositioned to avoid disturbance. No interference to archaeological places or objects will be made without an archaeologist to lead the process of salvage in consultation with Traditional Owners and in accordance with the *Heritage Act*.

2.2.10 The Northern Territory Aboriginal Sacred Sites Act 1989

The *Northern Territory Aboriginal Sacred Sites (ASS) Act* establishes a system for the protection and registration of sacred sites, establishing a procedure for the avoidance of sacred sites in the development and use of land, and providing for entry onto sacred sites subject to conditions. To

obtain information regarding any known (registered/recorded) Aboriginal sacred sites in or near the Project area, a request for information from records must be submitted to the Aboriginal Areas Protection Authority (AAPA). If Aboriginal sacred site/s are found to be present on the Project site, works near these sites must be carried out in accordance with an authority certificate issued under the *ASS Act* subject to approval of the AAPA and applicable custodians.

There are currently no recorded sacred sites within the Project area, however, to protect intangible cultural heritage in accordance with the *ASS Act* PNX applied for clearance for the Project area. PNX were subsequently granted AAPA certification on 24 March 2021 (Appendix 17).

2.3 Commonwealth Legislation

2.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*, any project which is likely to have a significant impact on the environment must be referred to the Department of Agriculture, Water and the Environment (AWE) formerly the Department of Environment and Energy (DoEE) for assessment. More specifically, projects that have, or will have, the potential to have a significant impact on a matter of national environmental significance (MNES) must also be referred to the Department of AWE for assessment. Matters of national environmental significance that are relevant to the Fountain Head Gold Project include:

- World heritage properties.
- National heritage places.
- Commonwealth marine areas.
- Ramsar wetlands of international importance.
- Commonwealth-listed threatened species and ecological communities.
- Migratory species protected under international agreements.

In February 2019, PNX submitted a referral under the *EPBC Act* for the development of the Hayes Creek Project which included processing of ore on the Fountain Head leases and use of the Fountain Head open pit to place tailings. The Department of AWE after a period of public consultation determined that the proposed activity was not a controlled action and would not require approval under the *EPBC Act*. PNX has decided not to submit a referral for the Project on the basis that a controlled action is not expected as there are no additional matters to be considered that were not addressed in the Hayes Creek Project referral. The change in processing method to CIP is not expected to produce any additional impacts to MNES, therefore PNX are not considering submission of a new referral to address this change.

The Project area does not fall within any world heritage properties or national heritage places and it is not located within a Commonwealth marine area. There are also no wetlands of international importance located in the vicinity of the Project area.

2.3.2 Aboriginal Land Rights and Native Title

The Commonwealth *Aboriginal Land Rights (Northern Territory) Act 1976* provides for the granting of a fee simple estate i.e., freehold ownership, for certain lands to Aboriginal Land Trusts where a group of Aboriginal people can prove that they were the traditional owners of the land in question.

The Commonwealth *Native Title Act 1993* recognises the rights and interests of Indigenous people in Australia over land and water possessed under their traditional laws and customs (i.e., native title) and provides for Indigenous people to claim native title and a process for negotiation and compensation for the loss or impairment of their native title over an area of land or water.

As of May 2021, a search of the National Native Title Tribunal register identifies a native title claimant application (NTD6021/2001) for Ban Ban Springs which includes the Fountain Head Project area, however, no determination of the application has been made. There is no current Native Title underlying the Fountain Head leases.

2.4 Other Relevant Legislation

Other Territory and Commonwealth legislation that has been considered during the preparation of this EIS, and will be complied with during Project operations include:

- *Aboriginal Land Act* (as in force 28 August 2013).
- *Bushfires Management Act* (as in force 2 November 2016).
- *Dangerous Goods Act* (as in force 1 January 2012).
- *Mineral Royalty Act* (as in force 1 July 1982).
- *Mineral Titles Act* (as in force 7 November 2016).
- *Northern Territory Control of Roads Act* (as in force 1 January 2015).
- *Northern Territory Traffic Act* (as in force 1 July 2007).
- *Public and Environmental Health Act* (as in force 1 May 2016).
- *Soil Conservation and Land Utilisation Act* (as in force 1 May 2016).
- *Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act* (as in force 1 May 2016).
- *Traffic Act* (as in force 1 May 2016).
- *Weeds Management Act* (as in force 28 August 2013).
- *Waste Management and Pollution Control Act* (as in force at 1 May 2016).
- *Work Health and Safety (National Uniform Legislation) Act 2011*.

2.5 Non-Statutory Obligations

PNX will work closely with Project stakeholders and operate with the guidance of non-government organisations, including:

- Northern Land Council (NLC) – Daly and Katherine.
- Minerals Council of Australia – Northern Territory Division.
- Fire and Emergency Response Groups.
- Lease holders/managers – Ban Ban Springs Station.
- Nearby operators – Kirkland Lake Gold and Bacchus Resources.

3. Project Description

3.1 Project Overview

PNX proposes to recommence mining of the Fountain Head pit, gold will be extracted from the ore via a leaching circuit that includes carbon-in-pulp (CIP) tanks. The leaching process to a produce the gold doré will be referred to as CIP throughout the document. Dewatering of the Fountain Head void is required for mining to recommence. Mining can recommence before all the water has been removed from the pit and subsequently a staged approach to dewatering is proposed. Dewatering will need to be strictly scheduled and managed so that there are no mining and processing delays. Modelling shows that dewatering would need to commence approximately six months in advance for mining to begin as scheduled.

To facilitate dewatering prior to mining, environmental approvals for the Project will involve two processes:

- Dewatering of the Fountain Head pit (Phase 1), which was approved on 19 March 2021 under the *Mining Management Act*, via submission of the Fountain Head Tally Ho Mining Management Plan Amendment (see Chapter 1 for details).
- The remaining Project activities relating to construction, mining, processing, closure and rehabilitation (Phase 2) will be addressed by this EIS (01238D_1_v1). An activity breakdown is provided in Table 3.1 below.

Table 3.1 – Project Phases and Activities

Project Phase	Activity	Approval Process
Phase 1 – Dewatering	• Dewatering of existing open pit • Remediation and extension of existing water storage dam (evaporation pond) walls	Mining Management Plan Amendment
Phase 2 – Construction, Mining, Processing, Closure and Rehabilitation	• Expansion of existing open pit • Construction and progressive rehabilitation of the integrated waste landform (IWL) • Establishment of potentially acid-forming (PAF) waste rock stockpile (WRS) adjacent to the pit • Construction of crushing facilities and gold processing plant (CIP) • Construction of supporting infrastructure, i.e., workshops, power station, roads, offices • Ore and overburden excavation and handling • Loading and hauling of waste rock and ore • Operation of CIP plant and supporting infrastructure • Ongoing dewatering of the pit and evaporation pond • Final rehabilitation of the IWL • Placement of PAF waste rock into mined out pit • Removal of evaporation pond and reshape*	EIS

Project Phase	Activity	Approval Process
	• Removal of infrastructure, e.g., process plant, and reshaping and rehabilitation of disturbed areas • Implementation of closure monitoring program • Maintenance as required i.e., weeds, erosion control	

Note: * If not required by the landholder.

Further detail regarding the Phase 2 activities outlined in Table 3.1 is provided in Section 3.5.

An overview of the key Project components of the current Project and the original proposal in the Project NOI is provided in Table 3.2. The detailed description relating to these components is provided in the sections that follow.

Table 3.2 – Key Project Components

Project aspect	Description	Scope	Scope as Outlined in the Fountain Head Gold Project NOI
Material Volumes (tn)	Ore mined	2,722,400	Not provided
	Waste mined	17,754,300	
Schedule (years)	Life of mine	3.5	3
Project footprint of key components (ha)	Open pit	19.39	Not provided
	PAF stockpile	2.72	
	Integrated Waste Landform	55.40	
	Topsoil stockpiles	4.35	
	Evaporation pond	24.06	
	Process plant	15.81	
	ROM/crusher	11.19	
	Total area	239.42	
Pit depth (m)	Pit depth	160	140
Mining method	Open pit drill and blast		
Mining operations	Drilling	24 hours per day, 7 days per week	
	Blasting	Daylight hours only	
	Process plant	24 hours per day, 7 days per week	
Processing method	Carbon-in-pulp (CIP)	Heap leach	
Transport	Ore to be hauled/transported on site		
Traffic	Project-related vehicle trips per day	Construction: 52 Operations: 32	No provided
Energy use	Annual (GJ)	Construction: 96,923 Operations yr 1: 488,691 Operations yr 2: 488,489 Operations yr 3: 488,073 Operations yr 4: 203,171	No provided
	Equipment/machinery/vehicles	48,351	Not provided

Project aspect	Description	Scope	Scope as Outlined in the Fountain Head Gold Project NOI
Greenhouse gas emissions (tCO_2-e)	Operations – Diesel-fired power station	74,424	
	Land clearing	12,800	
	Total estimated maximum annual emissions	38,383	
	Portion of NT annual emissions	0.24%	
Water use and management	Sources:	Potable water from Fountain Head lake (if suitable) or water trucked to site. 27t/hr of non-potable water which will be sourced from the Fountain Head pit (predominantly) or evaporation pond	Total water use of 40,000 kL per month, potable water trucked to site, non-potable water from pit.
	Discharge requirements:	No offsite discharge	
Workforce	Construction	50	
	Operations	134	113
Closure and rehabilitation	Open pit	Remain as water storage, safety bund established	
	Integrated Waste Landform	Re-profiled to create a stable, non-polluting landform, rehabilitated using native species	
	Infrastructure	Removed from site	
	Rehabilitation	Disturbed areas returned to grazing pasture	
	Public safety	Abandonment bund and safety signage established	

The indicative Project timeline including all Project phases is shown in Figure 3.1. The dates provided in Figure 3.1 reflect the Project schedule at the time the EIS was drafted and are subject to change.

3.2 Historical Disturbance

Historical mining activities have resulted in significant disturbance to the landscape and surrounding environment in the Project area. Remnant disturbance and infrastructure from past Projects includes:

- Existing waste rock storage (WRS).
- Fountain Head Tally Ho open pit (now referred to as the Fountain Head pit).
- Existing dam.
- Fountain Head Lake.

- Roads and tracks.

Existing disturbance and infrastructure is shown in Figure 3.2.

Existing on-site environmental issues resulting from previous mining activity are managed by PNX under the Fountain Head Tally Ho Care and Maintenance Mining Management Plan and include:

- Land erosion.
- Weed infestation.
- Unrehabilitated WRS.
- Large areas of bare soil, with no rehabilitation.

3.2.1 Project Interaction with Pre-existing Site Conditions

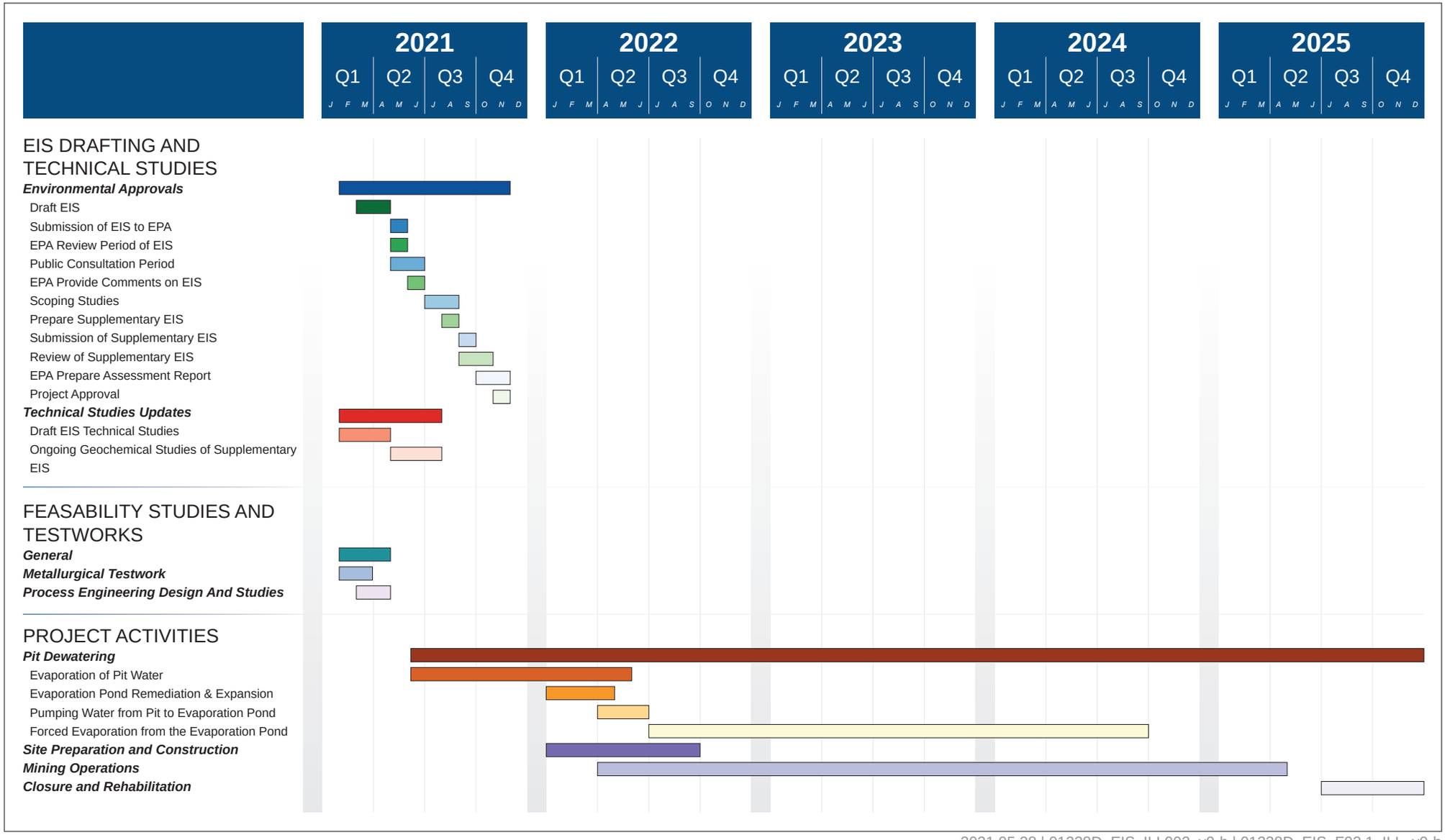
In selecting the location for Project infrastructure, PNX's preference has been to locate infrastructure on land that has already been disturbed, i.e., areas with little vegetation growth, thereby avoiding clearing areas of undisturbed vegetation so far as reasonably practicable.

The Project provides an opportunity for the controlled removal of weeds in the Project area, particularly dense infestations of Gamba grass located around existing infrastructure. A weed management plan will be implemented to manage the weeds on site to prevent further spread in the Project area.

PROJECT TIMELINE

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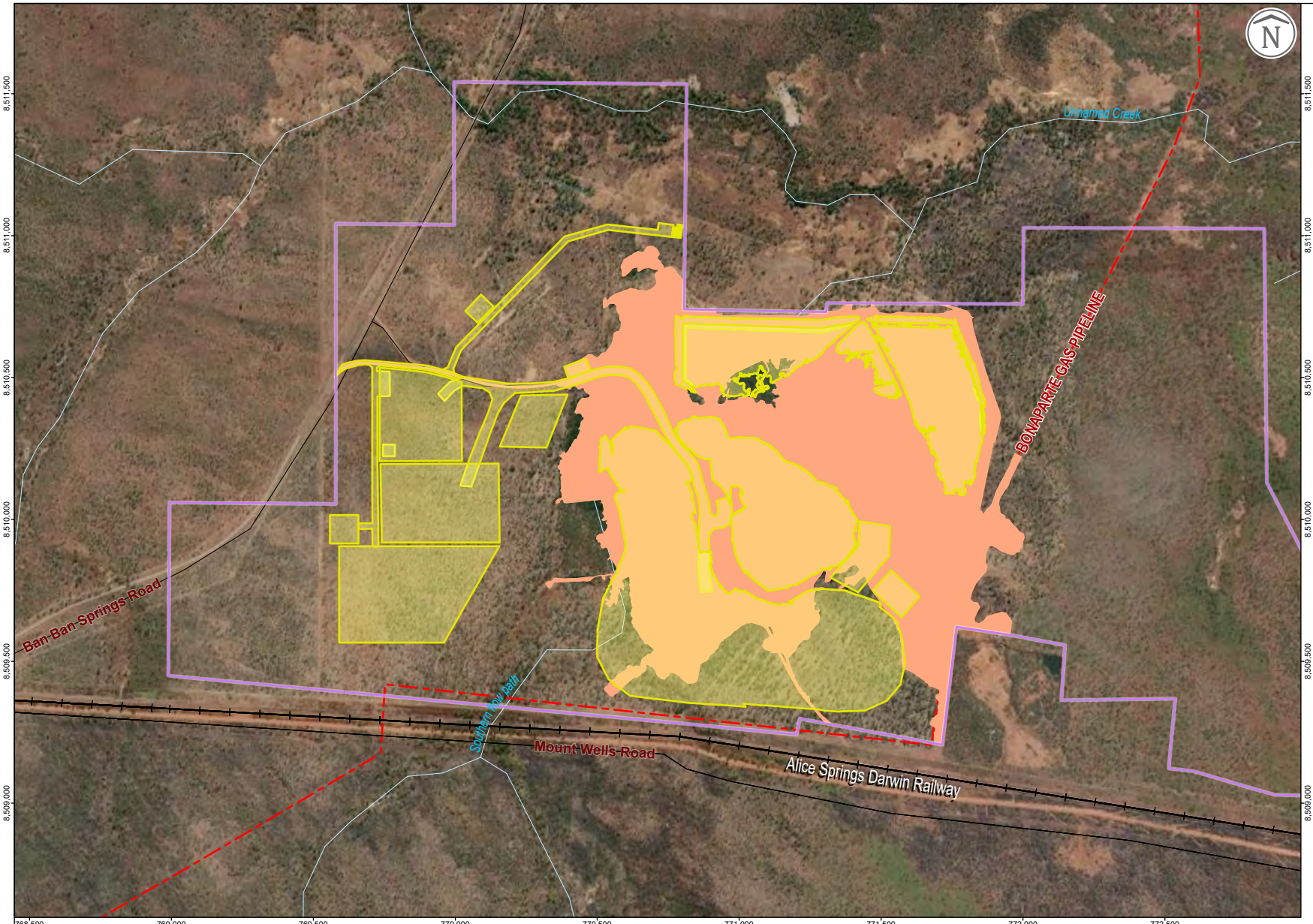
FIGURE 3.1



EXISTING AND NEW PROJECT DISTURBANCE

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FIGURE 3.2



- Road
- Railway
- Gas pipeline
- Watercourse
- Project area
- Existing Project disturbance
- New Project disturbance

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS013_v0-c

Figure Number: 01238D_EIS_F03.2_GIS_v0-c

ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

PNX plans to progressively rehabilitate areas of the site and will stockpile soil and cleared vegetation (if free of weeds) for later use in rehabilitation. Progressive rehabilitation will reduce the likelihood of further erosion in the Project area.

Sediment controls, e.g., sediment dams, will capture surface water runoff around the WRS and Project infrastructure (Section 7.5). The existing WRS has not been rehabilitated following previous mining activity. PNX plans to progressively rehabilitate the IWL as it is expanded during operations. Results of geochemical testing of the existing waste rock in the WRS show all samples as non–acid-forming (NAF), indicating that the waste rock tested is very unlikely to produce acid and metalliferous drainage (AMD) and is suitable for general construction (Section 3.5.7).

An existing dam will be converted to an evaporation pond following minor remediation to the existing wall and an extension to increase storage capacity. Remediation of the dam will improve structural integrity and the dam's potential use post closure for other land uses, e.g., water storage for stock water and/or irrigation.

3.2.2 Project Layout

The Project area is approximately 634 ha (Table 3.3). Existing disturbance affects 26% of the overall area and the new Project disturbance is estimated to be an additional 13%. The new Project footprint is shown in Figure 3.3.

Table 3.3 – Project Infrastructure and Land Clearing on the Project Area

Land Area	Area (ha)	% of Project area
Project area	634.58	-
Fountain Head Gold Project footprint area	155.0	24.4
Pre-existing disturbance, including pit lake and dam	164.7	26.0
Fountain Head Gold Project footprint within existing disturbance	74.5	11.7
Fountain Head Gold Project new land clearance	80.6	12.7

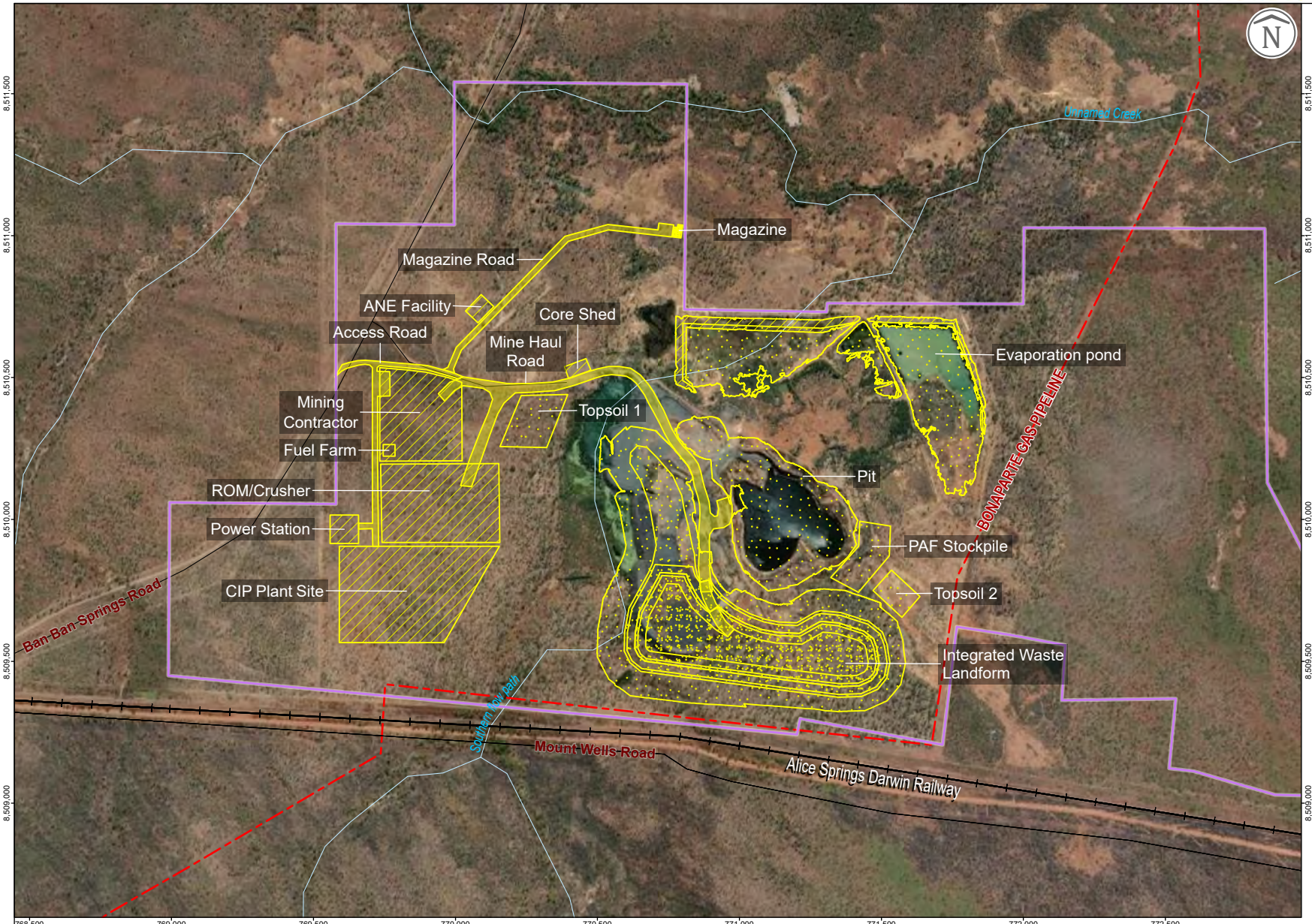
Additional land may be required for safety exclusion zones and vegetation buffers, but this land will not require the clearing of vegetation or be otherwise disturbed.

The Project design will be refined during detailed design, and the disturbance footprint may require to be updated with minor changes.

FOUNTAIN HEAD GOLD PROJECT LAYOUT

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FIGURE 3.3



Road
Railway
Gas pipeline
Watercourse
Project area

Infrastructure type

Area
Building
Road

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS003_v0-f

Figure Number: 01238D_EIS_F03.3_GIS_v0-f

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DATA SOURCES:
Project data from PNX Metals, 2021.
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3.3 Dewatering

Discharge of water from the mining lease is not proposed for the dewatering activity. Excess water will be managed by an evaporation dewatering process.

Activity relating to the extension and remediation of the dam wall and dewatering of the Fountain Head pit is subject to a separate approvals process, as discussed in Section 3.2. This section relates to ongoing dewatering of the pit during mining, and the evaporation of water in the evaporation pond, that will occur during Phase 2.

Once dewatering of the pit is completed via evaporation, pit water will be pumped to the remediated evaporation pond and the evaporators relocated to a central pad within the evaporation pond (Figure 3.4). This will ensure that wind drift in any direction will result in any unevaporated plume falling within the evaporation pond footprint. A typical setup of these evaporators is shown in Plate 3.1. The operation of the evaporators will be linked via telemetry to a weather station which will automatically shut down the evaporators when wind direction and/or wind speeds may result in the spray drifting outside of the pit and/or evaporation pond.

Plate 3.1 – Typical Evaporator System



Source: Minetek.

EVAPORATOR LOCATIONS

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FIGURE 3.4



Dam

Dam wall

Evaporator location

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS004_v0-d

Figure Number: 01238D_EIS_F03.4_GIS_v0-d

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DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

3.4 Early Works

Project early works will involve the following activities:

- Mobilisation of construction and land clearing equipment, e.g., earth moving equipment such as trucks and excavators.
- Land clearing for site access and mine haul roads, new mining and IWL areas, process plant, car park, core yard, run-of-mine (ROM) and other infrastructure. This site preparation will involve clearing and stockpiling topsoil and sub-soils for later use. Two topsoil stockpiles are proposed (see Figure 3.3). The stockpiles will be controlled for weeds and will be used for progressive rehabilitation such as rehabilitation of the IWL.
- Mobilisation of demountable infrastructure such as, fuel facilities, workshops, ammonium nitrate emulsion (ANE) facility, core shed, and ablution block.

3.5 Mining

3.5.1 Mine Production Schedule

The current mine production schedule has been designed to supply approximately 750,000 tpa of ore for processing. To achieve this production rate, and to ensure a constant ore supply, the pit will be mined in three main stages (shown in Figure 3.5). Further refinement of the mine production schedule is expected once a mining contractor and the specific mining equipment are selected and to accommodate any future modifications to the pit design related to the final geotechnical assessment.

The current pit design, which has a mine life of approximately 3.5 years, has the following material summary (Table 3.4)

Table 3.4 – Fountain Head Pit Materials

Material	Units	Quantity
Ore	Tonnes	2,722,400
Waste	Tonnes	17,754,300
Total materials	Tonnes	20,476,700
Strip ratio	Waste:Ore	6.5:1

3.5.2 Pit Design

The Project involves a cutback to the existing open pit void left following mining undertaken by GBS Gold, and an extension to the existing void in a northwards direction (Figure 3.6). The existing pit will be deepened by approximately 90 m.

The Fountain Head pit design parameters will be finalised pending additional geotechnical diamond core drilling. Pit parameters will be similar to Table 3.5 based on assessment of previous geotechnical reports and observations of wall performance of the existing pit.

Table 3.5 – Fountain Head Pit 2D2 and Haul Road Design Preliminary Parameters

Feature	Unit	
Surface RL (mine grid)	mRL	1,105
Final pit floor (mine grid)	mRL	945
Total pit depth	m	160
Pit length	m	750
Pit width	m	430
Road width – dual lane	m	30
Road width – single lane	m	17
Ramp gradient	V:H	1:8
Batter height	m	15
Berm width	m	5
Upper batter angle (weathered zone)	°	55-70
Lower batter angles (fresh rock)	°	70
Overall pit slope	°	~45

3.5.3 Existing Waste Rock Storage

The existing WRS, located to the west of the pit, was constructed during the last phase of mining by GBS Gold from 2007 to 2008 (see Figure 3.6). No rehabilitation of the WRS has occurred and while batters are at the angle of repose (Plate 3.2), the WRS is generally stable and some revegetation, particularly where oxide waste rock has been placed, has occurred. Geochemical testing of the existing waste rock in the WRS show all samples as NAF. The waste rock is suitable for construction of the haul roads, process plant, workshops and laydown areas. Some of this rock may also be crushed and screened during site establishment for blast hole stemming and aggregate for concrete. Further detail on the geochemical characterisation of the existing waste rock is discussed in Section 3.5.7.

Plate 3.2 – Existing Fountain Head Waste Rock Storage

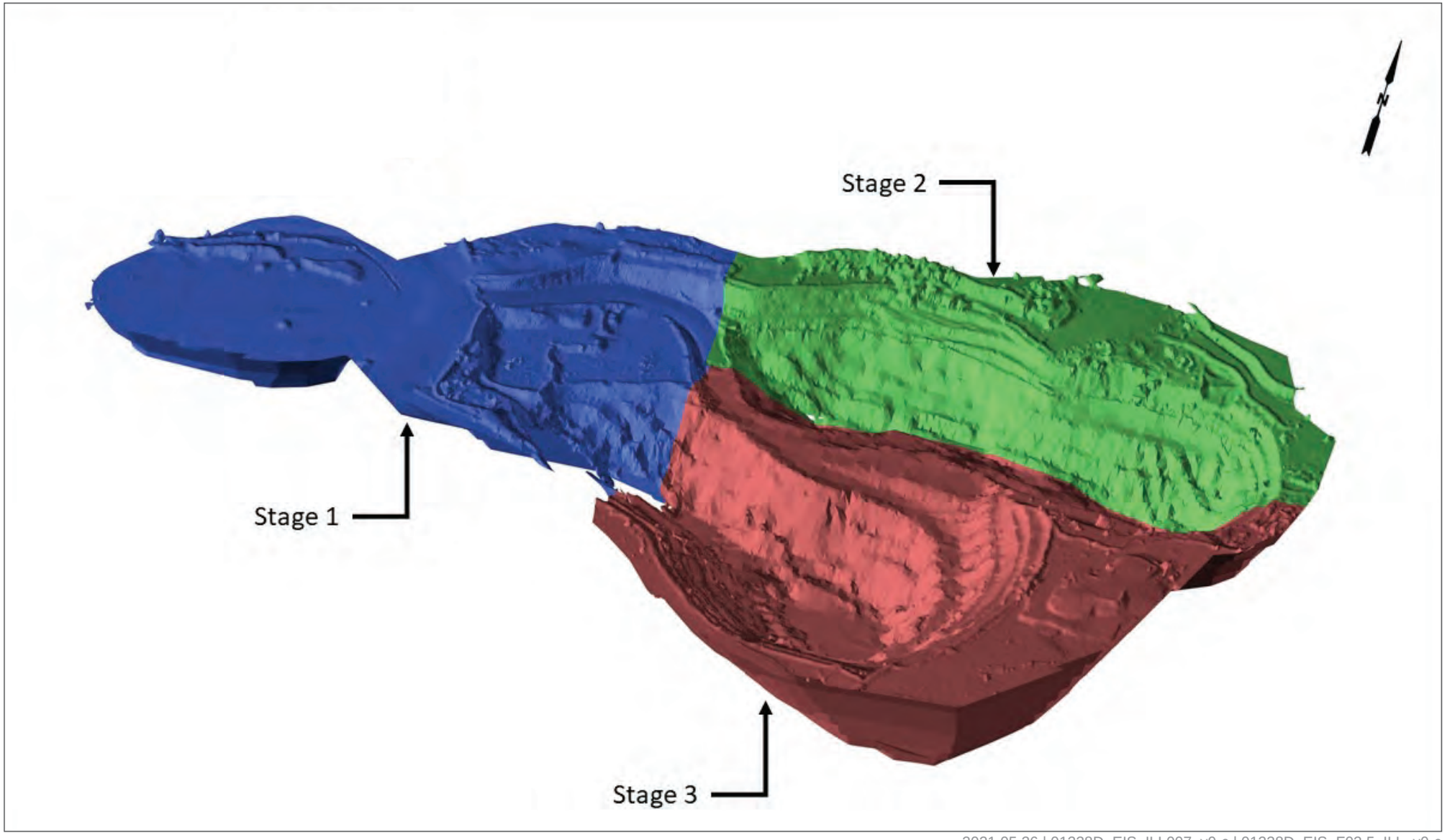


Source: PNX Metals.

STAGES OF THE FOUNTAIN HEAD PIT DEVELOPMENT

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FIGURE 3.5



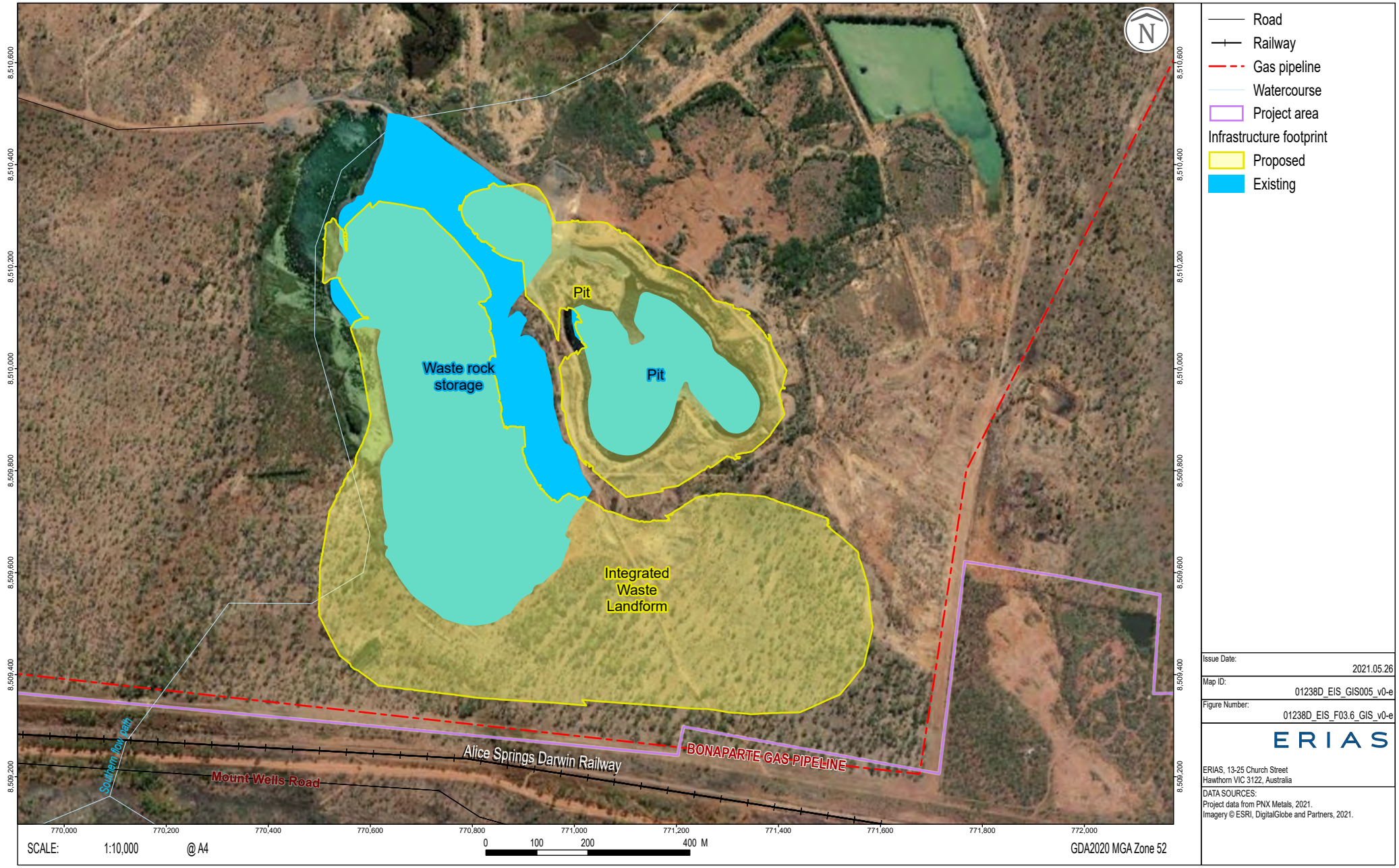
PROPOSED FOUNTAIN HEAD PIT AND IWL IN COMPARISON TO EXISTING PIT AND WRS

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FIGURE 3.6

PNX METALS

ERIAS



Road
Railway
Gas pipeline
Watercourse
Project area

Infrastructure footprint

Proposed
Existing

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS005_v0-e

Figure Number: 01238D_EIS_F03.6_GIS_v0-e

ERIAS

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Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
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The existing WRS encroaches into the proposed pit extension and therefore a section of the WRS will need to be relocated (refer Figure 3.6). Following removal of a section of the existing WRS there will be a minimum of 40 m from the pit crest to the WRS

3.5.4 Mining Equipment

The mining equipment will not be finalised until further technical studies are completed and contracts are awarded for the mining, crushing and screening operations. Due to the size of the operation an experienced earthmoving contractor will be engaged to undertake mining and haulage of waste rock and ore. It is expected that the mining equipment will be a combination of readily available new and used fit-for-purpose equipment. The type and quantities of mining equipment required is outlined in Table 3.6.

Table 3.6 – Mining and Processing Equipment with Ancillaries

Type	Size	No. Units
Excavator	125 – 200-t class	1
Excavator	30-t class	1
Trucks	90 – 100-t class	6
Dozer	50-t class	2
Grader	4.3-m Moldboard	1
Water cart	80 kL	1
Drill	Track mounted top hammer	2
MMU	Open pit unit	1
Stemming loader	3-m^3 class	1
Crusher loader	6.5-m^3 class	1
Fire tender	TBD	1
Workshop truck	TBD	1
Service truck	TBD	1
Boiler makers truck	TBD	2
Light vehicles	Various	12
Lighting plants	5 Head LED	10
Bus	26 seat coach (TBD)	1
Crane	25 t	1
Forklift	TBD	1
Tyre handler	TBD	1
Telehandler	TBD	1
Skid steer loaders	TBD	2

TBD = to be determined.

3.5.5 Blasting and Ore Delineation

3.5.5.1 Blasting

The majority of the material to be mined from the pit will require blasting. Limited volumes of free digging oxide materials are located on the surface. Rock fragmentation will be important to ensure productive throughput in the crushing circuit. It is more productive and cost efficient to correctly blast the rock in the pit than to perform additional crushing.

Blast holes will be drilled using conventional track-mounted, top hammer, mobile, drill rigs that are capable of drilling holes with a diameter 89 to 127 mm. Approximately 540 holes will be drilled per blast at depths that vary between from 2 m to over 10 m. The track mounted, top hammer drills have the added safety advantage of being able to be positioned back from the exposed edges of the Fountain Head pit cutback. The average area to be covered per blast will be approximately 7,500 m^2 and it is estimated approximately 65 blasts will be undertaken per year of operation.

It is expected that due to the relatively high water table in the region, the majority of the blast holes will be wet requiring water resistant emulsion explosives. The drill holes will be charged with bulk explosives, using ammonium nitrate & fuel oil (ANFO) in dry holes and bulk water-resistant emulsions will be used in wet holes. Both these products can be mixed in the pit using a subcontracted dedicated explosive mobile manufacturing unit (MMU). The Project is expected to use approximately 1,500 t of explosives per year of operation.

The proximity of sensitive receptors will be an important consideration during blasting. The buried high-pressure Bonaparte Gas Pipeline (BGP) is located within close proximity to the pit crest; at the closest point the pipeline is 370 m from the pit crest to the east and 480 m to the south. PNX has been consulting with Australian Pipeline Group (APA), the owners of the pipeline, and before mining and blasting can take place, a joint safety management study (SMS) involving a risk assessment will be conducted to determine allowable ground vibration limits that will be enforced to ensure there is no disruption to the flow of gas.

Approximately 540 m to the south of the operation is the Alice Springs Darwin railway line. This railway line has intermittent passenger and freight services which can pass through at any time, day or night. Therefore, the operation will have a zero-ejection policy for fly rock leaving the pit area to avoid any incidents with trains or other site infrastructure.

The restrictions on ground vibration and rock ejection are all achievable via professional drill and blast design and execution. Blasting will take place in daylight hours only and preferably during meal or shift breaks.

3.5.5.2 Ore Delineation

The blast holes will be sampled for grade control (GC) and transported to an off-site laboratory for gold (Au) assaying. The laboratory will either be in Pine Creek or Darwin or a combination of both.

Lines will be marked on the blasted rock delineating the ore zone to identify ore and waste based on the GC results. The waste rock will then be excavated and hauled to the IWL, and the ore will be hauled to the dedicated ROM pad for stockpiling and subsequent processing.

3.5.6 Mining and Haulage

Ore and waste mining will occur 24 hrs/day, 365 days per annum, subject to inclement weather conditions and equipment availability only. Mining will be based on conventional drill and blast mining techniques using excavators and 90 t off-highway haul trucks.

Laboratory and geological assessment will be conducted as the pit progresses to identify any waste rock with the potential to form acid mine drainage while stored in the IWL. Any such waste will be excavated and hauled separately to allow its placement in the dedicated PAF stockpile for dozing back into the pit void at the end of the mine life.

3.5.7 Waste Rock Characterisation

3.5.7.1 Overview

Geochemical testing of waste rock was commissioned to gain an understanding of the geochemical properties and to provide information on the leaching characteristics of various metals and other elements of potential concern. The geochemical properties are also used to determine the volumes of PAF waste. This determined whether waste rock material is currently being managed appropriately, whether it can be used for construction, and how to appropriately store and manage waste rock when mining recommences.

Previous geochemical testing of waste rock (Appendix 6), suggested Total Sulphur (S) content may be a suitable parameter to use for estimating the volume of PAF rock that will be excavated from the expanded Fountain Head pit. The original testing included 111 samples with Total S assay values, which was considered too small a data set to provide an estimate of likely PAF rock volume. Consequently, a recommendation was made that more extensive assaying should be undertaken to provide a larger data set of Total S assay results of waste rock and ore from Fountain Head.

Following this recommendation, pulp samples selected from 32 RC drill holes and 1 DD hole around the current Fountain Head pit were provided for analysis. Samples were selected with approximately 10 m gap between samples through the oxide/transition zones and approximately 5 m gap in fresh rock. A total of 551 samples were assayed from the 33 holes to characterise the following material:

- Existing oxidised waste rock in the WRS.
- Waste rock that will be removed from the pit during mining (oxidised and fresh rock).

The 551 samples represent just over 680 m of rock of which about 85% is intercepted waste rock, with the remainder representing ore. Just under 80% of the samples were from fresh rock with around 14% from oxide and 8% from transitional rock. Approximately one third of the samples were obtained from within the pit shell for the proposed expanded Fountain Head pit, with the remaining two thirds of the samples primarily from deeper fresh rock outside the pit shell. Characteristics of the samples assayed are shown in Table 3.7.

Table 3.7 – Characteristics of Samples Assayed for Total S – All Samples

Sample Type	Total Interval Length of Samples Represented by Sample Type (m)	Relative Amount of Sample Represented by Sample Type (%)
Type		
Waste	573.5	84.2
Ore	101.7	15.8
Total	681.2	100
Weathering		
Oxide	98	14.4
Transition	56	8.2
Fresh	527.2	77.4
Total	681.2	100
Location		
Within Current Expanded Pit Shell	215.30	31.6
Outside Current Expanded Pit Shell	465.9	68.4
Total	681.2	100

3.5.7.2 Acid Rock Drainage Classifications

Due to the relatively low acid neutralising capacity (ANC) and poor reactivity of neutralising materials in waste rock at Fountain Head, criteria based on Total S were selected as the best potential option for routine classification of acid rock drainage (ARD) rock types. Sulphur distributions were split according to ARD classification as non-acid forming (NAF), potentially acid forming – low capacity (PAF-LC) or PAF. The results show that NAF samples can be differentiated from PAF/PAF-LC samples by applying a Total S cut-off of 0.2% S, with 95% of samples classified NAF having a Total S value of 0.2% or less, and all PAF samples and 60% of PAF-LC samples having a Total S value of greater than 0.2% S. Further differentiation between PAF and PAF-LC materials can be achieved using a Total S cut-off of 0.4%, with 95% of PAF samples having a Total S above 0.4%, although around 25% of PAF-LC samples also contained more than 0.4% Total S.

Using the Total S criteria explained above and shown in Table 3.8, samples from the original set of 111 samples were classified as either PAF, PAF-LC or NAF. These classifications were then compared with classifications based on geochemical test results. The results are summarised in Table 3.9 below. Using Total S assay results to classify the samples as either PAF, PAF-LC or NAF, gave agreement with the corresponding classifications made using geochemical test results for nearly 90% of the samples. A further 8% of samples were given a conservative classification (PAF vs PAF-LC or PAF-LC vs NAF) when Total S was used instead of the full geochemical test results to provide the ARD classification. Only 5% of samples were given a lower-risk ARD classification (PAF-LC vs PAF or NAF vs PAF-LC) when Total S was used instead of the full geochemical test results to provide the ARD classification.

These results suggest that Total S assay results can be used with a reasonable degree of confidence to estimate the amount of higher risk waste rock which will be excavated from the pit during mining, given sufficient Total S data is available.

Table 3.8 – Criteria Based on Total S to classify ARD Types

ARD Classification Based on Total S	Total S
PAF	≥0.4%
PAF-LC	0.2≤ Total S <0.4%
NAF	<0.2%

Table 3.9 – Acid Forming Characteristics of Rock Samples

ARD Classification Based on Geochemical Testing	ARD Classification Based on Total S	Relative Number of Samples (%)
PAF	PAF-LC	1%
PAF-LC	PAF	3%
PAF-LC	NAF	4%
NAF	PAF-LC	5%
Geochemical Testing and Total S give the same ARD classification		87%

3.5.7.3 Characterisation

Oxide/Transitional Samples

Total S values for oxidised waste rock were very low with all samples from within the proposed expanded pit returning a Total S assay of below 0.2%. When all the oxide/transitional waste rock samples were included in the data set, over 95% of samples gave a Total S content below 0.2%, with no samples containing more than 0.4% S. All ore samples tested from within the oxide/transitional zones were inside the current pit design. These samples all had a Total S content of below 0.01%, although only five samples were included in this set.

Results suggest that there is likely to be very little waste rock (represented by the samples tested) excavated during expansion of the Fountain Head pit during the proposed mining operation which will potentially produce low pH drainage, with all waste rock samples classified as NAF.

If the oxidised waste rock sample set is expanded to include samples outside the current pit design, 98% of the sampled waste rock interval is classified as NAF, with 2% PAF-LC and no PAF samples. Based on the sample set analysed, results suggest that oxidised and transitional waste rock can be considered NAF and therefore unlikely to produce low pH drainage during surface storage.

Only five ore samples were tested from within the oxide/transitional rock zones at Fountain Head, with ore generally hosted within fresh rock. All ore samples hosted within oxidised rock were classified as NAF. Results suggest that, like waste rock, ore samples hosted within oxidised rock can be considered NAF. Consequently, tailings generated from this ore type would be unlikely to produce low pH drainage during surface storage. However, this sample type is not overly represented by the current sample set and may not be particularly illustrative.

Fresh Rock Samples

Total S values for fresh ore samples were generally higher than in fresh waste rock samples, with only 5% of fresh waste rock samples from within the proposed expanded pit returning a Total S assay of above 0.2% (cf. ≈40% of fresh ore samples with Total S >0.2%). When the deeper fresh waste rock and ore samples were included in the data sets, the percentage of fresh waste rock samples with a Total S content above 0.2% increased to around 10%, with around 50% of ore samples giving a Total S content above 0.2%.

Results show that around 95% of fresh waste rock sampled from within the proposed expanded Fountain Head pit classified as NAF, with most of the remaining samples classifying as PAF-LC (4%). Only a very small portion (1%) of the fresh waste rock samples gave a PAF classification. When the deeper fresh rock samples were included in the analysis, the number of samples classified as NAF decreased to around 90%, but only 2% classified as PAF (8% PAF-LC). These results suggest the volume of PAF fresh waste rock (represented by the current sample set) removed from the Fountain Head pit during mining would form a relatively low proportion of the total fresh waste.

The number of fresh ore samples from within the proposed pit classified as NAF was around 60%, with the majority of the remaining fresh ore samples classifying as PAF-LC and only 3% PAF. These results suggest that ore stockpiled during mining would be unlikely to produce significant amounts of low pH drainage during operations. However, tailings produced from processing of the fresh ore and any long term fresh low-grade stockpiles may have a risk of low pH drainage upon exposure to oxygen, although relatively low capacity. Note however, previous testing of tailings samples did indicate the possibility of drainage from cyanide leached ore may contain elevated arsenic and this is currently being investigated further (see section below).

When ore samples from deeper fresh rock were included in the analysis, the number of samples classifying as PAF increased to around 20%, with only just over half of the samples classified as NAF. These results indicate that should the pit design be expanded to capture deeper ore, the tailings produced from processing may have increased risk of low pH seepage during surface storage.

Quality of Drainage from Mined and Oxidised Waste Rock

In addition to the testing summarised above, water and peroxide extractions were conducted on selected samples to understand the likely quality of drainage from mined and oxidised waste rock. The results are summarised in Table 3.10.

Table 3.10 – Leaching Characteristics of Waste Rock

Analysis	Waste Rock
Water extraction	• Produced circum-neutral to mildly alkaline solutions with low salinity. Metal concentrations in water extracts were also very low to non-detectable • Leachates, in general, will be of reasonable quality. However, segregation of the PAF waste rock using a total S value of 0.2% may improve leachate quality for the majority of fresh waste rock containing <0.2%S
Peroxide leachates	• Iron, copper, cobalt, nickel and arsenic concentrations in peroxide leachates correlated with total S content of the waste rock samples, indicating that segregation of samples with significant sulphur content is likely to reduce the concentration of these heavy metals/metalloids in drainage from oxidised waste rock in the WRS • Drainage from oxidised waste rock containing more than 0.2% sulphur may contain substantial concentrations of aluminium, cobalt, manganese, nickel, lead, zinc and waste rock with total S concentrations above this value should be managed to minimise oxidation and release of heavy metals

These results suggest that drainage from oxidised waste rock containing more than 0.2% sulphur may contain substantial concentrations of a number of metals and should be managed to minimise oxidation and release of heavy metals (see Section 3.7.1.1 for discussion on further geochemical investigations).

3.5.7.3 Estimation of PAF Rock Volumes

Using the percentage of each ARD rock type based on Total S assay results in the volumes of NAF, PAF-LC and PAF waste rock and ore being estimated based on the volumes of waste rock and ore to be mined under the current mine plan. This was only done for fresh waste rock and ore samples, as the analysis of Total S data from oxide/transitional waste rock and ore suggest that these materials can be considered NAF.

Volumes (and masses) of both oxidised (oxide + transitional) and fresh waste rock and ore to be mined from the proposed expanded Fountain Head pit are shown in Table 3.11. The estimates show only around 60,000 m^3 (150,000 t) of PAF waste rock and 20,000 m^3 (70,000 t) of PAF ore will be mined. The total amount of PAF and PAF-LC waste rock is estimated at around 280,000 m^3.

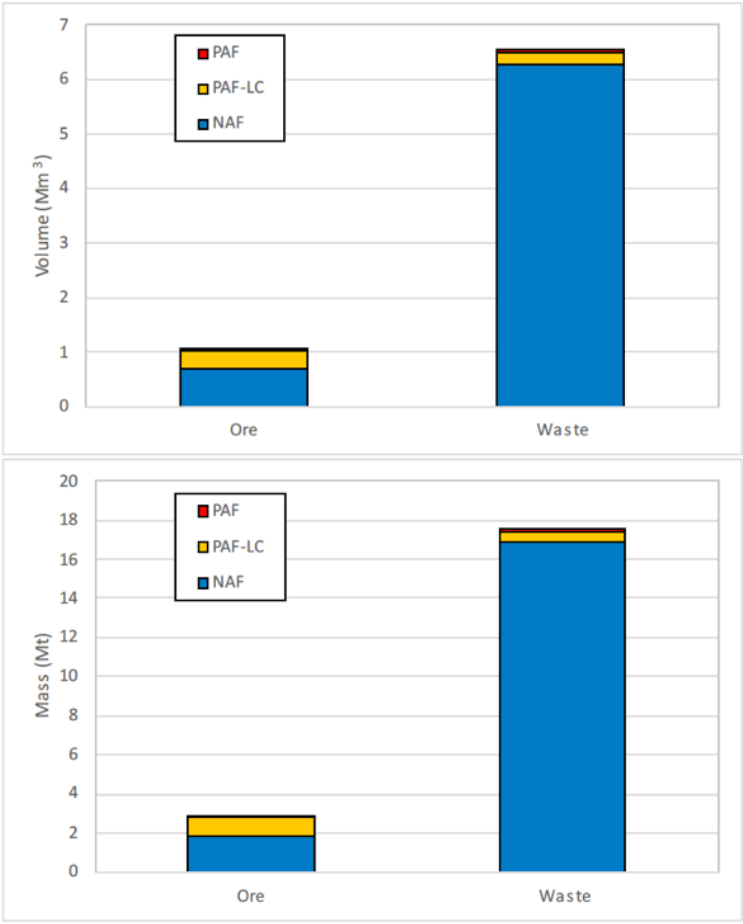
Figure 3.7 shows estimated volumes (and masses) of all waste rock and ore to be mined during the proposed expansion of the Fountain Head pit. This figure includes oxide/transitional material which were assumed to all classify as NAF. Results suggest that a substantial portion (≈95%) of waste rock will be NAF, with about two thirds of the ore mined also NAF.

It should be noted that the estimated volumes shown in Table 3.10 were based on a limited number of samples and assume these samples represent the distribution of sulphur across the entire rock assemblage to be mined.

Table 3.11 – Estimated Volumes of Fresh Waste Rock and Ore According to ARD Class

ARD Class	Relative Amount	Volume (Mm^3)	Mass (Mt)
Fresh Ore			
NAF	59.3%	0.56	1.52
PAF-LC	38.1%	0.36	0.98
PAF	2.5%	0.02	0.07
Total	100%	0.94	2.57
Fresh Waste			
NAF	94.4%	4.62	12.62
PAF-LC	4.5%	0.22	0.60
PAF	1.1%	0.06	0.15
Total	100%	4.90	13.38

Figure 3.7 – Estimates of Total Waste Rock and Ore Volumes (Top Graph) and Masses (Bottom Graph) as a Function of ARD Classification



3.6 Ore Processing

3.6.1 Process Plant

The construction of the gold processing plant will take approximately ten months with major components being manufactured off site. The gold bearing ore from mining will be stockpiled on the ROM at a rate of 750,000 tpa. The process plant will treat the ore by the well-known CIP method used in Australia and worldwide. The layout and general arrangement of the process facilities are shown in Figure 3.8. The major components of the plant (crushing, grinding and leaching circuits, gold recovery, cyanide detoxification circuit, reagents store, plant infrastructure services, laboratory and offices) are positioned to be accessible for operation and maintenance. The overall process flow chart is provided in Figure 3.9.

The plant will operate 24 hours a day, 365 days per year maintaining a daily throughput of 2,280 t/day with an expected plant availability of approximately 90%. The crushing facility is designed to operate up to 750,000 t/yr with a preference for dayshift only crushing.

A summary of the key process design criteria inputs are listed in Table 3.12.

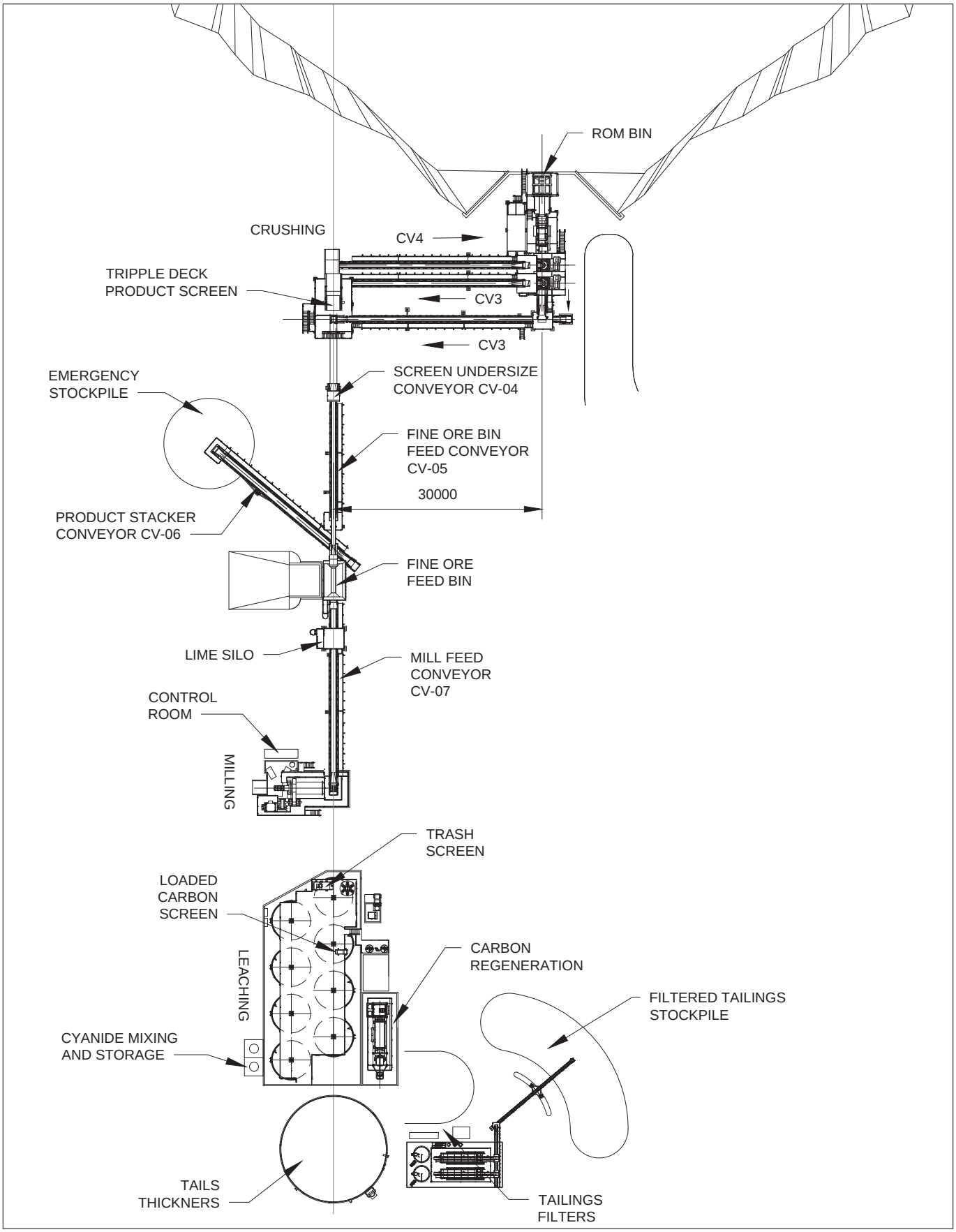
Table 3.12 – Fountain Head Process Design Summary

Design Basis	Fountain Head Design	Unit
Annual throughput	750,000	tpa
Hourly throughput	95	tph
Operational availability	90	%
Crushing and grinding work index range	8 to 18	kWhr/t
CIP head grade	1.23	g/t Au
Plant feed ounces	29,700	oz/annum
Gold recovery	90 to 95	%
Recovered ounces	28,200	oz/annum
Gold production	77	oz/day
PLS feed rate	143	m^3/hr
PLS AVG feed grade	1.0	g/L
Carbon loaded grade	9,000	g/t
Cyanide consumption rate	1.73	kg/t
Cyanide usage (leaching)	1,328	tpa
Lime usage	1,575	tpa

PROCESS LAYOUT

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 3.8

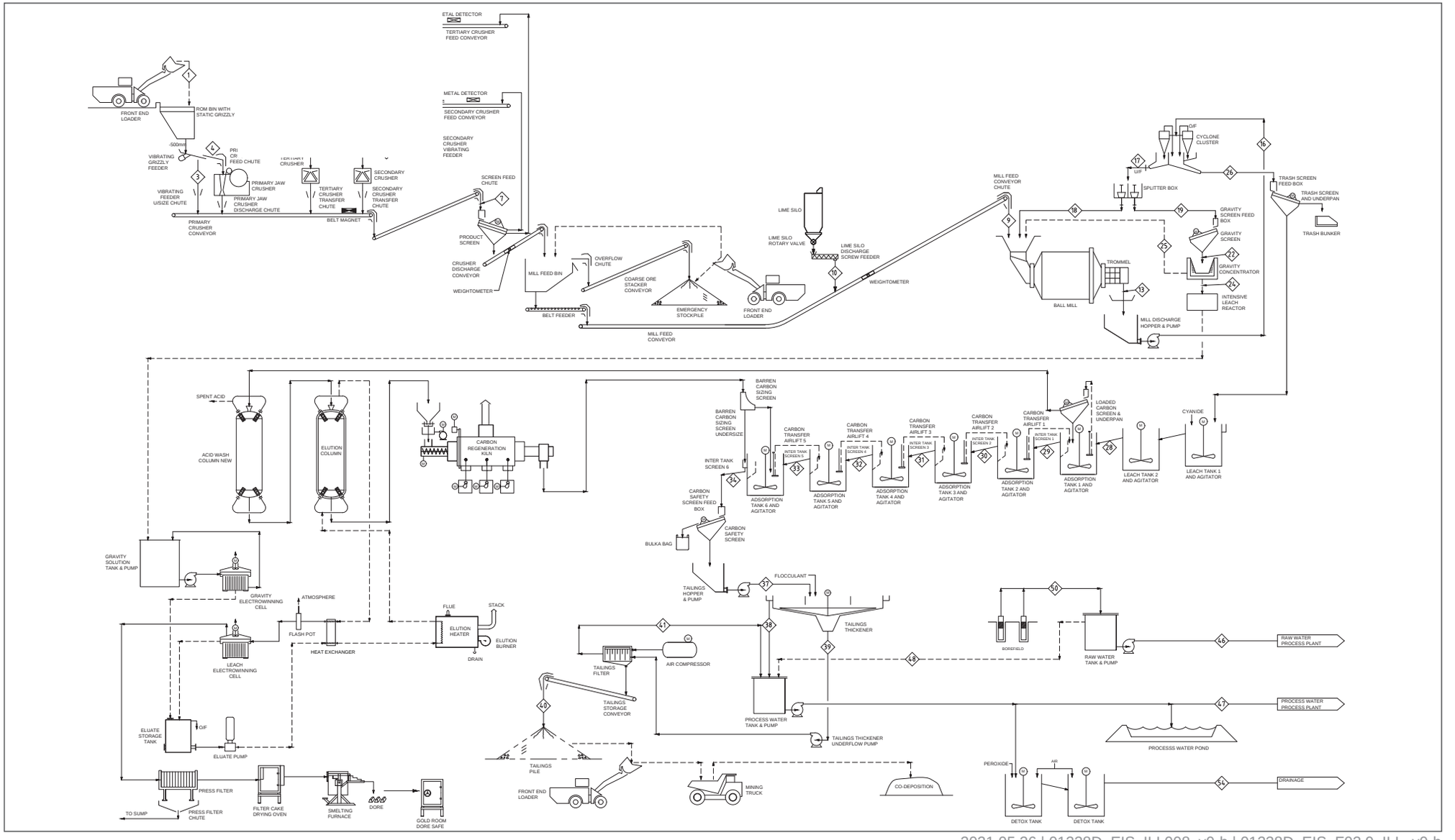


Source: COMO Engineers

PROCESS FLOW CHART

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 3.9



3.6.2 Process Description

3.6.2.1 ROM

Ore will be delivered to the ROM pad by trucks directly from the mine. Low grade ore will be stockpiled and used for blending or to make up production shortfalls. Any low grade ore remaining at the end of the mine life will be processed.

3.6.2.2 Crushing and Screening

A mobile crusher located on the ROM pad will crush and screen the ore prior to being fed into the ball mill. All pre-crushed ore will be transported to the ROM bin by a front-end loader from where it is directed into the primary crusher. Crushed material will be directed through secondary, and tertiary crushers if necessary, until correctly sized at 100% passing 12 mm. The crushed ore will be conveyed to the grinding circuit.

3.6.2.3 Lime Addition and Grinding

Lime will be added to the mill feed conveyor from an elevated lime silo to ensure the slurry entering the leach circuit is suitable for contact with cyanide solution, i.e., pH >9.5.

Crushed ore and lime will be fed into a 1 to 1.5-MW ball mill where the ore will be ground to a nominal particle size 80% passing of -150 um. Cyclones will screen the ball mill discharge (a slurry of water and ground ore) and coarse ore that does not meet the CIP feed sizing requirements will be recycled through the grinding process.

3.6.2.4 Gravity Gold Recovery

Prior to being returned to the mill, the coarse ore fraction from the cyclones will be directed to a Knelson concentrator where any coarse free gold or very high density gold-bearing particles will be recovered to a concentrate. The concentrate will then be discharged onto a gravity table to generate a final gravity gold concentrate. The gravity tailings is returned to the milling (grinding) circuit.

3.6.2.5 Leaching

The slurry will be pumped into a CIP circuit that comprises two Au leach tanks and six CIP tanks, i.e., total of eight tanks. Slurry will be pumped at approximately 45% solids weight for weight (w/w) to the trash screen where undersize will gravitate into leach tank 1 and then via gravity into leach tank 2. Cyanide solution, from the reagents mixing and handling area, will be added to the slurry in the leach tanks to dissolve the gold to produce gold bearing leach solution (called pregnant leach solution or PLS).

The slurry will flow from leach tank 2 into CIP tank 1 and thereafter to CIP tanks 2 to 6. Cyanide solution can be added to CIP tanks 1, 2, 3, or 4 to ensure maximum leaching of precious metals is achieved. Regenerated barren carbon will be used to adsorb the gold from the solution. The carbon is pumped counter-current to the slurry, starting in CIP tank 6, so that the freshest carbon acts on the most gold-dilute leach solution. The carbon will be periodically transferred from CIP tank to CIP tank by airlifts, adsorbing leached precious metals until it achieves the target loaded carbon grade in CIP tank 1. It is expected to achieve gold recovery of 90 to 95%.

Slurry from CIP tank 1 will be passed over the loaded carbon screen. The screen will be washed to remove any ore slurry. Gold-loaded carbon will then discharge to ground level into bulk bags for transportation to the elution circuit. Slurry will discharge into the tails hopper and be pumped to the tailings thickener.

3.6.2.6 Elution

The gold-loaded carbon is placed in a sealed elution column utilising a standard atmospheric Zadra elution system. Under temperature (85˚C) and pressure the gold is removed from the activated carbon, requiring 24 to 36 hours to fully elute the carbon.

The stripped (barren) carbon is transferred from the column either directly to the CIP circuit or via the carbon regeneration kiln for regeneration at 750°C prior to returning to the CIP circuit to extract further gold, while the concentrated gold-cyanide eluate proceeds to the electrowinning circuit.

3.6.2.7 Electrowinning and Goldroom

The elution solution is pumped to an electrowinning cell where the gold (and any silver) is plated as metal. The electrowinning cell contains steel wool cathodes to remove the gold and silver from the eluate. The loaded cathodes are washed and filtered before smelting into a bullion bar (or doré) ready for sale. Approximately 17 kg of gold doré will be produced each week.

3.6.2.8 Filtered Tailings and Cyanide Removal

Tailings from the CIP circuit will be dewatered in a tailings thickener. The thickener overflow will be returned to the CIP circuit as make up water to recover any residual gold or cyanide. The thickened underflow at 45 to 60% solids will be fed into a filter press or plate and frame filter. During filtration, a filter cake wash stage will remove some of the residual gold and cyanide. The filtered tailings moisture content will be below 10% and will be deposited into a bunker prior to co-disposal in the IWL. The filter cake wash solution is returned as make up water to the process water tank.

Depending on wash water used in filtration, the maximum residual WAD cyanide in solution will be <50 ppm, based on a total moist ore basis this represents less than 20 ppm. A cyanide detoxification circuit utilising hydrogen peroxide, to oxidise free cyanide to cyanate, while precipitating non-cyanide complexes, will treat any excess water generated by the process plant.

3.6.2.9 Reagents and Consumables

Cyanide

Leaching of gold from the ore will consume approximately 1.73 kg/t of NaCN. Based on approximately 750,000 tpa of ore the operation will require 1,328 tpa of NaCN. The NaCN will be delivered in bulk bags of sodium cyanide briquettes and stored in a secure dedicated reagent storage area.

When required, the NaCN will be prepared in a dedicated reagent mixing and handling facility consisting of an enclosed bag breaker, a mixing tank and solution storage tanks. Cyanide solution will be pumped to a ring main system for addition to the CIP tanks as required.

Lime and Carbon

Other major consumables will be lime and carbon. Lime for pH control will be delivered in trucks where it will be transferred into a storage silo. From the silo an auger system will be used to deliver lime (at the rate of 1,575 tpa) to a mixing plant where it will be mixed with process water. Approximately 10 to 20 tpa of activated carbon will be required each year to replace the activated carbon consumed in the gold recovery process.

Hydrochloric Acid

Dilute 3% hydrochloric acid will be used within the elution circuit to wash the loaded carbon. 68 t/yr of acid solution is consumed with the residual wash solution being diluted and discharged with the tailing stream.

3.6.3 Tailings Characterisation

3.6.3.1 Overview

Geochemical testing was undertaken by Environmental Geochemistry International (EGI) to characterise the following material:

- Drill core representative of ore samples prior to processing (stockpiled ore).
- Cyanide-leached ore to represent tailings that will be produced.

These samples were tested to gain an understanding of their geochemical properties and to provide information on the leaching characteristics of various metals and other elements of potential concern. This is to determine whether there any specific management measures are required for ore that is stockpiled prior to processing, tailings and any associated potential AMD, e.g., arsenic solubility.

3.6.3.2 Characterisation

Ore and Cyanide-leached Residue

Results of geochemical testing of ore and cyanide-leached ore residue show:

- The three ore samples used as feed for bottle roll cyanide leach tests contained negligible sulphur (<0.1%) and ANC (<10 kg H_2SO_4/t) and were classified as NAF.
- The tailings samples cover a range of acid producing and acid neutralising capacities and acid-forming potentials, ranging from acid producing to acid forming. Overall acid generating behaviour of tailings will depend on the range of ore types processed:
  - Comp #1 (1.37% S): positive net acid producing potential (31 kg H_2SO_4/t) and NAG (pH 2.8) indicating that it is likely to produce AMD during surface storage, i.e., PAF.
  - Comp #2 and #6 (0.12 and 0.01 % S): negative NAPP values (-12 and -58 kg H_2SO_4/t) and neutral NAG liquors, (pH 7.7 and 7.6) indicating these materials are unlikely to produce low pH drainage during surface storage, i.e., NAF.
  - Comp #3 and #4 (0.62 and 0.49% S): much closer balance between their acid producing and acid neutralising potentials. Comp #4 gave slightly positive NAPP (1

kg H_2SO_4/t) and NAG pH of 4, suggesting possible low pH drainage on exposure to the atmospheric conditions, but the amount of acidity will likely be low, i.e., PAF-LC. Comp #3 gave a slightly negative NAPP (-4 kg H_2SO_4/t) and neutral NAG liquor (pH 7.6) during the first stage of NAG testing. However, a second stage of NAG testing gave a liquor with pH 4.2 suggesting that despite the relatively low S content (0.62%), not all sulphide was oxidised during the initial stage of NAG testing and that further reaction during the second stage produced a slight excess of acid. These results suggest that this material is unlikely to produce significant acidity in drainage during surface storage, i.e., UC (PAF-LC).

Quality of Drainage from Tailings

In addition to the testing summarised above, water and peroxide extractions were conducted on selected samples to understand the likely quality of drainage from tailings. The results are summarised in Table 3.13.

Table 3.13 – Leaching Characteristics of Tailings

Analysis	Tailings
Water extraction	• Produced alkaline leachates with pH around 9 and moderate alkalinity and salinity • Metal concentrations in water extracts show arsenic occurring at concentrations significantly above the ANZECC guideline value for the 95% protection for freshwater systems, i.e., Comp #1 to #3 were more than 100 times above the guideline indicating that even is the absence of oxidation, Comp #4 and#6 were up to 100 times above the guideline. This indicates that fresh tailings may produce leachates with elevated arsenic concentrations on contact with water
Peroxide leachates	• Peroxide leachates from oxidised tailings may contain high concentrations of a number of metals and metalloids, including arsenic, aluminium, cadmium, cobalt chromium, copper, lead and zinc. While concentrations were highest for most metals in the low pH extract from the PAF tailings sample Comp #1, arsenic was found in peroxide extracts with neutral pH • Strong correlation between arsenic concentrations in the tailings and the total S content, with the exception of the Comp #4 sample. This suggests that arsenic is likely associated with sulphides in the tailings • Arsenic is significantly enriched in the relative to average crustal and soil abundance. This suggests that increased arsenic solubility as a result of cyanide leaching may lead to drainage containing elevated arsenic concentrations

These results suggest that should tailings undergo oxidation during surface storage, a number of metals and metalloids, especially arsenic, may be mobilised on contact with infiltrating water and could produce drainage which might present environmental risk. Further testing is underway to better understand the chemistry of drainage that may be generated by exposure of tailings to oxidative conditions.

3.7 Waste Management

3.7.1 Waste Rock and Tailing Management

3.7.1.1 Additional Geochemical Test work

Further investigation is required to confirm the conclusions in relation to waste rock (Section 3.5.7) and tailings characterisation (3.6.3) and provide more confidence in applying the results to the management of mine wastes during and post operations. The following geochemical investigations are currently underway:

- Kinetic leach testing to validate the suggested segregation criteria recommended for NAF waste, which is likely to contain some PAF-LC waste and would be stored permanently in the IWL post operation.
- Further investigation of the water solubility of arsenic in cyanide leach tailings to determine the likely concentrations of arsenic in drainage from the IWL.

Further detail on analysis, results and recommendations are provided in Appendix 6, 7 and 25.

3.7.1.2 Conceptual Approach

The current pit design estimates that a total of approximately 18 Mt of waste rock will be moved to access the ore (shown in Table 3.14). Tailing generation is also provided.

Table 3.14 – Ore, Waste and Tailing Tonnages (Mt)

Feature	Year 1	Year 2	Year 3	Year 4	Total
Waste	5.8	6.1	5.4	0.5	**17.8**
Ore	0.8	0.7	1.0	0.2	**2.7**
Tailing	0.8	0.7	1.0	0.2	**2.7**
Total	**6.6**	**6.8**	**6.4**	**0.7**	**20.5**

Selective handling and management of waste rock will be carried out during mining. Geochemical testing described in Section 3.5.7 demonstrated that sulphur can be used to determine whether waste rock is PAF or NAF and PNX will implement a sulphur testing program or geological controls to classify waste rock, this will be decided upon the completion of further testing. Waste rock will either be co-disposed with tailings in the IWL or placed in the PAF stockpile adjacent to the pit. Both the IWL and PAF stockpile will be engineered landforms to provide stability and minimise infiltration, the formation of AMD and surface erosion.

3.7.1.3 Integrated Waste Landform (Co-disposal)

General Design

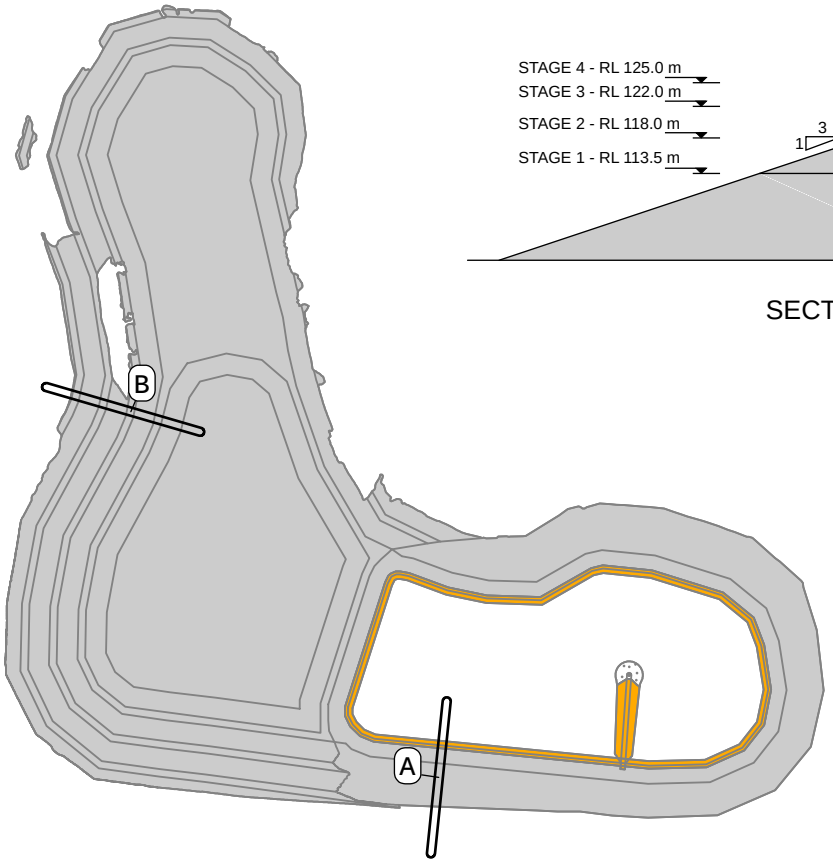
The IWL has been designed to optimise tailings storage capacity, maximise tailings density, remove water from the facility, and reduce seepage. Downstream construction methodology is proposed with the downstream embankments to be placed and traffic compacted progressively using mine waste produced as part of mining operations. The upstream face of the embankments is to be constructed using low permeability materials sourced from nearby areas. The floor of the IWL is to be lined with a compacted clay liner. The remainder of the waste rock produced as part of mining operations will be placed around the downstream zone to form an IWL. The IWL design is shown in Figure 3.10.

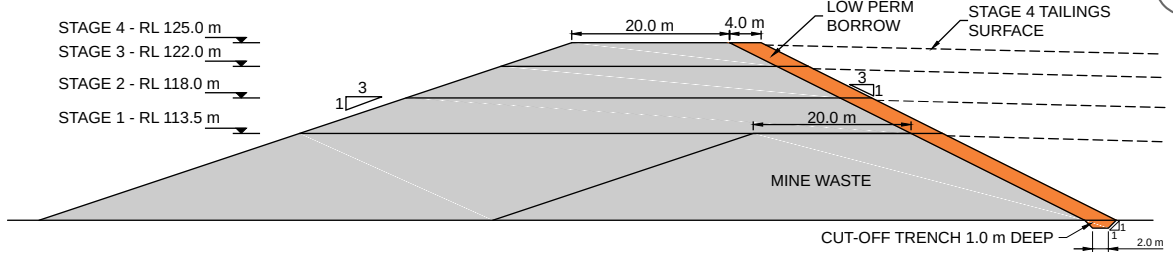
The IWL embankment raises (Stage 1 to Stage 4) are proposed to be constructed using mine waste. These perimeter embankments will be constructed progressively as waste is produced and hauled to the IWL. The upstream batter of each raise will be compacted to form a low permeability face comprising clayey borrow material won from a nearby location.

CONCEPTUAL IWL DESIGN

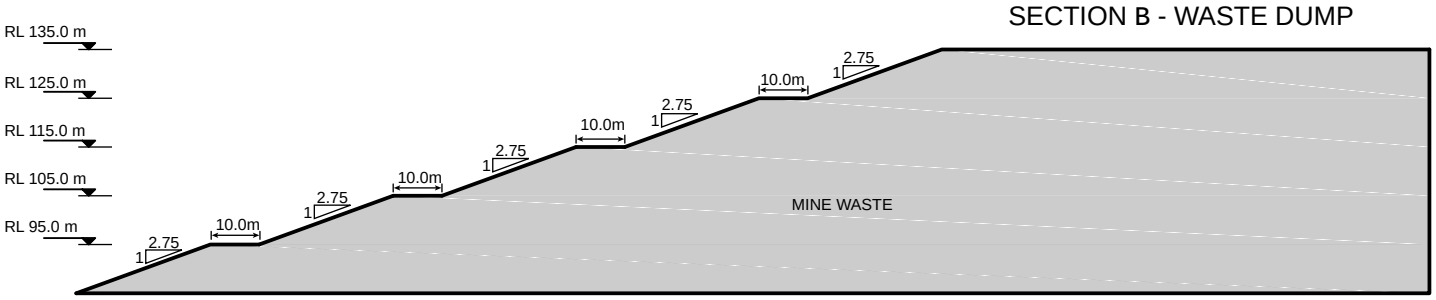
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FIGURE 3.10





SECTION A - PERIMETER EMBANKMENT



SECTION B - WASTE DUMP

SCALE: 1:10,000 @ A4

0 100 200 400 M

GDA2020 MGA Zone 52

Competent rock
Clay liner
Waste rock

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS023_v0-a

Figure Number: 01238D_EIS_F03.10_GIS_v0-a

ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
IWL design from Appendix 26 of the EIS.
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

At each stage, filter pressed tailings will be dumped within the facility and compacted to form a graded slope from the embankments towards the centre of the facility. The tailings will be required to be placed at specific slopes, depending on the stage of operation and varying between 2.25 % and 2.75 %, to ensure sufficient stormwater storage is provided across the IWL.

A decant facility will be located in the centre of the facility, with the purpose of capturing and removing incidental rainfall accumulated across the tailings surface. The IWL is designed such that tailings will be dumped within the facility with a graded slope from the embankments towards a centrally located decant. This will facilitate any incidental rainfall forming a decant pond located away from the embankment.

At an assumed average dry density of 2.1 t/m^3 for the IWL tailings following completion of the filter pressing, the IWL provides 1.37 Mm^3 of storage capacity for 2.87 Mt of tailings across four operational stages. This exceeds the required 1.30 Mm^3 of tailings storage capacity for 2.72 Mt over 4 years. The total IWL design stage capacities are presented in Table 3.15.

Table 3.15 – IWL Design Capacities (Total)

Material	Total
Embankment crest height (m)	22.5
Storage capacity (Mt)	2.87
Tailings storage capacity (Mm^3)	1.37
Maximum waste crest height (m)	40
Waste capacity (Mt)	18.75
Waste capacity (Mm^3)	6.94

Tailing characterisation suggests it may be possible to manage storage of tailings based on the sulphur content, where higher S content tailings are stored so that there is minimal infiltration of precipitation into these materials, with tailings with a lower sulphur content used to form part of a barrier to water infiltration. However, while sulphur content may constitute a major control on the acid-forming characteristics of the tailings, sulphur content may not indicate the propensity of these materials to leach metals and metalloids of environmental concern. Therefore the approach to tailings management will be:

- Floor and foundation of the embankments of the IWL will comprise of a 1.5 m thick layer of clay material overlying phyllite bedrock to provide low permeability.
- One decant well will be within the tailings cell to capture infiltration and runoff, and the water will be pumped to the process plant.
- An under drainage system will be placed beneath the IWL to capture seepage from the clay liner. The water will run to two sumps prior to being pumped to the process plant.
- A water tanker will be used during the dry season to prevent the exposed tailings from drying out and blowing out of the IWL tailings cell.
- At closure the IWL will be capped with 0.5 m of compacted clay and 1.5 m of waste rock to minimise infiltrating water through the IWL and reduce the risk of mobilising metals. The IWL will also be shaped into a convex landform to encourage runoff.

3.7.1.4 PAF Stockpile

PAF materials, i.e., sulphur content above 0.4%, will be segregated and stockpiled adjacent to the open pit (Figure 3.3). The location of the PAF stockpile has been selected to facilitate the pushing or dozing of PAF material into the pit for permanent storage (below water), without the need for haulage, at the completion of mining.

The volume of the PAF stockpile is estimated to be approximately 60,000 m^3 based on the most recent PAF estimations, however this is being further defined with kinetic leach testing. An engineered and compacted base will be constructed below the PAF storage stockpile. The base will incorporate perimeter bunding to contain rainfall and any seepage from the stockpile. All water captured will be directed to a water storage pond (Section 3.7.2.6).

At the completion of mining, PAF waste rock will be pushed into the pit so it can be inundated by natural groundwater recharge and rainfall. Once submerged, any potential impacts relating to AMD drainage will be mitigated. Prior to this, NAF waste rock from the IWL will be tipped over the edge of the pit to fill the berms and form a consistent slope so that the PAF material will not get caught on the berms and will fall to the base of the pit.

3.7.2 Water Supply and Management

3.7.2.1 Overview

Water resources, on a global scale are under increasing pressure, and to achieve resource sustainability and secure future access, it is widely recognised that a holistic approach to water management is required. Operational water requirements will be managed to maximise resource sustainability according to the ICMM Mining Principles (ICMM, 2017).

An assessment of hydrology was undertaken by CDM Smith to determine the following:

- Estimated ongoing dewatering rates.
- Size of evaporation pond to contain dewatering volume.
- Ongoing frequency and volume of overflow/flush at Fountain Head Lake.
- Pit water level recovery rate post mining.

The site water balance includes three stages: Stage 1 (dewatering), 2 (mining) and 3 (post-mining) (Figure 3.11).[1] Stage 1 is being undertaken via a separate approval process; however it is included in this section as it is a vital stage of the overall site water balance.

The model considered the main site water balance components: Fountain Head pit, evaporation pond, and the Fountain Head Lake, shown in Figure 3.12 and described in detail in Appendix 3.

[1] The dates in Figure 3.11 reflect the Project schedule at the time modelling was undertaken. In the event that the Project schedule shifts, the modelling will be revisited to account for any implications to the model parameters, e.g., seasonal variation.

3.7.2.2 Fountain Head Pit

Six months of dewatering the pit using evaporators will occur before mining commences. Once mining has commenced, the evaporators will operate in the pit for a further three months and will then be moved to the evaporation pond (Section 3.7.2.3). At this time, water will be pumped from the pit to the evaporation pond to maintain dry working conditions during mining. Pit groundwater inflow is expected to be 2 ML/day and pumping will occur at a maximum rate of 9 ML/d (with variation depending on seasonal factors) to achieve the required levels of dewatering. Pit dewatering rates will be controlled by the capacity of the evaporation pond. The dewatering rate is adjusted to maintain the evaporation pond water level beneath the operational trigger water level of 97.4 m AHD. The trigger level provides a 365 ML buffer before an evaporation pond overflow event.

3.7.2.3 Evaporation Pond

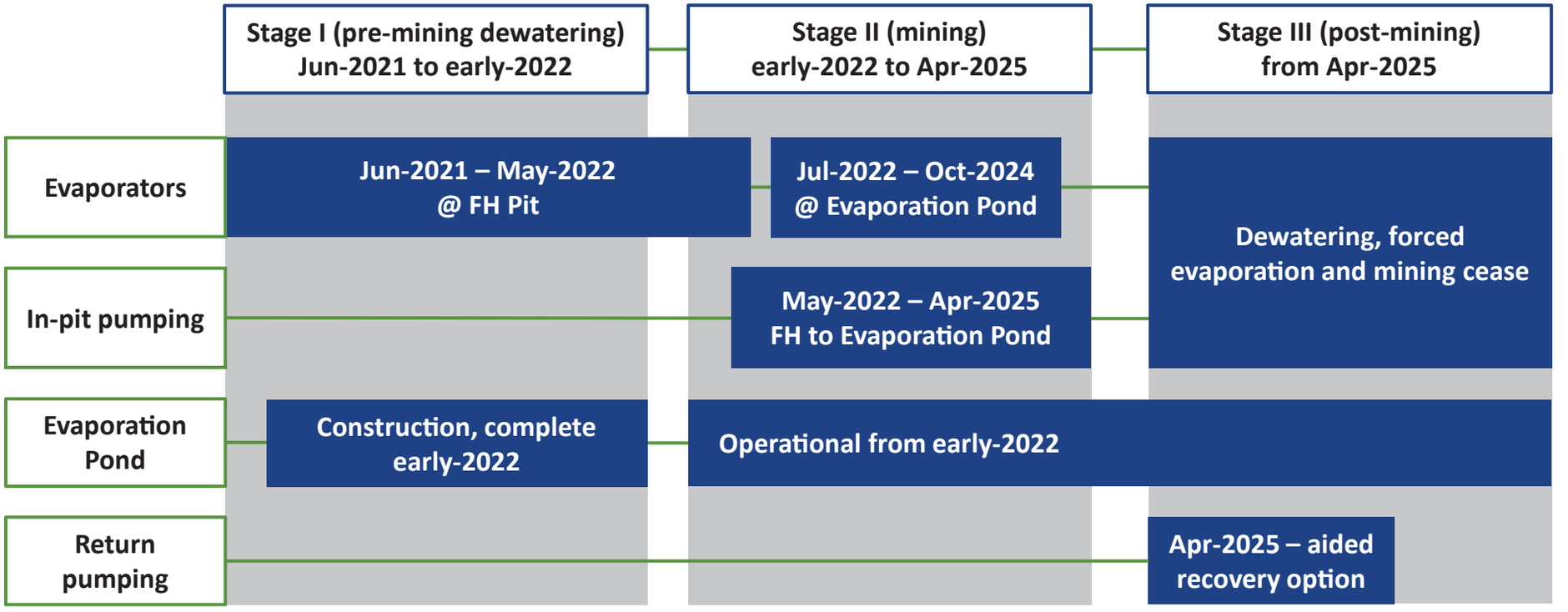
Satellite imagery shows that the evaporation pond has had a residual water body present for most years, from at least 1987 to present. For the modelling, this residual volume is assumed to be permanent and therefore is not accounted for in the storage capacity of the evaporation pond. Additional storage capacity based on the wall height of 98.8 m AHD will be 1,074 ML. However, the pond will mainly operate between a minimum level of 93 m AHD and a maximum operational level specified of 97.4 m AHD, which allows for approximately 1.2 m freeboard from the spillway at 98.6 m AHD. The lower threshold aims at keeping a 50 ML reserve of water to meet site water demand. The upper threshold aims at keeping a sufficient storage capacity in the evaporation pond to prevent a 1% AEP 72-hour rainfall event from reaching the spillway level. The operational volume defined by these thresholds amount to 660 ML (Figure 3.13). The proposed spillway level is 98.6 m AHD.

The three evaporators will increase natural evaporation rates (it is expected that evaporators will work at a rate of 135 m^3/hr and remove around 2 to 4.5 ML/d depending on evaporation efficiency and assuming 20.3 operating hours per day, daily). Natural evaporation from the pond is not expected to be impacted by the use of the evaporators. As the evaporation pond fills, groundwater infiltration (seepage) will progressively increase as the wetted area and the water level in the pond increases.

OVERVIEW OF FOUNTAIN HEAD PIT AND EVAPORATION POND WATER BALANCE STAGES

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FIGURE 3.11

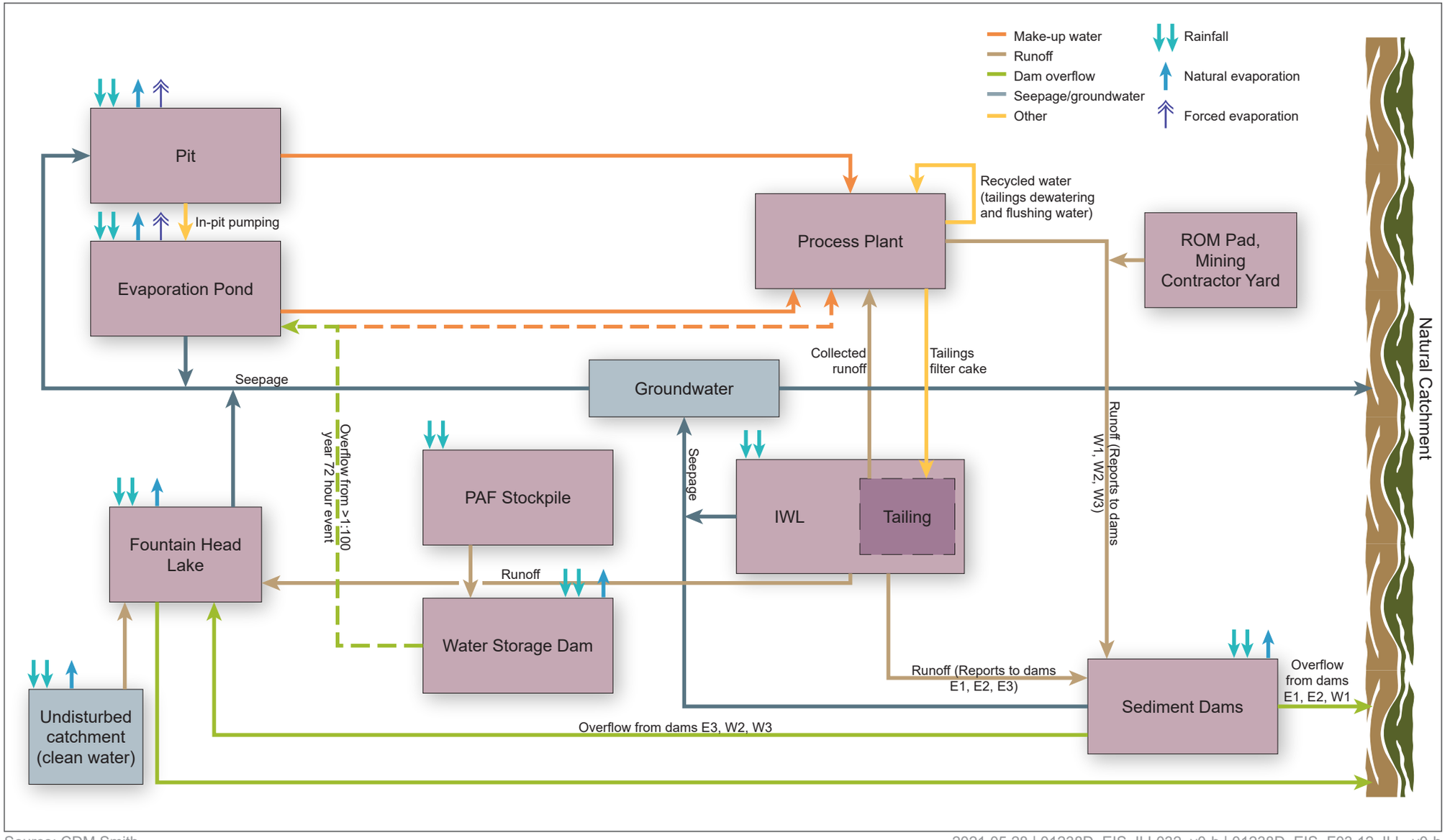


Source: CDM Smith

FOUNTAIN HEAD SITE WATER BALANCE SCHEMATIC

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FIGURE 3.12

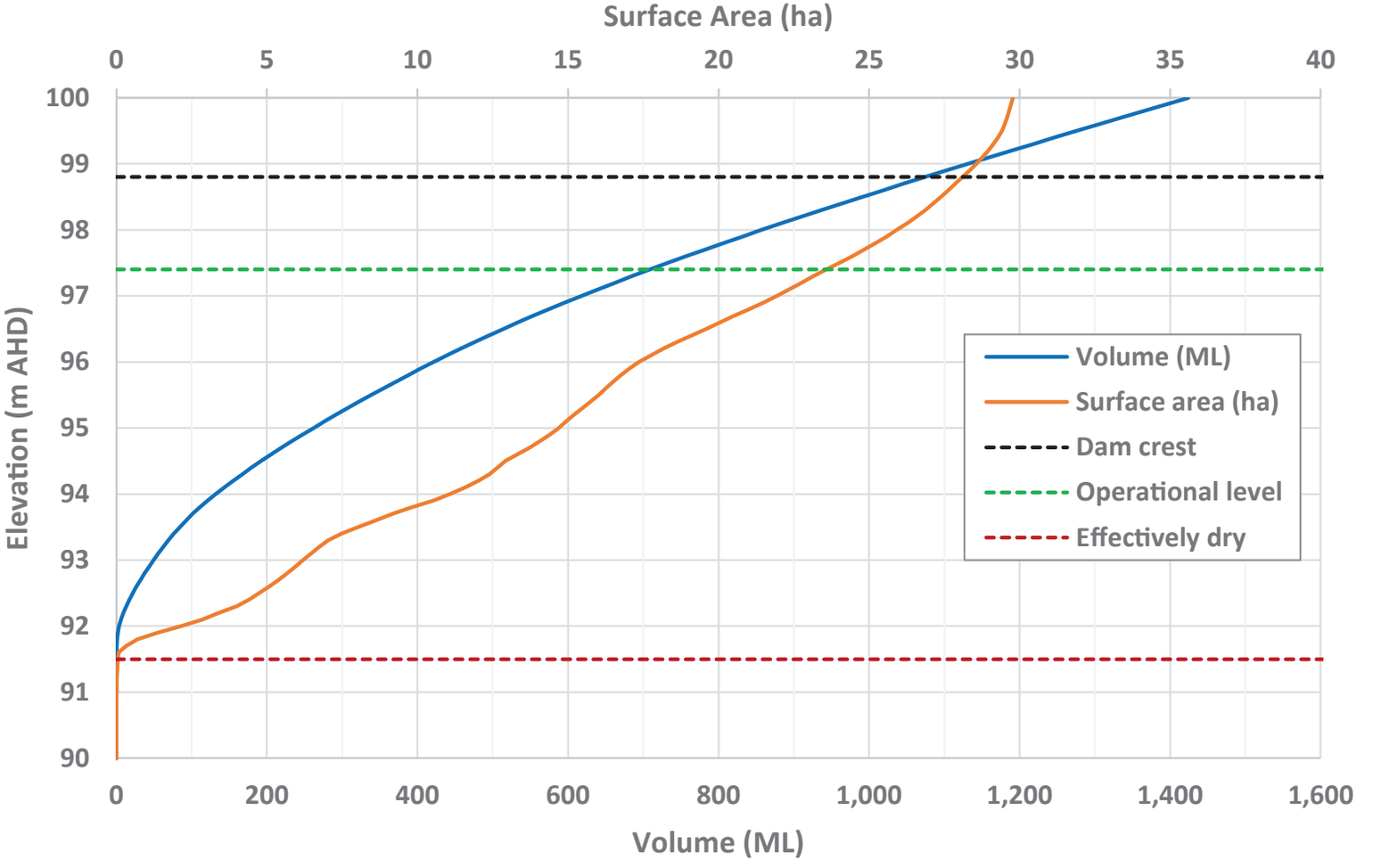


Source: CDM Smith

STAGE-VOLUME-AREA RELATION CURVE OF THE PROPOSED EVAPORATION POND

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FIGURE 3.13



Source: CDM Smith

Monthly evaporation efficiencies are provided in Table 3.16.

Table 3.16 – Monthly Evaporator Efficiency

Month	Evaporation Efficiency (%)
January	27%
February	24%
March	33%
April	42%
May	48%
June	50%
July	52%
August	55%
September	54%
October	50%
November	42%
December	33%

At the end of mining, pumping from the pit to the evaporation pond will cease along with the use of the evaporators, and the evaporation pond storage will evolve back to its previous natural rainfall-runoff input, evaporation and groundwater infiltration dynamics.

Operational Water Level Triggers and Potential Mitigation Options

Utilising historical weather data and a Monte Carlo simulation, there is a 59% likelihood that the operational water level trigger within the evaporation pond will not be exceeded during 2021/2022 and subsequent wet season thereby maintaining dry conditions in the pit. Conversely, there is 41% likelihood that the operational water level trigger in the evaporation pond (97.4 m AHD) will be exceeded at some point due to a lack of storage capacity and that pumping within the pit will be interrupted to manage evaporation pond operational levels. While in-pit pumping is interrupted, the evaporation pond level is at the operational water level trigger, relying on forced evaporation and infiltration to reduce the water level to balance the inputs from the in-pit pumps. At this time, mining will continue on available higher benches. It is not envisaged that mining will have to stop, except possibly late in the mine life when alternative mining areas may not be available.

Mitigation options that are currently being considered include:

- Raising the operational water level trigger (see Table 3.17) and/or introducing a staged trigger management scheme, i.e., a series of two triggers, the first reducing pumping rates and the second delaying pumping.

Sensitivity testing was undertaken to assess increasing the operational water level trigger. With an operational water level trigger of 98.4 m AHD the modelling predicts a 98% likelihood of achieving initial dewatering and 89.5% likelihood of maintaining uninterrupted dewatering during the entire mining period, within the assumptions of the modelling. The likelihood of exceeding the spillway level of 98.6 m AHD increases to 1 and 6.5% for potential operational water level triggers of 97.9 and 98.4 m AHD, respectively.

Table 3.17 – Sensitivity Testing for Evaporation Pond Water Level Operational Trigger#

Operational Water Level Trigger (m AHD)	Likelihood of Achieving Initial Dewatering (%)	Trigger Exceedance Likelihood Over Whole Mining Period (%)	Overflow Likelihood Over LOM (Spill Level : 98.8 m AHD)
97.4	89.5	41	0
97.9	94	28	1
98.4	98	11.5	6.5

Note: # Sensitivity testing does not consider the 72-hr 1% AEP rainfall event that the 97.4 m AHD accounts for including a 263 ML buffer. This would reduce capacity of the evaporation pond for the 97.9 and 98.4 m AHD scenarios.

- Raising the spillway level to increase the evaporation pond capacity thereby allowing for a higher operational water level trigger to reduce the likelihood of pit dewatering interruption.
- Diverting a portion of the runoff away from the evaporation pond to reduce the 1% AEP rainfall event volume thereby allowing a higher operational water level trigger.

3.7.2.4 Fountain Head Lake

The Fountain Head Lake is a man-made surface water feature and is the void remaining from historical alluvial mining. The lake exists due to the mine site haul road downstream of the lake which forms a barrier and dams the water in the lake. During heavy rainfall the pit water overtops this road. It is located in the centre of the Project area, between the existing WRS to the east and the proposed process plant and other infrastructure to the west, all of these features are located in the Fountain Head Lake catchment shown in Figure 3.14 and runoff/infiltration from the IWL and the sediment dams will report to the lake.

The surface level of the Fountain Head Lake is assumed to be comparable with water table elevation (i.e., it is possibly a surface expression of the water table) based on nearby groundwater levels and satellite imagery showing the frequent presence of water in the lake. However, the available data is not sufficient to quantify the surface water and groundwater interaction status or changes over time, hence, groundwater interactions were not included in the modelling.

3.7.2.5 Sediment Dams

Six appropriately sized sediment dams according to the best practice erosion and sediment control guidelines (IECA, 2008) are proposed (Figure 3.15). The sediment dams will capture surface water runoff from the IWL, processing plant, ROM pad, mining contractor yard and hardstand areas to allow suspended sediment to settle out prior to overflowing to the environment. Three of the sediment dams (W2, W3 and E3) will discharge directly in the Fountain Head Lake catchment and are included in the site water balance. Two will discharge downstream of the Fountain Head Lake catchment (W1 and E1), and one west of the evaporation pond catchment (E2) and are not included in the site water balance.

3.7.2.6 PAF Stockpile Runoff Dam

Runoff and infiltration from the PAF stockpile will be directed to a water storage pond to contain any potential low pH drainage water (see Section 3.5.7). The pond has been designed for a 1 in 100 AEP, 72 hour rain event. If the water quality allows, then the water will be pumped to the evaporation pond or, if required, it can be treated in situ prior to discharge to the evaporation

pond or reuse in the CIP processing plant. Water quality will dictate how drainage from the PAF stockpile will be used/managed.

3.7.2.7 Surface Runoff

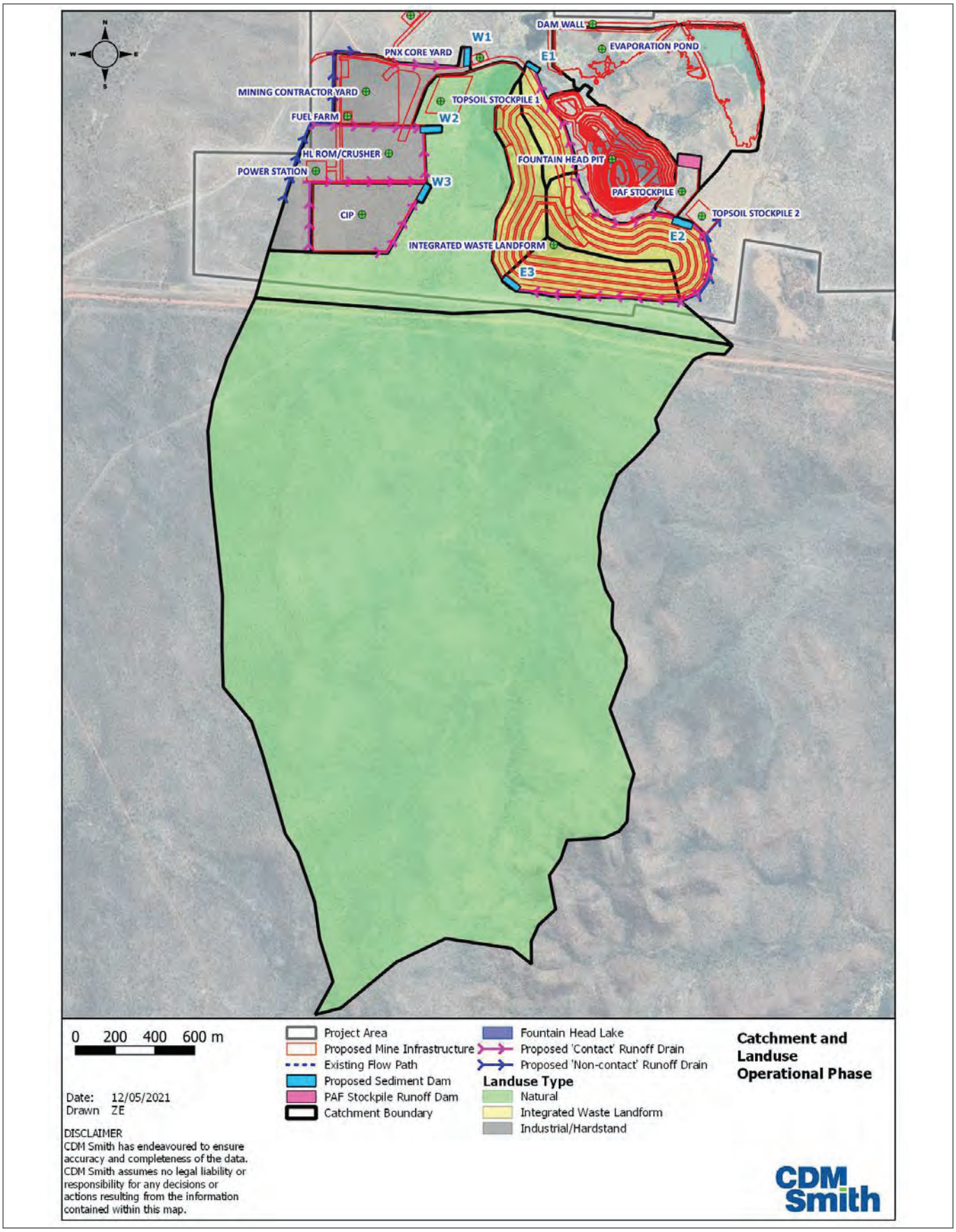
Based on the expected water quality, the site water management system includes two segregated systems as shown in Figure 3.15:

- 'Mine impacted' runoff drains to divert surface runoff from disturbed areas (such as IWL and mine infrastructure areas) to the sediment dams to capture and settle sediment.
- 'Clean' runoff drain to divert clean/natural catchment runoff from undisturbed areas away from disturbed areas. The majority of clean water from natural or undisturbed areas will generally be diverted to flow directly to the Unnamed Creek, bypassing mine infrastructure. The natural catchment south of the Project site will flow past the proposed mine infrastructure into the Fountain Head Lake before overflowing north, similar to its current manner

A number of mitigations have been included in the Project design to mitigate potential flood impacts (Appendix 4):

- Infrastructure, including waste rock and topsoil stockpiles, will be located on a raised pad above the 1% AEP peak flood levels with appropriate freeboard or protected by a flood protection structure to the adequate flood immunity. Other infrastructure (such as the core yard) will also be raised or protected by bunds to achieve the required flood immunity.
- A diversion channel will be constructed along the western side of the IWL to reinstate the natural flow path and to divert the natural catchment runoff into the existing Fountain Head Lake. A diversion is also proposed along the northern side of the proposed evaporation pond as the western portion of the proposed pond is located on an existing flow path.
- Erosion protection, such as rock armour protection will be installed on the western and northern toes of the evaporation pond. It is understood that the existing haul road is subject to erosion issues during overtopping events from the Fountain Head Lake and hence culverts will be installed, and erosion protection installed on the haul road batters.

FIGURE 3.14

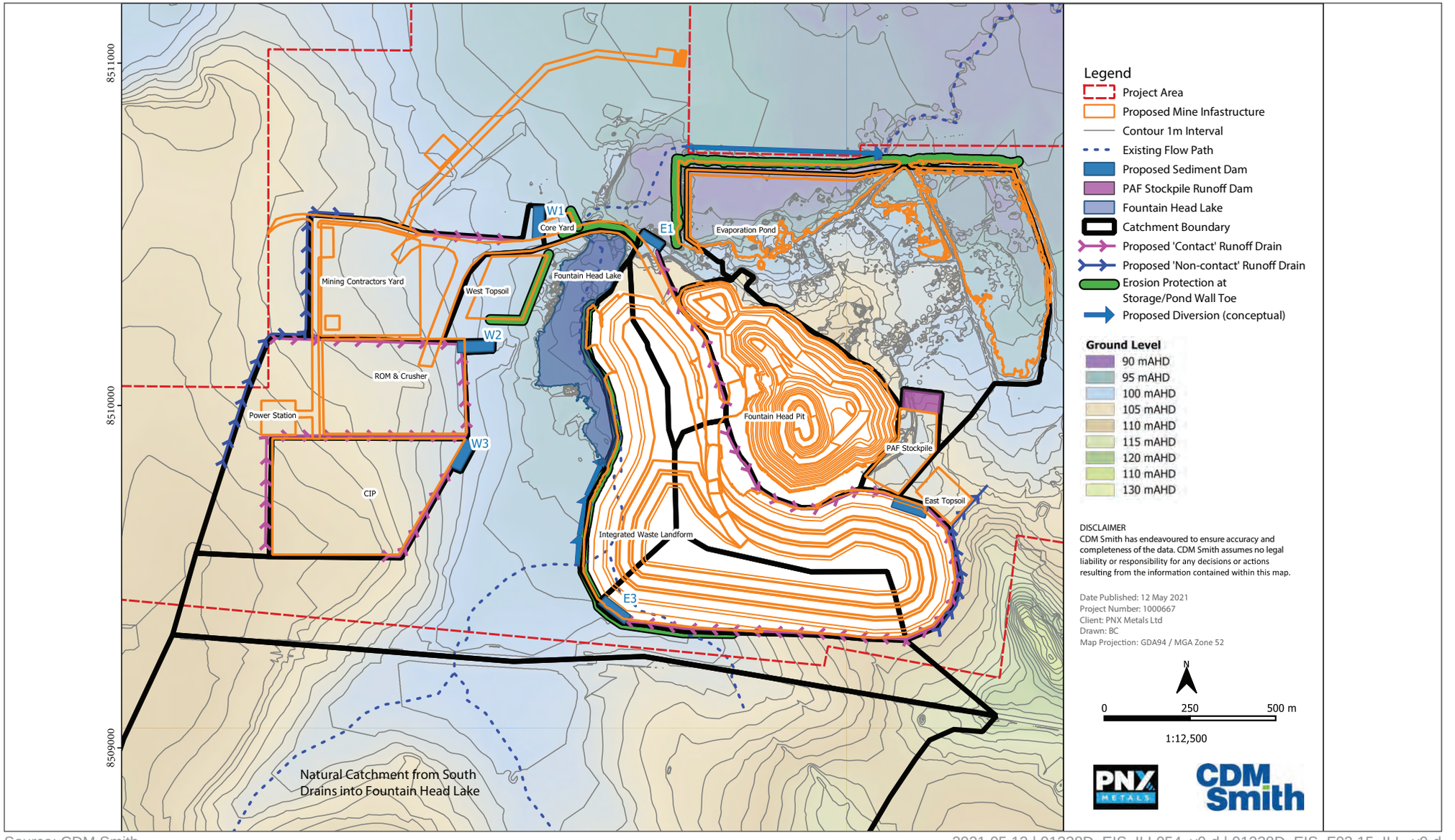


Source: CDM Smith

PROPOSED SURFACE WATER MANAGEMENT STRATEGY

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FIGURE 3.15



Source: CDM Smith

3.7.2.8 Water Requirements

Construction

Water use during construction will be for dust suppression, moisture conditioning of pavements and foundations only, the total consumption will be minimal. The water will be sourced from the Fountain Head Pit.

Potable Water

Potable water will initially be trucked to site and stored in sealed water tanks. Once operations are established, if clean water sources are available from the freshwater lake, then on site water will be utilised. If not, a skid mounted UV treatment and filtration system will be used to cleanse the water prior to use or water will continue to be trucked to site.

The potable water requirements on site are limited to drinking water, safety showers, pump gland seals, Knelson concentrators and explosive manufacture, total consumption will peak at around 5,500 L/hr.

Process Water

The Project requires approximately 27t/hr of non-potable water which will be sourced from the Fountain Head pit (predominantly) or evaporation pond (Table 3.18).

Table 3.18 – Process Water Requirements

Component	Use (t/hr)
Raw Water from Fountain Head Pit/Evaporation Pond	**27**
Crushing Circuit Dust Suppression Sprays	1.8
Gravity Concentrator Fluidisation Water	10
ILR Raw Water	0.8
Elution Circuit Raw Water	1.0
Pump Gland Water	4
Filter Cloth Spray Water	9

The water is suitable for:

- The process plant and mill.
- Pit and road dust suppression.
- Office ablutions.
- Vehicle washdown.
- Core cutting
- Crusher dust suppression.
- Plant wash water.

- Firefighting.

3.7.3 Non-Mine Waste Management

3.7.3.1 Overview

Strategies will be implemented to avoid or minimise waste production. Where this cannot be achieved, options to reduce, reuse and recycle/reprocess waste will be implemented. Waste disposal is the least preferred option.

The key elements of the waste management strategy, are as follows:

- Avoid and reduce – where possible, reduce waste volumes at the source by selecting processes, products and procedures that generate the least waste possible.
- Reuse – where possible, packaging materials will be returned to suppliers for reuse, e.g., empty drums and containers, cardboard and unused products.
- Recycle and reprocess – where possible, e.g., scrap metal, rubber tyres, will be reprocessed into useful materials or products by third parties.
- Treatment and disposal – if waste materials are still generated after the implementation of feasible waste avoidance, reduction, reuse, recycling and reprocessing measures, waste materials will be treated and disposed of, and measures taken to minimise potential impacts to human health and the environment.

The ultimate approach used for waste segregation, storage, collection and disposal, will be determined by the waste management contractor engaged to manage this aspect of the site operations.

All waste storage areas will be regularly inspected for integrity issues, emissions and leaks; and all waste generated will be tracked by type and volume including transport to its disposal destination.

3.7.3.2 General Waste

Non-hazardous general wastes expected during mining activities are:

- General domestic and putrescible waste.
- Construction and demolition waste.
- Operational waste, e.g., tyres, scrap steel.
- Recyclable wastes (packaging, metals, tyres).

All waste will be segregated in labelled bins for removal from the Project area by a licenced waste contractor. Domestic waste will be stored in sealed containers and removed from site regularly to prevent attracting feral animals. Containers for recyclable waste will be stored in lidded comingle containers. Construction waste, scrap metal and tyres will be placed in open-top skipped bins.

General domestic waste, construction wastes and recyclables will be taken either to the nearest waste transfer station that accepts commercial waste (i.e., VTG Waste & Recycling, located in Darwin) or directly to landfill (i.e., Katherine Waste Management Facility).

3.7.3.3 Hazardous Materials

Storage

All hazardous substances including diesel, explosives and cyanide will be stored according to Northern Territory standards, or Australian standards where Northern Territory standards do not exist. A register will be maintained on site, of all hazardous substances including chemicals for the life of the mine.

Processing additives such as cyanide will be stored in designated undercover storage areas.

Explosives will be stored in the on-site magazines with the bulk ammonium nitrate prill in the ANE shed (as shown in Figure 3.3).

Waste Management

Waste oils will be stored in bulk containers. Other workshop wastes such as used chemical containers and batteries, will be segregated in labelled bins and stored undercover to prevent rainfall from entering and subsequent release of contaminated water from storage areas.

Hazardous wastes will be taken directly to an appropriate receiving facility, such as VTG Waste and Recycling, by a licenced contractor.

All hazardous materials including explosives and cyanide will be transported to the site via road and will be transported according to the *Australian Dangerous Goods Code* (Edition 7.7) (NTC, 2020).

3.7.3.4 Sewage

During construction and operations, sewage, including grey water (i.e., effluent from sinks and washing facilities) and black water (i.e., toilet effluents) produced from the ablutions of temporary buildings and mobile ablution blocks will be collected into storage tanks, which will be regularly emptied with the waste taken offsite for disposal at a licensed facility. Sewage from semi-permanent buildings (e.g., crib room or offices) will be collected in subsurface septic tanks. Solids will be removed and disposed of at a licensed facility, while wastewater will flow to a subsurface drainage field.

Project septic systems will be located, constructed and managed in accordance with the Northern Territory *Code of Practice for Onsite Wastewater Management*.

3.8 Infrastructure and Transport

3.8.1 Energy

3.8.1.1 Project Energy Use

Project construction will use mobile silenced diesel generators, which will provide required power on demand, eliminating the power shortages that currently impacts on the PWC 66– kVa grid electrical powerline caused by lightning and inclement weather.

The use of renewable energy in the form of solar and wind have been investigated and will not be considered further as the life of the Project will not justify the significant capital expenditure of a solar system and the region does not have consistent winds for wind turbine power generation.

Operations energy needs will be provided by constructing an on-site diesel-fired power station. Electricity demand for the site will be approximately 30 MWh/yr with the power station expected to comprise three-1.5 MW units equating to 3.9 MW of total peak power, fuelled by 7,500 kL/yr of diesel during operations.

During power generation, a significant amount of energy is lost e.g., as heat, and only about 37% of the energy input is converted to useable energy. This is reflected in the ratio of the energy produced to diesel consumed in the power station. The estimated Project energy use (energy consumed, and energy produced) for construction and operations is shown in Table 3.19.

Table 3.19 – Project Estimated Annual Energy Use in Gigajoules (GJ)

Emission Sources	Construction (GJ)	Operations (GJ)			
	Year 0	Year 1	Year 2	Year 3	Year 4
Equipment/machinery/vehicles	96,500	192,547	192,547	192,547	12,666
Construction - diesel generators	423	-	-	-	-
Operations - diesel power station	-	289,106	289,106	289,106	189,851
Explosives (diesel content)	-	7,038	6,836	6,420	655
Energy Consumed – Totals					
Total energy consumed	96,923	488,691	488,489	488,073	203,170
Energy Produced – Totals					
Total energy produced	158	107,853	107,853	107,853	70,825

Source: Appendix 1.

3.8.1.2 Greenhouse Gas Emissions

A greenhouse gas (GHG) study was undertaken by KateStone (Appendix 1) to assess the emissions of the construction and operations activity and determine potential reporting requirements. Project GHG emissions are predominantly associated with mining and ore processing activities. Land clearing activities were also considered.

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) established a national framework for corporations to report GHG emissions and energy consumption, i.e., the NGER scheme. Details of the scheme and allowable calculation methods are contained in the *National*

Greenhouse and Energy Reporting Regulations (NGER Regulation) 2008. The NGER Regulation recognises Scope 1 and Scope 2 emissions as follows:

- Scope 1 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility.
- Scope 2 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility.

Project Scope 1 emissions will result from the combustion of fuel for mining equipment, explosives and electricity generation. Scope 2 emissions are not relevant to the Project as no electricity is being sourced externally. Annual Scope 1 GHG emissions have been estimated for the Project (shown in Table 3.20).

Table 3.20 – Annual GHG Emissions for the Project in Tonnes of Carbon Dioxide Equivalent (tCO_2-e)

Emission Sources	Scope	Construction (tCO_2-e)	Operations (tCO_2-e)			
		Year 0	Year 1	Year 2	Year 3	Year 4
Diesel						
Equipment/machinery/vehicles	1	6,794	13,555	13,555	13,555	892
Construction - diesel generators	1	9	-	-	-	
Electricity Supply						
Operations - diesel power station	1	-	20,353	20,353	20,353	13,365
Explosives						
Explosives (diesel content)	1	-	495	481	452	46
Land Clearing						
Cleared	1	2,560	2,560	2,560	2,560	2,560
Scope 1 - Totals						
All sources	1	9,383	36,964	36,950	36,920	16,863
Scope 2 – Totals						
All sources	2	-	-	-	-	-
Totals –excluding LULUCF						
All sources	1	6,823	34,404	34,390	34,360	14,303

Source: Appendix 1.

Maximum annual GHG emissions during construction are influenced by the inclusion or exclusion of land use, land use change and forestry (LULUCF) emissions. Estimated annual emissions during construction are 9,383 tCO_2-e including LULUCF, and 6,823 tCO_2 excluding LULUCF. The total maximum annual emissions including LULUCF are 36,964 tCO_2-e for year 1 of operations.

The total GHG emissions for the Project are comprised of:

- Diesel equipment and vehicles (35.3%).
- Electricity supply (diesel generators) (54.3%).

- Explosives (1.1%).
- Land clearing (9.3%).

Further details on the GHG assessment, contributions to Northern Territory and national inventories of GHG emissions and Project GHG reporting requirements is discussed in Section 7.2.2.2.

PNX is committed to reducing emissions by maximising efficiency and reducing consumption where possible during all Project phases in line with the NT Government 2050 emissions target. Specific management measures are detailed in Section 7.2.3.5.

3.8.2 Traffic and Transport

The Project transport route includes the Stuart Highway from Darwin, a turnoff from the Stuart Highway onto Fountain Head Road (east) which then leads onto Ban Ban Springs Road. Ban Ban Springs Road continues to be bituminised until the Glencoe Mine 2.5 km further north (shown in Figure 3.16). Detail on the road networks to be used by the Project are in Section 4.11. The potential impacts of Project traffic on other road users is assessed in Section 7.11.

A summary of the traffic and transport requirements for the Project are discussed in the following sections.

3.8.2.1 Construction

Project traffic is estimated to reach peak levels during the second and third months of the construction phase when an additional 52 trips (compared with existing traffic volumes) will be generated on the road network each day. This will include delivery of all mobile plant required for civil works, mining equipment and fleet, infrastructure (e.g., workshops, offices and processing plant) and supplies to site and staff transport to/from Cosmo Village by bus and light vehicle.

3.8.2.2 Operations

Project-related traffic volumes during operations will be lower than the construction phase. The dayshift and nightshift crews will travel to and from site (from Cosmo Village) daily using light vehicles and the staff bus. The operations phase will also require delivery trucks each day for consumables (e.g., fuel and explosives). There will not be any removal of bulk products or by-products from the site other than gold bullion doré bars and the various waste streams generated by the Project. The operations vehicle trips are estimated to be 32 trips per day on Fountain Head Road and four trips per day on the Stuart Highway.

Traffic volumes during mine closure and rehabilitation will diminish significantly at the completion of operations.

3.8.3 Ancillary Infrastructure

Supporting infrastructure will primarily be demountable buildings and will include:

- Main administration office, ablution block and carpark.
- Crib room for mine workers.

- Workshop, stores, service bay and stockyard.
- Heavy vehicle washdown pad with oil separators.
- Diesel fuel and oil storage with dispensing facilities.
- Power generation facility.
- Exploration core shed with office and ablutions.
- Perimeter and internal fencing with signage.
- Explosive magazines.
- ANE storage sheds/facility.
- UHF radio repeater communications network.

Diesel

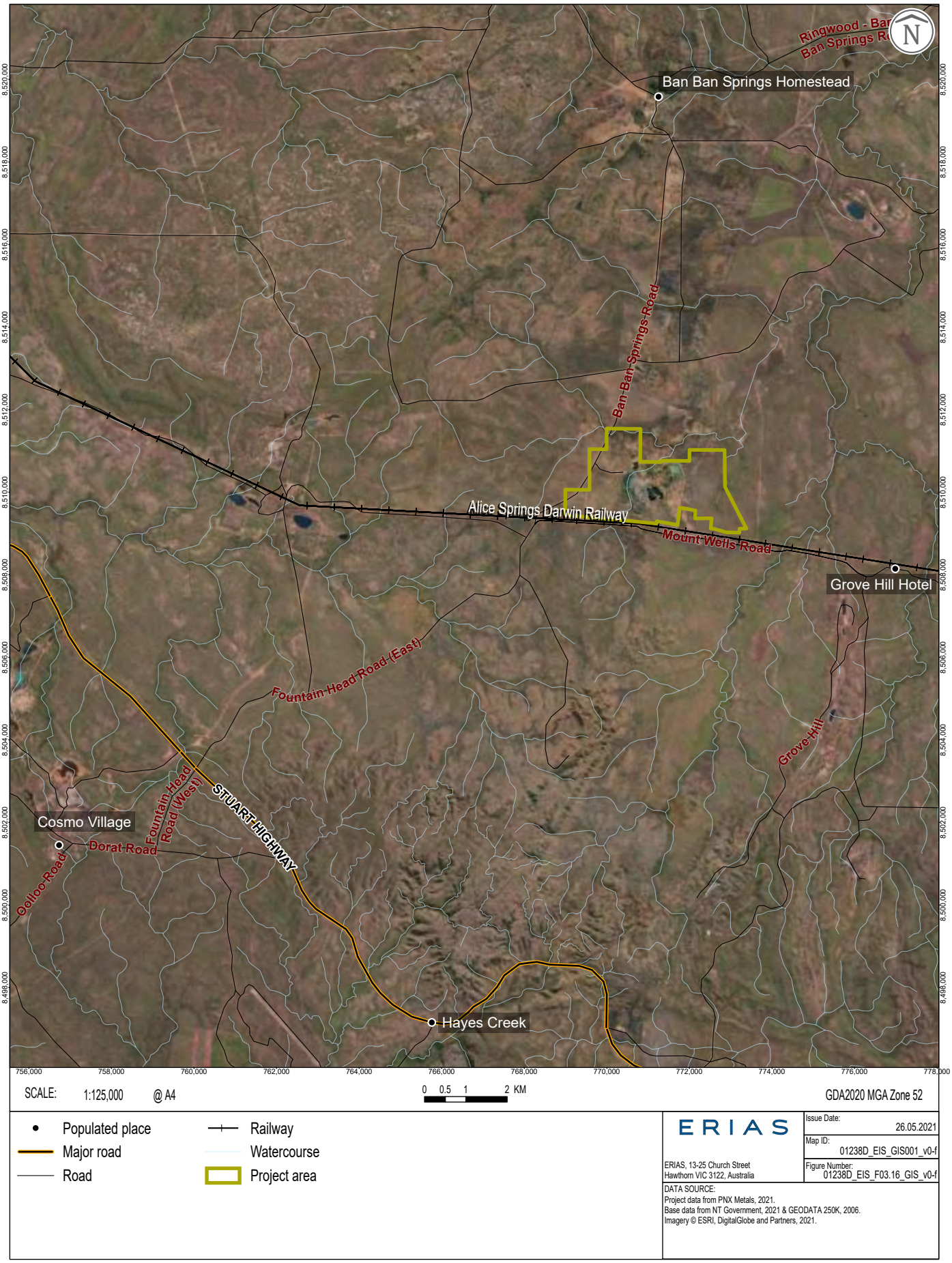
Diesel will be stored in a dedicated fuel farm facility that complies with Australian Standard AS1940 storage and handling of flammable and combustible liquids. Between one to two weeks supply of diesel will be stored on site to protect from any disruption caused to transport logistics e.g., adverse weather conditions. Diesel fuels will be supplied by a licenced contractor as required and all plant and equipment will be refuelled in a designated refuelling area.

Diesel will be stored in standard above-ground, self-bunded, 110 kl storage tanks (Plate 3.3) that will service both light and heavy vehicles. The refuelling facility will be located to aid efficient unloading of deliveries and will have good all-weather road access and will be secured at all times. The storage tanks will also store diesel for the generators and evaporators.

Project equipment and machinery, including heavy vehicles (not road registered) and road-registered vehicles will use approximately 2.5 ML of diesel per year during construction.

The operations phase will use approximately 12 ML per year from operating machinery, equipment and vehicles, diesel consumption from explosives and the diesel-fired power station.

FIGURE 3.16



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Figure Number: 01238D_EIS_F03.16_GIS_v0-f

DATA SOURCE:
Project data from PNX Metals, 2021.
Base data from NT Government, 2021 & GEODATA 250K, 2006.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

Plate 3.3 – Typical Self Bunded Fuel Storage Tank



Source: PNX Metals.

3.8.4 Workforce and Accommodation

The workforce required for the early construction phase associated with processing plant will peak at around 50 persons at any one time. Mining and processing will be undertaken 24 hr/day, 365 days/yr. It is expected that most employees will complete 12-hour shifts with two weeks on and one week off, or alternatively 9 days on and 5 days off, rosters. It is envisaged that management and administrative positions will be on a one week on and one week off roster. The positions and number of personnel required for operations are outlined in Table 3.21. There will be approximately 50 persons on site on day shift and 30 on night shift, the remainder will be on leave.

Personnel required for the operation will, in the first instance, be sourced from the local areas of Pine Creek and Darwin.

There will be no camp facilities constructed on site. The use of the Cosmo Village accommodation is in the process of being negotiated as it is the most practical option due to its close proximity to Fountain Head (shown in Figure 3.16). There will be approximately 80 people housed at the camp at any one time (day and night shift). The site will be a bus-in bus-out (BIBO) site from Darwin with any fly-in fly-out (FIFO) workforce required to make their own way to Darwin, in this way the local communities will have greater accessibility to employment on site.

The workforce will be transported from Cosmo Village, by bus, with the daily commute to and from the site to be less than 1 hr per journey. With prior approval, only local personnel not residing in the village and not on the bus route will be able to drive to site to commence their roster.

Table 3.21 – Total Operations Workforce Requirements

Area	Position	No. Required
Mining – Staff	Project Manager	1
	Maintenance Superintendent	1
	Senior Mining Engineer	2
	Mine Geologist	2
	Pit Technicians	2
	Mining Operations Supervisor	3
	Maintenance Supervisor	3
	Surveyor	2
	Site Admin	2
	Safety Coordinator	2
	HSET – Paramedic / ERT	2
Mining – Wages	Excavator Operators	3
	Loader Operators	3
	Dump Truck Operators	18
	Dozer Operators	6
	Grader Operators	3
	Watercart Operators	3
	Dewatering Crew	2
	Drill & Blast Shotfirer	2
	Brill & Blast Crew	8
	Drillers	6
	Workshop Trades	16
CIP Plant	Manager Processing	1
	Senior Metallurgist/ Relief Mill Manager	1
	Plant Metallurgist	1
	Laboratory Technician	4
	Shift Supervisor	4
	Crusher Operator	4
	Mill Operator	4
	CIP Operator	4
	Elution/Au Room Operator	4
	General/Daycrew/Relief Operators	2
	Maintenance Supervisor	1
	E & I Technicians	4
	Boilermaker and Fitter	4
	Trade Assistant	2
	Storeman	2
Total Workforce		**134**

3.9 Closure and Rehabilitation

The closure and rehabilitation strategy for the Project will be detailed in the Mining Closure Plan (MCP) provided in Appendix 18. The MCP will provide the specific closure objectives and completion criteria as well as a monitoring and maintenance program. A summary of the closure strategy is provided in the following sections.

3.9.1 Closure Domains

Mining will create different landforms and infrastructure on the site, each having different rehabilitation and closure requirements. The use of domains is a common approach in mine closure planning to identify areas within a mine site which have common issues. Once domains have been identified, a closure plan can be identified for each domain based on the key attributes and issues associated with the domain. The Project has been divided into eight closure domains (Table 3.22). The closure strategy for each domain will be detailed in the MCP and will include:

- Domain-specific objectives and completion criteria.
- The final land use.
- Detail on the infrastructure to be retained.
- The expected closure date.
- Detail on the activities to reach completion criteria.
- Information on sourcing closure material (e.g., topsoil, species for revegetation) and potential waste disposal.
- Any further investigations or liabilities, risks or hazards.

Table 3.22 – Project Closure Domains

Closure Domain	Components	Area (ha)
Process plant	Fuel farm Mining contractor yard CIP plant site Power station ROM/crusher Topsoil stockpile 1	0.2 8.2 15.8 1.0 11.2 3.0
	Sub-total	39.4
Supporting infrastructure	PNX core shed Magazine bunds ANE facility	0.4 0.1 0.5
	Sub-total	1.0
Integrated waste landform	Waste rock and tailings storage	55.4
Open pit	Fountain Head pit Potentially acid-forming (PAF) stockpile Topsoil stockpile 2	19.4 2.7 1.3
	Sub-total	23.4
Water storage (evaporation pond)	Evaporation pond	24.1

Closure Domain	Components	Area (ha)
Fountain Head Lake	Fountain Head Lake	7.6
Access roads	Mine haul roads Access roads Magazine road	7.1 2.4 2.2
	Sub-total	11.7
Historic disturbance	Miscellaneous areas	77.2
TOTAL		**239.8**

3.9.2 Post-mining Land Use

Consideration of potential post mining land uses has been undertaken by assessing the Project features post mining and current land uses surrounding the Project. The proposed post-mining land use is to return the land to cattle grazing, with the exception of the following that will be fenced to restrict access and exclude stock:

- Pit: the pit will fill with water as groundwater levels rebound.
- IWL: the IWL will be rehabilitated to establish a post-mining land use of native vegetation and remain a new feature of the landscape.

It is proposed that the evaporation pond will be rehabilitated and returned to grazing. Ban Ban Springs Station has indicated that it would like the evaporation pond to remain as a water storage for future pastoral activities. PNX will work with Ban Ban Springs Station during the operational phase of the Project to achieve this outcome.

Post-mining land use(s) will be finalised following discussion with stakeholders, e.g., the landowner, regarding potential land use opportunities post closure and, in particular, whether any of the infrastructure could be used for other land uses.

3.9.3 Progressive Rehabilitation

The short mine life limits the opportunity to establish rehabilitation trials. PNX will, however, undertake rehabilitation progressively. This will provide an opportunity to observe rehabilitation progress and outcomes that can be factored into closure planning. Progressive rehabilitation will be undertaken in areas that are no longer required for the operation (e.g., historical disturbance areas) and the lower batters of the IWL. These areas will be reprofiled as required, covered with topsoil, ripped and seeded.

Where possible, operations will be completed considering closure requirements to allow for progressive rehabilitation to be integrated into daily mining activities. This will also minimise the need for rehandling material, e.g., the IWL will be constructed to facilitate the final landform with berms sized to enable contouring to achieve final batter slopes and the pit safety bund being constructed with suitable waste rock as it is excavated from the pit. Progressive rehabilitation will assist minimise risks associated with unexpected, early, mine closure. This will be further mitigated by preparation of a care and maintenance plan that would be implemented in the event of premature mine closure.

3.10 Alternatives

3.10.1 Not Proceeding with the Project

3.10.1.1 Economic

PNX has identified the Fountain Head Gold Project as an immediate priority, with the original Hayes Creek Project that was to utilise the Fountain Head site for ore processing and tailings storage, to now be developed (subject to approval) following the Fountain Head Gold Project, specifically, ore from the Mount Bonnie and Iron Blow deposits would be processed at Fountain Head and the pit used for tailings storage.

This will allow PNX to generate cashflow from existing resources on the Fountain Head site, while preserving the future value of the Hayes Creek Project. By reversing the sequencing, PNX can maximise opportunities for the two projects to share processing, tailings storage and other infrastructure.

By not proceeding with the Fountain Head Project there would be no income stream from the site and the Hayes Creek Project would not benefit from potential synergies with the Fountain Head Gold Project, including tailings storage, processing options and other infrastructure commissioned for the Fountain Head Gold Project.

With the closure of Union Reefs processing plant in March 2020, there are no other operating processing facilities in the Pine Creek Region. Other smaller deposits in the region, could be developed and utilise the Fountain Head processing facilities. By not proceeding, potential projects would need to haul further distances to other processing facilities which could make those projects uneconomic.

3.10.1.2 Environment

The Fountain Head site is highly disturbed from mining activity, which dates back to the 1800s and more recently to 2008. The site has been under care and maintenance since this time, and has legacy issues relating to previous mining activity, including: unrehabilitated WRS, eroded soils, weeds and several large bodies of water with varying water quality. If the Project does not proceed, there will be no change to the status of the lease area with no clear strategy for long-term closure, including rehabilitation of the pre-existing historical disturbance and infrastructure such as the WRS.

3.10.1.3 Social

The Fountain Head Gold Project is expected to have a workforce of approximately 100 and 134 persons, for construction and operation, respectively. Employees will be preferentially sourced from the local areas of Pine Creek and Darwin. If the Project does not proceed, there would not be any local employment opportunities for the community of Pine Creek and surrounding communities. With the sudden closure of the Cosmo Gold Mine and Union Reefs, and loss of approximately 250 jobs, an additional operating mine in the area could re-employee some of the skilled workers who remain in the community.

3.10.2 Alternative Considerations in Project Planning

This section describes feasible alternatives that have been considered for the Project, including site selection. Discussion is provided on the environmental and social impacts of the alternatives and how the options assisted in avoiding or minimising potential environmental and social impacts.

3.10.2.1 Site Selection

Placement of the key mining components, e.g., IWL, processing facility and other related infrastructure, considered the areas of existing disturbance on the Fountain Head site and kept footprints largely within previously disturbed areas of the Project leases, to reduce the amount of clearing required.

3.10.2.2 Processing

The original Fountain Head Gold Project feasibility studies were completed based on utilising Heap Leach technology to process ore. In November 2020, PNX Metals announced that the processing methodology for the Fountain Head project would change from heap leach to conventional gravity, milling and carbon-in-pulp. The carbon-in-pulp processing is expected to deliver material operating benefits relating to increased overall recovery of gold in comparison to the previously envisaged gold heap leaching.

3.10.2.3 Environmental

PNX has considered a number of options to reduce the environmental footprint. This includes adopting management and mitigation strategies and committing to monitoring programs to avoid potential environmental impacts. The following decisions were made during Project planning:

- Ore will be processed at Fountain Head rather than hauling 75 km to the only existing, off-site, processing facility at Union Reefs, which is currently moth-balled and not available for PNX's use. Construction of a processing facility at Fountain Head will eliminate haulage off site reducing diesel consumption (and the associated emissions) and reduce Project traffic.
- Ore will be processed via CIP tanks rather than the previously proposed heap leach pads. Greater gold recovery can be achieved using CIP tanks that occupy less space than the heap leach pads, and the cyanide used in processing is fully contained within the process plant.
- Co-disposal of waste rock and tailings is preferred rather than constructing a tailings storage facility on site. Co-disposal reduces the overall footprint required to manage mine waste and has benefits in terms of the overall site water balance and mine closure and rehabilitation requirements.
- Discharge of pit dewatering water from the evaporation pond to the Margaret River was considered for operations; however, this would be constrained by the seasonality of the river system, e.g., seasonal or ephemeral. Discharge would not be permitted during times of low or no flow or when the river is dry greatly reducing the opportunity to discharge, this is because of potential impacts to hydrology and the inability for the discharge to dilute within the watercourse. Retaining and managing the water on site by

continued use of the evaporators and to meet non-potable water reduces the potential of impacts to surrounding surface water.

- Waste rock in the existing WRS will be reused for construction material for haul roads, workshops, and laydown areas. Some of the waste rock may also be crushed and screened during site establishment for blast hole stemming and aggregate for concrete.
- PNX has considered using the evaporation pond water during continued dewatering for other land uses such as irrigation. An assessment of the water quality determined it would be suitable for this purpose. The feasibility of this option is currently being investigated.

3.10.2.4 Social

PNX has reviewed the archaeological sites surveyed during the cultural heritage assessment in 2019. The site layout has considered the location of known Aboriginal places and objects and avoided them where possible. Only one Aboriginal object was located within the Project footprint; however, several others may be removed if it is determined they may be disturbed by Project activity due to construction activity for example (discussed in Section 4.10). PNX will not disturb archaeological places or objects without an archaeologist to lead the process of salvage in consultation with Traditional Owners and in accordance with the *Heritage Act*.

4. Existing Environment

4.1 Location and Climate

The Pine Creek region has a tropical savannah climate (Bureau of Meteorology (BOM), 2016) and is characterised by distinct wet and dry seasons. The wet season occurs from November to April, and is typified by hot, humid conditions, monsoonal rains and tropical cyclones, while the dry season occurs from May through October, and is typically dry and sunny (Appendix 1). Climate and meteorological data recorded from the nearest Bureau of Meteorology (BOM) monitoring station, the Douglas River Research Farm (station number 014901), located approximately 50 km southwest of the Project, indicates that the climate is largely typical of the tropical Northern Territory region. Temperatures are relatively warm throughout the year, and are highest from October to April with slightly cooler temperatures from May to August (Figure 4.1) (Appendix 1). The highest average maximum daily temperature recorded between 1996 and 2019 was 37.9°C, recorded in October, with the lowest average minimum temperature of 12.9°C recorded in July (Appendix 1). Humidity for the region peaks during February (average of 66 to 86%) and is lowest between August and September (averages of 23 to 52% and 25 to 59%, respectively) (BOM, 2020a). Average daily solar exposure from 1990 to 2020 indicates solar exposure levels are relatively even throughout the year with little seasonal variation (Appendix 1).

Annual average rainfall at the Douglas River Research Farm from 1968 to 2021 is 1,245.2 mm, with 91% of annual rainfall occurring from November to March, and less than 0.5% occurring from June to August. Dust emissions are influenced by rainfall, and as such dust levels in the Project area are more likely to be moderated during high rainfall periods from November and March (Appendix 1). Average monthly rainfall data is presented below in Figure 4.1. Relative humidity data recorded from the Douglas River Research Farm monitoring station between 1968 and 2010 shows relative humidity in the region is consistently higher at 9 am than at 3 pm throughout the year, and highest during December through March (Appendix 1).

Wind direction data from the Douglas River Research Farm monitoring station shows there are two dominant wind directions, with variation between seasons and between day and night. Winds during the wet season occur predominantly from the northwest, and from the southeast during the dry season (Figure 4.2). Diurnal wind distribution (Figure 4.3) indicates that during the day winds are predominantly from the southeast, particularly in the afternoon, and are typically the strongest winds to occur. Winds during the night are predominantly from the northwest.

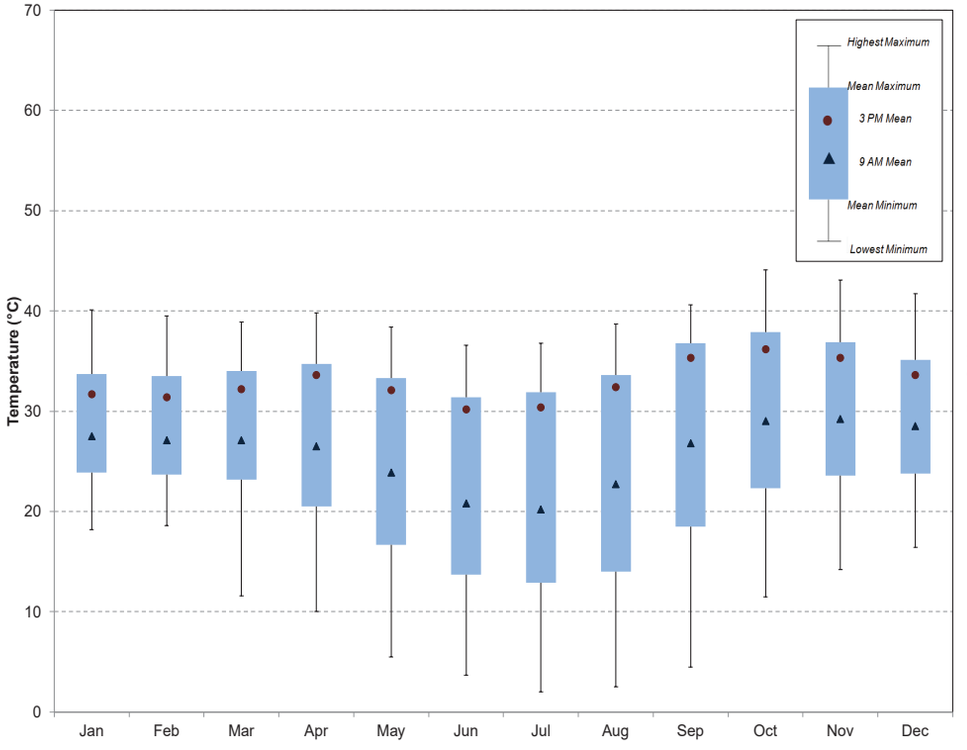
Cyclones occur in the Darwin catchments on average at least once every two years. From 1970 to 2016, a single cyclone occurred in 36% of years and two cyclones occurred in 11% of years. Recent research by the Commonwealth Scientific and Industrial Research Organisation (CSIRO, 2018) indicates tropical cyclones will be fewer but more intense in the future, although considerable uncertainties remain.

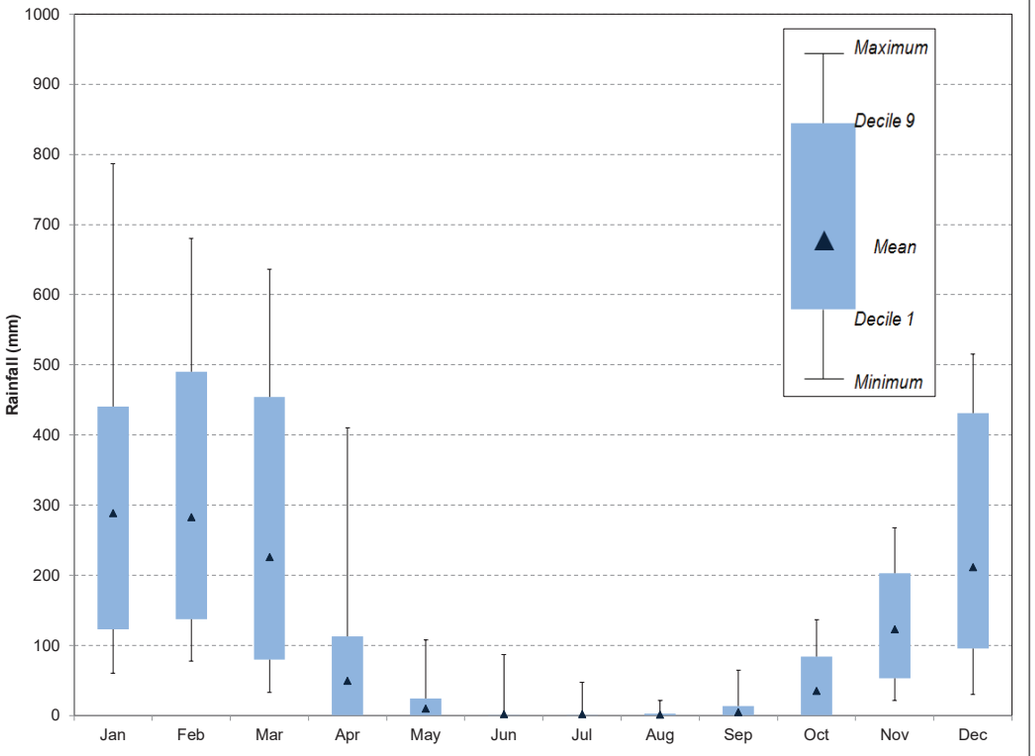
For the Darwin catchments, 24% of climate models project a drier future, 33% project a wetter future and 43% are within ±5% of the historical mean, indicating ‘little change’ (CSIRO, 2018).

TEMPERATURE RANGE AND AVERAGE MONTHLY RAINFALL

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FIGURE 4.1



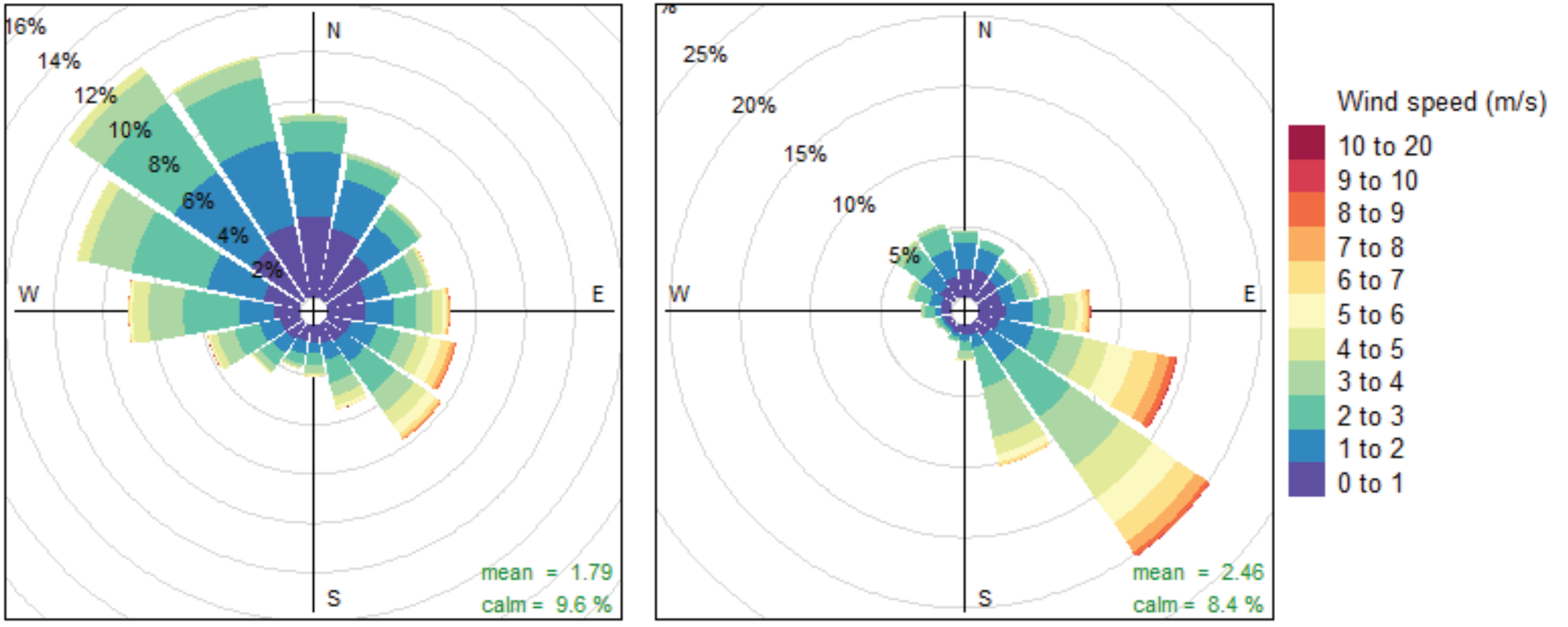


Source: Katestone, 2020

DISTRIBUTION OF WINDS DURING THE WET AND DRY SEASONS FROM 2015 TO 2019

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FIGURE 4.2

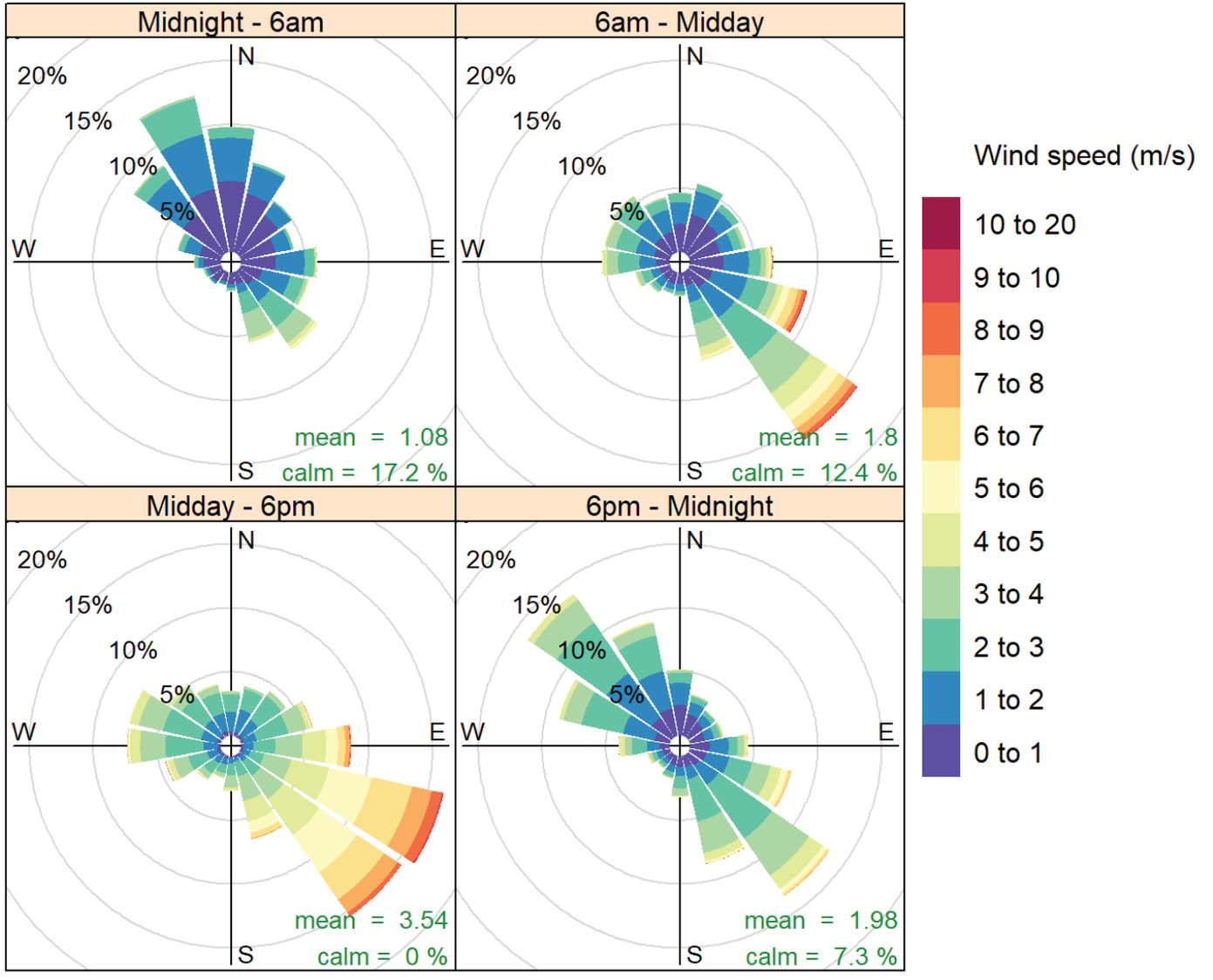


Source: Katestone, 2020

DIURNAL WIND DISTRIBUTION FROM 2015 TO 2019

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FIGURE 4.3



Source: Katestone, 2020

4.2 Topography, Geology and Soils

4.2.1 Topography

The Project is located in hilly, gently undulating terrain with scattered hills and alluvial flats interspersed with creek beds bordered by flood out country. The terrain surrounding the Project area has been described as having low ridges with elevations between 90 and 100 mAHD (GBS, 2007).

4.2.2 Geology

The Fountain Head and Tally Ho deposits are located within the Pine Creek Inlier or “Pine Creek Geosyncline”, an ancient granitic basin overlain by shallow marine to continental supracrustal rocks (sediments and volcanics) that accumulated in less than 20 million years (Needham et al., 1984).

The mineralisation at Fountain Head and Tally Ho occurs within the upper units of the Burrell Creek Formation, a tight to isoclinally folded sequence of mainly pelitic and psammitic Lower Proterozoic sediments with interlayered tuff units. These cyclic siltstone, mudstone and greywacke packages have been metamorphosed over time to greenschist facies. In the area, stratigraphy is folded along northwest-southeast axes that plunge shallowly to the southeast.

Mineralisation at Fountain Head is intimately associated with the Fountain Head Anticline. The Tally Ho deposit is located just to the southwest of the Fountain Head deposit and sits on the western limb of the Fountain Head Anticline.

Mineralisation occurs in veins as either conformable anticlinal lodes (with flanking mineralisation) or subvertical ‘ladder vein’ styled mineralisation associated with brittle failure sub-parallel to the fold axis, and is found within mudstones, greywackes and phyllite units. Sheeted quartz vein stock-works occur mainly in the axial zone with veins predominantly dipping northeast, and some saddle reefs occur in the axial zone. Increased grades encountered at Fountain Head are thought to result from secondary deformation of the Fountain Head anticline (PNX Metals, 2019b). Gold is associated with quartz veining containing a pyrite-arsenopyrite sulphide assemblage and coarse gold is also not uncommon.

4.2.3 Land Systems

The Department of Environment and Natural Resources online mapping database (NR Maps) was accessed to identify the land systems present within the Project area. The Project is located predominantly within the Rumwaggon land system with a small area in the McKinlay land system. The Rumwaggon and McKinlay land systems are described in Table 4.1.

Table 4.1 – Land Systems within the Project Area

Land System	Class	Class Description	Landform	Soils
Rumwaggon	Sandstone plains and rises	Plains, rises and plateaux on mostly sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrops	Low rounded hills and low gravelly ridges with intervening alluvial flats	Lithosols on rises, yellow podzolics on alluvial areas
McKinlay	Alluvial floodplains	Alluvial floodplains, swamps, drainage depressions and alluvial fans; sandy, silty and clay soils on Quaternary alluvium	Alluvial floodplains and channels	Siliceous sands, silty brown and yellow earths, yellow podzolics

4.2.4 Soils

Soil types within the Project area have been identified using the Atlas of Australian Soils (mapped by the Bureau of Rural Sciences after CSIRO, 1991; described by Northcote et al., 1968). Soil units Tb134 and JJ28 are present within the Project area (Figure 4.4) and are described in Table 4.2.

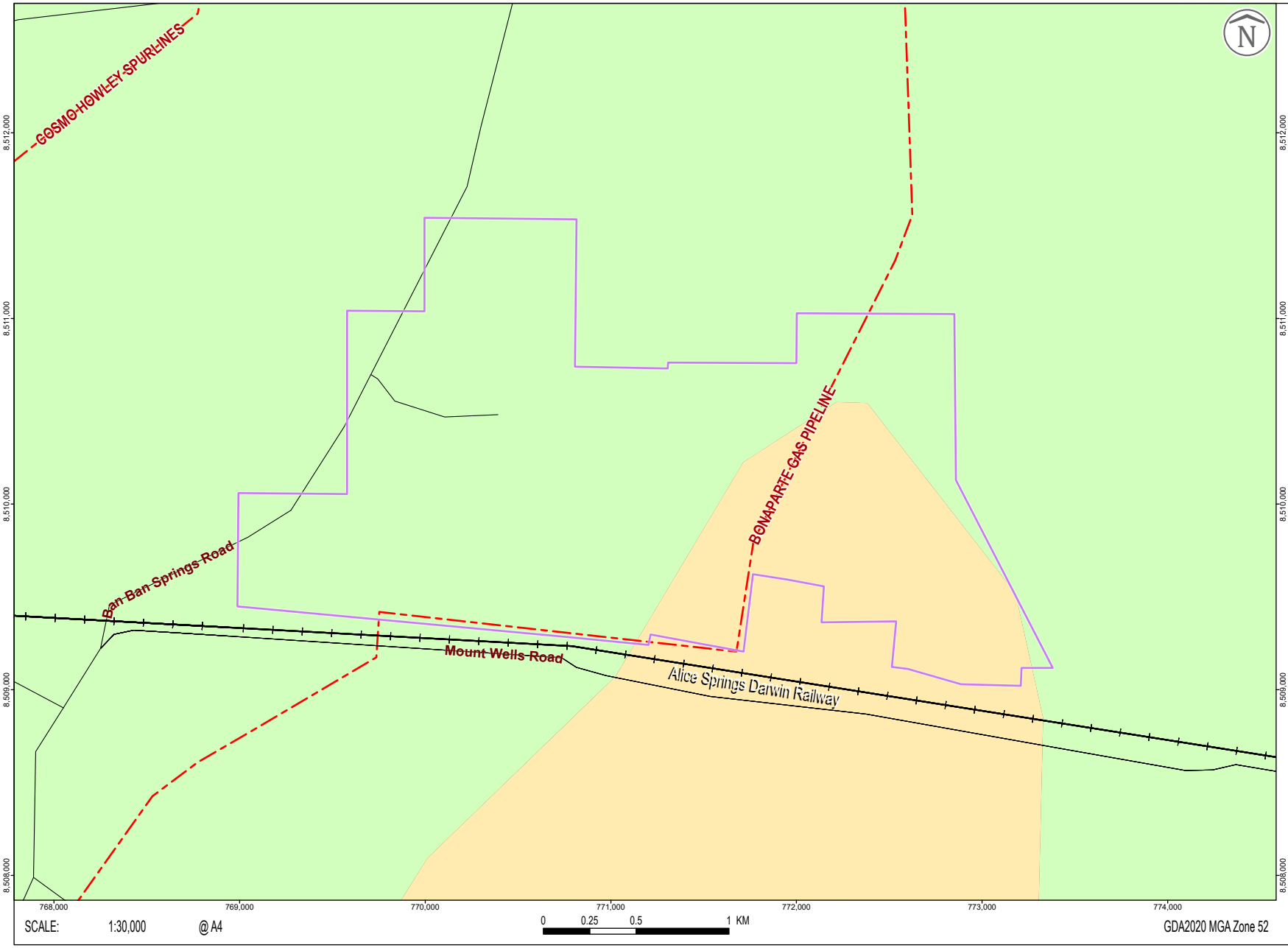
Table 4.2 – Description of Soil Types within the Project Area

Soil Unit	Australian Soils Atlas Description
Tb134	Strongly undulating to hilly lands on greywacke, siltstones, and sandstones with rock outcrops, and interspersed with gently sloping to flat-floored valleys of variable size and extent: soil dominance varies markedly between the valleys and the hilly portions Chief soils of the basal hill slopes and the valleys are hard acidic, and also neutral, yellow mottled soils, including hard settling bleached acid and neutral soils, sometimes alkaline and usually in association with yellow and grey earths such as non-calcareous yellow acid earths and grey bleached neutral earths Chief soils of the hill slopes are shallow stony and gravelly loams including pale grey-brown and firm shallow siliceous loams and sands such as hard-settling red duplex soils and yellow and yellow grey acid soils; and yellow earths such as acid bleached, and acid mottled yellow bleached massive earths Small areas of other soils, such as red acid massive earths, occur on included andesites and dolerite sills
JJ28	Low to steep hills, ridges and cuestas intersperse with small sandy plain areas, mainly on sandstones, with some shales; rock outcrops common; narrow valleys: chief soils are probably shallow stony sands/pale sands without B horizons, firm siliceous sand with pale sands with colour B horizons. Associated are slopes and plains of yellow earth sands with coherent earth subsoils, with gravelly ironstone and red non-calcareous massive earths, yellow neutral massive earths and mottled yellow earth soils; and narrow valley plains of yellow earths such as mottled yellow bleached acid soils. Small areas of adjoining units may be included

SOILS OF THE PROJECT AREA

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FIGURE 4.4



Road
Railway
Gas pipeline
Project area

Soil
JJ28
Tb134

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS022_v0-b

Figure Number: 01238D_EIS_F04.4_GIS_v0-b

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DATA SOURCES:
Project data from PNX Metals, 2021.
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4.3 Air Quality and Greenhouse Gas

4.3.1 Introduction

The Project is located in a relatively remote area of the Northern Territory, with predominant nearby land uses including cattle grazing and resource exploration (Appendix 1). The nearest sensitive receptor is the former Grove Hill Hotel, which is now a residence and is located approximately 5.5 km east of the Project. Other sensitive receptors in the Project vicinity are the Hayes Creek Wayside Inn and Caravan Park, located approximately 13 km to the southwest, and the Ban Ban Springs Homestead, approximately 9 km to the north.

4.3.2 Existing Sources of Emissions

Existing sources of air emissions in the vicinity of the Project include natural sources of emissions such as particulate matter from wind erosion of exposed ground and mining and exploration activity. Exploration activity is occurring throughout the Territory, with the closest current exploration activity 6.5 km directly to the north of the Project at the old Woolwonga mine site. The Cosmo Gold Mine (operating until March 2020) is located 15 km from the Project, and the Kirkland Lake Gold's Union Reefs processing facility (operating until March 2020), which processes the ore from the Cosmo Gold mine is located approximately 70 km south of the Project. The National Pollutant Inventory database reported that the Cosmo Gold Mine particulate matter (PM) emissions from the 2017/2018 reporting period were 10,000 kg/year of PM_{10} and 6,100 kg/year of $PM_{2.5}$, indicating that existing mining operations in the Project region are a current source of particulate emissions. The Union Reef Gold Mine reported 8,400 kg/year of PM_{10} and 8,000 kg/year of $PM_{2.5}$ in 2017/2018.

Industry in the Northern Territory emitted a total of approximately 840 million kg of PM_{10}, and 29 million kg of $PM_{2.5}$, as reported in the National Pollutant Inventory during 2017/2018. To put this into perspective, the emissions from the nearby Cosmo Gold Mine comprise approximately 1 to 8% and 0.0002% of the total PM_{10} and $PM_{2.5}$ industry emissions, respectively.

4.3.3 Existing Ambient Air Quality

Ambient air quality measurements from three NT EPA monitoring stations in the Darwin Region at Palmerston, Winnellie and Stokes Hill, provide the nearest existing air quality conditions, at the nearest location approximately 130 km from the Project area. Ongoing monitoring results from these three stations indicates that concentrations of PM_{10} and $PM_{2.5}$ are predominantly below the air quality guidelines of the National Environment Protection (Ambient Air Quality) Measure (Air NEPM) (NEPC, 1998), with occasional exceedances. Annual reporting by the NT EPA indicates that bushfires that largely occur during the dry season are the largest source of PM_{10} (Appendix 1; NT EPA, 2021a) and ultimately are the cause of the recorded exceedances.

Monitoring of PM_{10} concentrations at the three monitoring stations from 2016 to 2020 show that annual average concentrations of PM_{10}, averaged over a daily 24-hour period, are below the Air NEPM standard of 25 µg/m^3 (see Table 4.3). Annual average PM_{10} concentrations ranged from 13.4 µg/m^3 at Winnellie in 2018 to 23 µg/m^3 at Winnellie in 2019. Maximum 24-hour concentrations of PM_{10} were predominantly above the Air NEPM standard of 50 µg/m^3, often far exceeding the standard and ranged from 46.3 µg/m^3 at Stokes Hill in 2020 to 143.1 µg/m^3 at

Palmerston in 2018. Concentrations of PM_{10} for the 75th percentile (24-hour average) were below the Air NEPM standard of 50 µg/m^3 across all years at all locations (Table 4.3).

Table 4.3 – Summary of 24-hour Average PM_{10} Concentrations in Darwin Region

Year	Maximum 24-hour Average			75th Percentile 24-hour Average			Annual Average		
	Palmerston	Winnellie	Stokes Hill	Palmerston	Winnellie	Stokes Hill	Palmerston	Winnellie	Stokes Hill
2016	68.9	52.3	NM*	18.2	20.6	NM*	15.2	16.4	NM*
2017	58.8	53.8	48	26	20.9	25	19.5	15.5	19.9
2018	143.1	77.8	64.4	27.1	18.9	30.3	19.9	13.4	22.6
2019	84.5	84.6	95.2	28.3	30.9	27.8	22	23	22.4
2020	52.3	51.9	46.3	23.4	21.3	22.8	18.3	16.9	17.3
Standard	50 µg/m^3			50 µg/m^3			25 µg/m^3		

* NM = Not measured.
Source: Appendix 1; NT EPA, 2021a.

Annual average concentrations of $PM_{2.5}$ (recorded over a 24-hour averaging period occasionally exceed the relevant Air NEPM standard of 8 µg/m^3, with results ranging from 6.3 µg/m^3 at Stokes Hill in 2020 to 9.7 µg/m^3 at Palmerston in 2019 (see Table 4.4). The maximum 24-hour average concentration of $PM_{2.5}$ exceeded the Air NEPM guideline of 25 µg/m^3 at all three monitoring locations in all years from 2016 to 2020, and ranged from 28.5 µg/m^3 at Stokes Hill in 2017 to 111.7 µg/m^3 at Palmerston in 2018. The 75th percentile 24-hour averages of $PM_{2.5}$ at all three monitoring stations were below the Air NEPM standard of 25 µg/m^3 across all years, varying from 8.7 µg/m^3 at Palmerston in 2016 to 13.5 µg/m^3 3 at Palmerston in 2019 (Table 4.4).

Table 4.4 – Summary of 24-hour Average $PM_{2.5}$ Concentrations in Darwin Region

Year	Maximum 24-hour Average			75th Percentile 24-hour Average			Annual Average		
	Palmerston	Winnellie	Stokes Hill	Palmerston	Winnellie	Stokes Hill	Palmerston	Winnellie	Stokes Hill
2016	58.7	40.8	NM*	8.7	8.8	NM*	7.2	6.5	NM*
2017	42.3	40.8	28.5	10.4	10.1	10.6	7.3	6.7	7.3
2018	111.7	57.3	43.6	11.8	12.9	12.3	8.7	9.1	8.3
2019	62.5	49.0	42.8	13.4	12.5	12.6	9.7	9.0	9.2
2020	38.4	39.2	34.3	9.8	9.1	9.0	7.0	6.5	6.3
Standard	25 µg/m^3			25 µg/m^3			8 µg/m^3		

* NM = Not measured.
Source: Appendix 1; NT EPA, 2021a.

4.3.4 Greenhouse Gas

Sources of greenhouse gas (GHG) emissions relevant to the Project include stationary energy (generating electricity or energy generation), and land use, land use change and forestry (LULUCF). Greenhouse gas emissions from LULUCF is caused by the loss and release of carbon from cleared vegetation and decaying natural material, and specifically in the Project area from the clearing of eucalyptus woodland (Appendix 1). In 2017, Australia reported that the Northern

Territory contributed 16.6 metric tonnes of carbon dioxide equivalent ($MtCO_2$-e) to the national inventory of 534.7 $MtCO_2$-e, approximately 3.1% to the total national emissions inventory, from stationary energy and LULUCF (Commonwealth of Australia (CoA), 2019a, 2019b, Appendix 1).

PNX are currently not required to report on their energy use and GHG emissions under the National Greenhouse and Energy Reporting (NGER) framework, as the Project site has been under care and maintenance and emissions and energy use do not currently meet the NGER thresholds (see Section 7.2). As such, there is no available existing GHG data for the Fountain Head Gold Project.

4.4 Noise and Vibration

4.4.1 Noise Receptors

The Grove Hill Historic Hotel, located approximately 5.5 km east of the Project area on Mount Wells Road (Figure 4.5) was identified as the nearest sensitive receptor to the Project area. Existing background noise levels were monitored at the Grove Hill Historic Hotel from 3rd to 10th March 2020 as part of a noise assessment conducted for the Project (Appendix 2).

The next closest sensitive receptor – the Ban Ban Springs Homestead, approximately 9 km north of the Project area (Figure 4.5) – was not monitored as part of the assessment as it is approximately 3 km further away from the Project area than the Grove Hill Historic Hotel and will receive less Project-related noise than the hotel. Assuming the Grove Hill Historic Hotel is not adversely impacted by Project-related noise, the assessment deduces that the Ban Ban Springs Homestead will similarly not be adversely affected.

Consideration has also been given to the buried high-pressure Bonaparte Gas Pipeline (BGP), which at its closest point is 370 m from the pit crest to the east and 480 m in the south (Figure 4.5). Although noise emissions are unlikely to affect the BGP, it may be sensitive to vibrations produced from Project activities.

4.4.2 Measuring Background Noise

The level of a sound in decibels (dB(A)) is considered a good measure of the loudness of that sound. It is measured using the 'A-weighting' filter incorporated in sound-level meters. These filters have a frequency response corresponding approximately to that of human hearing. People's hearing is most sensitive to sounds at mid frequencies (typically 500 Hz to 4000 Hz) and less sensitive at lower and higher frequencies.

As environmental noise usually varies in levels over a particular period, it is common to present the results of environmental noise testing in the form of statistical descriptors. Background noise levels have been described in terms of L_{A90}, which is the A-weighted sound pressure level exceeded for 90% of a given measurement interval and is representative of the average minimum sound level.

4.4.3 Background Noise Environment

Measured background noise levels at the Grove Hill Hotel are shown in Figure 4.6 and summarised below:

- Daytime[2] L_{A90} background noise level: 28 dB(A).
- Evening[3] L_{A90} background noise level: 32 dB(A).
- Night[4] L_{A90} background noise level: 37 dB(A).

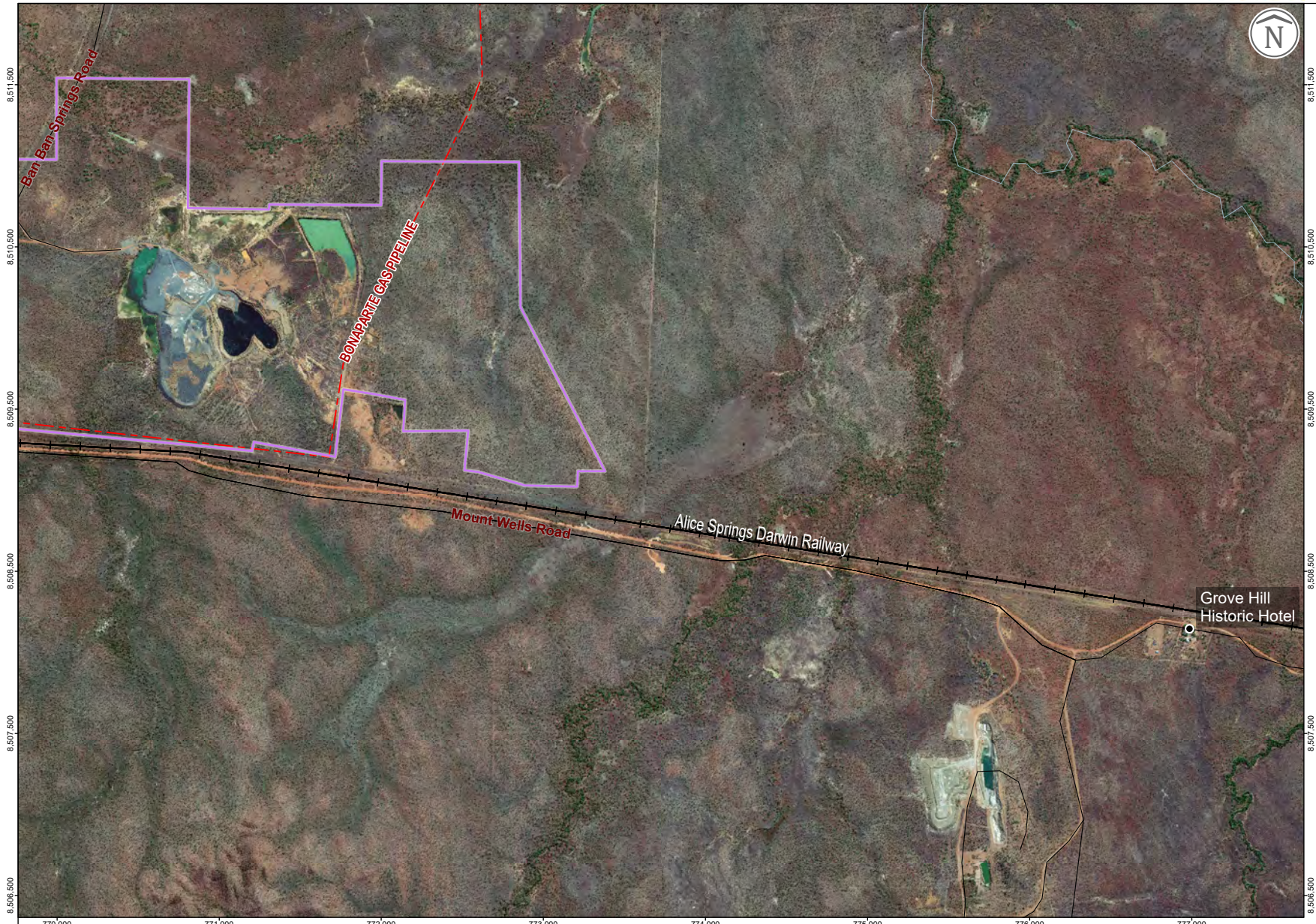
Results show that background noise is relatively low during the day, with increased noise during the evening and night. This is representative of an environment with very low levels of traffic noise and noise dominated by insects at night.

[2] Daytime – between 7 am and 6 pm (Monday to Saturday), 8am and 6 pm (Sunday and public holidays).
[3] Evening – between 6 pm and 10 pm (all days).
[4] Night – between 10 pm and 8 am (if the following day is a Sunday or public holiday), 10 pm and 7 am (all other days).

SENSITIVE NOISE RECEPTORS

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FIGURE 4.5



- Noise receptor
- Road
- Railway
- Gas pipeline
- Watercourse
- Project area

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS015_v0-c

Figure Number: 01238D_EIS_F04.5_GIS_v0-c

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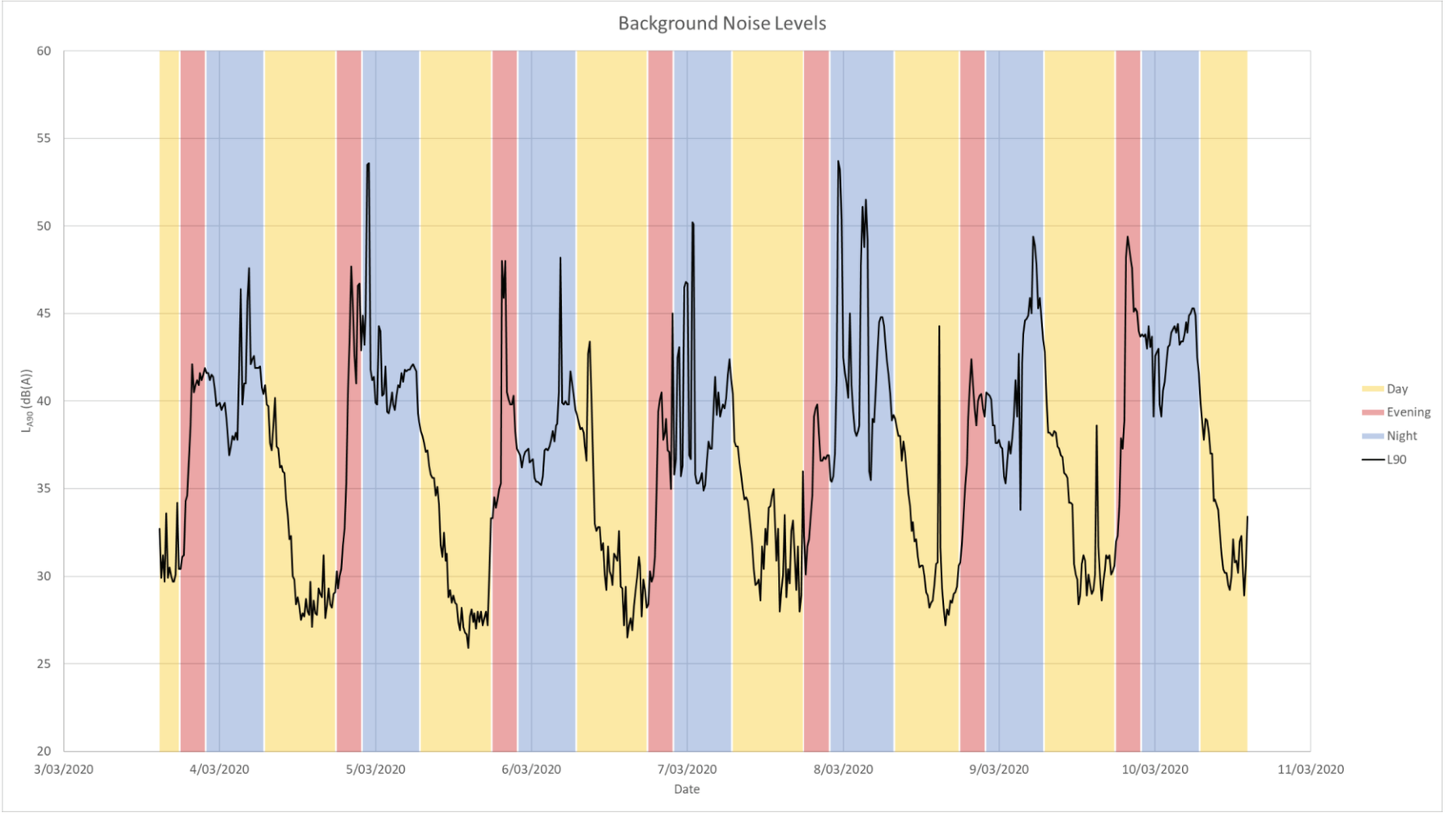
ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

BACKGROUND NOISE LEVELS

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FIGURE 4.6



Source: SONUS

4.5 Surface Water

4.5.1 Hydrology

4.5.1.1 Regional Hydrology

Darwin Catchments

The Project lies in the Adelaide River Basin surface water management area of the Timor Sea Drainage Division, as defined by the Australian Water Resources Council (AWRC) (Petheram et al., 2009). This drainage division encompasses an area of around 564,647 km^2, with streams tending to run west towards the Indian Ocean or north to the Timor Sea. Considering streamflow per area, it is the second wettest drainage division in Australia (CSIRO, 2009). Within this drainage division, the Project is located in the upper catchment of the Margaret River, which is a tributary of the Adelaide River. The Adelaide River flows through extensive coastal and marine floodplains east of Darwin into the Arafura Sea and has a total basin area of approximately 7,700 km^2 (Pusey et al., 2017). Along with the Finniss, Mary and Wildman rivers, the Adelaide River is part of the Darwin catchments (also known as the Van Dieman region) within the Timor Sea Drainage Division. The Darwin catchment covers an area of approximately 30,000 km^2 (CSIRO, 2018) (Figure 4.7).

The Darwin catchments include both highly modified urban and agricultural landscapes, operational and legacy mines, and large areas of relatively intact landscapes. More than half of the population of the Northern Territory lives in the Darwin catchments, yet 53% of the total area is retained as conservation lands and other natural environments, much of it relatively undisturbed. These landscapes are important for the wide range of ecosystem services they provide, including Darwin's water supply, recreational activities, tourism, cattle grazing on native pastures, and varied conservation and environmental values (CSIRO, 2018).

The Darwin catchments have a hot and humid climate with a more reliable rainfall than other parts of northern Australia, with wet season rainfall strongly influenced by the monsoon trough. The Darwin catchments can experience equally long runs of consecutive dry and wet years. Approximately 95% of the annual mean rainfall occurs in the wet season (November to April) (CSIRO, 2018). There is a strong rainfall gradient that runs from the northwest coastal corner (1,625 mm annual mean) to the southeast where the Project is located (1,250 mm annual mean). The rivers are all externally draining and are considered to be gaining systems because rainfall is generally highest near the coast and lowest in the headwater catchments (Petheram et al., 2009).

Approximately 82% of runoff in the Darwin catchments occurs during the period between January and March, with the highest monthly totals occurring during March (CSIRO, 2018). There is little rainfall during the dry season to sustain continuous flows in many of the surface waters of the Timor Sea Drainage Division, except where substantial groundwater input is received which maintains baseflows during the dry season (e.g., Daly, Roper, Jardine and Gregory rivers) (Pusey et al., 2017). Most streams throughout the region can be considered seasonally flowing, i.e., have no flow during most of the dry season.

Tidal ranges in northern Australia are large relative to southern Australia. As a consequence of the large tidal range, flat coastal topography and low dry season flow, salt water penetrates long

distances inland for many rivers in northern Australian, extending up to 100 km inland in Darwin catchment rivers (CSIRO, 2018). The tidal limit of the Adelaide River is located at Marrakai Crossing (Figure 4.7), almost 100 km from the coast (Hughes et al., 2018).

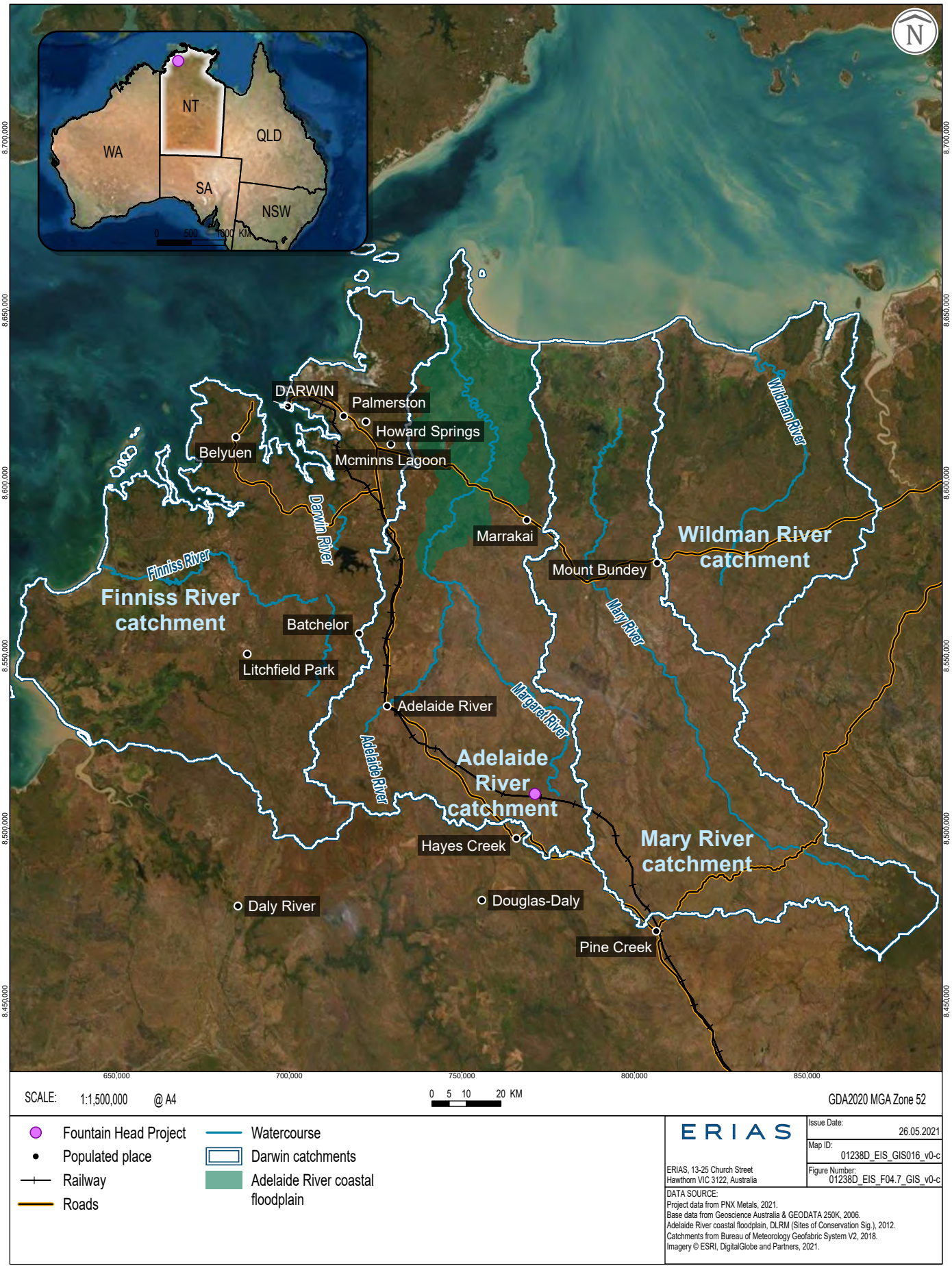
Broad-scale flooding in the Darwin catchments is largely limited to the coastal floodplains where inundation can occur for more than 20 consecutive days. Where flooding does occur upstream of the coastal plains it is limited, and areas typically remain inundated for less than three days (CSIRO, 2018).

The freshwater coastal floodplains of the Darwin catchments provide a mosaic of highly productive wetland habitats and contain five of the 33 Northern territory wetlands of national significance, including the Adelaide River coastal floodplain (Figure 4.7) within the Adelaide River Basin (CSIRO, 2018). This floodplain extends from the junction of the Margaret River in the south to the mouth of the Adelaide River at the coast and is a large seasonally inundated freshwater floodplain that is traversed by a permanent tidal section of the Adelaide River.

DARWIN CATCHMENTS AND REGIONAL FEATURES

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FIGURE 4.7



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Issue Date:	26.05.2021
Map ID:	01238D_EIS_GIS016_v0-c
Figure Number:	01238D_EIS_F04.7_GIS_v0-c

DATA SOURCE:
Project data from PNX Metals, 2021.
Base data from Geoscience Australia & GEODATA 250K, 2006.
Adelaide River coastal floodplain, DLRM (Sites of Conservation Sig.), 2012.
Catchments from Bureau of Meteorology Geofabric System V2, 2018.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

Darwin Water Supply

The Darwin region water supply system currently sources surface water from the Darwin River Dam (85%) (Figure 4.7) and groundwater from the McMinns and Howard East Borefields (15%) (PowerWater, 2013). The Darwin River is located within the Finniss River division of the Darwin catchments, to the west of the Adelaide River division.

Power and Water Corporation and the Northern Territory Government have been investigating potential dam sites to provide water supply options for Darwin into the future (PowerWater, 2013). The Marrakai Dam option is located on the Adelaide River immediately downstream of the confluence with the Margaret River. A significant number of existing and legacy mines exist within the Margaret River catchment of Marrakai Dam, including the Fountain Head mine, resulting in potential water quality risks for any future water supply scheme. A dam at this location would also impact on a large proportion of the Adelaide River catchment. Marrakai Dam is therefore not a preferred option for the medium term but remains an option for further assessment in the longer term (PowerWater, 2013).

4.5.1.2 Fountain Head Project Area Hydrology

Catchments and Waterways

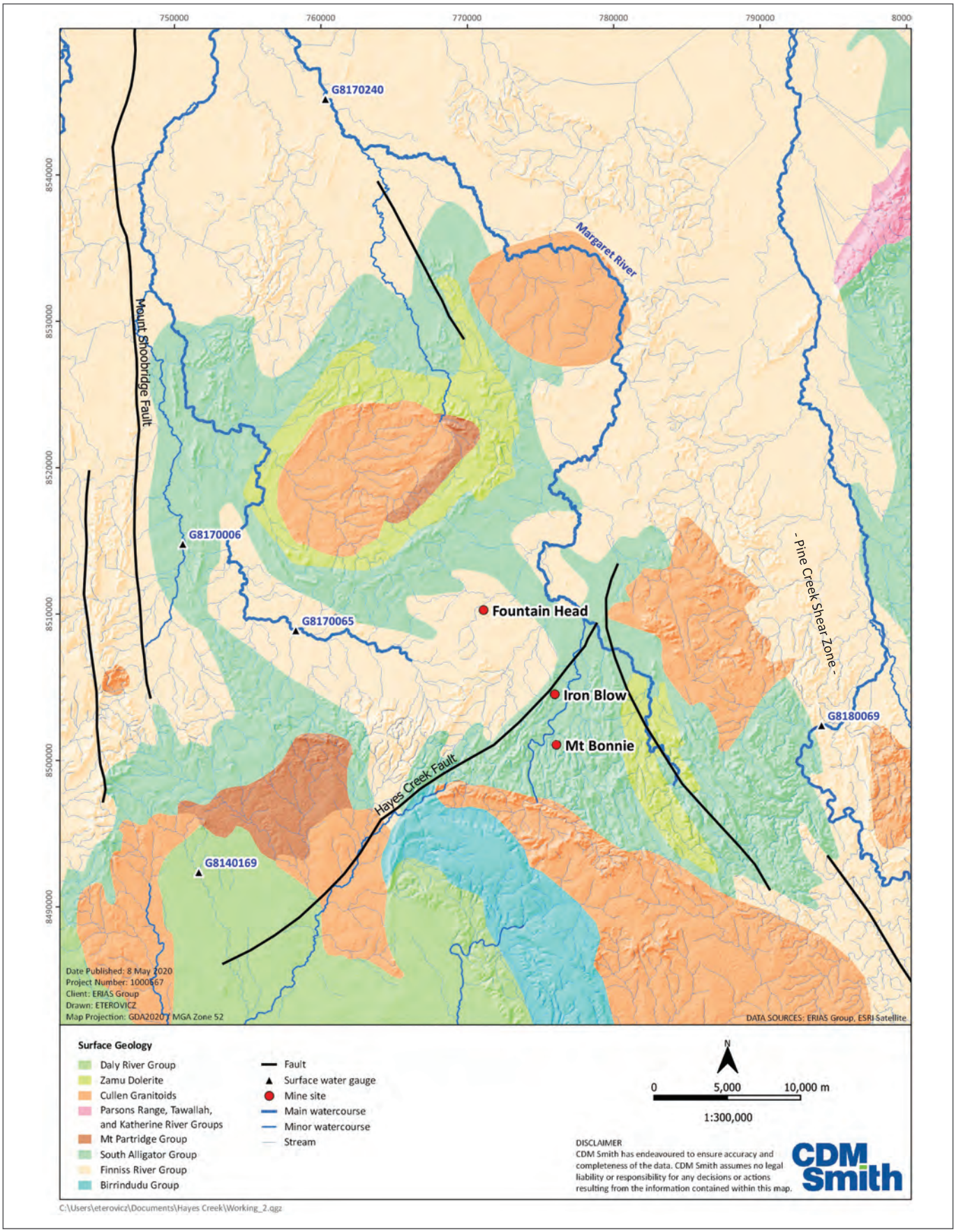
Surface water streams in the area of the Project include both intermittent streams, which have flowing water for all or most of the wet season but are dry during the drier months, and ephemeral streams such as tributaries to the Margaret River, which flow briefly following rainfall and are dry for most of the year. There are no perennial streams in the study area. The presence of water pools in the dry season is likely dependent on the previous wet season's rainfall and subsequent groundwater recharge (Appendix 3).

Limited information is available regarding the hydrology of the Margaret River and its tributaries in the vicinity of the Fountain Head mine. The closest site with available surface water flow data is the historical gauging station G8170240 located at Bobs Hill on the Margaret River approximately 50 km downstream of the mine site (Figure 4.8). An incomplete data record is available from 1967 to 1986 for this location. Figure 4.9 shows the mean monthly discharge and illustrates the intermittent nature of the Margaret River at this location. Flow duration is typically between three and six months.

SURFACE WATER AND REGIONAL GEOLOGY IN THE VICINITY OF FOUNTAIN HEAD

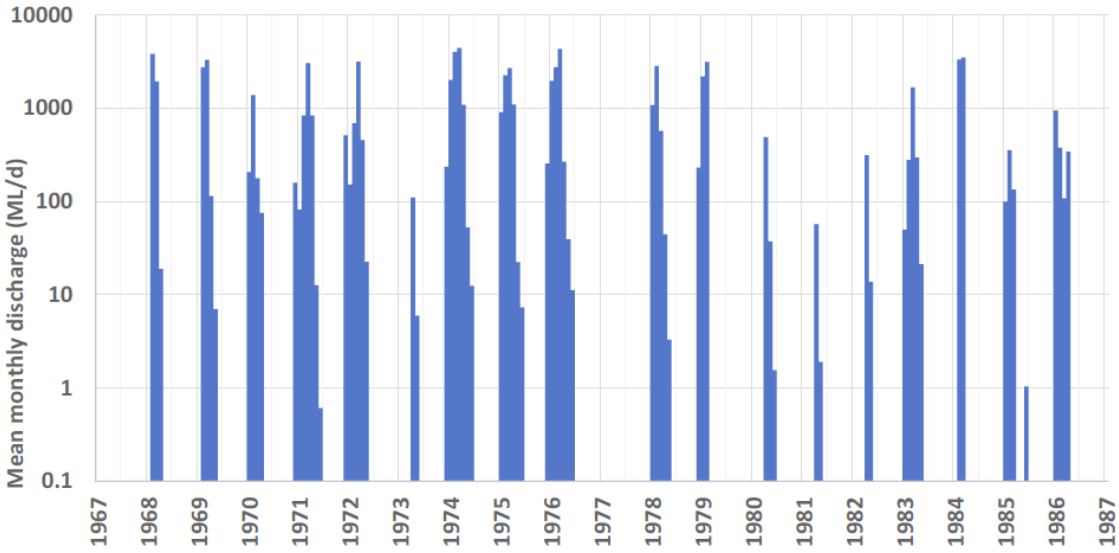
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FIGURE 4.8



Source: CDM Smith

Figure 4.9 – Mean Monthly Discharge of Margaret River at Bobs Hill (G8170240)



Source: Appendix 3.

Hydrological assessment of the Fountain Head area has been undertaken to identify local catchments and quantify surface water flows (Appendix 4). Topographic data and aerial photography were used with hydrological tools to generate surface water models of the Fountain Head site catchment so surface water behaviour can be investigated, described and better understood.

As shown in Figure 4.10, the Project area is located in the upper Margaret River catchment. The Project area is mostly within the catchment of an unnamed waterway, which is termed the 'Southern Flow Path' (Plate 4.1), that drains into Fountain Head Lake before overflowing into an unnamed creek (labelled Unnamed Creek in Figure 4.10). The Unnamed Creek drains in an easterly direction on the northern side of the Project area into the Margaret River approximately 7 km downstream. The catchment area of the 'Southern Flow Path' to the south of the Project site is approximately 6 km² and the catchment area of the Unnamed Creek north of the Project site is approximately 33 km². The total catchment of the Margaret River to the confluence of Unnamed Creek is approximately 374 km² (including Unnamed Creek).

Plate 4.1 – Southern Flow Path Upstream of Fountain Head Lake



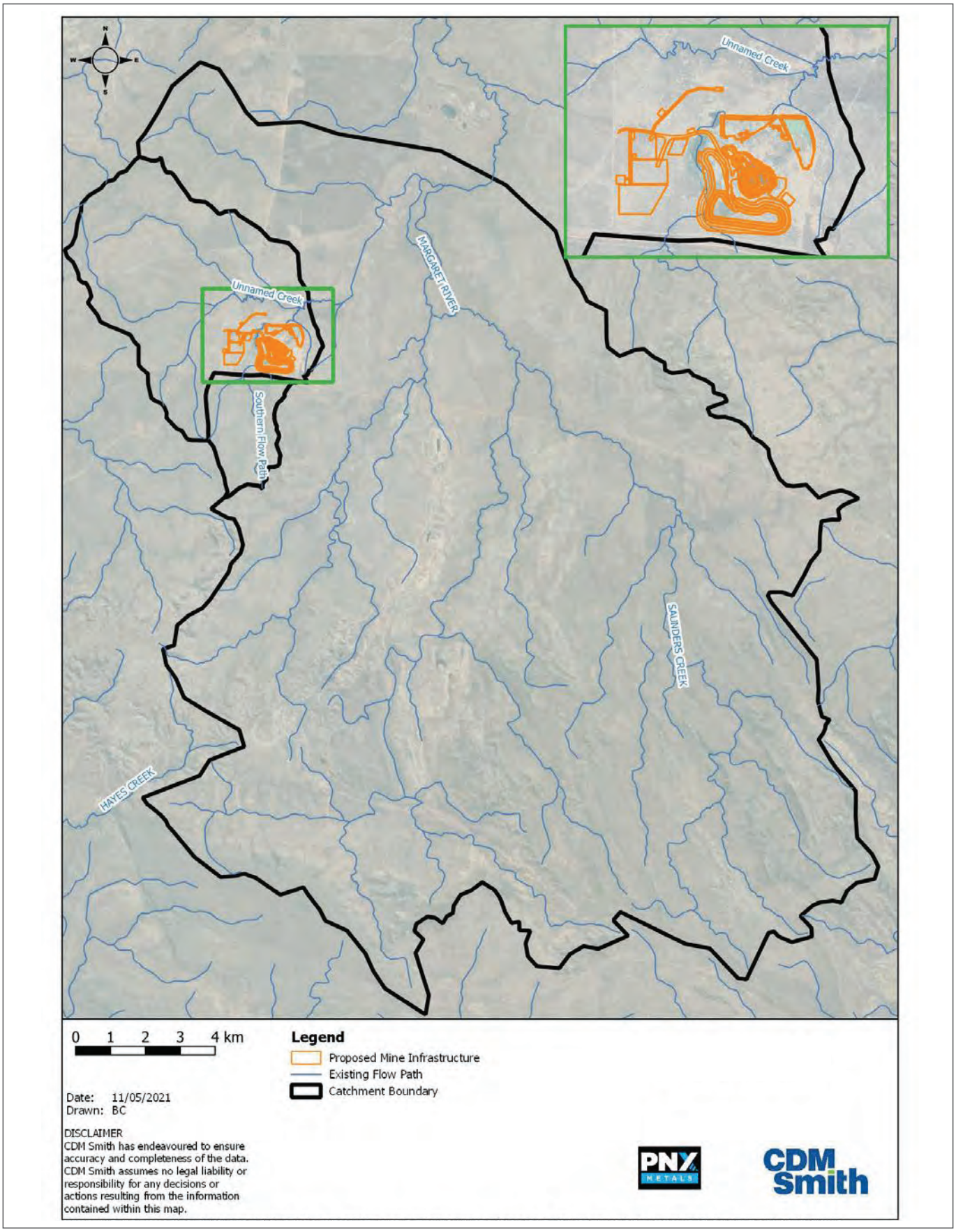
Source: L&MGSPL (2019).

All flow paths at the Project site are ephemeral and experience surface runoff only after rainfall events in the catchment during wet seasons. Surface runoff discharges are highly variable, and most flow paths are likely to dry out during dry seasons when rainfall is low, although some pools hold water for extended periods.

CATCHMENTS AND WATERWAYS IN THE FOUNTAIN HEAD PROJECT AREA

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FIGURE 4.10



Source: Appendix A003

The proposed mine infrastructure components are located on both sides of the existing Fountain Head Lake and to the south of the Unnamed Creek (Figure 3.3). Fountain Head Lake has formed within historical alluvial workings due to the construction of a causeway for a haul road by the previous mine operators. The lake is shown in Plate 4.2, which also shows the existing waste rock storage from previous mining operations. Given the observed water table elevation, water contained within the lake also possibly includes surface expressions of groundwater, as well as the dominant contributions from surface flows along the 'Southern Flow Path' following rainfall events (Appendix 3). Modelling undertaken as part of hydrological assessment for the Project shows that the Fountain Head Lake overflows and discharges over the causeway to the north of the site every year during the wet season, and that there is an average 0.3 m fluctuation in lake water levels between the dry and wet seasons (Appendix 3).

Plate 4.2 – Fountain Head Lake



Source: L&MGSPL (2019).

An existing water storage dam from previous mining operations is located immediately to the northeast of the Fountain Head pit. It is proposed to remediate and extend this dam to provide a facility for dewatering of the pit and provide a water supply for mine operations. This is referred to by the Project as the evaporation pond.

4.5.1.3 Flooding

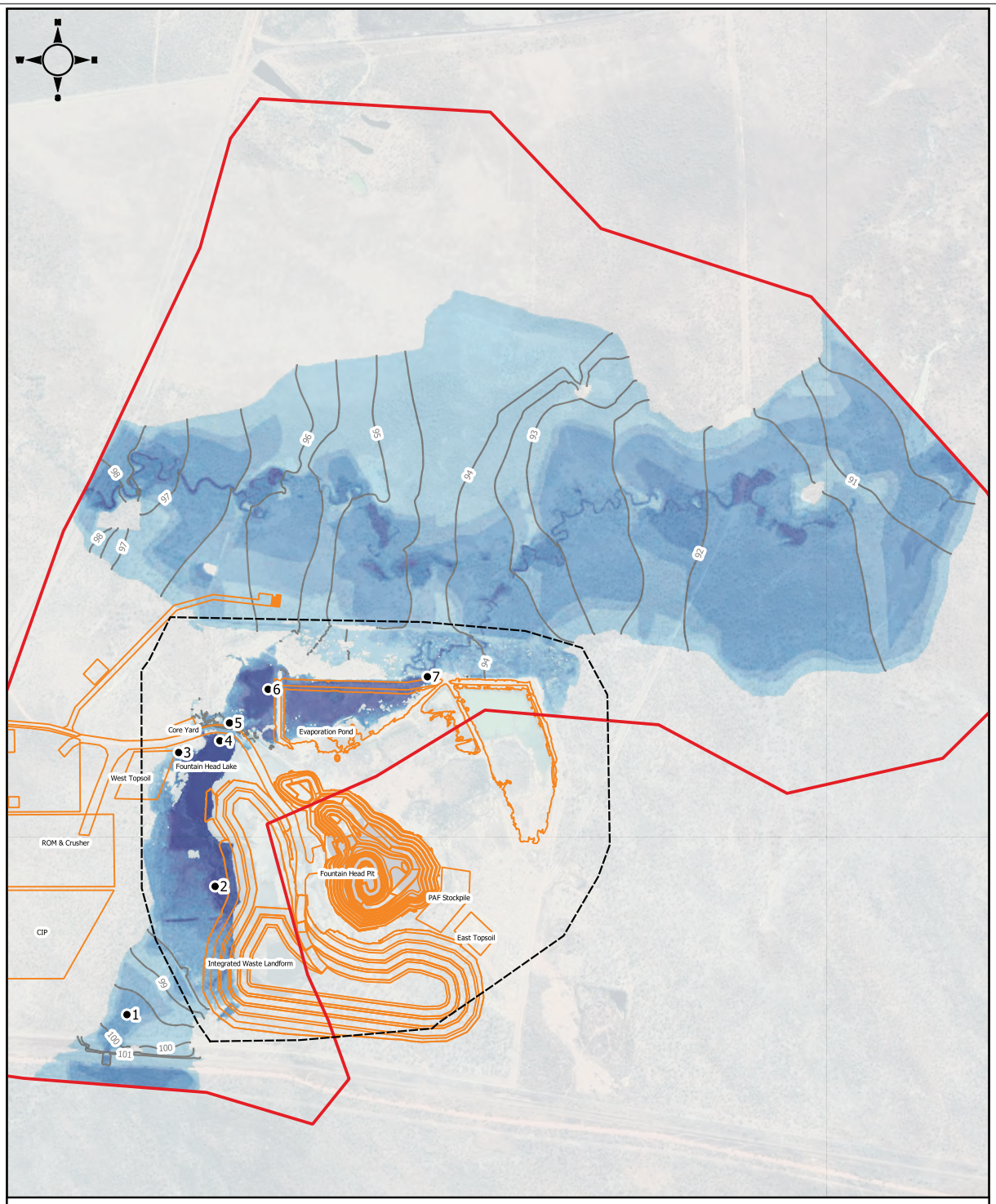
The hydrological assessment of the Fountain Head mine site included modelling to investigate the probability and extent of flooding, to inform operational constraints for mining operations and develop mitigation options to manage water and avoid environmental impacts (Appendix 4). The TUFLOW hydraulic model was used to simulate flood behaviour in the vicinity of Fountain Head Mine for the 10%, 5%, 2%, 1% and 0.1% annual exceedance probability (AEP) design events. This modelling characterised flood extent, depths and velocities for the existing conditions, and was also used to assess the potential flood impact from the proposed mine infrastructure of the Fountain Head Project. Modelled peak flood depths for a 1% AEP (i.e., 1 in 100 years) flood event are shown in Figure 4.11. Note: This shows the mine infrastructure footprint overlaying the predicted flood levels.

Most of the proposed mining infrastructure is located outside the 0.1% AEP flood extent. To reduce the flood risk, a few components of proposed infrastructure (such as the core yard and west topsoil stockpile) are proposed to be raised or protected by bunds to achieve the required flood immunity and reduce erosion potential (Figure 4.12). Further description of proposed flood mitigations is provided in Section 3.7.2.7.

MODELLED PEAK FLOOD DEPTHS (1% AEP) IN FOUNTAIN HEAD MINE AREA

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FIGURE 4.11

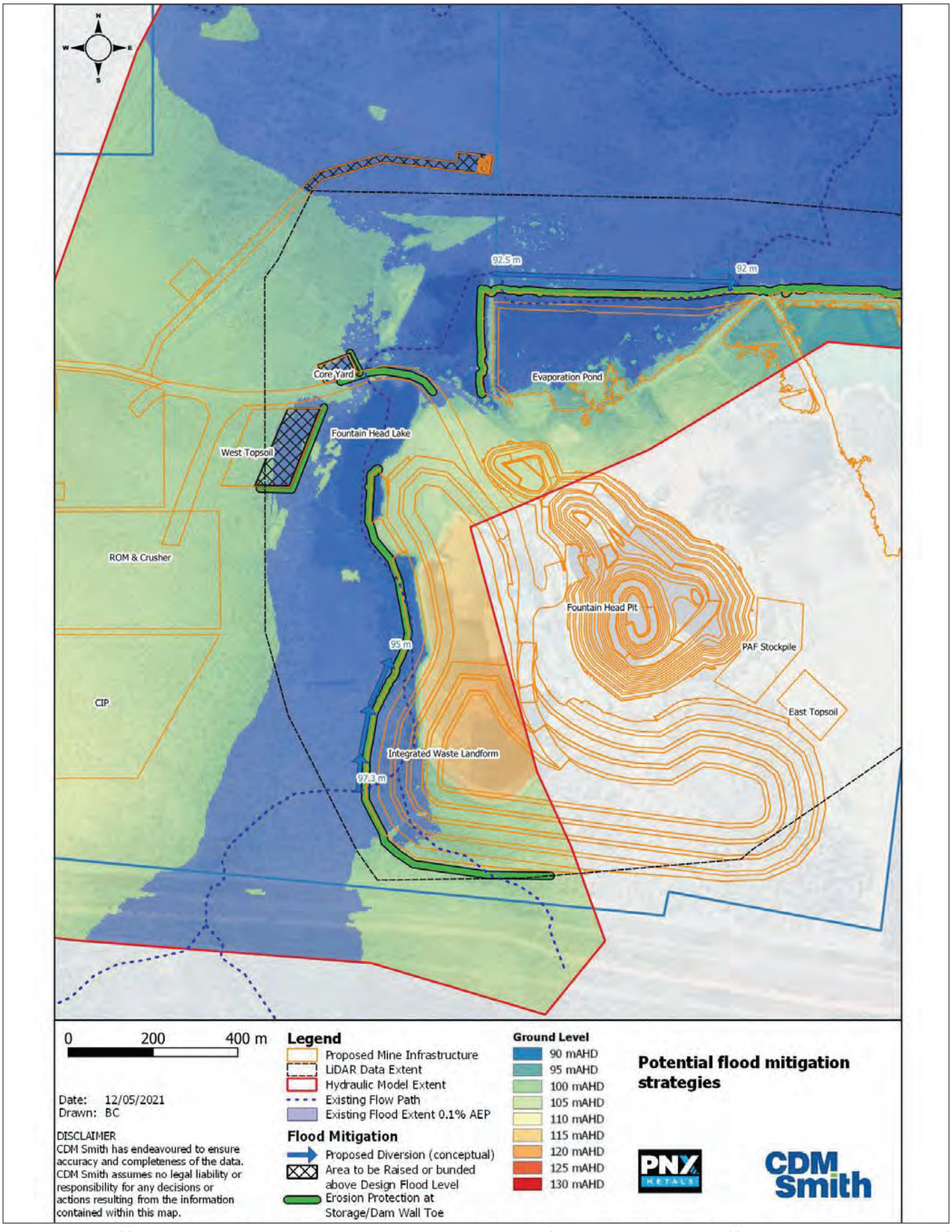


Source: CDM Smith

PROPOSED FLOOD MITIGATION DESIGN FEATURES

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FIGURE 4.12



Source: CDM Smith

4.5.2 Surface Water Quality

This section describes the historical and existing quality of offsite surface waters (i.e., Margaret River and nearby tributary creeks). This description combines data available from care and maintenance monitoring conducted for the previous mine operators from 2012 to 2016 and monitoring data collected for PNX, from April 2019 to April 2021, in line with the Care and Maintenance Operations Mining Management Plan (PNX Metals, 2019c).

Additional surface water quality data was collected during aquatic field surveys conducted by ERIAS (see Appendix 9 for full report) in April 2019 which included a broader suite of analysis than undertaken for the care and maintenance monitoring program. Some discussion of these results has also been included in this section[5].

4.5.2.1 Surface Water Monitoring Results

Surface water monitoring was previously conducted as part of the care and maintenance program by previous mine operators and is now conducted by PNX. Monitoring data is available from 2012 to 2016 and from 2019 to 2021. Sampling is conducted at locations in close proximity to Fountain Head as well as the broader region. Sample locations are provided in Table 4.5 and shown in Figure 4.13. The results of the monitoring program are discussed in the following sections.

Table 4.5 – Care and Maintenance Surface Water Monitoring Locations

Sampling Location	Description	Easting	Northing
FHSW01	Fountain Head, downstream of Fountain Head deposit, near confluence of Margaret River	775109	8515026
FHSW02	Fountain Head, upstream control for FHSW01	773994	8514327
FHSW03	Fountain Head, upstream control for FHLAKE (discussed in Section 4.5.3.3)	770123	8509278
FHSW04	Fountain Head, upstream control for all sites	770082	8511436

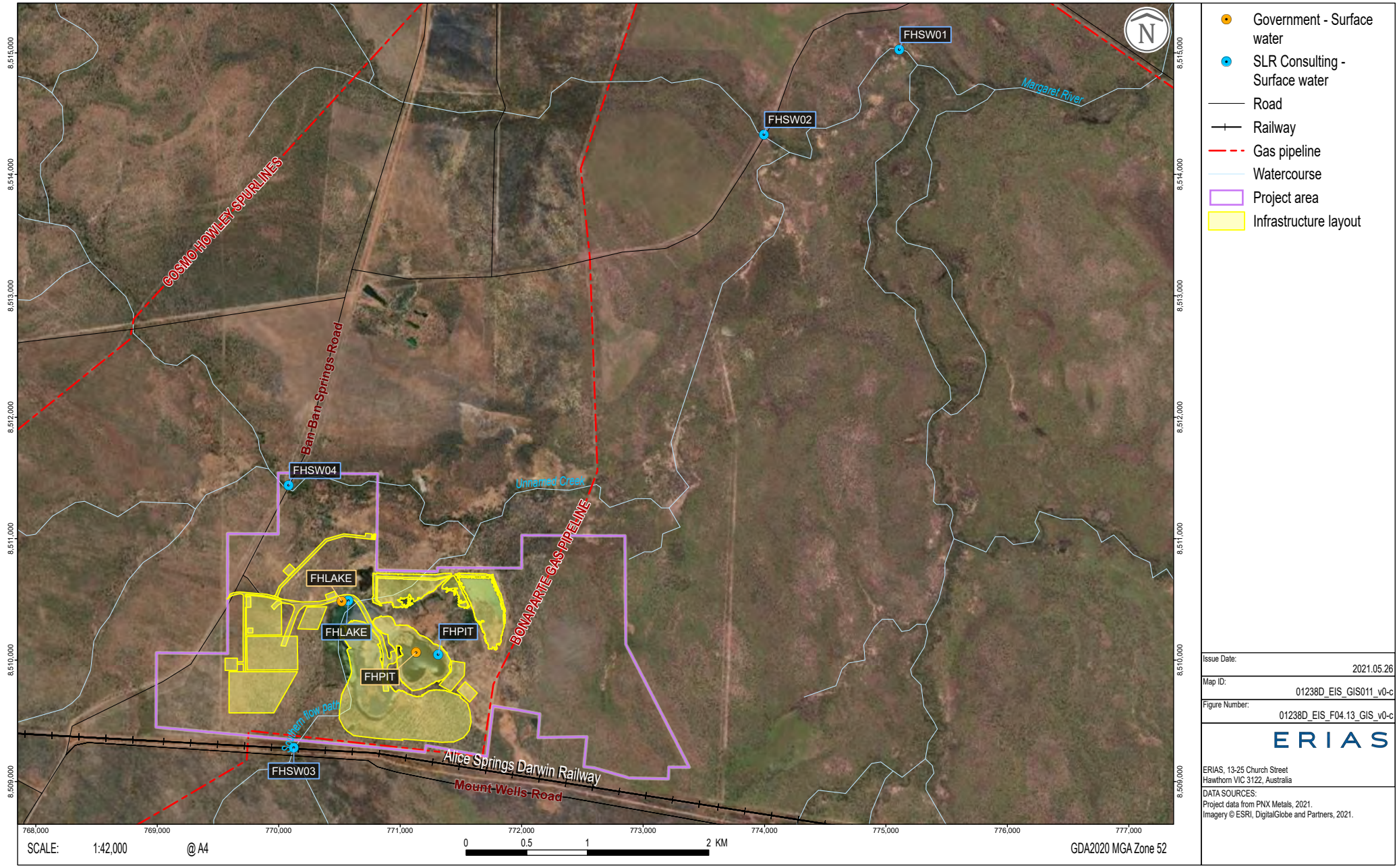
Coordinates are in WGS84 Zone 52 L.

5 The ERIAS field survey was commissioned for the Hayes Creek zinc-gold-silver Project, which also encompasses the Fountain Head Gold Project area. While Appendix 9 includes data from sites that are not relevant to the Fountain Head Gold Project area, only information relevant to this Project area is included in this section.

CARE AND MAINTENANCE SURFACE WATER MONITORING LOCATIONS

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FIGURE 4.13



Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS011_v0-c

Figure Number: 01238D_EIS_F04.13_GIS_v0-c

ERIAS

ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

General Water Quality Parameters

Results for general water quality parameters in surface water samples are presented in Appendix 19. Summary statistics for the available results are shown in Table 4.6. The following observations are made from the data:

- With the exception of two results from June 2012 at FHSW02, electrical conductivity results were within the Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ) (2000) default trigger values for upland and lowland rivers[6] in tropical Australia of 20 to 250 µS/cm. Electrical conductivity has generally been lower in more recent years compared to 2012 to 2014.

- pH values were close to neutral and within the ANZECC/ARMCANZ (2000) default trigger value range of pH 6.0 to 8.0 for lowland rivers in tropical Australia.

- Water hardness is classified as soft, with average hardness being less than 55 mg $CaCO_3$/L, with lower water hardness at FHSW03 and FHSW04 compared to FHSW01 and FHSW02.

- The average concentrations of major ions were generally low and below 10 mg/L for each individual ion, with the exception of sulphate at FHSW01 which had an average concentration of 17 mg/L and a maximum concentration of 170 mg/L in February 2013; however, aside from this result, all other sulphate concentrations were below 10 mg/L at this site.

- Average total suspended solids (TSS) concentrations ranged from 14 to 34 mg/L, and has been particularly variable at site FHSW01, where a maximum concentration of 140 mg/L was recorded in January 2014. The maximum TSS concentrations for the remaining sites were between 28 and 68 mg/L.

The results indicate that water quality between sites FHSW01 and FHSW02, located close to the Margaret River and between sites FHSW03 and FHSW04, located in the tributary creeks around the Fountain Head site have been similar, but there are notable differences between these two groups of sites. Electrical conductivity, pH, hardness, alkalinity and concentrations of most major ions have been higher at sites FHSW01 and FHSW02. Total suspended solids concentrations have been comparable between sites FHSW02, FHSW03 and FHSW04 and higher and more variable at site FHSW01.

[6] While the Australian and New Zealand Government (ANZG) (2018) replace the previous ANZECC/ARMCANZ (2000) guidelines, default guideline values for the Timor Sea drainage division where the Project is located have not yet been published; therefore, the regional default guidelines values from ANZECC/ARMCANZ (2000) have been used.

Table 4.6 – Summary Statistics for Surface Water General Water Quality Parameters 2012 to 2021

Site	Statistic	pH	Electrical Conductivity (µS/cm)	Dissolved Oxygen (% Saturation)	Turbidity (NTU)	Hardness (mg $CaCO_3$/L)	Total Alkalinity (mg $CaCO_3$/L)	Total Suspended Solids (mg/L)	Ca	Cl	Mg	K	Na	SO_4
									mg/L					
FHSW01	**Average**	7.1	112	74	59	46	45	34	6	6	6	1	7	17
	Std. deviation	0.4	66	35	24	53	27	44	7	15	7	1	4	48
	Median	7.1	83	88	59	30	38	12	4	2	4	1	6	3
	Maximum	8	241	97	76	210	110	140	30	59	32	5	19	170
	Count	14	14	4	2	13	15	15	15	15	15	15	15	12
FHSW02	**Average**	7.1	139	67	139	32	49	15	5	3	5	1	7	3
	Std. deviation	0.4	67	13	126	17	19	7	3	1	2	0	1	2
	Median	7.2	119	64	139	26	42	16	4	3	4	1	7	3
	Maximum	7.6	271	86	228	71	85	28	12	3	10	2	9	8
	Count	17	17	4	2	14	14	14	14	14	14	13	14	12
FHSW03	**Average**	6.8	73	84	39	16	35	14	2	1	3	1	6	2
	Std. deviation	0.3	33	19	43	7	15	10	1	1	1	1	2	3
	Median	6.8	65	88	39	15	35	10	2	1	3	1	6	1
	Maximum	7.3	118	101	70	29	62	35	4	2	5	3	11	10
	Count	9	9	4	2	12	12	11	11	11	12	11	12	12
FHSW04	**Average**	6.9	80	67	94	18	35	21	2	2	3	2	7	1
	Std. deviation	0.3	26	29	83	6	10	18	1	1	1	2	1	1
	Median	7.1	77	77	94	17	33	14	2	2	3	1	7	1
	Maximum	7.4	126	89	152	31	56	68	4	4	5	7	9	5
	Count	12	13	4	2	11	11	11	11	11	11	11	11	11

Note: Ca = calcium, Cl = chloride, Mg = magnesium, K = potassium, Na = sodium, SO_4 = sulphate.

In situ measurements of dissolved oxygen and turbidity have also been included during sampling conducted since 2019. Results indicate that dissolved oxygen saturation is variable between sites and sampling events, but generally below the lower limit of the default trigger value range of 85%. Low levels of dissolved oxygen are not uncommon in ephemeral inland freshwater systems, where there is intermittent, low or no flow. Turbidity was only recorded in April 2019 and February 2021, but during both sampling events, turbidity was elevated at all sites, except site FHSW03 in February 2021. All other results were above the upper limit of the default trigger value range of 15 NTU, ranging from 42 to 228 NTU.

Heavy Metals and Metalloids

Results for dissolved metal and metalloid concentrations in surface water samples are presented in Appendix 19 with comparison made to the ANZECC/ARMCANZ (2000) trigger values for slightly to moderately disturbed ecosystems. This level of protection (i.e., slightly to moderately disturbed ecosystems) is considered most appropriate given the long history of mining and agriculture in the study area. The adopted trigger values for cadmium, chromium, copper, lead, nickel and zinc are based on a water hardness of 30 mg/L. As shown in Table 4.6, average water hardness across the sites has ranged from 16 to 46 mg/L. As toxicity of these metals decreases with increasing water hardness this is a conservative approach for FHSW01 and FHSW02. Summary statistics are shown in Table 4.7. The following observations are made from the data:

- The majority of individual results and all average and median values for aluminium concentrations from all sampling locations exceeded the ANZECC/ARMCANZ (2000) trigger value of 55 µg/L.
- Chromium concentrations were mostly below the laboratory limit of reporting of 1 µg/L at all sites for all sampling events with the exception of concentrations between 1 and 2 µg/L at site FHSW01 in 2012, 2013, 2014 and 2021 and a concentration of 5 µg/L at site FHSW04 in January 2013. These results were equal to or above the ANZECC/ARMCANZ (2000) trigger value of 1 µg/L. This trigger value is however, for chromium (VI) whereas the results reported include chromium species Cr (VI) and Cr (III). It is unknown if the Cr(VI) fraction of the chromium result exceeded 1 µg/L; however, for the purpose of this assessment an exceedance of this value has been assumed. In addition, chromium was notably elevated in February 2020 with a concentration of 40 µg/L at site FHSW01 and 22 µg/L at site FHSW04 reported, both well above the default trigger value. It is noted that concentrations were however within typical levels for subsequent sampling events in March 2020, and February and April 2021.
- Individual results for cobalt and nickel were generally below the limit of reporting of 1 µg/L and below the trigger value of 1.4 µg/L for cobalt and 11 µg/L for nickel. In February 2020, cobalt was recorded at a concentration of 8 µg/L at sites FHSW01(downstream of Fountain Head) and FHSW04 (upstream of Fountain Head) and was above the trigger value, while nickel also exceeded the trigger value at these same sites. Subsequent results indicate cobalt and nickel were below or close to the limit of reporting of 1 µg/L, consistent with historical trends.
- There were some individual exceedances of the ANZECC/ARMCANZ (2000) trigger value for copper of 1.4 µg/L at sites FHSW01 and FHSW04 in 2013 and again in April

2019 and February 2020 at site FHSW01 (the site furthest downstream from Fountain Head), with concentrations of 2 and 22 µg/L recorded respectively while there was also one minor exceedance at site FHSW02 in February 2021 (2 µg/L).

- Individual results for concentrations of zinc were generally below the ANZECC/ARMCANZ (2000) trigger value of 8 µg/L; however, elevated zinc levels were found during some sampling events in 2012, 2013, 2014 and 2020 which has resulted in the average zinc concentrations at all sites except FHSW03 being above 8 µg/L. The most recent data from February and April 2021 indicates that concentrations of zinc were below the limit of reporting of 5 µg/L at all sites.
- All other metal concentrations were below the applicable ANZECC/ARMCANZ (2000) trigger values for slightly to moderately disturbed ecosystems.
- Concentrations of metals in February 2020 were substantially higher at site FHSW01 (the furthest downstream site) and FHSW02 (upstream control for all sites) for all metals (except cadmium and zinc) compared to all other results, with higher concentrations generally recorded at FHSW01. These results indicate there was a potential source of metals in the unnamed tributary creek upstream of Fountain Head, but metal concentrations increased further downstream from Fountain Head. Concentrations of metals at FHSW02, the control for FHSW01, did not show the same trend, with results consistent with previous findings for this site.
- Results for site FHSW01 and the upstream control site FHSW02 indicate that metal concentrations are generally comparable, but concentrations of aluminium, arsenic, chromium, copper, iron and zinc have been slightly higher at FHSW01. The results for sites FHSW03 (upstream of Fountain Head) and FHSW04 (upstream control for all sites) indicate that metal concentrations are generally higher at FHSW04 compared to FHSW03 for aluminium, chromium, copper, iron, manganese, nickel and zinc.

Overall, the results from 2012 to 2021 indicate that aluminium regularly exceeds the default trigger value at all sites, while other metals such as chromium, chromium, copper and zinc have exceeded default trigger values on a number of occasions, particularly at site FHSW01 and FHWS04. With the exception of results from February 2020, the data collected from 2019 to 2021 is generally comparable to results from 2012 to 2016. The results indicate existing elevated background concentrations of these metals both upstream and downstream of Fountain Head.

Table 4.7 – Summary Statistics for Surface Water Dissolved Heavy Metals and Metalloids 2012 to 2021

Site	Statistic	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Zinc
		µg/L										
FHSW01	**Average**	3,421	4	NC	4	NC	3	1,807	NC	14	NC	8
	Std. deviation	11,793	3	NC	10	NC	5	5,522	NC	15	NC	9
	Median	260	3	NC	1	NC	1	300	NC	10	NC	5
	Maximum	46,000	13	<0.2	40	8	22	21,700	8	67	26	35
	Count	15	15	15	15	1	15	15	15	15	15	15
FHSW02	**Average**	353	1	NC	NC	NC	NC	329	NC	35	NC	7
	Std. deviation	529	0.6	NC	NC	NC	NC	307	NC	28	NC	8
	Median	155	1	NC	NC	NC	NC	270	NC	29	NC	5
	Maximum	1,750	3	<0.1	<1	<1	2	1,010	<1	97	2	29
	Count	14	14	14	14	14	14	14	14	14	14	14
FHSW03	**Average**	147	2	NC	NC	NC	NC	666	NC	20	NC	6
	Std. deviation	106	1.6	NC	NC	NC	NC	567	NC	17	NC	5
	Median	135	2	NC	NC	NC	NC	475	NC	12	NC	5
	Maximum	350	6	<0.1	<1	<1	<1	1,840	<1	46	2	21
	Count	12	12	12	12	12	12	12	12	12	12	12
FHSW04	**Average**	2,959	2	NC	3	NC	2	2,173	NC	65	NC	11
	Std. deviation	8,186	2	NC	6	NC	3	4,732	NC	115	NC	11
	Median	360	1	NC	1	NC	1	480	NC	23	NC	5
	Maximum	27,600	8	<0.1	22	8	11	16,300	5	398	14	38
	Count	11	11	11	11	11	11	11	11	11	11	11

Site	Statistic	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Zinc
		µg/L										
ANZECC/ARMCANZ (2000) Trigger Value for Slightly to Moderately Disturbed Ecosystem		55	13 (As(V))	0.2	1 (Cr(VI))	1.4[#]	1.4	NA	3.4	1,900	11	8

Note: Grey shading indicates value is equal to or exceeds the ANZECC/ARMCANZ (2000) trigger value for slightly to moderately disturbed ecosystems.
NC: Not calculated as all or the majority of results were below the laboratory limit of reporting.
* While the majority of results were below the laboratory limit of reporting there was the occasional detection.
[#] Low reliability trigger value.

4.5.2.2 Additional Analytical Results

In addition to the available data from care and maintenance monitoring described in the previous sections, ERIAS conducted an aquatic field survey in April 2019 investigating a variety of surface water environments close to Fountain Head and in the broader region. Figure 4.14 shows the location of relevant survey sites while Table 4.8 provides the coordinates. Site S6 aligns with care and maintenance sampling site FHSW04 while the remaining sites have not been previously sampled.

Table 4.8 – ERIAS Aquatic Sampling Locations

Sampling Location	Photo	Description	Latitude	Longitude
S5		Margaret River at Grove Hill east of Fountain Head	-13.484182	131.565601
S6 (same location as FHSW04)		Unnamed tributary of the Margaret River downstream of Fountain Head along Ban Ban Springs Road	-13.452777	131.494643
S7		Unnamed tributary of the Margaret River upstream of Fountain Head and upstream of site S6*	-13.440845	131.482538

Sampling Location	Photo	Description	Latitude	Longitude
S8		Margaret River east of the Woolwonga mine and downstream of site S5	-13.404039	131.565161

Note: coordinates are in WGS84 Zone 52 L.
* As noted in Appendix 9 localised backflow was observed at this sampling site in April 2019 during low flow conditions.

Nutrients

Table 4.9 presents the nutrient results and the ANZECC/ARMCANZ (2000) default trigger values for tropical Australia.

Table 4.9 – Nutrients April 2019

Site	Total Nitrogen	Nitrate	Nitrite	Nitrate + Nitrite	Ammonia	Total Phosphorous	Phosphate
	(mg/L)						
S5	0.46	0.015	0.005	0.025†	0.14	0.025	0.005
S6 (FHSW04)	0.40	0.015	0.005	0.02	0.055	0.030	<0.005
S7	0.64	<0.005	0.005	0.01	0.145	0.045	<0.005
S8	0.53	0.015	0.01	0.025	0.06	0.035	<0.005
ANZECC/ARMCANZ Default Trigger Value (2000)	0.5*	0.7#	NA	0.1*	0.9#	0.05*	NA

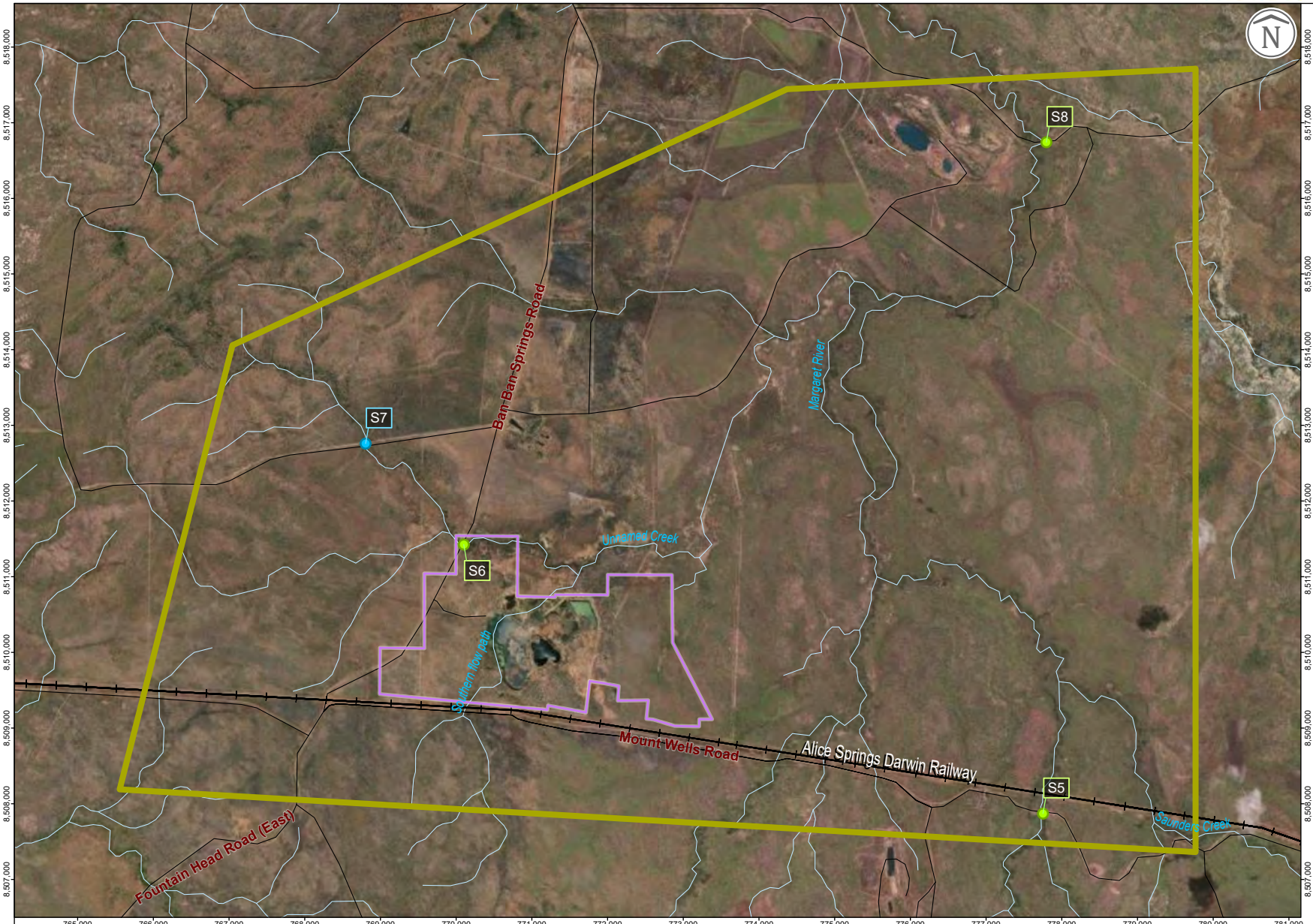
Note: Grey shading indicates value exceeds the ANZECC/ARMCANZ (2000) default trigger value for tropical Australia.
NA: No guideline available.
* Default trigger value for lowland rivers in tropical Australia.
# Trigger value for slightly to moderately disturbed ecosystems.
† As reported by the laboratory, noting that this concentration is higher than individually summing nitrate and nitrite concentrations reported by the laboratory as the per the adjacent columns.

Nutrient concentrations were generally low and below the default trigger values, with the exception of total nitrogen at sites S7 (downstream of Fountain Head) and S8 (downstream in the Margaret River).

AQUATIC SURVEY STUDY AREA AND SAMPLING LOCATIONS

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 4.14



Road
Railway
Watercourse
Project area
Study area

Aquatic survey sample location and type

- Water Quality
- Water Quality, Fish & Macrocrustaceans, Macroinvertebrates

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS009_v0-b

Figure Number: 01238D_EIS_F04.14_GIS_v0-b

ERIAS

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Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

Hydrocarbons

Total recoverable hydrocarbons and benzene, toluene, ethylbenzene, xylenes and naphthalene concentrations were below the laboratory limits of reporting (see Appendix 9) in all samples indicating no evidence of existing hydrocarbon contamination.

Coliforms

Table 4.10 presents the results for microbial analyses for *E. coli*, total coliforms and faecal coliforms.

Table 4.10 – Microbiological Quality April 2019

Site	*E. Coli* (MPN*/100 mL)	Total Coliforms (MPN/100 mL)	Faecal Coliforms (MPN/100 mL)
S5	365	>2,400	163
S6	205	>2,400	980
S7	435	>2,400	548
S8	81	>2,400	236

* Most probable number.

E. coli was detected at all sites and ranged from 81 MPN/100 mL at S8 in the Margaret River to 435 MPN/100 mL at S7, in the tributary creek downstream of Fountain Head. Total coliforms were above 2,400 MPN/100mL at all sites, while faecal coliforms ranged from 163 MPN/100mL at site S5 to 980 MPN/100 mL at site S6. Manure from cattle and buffalo present in the Project area is likely the major source of coliforms.

4.5.3 Mine Water Quality

This section describes the historical and existing quality of mine site water bodies (i.e., Fountain Head pit, existing dam and Fountain Head Lake). This description combines data available from historical monitoring collected by previous mine operators between and data collected by PNX since 2019.

4.5.3.1 Pit Water Quality

Water quality data for the Fountain Head pit was collected between 2009 and 2016 by previous mine operators and has been collected since 2019 on behalf of PNX (see sampling locations in Figure 4.13). Samples were collected of surface water except during October 2016 when sampling was undertaken at 10 m depth intervals to a maximum depth of 50 m below surface at two separate locations in the pit. Results from the sampling conducted since 2019 are consistent with results from previous sampling events undertaken from 2009 to 2016. Profile sampling of the pit water column in October 2016 shows that water quality is generally similar with depth, with the exception of higher pH in the surface 10 m and notably higher concentrations of a number of metals (aluminium, cobalt, copper, iron, lead, nickel and zinc) in the bottom profile at one of the two sampling locations in the pit.

General Water Quality Parameters

Results for general water quality parameters and major ion concentrations in pit water samples are presented in Appendix 19. Summary statistics for all results are shown in Table 4.11 below. Comparison is made to the following ANZECC/ARMCANZ (2000)[7] guideline values:

- Short-term trigger value (STV) for use of water for irrigation for less than a 20-year period.
- Trigger values for slightly to moderately disturbed ecosystems. While comparison to these values is not strictly applicable to the pit water, comparison to these criteria provides an indication of the level of risk posed if pit water is discharged to the receiving environment, although does not consider mixing that would occur in receiving waters (where the guidelines would be applicable).
- Livestock drinking water quality guidelines.

With the exception of electrical conductivity and pH, the average, median and maximum concentrations of general parameters and major ions were below applicable guideline values considering irrigation, livestock drinking water and aquatic ecosystem protection.

The electrical conductivity of pit water has been consistently higher than the default trigger value for slightly disturbed rivers in tropical Australia, with an average and standard deviation of 420±77 µS/cm. The salinity of the pit water would; however, be considered 'very low' by irrigation standards and is suitable for use on salinity sensitive crops and as stock drinking water.

The pH and hardness of the pit water indicates it is unlikely to cause corrosion or scaling issues in pumping equipment or pipelines. The alkaline pH of the pit water (average pH of 8.1) indicates the influence of carbonate minerals in host rocks of the pit, and the absence of acid and metalliferous drainage (AMD) from pit walls. This is supported by the relatively high alkalinity measured in the pit water (average concentration of 138±15 mg $CaCO_3$/L from 32 measurements), which provides considerable buffering capacity. The pH of pit water has generally exceeded the default trigger values of 6.0 to 8.0.

Considering concentrations of chloride and sodium, the pit water is suitable for irrigation use on sensitive crops. Concentrations of sulphate in pit water are low (average concentration of 67±8 mg/L), indicating that the occurrence of AMD, or neutral metalliferous drainage (NMD), from pit walls is not problematic. The sodium adsorption ration (SAR) is an indicator of the suitability of water for use in agricultural irrigation and considers concentrations of sodium, calcium and magnesium. The SAR value is calculated to be 1.1 based on average concentrations of the alkaline ions in pit water, indicating water quality is good with no major concerns for irrigation use.

[7] While the ANZG (2018) replace the previous ANZECC/ARMCANZ (2000) guidelines, there have been no updates to the trigger values for irrigation and general water use and the revised livestock drinking water guidelines are yet to be published. Default guideline values for the Timor Sea drainage division where the Project is located have not yet been published; therefore, the regional default guidelines values from ANZECC/ARMCANZ (2000) have been used.

Table 4.11 – Summary Statistics for Pit Water General Water Quality Parameters 2009 to 2021

Statistic	pH	Electrical Conductivity (µS/cm)	Hardness (mg $CaCO_3$/L)	Total Alkalinity (mg $CaCO_3$/L)	Ca	Cl	Mg	K	Na	SO_4
					mg/L					
Average	8.1	526	141	138	12	6	27	1.7	30	67
Std. deviation	0.8	617	8	15	1	1	1	0.3	2	8
Median	8.3	415	140	142	13	5	28	1.7	29	66
Maximum	9.4	3,991	153	170	15	8	29	2.4	34	85
Count	34	34	21	32	36	36	36	36	36	35
ANZECC/ARMCANZ (2000) Default Trigger Values for Slightly Disturbed Rivers in Tropical Australia	6.0 to 8.0	20 to 250	NA	NA	NA	NA	NA	NA	NA	NA
ANZECC/ARMCANZ (2000) Short-term Trigger Value for Irrigation and General Water Use	6.0 to 9.0	650#	60 to 350**	NA	NA	350†	NA	NA	230†	NA
Livestock Drinking Water Guidelines ANZECC/ARMCANZ (2000)	5.0 to 9.0	0 to 2,680*	NA	NA	1,000	NA	NA	NA	NA	1,000

Notes: Grey shading indicates value exceeds the ANZECC/ARMCANZ (2000) default trigger value for tropical Australia. Ca = calcium, Cl = chloride, Mg = magnesium, K = potassium, Na = sodium, SO_4= sulphate.
NA: No trigger value available.
* Based on total dissolved solids conversion provided in ANZECC/ARMCANZ (2000).
# Guideline for sensitive crops.
† Upper tolerance for moderately tolerant crops (e.g., lucerne and sorghum).
** For fouling and corrosion.

Metals and Metalloids

Results for total (i.e., unfiltered) and dissolved (filtered) metal and metalloid concentrations in pit water samples are presented in Appendix 19. Summary statistics for all results are shown in Table 4.12 (total concentrations) and 4.13 (dissolved concentrations). Comparison is made to the same guideline values described in Section 4.5.3.1; however, as the aquatic ecosystem guidelines refer to dissolved metal concentrations and the irrigation and general water use and livestock drinking water guidelines refer to total metal concentrations, these have been shown separately. As shown in Table 4.11, average water hardness in the pit was 141 mg $CaCO_3$/L; therefore, the adopted trigger values for cadmium, copper, lead, nickel and zinc have been adjusted in Table 4.13 based on a 'hard' water hardness (120 to 179 mg $CaCO_3$/L) as per ANZECC/ARMCANZ (2000).

Average, median and maximum concentrations of all metals and metalloids were well below the irrigation STVs, indicating that phytotoxic effects would not be expected if pit water is used for irrigation.

Arsenic concentrations have consistently exceeded the livestock drinking water guideline value of 500 µg/L with the average and median values above this, indicating that pit water poses some risk to livestock if consumed. All remaining total metal concentrations were below the livestock drinking water guidelines.

There were some exceedances of applicable trigger values for aquatic ecosystem protection for dissolved arsenic, copper and chromium with results for the remaining metals below trigger values. Arsenic has consistently exceeded the trigger value for slightly to moderately disturbed aquatic ecosystems of 13 µg/L (for As(V)) with an average and standard deviation of 599±141 µg/L. This indicates the influence of arsenic from the mineralised area of the pit. Arsenic can be naturally elevated in the vicinity of gold deposits due to their geological association, as both are hosted in iron-sulphide minerals such as pyrite, marcasite and arsenopyrite (Xing et al., 2019).

Concentrations of copper were generally below the adjusted trigger value for slightly to moderately disturbed aquatic ecosystems (5.5 µg/L) but were above in February 2009 at site FHPITW and FHPITE (12.5 µg/L, 7.1 µg/L) and February 2015 (28 µg/L), which was the most recent. Results from 2019 to 2021 for dissolved copper were all below the laboratory limit of reporting of 1 µg/L.

Concentrations of chromium have generally been below the laboratory limit of reporting, which has ranged from <0.1 to <1 µg/L, but exceeded the default trigger value of 1 µg/L for Cr(VI) in two samples, one being from February 2009 (3 µg/L) and the other from January 2014 (5 µg/L). All results since January 2014 have been less than 1 µg/L.

Table 4.12 – Summary Statistics for Pit Water Total Heavy Metals and Metalloids 2009 to 2021

Statistic	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Ni	Se	U	V	Zn
	µg/L														
Average	43	618	16	NC	NC	NC	2.0	73	1.1	114	0.9	NC	6	0.5	7.0
Std. deviation	151	156	2	NC	NC	NC	7.1	154	1.7	169	0.8	NC	1	0.3	9.1
Median	10	620	15	NC	NC	NC	1.0	37	1.0	12	1.0	NC	6.3	0.5	5.0
Maximum	906	784	20	<0.1	0.9	0.4	43	852	9.7	437	4.7	<0.2	6.4	1.3	40
Count	35	35	13	34	34	34	35	34	34	35	34	14	3	13	35
ANZECC/ARMCANZ (2000) Short-term Trigger Value for Irrigation and General Water Use	20,000	2,000	4,000 to 6,000#	50	1,000	100	5,000	10,000	5,000	10,000	2,000	50	100	500	5,000
Livestock Drinking Water Guidelines ANZECC/ARMCANZ (2000)	5,000	500	5,000	10	1,000	1,000	1,000*	NA	100	NA	1,000	20	200	NA	20,000

NA: No trigger value available.
NC: Not calculated as all results were below the laboratory limit of reporting.
* Guideline for beef cattle.
# Trigger value for irrigation of sorghum.

Table 4.13 – Summary Statistics for Pit Water Dissolved Heavy Metals and Metalloids 2009 to 2021

Statistic	Al	As	Be	B	Cd	Cr	Co	Cu	Pb	Mn	Hg	Ni	Se	Ag	Zn
	µg/L														
Average	16	599	NC	14.7	NC	2.7	0.7	2.0	0.8	98	NC	0.9	NC	NC	5.0
Std. deviation	25	141	NC	1.6	NC	2.4	0.4	4.8	0.8	164	NC	1.1	NC	NC	4.7
Median	10	600	NC	14.0	NC	3.0	1.0	1.0	1.0	5	NC	1.0	NC	NC	3.8
Maximum	113	795	<0.5	20	<0.2	5	1	28	4.7	439	<0.2	6	0.2	<0.5	19
Count	38	38	4	15	36	3	36	38	36	38	4	36	19	4	36
ANZECC/ARMCANZ (2000) Trigger Value for Slightly to Moderately Disturbed Ecosystem	55	13 (As(V))	NA	370	0.84†	1 (Cr(VI))	1.4*	5.5†	25.8†	1,900	0.06#	43†	5	0.05	31†

Note: Grey shading indicates value exceeds the ANZECC/ARMCANZ (2000) trigger value for slightly to moderately disturbed ecosystems
NA: No trigger value available.
NC: Not calculated as all results were below the laboratory limit of reporting.
* Low reliability trigger value.
# For inorganic mercury.
† Default trigger value adjusted for hard water (120 to 179 mg $CaCO_3$/L) as per Table 3.4.4 of ANZECC/ARMCANZ (2000).

4.5.3.2 Existing Dam Water Quality

Three surface water samples were collected from the edge of the existing dam in March 2020 for laboratory analysis.

General Water Quality Parameters

The results from the analysis of samples collected from the existing dam for general parameters are provided in Table 4.14. Comparison is made to the same guideline values described in Section 4.5.3.1. All results were within/below these trigger guideline values (where available).

The results show that the water in the existing dam has low hardness (i.e., is soft water) and very low salinity and is suitable for use on sensitive crops.

The chloride concentration (17 to 37 mg/L) is higher than measured in pit water but is less than the trigger value for chloride causing foliar injury. The dam water is therefore suitable for irrigation of chloride sensitive crops. Sodium concentrations in the dam are less than measured in pit water, and less than the trigger value for sodium causing foliar injury.

The SAR value was calculated to be less than 1 indicating water quality is good with no major concerns for irrigation use.

Table 4.14 – Existing Dam General Water Quality Parameters March 2020

Sample	Electrical Conductivity (µS/cm)	Water Hardness (mg $CaCO_3$/L)	Total Alkalinity (mg $CaCO_3$/L)	Ca	Cl	Mg	K	Na	SO_4
				mg/L					
N/E Dam 1	36	11	<20	<0.5	17	2.3	0.7	2.3	<5
N/E Dam 2	47	10	26	<0.5	34	2.3	0.6	2.4	<5
N/E Dam 3	33	10	<20	<0.5	37	2.3	0.5	2.3	<5
ANZECC/ARMCANZ (2000) Default Trigger Values for Slightly Disturbed Rivers in Tropical Australia	20 to 250	NA	NA	NA	NA	NA	NA	NA	NA
ANZECC/ARMCANZ (2000) Short-term Trigger Value for Irrigation and General Water Use	650[#]	60 to 350**	NA	NA	350[†]	NA	NA	230[†]	NA
Livestock Drinking Water Guidelines ANZECC/ARMCANZ (2000)	0 to 2,680*	NA	NA	1,000	NA	NA	NA	NA	1,000

Note: Ca = calcium, Cl = chloride, Mg = magnesium, K = potassium, Na = sodium, SO_4= sulphate.
NA: No trigger value available.
* Based on total dissolved solids conversion provided in ANZECC/ARMCANZ (2000).
[#] Trigger value for irrigation of sorghum.
[†] Upper tolerance for moderately tolerant crops (e.g., lucerne and sorghum).
** For fouling and corrosion.

Metals and Metalloids

Results for total (i.e., unfiltered) and dissolved (i.e., filtered) metal and metalloid concentrations in the existing dam water samples are presented in Table 4.15 and 4.16. Comparison is made to the same guideline values described in Section 4.5.3.1. The adopted trigger values for cadmium, chromium, copper, lead, nickel and zinc are based on a water hardness of 30 mg/L. As shown in Table 4.14, water hardness across the sites was between 10 and 11 mg CaCO3/L.

Average, median and maximum total concentrations of all metals and metalloids were well below the STVs and livestock drinking water quality guidelines, indicating that phytotoxic effects would not be expected if the existing dam water is used for irrigation and that the water poses no risk to livestock if consumed.

Dissolved metal concentrations were all below the trigger values for slightly to moderately disturbed ecosystems with the majority of metals below the laboratory limit of reporting[8]. There were detections of dissolved arsenic and manganese, but concentrations were well below the trigger values. In comparison to the Fountain Head pit water, arsenic concentrations are two orders of magnitude lower in the existing dam. As discussed in 4.5.3.1, elevated arsenic in the pit water indicates the influence of arsenic from the mineralised area of the pit. Metal concentrations in the dam are also notably lower than in the Fountain Head Lake (discussed further in Section 4.5.3.3).

[8] The laboratory limit of reporting for dissolved mercury was above the trigger value for inorganic mercury, therefore direct comparison cannot be made with the trigger value.

Table 4.15 – Existing Dam Total Heavy Metals and Metalloids March 2020

Sample	As	Be	B	Cd	Cr	Co	Cu	Pb	Mn	Hg	Ni	Se	Zn
	µg/L												
N/E Dam 1	18	<1	5	<0.2	3	<1	2	2	21	<0.1	2	<1	<5
N/E Dam 2	19	<1	<5	<0.2	3	<1	2	2	15	<0.1	1	<1	<5
N/E Dam 3	17	<1	<5	<0.2	2	<1	2	2	1	<0.1	1	<1	<5
ANZECC/ARMCANZ (2000) Short-term Trigger Value for Irrigation and General Water Use	2,000	500	4,000 to 6,000[#]	50	1,000	100	5,000	5,000	10,000	2	2,000	500	5,000
Livestock Drinking Water Guidelines ANZECC/ARMCANZ (2000)	500	NA	5,000	10	1,000	1,000	1,000*	100	NA	2	1,000	20	20,000

NA: No trigger value available.
* Guideline for beef cattle.
[#] Trigger value for irrigation of sorghum.

Table 4.16 – Existing Dam Dissolved Heavy Metals and Metalloids March 2020

Sample	As	Be	B	Cd	Cr	Co	Cu	Pb	Mn	Hg	Ni	Se	Zn
	µg/L												
N/E Dam 1	6	<1	<5	<0.2	<1	<1	<1	<1	13	<0.1	<1	<1	<5
N/E Dam 2	5	<1	<5	<0.2	<1	<1	<1	<1	13	<0.1	<1	<1	<5
N/E Dam 3	6	<1	<5	<0.2	<1	<1	<1	<1	9	<0.1	<1	<1	<5
ANZECC/ARMCANZ (2000) Trigger Value for Slightly to Moderately Disturbed Ecosystem	13 (As(V))	NA	37	0.2	1 (Cr(VI))	1.4[#]	1.4	3.4	1,900	0.06[†]	11	11	8

NA: No trigger value available.
[#] Low reliability trigger value.
[†] For inorganic mercury.

4.5.3.3 Fountain Head Lake

Water quality data for the Fountain Head Lake was collected between 2009 and 2016 by previous mine operators and since 2019 PNX has conducted regular monitoring under a care and maintenance program (see locations in Figure 4.13). Results from the sampling conducted since 2019 are consistent with results from previous sampling events undertaken from 2009 to 2016. General water quality parameters and metal concentrations vary throughout the year, with major ions and water hardness and some metals increasing in concentration during the dry season, likely a result of evapoconcentration and decreasing at the onset of the wet season from the effects of dilution.

General Water Quality Parameters

Results for general water quality parameters are provided in Table 4.17. Comparison is made to the same guideline values described in Section 4.5.3.1. All results met the livestock drinking water guidelines.

The lake pH values are within the irrigation and general water use guidelines and livestock drinking water guidelines (with the exception of April 2021 when pH was 9.7) and have generally been within the aquatic ecosystem guidelines for tropical Australia, but have been just outside this range on some occasions with lake water moderately alkaline at times.

The average electrical conductivity of the Fountain Head Lake is above the trigger value for slightly disturbed rivers in tropical Australia, and at times has exceeded the STV for irrigation of sensitive crop species. Electrical conductivity has fluctuated considerably over time and in some years has had a tendency to increase towards the end of the dry season/beginning of the wet season (e.g., in 2014), which can be attributed to evaporation leading to decreased water volume in the lake and higher salt concentrations.

The results show that the water in the Fountain Head Lake varies seasonally, varying between moderate to very hard water, with water hardness generally increasing during the dry season due to evapoconcentration.

Major ion concentrations indicate the water is predominantly a magnesium-sulphate type water with some spread towards magnesium-bicarbonate (Appendix 3).

Average values for general water quality parameters in Fountain Head Lake are similar to pit water; however, parameters vary considerably more seasonally in the lake compared to the pit where water quality parameters have been more stable over time.

While the SAR value was calculated to be less than one, indicating water quality is good with no major concerns for irrigation use, parameters fluctuate during the year and at times electrical conductivity has exceeded the STV for irrigation of sensitive crops.

Table 4.17 – Summary Statistics for Fountain Head Lake General Water Quality Parameters 2009 to 2021

Sample	pH	Electrical Conductivity (µS/cm)	Water Hardness (mg $CaCO_3$/L)	Total Alkalinity (mg $CaCO_3$/L)	Ca	Cl	Mg	K	Na	SO_4
					mg/L					
Average	7.5	355	102	42	34	12.5	6	16.6	1.7	14.2
Std deviation	0.7	325	133	27	153	15.4	19	22.2	1.8	15.6
Median	7.5	248	58	35	7	7.8	2	10.3	1.0	8.9
Maximum	9.7	1,578	660	140	1,000	75	130	120	9	88
Count	44	43	42	42	42	46	45	46	45	45
ANZECC/ARMCANZ (2000) Default Trigger Values for Slightly Disturbed Rivers in Tropical Australia	6.0 to 8.0	20 to 250	NA	NA	NA	NA	NA	NA	NA	NA
ANZECC/ARMCANZ (2000) Short-term Trigger Value for Irrigation and General Water Use	6.0 to 9.0	650[#]	60 to 350**	NA	NA	350[†]	NA	NA	230[†]	NA
Livestock Drinking Water Guidelines ANZECC/ARMCANZ (2000)	5.0 to 9.0	0 to 2,680*	NA	NA	1,000	NA	NA	NA	NA	1,000

Notes: Notes: Grey shading indicates value exceeds the ANZECC/ARMCANZ (2000) default trigger value for tropical Australia. Green shading indicates value exceeds the ANZECC/ARMCANZ (2000) short-term trigger value for irrigation and general water use. Ca = calcium, Cl = chloride, Mg = magnesium, K = potassium, SO_4= sulphate.
NA: No trigger value available.
* Based on total dissolved solids conversion provided in ANZECC/ARMCANZ (2000).
[#] Trigger value for irrigation of sorghum.
[†] Upper tolerance for moderately tolerant crops (e.g., lucerne and sorghum).
** For fouling and corrosion.

Metals and Metalloids

Results for total (i.e., unfiltered) and dissolved (filtered) metal and metalloid concentrations in Fountain Head Lake water samples are presented in Appendix 19. Summary statistics for all results are shown in Table 4.18 (total concentrations) and Table 4.19 (dissolved concentrations). Comparison is made to the same guideline values described in Section 4.5.3.1. As shown in Table 4.17, average water hardness in the lake was 102 mg $CaCO_3$/L; therefore, the adopted trigger values for cadmium, copper, lead, nickel and zinc have been adjusted in Table 4.19 based on a 'moderate' water hardness (60 to 119 mg $CaCO_3$/L) as per ANZECC/ARMCANZ (2000).

With the exception of aluminium and iron, total metal and metalloid concentrations were well below the irrigation STVs and livestock drinking water quality guidelines. Maximum total concentrations of aluminium and iron exceeded the applicable guidelines on some occasions, but average values were below. Total aluminium was equal to the short term trigger value of 20,000 µg/L (February 2013) and also exceeded the livestock drinking water guidelines on this occasion and during one other sampling event (February 2014). Total iron concentrations were also uncharacteristically high in February 2013, with a total concentration of 26,000 µg/L. All other individual results for these two metals were below the irrigation and general water use and livestock drinking water trigger values indicating the water is generally acceptable for these uses.

With the exception of aluminium, all average dissolved metal and metalloid concentrations (Table 4.19) were below the applicable trigger values for aquatic ecosystem protection. Dissolved aluminium concentrations fluctuated considerably during the monitoring period and have exceeded the trigger value around 30% of the time. In most years aluminium concentrations have peaked in January or February, during the peak of the wet season, but in 2015 concentrations were highest in July, in the middle of the dry season.

There are also some individual exceedances of applicable trigger values for aquatic ecosystem protection for arsenic, chromium, cobalt, copper and zinc, but the majority of results for these metals and metalloids have been below. All results for the remaining metals were below trigger values.

In comparison to pit water, the Fountain Head Lake has higher average concentrations of aluminium and iron (even when excluding outlier results) and notably lower concentrations of arsenic. Lower concentrations of arsenic suggest less interaction with mineralised geology and groundwater than the pit.

Concentrations of beryllium, boron, cadmium, copper, lead, nickel, selenium, uranium and vanadium are comparable between both water bodies, while concentrations of zinc have generally been higher in the lake and manganese concentrations have been higher in the pit.

In comparison to surface water monitoring site FHSW03 (upstream control for Fountain Head Lake, see Section 4.5.2.1), concentrations of aluminium, arsenic, copper and zinc are higher in the lake while the concentrations of the remaining metals and metalloids are comparable.

Table 4.18 – Summary Statistics for Fountain Head Lake Total Heavy Metals and Metalloids 2009 to 2021

Statistic µg/L	Al	As	Cd	Cr	Co	Cu	Fe	Pb	Mn	Ni	Zn
	µg/L										
Average	886	11	NC	NC	NC	3	1,065	3	30	4	21
Std. deviation	3,191	9	NC	NC	NC	4	3,949	3	48	6	24
Median	115	8	NC	NC	NC	2	215	2	12.1	2	11
Maximum	20,000	54	0.1	41	9	29	26,000	14	260	16	98
Count	44	44	44	44	44	44	44	44	44	12	44
ANZECC/ARMCANZ (2000) Short-term Trigger Value for Irrigation and General Water Use	20,000	2,000	50	1,000	100	5,000	10,000	5,000	10,000	2,000	5,000
Livestock Drinking Water Guidelines ANZECC/ARMCANZ (2000)	5,000	500	10	1,000	1,000	1,000*	NA	100	NA	1,000	20,000

Notes: Green shading indicates value exceeds the ANZECC/ARMCANZ (2000) short-term trigger value for irrigation and general water use.
NA: No trigger value available.
NC: Not calculated as all or the majority of results were below the laboratory limit of reporting.
* Guideline for beef cattle.

Table 4.19 – Summary Statistics for Fountain Head Lake Dissolved Heavy Metals and Metalloids 2009 to 2021

Statistic	Al	As	Be	B	Cd	Cr	Co	Cu	Pb	Mn	Hg	Ni	Se	Ag	Zn
	µg/L														
Average	305	9	NC	14	NC	NC	NC	2	NC	13	NC	NC	NC	NC	12
Std. deviation	1355	8	NC	5	NC	NC	NC	1	NC	25	NC	NC	NC	NC	17
Median	20	7	NC	12.5	NC	NC	NC	2	NC	5	NC	NC	NC	NC	5
Maximum	9300	52	<0.5	20	0.1	9	3	6	8	168	<0.2	5	<2	<0.5	88
Count	47	47	4	4	47	47	47	47	47	47	4	47	5	4	46
ANZECC/ARMCANZ (2000) Trigger Value for Slightly to Moderately Disturbed Ecosystem	55	13 (As(V))	NA	370	0.54†	1 (Cr(VI))	1.4*	3.5†	13.6†	1,900	0.06#	27.5†	5	0.05	20†

Note: Grey shading indicates value exceeds the ANZECC/ARMCANZ (2000) trigger value for slightly to moderately disturbed ecosystems.
NA: No trigger value available.
NC: Not calculated as all results were below the laboratory limit of reporting.
* Low reliability trigger value.
# For inorganic mercury.
† Default trigger value adjusted for a moderate water hardness (60 to 119 mg $CaCO_3$/L) as per Table 3.4.4 of ANZECC/ARMCANZ (2000).

4.6 Groundwater

4.6.1 Hydrogeology

4.6.1.1 Hydrostratigraphy

The Project is located within the Pine Creek Geosyncline geological province where there are the following four Proterozoic hydrostratigraphic units:

- Alluvial sediments (alluvial aquifer where saturated).
- Burrell Creek Formation (fractured rock aquifer).
- Mt Bonnie Formation (fractured rock aquifer).
- Gerowie Tuff (fractured rock aquifer).

The Pine Creek Geosyncline is bounded by the Hayes Creek Fault to the south, the Pine Creek Shear Zone to the east and the Shoobridge Fault to the west (Figure 4.8). Surface geology at Fountain Head is dominated by weathering products of the Burrell Creek Formation.

4.6.1.2 Conceptual Model

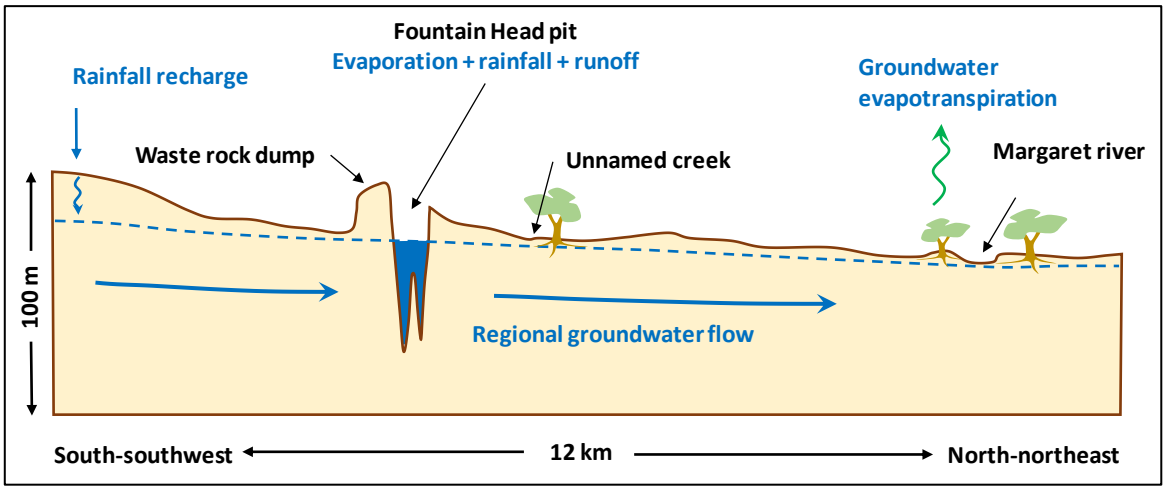
A conceptual model of the hydrogeological conditions at the Fountain Head site has been developed based on available data and characteristics of the area (Appendix 3).

Groundwater flow within alluvial sediments is likely to follow a subdued form of the topography and to be structurally controlled in deeper formations due to the presence of fractured rock aquifers (i.e., flow through networks of connected fractures). Regional groundwater flow is assumed, based on topography, to be in a northeast direction. Groundwater discharge is expected along ephemeral creek lines as groundwater evapotranspiration from riparian vegetation and as direct groundwater discharge when groundwater heads are higher than those in the ephemeral creeks. An unnamed ephemeral creek is located approximately 1 km north of the Fountain Head pit while the Margaret River is approximately 5 km to the northeast. End of wet season baseflow may occur but this is unclear due to a lack of flow information or groundwater measurements in the vicinity of the surface water features.

The Fountain Head pit may be drawing groundwater from the aquifer, but it may also be acting as a throughflow feature given it is likely to have fully recovered from previous dewatering. Based on the time for the pit to fill since cessation of previous mining and water balance modelling, the hydraulic conductivity of rocks hosting the Fountain Head pit is estimated to be approximately 0.2 m/day (Appendix 3).

This simplified hydrogeological conceptual model is shown in a cross-section from the top of the surface water catchment (south of the site) through the Fountain Head pit and to the Margaret River in Figure 4.15. Regional groundwater flows from southwest to northeast.

Figure 4.15 – Simplified Hydrogeological Conceptual Model



Source: Appendix 3.

4.6.1.3 Groundwater Levels and Flow Directions

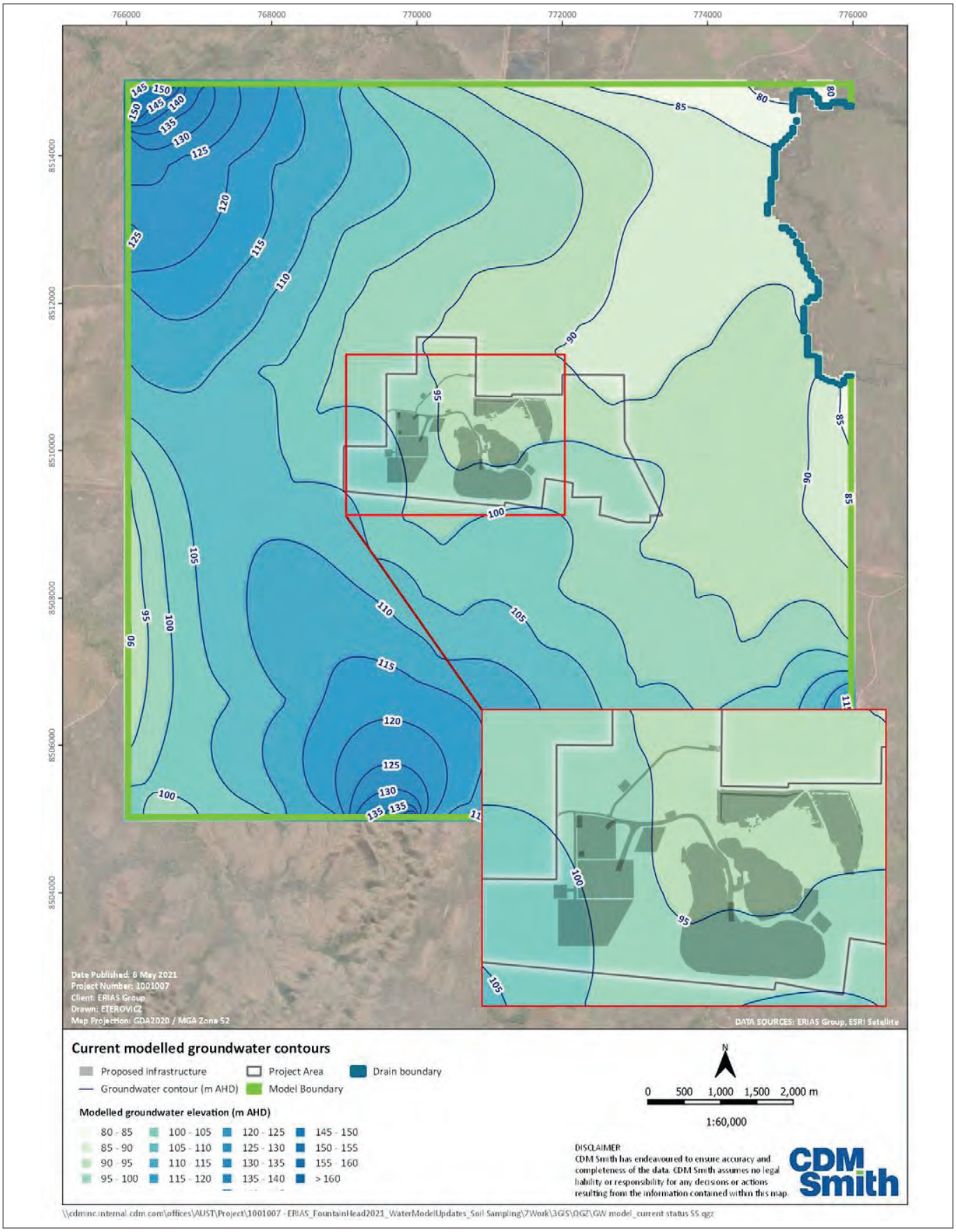
The natural water table level in the vicinity of the pit is estimated to be about 95 m AHD, ranging between 93 and 97 m AHD, with the water table sitting within 5 to 10 metres below ground surface (mbgs).

A three-dimensional numerical groundwater model, using the USGS MODFLOW, has been developed to generate steady state water table surfaces in the Project area (Appendix 3). Results are shown in Figure 4.16 for existing conditions and indicates groundwater flow direction is generally to the northeast towards Margaret River. The modelling indicates the pit lake acts as a flow-through feature where regional groundwater flows in from the southwest and out towards the northeast. However, the Fountain Head pit is likely to be a 'gaining feature' due to the overall deficit between evaporation and rainfall (i.e., lower pit water levels due to evaporation exceeding rainfall draws surrounding groundwater into the pit).

MODELLED EXISTING GROUNDWATER LEVELS IN THE PROJECT AREA

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FIGURE 4.16



Source: Appendix A002

4.6.2 Groundwater Use

A search of the Australian Groundwater Explorer (BOM, 2020b) indicates that there are 62 groundwater bores located within 10 km of Fountain Head. Thirty of these are no longer in use, 11 are listed as, or known to be, functional while the status of the remaining 21 bores is unknown. Identified uses for groundwater bores includes stock and domestic water, commercial and industrial water and exploration. Refer to Figure 4.17 for the locations of the known functional bores. Also shown on the figure are groundwater monitoring bores installed for previous mining operations (FHMB01 to FHMB06).

Bore RN026344, registered for stock and domestic water use, is located within the mine lease approximately 500 m south of the pit, but is not in use and is within the footprint of the proposed expanded WRS. However, bore RN024290 located outside the mine lease approximately 800 m northeast of the pit is periodically used by Ban Ban Springs Station for stock watering. The remaining known functional bores within 10 km of Fountain Head are located at Grove Hill, North Point and Princess Louise (Figure 4.17).

Aside from human uses of groundwater resources, groundwater in the Darwin catchment can be important for groundwater dependent-ecosystems. Monsoon vine forests are groundwater-dependent forests that require permanent water availability and can be found where water is trapped, or the water table is close to the surface (CSIRO, 2018). No monsoon vine forests are located close to the Project area. The majority of monsoon vine forest habitat found in the Darwin catchment located in the coastal and sub-coastal belts rather than in inland areas such as the Project area (CSIRO, 2018). The nearest monsoon vine forest habitat is located around 15 km to the northwest (Barber et al., 2018).

4.6.3 Groundwater Quality

The Fountain Head site is approximately 50 km from Pine Creek, which has been previously described as naturally having irregularly high arsenic concentrations occurring in groundwater and surface waters (Tickell, 2008). The elevated arsenic concentrations in groundwater are associated with the regional geology, in particular, quartz vein hosted deposits of gold and base metals that occur along major lineaments and faults (Karp, 2008).

The Fountain Head site has six monitoring bores in various condition (Figure 4.17) from which water quality data has been collected between 2011 to 2016 by previous mine operators, and more recently since 2019 by PNX.

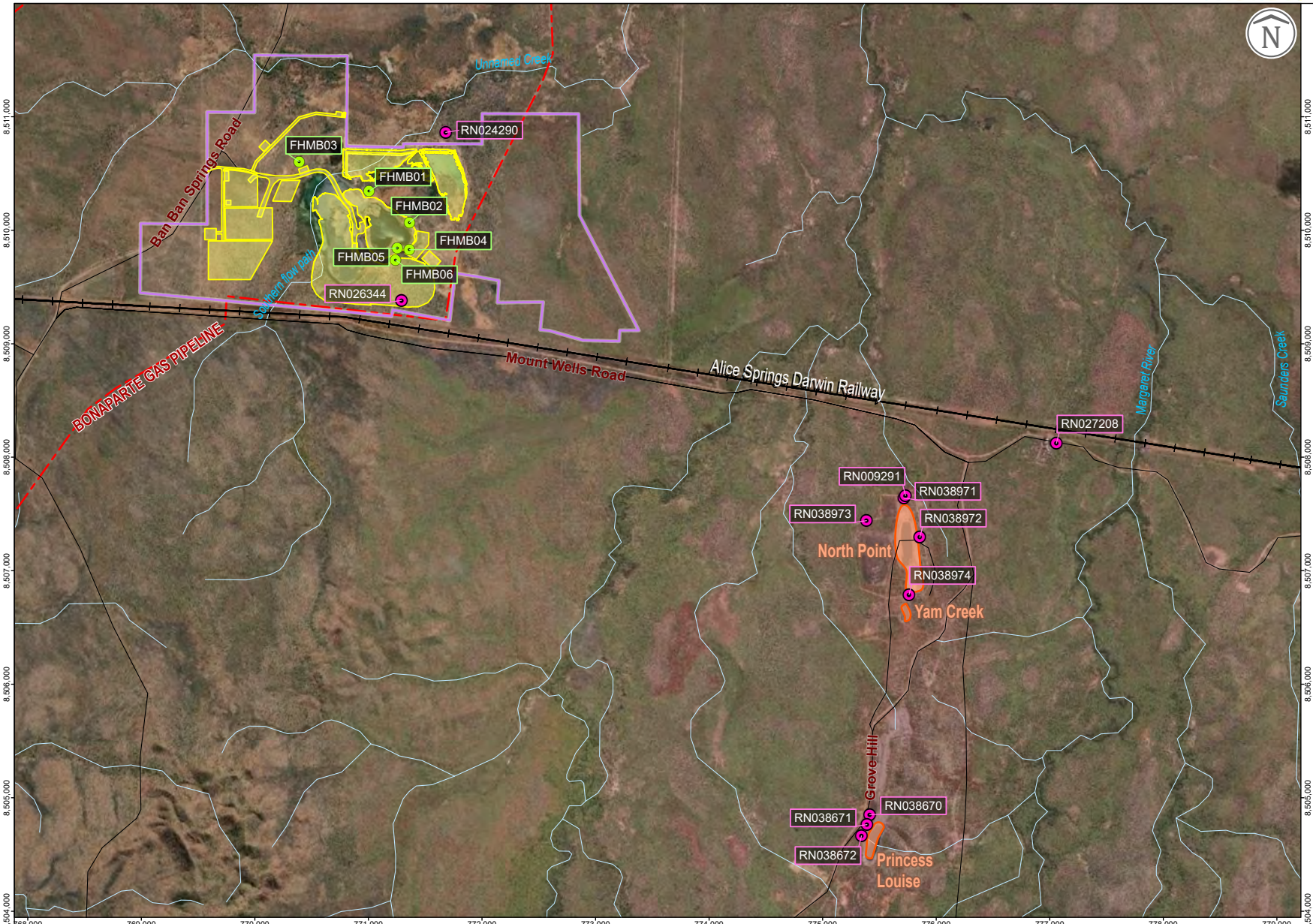
Summary statistics for combined results from 2011 to 2021 for all monitoring bores are shown in Table 4.20. The ANZECC/ARMCANZ (2000) guidelines do not provide trigger values specific to groundwater; however, given its known and potential beneficial uses which include supporting aquatic ecosystems and its use for primary industry the following ANZECC/ARMCANZ (2000) guidelines have been considered in the water quality assessment:

- Short-term trigger value (STV) for irrigation use for less than a 20-year period.
- Trigger values for slightly to moderately disturbed aquatic ecosystems.
- Livestock drinking water guidelines.

GROUNDWATER MONITORING BORES

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FIGURE 4.17



- Groundwater bores
- Monitoring bores
- Road
- Railway
- Gas pipeline
- Watercourse
- Project area
- Infrastructure layout
- Historic open pits

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS012_v0-c

Figure Number: 01238D_EIS_F04.17_GIS_v0-c

ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

In addition, comparison of groundwater quality has been made to the Australian drinking water guidelines (NHMRC/NRMMC, 2011); however, such use of the groundwater resource is not known to occur locally.

Generally, results from the 2019 to 2021 sampling are consistent with results from previous sampling undertaken from 2011 to 2016.

4.6.3.1 General Water Quality Parameters

The groundwater has an average electrical conductivity of 372±163 µS/cm. Electrical conductivity less than 650 µS/cm is considered suitable for irrigation use on sensitive crops and as livestock drinking water. The average electrical conductivity of groundwater is above the range for slightly disturbed rivers in tropical Australia and is higher than surface waters in the nearby area, which generally have an electrical conductivity between 60 and 180 µS/cm, but lower than pit water, which has had an average electrical conductivity of 420 µS/cm.

The pH of groundwater is circumneutral with the average and median values within applicable guideline values, with the exception of two sampling occasions (April 2012 and November 2015) where pH values were slightly above the upper limit for rivers in tropical Australia, and in April 2012 pH was also just above the STV for irrigation and general water use and the drinking water guidelines.

Groundwater is moderately hard, with an average hardness of 108±60 mg $CaCO_3$/L, The pH and hardness of groundwater indicates it is unlikely to cause corrosion or scaling issues in pumping equipment or pipelines. While the average water hardness is below the human drinking water guidelines, the maximum is slightly above.

Concentrations of major ions are all below applicable guidelines for irrigation use and livestock drinking water. No guidelines are provided for major ions for the protection of aquatic ecosystems or for human drinking water. The SAR value is calculated to be 1.1 based on average concentrations of the alkaline ions in groundwater, indicating water quality is good with no major concerns for irrigation use.

Table 4.20 – Summary Statistics for Groundwater General Water Quality Parameters (All Sites Combined) 2011 to 2021

Statistic	pH	Electrical Conductivity (µS/cm)	Hardness (mg $CaCO_3$/L)	Total Alkalinity (mg $CaCO_3$/L)	Ca	Cl	Mg	K	Na	SO_4
					mg/L					
Average	6.7	372	108	163	10	5	20	2	26	3
Std. deviation	0.5	163	60	77	9	2	9	1	10	3
Median	6.6	357	102	168	8	5	21	2	28	1
Maximum	8.6	844	270	380	44	16	40	5	64	15
Count	81	83	70	69	70	70	70	70	70	65
ANZECC/ARMCANZ (2000) Default Trigger Values for Slightly Disturbed Rivers in Tropical Australia	6.0 to 8.0	20 to 250	NA	NA	NA	NA	NA	NA	NA	NA
ANZECC/ARMCANZ (2000) Short-term Trigger Value for Irrigation and General Water Use	6.0 to 8.5	650[#]	60 to 350**	NA	NA	350[†]	NA	NA	230†	NA
Livestock Drinking Water Guidelines ANZECC/ARMCANZ (2000)	5.0 to 9.0	0 to 2,680*	NA	NA	1,000	NA	NA	NA	NA	1,000
Australian Drinking Water Guidelines (NHMRC/NRMMC, 2011)[##]	6.5 to 8.5[††]	NA	200[††]	NA	NA	NA	NA	NA	NA	NA

Note: Grey shading indicates value exceeds the ANZECC/ARMCANZ (2000) default trigger value for tropical Australia. Green shading indicates value exceeds the ANZECC/ARMCANZ (2000) short-term trigger value for irrigation and general water use. Blue shading indicates exceedances of the Australian drinking water guidelines (NHMRC//NRMMC, 2011). Ca = calcium, Cl = chloride, Mg = magnesium, K = potassium, Na = sodium, SO_4= sulphate.
NA: No trigger value available.
* Based on total dissolved solids conversion provided in ANZECC/ARMCANZ (2000).
[#] Trigger value for irrigation of sorghum.
[†] Upper tolerance for moderately tolerant crops (e.g., lucerne and sorghum).
** For fouling and corrosion.
[##] Health-based guideline unless otherwise indicated.
[††] Aesthetic-based guideline

4.6.3.2 Metals and Metalloids

Summary statistics for combined results from 2011 to 2021 for all monitoring bores for total (i.e., unfiltered) metals are shown in Table 4.21 with comparison made to ANZECC/ARMCANZ (2000) guidelines for irrigation and general water use, and livestock drinking water.

The average and median concentrations of total metals and metalloids are well below the applicable guidelines for irrigation and general water use and livestock drinking water. There have been some exceedances of the Australian drinking water guidelines for arsenic, iron and manganese.

The maximum total aluminium concentration in groundwater exceeded the livestock drinking water guidelines on one occasion at FHMB05 in February 2012 (13,000 µg/L) and was equal to the guideline value of 5,000 µg/L at FHMB06 in April 2016. All other results were below irrigation and livestock drinking water guidelines.

The average total iron concentration in groundwater (from all bores) is less than the STV; however, seven of the 13 results from bore FHMB01 and eight of the 11 results from bore FHMB02 exceed the STV. This indicates that crops may potentially be impacted by the phytotoxic effects of iron if groundwater from bores FHMB01 and FHMB02 is exclusively used for irrigation for a lengthy period (i.e., 20 years). These two bores are located to the north (FHMB01) and north east of the pit (FHMB02).

Groundwater would not be suitable for drinking water based on regular exceedances of arsenic, iron and manganese drinking water guideline values. Average concentrations of arsenic and iron have been over an order of magnitude above their respective guideline values. The average manganese concentration has exceeded the aesthetic-based guideline value of 100 µg/L on a number of occasions but has rarely exceeded the health based guideline value of 500 µg/L.

Other notable observations from the monitoring data are as follows:

- There is a wide range in aluminium results with a standard deviation nearly four times the average value; however, concentrations in groundwater are generally similar to pit water excluding outlier results.
- Arsenic concentrations are lower in groundwater than in pit water, and there is considerable variation in concentrations between different bores.
- Iron concentrations are higher in groundwater than in pit water, and there is considerable variation in concentrations between different bores.

Summary statistics for combined results from 2011 to 2021 for all monitoring bores for dissolved (i.e., filtered) metals are shown in Table 4.22 with comparison made to ANZECC/ARMCANZ (2000) guidelines for slightly to moderately disturbed aquatic ecosystems. Results have been separated by bore for dissolved metals, rather than combined as done in Table 4.21 due to there being some exceedances of the trigger values and to further explore spatial differences in dissolved metal concentrations. As shown in Table 4.14, average water hardness across the monitoring bores was 108 mg $CaCO_3$/L; therefore, the adopted trigger values for cadmium,

copper, lead, nickel and zinc have been adjusted based on a 'moderate' water hardness (60 to 119 mg $CaCO_3$/L) as per ANZECC/ARMCANZ (2000).

Dissolved cadmium, chromium, cobalt and lead concentrations were generally below or very close to the respective laboratory limits of reporting at all monitoring bores and for all sampling events. The average, median and maximum dissolved concentrations of cadmium, chromium, cobalt, manganese, lead, nickel and zinc are below the adjusted trigger values for slightly to moderately disturbed aquatic ecosystems. There are exceedances of aluminium, arsenic and copper at some or all of the groundwater monitoring bores.

Although maximum concentrations of dissolved aluminium are above the trigger value for slightly to moderately disturbed aquatic ecosystems at all monitoring bores except FHMB02, 53 of the 67 results were below the laboratory limit of reporting of 10 µg/L indicating that the maximum results are outliers for the monitoring period.

Maximum concentrations of dissolved arsenic are above the guideline for slightly to moderately disturbed aquatic ecosystems (13 µg/L for As(V)) at all monitoring bores, and average concentrations are also above these guidelines at all monitoring bores except FHMB04. Arsenic concentrations have been highest at FHMB01 (located to the north) with an average concentration of 189±171 µg/L compared to average concentrations of between 8 and 141 µg/L for the remaining bores. As described earlier in the section, groundwaters in the region are known to have naturally elevated arsenic levels due to the regional geology.

Dissolved copper concentrations are generally below the laboratory limit of reporting of 1 µg/L for all monitoring bores and sampling events; however, there were two results out of a total of 69, where concentrations were 4 µg/L and marginally exceeded the adjusted trigger value of 3.5 µg/L.

Overall the results for total and dissolved metals indicate that groundwater is not suitable for drinking water based on elevated levels of arsenic, iron and manganese but is generally suitable for irrigation use and for livestock drinking water; however, groundwater from FHMB01 and FHMB02 has elevated levels of iron above irrigation guidelines and aluminium has exceeded livestock drinking water guidelines at FHMB05 and FHMB06. Concentrations of dissolved aluminium, arsenic and copper have also exceeded trigger values for slightly to moderately disturbed aquatic ecosystems on some occasions. As described in Section 4.5.2.1, historical and recent results for surface waters in the nearby area show widespread elevated aluminium concentrations above trigger values for slightly to moderately disturbed aquatic ecosystems. Groundwater may therefore be a contributing source of aluminium reporting to these environments where there is connectivity.

Table 4.21 – Summary Statistics for Groundwater Total Metals and Metalloids (All Bores Combined) 2011 to 2021

Statistic	Al	As	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Ni	Se	U	V	Zn
	µg/L																
Average	513	108	NC	NC	NC	2.3	1.1	2.7	6,037	2.8	165	NC	2.2	NC	NC	NC	9
Std. deviation	1,847	119	NC	NC	NC	6.8	0.4	5.6	7,824	4.9	154	NC	4.4	NC	NC	NC	13
Median	38	79	NC	NC	NC	1	1	1	2,100	1	120	NC	1	NC	NC	NC	6
Maximum	13,000	450	<1	<50	0.3	53	3	40	32,000	26	860	<0.04	35	<10	<10	<10	86
Count	58	60	2	2	61	61	61	61	59	61	61	2	61	2	2	2	61
ANZECC/ARMCANZ (2000) Short-term Trigger Value for Irrigation and General Water Use	20,000	2,000	500	4,000 to 6,000#	50	1,000	100	5,000	10,000	5,000	10,000	2	2,000	50	100	500	5,000
Livestock Drinking Water Guidelines ANZECC/ARMCANZ (2000)	5,000	500	NA	5,000	10	1,000	1,000	1,000*	NA	100	NA	2	1,000	20	200	NA	20,000
Australian Drinking Water Guidelines (NHMRC/NRMMC, 2011)†	NA	10	60	4,000	2	50 (Cr(VI)	NA	1,000† 2,000**	300**	10	500† 100**	1	20	10	17	NA	3,000**

Note: Green shading indicates value exceeds the ANZECC/ARMCANZ (2000) short-term trigger value for irrigation and general water use. Orange shading indicates value exceeds the ANZECC/ARMCANZ (2000) livestock drinking water guidelines. Blue shading indicates value exceeds the NHMRC/NRMMC (2011) drinking water guidelines.
NA no trigger value available.
NC not calculated as all, or the majority of results were below the laboratory limit of reporting.
* Guideline for beef cattle.
# Trigger value for irrigation of sorghum.
† Health-based guideline unless otherwise indicated.
** Aesthetic-based guideline.

Table 4.22 – Summary Statistics for Groundwater Dissolved Metals and Metalloids (Per Bore) 2011 to 2021

Bore	Statistic	Al	As	Cd	Cr	Co	Cu	Fe	Pb	Mn	Ni	Zn
FHMB01	**Average**	NC	189	NC	NC	NC	NC	6,307	NC	202	NC	NC
	Std. Deviation	NC	171	NC	NC	NC	NC	5,987	NC	142	NC	NC
	Median	NC	110	NC	NC	NC	NC	4,680	NC	190	NC	NC
	Maximum	90	450	<0.1	<1	<1	<1	18,000	<1	440	<1	4
	Count	14	15	14	15	15	15	14	NC	15	15	7
FHMB02	**Average**	NC	60	NC	NC	NC	NC	10,452	NC	218	2	5
	Std. Deviation	NC	43	NC	NC	NC	NC	6,605	NC	223	2	2
	Median	NC	67	NC	NC	NC	NC	9,300	NC	130	1	5
	Maximum	<10	150	<0.1	<1	2	<1	20,000	<1	800	4	8
	Count	13	14	14	14	14	14	13	14	14	14	6
FHMB03	**Average**	NC	141	NC	NC	NC	NC	142	3	117	1	4
	Std. Deviation	NC	44	NC	NC	NC	NC	241	4	47	0	3
	Median	NC	135	NC	NC	NC	NC	52	1	120	1	3
	Maximum	68	220	<0.1	<1	<1	1	630	10	175	1	8
	Count	6	6	6	6	6	6	6	6	6	6	4
FHMB04	**Average**	NC	8	NC	1	NC	NC	87	NC	19	2	5
	Std. Deviation	NC	5	NC	0	NC	NC	106	NC	14	2	3
	Median	NC	6.5	NC	1	NC	NC	33	NC	13	1	5
	Maximum	68	24	0.1	1	<1	2	320	<1	48	4	8
	Count	14	14	14	14	14	14	14	14	14	14	6
FHMB05	**Average**	NC	58	NC	NC	NC	NC	652	NC	174	1	7
	Std. Deviation	NC	30	NC	NC	NC	NC	692	NC	97	0	6
	Median	NC	64	NC	NC	NC	NC	320	NC	140	1	5
	Maximum	430	100	<0.1	1	3	4	2,200	2	310	2	17

Bore	Statistic	Al	As	Cd	Cr	Co	Cu	Fe	Pb	Mn	Ni	Zn
	Count	14	14	14	14	14	14	14	14	14	14	7
FHMB06	**Average**	53	61	NC	NC	NC	NC	683	NC	181	1	9
	Std. Deviation	56	39	NC	NC	NC	NC	234	NC	137	0	4
	Median	40	62	NC	NC	NC	NC	665	NC	155	1	9
	Maximum	160	120	<0.1	<1	1	4	990	<1	380	1	12
	Count	6	6	6	6	6	6	6	6	6	6	2
ANZECC/ARMCANZ (2000) Trigger Value for Slightly to Moderately Disturbed Ecosystem		55	13 (As(V))	0.54*	1 (Cr(VI))	1.4#	3.5*	NA	13.6*	1,900	27.5*	20*

Note: Grey shading indicates value is equal to or exceeds the ANZECC/ARMCANZ (2000) default trigger value for tropical Australia.
NA no trigger value available.
NC not calculated as all, or the majority of results were below the laboratory limit of reporting.
Low reliability trigger value.
* Default trigger value adjusted for a moderate water hardness (60 to 119 mg $CaCO_3$/L) as per Table 3.4.4 of ANZECC/ARMCANZ (2000).

4.7 Terrestrial Ecology

4.7.1 Bioregion

The Project area is situated within the Pine Creek bioregion area which comprises of foothill environments below and to the west of the western Arnhem land sandstone massif. It also includes parts of the Darwin rural area. Land types of the area are mainly gently undulating terrain with scattered hills, low ridges of elevations between 90 and 100 mAHD and alluvial flats. Vegetation communities include eucalypt tall open forests, woodlands, with smaller areas of monsoon rainforest patches, Melaleuca woodlands, riparian vegetation and tussock grasslands. The extent of national parks and other protected areas makes up 42% of the total Pine Creek bioregion area, including the largest terrestrial national park in Australia, Kakadu National Park (Baker et al., 2005). The area supports over 90 flora and fauna species endemic to the Pine Creek bioregion, of which 39 are listed as threatened.

Major land uses in the Pine Creek Bioregion are conservation, pastoralism, intensive rural freehold blocks, horticulture and mining. The Fountain Head mine site has been subject to mining and pastoral activity since the early 1800's and as a result has experienced extensive past disturbance including clearing.

4.7.2 Flora and Fauna Surveys

Two flora and fauna surveys were conducted from 15 to 18 of May 2017 (post wet-season) and 20 to 24 August 2019 (late-dry season) (Appendix 8). These two surveys were commissioned for the Hayes Creek Project, which encompasses the Fountain Head Gold Project area. Any reference to the 'survey area' refers to the entire area surveyed as part of the two Hayes Creek flora and fauna surveys, whereas the 'Project area' refers to information relevant to only the Fountain Head Gold Project area (Figure 4.18). Where the 'production area' is stated, this refers to the extent of the project infrastructure layout only.

Prior to the commencement of the surveys, a desktop assessment was undertaken to provide information of the existing environment within the Project area and the likelihood that threatened species may occur (species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) and/or *Territory Parks and Wildlife Conservation Act 1976* (*TPWC Act*)). The surveys were designed to gain a detailed understanding of the environment of the Project area, as well as to target threatened species that may be present. Survey sites were chosen to incorporate the main habitat types in the area and various methods were used to survey all taxa (shown in Table 4.23).

Table 4.23 – Flora and Fauna Survey Methodology Used at Each Survey Site

Site	Site Description	Vegetation Transect	Live-trapping	Bat Detector	Bird Survey	Secondary Sign Survey	Area Search	Camera Trap
FH1			X					X
FH2	X	X	X	X	X	X	X	
FH3					X			
FH4				X				

Site	Site Description	Vegetation Transect	Live-trapping	Bat Detector	Bird Survey	Secondary Sign Survey	Area Search	Camera Trap
FH5				X				
FH6					X			
FH7				X				
FH8	X							
FH9					X			
FH10	X							
FH11	X		X		X			

The methodology of the field surveys is outlined in detail in the Hayes Creek Project Flora and Fauna Report – Appendix 8.

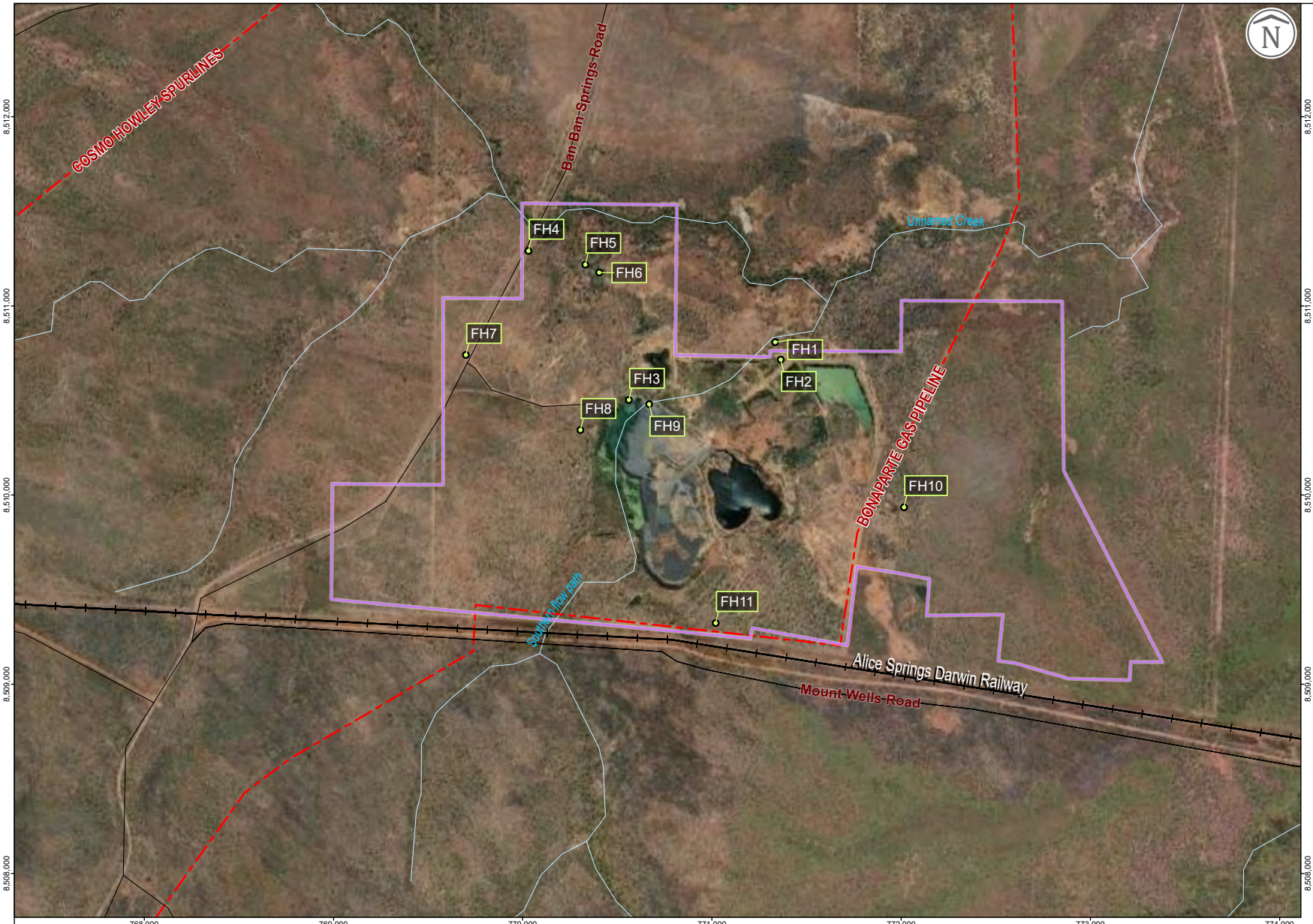
4.7.3 Sites of Conservation Significance

There are 67 Sites of Conservation significance (SoCS) in the Northern Territory identified as the most important for biodiversity, and that require further protection (DLRM, 2019). Sites of Botanical Significance (SoBS) are defined as areas that have botanical features distinguishing them from the surrounding landscape, and that are important for general plant conservation and for specifically mentioned species (White, et al., 2000). There were no SoCS or SoBS identified within 20 km of the survey area. The nearest SoCS are the Daly River middle reaches, Western Arnhem Plateau and Yinberrie Hills; located approximately 40 km south-west, 40 km west and 60 km south-east of the survey area, respectively. No further descriptions are provided as these areas are considered outside of the potential area of Project impact.

FLORA AND FAUNA SURVEY SITES - 2017 AND 2019

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FIGURE 4.18



Survey sites
Road
Railway
Gas pipeline
Watercourse
Project area

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS006_v0-b

Figure Number: 01238D_EIS_F04.18_GIS_v0-b

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Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

4.7.4 Matters of National Environmental Significance

A search for matters of national environmental significance was completed in March 2020 (Appendix 8) using the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) Protected Matters Search Tool (PMST).

Anything that is considered of conservation or environmental significance, whether it be sites, animals, plants, habitats or heritage places, are defined as being matters that require careful consideration if any potential negative impacts on them are likely to occur (DAWE, 2020). A species identified as being of conservation significance may also be a threatened species but not in all cases. When a species is threatened it refers to the intactness of a species' population and the abundance of said species. Not all species of conservation significance are considered threatened species.

The PMST confirmed the following:

- World Heritage properties – There are no World Heritage properties in the vicinity of the proposed Project. The closest site is the Kakadu National Park located approximately 49 km east of the Project.
- World Heritage places – There are no World Heritage places in the vicinity of the proposed Project. The closest site is the Kakadu National Park located approximately 49 km east of the Project.
- Wetland of international importance (declared Ramsar wetlands) – There are no wetlands of international importance (Ramsar-listed wetlands) in close proximity to the proposed Project. The closest site is the Kakadu National Park, located approximately 49 km east of the Project.
- Commonwealth marine area or the Great Barrier Reef Marine Park – the Project is not located within or near the Great Barrier Reef Marine Park, and no Commonwealth marine areas are present within or close to the proposed Project.
- Commonwealth land – the proposed Project will not be located on, or adjacent to, Commonwealth land.
- Listed threatened species and ecological communities (discussed further in Sections 4.7.5, 4.7.6, 4.7.9 and 4.7.10) – There are 21 threatened species and no ecological communities identified as having the potential to occur within a 20 km buffer of the Project area. One of these species, the Merten's water monitor (*Varanus mertensi*), was identified within the Project area during the May 2017 flora and fauna surveys for the Hayes Creek Project but not during the August 2019 surveys. The sighting was anecdotally recorded prior to the surveys, close to the Fountain Head Lake. No threatened ecological communities were identified in the EPBC, PMST or during the surveys completed in May 2017 and August 2019.
- Migratory species (discussed further in Section 4.7.12) – A total of 18 listed migratory species (three of which are classified as threatened species) were identified as having the potential to occur within a 20 km buffer of the Project area. Two listed migratory

species were identified during the May 2017 and August 2019 flora and fauna surveys, however neither are species of conservation significance.

4.7.5 Vegetation Types in the Survey Area

Vegetation in the Project area has been mapped at a scale of 1: 100,000 in the Vegetation Survey of the Northern Territory (Wilson, et al., 1990). Vegetation units 316, 572 and 1064 (described in Table 4.24) were identified as occurring within the Project area.

Table 4.24 – Description of Vegetation Types within the Project Area

Vegetation Unit	Broad Vegetation Classification	Structural Formation	Fine Vegetation Description
316	Melaleuca woodland	Woodland	*Melaleuca viridiflora/leucadendra*, *Melaleuca argentea, Barringtonia acutangula4–68, Pandanus aquaticus, Chysopogon fallax, Heteropoon contortus, Pseudoraphis spinescens*
572	Eucalyptus woodland	Woodland	*Eucalyptus tectifica, E. bigalerita, Erythrophleum chlorostachys, Corymbia latifolia, Terminalia ferdinandiana, Petalostigma pubescens, Sorghum* spp., *Heteropogon triticeus, Chrysopogon fallax*
1064	Pastoral/ Horticultural/ Roads	–	*Acacia holesericea, Calytrix* sp., *Gamba grass* (*Andropogon gayanus*) *hyptis* (*Hyptis suaveolens*), *mission grass* (*Cenchrus pedicellatus*)

4.7.6 Habitat Types in the Project Area

Five habitats were identified during the on-ground survey within the Project area; open forest on alluvial floodplain, open woodland on sandstone plain, creek lines and riparians zones, pit lakes and tailings dams and disturbed areas. Examples of these habitats in the Project area are shown in Plates 4.3, 4.4, 4.5, 4.6 and 4.7. Habitat areas identified during the on-ground survey are consistent with existing land classifications by Lynch et al. (2012) and the vegetation classes described by Wilson, et al. (1990) for the Project area. These habitat types and the extent within the production area are described in detail in Table 4.25 and shown in Figure 4.19.



Plate 4.3 – Open Forest on Alluvial Floodplain – FH2



Plate 4.4 – Open Woodland on Sandstone Plain – Fountain Head Survey Area



Plate 4.5 – Creek Lines and Riparian Zones – Fountain Head Survey Area



Plate 4.6 – Pit Lakes and Tailings Dams – Fountain Head Survey Area



Plate 4.7 – Pastoral and Mining Impacted Habitat – Fountain Head Survey Area

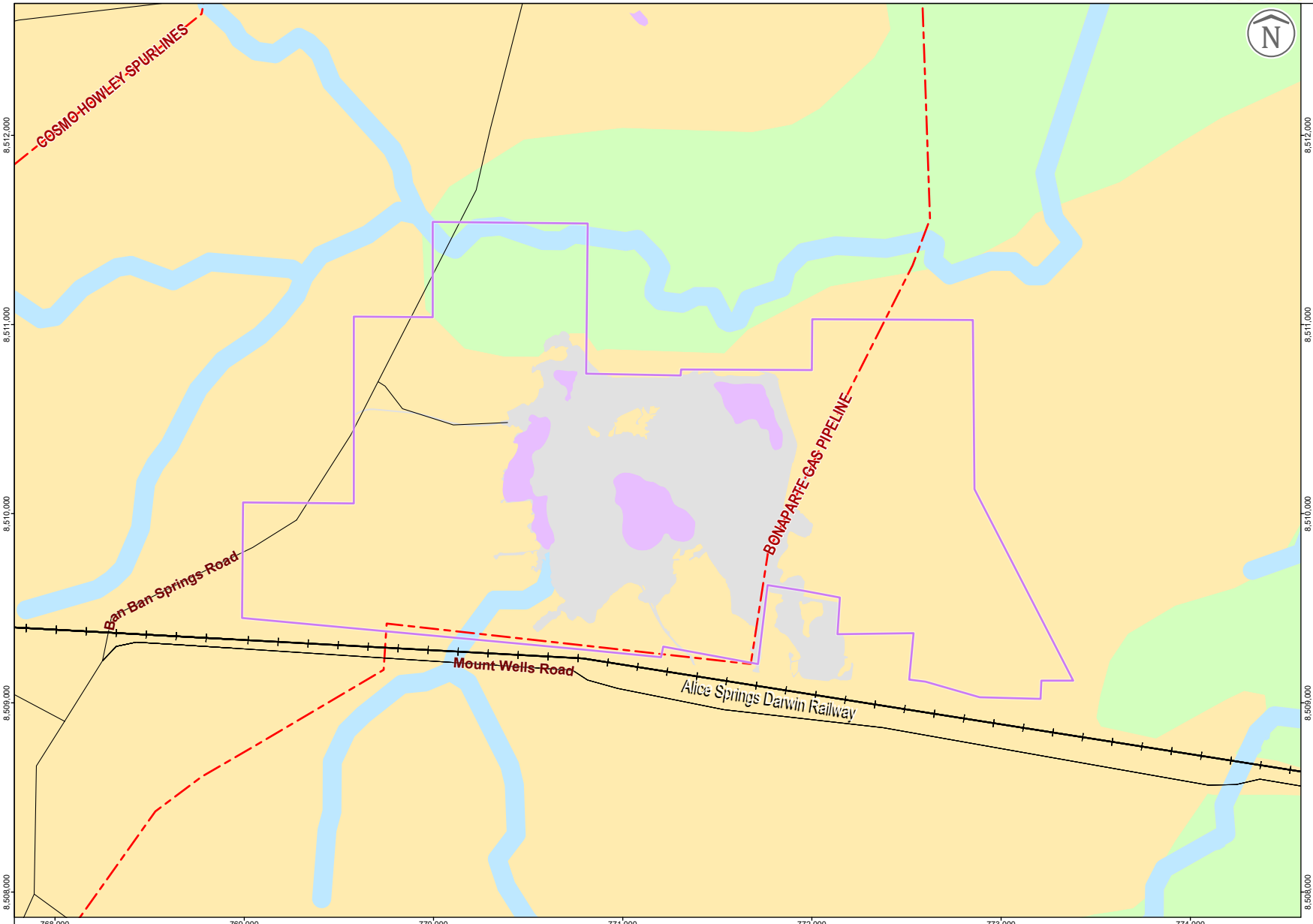
Table 4.25 – Habitat Types Identified During the On Ground Survey

Northern Land Systems (Lynch, et al., 2012)	Vegetation Class (Wilson et al., 1990)	Habitat and Land Classification	Survey Area	Primary Vegetation Recorded	Extent of Habitat Type in the Project Area	
					ha	%
McKinley	–	Open forest on alluvial floodplain	FH2	*Melaleuca viridiflora*, *Corymbia polycarpa*, *Eucalyptus confertiflora*, *Corymbia apodophylla*, *Lophostemon lactifluus*, *Acacia auriculiformis*	43.85	6.91
Rumwaggon	572	Open woodland on sandstone plain	FH11, FH10, FH8	*Corymbia latifolia*, *Erythrophleum chlorostachys*, *Eucalyptus tectifica*, *Eucalyptus miniata4–70* and *Eucalyptus tintinnans*	410.82	64.74
–	–	Creek lines and riparian zones	–	*Nauclea orientalis*, *Bambus arnhemica, Ficus* sp. and *Melaleuca leucadendra*	14.99	2.36
–	–	Pit lakes and tailings dams	Fountain Head pit and dam	Pit lakes and tailings dams holding substantial amounts of water	26.70	4.21
–	–	Disturbed areas (pastoral/ mining/ tracks)	Disturbed areas	Disturbed areas were a combination of cleared tracks, pits and gravel patches with little to no vegetation and revegetated areas consisting of *Eucalyptus tectifica*, *Acacia holosericea* and *Calytrix* sp.	138.22	21.78

HABITAT TYPES IN THE PROJECT AREA

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 4.19



Road
Railway
Gas pipeline
Project area
Alluvial floodplains
Creekline/riparian zone
Disturbed areas
Pit lakes and tailings dams
Sandstone plains and rises

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS020_v0-c

Figure Number: 01238D_EIS_F04.19_GIS_v0-c

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Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

4.7.7 Flora Species of Conservation Significance

The NT Flora Atlas found 4281 records of 661 species within a 20 km buffer of the survey area. Two species of conservation significance were identified by the EPBC PMST or Territory Parks and Wildlife Conservation (TPWC) Flora Atlas as occurring or potentially occurring within a 20 km radius of the survey area, of these two identified flora species, one is listed as endangered, *Stylidium ensatum*, and one is listed as vulnerable, *Acacia praetermissa*. A review of the NT Flora Atlas identified 222 records of *A. praetermissa* within the same search area.

Four species listed as near threatened and eight species listed as data deficient under the *TPWC Act* (2014) were also previously recorded within 20 km of the survey area. Table 4.26 lists all species of conservation significance and the potential likelihood of occurrence in the Project area. The criteria and method for assessing the likelihood of a species being present in the Project area is explained in Appendix 8.

Table 4.26 – Listed Flora Species Potentially Occurring within 20 km of the Survey Area

Family	Scientific Name	Status		PMST	NT Flora Atlas	Likelihood of Occurrence
		TPWC	EPBC			
Fabaceae	*Acacia praetermissa*	VU	VU	X	X	High
Fabaceae	*Alysicarpus suffruticosus*	DD	–	–	X	Moderate
Centrolepidaceae	*Centrolepis curta*	NT	–	–	X	Moderate
Malvaceae	*Decaschistia byrnesii* subsp. *Byrnesii*	NT	–	–	X	High
Cyperaceae	*Eleocharis acutangula*	DD	–	–	X	Moderate
Amaranthaceae	*Gomphrena involucrata*	DD	–	–	X	High
Goodeniaceae	*Goodenia glandulosa*	NT	–	–	X	Moderate
Pittosporaceae	*Pittosporum moluccanum*	NT	–	–	X	Moderate
Cyperaceae	*Scleria pergracilis*	DD	–	–	X	Moderate
Cyperaceae	*Scleria psilorrhiza*	DD	–	–	X	High
Fabaceae	*Senna procumbens*	DD	–	–	X	Moderate
Stylidiaceae	*Stylidium ensatum*	EN	EN	X	X	High
Santalaceae	*Viscum whitei subsp. Flexicaule*	DD	–	–	X	Moderate
Poaceae	*Whiteochloa multiciliata*	DD	–	–	X	Moderate

VU = Vulnerable, DD = Data Deficient, NT = Near Threatened.

During the May 2017 and August 2019 on-ground surveys a total of 143 flora taxa were recorded across the survey area. No flora species of conservation significance were identified in the survey area during the May 2017 and August 2019 surveys, despite targeted survey effort for *Acacia praetermissa* and *Stylidium ensatum*. Potential habitat for *S. ensatum* was identified as part of the open forest on alluvial plains but no individuals were identified. Specimens collected from FH1 and FH2 during the May 2017 survey were sent to the NT Herbarium and identified as *Stylidium*

sp. but could not be identified to species level due to a lack of flowers or fruits. No specimens of *Stylidium* were recorded during the August 2019 survey. Several other flora species could not be identified to species level. However, all were determined to not be threatened species due to their identified genus, description and/or location.

4.7.8 Threatened Ecological Communities

No threatened ecological communities were identified within 20 km of the Project area.

4.7.9 Introduced Flora and Weed Species

During the 2017 and 2019 field surveys, a total of 24 introduced flora species were identified within the survey area. An introduced species is defined as plants, animals, pathogens and other organisms that are living outside their native distributional range and have arrived there predominately due to anthropogenic activity, either deliberately or accidentally. Five of the 24 introduced species that identified within the survey area were identified within the Fountain Head Project area. Two species identified in the Project area (Gamba grass and Grader grass) are listed weeds in the Northern Territory. Weeds present in the Project area and their classifications are provided in Table 4.27. Gamba grass was prevalent across the Project area, particularly around most of the edge of the existing pit, along the fence running parallel with the train line and scattered throughout disturbed areas. The identified species have all been declared as weeds under the NT *Weeds Management Act*.

Table 4.27 – Declared Weed Species Recorded in the Fountain Head Project Area during the May 2017 and August 2019 surveys, Including Classification under the NT Weeds Act, EPBC Act and Inclusion on the WoNS list

Scientific Name	Common Name	Survey	Status			PMST	NT Flora Atlas
			NT	EPBC	WoNS		
Andropogon gayanus	Gamba Grass	May-17, Aug-19	B	Invasive	X	X	X
Calotropis procera	Rubber Bush	May-17, Aug-19	B (zoned*)	–	–	–	X
Cynodon dactylon	Couch Grass	May-17	–	–	–	–	X
Passiflora foetida	Wild Passionfruit	May-17, Aug-19	–	–	–	–	X
Themeda quadrivalvis	Grader Grass	May-17, Aug-19	B, C	–	–	–	X

NT– NT weed legislation listed species.
EPBC – EPBC listed as an invasive species.
WoNS – Federally listed Weeds of National significance.
Zoned* – South of 16°30' S latitude (growth and spread to be controlled).
B – Growth and spread to be controlled.
C – Not to be introduced into the Northern Territory.

4.7.10 Native Fauna Species

A total of five native amphibians, 61 native birds, 10 native mammals and two native reptile species were recorded across the Project area during the May 2017 and August 2019 surveys. An additional one bird taxa and six mammal taxa could not be identified to species level. Table

4.28 shows the number of each fauna group found across the Project area during each survey effort.

Table 4.28 – Number of Fauna recorded in the Project Area

Survey	Fauna Group	Number of Species
May-17	Amphibian	5
	Bird	26 (1)
	Mammal	4 (2)
	Reptile	2
Aug-19	Amphibian	0
	Bird	50
	Mammal	9 (4)
	Reptile	0

Numbers of individuals recorded in closed brackets were incidental.

Details of the individual species recorded from 4.28 are listed in Appendix 8.

4.7.11 Fauna Species of Conservation Significance

The EPBC PMST identified 20 fauna species listed as threatened under the *EPBC Act* as occurring or potentially occurring within 20 km of the survey area. Records of three species listed as endangered and three species listed as vulnerable under the *EPBC Act* were identified by the NT Fauna Atlas within a 20 km radius of the survey area. The NT Fauna Atlas also identified records of four species listed as vulnerable under the *TPWC Act*, but not listed under the *EPBC Act* potentially occurring across the same area. Records of an additional 15 species listed as near threatened and seven listed as data deficient under the *TPWC Act* were found for the survey area.

Of the threatened species identified by the desktop study classified as moderately or highly likely to occur within the survey area, none were recorded during the surveys within the Project area. The Merten's water monitor (*Varanus mertensi*), listed as vulnerable under the *TPWC Act*, was anecdotally recorded prior to the May 2017 survey close to the Fountain Head Lake. The key threatening process impacting the Merten's water monitor population in the Northern Territory is the propensity for them to eat the invasive cane toad, leading to death from ingestion of toxins (DENR, 2006). This has caused a substantial decline in the population across the territory. The cane toad has been recorded within the Project area and is widespread across the Northern Territory. The Gouldian Finch was recorded within the survey area, five to eight km from the Project area. Potential impacts of the Project on threatened species is discussed in Sections 7.7 and 7.8.

4.7.12 Threatened Species

Threatened species identified in the desktop study that were moderately or highly likely to occur within the survey area but not recorded within close proximity to the Project area during the May 2017 or August 2019 surveys, despite targeted survey effort, are listed in Table 4.29. The criteria and method for assessing the likelihood of a species being present is explained in Appendix 8.

Table 4.29 – Threatened Species Moderately or Highly Likely to Occur in the Survey Area

Species	Status		Likelihood
	TPWC	EPBC	Residual
Curlew sandpiper (*Calidris ferruginea*)	Vu	Cr	Moderate
Red goshawk (*Erythrotriorchis radiatus*)	Vu	Vu	Moderate
Partridge pigeon (eastern) (*Geophaps smithii smithii*)	Vu	Vu	High
Masked owl (northern) (*Tyto novaehollandiae Kimberli*)	Vu	Vu	High
Ghost bat (*Macroderma gigas*)	NT	Vu	Moderate
Northern brush-tailed phascogale (*Phascogale pirata*)	En	Vu	Moderate
Pale field rat (*Rattus tunneyi*)	Vu	NT	High
Mitchell's water monitor (*Varanus mitchelli*)	Vu	NT	High
Floodplain monitor (*Varanus panoptes*)	Vu	NT	Moderate

Vu – Vulnerable, Cr – Critical, En – Endangered, NT – Not threatened, DD – Data deficient.

4.7.13 Near Threatened and Data Deficient Fauna Species

Fauna species listed as near threatened (NT), data deficient (DD), marine (Ma) or migratory (Mi) under the *EPBC Act* or *TPWC Act* recorded within the Project area during the May 2017 and August 2019 surveys are shown in Table 4.30. Co-ordinates are provided in the Geocentric Datum of Australia 1994 (GDA94).

Table 4.30 – Near Threatened and Data Deficient Fauna Species Recorded in the Project Area

Species	Status	Date	Co-ordinates	Location	Number of Individuals
Australian bustard (*Ardeotis australis*)	NT (TPWC)	21/08/2019	Not recorded	Fountain Head production area	1
		21/08/2019	Not recorded	Fountain Head production area	1
Bush stone-curlew (*Burhinus grallarius*)	NT (TPWC)	22/08/2019	-13.47096, 131.50987	Fountain Head production area	1
Hooded parrot (*Psephotus dissimlis*)	NT (TPWC)	23/08/2019	Not recorded	Fountain Head production area	5
Orange leaf-nosed bat (*Rhinonicteris aurantia*)	NT (TPWC)	17/05/2017 – 19/05/2017	-13.459068, 131.506359	FH2 – disturbed woodland in Fountain Head production area	NA

NA indicates that the number of individuals of a bat species cannot be discerned from echolocation call recordings.

4.7.14 Marine and Migratory Fauna Species

A total of 18 listed migratory species, three of which are classified as threatened species, were identified using the PMST as having the potential to occur within 20 km of the Project area. The threatened migratory species identified included the curlew sandpiper (*Calidris ferruginea*) and the eastern curlew or far eastern curlew (*Numenius madagascariensis*), which are listed as critically endangered, and the freshwater sawfish (*Pristis pristis*), which is listed as vulnerable (Table 4.31). None of these species were observed during the May 2017 or August 2019 flora and fauna surveys or 2019 aquatic ecology survey.

A majority of the 18 listed migratory species identified using the PMST as having the potential to occur within 20 km of the Project area are also listed marine species, excluding the freshwater sawfish and the oriental cuckoo. An additional 7 listed marine species were identified, none of which are endangered (Table 4.31). The Rainbow bee-eater was identified during both the May 2017 and August 2019 surveys, as well as a Great egret during the August 2019 survey. Both species are listed marine species, however neither are endangered species.

Table 4.31 – Marine and Migratory Species Potentially Occurring within 20 km of the Survey Area

Species	Marine	Migratory	EPBC Status	Likelihood of Occurrence
Fork-tailed Swift (*Apus pacificus*)	X	X	–	Species or species habitat likely to occur within area
Salt-water Crocodile (*Crocodylus porosus*)	X	X	–	Species or species habitat likely to occur within area
Freshwater Crocodile (*Crocodylus johnstoni*)	X	–	–	Species or species habitat may occur within area
Freshwater Sawfish (*Pristis pristis*)	–	X	VU	Species or species habitat likely to occur within area
Red-rumped Swallow (*Cecropis daurica*)	X	X	–	Species or species habitat may occur within area
Oriental Cuckoo (*Cuculus optatus*)	–	X	–	Species or species habitat may occur within area
Barn Swallow (*Hirundo rustica*)	X	X	–	Species or species habitat may occur within area
Grey Wagtail (*Motacilla cinerea*)	X	X	–	Species or species habitat may occur within area
Yellow Wagtail (*Motacilla flava*)	X	X	–	Species or species habitat may occur within area
Rufous Fantail (*Rhipidura rufifrons*)	X	X	–	Species or species habitat may occur within area
Oriental Reed-Warbler (*Acrocephalus orientalis*)	X	X	–	Species or species habitat may occur within area
Common Sandpiper (*Actitis hypoleucos*)	X	X	–	Species or species habitat may occur within area
Sharp-tailed Sandpiper (*Calidris acuminata*)	X	X	–	Species or species habitat may occur within area

Species	Marine	Migratory	EPBC Status	Likelihood of Occurrence
Curlew Sandpiper (*Calidris ferruginea*)	X	X	CE	Species or species habitat may occur within area
Pectoral Sandpiper (*Calidris melanotos*)	X	X	–	Species or species habitat may occur within area
Oriental Plover (*Charadrius veredus*)	X	X	–	Species or species habitat may occur within area
Oriental Pratincole (*Glareola maldivarum*)	X	X	–	Species or species habitat may occur within area
Eastern Curlew (*Numenius madagascariensis*)	X	X	CE	Species or species habitat may occur within area
Osprey (*Pandion haliaetus*)	X	X	–	Species or species habitat likely to occur within area
Magpie Goose (*Anseranas semipalmata*)	X	–	–	Species or species habitat may occur within area
Great Egret (*Ardea alba*)	X	–	–	Species or species habitat known to occur within area
Cattle Egret (*Ardea ibis*)	X	–	–	Species or species habitat may occur within area
Black-eared Cuckoo (*Chrysococcyx osculans*)	X	–	–	Species or species habitat likely to occur within area
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	X	–	–	Species or species habitat likely to occur within area
Rainbow Bee-eater (*Merops ornatus*)	X	–	–	Species or species habitat known to occur within area

CE = Critically Endangered, VU = Vulnerable.

4.7.15 Introduced Fauna Species

Twelve introduced fauna species were identified by the EPBC PMST as occurring or potentially occurring within 20 km of the survey area. Eight introduced fauna species were identified by the NT Fauna Atlas within 20 km of the survey area. Three of these species were recorded in the May 2017 and August 2019 survey (cane toads, cattle and pigs) in and around the survey area. Although not recorded during either of the site surveys, house mice, Asian house geckos, feral dogs, flowerpot blind snakes, and rock doves could be present or have the potential to occur in the survey area.

4.8 Aquatic Ecology

This section describes the existing aquatic ecological environment relevant to the Project. This description draws on available literature and data collected during an aquatic ecology field survey conducted by ERIAS in April 2019 (see Appendix 9 for full report). The field survey was commissioned for the Hayes Creek zinc-gold-silver Project, which also encompasses the Fountain Head Gold Project area. While Appendix 9 includes data from sites not relevant to the Fountain Head Gold Project area, only information relevant to this Project area is included in this section.

4.8.1 Regional Context

The Project lies in the Timor Sea drainage division, which encompasses an area of around 564,647 km^2. Streams tend to run west towards the Indian Ocean or north to the Timor Sea. Considering streamflow per area, it is the second wettest drainage division in Australia (CSIRO, 2009). Within this drainage division, the Project is located in the Adelaide River basin 7,700 km^2) (Pusey et al., 2017). There are nearly 100 freshwater fish species known to the division of which 27 are considered endemic (CSIRO, 2009). There is little rainfall during the dry season to sustain continuous flows in many of the surface waters of the division, except where substantial groundwater input is received which maintains baseflows during the dry season (e.g., Daly, Roper, Jardine and Gregory Rivers) (Pusey et al., 2017).

4.8.2 Field Survey

ERIAS conducted aquatic ecology field surveys from 2 to 4 April 2019 which included sites close to Fountain Head and in the broader region (see Appendix 9 for full report). The aquatic ecology field survey investigated a variety of aquatic habitats and included sampling of macrocrustaceans, macroinvertebrates and fish using a variety of sampling techniques. Figure 4.14 shows the location of survey sites (Section 4.5.2) while Table 4.32 provides the coordinates and description of relevant sampling locations and a summary of the survey effort at these locations.

Due to the different conditions (e.g., stream width and depth) encountered at each sampling location, aquatic biodiversity sampling methods were not the same at each sampling location. The objective of the survey was to understand the occurrence, distribution and abundance of aquatic biodiversity in the study area using rapid assessment methods rather than to quantitatively compare the aquatic biodiversity between sampling locations; however, survey methods were standardised to allow some comparison between sites where the same methods were employed.

Table 4.32 – Aquatic Sampling Locations and Survey Effort

Sampling Location	Description	Latitude	Longitude	Sampling Conducted*
S5	Margaret River at Grove Hill east of Fountain Head	3.484182	131.565601	• Water quality • Macroinvertebrates • Fish (FN(2), BT) • Macrocrustaceans • Stream assessment
S6	Unnamed tributary of the Margaret River upstream of Fountain Head along Ban Ban Springs Road	13.452777	131.494643	• Water quality • Macroinvertebrates • Fish (EF) • Macrocrustaceans • Stream assessment
S7	Unnamed tributary of the Margaret River upstream of Fountain Head and upstream of site S6	13.440845	131.482538	• Water quality

Sampling Location	Description	Latitude	Longitude	Sampling Conducted*
S8	Margaret River east of the Woolwonga mine, downstream of Fountain Head and downstream of site S5	13.404039	131.565161	• Water quality • Macroinvertebrates • Fish (EF, BT) • Macrocrustaceans • Stream assessment

Note: coordinates are in WGS84 Zone 52 L.
*EF = electrofishing (900 seconds), FN = fyke net (overnight), BT = bait traps (five traps per site).

4.8.3 Aquatic Habitats

The surface waters of the study area include both intermittent streams, which have flowing water for all or most of the wet season but are dry during the drier months (e.g., Margaret River), and ephemeral streams, which flow briefly following rainfall and are dry for most of the year (tributary creeks of the Margaret River and other small tributary creeks in the study area). There are no permanent flowing surface water bodies in the study area.

A variety of aquatic habitats occur in the study area and within sampling locations, including:

- Low gradient sections of the Margaret River main channel and its tributaries, characterised by shallow, slow moving or stagnant, slightly turbid water with cobbles, boulders and sandy substrate (Plate 4.8a).
- Deeper pools of the Margaret River main channel, characterised by slow moving or stagnant, slightly turbid water with a predominantly sandy substrate, with water depths typically between 0.5 to 1 m (Plate 4.8b).
- Low gradient tributary creeks, characterised by slow to moderate flow velocities, moderate to high turbidity and a narrow channel (Plate 4.8c).

Plate 4.8 – Examples of Aquatic Habitats of the Study Area



(a) Low gradient sections of the Margaret River (S8)



(b) Deeper pools of the Margaret River with slow moving or stagnant turbid water (S5)



(c) Low gradient tributary creeks (S6)

4.8.4 Aquatic Fauna

4.8.4.1 Macrocrustaceans

Freshwater prawns were common at all sites surveyed for aquatic biodiversity. Species recorded included northwest Australian river prawn (*Macrobrachium bullatum*) as well as large numbers of small (i.e., with a carapace length of less than 1 to 2 cm) *Macrobrachium* individuals that could not be counted and identified to species level due to their sheer numbers and small size which made identification and quantification impractical.

The northwest Australian river prawn has a widespread distribution in northwestern Australia, occurring in a wide range of freshwater habitats including permanent creeks and streams as well as billabongs, seasonal watercourses, man-made reservoirs and lakes (De Grave et al., 2013).

One freshwater crab species, the river swimming crab (*Veruna litterata*), was recorded at sites S5 and S8. The river swimming crab was most abundant at site S5, with 20 individuals recorded while three individuals were recorded at site S8. The river swimming crab is a euryhaline species, i.e., able to survive in a range of salinities. It is found throughout the Indo-west Pacific, including South Africa, India, Vietnam, Taiwan, Indonesia, Papua New Guinea, New Caledonia and Australia (Davie, 2002; Waltham et al., 2014). In Australia, it is found from the north of the Northern Territory and along the Queensland coast, down into northern New South Wales (Mos et al., 2017).

4.8.4.2 Macroinvertebrates

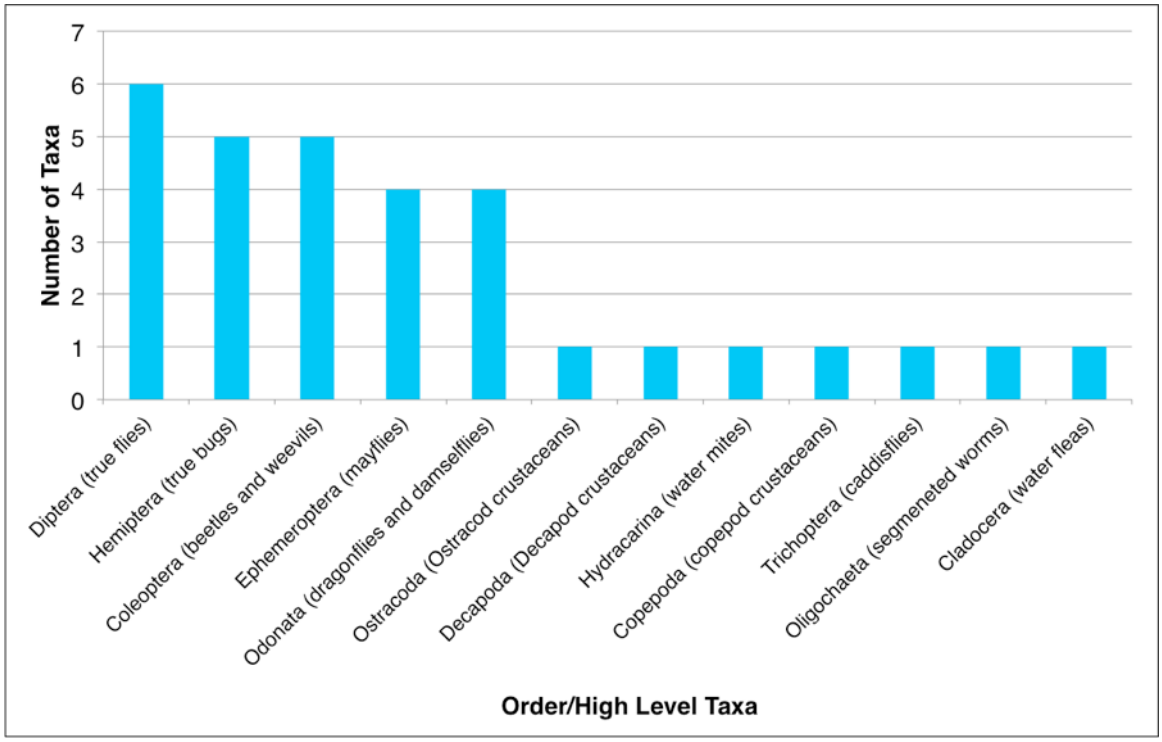
A total of 202 individuals from at least 11 orders, 22 families and 26 taxa were identified (Figure 4.20). The abundance and richness of macroinvertebrates was low in the study area.

Macroinvertebrate assemblages were numerically dominated by:

- Ephemeroptera (mayflies) (4 taxa, 106 individuals).
- Hemiptera (true bugs) (5 taxa, 43 individuals).

- Diptera (true flies) (6 taxa, 28 individuals).

Figure 4.20 – Abundance of Macroinvertebrates in the Study Area

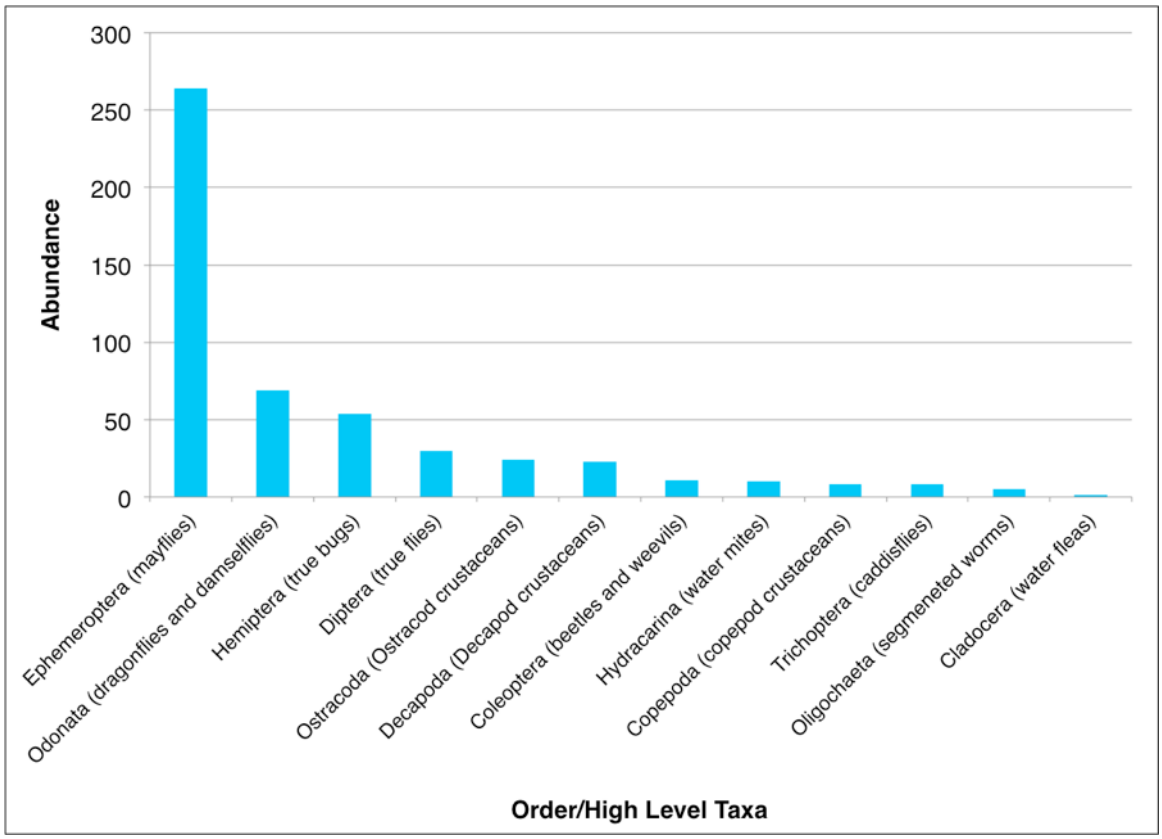


These three orders accounted for 88% of total abundance across the surveyed sites. Caenidae (small square-gill mayflies) was the most numerically dominant family (84 individuals), followed by Corixidae (water boatmen, 30 individuals), which together accounted for 56% of all observed macroinvertebrates. Other relatively abundant families included Chironomidae (non-biting midges) and Baetidae (mayflies) with 21 and 19 individuals recorded, respectively (Figure 4.20). The remaining 18 families accounted for only 24% of all observations.

Immature Corixidae (water boatmen), Chironomidae (non-biting midges) and Caenidae (small square-gill mayflies) were common across all sites, while Baetidae (mayflies) were common to all sites except site S5.

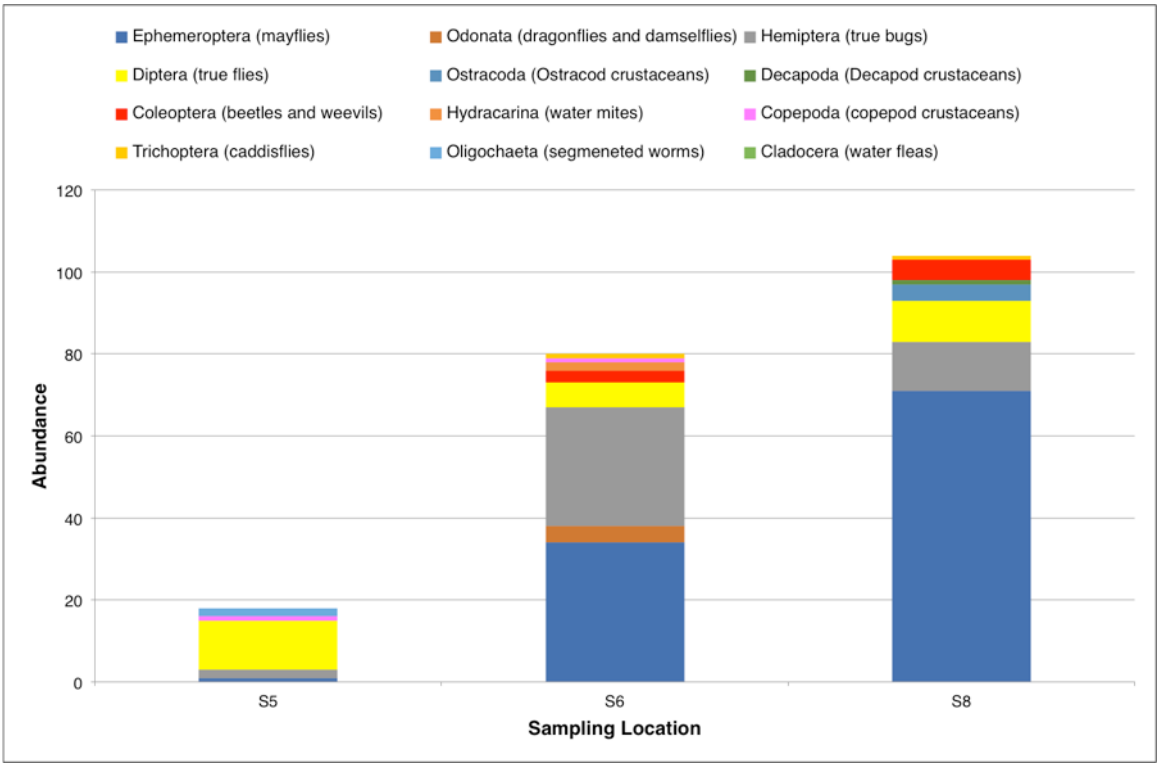
Diptera (true flies), Hemiptera (true bugs), Ephemeroptera (mayflies) and Coleoptera (beetles and weevils) were the most taxonomically rich orders, with six, five, four and four taxa recorded respectively (Figure 4.21). There was only one taxa recorded for each of the remaining seven orders/taxonomic groups.

Figure 4.21 – Richness of Macroinvertebrates in the Study Area



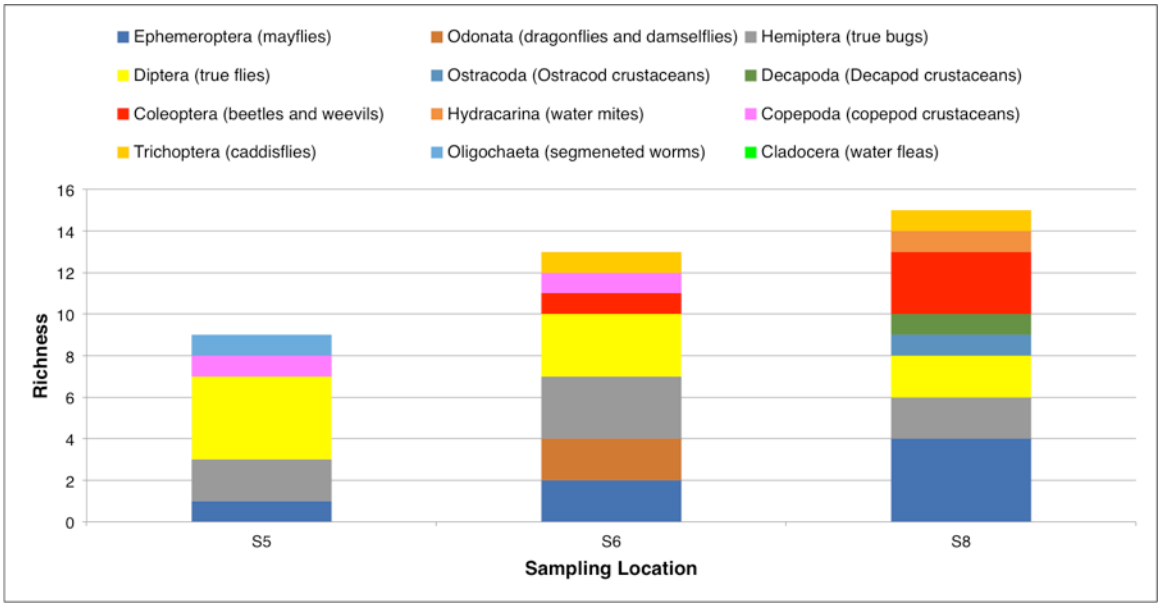
Total abundance varied between sites, with notably lower abundance recorded at site S5, with only 18 individuals recorded compared to 80 and 104 at sites S6 and S8 respectively (Figure 4.22). Hemiptera (true bugs) were notably more abundant at site S6 compared to the other sites and Ephemeroptera (mayflies), which accounted for 68% of all recorded macroinvertebrates at site S8 were notably higher than at the other two sites. Mayflies are a pollution sensitive order of macroinvertebrates that generally prefer well oxygenated, cool waters and may be absent where there is significant disturbance (EPA Victoria, 2003).

Figure 4.22 – Abundance of Macroinvertebrates per Sampling Location – All Surveyed Sites



The number of taxa ranged from nine at site S5 to 15 at site S8 (Figure 4.22). Although the number of taxa was similar between S6 and S8, with 13 and 15 taxa recorded respectively, the general makeup of macroinvertebrate taxa was different between sites (Figure 4.23).

Figure 4.23 – Richness of Macroinvertebrates per Sampling Location – All Surveyed Sites

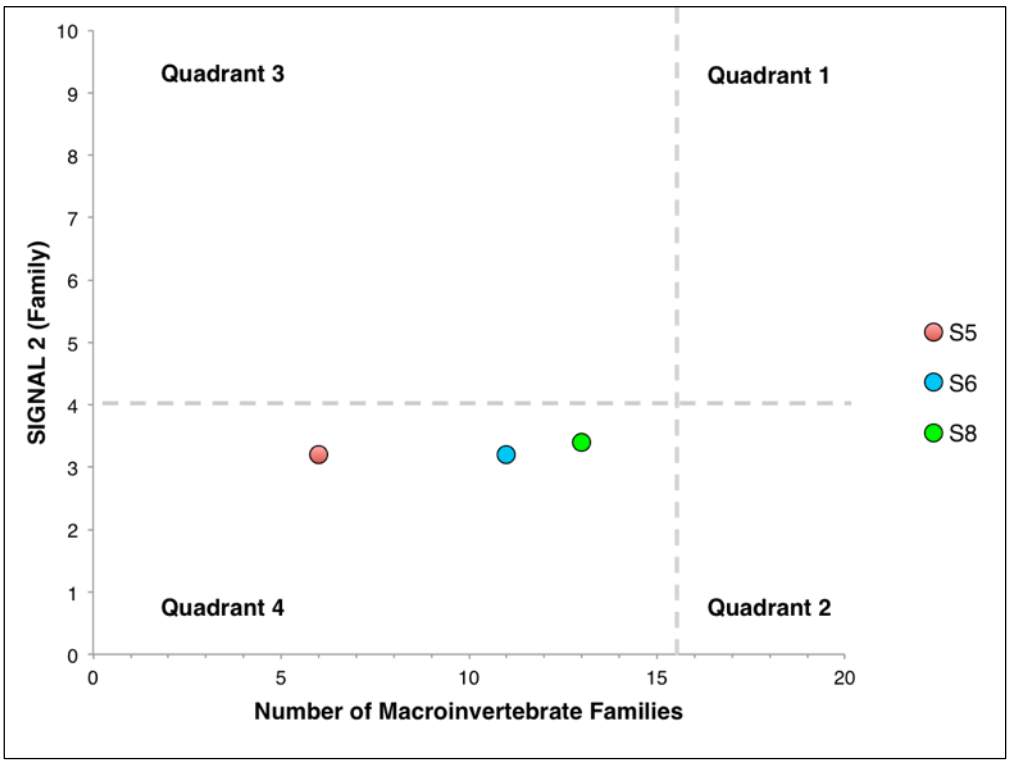


The stream invertebrate grade number-average level (SIGNAL 2) was calculated for each site based on family level taxa in accordance with the procedure described in Chessman (2001), except for Oligochaeta for which a score for this subclass was used, as macroinvertebrates from this subclass were not identified to family level. A SIGNAL score provides an indication of water quality in the aquatic environment sampled, where rivers with high SIGNAL scores are likely to have low levels of salinity, turbidity and nutrients such as nitrogen and phosphorous (Chessman, 2001). When considered in conjunction with macroinvertebrate richness, SIGNAL can also provide an indication of the types of pollution and other physical and chemical stressors in the aquatic environment (Chessman, 2001).

Figure 4.24 shows a plot of the number of macroinvertebrate family taxa versus the calculated SIGNAL 2 score per site, with raw calculations provided in Appendix 20. The quadrant borders shown are based on the default values provided in Chessman (2001). Due to the variability of macroinvertebrate assemblages at the site level, it is usual to collect three replicate samples per site; however, the results of a single sample from the rapid assessment are still considered to provide some further context for the characterisation of the existing environment.

Macroinvertebrate assemblages from all three sites are placed within quadrant four. Results in this quadrant represent low values for both the SIGNAL 2 score and the number of invertebrate types. Typically, sites falling within this quadrant indicate urban, industrial or agricultural pollution or downstream effects of dams (Chessman, 2001). This is further supported by the water quality results which indicated elevated nutrient concentrations, low dissolved oxygen levels and elevated microbial contaminants at some or all sampling locations (see Section 4.5).

Figure 4.24 – Number of Macroinvertebrate Families Versus SIGNAL 2 Score per Sampling Location – All Surveyed Sites



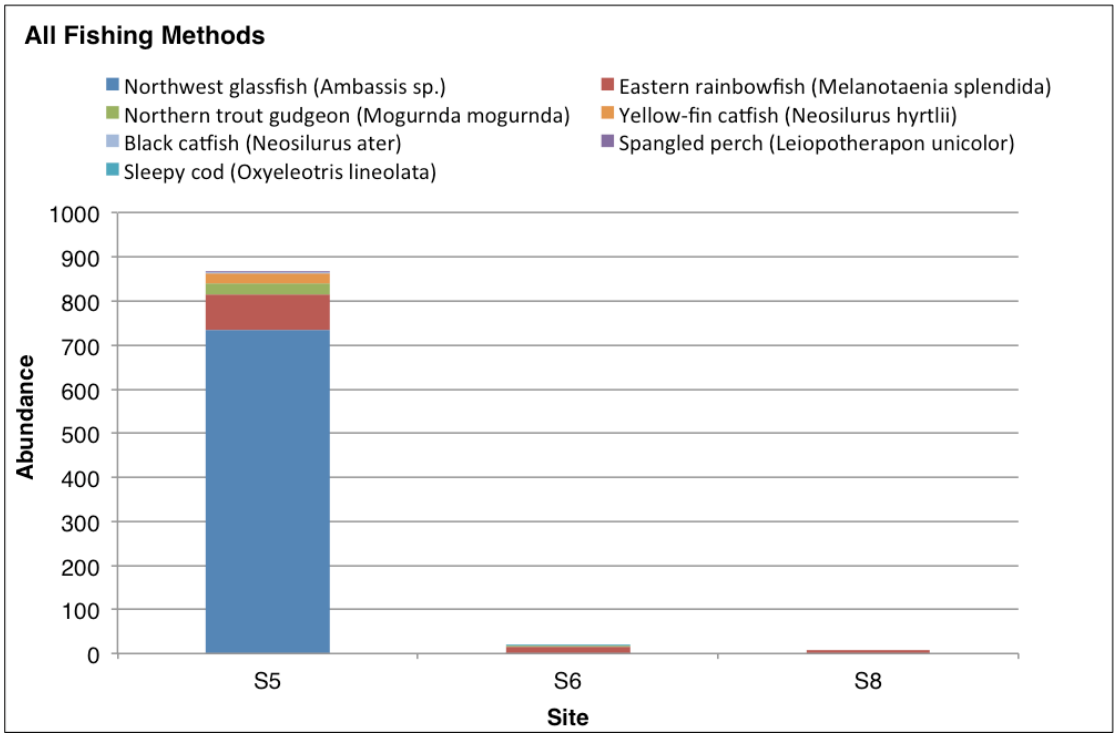
4.8.4.3 Fish

A total of 896 individuals represented by seven species were recorded across the three sites surveyed for aquatic biodiversity (based on pooling the data from all survey techniques). The abundance and diversity of fish fauna is low, with only seven species recorded. Fish assemblages were composed of:

- Northwest glassfish (*Ambassis* sp., 735 individuals).
- Eastern rainbowfish (*Melanotaenia splendida*, 104 individuals).
- Northern trout gudgeon (*Mogurnda mogurnda*, 27 individuals).
- Hyrtl's catfish (*Neosilurus hyrtlii*, 24 individuals).
- Spangled perch (*Leiopotherapon unicolor*, four individuals).
- Black catfish (*Neosilurus ater*, one individual).
- Sleepy cod (*Oxyeleotris lineolata*, one individual).

The northwest glassfish (*Ambassis* sp.) accounted for 82% of all fish observations, while the eastern rainbowfish (*Melanotaenia splendida*) represented 12% of individual fish. The remaining five species accounted for only 6% of all individuals. While the northwest glassfish was the most abundant fish species in the study area, it was not observed at site S8. Although less abundant, the eastern rainbowfish was common across all sites and the northern trout gudgeon was found at all sites except site S8 (Figure 4.25). The sleepy cod was only recorded at site S6, with a single individual recorded.

Figure 4.25 – Abundance and Richness of Fish Recorded per Sampling Location – All Surveyed Sites



Overall fish abundance and richness was highest at site S5, with fish from this site accounting for 97% of all fish recorded (869 individuals), represented by six of the seven recorded species in the study area (Figure 4.25). In comparison, the number of individuals recorded at sites S6 and S8 was low with 18 and 9 individuals respectively. Most of the fish at site S5 (705 individuals) were captured from a deep-water pool indicating that such habitat provides important refuge for fish fauna of the wet season. However, it is however unknown whether this pool permanently holds water.

The majority of fish recorded at site S5 were captured in fyke nets (814 of 869 individuals); however, fyke nets could not be deployed at sites S6 or S8 due to insufficient water depth at these sites. As such, the differences in abundance and diversity between sites shown in Figure 4.25 may be in part due to this differing survey effort. The differences in abundance and diversity may also be indicative of more preferential habitat conditions being available at some sites, such as deeper water habitats which were not observed at sites S6 and S8.

All the species recorded during the April 2019 survey are known to occur throughout northern Australia, with the most abundant species being northwest glassfish (*Ambassis* sp.) and eastern rainbowfish (*Melanotaenia splendida*). This finding is consistent, with a recent study into the distribution of 111 freshwater fishes throughout northern Australia, which reported these species as being some of the most abundant in northern Australia (Pusey et al., 2017).

Overall, the results indicate that northwest glassfish (*Ambassis* sp.) is the most abundant fish species within the study area, while eastern rainbowfish (*Melanotaenia splendida*) and northern trout gudgeon (*Mogurnda mogurnda*) are the most widespread. Species richness is considered

low, with only seven species recorded. The study area appears to provide suitable habitat for other species of catfish (Ariidae), gobies (*Glossogobius* sp.), sooty grunter (*Hephaestus fuliginosus*), tarpons (*Megalops* sp.) and barramundi (*Lates calcarifer*) and also includes the known distribution of these fishes. There are also historical records of these fishes downstream of the Project area within either the Margaret River or the broader Adelaide River catchment (Pusey et al., 2017; Pollino et al., 2018). The absence of these species from the study area is likely indicative of the time of year and/or low water levels observed during the survey period. A list of all fish species with potential to occur in the study area, based on Pusey et al. (2017), is provided in Appendix 9. This includes a further 31 species of bony fish and three elasmobranchs not recorded during the field survey that have potential to occur based on previous studies and the presence of potentially suitable habitat for these species in the study area.

4.8.5 Sensitive Species, Ecosystems and Habitat Features

Sensitive aquatic species are considered to be those listed as threatened under the IUCN Red List, on federal (*Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*)) or State (*Territory Parks and Wildlife Conservation Act 1976*) lists, and species considered to be endemic or to have restricted ranges. A list of threatened, endemic and restricted range species with potential to occur within the study area is provided in Table 4.33, with the likelihood of occurrence described. The remaining 38 fish species with potential to occur in the study area identified in Appendix 9 are not listed as threatened on the IUCN Red List or on federal or state lists. None of the species identified with potential to occur in the study area are considered restricted range species or endemic to the study area.

Table 4.33 – Listed Aquatic Species with Potential to Occur in the Study Area

Common Name	Scientific Name	IUCN Status	National Status	NT Status	Likelihood/Reason
Largetooth Sawfish	*Pristis pristis*	CR	VU	VU	Unlikely, usually found in water depths greater than 1 m and adults are primarily a marine/estuarine species while juveniles spend the first three to four years in freshwater. Known to the Adelaide River drainage
Northern river shark	*Glyphis garricki*	CR	EN	EN	Possible, considered rare in Northern Territory but previously recorded just downstream of the confluence of the Margaret River and the Adelaide River (Ward and Larson, 2012a)
Speartooth shark	*Glyphis glyphis*	EN	CR	VU	Possible, distribution not well known, but known to occur in the Adelaide River coastal floodplain and juveniles are not uncommon in the upper reaches of the Adelaide River system (DNRETAS, 2019; Ward and Larson, 2012b)

*CR = Critically Endangered, EN = Endangered, LC = Least Concern, VU = Vulnerable.

Listed species with potential to occur within the study area are all elasmobranchs (see Table 4.33), of which none were recorded during the April 2019 survey. The presence of the freshwater

sawfish in the study area is considered unlikely, although they are known to occur downstream in the Adelaide River drainage and could feasibly migrate upstream during an above average wet season and reside in deep water pools. Threatened sharks could occur in the study area, although the water depths observed during the April 2019 survey were generally too shallow to allow passage upstream from the Adelaide River and its upper reaches where they are known to occur. If found, both sharks and sawfish would be more likely restricted to deeper pools and flowing water sections in the Margaret River rather than the tributaries located close to Fountain Head.

Sensitive ecosystems and habitat features are considered to be those listed as threatened ecological communities and/or wetlands of international importance under the *EPBC Act* and the 67 conservation sites identified by the Northern Territory Department of Land Resource Management. No such sensitive ecosystems have been identified in the study area. Downstream of the study area, the Margaret River converges with the Adelaide River which flows to Adam Bay. This area includes the Adelaide River coastal floodplain, one of the Northern Territory's designated conservation sites.

The Adelaide River coastal floodplain is seasonally inundated with freshwater and is traversed by a major and permanent tidal river (DNRETAS, 2019). The floodplain includes both tidal and seasonal wetland habitats and is dominated by grass and sedge communities with open woodland and pockets of monsoon forest found along the fringe (DNRETAS, 2019). Fourteen threatened species have been recorded in the Adelaide River coastal floodplain, including four plant and 10 vertebrate species (DNRETAS, 2019). With respect to threatened aquatic species, freshwater sawfish (*Pristis microdon*), northern river shark (*glyphis garricki*) and speartooth shark (*Glyphis glyphis*) have all been recorded, i.e., while these species are unlikely to occur within the study area, they have been recorded further downstream.

As discussed in Section 4.6.2, monsoon vine forests, considered a sensitive habitat, are groundwater-dependent forests that require permanent water availability and can be found where water is trapped or the watertable is close to the surface (CSIRO, 2018). The nearest monsoon vine forest habitat is located around 15 km to the northwest (Barber et al., 2018).

4.8.6 Introduced and Invasive Species

No introduced or invasive aquatic fauna species were recorded during the April 2019 survey. Much of northern Australia remains free of introduced and invasive species, with known incursions generally limited to isolated areas (Pusey et al., 2017) and the majority of incursions eradicated prior to establishment. There are nine declared aquatic weed species in the Northern Territory, this includes:

- Alligator weed (*Alternanthera philoxeroides*).
- Amazon frogbit (*Limnobium laevigatum*).
- Cabomba (*Cabomba caroliniana*).
- Limnocharis (*Limnocharis flava*).
- Pistia (*Pistia stratiotes*).

- Sagittaria (*Sagittaria platyphylla*).
- Salvinia (*Salvinia molesta*).
- Water hyacinth (*Eichhornia crassipes*).
- Water mimosa (*Neptunia plena*).

There have isolated infestations of alligator weed, water hyacinth and water mimosa, but these have been successfully eradicated. Pistia is believed to be native to the Northern Territory, but is considered a threat to other states in Australia. There are known infestations of cabomba in the Darwin River, and salvinia is also found in the Northern Territory, widely planted as an ornamental in garden ponds and found in still or slow moving water with high nutrient levels and is able to survive temperatures up to 43 degrees and tolerate salinities one tenth that of sea water (NT Government, 2020a). There are no other known occurrences of the listed aquatic weed species in the Northern Territory.

The invasive Siamese fighting fish (*Betta splendens*), native to central Thailand, has been recently identified in large numbers in the Adelaide River and floodplains near Darwin, downstream of the study area. Its presence is likely a result of being released into the wild from residential ponds or aquariums (Lyons, 2019). This species has the potential to establish within the study area, with eradication from the Adelaide River and the nearby area considered unlikely.

No other introduced or invasive aquatic fauna species are known, or are considered likely, to occur in the study area.

4.9 Socio-economic

This section characterises the socio-economic environment, including the people and communities, social structures, infrastructure and values, of the area around the proposed Project, and addresses the requirement to describe the values in Section 2.3.5 of the EIS Terms of Reference and the objective: ‘to protect the rich social, economic, cultural and heritage values of the Northern Territory’. The information for this section has been drawn from the Socio-economic Impact Assessment (SIA) report prepared by ERIAS Group (2021) (Appendix 11).

4.9.1 Population and Demographics

There are no population centres located immediately adjacent to the Project location. Hayes Creek is a small roadside settlement located approximately 13 km south of the Project and previously consisted of a caravan park and a hotel/tavern complex with petrol station and post office, these are all now closed. The main population centres in the broader Project area are Pine Creek, located approximately 50 km southeast of the Project location in Victoria Daly local government area (LGA), and Adelaide River located approximately 50 km to the northwest of the Project location in Coomalie LGA.

In 2019 the population of the Victoria Daly LGA was estimated at around 3,155 people (based on 2016 census data) (id, undated(a)), and the Coomalie LGA has an estimated population of 1,370 people (id, undated(b)). Coomalie and Victoria Daly LGAs rank as the eighth and tenth most disadvantaged areas in the NT respectively, and both are lower than the NT and Australia as a whole (id, undated(c)).

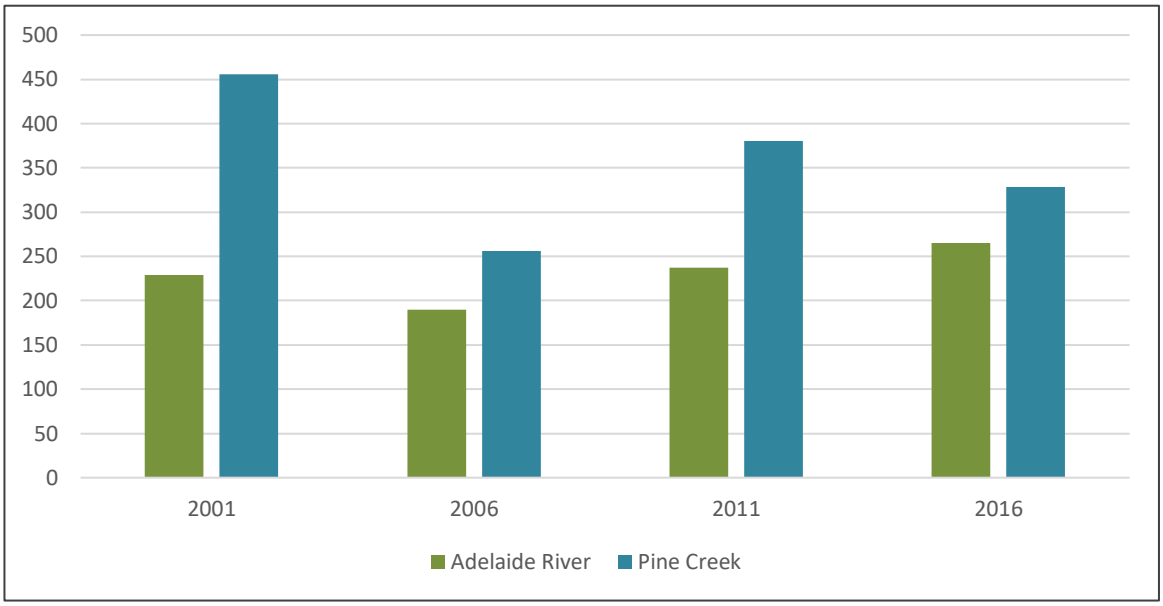
Population data for Adelaide River and Pine Creek are presented in Table 4.34 and Figure 4.26 below.

Table 4.34 – Population and Demographics of Adelaide River and Pine Creek

Location	Population (% Male/ female)	Aboriginal and Torres Strait Islanders (%)	Aboriginal and Torres Strait Islanders Median age	Non-Aboriginal and Torres Strait Islanders Median age	Growth Rate (2011 – 2016)
Adelaide River	353 (51.8/48.2)	25.1%	22	47	49%
Pine Creek	328 (53.2/46.8)	46%	21	39	-13%
Northern Territory	228,833 (51.8/48.2)	25.5%	25	32	8%

Source: ABS 2011a and 2011b, 2016a and 2016b. Data is taken from State Suburb (code SSC).

Figure 4.26 – Population Trends of Adelaide River and Pine Creek



Source: Data is taken from Census Quickstats (ABS, 2016c) Urban Centre Localities (code UC/L) as this data is consistently presented across census years. Note that Adelaide River's 'State Suburb' population is higher than the Urban Centre data.

In both Pine Creek and Adelaide River, approximately 75% of residents were born in Australia (ABS, 2016a, 2016b).

The ABS (2016b) describes the top five ancestries for people in Adelaide River as Australian, English, Aboriginal Australian, Irish and Scottish, and the top five languages (other than English) spoken as Tagalog, Dutch, Indonesian and Japanese (however the percentages of speakers are less than four people for all languages). The top five ancestries for people in Pine Creek is Australian, Aboriginal Australian, English, Scottish and Irish, and the top five languages (other

than English) spoken as Wagiman (5.7%), Mayali (3.8%), Kriol (1.6%), Telugu (1.3%) and French (0.9%) (ABS, 2016a).

4.9.2 Economy

The history of the NT's economic development has largely been driven by the resources sector, but also it also has a relatively large public sector and a significant defence force presence. The construction and mining industries have been the main drivers of economic growth in recent years (NT DTF, 2018).

The largest industry (by employment) in the Victoria Daly LGA is mining (id, undated(d)), however cattle and farming are the primary land use. There are 45 businesses registered in the area and 1,087 local jobs (id, undated(d)). The dry season sees an influx of visitors that come to see the nearby Litchfield National Park, which supports accommodation, food and other visitor services during the season. In Coomalie the largest employer is the education and training sector, followed by accommodation and food services (id, undated(e)).

Both Victoria Daly and Coomalie's gross regional product (GRP) has fluctuated through growth and decline over the past 18 years, which is likely a function of the high reliance of the regional economy on the mining and construction sectors and a smaller reliance on the public administration and safety sector in comparison with the NT (id, undated(d)).

4.9.3 Employment, Education and Training

The most recent data available for communities of Adelaide River and Pine Creek is the 2016 census data (ABS, 2016a and 2016b). Based on this data, people of working age (15 to 64 years of age) comprised 57.8% of Adelaide River's population and 64.8% of Pine Creek's population.

The ABS (2016a and 2016b) records that 128 people reported being in the labour force in the week before census in Adelaide River. Of these 62.5% were employed full time, 21.1% were employed part-time and 10.9% were unemployed. There were 147 people who reported being in the labour force in Pine Creek in the week before census. Of these 49% were employed full time, 27.9% were employed part-time and 20.4% were unemployed (ABS, 2016a and 2016b).

Employment profiles for Adelaide River and Pine Creek, compared with NT rates are detailed in Table 4.35. Unemployment in Adelaide River and Pine Creek is high compared to the NT (7%) and Australia (6.9%) (ABS, 2016a, 2016b and 2016d).

Table 4.35 – Employment for Adelaide River, Pine Creek and the Northern Territory

Status	Adelaide River	Pine Creek	Northern Territory
Employed full time	80 (62.5%)	72 (49%)	74,100 (67.1)
Employed part time	27 (21.1%)	41 (27.9%)	21,493 (19.5%)
Away from work	7 (5.5%)	4 (2.7%)	7,112 (6.4%)
Unemployed	14 (10.9%)	30 (20.4%)	7,685 (7%)
Total labour force	128	174	110,390

Source: ABS 2016a, 2016b, 2016d. Data is taken from State Suburbs (code SSC).
Note: The total labour force is derived from self-reported census data. Questions used to determine the labour force include whether the respondent was working or looking for work.

The largest employer in Adelaide River was technical and vocational education (14.3%), followed by accommodation (13.2%) and primary education (8.8%). Road freight transport and beef cattle farming accounted for 7.7% and 6.6% of responses respectively.

In Pine Creek at the time of the 2016 census, the largest employer was the accommodation industry (14.4%), followed by beef cattle farming (11.1%), local government administration (7.8%), iron ore mining (5.6%) and gold ore mining (5.6%).

During the 2016 census, in Adelaide River, 33.8% of people were attending an educational institution comprising 33.3% at primary school, 9.8% at secondary school and 5.7% at a tertiary or technical institution. Of people aged 15 and over, 13.5% reported having completed Year 12 as their highest level of educational attainment, 17.1% had completed a certificate III or IV and 3.9% had completed an advanced diploma or diploma (ABS, 2016b). Only 6.4% of people in Adelaide Creek reported having attained a bachelor's degree or higher (ABS, 2016b).

In Pine Creek, 28.1% of people were attending an educational institution comprising 24% at primary school, 19.8% at secondary school and 3.1% at a tertiary or technical institution. Of people aged 15 and over, 6.9% reported having completed Year 12 as their highest level of educational attainment, 11.6% had completed a certificate III or IV and 3.9% had completed an advanced diploma or diploma (ABS, 2016a). Only 6.6% of people in Pine Creek reported having attained a bachelor's degree or higher (ABS, 2016a).

4.9.4 Infrastructure and Services

4.9.4.1 Government and Community Services

Both Adelaide River and Pine Creek have community health centres serviced by a visiting general practitioner. Both towns have primary schools, however the nearest secondary schools are located in Bachelor and Katherine.

There is a police station in both Adelaide River and in Pine Creek. Both towns also have a Fire and Emergency Volunteer Group, trained in road crash rescue. The closest St John Ambulance location to the Project area is in Katherine. There are no registered airstrips in the Pine Creek area. In an emergency, small planes can access the McDonald Airstrip, 15 km from town.

Power is supplied to both towns by the high-voltage transmission lines that run between Darwin and Katherine. Water supply is provided by the Power Water Corporation (PWC). Nighty-five percent of the remote potable water supplies are sourced from groundwater; however Pine Creek also has access to surface water supplies (PWC, 2020). Section 4.6.2 highlights the groundwater bores in the vicinity of the mine and their uses. One bore located outside the mine lease approximately 800 m northeast of the pit is periodically used by Ban Ban Springs Station for stock watering.

4.9.4.2 Housing and Accommodation

The dwelling structure of occupied private dwellings in Adelaide River and Pine Creek is presented in Table 4.36. At the time of the 2016 census, Adelaide River had 120 occupied and 19 unoccupied dwellings, and Pine Creek had 106 occupied and 40 unoccupied dwellings.

Table 4.36 – Occupied Private Dwelling Structure – Adelaide River and Pine Creek

Dwelling Type	Adelaide River	Pine Creek
Separate house	93 (77.5%)	83 (78.3%)
Semi-detached, row or terrace house, townhouse, etc.	11 (9.2%)	7 (6.6%)
Flat or apartment	0	5 (4.7%)
Other dwelling	12 (10.0%)	11 (10.4%)
Total occupied private dwellings	120	106

Source: ABS 2016a and 2016b. Data is taken from State Suburbs (code SSC).

4.9.5 Social Cohesion

There have been no known studies in or relevant to the Project area that assess the baseline social cohesion using this framework. However, the communities closest to the Project area are small and remote, lacking many of the government services available in larger towns. These communities therefore have to be highly self-sufficient and reliant. The large Aboriginal community and the Victoria-Daly council's focus on respect for culture and heritage, the opportunities for recreational activities (and supporting infrastructure), regular community events and support for local employment and housing all support strong social cohesion.

Conversely, a transient workforce can negatively affect community cohesion, as it reduces participation and a sense of belonging, and the workforce in the Project area tied to mining and construction, freight and transport is transient (SIHFNT, 2018). Crime is another factor that can erode community cohesion, often fuelled by alcohol abuse. Crime rates in the broader Katherine region are high (per 100,000 population) compared to larger towns such as Darwin and the NT more broadly (NT PFES, 2020).

These communities were established due to the discovery of gold in the region in the late 1800s and gold mining activities have played a part in the local economy ever since. Pine Creek in particular has a town identity tied to mining.

4.9.6 Community Health and Safety

The NT Health Strategic Plan 2018-2022 (NT Government, 2018) outlines the key health-related issues for the territory. Like other Australian jurisdictions, the NT faces a growing prevalence of chronic conditions, ageing infrastructure that does not align well to population health needs, and systems that do not always meet demand and therefore do not support safety and quality.

The NT has the highest premature death rates in Australia, and significant geographical and cultural barriers. It is a constant challenge to provide equity of access to health services to residents, with many people living regionally and remotely. The NT population also has high rates of social disadvantage such as poverty, which leads to higher rates of poor health.

4.10 Cultural Heritage

This section characterises the cultural heritage environment of the area around the proposed Project and addresses the requirement to describe the values in Section 2.3.5 of the EIS Terms of Reference and the objective: 'to protect the rich social, economic, cultural and heritage values of the Northern Territory'. The information for this section has been drawn from the Project

archaeological assessment prepared by In Depth Archaeology (Appendix 10) and the report prepared by ERIAS Group (Appendix 11). Where Appendix 10 includes information from sites and locations not relevant to the Fountain Head Gold Project area, only information relevant to the Project area is included in this section.

4.10.1 Traditional Owners

The Jawoyn people are the Traditional Owners of 50,000 km^2 of land and waters east of (and incorporating) Pine Creek. The Project is located on the traditional lands of the Warai and Wagiman peoples. Warai country extends west to include the area around Batchelor, then runs south-east along the watershed between the Douglas/Daly and the Adelaide/Margaret Rivers, and includes the headwaters of McKinlay River which runs back almost to Pine Creek (AUSTLANG, undated), including the land on which the Project is located. The Wagiman traditional lands extend to the east of the Project area and include Pine Creek. The Warai, Wagiman and the Jawoyn are part of the Gunwinyguan language group (AUSTLANG, undated).

The Northern Land Council (NLC) lodged a Native Title application (NTD6021/2001) over an area just to the east of the Project location, on Ban Ban Springs Station in 2001, on behalf of the Warai and Wagiman Peoples. This application was accepted however, to date no determinations of native title have been made for this application.

There is an active ILUA for the PWC's access to power infrastructure overlaying the Project mining tenement. Figure 4.27 highlights the land vested under various Indigenous legislation and agreements around the Project area. The green areas are existing ILUAs for pipeline easements and the hatched areas are registered native title determinations.

4.10.2 Aboriginal Heritage and Archaeology

A cultural heritage survey was carried out over the Project area between 18 to 23 October 2019 with representatives from the Warai and Wagiman traditional owner groups. Previous surveys in the region have uncovered and documented flakes, cores, retouched flakes, flaked pieces, unifacial points, bifacial points, Kimberley points, ground-edged axes, flaked axes, axe blanks, blades, bipolar-percussed blades, hammer stones, grindstones, and debitage (tiny waste flakes from the knapping process) (Appendix 10).

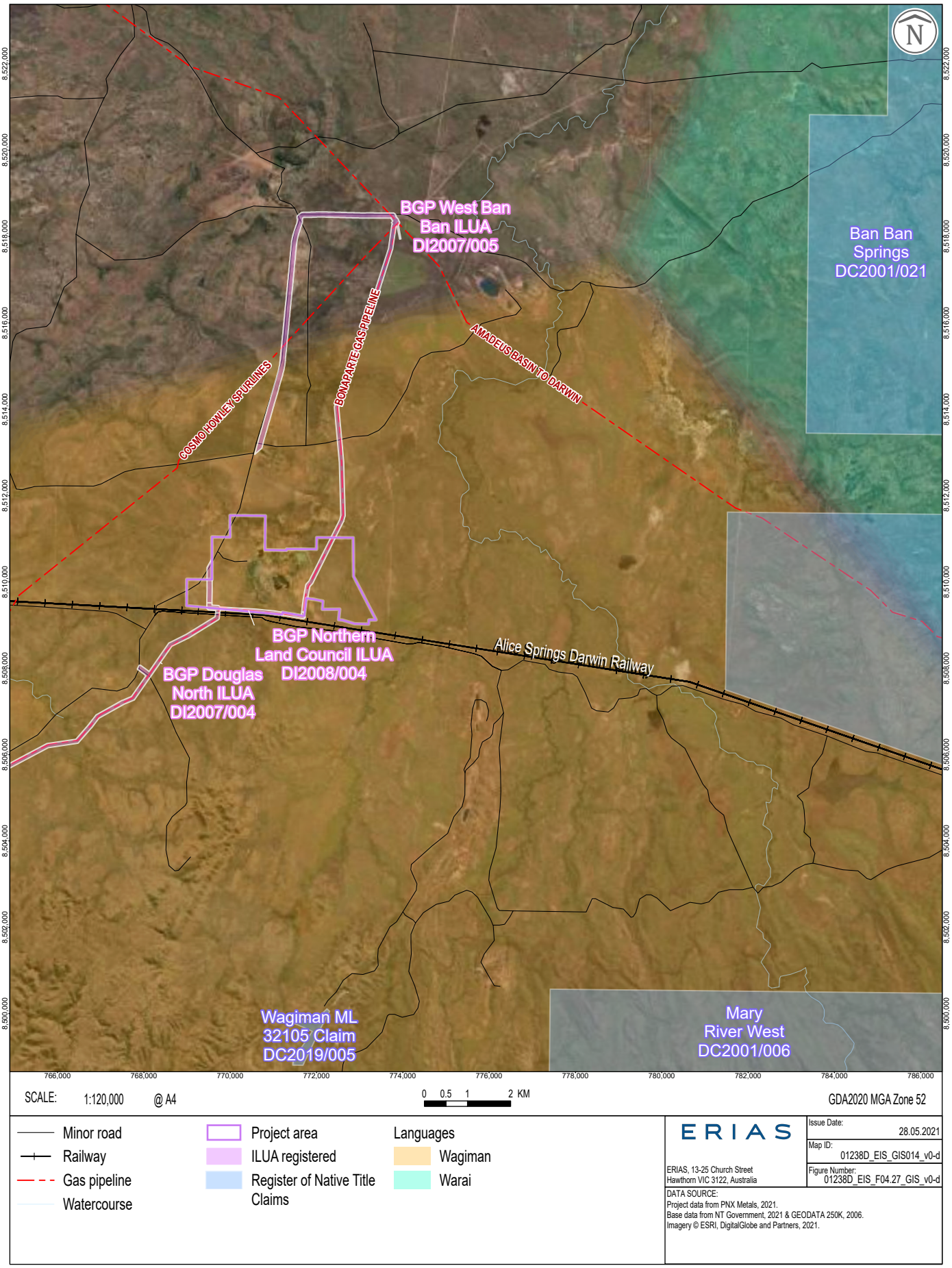
The archaeological survey recorded six Aboriginal places and five archaeological objects, as defined under the *NT Heritage Act 2011*. Seven sites (comprising three Aboriginal places and four historic sites) have been recorded during a previous survey (Crassweller, 2006).

Based on the issue of authority certificate issued 24 March 2021 by the Aboriginal Areas Protection Authority (AAPA, 2021), there are two recorded sacred sites located approximately 2 km to the north of the Project area. (Figure 4.28). Custodians consulted for the application also identified that the Project area may contain termite mounds (greater than 3 m tall) that are of cultural significance to them (AAPA, 2021).

INDIGENOUS ESTATES SURROUNDING THE PROJECT AREA

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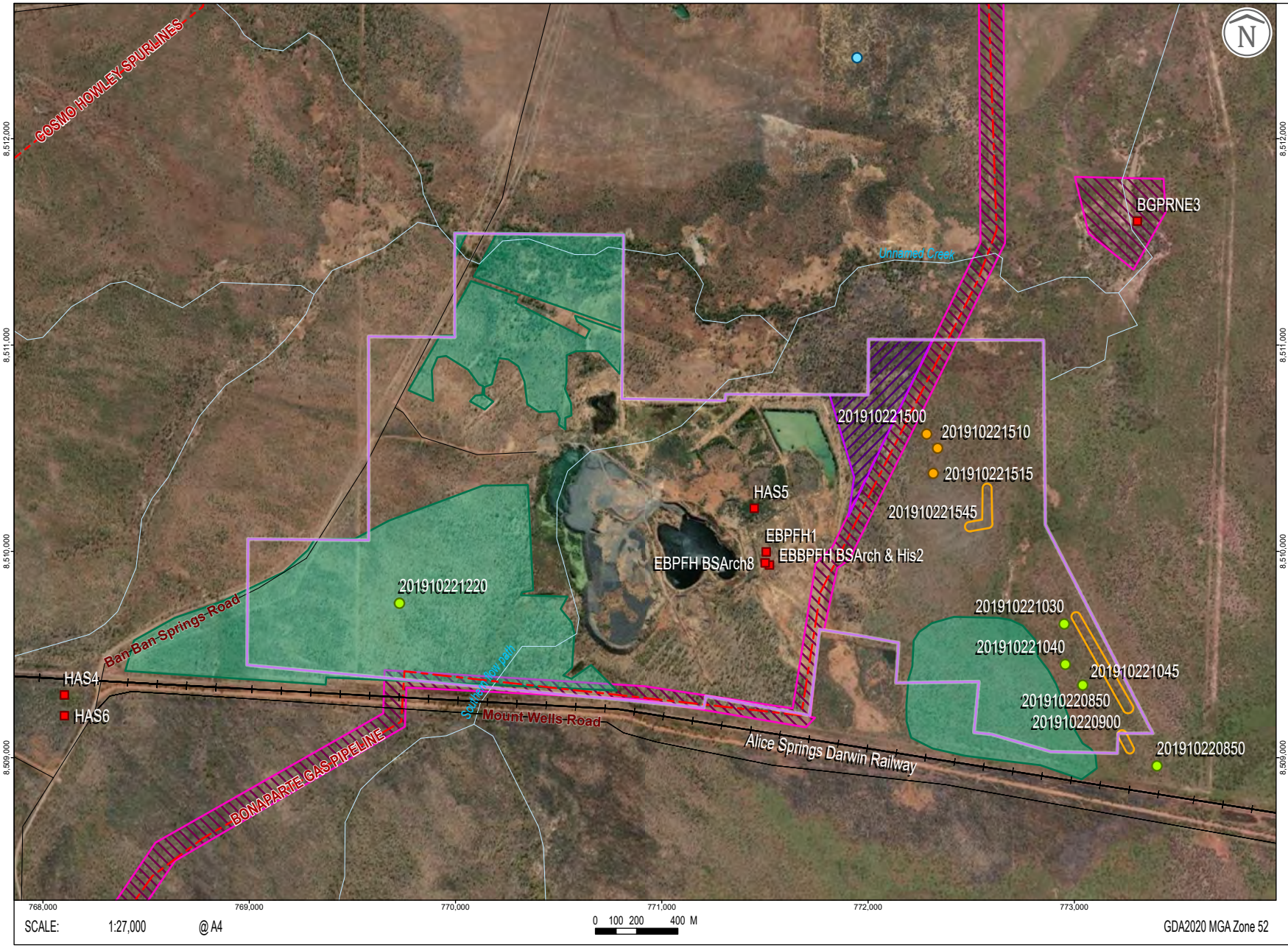
FIGURE 4.27



CULTURAL HERITAGE SITES RECORDED IN AND AROUND THE PROJECT AREA

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FIGURE 4.28



- Aboriginal object
- Aboriginal place
- Previously recorded archaeological site
- Recorded sacred site
- Road
- Railway
- Gas pipeline
- Watercourse
- Project area
- Low probability area
- Area not surveyed
- Restricted work area
- Extensive Aboriginal place

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS017_v0-c

Figure Number: 01238D_EIS_F04.28_GIS_v0-c

ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.

Imagery © ESRI, DigitalGlobe and Partners, 2021.

Table 4.37 and Figure 4.28 show the heritage places, Aboriginal places and objects recorded during 2006 (Crassweller, 2006) and 2019 (Appendix 10) surveys over the Project area. Martin-Stone, (Appendix 10) describes the significance assessment criteria used to determine the significance of each place or object. All places and objects recorded in the 2019 survey were determined as culturally significant in consultation with the Traditional Owners, and all Aboriginal places are archaeologically significant (Appendix 10). Objects are of low archaeological significance (Appendix 10). Due to the difference in methodologies used in Crassweller (2006), significance values are not given for the previously surveyed objects and places.

Table 4.37 – Summary of Archaeological Survey Findings

Site Name	Site Type	Description	Significance (Cultural/archaeological)
201910220850	Aboriginal object	3 artefacts (2 x unifacial points, 1 x blade) within 5 m^2, on low ridge	Significant/low significance
201910221030	Aboriginal object	Feldspathic metagreywacke (FMG) retouched blade, 50 m from ridge site	Significant/low significance
201910221040	Aboriginal object	Broken FMG bifacial point. Distal break	Significant/low significance
201910221045	Aboriginal object	Quartz cobble core with 2 negative flake scars from 2 platforms	Significant/low significance
201910221220	Aboriginal object	FMG flaked piece	Significant/low significance
201910221500	Aboriginal place	Low density stone artefact scatter (max 2 per m2). Includes stone, green bottle glass, metal. Approximately 50+ artefacts - flake, broken flake, flaked piece. 100% tuff	Significant/significant
201910221510	Aboriginal place	Low density artefact scatter, stone artefacts only. Approximately 15 artefacts in 20 m^2 area. Flake, broken flake, bifacial point	Significant/significant
201910221515	Aboriginal place	500+ artefacts - quartz 50%, tuff 45%, greywacke 5%. Stone artefacts only. Whole flake, broken flake, flaked piece, blade, unifacial point, bifacial point	Significant/significant
201910220900	Aboriginal place	Stone artefact scatter, 150+ artefacts. One chert flaked piece, small quartz quarry. Broken hammerstone. Low density of artefacts across whole ridge, with clumps of higher density. FMG. Whole flake, broken flake, flaked piece, core, hammerstone, blade, unifacial point, bifacial point	Significant/significant
201910220945	Aboriginal place	2500+ artefacts. Artefact scatter continues across entire ridge, at varying levels of density. High density artefact scatter at highest point ridge. Knapping floors, manuports, diverse raw materials	Significant/significant

Site Name	Site Type	Description	Significance (Cultural/archaeological)
		(FMG 50%, quartz 49%, chert, silcrete n=1). Site faces N/NE, towards Yam Creek. Whole flake, retouched flake, broken flake, flaked piece, core, grindstone, hammerstone, blade, unifacial point, bifacial point, debitage, unifacial point blanks / preforms. Maximum density= 50 per m^2 (at 773198E, 8509327N). Interesting artefacts include a cobble core and grindstone	
21910221545	Aboriginal place	1,000+ artefacts. Hilltop stone artefact scatter with knapping floors. 90% tuff/greywacke, 9% quartz, 1% dolerite. Site contents are clustered and scattered. Whole flake, broken flake, flaked piece, hammerstone, blade, unifacial point, bifacial point, debitage. Site continues in varying degrees of density along the ridgeline, including lower areas of gravel exposure. It was recorded in conditions of 50% visibility	Significant/significant
HAS4	Historical place	Fountain Head cattle yards	Unknown
HAS5*	Historical place	Fountain Head mine	Unknown
HAS6	Historical place	Fountain Head railway siding	Unknown
BGPRNE3	Historical place	Glencoe Head Station	Unknown
EBPFH BSArch & His2	Aboriginal place	Artefact scatter	Unknown
EBPFH BSArch8	Aboriginal place	Background scatter	Unknown
EBPFH 1	Aboriginal place	Artefact scatter	Unknown

* Has5 is the Fountain Head mine site.

4.10.3 European and Chinese Heritage

The area surrounding the Project has a long history of mining and pastoralism.

The discovery of gold during the construction of the overland telegraph line in 1870 initiated a gold rush to the area from 1872 to 1874. Other metals including silver, copper and tin were also extracted. The area has subsequently experienced a ‘boom and bust’ economy (Jones, 1987), with the most recent peak in the early 21st Century.

The goldfields and the construction of the Adelaide to Darwin railway, which began in 1878, brought thousands of Chinese miners to the area around Pine Creek. The Chinese community outnumbered Europeans in the NT in the 1880s and went on to become a well-established community in both Darwin and Pine Creek, and surrounding settlements, remaining even in times of bust.

Around the same period (between the mid-1860s to 1895) was a time of large-scale pastoral settlement and development in the NT. Large pastoral runs were taken up, large sums of money invested, and hundreds and thousands of sheep, cattle and horses were overlanded to stock the new properties (NT DTSC, 2020).

4.11 Traffic and Transport

4.11.1 Existing Road and Rail Network

The existing transport network that will carry Project traffic will include major highways and minor roads and is shown in Figure 3.16 in Chapter 3. Fountain Head road is referred to in this report as Fountain Head Road (east) and Fountain Head Road (west) when specifically mentioning the sections of road on either side of the Stuart highway. When the road is being discussed in general terms it is referred to as Fountain Head Road (collectively east and west).

4.11.1.1 Stuart Highway

The Stuart Highway is the main road servicing the Project Area. The highway is one of Australia's major roads, running from Darwin, Northern Territory to Port Augusta, South Australia. The Stuart Highway is constructed to a rural highway standard, with one lane travelling in each direction, additional turning lanes at key intersections and a posted speed limit of 130 kilometres per hour (km/h). Being a major heavy haulage, road-train and tourist route the road surface is well maintained by the Department of Infrastructure, Planning and Logistics (DIPL). Through townships and urban centres (such as Darwin and Adelaide River) the Stuart Highway is an urban arterial road with a reduced speed limit. Around the Project area, Stuart Highway is paved with no formal shoulders, but clearings on either side.

4.11.1.2 Fountain Head Road (east)

Fountain Head Road (east) is a standard sealed rural road with one lane in each direction. The sealed width is approximately 6.6 m with no shoulders. Fountain Head Road forms a part of the Northern Goldfields Loop in the Pine Creek Region and provides the northern most access to the Mount Wells Road, the Alice Springs Darwin Railway line and Ban Ban Springs Road. Fountain Head Road originates at Stuart Highway and continues up to the Alice Springs Darwin Rail level crossing where it continues as Ban Ban Springs Road.

4.11.1.3 Ban Ban Springs Road

Ban Ban Springs Road is a partially sealed road that originates as the continuation of Fountain Head Road (east) at the Alice Springs Darwin Rail level crossing. Ban Ban Springs Road is approximately 11 km in length, with only the first 4.5 km north of the rail crossing sealed. The unsealed road then continues up to Ban Ban Springs Pastoral Station approximately 11.5 km north of the Fountain Head site. There are stock proof gates across the Ban Ban Springs road on the southern boundary of the Pastoral Station. These gates are 100 m north of the Alice Springs Darwin Railway line and are left in the closed position when not in use preventing entry, therefore this section of road is not considered to be a thoroughfare for general road users.

4.11.1.4 Mount Wells Road and Fountain Head Road (west)

Mount Wells Road runs parallel to the Alice Springs Darwin Railway line and is an unsealed road. It runs from the intersection with Fountain Head Road to Kakadu Highway approximately 80 km to

the southeast. Mount Wells Road runs in close proximity to the Fountain Head site and is the main tourist route of the Northern Goldfields Loop passing the now closed Grove Hill Historic Hotel, Mount Wells, Francis Creek & Union Reefs Mines. The road runs parallel to the Alice Springs Darwin Railway line and would be used by railway maintenance crews. The road is regularly maintained by DIPL.

Fountain Head Road (west) is managed and maintained by the local council. It runs in a north-south direction between Stuart Highway and Dorat Road. The road is sealed with one traffic lane in each direction.

4.11.1.5 Railway Infrastructure

Intersecting Ban Ban Springs Road to the south of the Project area is the Alice Springs Darwin Railway line, which has intermittent passenger and freight services. The railway forms part of the larger Adelaide-Darwin Railway, and is owned by the Australasian Railway Corporation and operated by Geneese and Wyoming Incorporated. There are currently 12 return train services weekly, comprised of four bulk mining products trains, 6 intermodal freight and 2 passenger services. There is a level crossing at the intersection with Ban Ban Springs Road, which is controlled by 'give-way' signage.

4.11.2 Existing Traffic Volumes

The Stuart Highway has two traffic monitoring stations in proximity to the Fountain Head site to measure the volume and type of traffic. These sites are located 500 m south of Adelaide River (RDVDP003 – 48 km north of Fountain Head Road), and a monitoring point 2 km north of Kakadu Highway turnoff near Pine Creek (RDVDP005 – 61 km south of Fountain Head Road). Similarly, Fountain Head Road has a traffic monitoring station located 2 km east of Stuart Highway (RDVDC057). The traffic monitoring stations are shown in Figure 4.29.

The Annual Average Daily Traffic (AADT) at the three stations is shown in Table 4.38.

Table 4.38 – Existing Traffic Volumes on Project Roads

Traffic Station	Direction	2015	2016	2017	2018	2019
Stuart Highway – RDVDP003	Inbound	616	628	622	657	671
	Outbound	607	619	612	649	661
Stuart Highway – RDVDP005	Inbound	573	589	608	605	631
	Outbound	549	566	587	586	610
Fountain Head Road – RDVDC057	Inbound	15	*	17	*	12
	Outbound	15	*	16	*	12

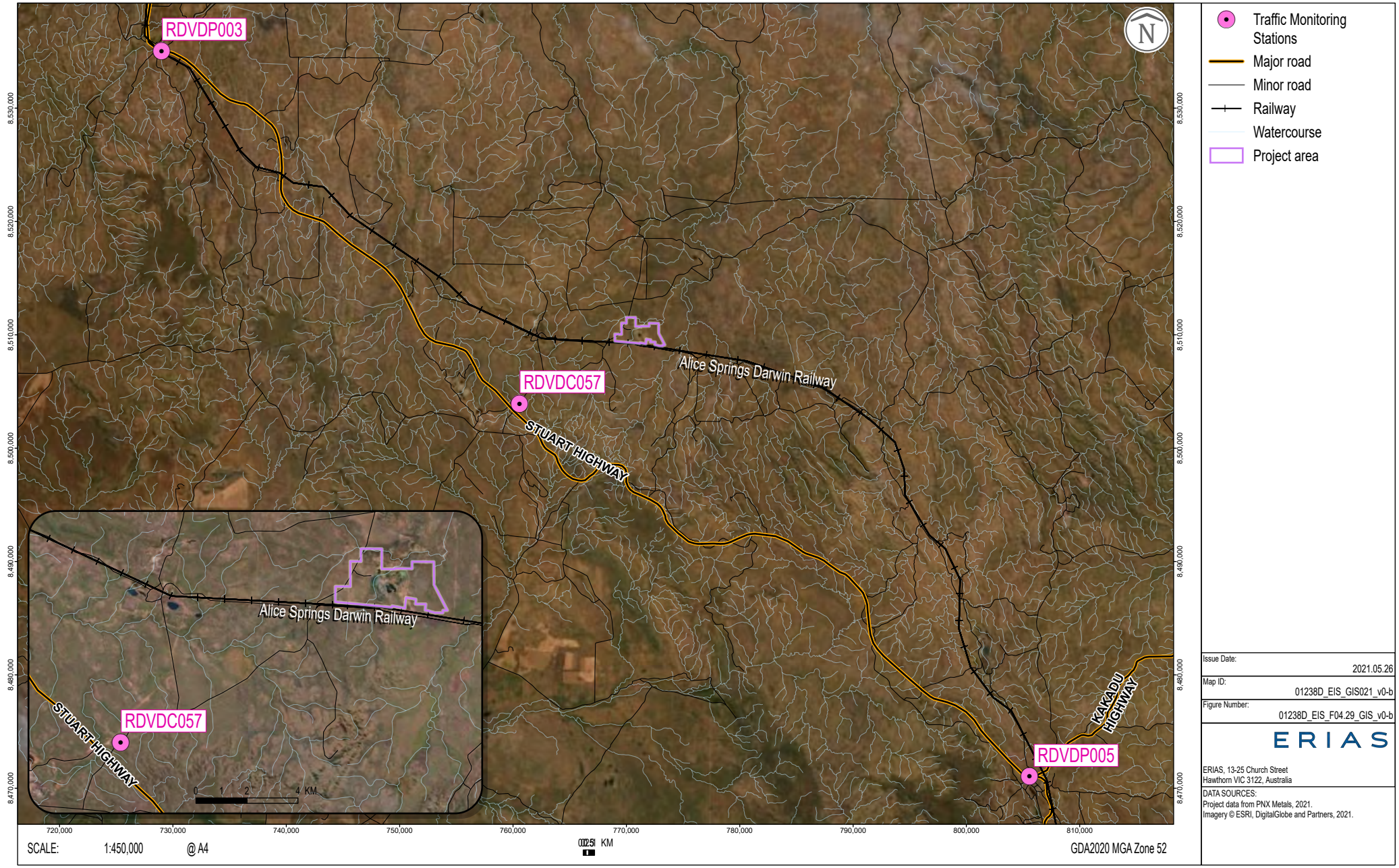
Source: DIPL, 2019.
* No data available.

The average heavy vehicle spilt for RDVDP003, RDVDP005 and RDVDC057 are 26.4, 2.2% and 20.3% respectively.

LOCATION OF TRAFFIC MONITORING STATIONS

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FIGURE 4.29



Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS021_v0-b

Figure Number: 01238D_EIS_F04.29_GIS_v0-b

ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

4.11.3 Accident History

Nine crashes have been recorded on the Stuart Highway within 3 km to the north and south of Fountain Head Road between 2015 and 2019 (data supplied by DIPL on request).

There have been six crashes within 3 km north of Fountain Head Road, one in the vicinity of the intersection between Stuart Highway and Fountain Head Road, and two between the intersection of Dorat Road 3 km to the south. The crash that occurred in the vicinity of the Fountain Road intersection involved a vehicle that ran off the road heading north on the Stuart Highway.

The Alice Springs Darwin Rail level crossing was the site of a Ghan passenger train and road-train truck collision on the 12th of December 2006 (ATSB, 2008). The road-truck train carrying road base material failed to stop and check for oncoming trains and the collision caused the derailment of two locomotives, one motorail wagon and nine passenger wagons. The train had been traveling northbound and collided with the vehicle. There were two hospitalisations, and several others were treated for minor injuries on site. The driver of the road-train was found to have slowed whilst crossing, instead of coming to a complete stop and checking for oncoming trains.

4.11.4 Other Road Users

The current turn-off from the Stuart Highway onto Fountain Head Road was used historically for the haulage of gold bearing ore from the Woolwonga Gold Mine (approximately 6.5 km north of Fountain Head) for processing at the Cosmo Gold Mine. The Woolwonga Gold Mine is currently undertaking exploration activities comprised of six personnel who use Fountain Head Road for access (Bacchus Resources, 2017). The Cosmo Gold Mine, located approximately 15 km to the west of the Project area, was the only operating mine in the immediate area. The mine is owned by Kirkland Lake Gold and operation ceased in March 2020. Access to the Cosmo Gold Mine utilises the turn off from the Stuart Highway and Fountain Head Road (west).

The largest vehicles currently using the road are triple cattle road trains (approximately 52 m long) moving stock to and from Ban Ban Springs Station. Each truck carries between 150 and 250 head and the cattle are sold to either local abattoirs or exported from Darwin Harbour. Other identified road users include tourists and mine exploration employees accessing the numerous gold mines in the area and the Australian Pipeline Association (APA) who access the Bonaparte and Amadeus Gas pipeline junction in the region. From November to May, the roads are also used by contract farmers moving equipment and machinery.

5. Stakeholder Engagement

5.1 Purpose and Objectives

Stakeholder engagement is a fundamental process underpinning environmental impact assessment, aiming to ensure affected and interested stakeholders have an understanding of Project impacts and benefits and the opportunity to communicate any concerns and to contribute to project design. Meaningful stakeholder engagement supports the early identification of issues, addresses community expectations of input into decisions that affect them, and leads to better decision-making.

The importance of community involvement in the environmental impact assessment process, particularly of Aboriginal people and communities, is expressly recognised in the *Environment Protection Act 2019* (EP Act). These are:

- To provide for broad community involvement during the process of environmental impact assessment and environmental approval.
- To recognise the role that Aboriginal people have as stewards of their country as conferred under their traditions and recognised in law, and the importance of participation by Aboriginal people and communities in environmental decision-making processes.

The *EP Act* requires a proponent to consult with communities, take account of their views, document their knowledge, and address Aboriginal values and rights.

This chapter outlines how PNX has met the engagement requirements under the *EP Act*. It sets out the purpose and objectives of stakeholder engagement, identifies key Project stakeholders, discusses how stakeholders were analysed to inform the engagement methods used, details the stakeholder engagement that has been conducted during Project planning and development and identifies further engagement activities yet to take place. The full Project stakeholder engagement plan (SEP) is provided as Appendix 21.

In accordance with the NT EPA's recommended approach (NT EPA, 2021b)[9], PNX have used the International Association for Public Participation's (IAP2) core values of engagement (IAP2, 2019a) to guide their stakeholder engagement approach. These core values are:

- Stakeholder participation is based on the belief that those who are affected by a decision have a right to be involved in the decision-making process.
- Stakeholder participation includes the promise that the stakeholder's contribution will influence the decision.

[9] The SEP and engagement approach were developed under version 1.0 of the NT EPA (2019) guidance for proponents, and engagement activities have been updated to reflect the 2021 guidance as and where possible.

- Stakeholder participation promotes sustainable decisions by recognising and communicating the needs and interests of all participants, including decision makers.
- Stakeholder participation seeks out and facilitates the participation of those potentially affected by or interested in a decision.
- Stakeholder participation seeks input from participants in designing how they participate.
- Stakeholder participation provides participants with the information they need to participate in a meaningful way.
- Stakeholder participation communicates to participants how their input affected the proposal and decision.

PNXs' stakeholder engagement approach aligns with these core values and has the following specific objectives:

- Enable early, effective two-way communication between PNX and Project stakeholders, that meets government requirements and community expectations.
- Build government and community understanding and support for the Project.
- Assist in identifying key social and environmental issues that need to be addressed.
- Ensure that those potentially impacted by the Project can raise issues and concerns, and for stakeholder feedback to inform Project design and development.

5.2 Stakeholder Identification and Analysis

Stakeholders are people or groups that may be directly or indirectly affected by a project, or who have an interest in, or the ability to influence a project's outcomes (IFC, 2009). Stakeholders can include local communities, government authorities, non-government organisations, commercial and industrial enterprises, and vulnerable cohorts (i.e., those that could be especially impacted by the Project). Stakeholder identification and analysis helped identify those potentially affected by or interested in the Project.

Stakeholders were identified based on:

- Desktop research of publicly available information.
- PNXs' appreciation of the community and previous stakeholder interactions.

Identification and analysis of stakeholders was undertaken during the Project planning phase and has been progressively reviewed over Project development. Table 5.1 summarises the stakeholders identified for the Project.

Table 5.1 – Stakeholder Groups

Group	Individual Stakeholders
Traditional Owners and Aboriginal organisations	• Northern Land Council (Daly, Katherine)* • Aboriginal Areas Protection Authority (AAPA)* • Jawoyn Association Aboriginal Corporation • Warai and Wagiman representatives* • Pine Creek Aboriginal Advancement Association Incorporated (Kybrook Farm)
Local community and businesses	• Adelaide River Inn • Grove Hill Hotel (Pine Creek)* • The Lazy Lizard (accommodation in Pine Creek) • Amateur Fisherman's Association NT • Adelaide River and Pine Creek residents
Local Landholders	• Ban Ban Springs Station* • Douglas Station*
Government and service providers	• Commonwealth Department of Agriculture, Water and the Environment (AWE) • NT Department of Industry, Tourism and Trade (DITT)* • NT Environment Protection Authority (NT EPA)* • NT Department of Environment, Parks and Water Security (DEPWS)* • NT Department of Infrastructure, Planning and Logistics (DIPL)* • NT Department of Territory Families, Housing and Communities (DTFHC)* • Parks and Wildlife Commission of the NT (Katherine) • NT Police, Fire and Emergency Services (PFES), including: – NT Fire and Rescue Service – NT Emergency Service – Adelaide River Police Station – Pine Creek Police Station • Worksafe NT • Power and Water Corporation (PWC)* • Victoria Daly Regional Council – Pine Creek • St John Ambulance NT
Members of Parliament and local council officials	• Member for Lingiari, Hon Warren Snowdon (Labor Party) • Member for Daly, Hon Gary Higgins (Country Liberal Party) • NT Minister for Industry and Resources, Paul Kirby • NT Minister for Environment and Natural Resources, Eva Lawler • Victoria Daly Regional Council* – Mayor – Brian Pedwell – CEO – Russell Anderson – Councillor Pine Creek Ward – Gaye Lawrence
Industry and local operators	• Kirkland Lake Gold (NT Operations) • Bacchus Resources* • Bridge Creek Mining • Australian Pipeline Group (APA)* • One Rail Australia (previously GWA) • AustralAsia Railway Corporation (ARC)*

Note: Stakeholders identified with a (*) are those assessed as being 'high interest, high influence' (or priority stakeholders) for which more involved engagement methods have been used.
^ formerly Hon Gary Higgins.
# formerly Hon Paul Kirby.

Stakeholder analysis involved determining the level of interest and influence of each stakeholder or group. Stakeholder interest is the extent to which the interests of a stakeholder may be positively or negatively affected by the Project. Stakeholder influence refers to the influence or power that a stakeholder may have over Project outcomes and decision-making.

5.3 Engagement and Key Issues Raised

The results of stakeholder identification and analysis guided the engagement methods and tools employed for each individual or stakeholder group. The appropriate level of engagement was determined by where on the 'impact/influence' matrix they fell, which informed the approach selected from the IAP2 'Spectrum of Public Participation' (IAP2, 2019b), outlined in Plate 5.1 below. Methods also considered the principles, methods and tools outlined within leading practice resources for the Australian mining sector (CoA, 2016a; CoA, 2016b).

Plate 5.1 – The IAP2 Spectrum of Public Participation

IAP2'S PUBLIC PARTICIPATION SPECTRUM

iap2 international association for public participation

The IAP2 Federation has developed the Spectrum to help groups define the public's role in any public participation process. The IAP2 Spectrum is quickly becoming an international standard.

INCREASING IMPACT ON THE DECISION

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

Source: IAP2, (2019b)

Before PNX acquired an interest in the Fountain Head exploration leases, stakeholder engagement was already occurring in the area however, primarily focussing on the Hayes Creek Project. Engagement activities specific to the Fountain Head Gold Project continued in July 2019 with the Australian Stock Exchange (ASX) Minerals Resources announcement, followed by Project scoping and the preparation of the NOI and has continued into the draft EIS preparation

phase. Table 5.2 shows some of the key engagement activities by phase, including planned activities for the upcoming formal public consultation period.

Table 5.2 – Engagement Over Project Phases

Project Phase		
June 2019 – March 2020	***March 2020 – May2021***	***May – June 2021***
Project Scoping and NOI	***Draft EIS Preparation***	***Public Consultation Period***
• Stakeholder identification and analysis • Preliminary risk assessment • Preparation of draft stakeholder engagement plan • Conducting early stakeholder engagement (i.e., with landowners, Traditional Owners and government departments) • Conducting engagement during baseline surveys	• The ToR for the assessment of the proposal is exhibited for up to 14 days for community input • Structured community engagement (e.g., distribution of Project information materials, meetings with decision-makers) • Respond to stakeholder concerns and incorporate feedback into Project design • Conduct Project briefings	• Public exhibition of EIS (available in hard copy and on the NT EPA website) – supported by methods outlined in Table 5.3 • Review public submissions and draft response

Table 5.3 highlights some of the methods and tools used to support stakeholder engagement that is consistent industry good practice (e.g., IFC, (2009) and NT EPA, 2021b). These methods were supported by a set of 'FAQ responses' used by PNX employees to present consistent and accurate information to stakeholders (refer to Appendix 21).

Table 5.3 – Engagement Methods Used

Method	Description
Public exhibition	Useful technique to present the Project at an appropriate level and provide opportunity for the public, community organisations and other stakeholders and Government to comment on the Project's environmental and social issues
Face-to-face meetings	Useful technique to build rapport with highly influential stakeholders requiring in-depth engagement
Telephone calls/ teleconferences	Useful follow up tool (in addition to email), once a face-to-to face meeting has occurred, or in lieu of a face-to-face meeting when they cannot be arranged. Also used for seeking any clarifications from regulatory authorities during the approvals process and for keeping them updated of application progress
Letters	A means to disseminate Project information and can also be used as a feedback mechanism to update stakeholders on how their comments have been considered
Emails	A cost-effective tool for communicating with a broad range of stakeholders. Used in conjunction with letters and printed material to ensure all stakeholders are reached (as not all will have access to or regularly check emails)
Flyers or leaflets	Used to keep all stakeholders informed about the status and progress of the Project
Online news articles	Targeted at the mining industry, online articles provide information about resource estimates and Project viability
PNX website	Provides Project updates and announcements to industry, government and potential investors

The Project also maintains a stakeholder management system to record all interactions with community stakeholders, including grievances and commitments relating to issues raised.

Table 5.4 summarises the key engagement activities held to-date. Due to the nature of the Project (i.e., small in scale, remote location and brownfield character), much of the engagement has been conducted with government department representatives surrounding the environmental assessment and approvals process. However, field visits (e.g., to complete cultural heritage surveys) also constitute an important stakeholder engagement activity and has given participants the opportunity to discuss aspects of the Project, the EIS process and potential issues.

During the preparation of the EIS, Covid-19 travel and social distancing rules meant that the face-to-face meetings planned with community, industry groups and government were unable to take place. These were replaced by a general and a targeted outreach program which involved sending stakeholders Project update to support their understanding and review of the EIS. The fliers outlined the location, key components and timing of the Project, changes to the Project processing methodology and studies undertaken, along with potential impacts and benefits, and offered the opportunity for stakeholders to ask questions or raise issues or concerns directly with PNX.

Table 5.4 – Summary of Key Project Engagement Activities and Issues Raised

Project Phase	Stakeholder	Date	Topic	Issues Raised/discussed	Status of Issues
Project Scoping and NOI	NT DITT (formerly DPIR)	8th May 2019	Fountain Head Dewatering MMP	• No concerns raised • Supportive, constructive comments on how to complete the Dewatering MMP • Proposal was to process ore at Union Reefs North Underground Mine	NA
	NT DEPWS (formerly DENR)	6th June 2019	Fountain Head Dewatering MMP – water extraction licensing	• No concerns raised • Advice provided that when using a pump to dewater a pit, a surface water extraction licence is not required • The pit is not a waterway therefore no permits are required	NA
	Ban Ban Springs Station	3–d - 5th September 2019	Update on the Fountain Head Gold Project and to introduce Craig Wilson	• None	NA
	Grove Hill Hotel owners	11th September 2019	Margaret River flooding	• No concerns raised • Hotel is for sale as owners are retiring	NA
	Northern Land Council	1st October 2019	Cultural heritage surveys	• No concerns raised • Provided advice on appropriate representatives to contact for field survey	NA
	Warai and Wagiman representatives	18th – 23rd October 2019	Cultural heritage surveys	• No concerns raised	NA

Project Phase	Stakeholder	Date	Topic	Issues Raised/discussed	Status of Issues
	Kirkland Lake Gold	Regular communications	Mark has been kept informed with the project at every stage and has regular communications with James Fox	• No concerns raised • Provided support and guidance	NA
	Bridge Creek Mining	Regular communications	Tony has been kept informed with the project at every stage and has regular communications with James Fox	• No concerns raised • Working on processing options	NA
	Bacchus Resources	Regular communications	Vaughan has regular conversations with Charles Nesbitt and to a lesser extent James Fox	• No concerns raised • Aware of all of exploration activities and Project intents	NA
	Ban Ban Springs Station	15th January 2020	PNX accepted offer to sponsor the Camp Draft 2020	• No concerns raised	Camp Draft was unable to be held due to Covid-19, now being held in June 2021
	NT DITT	25th February 2020	Fountain Head Dewatering Mine Management Plan (MMP)	• Supportive, constructive comments on how to complete the Dewatering MMP • Site water balance – raised whether the site can be managed as a no discharge site	Care and Maintenance MMP needs to be approved before the dewatering MMP can be submitted. Revised MMP responding to DITT issues submitted
	NT EPA	26th February 2020	Fountain Head Gold Project EIS	• Transition to new *Environment Protection Act* and timeframes • Supportive, constructive comments on how to complete the EIS	NA

Project Phase	Stakeholder	Date	Topic	Issues Raised/discussed	Status of Issues
	Grove Hill Hotel	3rd March 2020	Request access to property for background sound monitoring	• No concerns. raised • Access granted	NA
	NT DITT	10th March 2020	Fountain Head Dewatering MMP	• No concerns raised • Requested information on whether a discharge licence would be required • Advice provided on structure of MMP amendment	Advice provided to NT DITT from Water Resources Division – DENR (now DEPWS) from June 2019 in relation to the *Water Act* and potential requirements for a water extraction licence
	NT EPA and NT Government advisory bodies	10th March 2020	Fountain Head NOI	• The NT EPA raised the potential for several impacts that are to be addressed in further detail in the EIS	Addressed in the EIS
	NT DIPL	12th March 2020	Fountain Head Gold Project EIS – traffic and transport	• No concerns raised • Advice provided on what level of information required for proposal	NA
Draft EIS	Ban Ban Springs Station	16th March 2020	Water for irrigation	• Ty expressed interest in having access to the water for irrigation purposes. He is going to investigate the costs of centre pivot irrigators	Work in progress
	ARC	23rd March 2020	Fountain Head Gold Project and blasting near the railway	• No concerns raised • The Corporation advised that they had spoken to the NT EPA	NA

Project Phase	Stakeholder	Date	Topic	Issues Raised/discussed	Status of Issues
				to ensure they are included in the EIS review (14th April 2020)	
	APA	23rd March 2020	Fountain Head Gold Project and blasting near gas pipelines	• A risk assessment will need to be conducted, and an access agreement negotiated for the pipeline corridor	Risk assessment and agreement to occur
	Ban Ban Springs Station	8th April 2020	Cattle transportation	• Owners confirmed that a cattle grid can be installed near Fountain Head and gates can be left open whilst operational	NA
	ARC	11th – 29th June 2020	Rail traffic data request	• Data was requested and provided concerning typical weekly local rail traffic	NA
	AAPA	5th May 2020	Completed application for a certificate of sacred sites clearance for the Project area	• No concerns raised	NA
	All project stakeholders listed in Table 5.1	9th July 2020	Project update/general information on project progress	• One query about EIS process and dates • No concerns raised	NA
	Ban Ban Springs Station	7th – 30th July 2020	Station access to water during mine operations	• Ban Ban Springs Station confirmed they do not use bore RN024290 during the dry • They asked for confirmation regarding cattle access to the Fountain Head lake water during mining, what alternative supply would be provided	A solution to provide water to cattle, including water requirements (i.e., amount, timing etc) is still being discussed
	NT DITT	14th July 2020	Updated regarding proposed Fountain Head joint venture	• No concerns/receipt acknowledged	NA

Project Phase	Stakeholder	Date	Topic	Issues Raised/discussed	Status of Issues
	Ban Ban Springs Station	8th February 2021	Station access to water during mine operations, fire breaks	• Requesting bore be drilled for watering weaner stock once project site access is restricted and requesting fire breaks be maintained on site	Requested f2f – no response/resolution yet
	Ban Ban Springs Station	11th February 2021	Drone use	• Complaint regarding the flying of a drone without notification – potential to intercept helicopter flight path	Confirmed that the drone was being flown by the NT Department of Mines and that in future they would ensure to contact station owners prior
	NT EPA	10th March 2021	• Project update/general information on project progress: • Proposed method of tailings disposal (IWL) using filtered tailings • Project water balance and management of water in particular in relation to the IWL and PAF stockpile • Management of potentially acid forming waste rock and placement of this material under a water cover in the pit • Stakeholder engagement activities undertaken and planned by PNX	• Queried whether discharge to a waterway was required during dewatering process	Informed no discharges off lease are proposed

Project Phase	Stakeholder	Date	Topic	Issues Raised/discussed	Status of Issues
			• Expected schedule for lodgement of the EIS		
	NT DITT	15th March 2021	Project update/general information on project progress: • Proposed method of tailings disposal (IWL) using filtered tailings • Closure of the site following completion of mining • Stakeholder engagement activities undertaken and planned by PNX	• No concerns raised.	NA
	Ban Ban Springs Station	15th May 2021	Infrastructure post mine closure	• Landholder expressed interest in retaining dams, roads, fences and cattle grids post closure	Conversations with landholder regarding post closure will be ongoing
	All project stakeholders listed in Table 5.1	26th May 2021	Project update/general information on project progress	• No concerns raised	NA

^ NT Government advisory bodies for the NOI were: DEPWS, DIPL, DITT, DTFHC, PFES, DoH, DTBI, DLGHCP, PWC, AAPA, Department of the Attorney-General and Justice, Land Development Corporation and the Department of the Chief Minister.

Table 5.5 summarises the roles and responsibilities for planning and implementing stakeholder engagement activities.

Table 5.5 – Stakeholder Engagement Roles and Responsibilities

Activity	Roles and Responsibility	Description
Pre-project awareness and EIS disclosure	PNX Metals or their delegate (case by case)	PNX Metals will undertake pre-awareness consultation with stakeholders identified in Table 5.1 using the methods outlined in Table 5.3 and support EIS disclosure activities led by the NT EPA
Consultation during construction, operations and closure	PNX Metals or their delegate (case by case)	PNX Metals will undertake regular consultation with key stakeholders regarding planned construction activities, and maintain open communications channels supporting community feedback
Managing grievances	Managing Director Project Manager	PNX Metals will maintain feedback, complaints and grievances within the stakeholder consultation log
Management of stakeholder management system	Managing Director Project Manager	PNX Metals will maintain the stakeholder consultation log. It will be regularly reviewed and updated to reflect latest understanding of Project stakeholders. All Managers will have access to the master log and will update information regularly

5.4 Engagement Outcomes and Next Steps

The Statement of Reasons (SoR), which is the NT EPA's response to the NOI, identified the following impacts which were raised by government advisory bodies, that have since been addressed in this EIS:

- The potential for Project traffic to impact other users, including tourists and tour operators.
- The potential for the proposed pit dewatering, the operation of the processing facility and use of hazardous materials to impact on ground and surface water quality.
- The potential for alternations to surface water quality to negatively impact aquatic ecosystems and/or other water users.
- Potential legacy conditions associated with wastes generated at site and the need for additional geochemical investigations and a mine closure plan to be presented as a contingency in the case that the Project does not go ahead as planned.
- The Aboriginal Areas Protection Authority (AAPA) advised that one sacred site has previously been recorded close to the Project area[10], and that the archaeological significance of sites found within the Project area need to be assessed.

[10] AAPA have since issued an Authority Certificate dated 24/03/21.

Engagement with NT government authorities during the NOI process identified the Project requires assessment at the level of an EIS and identified the preliminary key environmental factors that will require assessment for the proposal (outlined in the final ToR). In order to sufficiently assess these factors and potential impacts from Project activities, a number of specialist studies were commissioned. To support the studies, engagement was required to undertake noise modelling to demonstrate that residents at Grove Hill Hotel (5.5 km from the Project area) would not be adversely affected by Project activities, and to ensure that representatives from the appropriate Aboriginal groups (i.e., the Warai and Wagiman) were asked to accompany the cultural heritage specialist on surveys of the Project area.

Consultations with APA and ARC concerning blasting around the gas pipeline and rail line did not identify any issues that could not be addressed. PNX has committed to undertake a risk assessment to identify and address potential risks associated with blasting.

The public exhibition period for the Draft EIS is for a minimum of 28 days and will be supported by government briefings, notification of key stakeholders of the Draft EIS and review period, and information about the Project and review period on the PNX website.

Following the review period, NT EPA will review public feedback and determine whether the public have raised any new issues not addressed in the report and/or if further information is required regarding information within the EIS i.e., additional clarification.

PNX will continue to update and refine the Project SEP (Appendix 21) which provides structure and processes for continuing to keep communities, government and other stakeholders informed of Project updates and milestones. The ongoing program of engagement will include:

- Maintaining good relationships with landholders, local business and industry, Traditional Owners and government (at all levels).
- Identifying new stakeholders and re-analysing levels of interest and impact regularly to maintain a good understanding of stakeholder needs and concern.
- Keeping stakeholders up to date with relevant Project information in a timely manner and addressing concerns as they arise.
- Meeting government requests for information or further engagement.
- Providing community and government with information about the performance of the Project against environmental objectives and the success of mitigations outlined in the EIS.
- Monitoring and responding to issues raised through the stakeholder management system and incorporating feedback into the Project, where possible.
- Consideration of community programs to help monitor Project impacts.
- Continuing to provide updates on the progress of the Project on the PNX website.

PNX will continue to engage with the Heritage branch in the Department of Territory Families, Housing and Communities, the Northern Land Council and Traditional Owner representatives

concerning the salvage of the cultural heritage object and places located within the mine's proposed footprint and operating area (refer to Section 7.10.2).

Engagement with landholders, specifically the underlying pastoral lease holder, will be maintained by PNX throughout the life of the Project.

6. Impact Assessment Methods

6.1 Introduction

This Chapter describes the methodology of the environmental impact assessment for the Fountain Head Gold Project. The method has been derived to ensure the overall approach remains in alignment with legislative and Project requirements.

The Project impact assessment must satisfy the NT EPA regulatory requirements for an Environmental Impact Statement (EIS) under the *Environment Assessment Act 1982*.

The NT EPA assessment guidelines (NT EPA, 2019) state that the draft EIS must:

- Identify, describe and evaluate the significance of direct, indirect and cumulative impacts and risks to environmental values or sensitive receptors where a credible pathway exists, consistent with a 'Source, Pathway, Receptor' model.
- Consider all potential impacts and risks from all stages of the proposal.
- Evaluate significance in consideration of the NT EPA Environmental Factors and Objectives (NT EPA, 2018).
- Outline the proposed measures for mitigating the identified potential impacts and risks to environmental values associated with each environmental factor (see Table 6.1), for all phases of the proposal. This will include contingency measures that may be implemented if thresholds are exceeded.

6.2 General Approach to Impact Assessment

6.2.1 Overview

This section provides an overview of the environmental impact assessment methodology which will be described in the proceeding sections.

- Identify environmental values and factors or sensitive receptors associated with the Project by describing the existing physical environment within and around the Project area, including relevant 'receptors' and beneficial values (Section 6.2.2).
- Identify Project activities/aspects and potential impacts of those activities on environmental factors by describing the Project and associated activities, particularly within the context of potential interactions with the existing environment (Section 6.2.3).
- Determine appropriate avoidance, mitigation and management measures that will address the potential impacts and are both technically and economically feasible and are assumed to be implemented in a timely manner during Project development.
- Undertake residual impact assessment, taking into account the implementation of mitigation and management measures (for construction, operation and closure).

- Undertake cumulative impact assessment to assess the total potential impact in conjunction with other current or future projects (Section 6.2.7).
- Undertake risk assessment of major hazards associated with accidental, upset or abnormal events e.g., cyclone or major spill. Assessment involves identifying potential events, its consequences, and proposed management and mitigation measures, using information from a hazard identification (HAZID) workshop (Section 6.2.8).

This approach is consistent with that used in other recently completed environmental and social impact assessments for Projects in the Northern Territory and elsewhere.

6.2.2 Environmental Values

The relevant environmental factors and their associated objectives have been determined by the NT EPA following review of the Notice of Intent (ERIAS, 2019) and consideration of the potential environmental impacts and risks of the proposed Project. These factors are broad components of the environment such as aquatic ecosystems, water or air quality. The environmental objectives are the desired outcome, goal or direction for change identified for each environmental factor. The factors are outlined in the Final Fountain Head Gold Project Terms of Reference (ToR) and are listed in Table 6.1.

Table 6.1 – Terms of Reference Environmental Factors and Objectives

Theme	Key Environmental Factors	Objectives
Land	Terrestrial environmental quality	Maintain the quality of land and soils so that environmental values are protected
Water	Hydrological processes	Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected
	Inland water environmental quality	Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are protected
	Aquatic ecosystems	Protect aquatic ecosystems to maintain the biological diversity of flora and fauna and the ecological functions they perform
People and communities	Social, economic and cultural surroundings	Protect the rich social, economic, cultural and heritage values of the Northern Territory

The Final ToR did not include environmental factors in relation to: air, ambient noise or terrestrial ecology. However specialist studies were undertaken for these factors and Project impacts have been assessed against the corresponding environmental values for completeness.

6.2.3 Environmental Impacts from Planned Activities

6.2.3.1 Identifying Project Aspects/Activities

Planned Project components include the dewatering and mining of the Fountain Head pit, expansion of the existing waste rock storage to an IWL, construction and operation of crushing facilities and a gold processing plant (CIP), and associated infrastructure, including workshops, power station, roads and offices. Table 6.2 identifies the corresponding project components and environmental factors.

Aspects of these Project components that have potential to impact the Project environmental factors (described in Section 6.2.2, Table 6.1) are to be considered in the impact assessment.

An environmental aspect, according to the definition provided by ISO 14001 is an ‘element of an organisation’s activities, products or services that can interact with the environment’. An environmental impact is the change that takes place from occurrence of any given aspect.

Table 6.2 – Environmental Factors and Corresponding Project Aspects/Activity

Environmental Factors		Project Aspect/Activity
Amenity	Air quality and greenhouse gas	• Topsoil stripping and stockpiling • Land clearing • Construction of crushing facilities, CIP plant, power station, and associated infrastructure • Drilling of waste rock and ore • Overburden excavation and handling • Excavation and handling of ore • Loading and hauling of waste rock and ore • Ore transport, stockpiling, and preparation • WRS expansion and tailings disposal within IWL • CIP processing, storage and mixing • Use of evaporators to dewater existing pit • Operation of diesel generators • Operation of diesel power station • Operation of machinery, equipment and vehicles with diesel fuel • Operation of gold processing plant, storage and mixing, electrowinning, operation of carbon regeneration kiln • Use of explosives with diesel content for blasting
	Noise	• Construction of crushing facilities, CIP plant, power station, and associated infrastructure • Drilling of waste rock and ore • Operation of machinery, equipment and vehicles • Operation of CIP plant and supporting infrastructure • Overburden excavation and handling • Grading and dozing • Use of evaporators to dewater existing pit • Spinning of concrete mixers at a high speed • Blasting • Operation of diesel power station

Environmental Factors		Project Aspect/Activity
	Traffic and transport	• Transport of staff, supplies, machinery and equipment to/from the Project site
Terrestrial environmental quality	Land and soils	• Pit dewatering • Topsoil stripping and stockpiling • WRS expansion and tailings disposal within IWL • Land clearing • General vehicle movement • Handling and storage of hazardous and non-hazardous materials
Terrestrial flora and fauna	Flora	• Earthworks/ground disturbance • Topsoil stripping and stockpiling • Drilling and blasting of waste rock and ore • Overburden excavation and handling • Excavation and handling of ore • Loading and hauling of waste rock and ore • Ore processing, including transfers, screening crushing and stacking on the ROM pad • Use of chemical reagents, vehicles, plant and equipment, fuel and chemical handling and storage • Operation of CIP plant and supporting infrastructure
	Fauna	
Inland water environmental quality	Surface water	• Earthworks/ground disturbance • Topsoil stripping and stockpiling • Overburden excavation and handling • Excavation and handling of ore • Loading and hauling of waste rock and ore • Ore transport, stockpiling, and preparation • Use of chemical reagents, vehicles, plant and equipment, fuel and chemical handling and storage • Operation of CIP plant and supporting infrastructure
	Groundwater	• Pit dewatering • Expansion of the evaporation pond

Environmental Factors		Project Aspect/Activity
		• Use of chemical reagents, vehicles, plant and equipment, fuel and chemical handling and storage • Operation of CIP plant and supporting infrastructure • IWL and final pit lake
	Aquatic ecosystems	• Pit dewatering • Expansion of the evaporation pond • Earthworks/ground disturbance • Topsoil stripping and stockpiling • Site preparation works i.e. topsoil removal • Overburden excavation and handling • Excavation and handling of ore • Loading and hauling of waste rock and ore • Ore transport, stockpiling, and preparation • Use of chemical reagents, vehicles, plant and equipment, fuel and chemical handling and storage • Operation of CIP plant and supporting infrastructure
Hydrological processes		• Pit dewatering • Expansion of the evaporation pond • Construction of crushing facilities, CIP plant, power station, laydown areas, access roads and infrastructure • Operation of CIP plant and supporting infrastructure • IWL and final pit lake
People and communities	Economy and regional development	• Royalties and mining levy payments
	Employment and training	• Project employment and training
	Local industry and land users	• Pit dewatering • Mining operations • Transport of staff, supplies, machinery and equipment to/from the Project site • Blasting (vibration)

Environmental Factors		Project Aspect/Activity
	Infrastructure and services	• Project workforce, logistics and transport
	Social cohesion and amenity	• Mine site rehabilitation • Project employment and procurement
	Community health and safety	• Blasting (fly rock)
	Cultural heritage	• Expansion of mine footprint

6.2.3.2 Significance Impact Assessment Method

The significance assessment approach will be used to assess potential environmental impacts. The method is based on understanding the vulnerability of an environmental value, resource or sensitive receptor to determine the potential severity of impacts. The method assesses credible impacts that are expected to occur during the Project's life cycle. The approach for this method is shown in (Figure 6.1).

Sensitivity of Environmental Values and Receptors

The sensitivity of an environmental value is determined on the basis of its intrinsic value as well as its susceptibility or vulnerability to threatening processes. In order to reflect the specific focus of each technical study, key attributes that define sensitivity were reviewed, including:

- **Intactness**: a measure of the existing condition of the environmental value, including its representativeness and how intact it is.
- **Formal status**: this may be assigned by statutory or regulatory authorities or by appropriately recognised national or international organisations. This may involve legislation, regulations or international conventions or other mechanisms that attribute a particular status to a value or receptor.
- **Rarity or uniqueness**: as assessment of an environmental value's incidence, abundance and distribution within and beyond its bioregion.
- **Replacement potential**: an assessment of the potential for any losses of the environmental value to be replaced by an equivalent or representative example.
- **Resilience to change**: an assessment of the capacity of an environmental value to adapt to change without adversely affecting its intactness, conservation status, rarity or uniqueness.
- **Importance**: it's worth to local communities and society, its iconic or symbolic importance to cultural value systems.

Applying these elements enables the sensitivity of an environmental value to be ranked as high, moderate, or low, as described by the model criteria in Table 6.3.

FIGURE 6.1

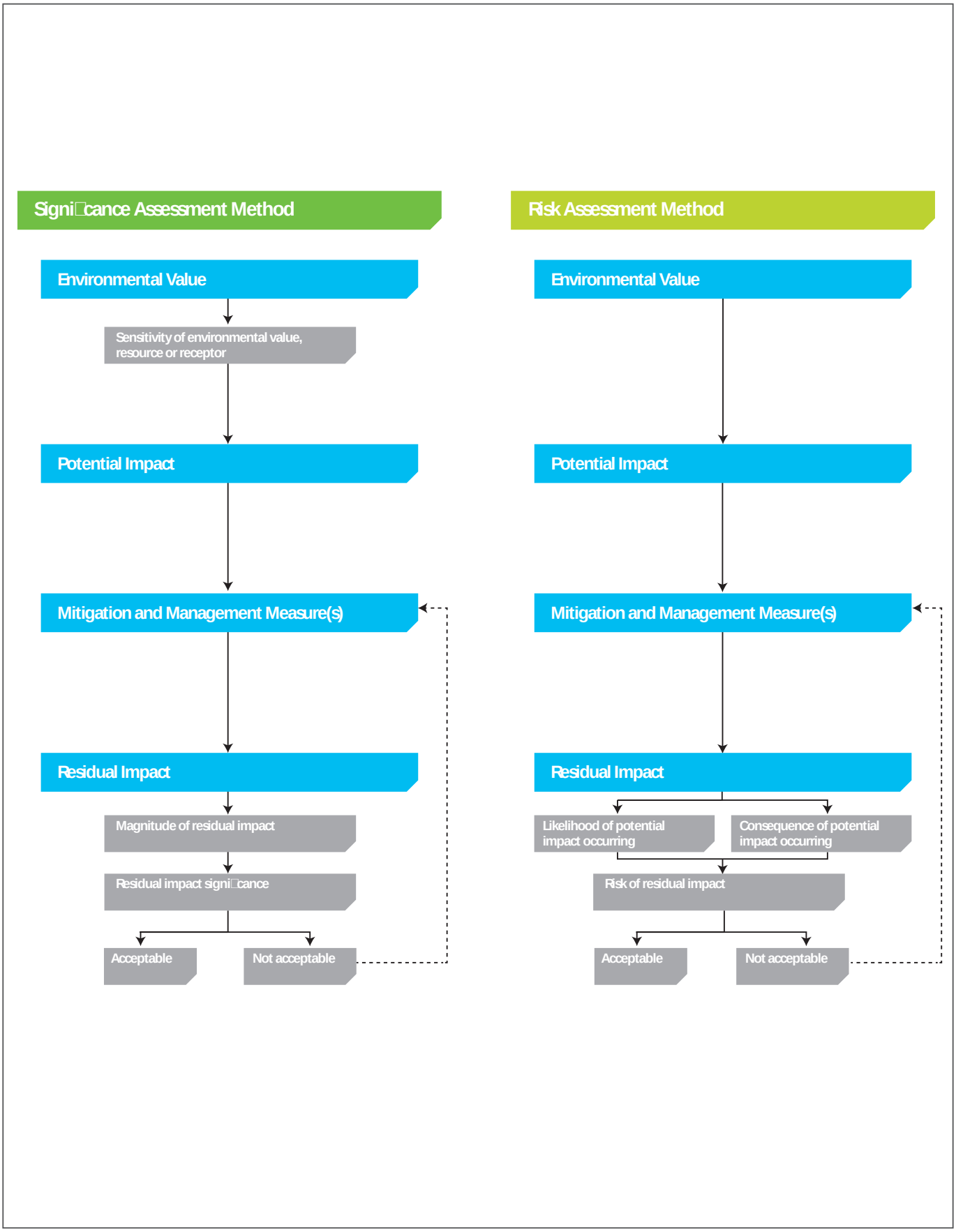

Signi□cance Assessment Method
Environmental Value
Sensitivity of environmental value, resource or receptor
Potential Impact
Mitigation and Management Measure(s)
Residual Impact
Magnitude of residual impact
Residual impact signi□cance
Acceptable
Not acceptable
Risk Assessment Method
Environmental Value
Potential Impact
Mitigation and Management Measure(s)
Residual Impact
Likelihood of potential impact occurring
Consequence of potential impact occurring
Risk of residual impact
Acceptable
Not acceptable

Table 6.3 – Sensitivity Criteria

Sensitivity	Description
High	• The environmental value is listed as being of conservation significance on a statutory or recognised international, national or state register • The environmental value is unique to the environment in which it occurs. It is isolated to the affected area or system, and is poorly represented in the region, territory, country or the world • The environmental value has not been exposed to threatening processes, or there has not been a noticeable impact on the integrity of the environmental value • The potentially affected community is highly reliant on the environmental value that may be affected, or the environmental value may hold significant cultural heritage or traditional value • There is a lack of skilled and experienced labour 'pool'
Medium	• The environmental value is recognised as being important at a regional level, and may have been nominated for listing on recognised or statutory registers • The environmental value is in a moderate to good condition despite it being exposed to previous impacts or threatening processes. It retains many of its key characteristics and structural elements • The environmental value is relatively well represented in the areas/systems in which it occurs, but its distribution and abundance are limited by threatening processes • The potentially affected community is somewhat reliant on the environmental value that may be affected, or the environmental value is moderately important from a cultural heritage or traditional perspective • Some skills in labour 'pool' with only limited experience
Low	• The environmental value is not listed on any recognised or statutory register. It might be recognised locally by relevant and suitably qualified experts or organisations • The environmental value is in a poor to moderate condition as a result of previous impact or threatening processes, which have degraded its intrinsic value • The environmental value is not rare or unique, and numerous representative examples exist throughout the area/system • The potentially affected community is not reliant on the environmental value that may be affected, or it holds no cultural heritage or traditional value • Highly skilled and experienced labour 'pool'

Magnitude of Potential Impacts

The magnitude of a potential impact reflects the predicted size and nature of change based on several elements. For the purposes of this assessment these elements are defined as follows:

- Duration: the timescale of the effect, whether short, medium (i.e., reversible) or long term (i.e., effectively permanent).
- Geographical extent: the spatial extent of the impact where this is defined as site, local, regional or widespread (provincial, national or trans-boundary).
- Severity: the scale or degree of change (both positive and negative) from the existing condition, as a result of the environmental impact.

Applying the above elements enables the magnitude of an impact to be ranked as high, moderate, low, negligible or positive as described in Table 6.4.

Table 6.4 – Magnitude Criteria

Magnitude	Description
High	• An impact that is long lasting (i.e., more than 15 years), widespread, and leads to substantial and possibly irreversible change to the environmental and/or social value • To address the impact, avoidance of the value through appropriate design responses and/or implementation of site-specific environmental and/or social management controls are required
Medium	• An impact that is medium term (i.e., lasting 5 to 15 years), is contained within the region where the Project is being developed and/or where the intensity and frequency of the impact is outside the range of natural variability or environmental/social value is supported in a moderately modified condition • It is possible to reduce or largely reverse the impacts/changes via specific environmental and/or social management controls
Low	• An impact that is short term (i.e., less than 5 years) and localised in extent and/or the intensity and frequency of the impact is detectable with respect to natural variability or the environmental/social value is only slightly impacted • The change can be effectively mitigated and reversed through routine environmental and/or social management controls
Negligible	• An impact that is unlikely to be detectable or completely reversed with respect to natural and social variability
Positive	• A beneficial impact on an environmental and/or social value

6.2.4 Mitigations and Management Measures

Potential environmental impacts will be assessed after mitigations and management measures have been implemented. Project mitigations have been derived following the mitigation hierarchy of; avoidance, minimisation, rehabilitation and offset (TBC, 2015). Project mitigations have been developed from the early stages of Project design (embedded design), input from specialist studies and best practice. The complete list of mitigation and management measures is provided in the Commitments Register (Appendix 22).

6.2.5 Residual Impact Significance

The significance of an impact on a value or receptor was determined using the significance matrix presented in Table 6.5 which combines the likely magnitude of an impact with the sensitivity of the value or receptor. The magnitude of an impact was assessed considering the application of mitigation measures which were expected to reduce the impact's severity, geographic extent or duration.

The result is a significance rating for the residual impact.

Table 6.5 – Significance Assessment Matrix

		Sensitivity of Value		
		High	*Medium*	*Low*
Magnitude of Impact	*High*	Severe	Major	Moderate
	Medium	Major	Moderate	Low
	Low	Moderate	Low	Negligible
	Negligible	Negligible	Negligible	Negligible
	Positive	Positive	Positive	Positive

The classifications (severe, major, moderate, low, negligible and positive) for significance of an impact are defined as follows:

- **Severe**: when an impact will potentially cause widespread or irreversible harm to an environmental value that is irreplaceable because of its rarity or uniqueness. Avoidance of the value/impact through appropriate design responses is the only effective mitigation.
- **Major**: when proposed activities are likely to worsen threatening processes affecting the core characteristics or structural elements of an environmental value. Although replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred in order to preserve the environmental value's conservation status or intactness.
- **Moderate**: where an environmental value is somewhat resilient to change, but would be further degraded due to the scale of the impact or its susceptibility to further change. The abundance and/or distribution of the environmental value ensures that it is adequately represented in the region, and that replacement, if required, is achievable.
- **Low**: where an environmental value is of local importance, but temporary changes will not adversely affect its viability, provided that routine environmental management controls are implemented.
- **Negligible**: where impact to an environmental value will not result in any noticeable change in its intrinsic value, and as such, the proposed activities will have negligible effect on its viability.
- **Positive**: where a Project activity will have a beneficial impact on an environmental value that enhances its resilience to change.

The criteria for sensitivity and magnitude have also been reviewed and defined in Chapter 7 to reflect the specific focus of each technical study.

6.2.6 Compliance Assessment Method

Impacts associated with some Project activities – such as air quality, noise or water quality – can be readily evaluated by comparison with objective, quantitative criteria, guidelines or standards where modelling has been undertaken to predict impacts of discharges on ambient quality. Predicted Project derived values can be compared with these criteria, guidelines or standards. In

the event of predicted non-compliances, impacts may be further evaluated in terms of the likely actual impacts on relevant environmental values, using the impact significance method where necessary.

6.2.7 Cumulative Impacts

The EIS ToR requires an assessment of cumulative impacts for all Project factors. Only residual impacts assessed as moderate, major or severe will be required to be assessed.

Cumulative impacts can be defined as the total impact arising from the Project in conjunction with other current or future activities (e.g. by that of developers, local communities, government). The analysis of the Project's incremental impacts combined with the effects of other known activities will provide a holistic understanding of the likely impacts of the Project's presence as opposed to considering the Project's impacts only in isolation. The Project's impact is therefore one part of the total cumulative impact on the environment. Section 6.2.7.1 describes the Project's assessment methodology for the cumulative impact assessment.

6.2.7.1 Assessment Approach

This section describes the approach used to undertake an overarching assessment of the cumulative impacts as a result of the proposed Project activities.

The process involves examining:

1. Project impacts that could be contributing factors, i.e. residual impacts assessed as moderate and above (see Section 6.2.5).
2. Determining spatial boundaries by identifying geographical connections between projects and temporal boundaries, or the timeframe over which analysis takes place (i.e., expected life of the Project).
3. Identifying credible projects, which are defined as those that are existing, planned or reasonably anticipated based on publicly available information:
   - Currently operating or are expanding.
   - Under construction or being commissioned.
   - Undertaking detailed feasibility studies or a small-scale pilot project in preparation for the full-scale project.
   - Approved by State government and awaiting final investment decision or are in the final design stages.
   - Midway through their environmental approvals process and are likely to proceed if a permit is granted.
4. Assessment of cumulative impacts.
5. Design and implementation of mitigation measures.

The identified projects and assessment of cumulative impacts is discussed in the impact assessment chapter (Section 7.12).

6.2.8 Major Hazards

Unplanned discharges of environmentally hazardous substances or other impacts may occur due to major hazards and extreme natural events. These events are normally associated with loss of containment leading to spills, fires, explosions, collisions and/or hazardous emissions. While rare, such events may result in significant loss of life, serious environmental harm and asset and reputation damage.

In May 2021, analysis of major hazards and associated risks was undertaken for the Project in a hazard identification (HAZID) workshop involving PNX and ERIAS Group personnel. The workshop tested the existing risk controls, and subsequently confirmed that the control measures were sufficient to mitigate and manage the potential hazards that may arise.

Outcomes of the hazard identification and risk assessment are outlined in Section 7.13 of the impact assessment chapter and in the Fountain Head Gold Project Risk Register provided in Appendix 23. The risk assessment method used in this workshop is described in Section 6.2.8.1.

6.2.8.1 Risk Assessment Approach

PNX and ERIAS Group have determined potential hazards of the Project based on knowledge of the existing environment, current Project planning and experience with other similar mining projects in the Northern Territory and elsewhere. The risk assessment was undertaken as a three-step process:

1 Review of all Project activities that could result in unplanned hazards with the potential to impact the environment and local community.

2 Assessment of the potential hazards or threats that those activities might pose to the physical, biological or social environment.

3 Assessment of the potential risks of those hazards or events.

ERIAS Group's risk assessment matrix was used to undertake the risk assessment. It includes qualitative criteria to rank the likelihood and consequence of potential risks. The rating of the risk is made by reference to an assessment of the severity of the potential consequences and the likelihood[11] at which those consequences are estimated to occur. The level of risk of each environmental hazard is determined by combining likelihood and consequence in the matrix. The risk assessment assumes the effective implementation of the proposed mitigation measures that PNX will implement for the Project. Examples of criteria used for consequence and likelihood are shown in Tables 6.6 and 6.7, respectively, with the risk assessment matrix shown in Table 6.8. The potential hazards or events were assessed as either likely to occur under normal operating conditions, abnormal conditions, or emergency conditions in accordance with the Project ToR.

[11] It is an important distinction that likelihood refers to the likelihood of the consequence occurring, rather than the likelihood of the event that leads to the consequence.

The principles described in the following documents were adopted in the risk assessment method:

- AS/NZS ISO 31000:2018 Risk management – Guidelines (Standards Australia, 2018).
- SA/SNZ HB 436:2013 Risk management guidelines companion to AS/NZS 31000:2009 (Standards Australia, 2013).
- HB 203:2012 Managing environmental-related risk (Standards Australia, 2012).

Table 6.6 – Qualitative Criteria for Risk Consequence

Consequence	Health and Safety	Environment	Business Reputation	Financial Loss
Negligible	Minimal impact	Possible impacts but without noticeable consequence	Minimal impact	< $100,000 AUD
Minor	First-aid treatment	Some limited temporary consequence but no significant long-term impact. Examples include a spill which is easily remediated or minor damage to a cultural heritage site which can be repaired	Some impact	>$100,000, <$1 million AUD
Moderate	Medical treatment	Significant temporary or minor permanent impact. Examples include seepage from a dam that requires rectification works over several months to repair or permanent damage to a cultural heritage site	Small to moderate impact	$1 to 5 million AUD
Major	Extensive injury or hospitalisation	Substantial and significant changes, will attract public concern, only partially able to be rehabilitated or uncertain if impact can be successfully rehabilitated. Examples include spill that results in major downstream impact that requires remediation over a 12-month period or major destruction to a cultural heritage site	Significant impact and/or national media exposure	$5 to 10 million AUD
Catastrophic	Fatality	A major event that could cause severe or long-term damage to the natural and/or human environment. Examples include spill that causes major downstream impact that requires at least 12 months to remediate or total destruction of cultural heritage site	Critical impact and/or international media exposure	>$10 million AUD

Table 6.7 – Qualitative Criteria for Risk Likelihood

Likelihood	Description
Virtually impossible	• The impact may only occur in exceptional circumstances. Extremely rare occurrence (once per 1,000 years). Unlikely that it has occurred elsewhere and, if it has occurred, it is regarded as unique
Unlikely	• The impact could occur but is not expected. May be technically possible but would be considered extremely unusual (once per 100 years)
Possible	• The impact could occur, however has seldom occurred in similar operations. There is likely to be an impact on average every 5 to 20 years
Likely	• There is likely to be an impact on average every 1 to 5 years. Likely to have been a similar incident occurring in similar environments. The impact will probably occur in most circumstances
Virtually certain	• The impact will occur, is of a continuous nature, or the likelihood is unknown. There is likely to be an impact at least once per year or more (up to 10 times per year). It often occurs in similar environments. The impact is expected to occur in most circumstances

Table 6.8 – Fountain Head Risk Assessment Matrix

		Likelihood				
Consequence		Virtually Certain	Likely	Possible	Unlikely	Virtually Impossible
	Catastrophic	Extreme				
	Major		High			
	Moderate			Moderate		
	Minor				Low	
	Negligible					Very Low

7. Environmental Impacts and Management Measures

7.1 Land and Soils

The Project area is located on hilly to rugged land, with two main soil types (described in Section 4.2). This section describes potential impacts to land and soils from Project activities (as described in Chapter 3).

7.1.1 Discipline-specific Approach

The NT EPA identified terrestrial environmental quality as a key environmental factor to be addressed in the Project EIS. The corresponding objective is to maintain the quality of land soils so that environmental values are protected. The environmental value of land and soils relevant to the Project area is soil quality. To ensure the Project meets this objective, potential impacts to land and soils have been assessed using the significance assessment method described in Chapter 6. This approach takes into consideration the sensitivity of environmental values and the magnitude of potential impacts to allow for a residual impact significance rating to be assigned.

Soil quality, which includes stability and strength, ground cover, roots and vegetation all interact and are integral to ecosystem health. The stored and cycled nutrients support plant growth and productivity, and can have implications for the maintenance of healthy waterways and regeneration of native flora and habitat. Impacts relating to, surface water quality and terrestrial ecology are assessed in Sections 7.5 and 7.7 respectively and are not assessed in this section.

7.1.2 Potential Impacts

The land and soils within the Project area have been previously disturbed from historic mining and agricultural activities dating back over a hundred years, and this pre-existing impact has been taken into account in the assessment of the sensitivity of soil quality.

Project activities that may cause potential impacts to land and soils within the Project area and associated potential impacts are described in Table 7.1.

Table 7.1 – Potential Impacts to Land and Soils

Project Phase	Activity/Aspect	Project Component	Potential Impact
Construction, Operation	Clearing of vegetation, general vehicle movement, topsoil removal and stockpiling	Pit expansion; Waste Rock Storage (WRS) expansion to integrated waste landform (IWL); construction of crushing facilities, carbon-in-pulp (CIP) plant, power station, laydown areas, access roads and infrastructure; general vehicle movement	Reduction in flora establishment as a result of erosion and soil compaction
Construction, Operation, Closure and Rehabilitation	All activities involving handling and storage of hazardous and non-	Pit expansion; WRS expansion to IWL; construction of crushing facilities, CIP plant, power station, laydown areas, access roads and	Contamination of soil by hazardous and non-hazardous materials

Project Phase	Activity/Aspect	Project Component	Potential Impact
	hazardous materials	infrastructure; general vehicle movement; septic system	
Rehabilitation, Closure	Topsoil stripping and stockpiling	Rehabilitation of IWL and cleared areas	Rehabilitation failure as a result of loss of soil structure and seedbank in topsoil stored for rehabilitation
Operations	Emissions of arsenic and heavy metals from pit water	Use of evaporators to dewater existing pit	Deterioration of soil quality due to the dispersion of arsenic and heavy metal particulate matter

7.1.2.1 Reduction in Flora Establishment

Early construction activities will include clearing of vegetation for the expansion of the existing pit, the WRS expansion to the IWL and construction of the crushing facilities, process plant, power station, laydown areas, access, haul roads and other associated infrastructure. Once areas are cleared, stripping and stockpiling of topsoil and subsoils will be undertaken for later use in site rehabilitation. Detail on the amount of clearing required is discussed in Section 7.7.

An increase in erosion of topsoil can result from the clearing of vegetation from construction activities. Vegetation clearing will result in soil previously covered by vegetation being no longer bound by roots and protected by vegetative matter (Appendix 8) and the loss of topsoil via erosion can reduce the available seed bank and decrease the effectiveness of rehabilitation. Erosion is most likely to occur in areas that have little to no vegetation cover, such as dam walls, roads and vehicle tracks, hardstand areas and the IWL (Appendix 8).

Soil compaction can also occur as a result of Project activities such as general vehicle movement and machinery operation on disturbed and non-disturbed areas. Soil compaction increases the soil density of affected areas by packing the soil particles closer together. This can impact vegetation that was not planned to be disturbed and affect the capacity for rehabilitation success.

7.1.2.2 Soil Contamination

The Project will involve the transport, use, storage, and disposal of hazardous and non-hazardous materials, which has the potential to contaminate soils across the Project area if not appropriately managed. Relevant hazardous materials include (but are not limited to) fuels, oils, lubricants, hydraulic fluids, cyanide and lime (reagents). Potential sources of contamination include accidental spills or leaks of hazardous substances such as hydrocarbons, and stored chemicals.

Waste produced from the ablutions of temporary buildings and mobile ablution blocks, including grey water (i.e., effluent from sinks and washing facilities) and black water (i.e., toilet effluents) will be collected in storage tanks, which will be regularly emptied, and the waste taken offsite for proper disposal at a licensed facility. Sewage from permanent buildings (e.g., crib room or offices)

are likely to be collected in subsurface septic tanks, where solids will be removed and disposed of at a licensed facility, and wastewater will flow to a subsurface, on-site drainage field. Septic wastewater could contain elevated nutrients, higher oxygen demand and microbes. These all

have the potential to contaminate the affected land and alter soil quality. Additionally, there is the potential for further contamination by an overflow of solids if pumping out of solids is not frequent enough, or if there is a leak in the septic tank(s).

Potential contamination of other environmental factors, such as air, surface water and groundwater are discussed in Sections 7.2, 7.5 and 7.6 respectively.

7.1.2.3 Rehabilitation Failure

Topsoils and subsoils that will be stripped will either be stockpiled until re-contoured areas are available, or preferably directly returned immediately across the areas to be rehabilitated. In relation to the Project's planned disturbance, certain areas will be progressively disturbed and rehabilitated over the life of the Project (such as the IWL), while other areas will be disturbed during early works and will remain disturbed until rehabilitation is conducted as part of the mine closure process (such as the areas cleared for infrastructure). The stripping of topsoil should be undertaken following the Project topsoil management procedure, which will outline appropriate protocol for soil handling and storage to optimise the retention of soil characteristics (in terms of nutrients and micro-organisms) favourable for plant growth and propagules for natural regeneration (e.g., seed banks). If stripping is not undertaken following the correct procedure, rehabilitation of disturbed areas could contribute to ongoing localised reduction in vegetation quality, erosion, compaction of soils and spread of weed species. Revegetation may also be further compromised on steep slopes and unstable landforms, such as the IWL where topsoil is more easily eroded.

7.1.2.4 Deterioration of Soil Quality due to the Dispersion of Arsenic

Fugitive spray from the evaporators of airborne particulate matter during dewatering activities was identified as a potential impact to soil quality. Water quality sampling from within the pit found consistent elevated levels of arsenic, as well as heavy metals (aluminium, cobalt, copper, iron, lead, nickel and zinc (see Section 4.5.3.1)) which could be dispersed to surrounding soils upon evaporation of the water droplets.

An assessment for the potential impact of particulate emissions as a result of the operation of the evaporators was determined by an evaporator emissions study (Appendix 27). The assessment determined that particulate emissions from the evaporators would comply with air quality criteria at the nearest sensitive receptor (5.5 km from the Project site). It is determined that the majority of droplets (72.3 % of the total volume) will fall back into the pit void, however drift of the evaporator plume would occur under certain wind conditions, potentially depositing evaporated particulate matter on the soils surrounding the pit, up to 500 m from the evaporator location.

7.1.3 Mitigation and Management Measures

This section presents the proposed mitigation and management measures to reduce the potential impacts Project activities may have on soil quality.

7.1.3.1 Reduction in Flora Establishment

Mitigation measures that will be implemented to reduce impacts from erosion and soil compaction include:

- Implementation of vegetation clearing approvals process (LS01).

- Where possible Project infrastructure will be located in areas previously disturbed (LS02).
- Progressively rehabilitate areas as activities cease (LS03).
- Ensure Project vehicles remain on Project roads and tracks as far as reasonably practical (LS04).

7.1.3.2 Soil Contamination

Mitigation measures that will be implemented to reduce the potential for soil contamination from hazardous and non-hazardous substances include:

- Storing fuels, lubricants and process reagents in covered areas or in bunded and lined areas. Bunding will be implemented in accordance with relevant standards and guidelines including AS 1940 Storage and handling of flammable and combustible liquids and the *Australian Dangerous Goods Code* (SW11).
- Processing additives such as cyanide and lime to be stored in secure undercover reagent storage area (LS06).
- All plant, equipment and vehicles to be refuelled within specified refuelling area (LS07).
- Develop and maintain a Standard Work Procedure for hydrocarbon and chemical spill response (LS08).
- Locating, constructing and using septic systems according to the Northern Territory *Code of Practice for Onsite Wastewater Management* (GW02).
- Regularly pumping solids from the septic tank to prevent blockages and overflow (GW03).

7.1.3.3 Rehabilitation Failure

Mitigation measures that will be implemented to reduce impacts to soils during the rehabilitation phase (progressive and at mine closure) include:

- Develop and adhere to the topsoil management procedure (LS09), which will include the following mitigation and management measures:
  - Strategic placement of stockpiled soils, i.e., to protect from prevailing wind and drainage lines (LS10)
  - Minimise the timeframe between area no longer being used for Project requirements and rehabilitation to reduce the likelihood of weeds becoming established (LS11).
  - Locate soils in areas where soils were previously removed (LS12).
  - Minimise stockpile height to maximum 3 m (LS13).
  - Stockpiles to be revegetated with native vegetation to minimise loss of soil quality (LS14).

- Stockpiles to be monitored for weeds and control programs implemented as required (LS15).

7.1.3.4 Deterioration of Soil Quality due to the Dispersion of Arsenic

Mitigation measures that will be implemented to reduce the potential for fugitive spray from the evaporators during dewatering activities include:

- Shutting off evaporators during wind conditions that place sensitive receptors downwind, based on measured or forecast wind conditions if required (AQ13).

7.1.4 Residual Impacts

The residual impacts of Project activity to soil quality, assuming the successful implementation of the recommended mitigation and management measures is discussed below.

7.1.4.1 Reduction in Flora Establishment

Soils within the Project area have been largely disturbed due to previous mining and agricultural activities and are very likely to be contaminated. Erosion and compaction of soils are environmental issues which have already been previously identified and are being managed under the Fountain Head care and maintenance program. As a result, the quality of the soils within the Project area is not an environmental value which is highly sensitive to new Project activity. Additionally, the soils of the Project area are not rare or unique, found commonly across the region and are therefore described as having a sensitivity ranking of ***Low***.

The potential for further erosion and compaction across the Project area during the construction and operation phases are not seen as highly significant impacts. The impacts are likely to be short term and localised to the Project area and the immediate surrounding area. Much of the vegetation clearing that is required for Project infrastructure and related Project activities that could potentially cause erosion will be undertaken on previously disturbed areas, or on habitat types that are widespread across the region. Project activities that are likely to cause compaction are similarly going to largely take place on previously disturbed areas or designated areas. As such, with the implementation of the management measures described in Section 7.1.3, potential erosion and compaction impacts are likely to have a ***Low*** impact magnitude on existing soils and the ability for flora establishment. The significance of residual impacts to soils and flora establishment from erosion and compaction of soils is therefore ***Negligible***.

7.1.4.2 Soil Contamination

As described in Section 7.1.4.1 above, the sensitivity ranking of soil quality is ***Low***. The likelihood of spills or leaks occurring is largely reduced via specific environmental management controls, outlined in Section 7.1.3. Similarly, the implementation of management of the on-site septic system in accordance with the *Northern Territory Code of Practice for Onsite Wastewater Management* will significantly reduce any impacts associated with planned and unplanned discharge of sewage waste and impacts have been assessed as ***Low***.

Minor spills or leaks, even with effective management, are a common occurrence on mining sites but impacts are localised to the site as they are not difficult to contain with measures such as a Spill Response Procedure and as a result have the potential to be short term. As such, the magnitude of a minor spill or leak has been assessed as ***Low***. The significance of residual

impacts to soil quality from contamination is therefore ***Negligible***. Environmental impacts of larger spills and leaks, relating to unforeseen events is discussed in Major Hazards, Section 7.13.

7.1.4.3 Rehabilitation Failure

As described in Section 7.1.4.1 above, the sensitivity ranking of soil quality is ***Low***. The rehabilitation of disturbed areas will be completed following the Project topsoil management procedure and Rehabilitation Management Plan. The impacts associated with failure to rehabilitate disturbed areas and the IWL due to mismanagement include erosion, loss of soil nutrients, seedbank and potential weed growth. Mismanagement is defined as failure to follow the procedure in place to manage the removal of topsoil, stockpiles and the time between stripping and re-instating topsoils. The failure to rehabilitate the site may result in long term impacts if not rectified. The site would also not benefit from being returned to a more intact state due to the lack of rehabilitation following previous mining activity. However, due to the disturbed condition of the site, this has been taken into account and the magnitude of the impact to soil quality of rehabilitation failure is considered ***Medium***. The significance of residual impacts to soil quality from failed rehabilitation is therefore ***Low***. Potential impacts relating to the structural stability of the IWL are discussed in the Project Risk Register (Appendix 23).

7.1.4.4 Deterioration of Soil Quality due to the Dispersion of Arsenic and Heavy Metals

As described in Section 7.1.4.1 above, the sensitivity ranking of soil quality is ***Low*** The evaporator emissions study concluded that only a small portion of dissolved arsenic in ultra-fine water droplets would have the potential to be blown in the wind drift (approximately 27.7% of the total volume prior to the application of the suppression factor). The model concluded that an efficient operating scenario was possible, whereby droplets remain within a 500 m radius of the set up location, with an evaporator runtime of 89%. The remaining 11% of the time the evaporators will be shutoff due to unfavourable weather conditions which could cause plume drift further than 500 m. To ensure minimal drift is achieved, the evaporators will be shut off during unfavourable wind speeds (over 7.6 m/s), based on measured or forecast wind conditions. As a result, any dispersion of particulate matter would be highly localised to the Project site, and the soils within 500 m of the evaporator could be monitored and remediated. The magnitude of impacts from airborne arsenic and heavy metal particulate on soils have been assessed as ***Low***. The sensitivity of the Project soils is also categorised as ***Low***, and as such the residual impact significance for impacts from dispersion of arsenic and heavy metals is assessed as ***Negligible***.

7.1.4.5 Summary of Impact Assessment

A summary of the land and soil assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.2.

Table 7.2 – Land and Soils Residual Impact Assessment Summary

Project Phase	Environmental Value	Potential Impact	Activity/Aspect	Mitigation and Management Measures	Sensitivity/Magnitude	Residual Impact Significance
Construction	Soil quality	Reduction in flora establishment as a result of erosion and soil compaction	Clearing of vegetation, general vehicle movement, topsoil removal and stockpiling	• LS01 • LS02 • LS03 • LS04	Low/Low	Negligible
Construction, Operation, Closure	Soil quality	Contamination of soils by hazardous and non-hazardous materials	All activities involving the handling and use of hazardous and non-hazardous materials	• SW11 • LS06 • LS07 • LS08 • GW02 • GW03	Low/Low	Negligible
Closure	Soil quality	Rehabilitation failure as a result of loss of soil structure and seedbank in topsoil stored for rehabilitation	Topsoil stripping and stockpiling	• LS09 • LS10 • LS11 • LS12 • LS13 • LS14 • LS15	Low/Medium	Low
Operation	Soil quality	Deterioration of soil quality due to the dispersion of arsenic and heavy metal particulate matter	Emissions of arsenic from pit water	• AQ013	Low/Low	Negligible

7.1.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to soil quality are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

7.2 Air Quality and Greenhouse Gas

This section describes the potential and predicted residual impacts relating to air quality and greenhouse gas (GHG) emissions resulting from the Project, based on the Project activities described in Chapter 3. Although not specified as a key environmental value in the ToR, a conservative approach has been taken to ensure that ambient air quality is assessed within the EIS, and that potential impacts to sensitive receptors (i.e., nearby communities, residences or populations) as a result of impacts to air quality, are addressed. The Project ToR specifically requires the EIS to provide estimates of GHG emissions, and measures to maximise energy efficiency and avoid and/or reduce GHG emissions in line with the NT Government 2050 emissions target. As such, the impact assessment for GHG emissions as a result of the Project has also been addressed.

7.2.1 Discipline-specific Approach

7.2.1.1 Air Quality

Potential impacts to air quality and sensitive receptors within the Project area were assessed qualitatively in relation to particulate matter (PM), dust deposition and hydrogen cyanide (HCN) using an estimation of likely ground-level concentrations at sensitive receptors and comparison to the relevant air quality criteria (Table 7.3). Predicted ground-level concentrations for the Project were inferred using data from the Mount Todd Gold Mine Project, which was determined as similar in nature, location and meteorological conditions to the Project (Appendix 1). As predicted concentrations are inferred and not quantitatively modelled, a quantitive assessment of Project compliance cannot be undertaken. As such, the air quality impact assessment has taken a qualitative approach using the significance assessment approach provided in Chapter 6. The significance assessment approach, using the residual significance of an impact, which assumes the successful implementation of impact avoidance and mitigation measures, is determined through the assessment of the magnitude of the potential impact and the sensitivity of the environmental value, or sensitive receptor.

Qualitative Assessment of Dust, Particulate Matter and Hydrogen Cyanide

The air quality criteria used in the qualitative assessment include:

- National Environment Protection (Ambient Air Quality) Measure (Air NEPM).
- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW Approved Methods).
- Victoria Protocol for Environmental Management: Mining and Extractive Industries (Victoria PEM).

Likely concentrations of air pollutants from the Project were inferred using the Mount Todd Project's air quality assessment and dispersion modelling results. A dust emissions inventory was calculated for the construction phase of the Project, and the third year of operations, which is expected to have the highest level of dust emissions (Appendix 1). The dust emissions inventory was calculated using data from the Mount Todd Project, accounting for differences in activities between the projects (Appendix 1).

The majority of ground-level concentrations were estimated at the Grove Hill Hotel, the nearest sensitive receptor approximately 5.5 km east of the Project. The methodology and Project activity data used to determine estimates are provided in Appendix 1.

Potential impacts relating to potential emissions from dewatering activities, including the use of evaporators, is outside the scope of the air quality impact assessment. Potential impacts associated with dewatering are addressed in Section 7.1.

Air Quality Criteria

Relevant air quality criteria are provided in Table 7.3.

Table 7.3 – Project Ambient Air Quality Criteria

Pollutant	Averaging Period	Air Quality Criteria/Standard	Source
Total Suspended Particulates	1-year	90 µg/m^3	NSW Approved Methods
Particulate matter as PM_{10}	24-hour	50 µg/m^3	Air NEPM
	Annual	25 µg/m^3	Air NEPM
Particulate matter as $PM_{2.5}$	24-hour	25 µg/m^3	Air NEPM
	Annual	8 µg/m^3	Air NEPM
Deposited Dust (incremental)*	1-year	2 g/m^2/month	NSW Approved Methods
Hydrogen cyanide	1-year	9 µg/m^3	Victoria PEM

Source: Appendix 1.
* Incremental guideline in NSW Approved Methods applies to the dust deposition rate due to the Project only.

7.2.1.2 Greenhouse Gas

The GHG assessment estimated the annual energy use and GHG emissions associated with the Project, on the basis of Project activity information for the construction and operation phases. This included:

- Use of diesel-powered equipment/machinery/vehicles.
- Operation of diesel generators.
- Operation of the diesel power station for Project electricity supply.
- Electricity demand from the existing grid.
- Use of explosives with diesel content during blasting.

- Clearing of vegetation.

Estimated results were compared with existing emissions inventories for both Australia and the Northern Territory, and with GHG reporting thresholds under the *National Greenhouse and Energy Reporting (NGER) Act 2007* (*NGER Act*) framework. Thresholds under the NGER framework, referred to as the NGER Scheme, are provided in Table 7.4.

Table 7.4 – Project Greenhouse Gas and Energy Criteria

Threshold Level	Threshold Type		
	GHG ($ktCO_2$-e)	Energy Consumption (TJ)	Energy Production (TJ)
Facility	25	100	100
Corporate	50	200	200

Source: Appendix 1.

Estimated inventories were compiled for Scope 1 and Scope 2 emissions, as defined under the NGER Scheme as follows:

- Scope 1 emissions: in relation to a facility, is the release of GHG into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility.
- Scope 2 emissions: in relation to a facility, is the release of GHG into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility.

Although emissions from land use, land use change and forestry (LULUCF) associated with Project activity such as clearing are considered in the assessment, these do not have reporting thresholds under the NGER Scheme. GHG emissions associated with land clearing are Scope 1 emissions, and have been estimated based on the Full Carbon Accounting Model (FullCAM) developed by the Australian government (CoA, 2020). FullCAM estimations are based on a specific forest category, and for the purposes of this assessment the vegetation type to be cleared for the Project has been assumed to be eucalyptus woodland category (Appendix 1).

The main GHGs associated with the Project (see Section 4.3) were converted to carbon dioxide equivalent units (CO_2e-) in order to account for varying levels of each GHGs warming effectiveness and longevity, referred to as global warming potential. Specific methods, emissions factors, energy and carbon content factors used for estimating the annual energy use and emissions for the Project are provided in Appendix 1. Potential impacts relating to greenhouse gases were then qualitatively assessed using the significance assessment approach provided in Chapter 6.

7.2.2 Potential Impacts

This section presents the potential impacts to sensitive receptors as a result of deterioration to air quality or changes to GHG levels as a result of Project activities. Details of these Project activities

and their potential impacts to sensitive receptors, including the Grove Hill Hotel and the Ban Ban Springs Homestead, and a broader scale (in relation to GHG) are provided in Table 7.5.

Table 7.5 – Potential Impacts on Air Quality and Greenhouse Gases

Project Phase	Activity/Aspect	Project Component	Potential Impact
Construction, Operations	Dust and particulate matter emissions	Site preparation works, drilling and blasting of waste rock and ore; overburden excavation and handling; grading and dozing; excavation and handling of ore; loading and hauling of waste rock and ore; ore processing, including transfers, screening, and crushing; topsoil stockpiles	Deterioration in receiving air quality and adverse impacts to human health and amenity of area
Construction, Operations*	Carbon emissions through clearing and decay of natural material	Land clearing	Increased levels of greenhouse gases and changes to climate as a result of land clearing
Operations	Hydrogen cyanide (HCN) emissions	Operation of gold processing plant, storage and mixing; electrowinning; operation of carbon regeneration kiln	Deterioration in receiving air quality due to volatilisation of HCN resulting in adverse impacts to human health
Construction, Operations	Diesel fuel combustion	Operation of diesel generators; operation of machinery, equipment and vehicles with diesel fuel; use of explosives with diesel content for blasting; operation of diesel power station	Increased levels of greenhouse gases and changes to climate as a result of fuel combustion

* Clearing activity will occur in the construction phase, however carbon emissions relating to clearing will be slow releasing over the operations phase.

Potential impacts to native vegetation and fauna from dust emissions and dust deposition is covered in Section 7.7 (terrestrial ecology impact assessment).

7.2.2.1 Air Quality Potential Impacts

Key air pollutants that may be generated during both the construction and operations phases of the Project and that within the air quality impact assessment scope include:

- Total Suspended Particulates (TSP).
- Particulate matter, as PM_{10} and $PM_{2.5}$.
- Deposited dust (incremental).
- Hydrogen cyanide (HCN).

Estimated ground-level concentrations from the Project, in addition to background levels of ambient air, are presented in Table 7.6 for the key air pollutants with comparison to the relevant air quality criteria.

Table 7.6 – Estimated Ground-Level Concentrations Due to the Project

Pollutant	Averaging Period	Predicted Ground-Level Concentration at Grove Hill Hotel (µg/m^3)		Air Quality Criteria	Air Quality Standard
		Project	Project + Background*		
Total Suspended Particulates	1-year	0.8	46.8	90 µg/m^3	NSW Approved Methods
Particulate matter as PM_{10}	24-hour	4.9	35.8	50 µg/m^3	Air NEPM
	Annual	0.3#	23.3	25 µg/m^3	Air NEPM
Particulate matter as $PM_{2.5}$	24-hour	0.7	14.1	25 µg/m^3	Air NEPM
	Annual	0.05	9.8	8 µg/m^3	Air NEPM
Deposited Dust (incremental)	1-year	0.05 g/m^2/month	-	2 g/m^2/month	NSW Approved Methods
Hydrogen cyanide	1-year	0.34†	-	9 µg/m^3	Victoria PEM

* Background concentrations have been determined as the highest 75th percentile or annual average measurement from the monitoring data presented in Section 3.3.3.2 of Appendix 1, and the background for TSP has been taken to be twice the annual average PM_{10} background concentration.
# Calculated from the estimated annual average $PM_{2.5}$ concentration using the $PM_{2.5}/PM_{10}$ ratio of emission rates from the Project.
†Calculated from the estimated annual average TSP concentration and the HCN/TSP ratio of emission rates from the Project.

Particulate Matter and Dust Emissions

Dust and particulate matter emissions are expected to be the largest emissions produced by the Project (Appendix 1), and will be generated during both the construction and operations phases. Activities expected to generate the highest dust and particular matter emissions during construction are haulage of materials and grading, and wind erosion of exposed areas and stockpiles. During operations, activities expected to generate the highest dust emissions are material haulage, ore processing including transfers, screening, crushing and stacking, wind erosion of exposed areas and stockpiles, and overburden excavation and handling. Dust emissions are expected to be higher during operations than construction (Appendix 1).

The predicted ground-level concentration of PM_{10} (24-hour averaging period) is estimated as 35.8 µg/m^3, and is expected to comply with the Air NEPM criteria of 50 µg/m^3 at the nearest sensitive receptor, the Grove Hill Hotel residence located 5.5 km to the east. Ground-level concentrations of TSP, PM_{10} (annual averaging period) and deposited dust are predicted to comply with the relevant air quality criteria at the Grove Hill Hotel. (Appendix 1). The total predicted concentration of $PM_{2.5}$ (annual averaging period) from the Project, occurring at the Grove Hill Hotel (5.5 km from the Project), is 9.8 µg/m^3, and is therefore expected to exceed the relevant air quality criteria of 8 µg/m^3 (Table 7.6). However, the Project is estimated to only contribute 0.05 µg/m^3 (less than 1% of the total concentration) of that total 9.8 µg/m^3, with existing backgrounds levels already exceeding the criteria.

Predicted concentrations for dust are considered conservative, as estimates were inferred from the Mount Todd Project dispersion modelling which did not account for dust depletion from rainfall (Appendix 1). The emission and dispersal of dust and particulate matter will be influenced by local wind speeds and distributions, as well as rainfall patterns within the region. Existing meteorological data indicates that dust levels will be more likely to be moderated between November and March during periods of high rainfall.

Seasonal and diurnal wind variation will result in varied dust concentrations and distributions, with greater dilution of dust occurring during periods of stronger wind speeds, which are typically during the day. During the dry season, winds are predominantly from the southeast and will largely disperse dust away from the sensitive receptor closest to the Project which is the single residence at the Grove Hill Hotel located to the east. Dust emissions from exposed areas, such as stockpiles and waste rock stockpile areas, will be highest during strong winds, while dust emission rates from activities such as vehicle movements will be dependent on the activity rate (Appendix 1).

Hydrogen Cyanide

Emissions of HCN may occur as a result of the use of sodium cyanide (NaCN) in the CIP process, in which HCN may be emitted to air through volatilisation, and during the electrowinning process (Section 3.6.2.7) and operation of the carbon regeneration kiln (Section 3.6.2.6). Volatilisation is the vaporisation of a dissolved substance, and is enhanced by acidic conditions (Appendix 1). Volatilisation of HCN has the potential to occur in the CIP plant and ore processing area, and during storage and mixing. Predicted HCN emissions rates from the Project are based on estimated rates and calculations provided in the NPI Emission Factor Estimation Manual for Gold Ore Processing (DoEH, 2006), and are detailed in Appendix 1. As shown in Table 7.6, the Project's estimated ground-level concentration of HCN is 0.34 µg/m^3 for a 1-year averaging period, and is therefore expected to be below the relevant air quality criteria of 9 µg/m^3.

7.2.2.2 Greenhouse Gas Potential Impacts

The emissions of GHGs is a primary driver of climate change, and the Project will contribute to the annual GHG emissions inventories of both Australia and the Northern Territory (Appendix 1). Key GHG emissions that may be generated during both the construction and operations phases of the Project include:

- Carbon dioxide (CO_2).
- Methane (CH_4).
- Nitrous oxide (N_2O).

Emissions of GHGs from the Project will occur during construction and operations, from a combination of LULUCF activities, mining and ore processing activities (Table 7.5). Table 7.7 provides a summary of the Project's estimated annual energy consumption and production in gigajoules (GJ). The maximum annual energy consumption estimated (Year 1 of operations) has been estimated at 488,691 GJ. Table 7.8 provides the Project's estimated annual GHG emissions in tonnes of CO_2-e (tCO_2-e).

Table 7.7 – Annual Energy Use for the Project (GJ)

Emission Sources	Construction	Operations			
	Year 0	Year 1	Year 2	Year 3	Year 4
Diesel use - Equipment/machinery/vehicles	96,500	192,547	192,547	192,547	12,665
Diesel use - diesel generators/power station	423	289,106	289,106	289,106	189,851
Explosives (diesel content)	0	7,038	6,836	6,420	655
Annual Energy Use	96,923	488,691	488,489	488,073	203,171

Source. Appendix 1.

Table 7.8 – Project Estimated Annual GHG Emissions (tCO_2-e)

Emission Sources	Construction	Operations			
	Year 0	Year 1	Year 2	Year 3	Year 4
Diesel use - equipment/machinery/vehicles	6,794	13,555	13,555	13,555	892
Diesel generators/power station	30	20,353	20,353	20,353	13,365
Explosives (diesel content)	-	495	481	452	46
Land clearing*	3,979	3,979	3,979	3,979	3,979
Annual GHG emissions	10,803	38,383	38,369	38,340	18,282
Annual GHG emissions (excluding LULUCF)	6,823	34,404	34,390	34,360	14,303

Source: Appendix 1.
Note. All emissions are Scope 1 emissions.
*As detailed in Section 4.3.1, whilst land clearing occurs during the construction period, emissions of GHG occur progressively over subsequent years. Emissions have been distributed equally over each year of the project life.

Maximum annual GHG emissions during construction are influenced by the inclusion or exclusion of LULUCF emissions. Maximum annual emissions associated with the Project are estimated as:

- Construction: 10,803 tCO_2-e, including LULUCF.
- Operations: 38,383 tCO_2-e for Year 1, including LULUCF (Year 1 of operations).

Estimated GHG emissions during construction excluding LULUCF is 6,823 tCO^2-e. The total contribution of each emissions source (Table 7.8) across construction and operations are as follows:

- Diesel equipment and vehicles: 33.6%.
- Electricity supply: 51.6%.
- Explosives: 1%.

- Land clearing: 13.8%.

As shown in Table 7.9, the maximum annual emissions of the Project, including LULUCF, will contribute approximately 0.01% of the total national inventory of GHG emissions (as reported in 2018) and 0.24% of the total Northern Territory inventory (2018). Excluding LULUCF, the Project will contribute approximately 0.01% of the total Australian inventory (2018) and 0.33% of the Northern Territory inventory (2018).

The Project's estimated emissions, excluding LULUCF as this is not covered under the NGER Scheme, do not meet or exceed the GHG facility or corporate thresholds of the NGER Scheme (see Table 7.4). However, the maximum annual energy use of 488,691 GJ exceeds both the facility and corporate NGER Scheme energy consumption thresholds (100,000 GJ and 200,000 GJ respectively). As such, the Project's energy use will require reporting under the NGER Scheme.

Table 7.9 – Project Contribution to Annual GHG Emissions 2018

Category	Australia		Northern Territory	
	Emissions ($MtCO_2$-e)*	Project (%)	Emissions ($MtCO_2$-e)	Project (%)
Including LULUCF	537.4	0.01%	16.0	0.24%
Excluding LULUCF	558.0	0.01%	10.5	0.33%

Source. Appendix 1.
*State and Territory Greenhouse Gas Inventories May 2020 (CoA, 2020), Emissions time series data.xlsx.

Climate change as a result of increasing GHG levels is an environmental issue of significant global concern, with potential impacts including increased risk of drought, flooding and fire, increased risk of natural hazards, changes in ecosystem processes including vegetation and species assembly, and increased illness from vector-borne diseases and heat stress. While this Project is not expected to have any observable impact on global climate change or to communities and ecosystems as a result of climate change, the Project's emissions will contribute to the Northern Territory's, Australia's, and global anthropogenic GHG emissions. As such, Project emissions may affect the Australian government's ability to comply with its commitments under the United Nations Framework Convention on Climate Change (UNFCCC), including the Kyoto Protocol and Paris Agreement, and the Northern Territory government's ability to achieve its objectives under the draft '2019 – Climate Change Response: Towards 2050'.

7.2.3 Mitigation and Management Measures

This section presents the proposed mitigation and management measures to reduce the potential impacts to ambient air quality, greenhouse gas levels, and nearby sensitive receptors. Mitigation measures presented for managing potential impacts from arsenic emissions, excluding the monitoring programs, have been identified for investigation in the event monitoring indicates further mitigation may be required.

7.2.3.1 Deterioration in Receiving Air Quality due to Dust

- Sustainable use of water for supressing dust on haul roads, topsoil, ore and overburden stockpiles, crushing areas and active mining areas (AQ001).
- Sustainable use of water for supressing dust on crusher hoppers, transfer chutes and drops (AQ028).
- Sustainable use of water for to maintain moisture of tailings within the IWL (AQ027).
- Progressive rehabilitation of the waste rock storage (AQ002).
- Progressive rehabilitation of production areas as mining and operations cease (AQ003).
- Implement speed limits to minimise dust creation (AQ004).
- Use of water spray on screening and crushing (AQ005).
- Minimise area of clearing as far as practicable (AQ008).
- Minimise areas exposed to wind erosion (AQ009).
- Crushing to predominantly occur during the day shift (AQ025).

7.2.3.2 Deterioration in Receiving Air Quality due to Volatilisation of HCN

- Leaching solution to be dosed with lime to maintain a pH of 10, to minimise volatilisation of HCN (AQ011).

7.2.3.3 Increased Levels of Greenhouse Gases and Changes to Climate as a Result of Land Clearing

- Taking an approach of continuous improvement, implemented through ongoing monitoring, reporting GHG emissions and identifying opportunities to reduce emissions (AQ015).
- Minimise area of clearing as far as practicable (AQ008).
- Progressive rehabilitation of the waste rock storage (AQ002).
- Progressive rehabilitation of production areas as mining and operations cease (AQ003).

7.2.3.4 Increased Levels of Greenhouse Gases and Changes to Climate, as a Result of Fuel Combustion

- Compliance with emissions and energy use reporting obligations, as required under the NGER Scheme (AQ016).
- Utilisation of best practice technologies in the mining and minerals processing operations to ensure that energy efficiency and associated GHG emissions are optimised (AQ017).
- Taking an approach of continuous improvement, implemented through ongoing monitoring, reporting GHG emissions and identifying opportunities to reduce emissions (AQ015).

- Using low energy lighting (e.g., LED lighting systems), where practicable (AQ018).
- Reduce mining equipment diesel consumption through equipment selection, load optimisation, route optimisation and production scheduling and reduced idle time (AQ019).
- Maintain and operate equipment based on manufacturer/supplier guidelines and recommendations (AQ020).
- Reduce generator diesel consumption through selecting a flexible configuration that allows for electricity output to be adjusted in line with demand (AQ021).
- Scheduling of production to ensure energy efficient operations of processing equipment (AQ023).
- Adjusting peak demand through production scheduling to allow for optimal use of electricity (AQ024).

7.2.4 Residual Impact Assessment

7.2.4.1 Residual Air Quality Impacts

Particulate Matter and Dust

The construction and operations phases of the Project are expected to result in the generation of dust and particulate matter in the form of TSP, PM_{10}, $PM_{2.5}$, and dust deposition. Emissions of PM_{10} (24-hour averaging period) will increase existing levels by approximately 15% however will still remain below air quality criteria of Air NEPM (see Table 7.6). All dust and particulate matter concentrations are expected to comply with the relevant air quality criteria at the nearest sensitive receptor, the Grove Hill Hotel, with the exception of $PM_{2.5}$ (annual averaging period). However, existing background levels of $PM_{2.5}$ (annual averaging period) already exceeds the criteria value, and the Project will contribute less than 1% of the predicted total $PM_{2.5}$ (annual averaging period) emissions (0.05 µg/m^3 of the total 9.8 µg/m^3). The nearest sensitive receptor, the single residence at the former Grove Hill Hotel, is southeast of the Project, and therefore upwind of the mine during most of the dry season, when dust is less likely to be depleted as a result of rainfall. Mitigation measures such as dust suppression will also minimise the generation of dust.

The magnitude of the impact is considered to be ***Low***, with impacts expected to be short term or temporary due to dust dispersion or depletion, the severity of change for pollutants for the most part barely detectable or below air quality criteria, and the geographical extent restricted to less than 5.5 km from the Project. The sensitivity of the three nearest sensitive receptors, i.e., the single residence at the Grove Hill Hotel (5.5 km east of the Project), the Hayes Creek Wayside Inn Caravan Park (which is now closed) and the Ban Ban Springs homestead, all of which have very few people that inhabit or utilise these sites, is assessed as ***Low***, and change is not expected to result in further degradation of these locations. As such, the sensitivity of these sensitive receptors is considered to be ***Low***. The residual impact significance of dust and particulate matter to human receptors and amenity is therefore considered to be ***Negligible***.

Hydrogen Cyanide

Emission of HCN as result of volatilisation during operations may occur, with the predicted ground-level 5.5 of the Project is 0.34 µg/m^3, below the air quality criteria of 9 µg/m^3. The application of lime will help reduce acidity in the leaching process and therefore the potential for volatilisation. The magnitude of the impacts from HCN emissions is considered to be ***Negligible***, as the severity of change is barely detectable with respect to natural variability, and complies with air quality criteria within 5.5 km of the Project. Impacts will mostly likely be temporary or short term and limited to occurring during periods of high winds directed towards sensitive receptors. As above, the sensitivity of the nearest sensitive receptors is considered to be ***Low***, and the impact magnitude of HCN emissions to air are considered to be ***Negligible***, the residual significance assessment is considered to be ***Negligible***.

Greenhouse Gases

For the purposes of this assessment, the sensitivity of existing greenhouse gases and the global climate has been characterised as ***High*** due to the international concern regarding GHGs and global climate change, and Australia's international commitments under the UNFCCC, and the importance of global climate to communities in the Northern Territory, Australia and internationally. The geographical extent of climate change impacts from increases in GHGs as a result of both diesel fuel combustion (including for operation of the power station) and LULUCF can be considered widespread given climate change occurs at a global scale. GHG emissions from LULUCF will be of a short duration (i.e., temporary during construction phase). Emission from fuel combustion will occur throughout the lifetime of the Project (including ten months construction and 3.5 years of operational mine life). However, the severity of change to global climate as a result of the Project emissions is unlikely to be detectable, given the very low contribution of the Project's estimated maximum annual emissions the Project to the overall annual GHG emissions of Australia (0.01%) and the Northern Territory (0.33%). Additionally, the Project's contribution to global GHG emissions, is also unlikely to be detectable. As such, the magnitude of the impact from GHG emissions of the Project is assessed as ***Negligible***. As the magnitude of the impacts are considered to be ***Negligible***, and the sensitivity of the values are considered to be ***High***, the overall residual impact significance for the Project's potential impacts to global climate change from LULUCF and fuel combustion are both assessed as ***Negligible***.

7.2.4.2 Summary of Impact Assessment

A summary of the air quality and GHG assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.10.

7.2.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to air quality and greenhouse gas are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

Table 7.10 – Air Quality and Greenhouse Gas Residual Impact Assessment Summary

Project Phase	Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Sensitivity/ Magnitude	Residual Impact
Construction, Operation	Local communities and residences	Deterioration in receiving air quality and adverse impacts to human health and amenity of area	Emissions of dust and particulate matter	• AQ001 • AQ002 • AQ003 • AQ004 • AQ005 • AQ008 • AQ009 • AQ025 • AQ027 • AQ028	Low/Low	Negligible
Operation	Local communities and residences	Deterioration in receiving air quality due to volatilisation of HCN resulting in adverse impacts to human health	Hydrogen cyanide (HCN) emissions	• AQ011	Low/Negligible	Negligible
Construction	Greenhouse gas levels and climate	Increased levels of greenhouse gases and changes to climate as a result of land clearing	Carbon emissions through clearing and decay of natural material	• AQ015 • AQ008 • AQ002 • AQ003	High/Negligible	Negligible
Construction, Operation	Greenhouse gas levels and climate	Increased levels of greenhouse gases and changes to climate as a result of fuel combustion	Diesel fuel combustion	• AQ016 • AQ017 • AQ015 • AQ018 • AQ019 • AQ020 • AQ021 • AQ023 • AQ024	High/Negligible	Negligible

7.3 Noise and Vibration

This section describes potential noise and vibration related impacts to sensitive receptors from Project activities, as described in Chapter 3. The acoustic environment was not identified as a key environmental factor by the NT EPA but was considered for assessment due to the potential for noise from Project activity to impact the nearest sensitive receptor located approximately 5.5 km from the Project area and the potential impact of vibration on the Bonaparte Gas Pipeline (BGP) easement which runs through the Project area.

7.3.1 Discipline-specific Approach

The assessment of noise-related impacts was undertaken using the compliance assessment method (described in Section 6.2.6). This method was chosen as ambient noise data was collected and modelling undertaken which could assess predicted impacts on ambient quality by comparing the quantitative data with the following guidelines:

- Northern Territory Noise Management Framework Guideline (NT Noise Management Framework Guideline) (NT EPA, 2018).
- Australian and New Zealand Environmental Conservation Council “Technical Basis for Guidelines to Minimise annoyance due to Blasting Overpressure and Ground Vibration” (ANZECC Guidelines) (ANZECC, 1990).
- Australian Pipeline Association (APA) guidelines “Standard conditions for work near APA Gas Transmission Pipelines” (APA Guidelines) (APA, 2019).

This impact assessment is also guided by the noise assessment (Appendix 2).

This noise environment within and surrounding the Project area is indicative of an area with very low levels of traffic noise and noise dominated by insects at night. The Grove Hill Hotel was identified as the closest sensitive receptor (approximately 5.5 km east) of the Project area, along Mount Wells Road. All other sensitive receptors are a significant distance from the Project area (> 8 km). Therefore, if the predicted noise levels at the Grove Hill Hotel are compliant with guideline criteria, then noise levels at other identified sensitive receptors will also be compliant.

Consideration has also been given to the potential impact of vibrations on the high-pressure BGp. which at its closest point is, 370 m from the pit crest to the east and 480 m in the south.

7.3.2 Potential Impacts

This section presents the potential impacts on the existing acoustic environment as a result of Project activities. Details of these Project activities and their potential impacts to sensitive receptors are provided in Table 7.11.

Table 7.11 – Potential Impacts on Acoustic Environment

Project Phase*	Aspects/Activities	Project Component	Potential Impact
		Construction of crushing facilities, CIL/CIP plant, diesel power station,	Increase in noise levels with adverse impacts on

Construction, Operation	Noise emissions from the operation of: • Vehicles (including reversing alarms) • Machinery (e.g. drills, loaders, haul trucks, excavators) • Pit expansion • Process plant operations	laydown areas, access roads and infrastructure, drilling of waste rock and ore, operation of machinery, equipment and vehicles, overburden excavation and handling, grading and dozing, use of evaporators to dewater existing pit, operation of hand tools, spinning of concrete mixers at a high speed	human health and amenity
		• Blasting	Air blast overpressure causing annoyance and/or discomfort to persons at sensitive receptors
			Ground vibrations causing annoyance and/or discomfort to persons at sensitive receptors
			Ground vibrations damaging the integrity of the buried BGP Pipeline

* Impacts from noise have been assessed for the worst-case scenario (including construction and operation), and the potential impacts have been identified as such, combining impacts for all activities for construction and operation.

Potential impacts to wildlife by noise and vibration is addressed in Section 7.7.

7.3.2.1 Noise Levels

Project noise levels were modelled using information provided in the Notice of Intent (NOI) (ERIAS, 2019) and in recent Project updates on the planned activities. Noise modelling for the Project was undertaken using a conservative, worst-case scenario approach (i.e. highest noise level conditions using all noise sources operating simultaneously and background ambient noise). The Project noise levels were assessed using the relevant criterion (Appendix 2). The results are summarised in Table 7.12.

Table 7.12 – Project Modelled Noise Levels and Relevant Criteria

Project Activity		Criteria	Source of Criteria	Modelled Noise Level*
Operational Noise	Day	40 dB(A)	NT Noise Management Framework Guideline	31 dB(A)
	Evening	40 dB(A)	NT Noise Management Framework Guideline	31 dB(A)
	Night	35 dB(A)	NT Noise Management Framework Guideline	31 dB(A)
Construction Noise	Standard Hours	45 dB(A)	NT Noise Management Framework Guideline	31 dB(A)
	Outside Standard Hours	37 dB(A)	NT Noise Management Framework Guideline	31 dB(A)

Day – Between 7 am and 6 pm (Monday to Saturday), 8am and 6pm (Sunday and public holidays).
Evening – Between 6 pm and 10 pm (all days).
Night – Between 10 pm and 8 am (if the following day is a Sunday or public holiday), 10 pm and 7 am (all other days).
Standard Hours – Between 7 am and 7 pm (Monday to Saturday), 9 am and 6 pm Sundays and public holidays.
Outside Standard Hours – Any time that isn't part of the 'Standard hours'
* – Noise levels at the sensitive receptor (the Grove Hill Hotel)

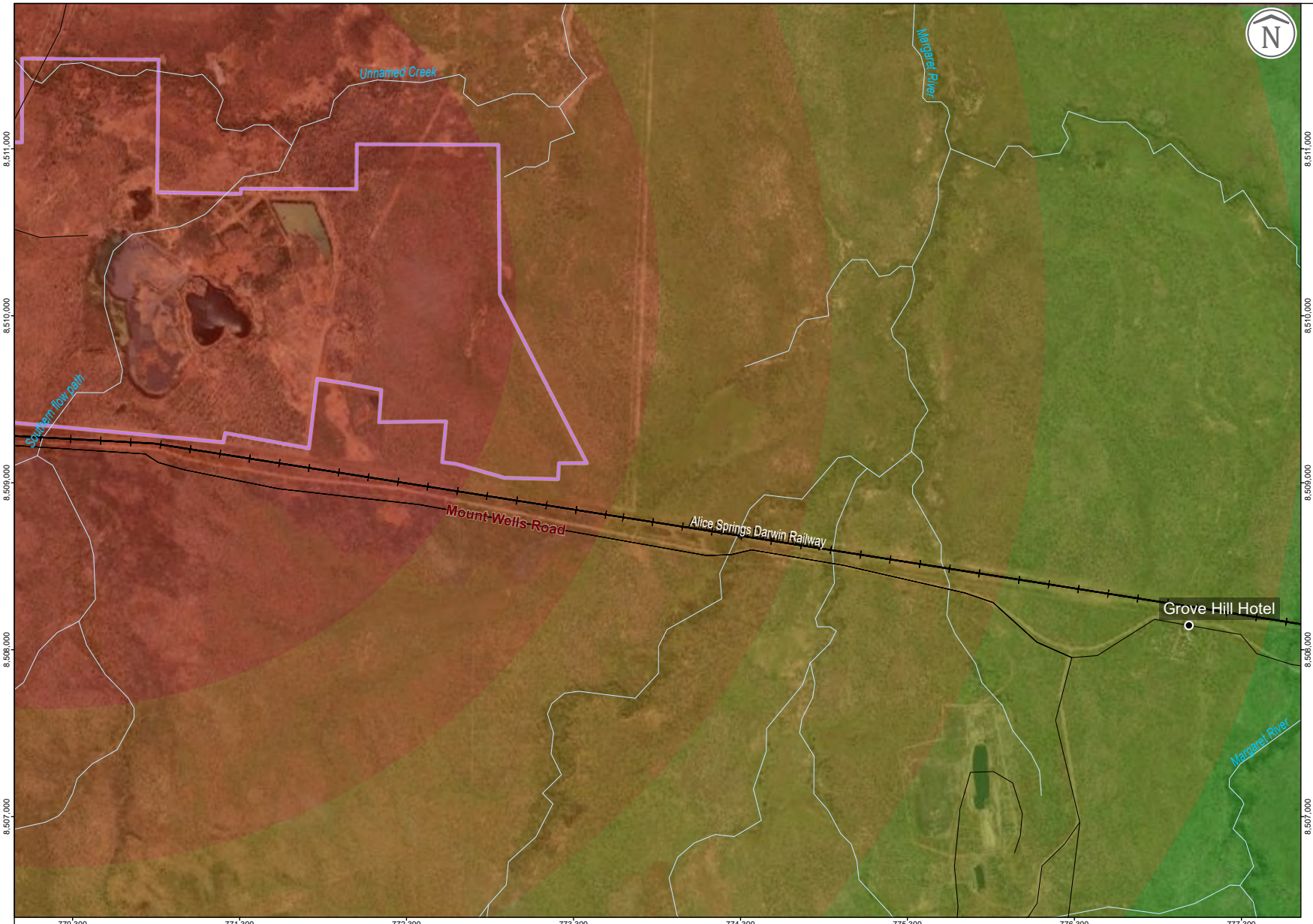
The criterion's purpose is to ensure that the closest sensitive receptors won't experience adverse impacts from Project noise emissions. The modelled worst-case scenario (including construction and operation activities) noise level is estimated as 31 dB(A) at the sensitive noise receptor (the Grove Hill Hotel). The most onerous criterion is 35 dB(A) at nighttime and as the predicted level is below this criterion, the Guidelines will be achieved during operation and construction at all time periods. The modelling indicates that noise from Project activities is highly unlikely to have adverse impacts to human health or amenity at the sensitive receptors (Figure 7.1).

Predicted noise levels are considered the worst-case scenario, with the inclusion of all noise sources operating simultaneously, ambient noise and background conditions considered (e.g. wind, humidity) favouring the spread of noise pollution. As it is unlikely that all noise sources will be operating at the same time, noise levels should be expected to be lower than 31 dB(A). Similarly, seasonality and general weather variation experienced in the region that will result in the "worst-case scenarios" for background conditions are highly unlikely, which will decrease the intensity of Project noise in the surrounding areas.

NOISE CONTOURS

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 7.1



- Populated place
- Road
- Railway
- Watercourse
- Project area

Noise level Ldn in dB(A)

- > 50
- > 45 & ≤ 50
- > 40 & ≤ 45
- > 35 & ≤ 40
- > 30 & ≤ 35
- ≤ 30

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS010_v0-b

Figure Number: 01238D_EIS_F07.1_GIS_v0-b

ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

7.3.2.2 Blasting

Modelling was conducted to predict the impacts from blasting activities to sensitive receptors. Similar to the predicted Project noise levels, a conservative approach was taken with model assumptions. The Grove Hill Hotel and the buried pipework from the BGP Pipeline were considered as sensitive receptors and the modelling results, along with the relevant criterion, are listed in Table 7.13. All air blast overpressure and ground vibrations expected are compliant with the ANZECC Guidelines in relation to air blast overpressure and APA Guidelines for potential impacts to the BGP (Appendix 2).

Table 7.13 – Project Modelled Air blast Overpressure and Ground Vibrations and Relevant Criteria

Project Activity		Criteria	Source of Criteria	Modelled Noise Level
Blasting Impact on Sensitive Receptor (Grove Hill Hotel)	Air blast Overpressure	115 dB	ANZECC Guidelines	< 90 dB
	Ground Vibration (ppv)	5 mm/sec	ANZECC Guidelines	< 0.1 mm/sec
Blasting Impact on APA buried BGP Pipeline	Ground Vibration (ppv)	20 mm/sec	APA Guidelines	~ 3 mm/sec

Air blast Overpressure

The ANZECC Guideline criterion is intended to protect the sensitive receptors from adverse impacts (i.e., unnecessary annoyance and/or discomfort). The predicted, “worst-case scenario” for air blast overpressure from blasting at the Grove Hill Hotel is less than 90 dB, less than the ANZECC criteria of 115 dB. This indicates that it’s highly unlikely that air blast overpressure will cause any unnecessary annoyance and/or discomfort.

Ground Vibration

Similar to the predicted impact of air blast overpressure on the Grove Hill Hotel, ground vibrations is also seen as unlikely to cause unnecessary annoyance and/or discomfort. The model predicted a worst-case scenario of less than 0.1 mm/sec, well below the ANZECC criteria of 5 mm/sec. The impact ground vibrations may have on the buried APA BGP pipeline (370 m from the pit crest to the east and 480 m in the south) is different in that it relates to direct impact rather than amenity. For this reason it is assessed under the APA Guidelines. The predicted ground vibrations at the pipework is approximately 3 mm/sec, well below the APA Guideline criteria of 20 mm/sec. Ground vibrations are unlikely to have an adverse impact on either sensitive receptor.

7.3.3 Mitigation and Management Measures

This section presents the proposed management measures to reduce the potential impacts of Project noise on nearby sensitive receptors.

7.3.3.1 Noise Levels

Mitigation measures that will be implemented to reduce noise levels during the construction phase will include:

- All reasonable and practicable measures will be taken to reduce noise during construction and any activities that cannot be attenuated sufficiently are to be conducted during standard hours only (NO02).
- If complaints are received, monitoring at sensitive receptors (i.e. the Grove Hill Hotel) will be done to ensure noise levels do not exceed the background noise levels by more than 10 dB during standard hours, and no more than 5 dB at all other times (NO03).

Mitigation measures that will be implemented to reduce noise levels during the operation phase will include:

- All reasonable and practicable measures will be taken to reduce noise during operations and any activities that cannot be attenuated sufficiently are to be conducted during standard hours only (NO04).
- If complaints are received, monitoring at the closest sensitive receptor (i.e., the Grove Hill Hotel) will be undertaken to ensure operation noise levels do not exceed 40 dB during the day, 40 dB during the evening and 35 dB at night. Slight exceedances of these values will be acceptable when weather conditions are conducive. Day is between 7 am and 6 pm (Monday to Saturday), 8 am and 6 pm (Sunday and public holidays). Evening is between 6pm and 10pm (all days). Night is between 10 pm and 8 am (if the following day is a Sunday or public holiday), 10 pm and 7 am (all other days) (NO05).

7.3.3.2 Blasting

Air blast Overpressure

Mitigation measure that will be implemented to reduce air blast overpressure from blasting activities will include:

- Blasting activities will be restricted to daylight hours only, all days of the week (NO13).
- A site based trained blasting professional will design each blast (NO07).
- If complaints are received, blasting professional will revaluate blast design and check air blast overpressure levels do not exceed 115 dB (Lin, Peak) for more than 5% of the total number of blasts over a period of 12 months at sensitive receptors (i.e., the Grove Hill Hotel) (NO14).
- If complaints are received, blasting professional will revaluate blast design and check air blast overpressure levels do not exceed 120 dB (Lin, Peak) at any time at sensitive receptors (i.e., the Grove Hill Hotel) (NO15).

Ground Vibration

Mitigation measure that will be implemented to reduce ground vibration from blasting activities will include:

- Blasting activities will be restricted to daylight hours only, all days of the week (NO13).
- A site based trained blasting professional will design each blast (NO07).
- If complaints are received, blasting professional will revaluate blast design and check ground vibrations do not exceed 5 mm/sec (ppv) for more than 5% of the total number of blasts over a period of 12 months at sensitive receptors (i.e. the Grove Hill Hotel) (NO16).
- If complaints are received, blasting professional will revaluate blast design and check ground vibrations do not exceed 10 mm/sec at any time at sensitive receptors (i.e. the Grove Hill Hotel) (NO17).
- Blasting professional to ensure ground vibration will not exceed 20 mm/sec at any time at the BGP (NO12).

7.3.4 Residual Impacts

Both the construction and operations phases of the Project are expected to result in the generation of noise and vibrations. Project activities will result in an increase in noise levels at and around the Project area, however, will comply with the relevant criteria 5.5 km from the Project (see Table 7.14). The predicted levels of air blast overpressure and ground vibration will also comply with the relevant criteria at the sensitive receptors (see Table 7.14).

Table 7.14 – Summary of Project Modelled Noise and Vibration Levels and Relevant Criteria

Project Activity		Criteria	Modelled Noise Level
Operational Noise	Day	40 dB(A)	31 dB(A)*
	Evening	40 dB(A)	31 dB(A)*
	Night	35 dB(A)	31 dB(A)*
Construction Noise	Standard Hours	45 dB(A)	31 dB(A)*
	Outside Standard Hours	37 dB(A)	31 dB(A)*
Blasting Impact on Sensitive Receptor (i.e., the Grove Hill Hotel)	Air blast Overpressure	115 dB	<90 dB*
	Ground Vibration (ppv)	5 mm/sec	<0.1 mm/sec*
Blasting Impact on APA BGP Buried gas pipeline	Ground Vibration (ppv)	20 mm/sec	~3 mm/sec

Day – Between 7 am and 6 pm (Monday to Saturday), 8am and 6pm (Sunday and public holidays).
Evening – Between 6 pm and 10 pm (all days).
Night – Between 10 pm and 8 am (if the following day is a Sunday or public holiday), 10 pm and 7 am (all other days).
Standard Hours – Between 7 am and 7 pm (Monday to Saturday), 9 am and 6 pm Sundays and public holidays.
Outside Standard Hours – Any time that isn't part of the 'Standard hours'
* – Levels expected at the sensitive receptor (the Grove Hill Hotel)

It should be noted that the modelling process for noise emissions, air blast overpressure and ground vibrations were all conducted using the most conservative, "worst-case" scenario

approach, as discussed earlier in Section 7.3.2. The likelihood of the “worst-case” scenarios predicted in the modelling process eventuating is unlikely, indicating that noise emission levels are likely to be less than those presented in Table 7.14.

Additionally, all modelling was completed under the assumption that there were no mitigation or management measures in-place. With the implementation of mitigation and management measures listed above the noise and vibration levels are more likely to comply with the relevant criteria.

The impact assessment of the acoustic environment was conducted using the compliance assessment method, and therefore no further assessment is required, as compliance has been met for all noise emission criteria. Further assessment of the residual impacts from noise emissions using the impact significance method is not required.

7.3.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to noise and vibration are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

7.4 Hydrological Processes

7.4.1 Discipline-specific Approach

The significance assessment method described in Chapter 6 was adopted to qualitatively assess impacts relevant to the environmental factor of hydrological processes. This considers the sensitivity of the resource/receptor and magnitude of impact on that resource/receptor.

The sensitivity of hydrological processes is considered with regard to the NT EPA objective of maintaining the hydrological regimes of surface water and groundwater so that environmental values are protected.

The surface water hydrology of the Project area and downstream waterways is described in Section 4.5.1. All flow paths at the Project site are ephemeral and experience surface runoff only after rainfall events in the catchment primarily during wet seasons. Surface runoff discharges are highly variable, and most flow paths are likely to dry out during dry seasons when rainfall is low, although some pools hold water for extended periods.

Fountain Head Lake has formed due to the construction of a causeway for a haul road for previous mine operations (see Figure 3.3). Water within the lake is mostly from surface flows captured from rainfall events; however, surface expressions of groundwater may also occur since water remains in the lake during dry periods (Appendix 3). Fountain Head Lake overflows and discharges over the causeway to the north of the site every year during the wet season, flowing along a drainage line to an unnamed creek to the south (see Figure 4.10). This creek flows to the Margaret River approximately 7 km downstream.

The sensitivity of surface water in the Project area with regard to hydrological processes is categorised as ***Low***, considering the location high in the upper catchment where surface runoff only occurs intermittently after rainfall events. Such hydrological regimes are not rare or unique, and numerous representative examples exist throughout the Adelaide River basin. Additionally,

modification of the natural regime has occurred from previous mining operations by the installation of a causeway, forming Fountain Head Lake.

The sensitivity of groundwater in the Project area with regard to hydrological processes is also categorised as ***Low***. This categorisation is based on there being no groundwater dependent ecosystems (such as monsoon vine forest habitat) in the area of the mine, high levels of arsenic and iron make it unsuitable for use as human drinking water and groundwater also has been subject to considerable variation in levels and influences from previous mining activities. Notwithstanding that a bore located adjacent the mine lease boundary is periodically used by Ban Ban Springs Station (see Section 4.6.2), groundwater availability is quite extensive in the broader region.

7.4.2 Potential Impacts

This section describes the potential impacts to hydrological processes due to the Project that have been considered in the impact assessment. These potential impacts are summarised in Table 7.15 and described in more detail in the following sections.

Table 7.15 – Summary of Potential Impacts on Hydrological Processes

Project Phase	Activity/Aspect	Project Component	Potential Impact
Operations and Closure	Project infrastructure footprint	Process plant; ROM pad, mining contractors yard, access roads; evaporation pond; IWL	Altered surface water hydrological regime
Construction, Operations and Closure	Pit dewatering	Open pit	Groundwater drawdown
Construction, Operations and Closure	Evaporation pond seepage	Evaporation pond	Groundwater mounding

As described in Section 3.7.2, water produced from pit dewatering will be pumped to the evaporation pond for evaporation. The pond has been designed to contain water from extreme rainfall events, with operational limits set on pond water levels and cessation of in-pit pumping to prevent overflow from the pond. No impacts on the surface water hydrological regime are therefore expected to occur due to pit dewatering, and this issue is not further considered in the impact assessment.

The non-potable water supply for the Project will be sourced from the Fountain Head pit or evaporation pond (Section 3.7.2). Potable water supply will be trucked to site and stored in sealed water tanks. No other surface water will be used by the Project hence no hydrological impacts are expected due to Project water demand, and this issue is not further considered in the impact assessment.

7.4.2.1 Altered Surface Water Hydrological Regime

Project Infrastructure

Hydrological processes may potentially be impacted by Project infrastructure due to alteration of the natural surface drainage regime, including flow direction, volume, velocity (and associated increased scour potential) and altered flood patterns caused by:

- Changes in topography (i.e., cut and fill).
- Construction of infrastructure and spoil disposal sites in drainage depressions, floodplains and waterways.
- Installation of stream diversions, surface runoff diversion drains and sediment dams.
- Decreased vegetation and increased impervious surfaces.

These hydrological impacts are expected to continue post-closure since the infrastructure footprint will remain in place.

Assessment of flooding potential has been undertaken to investigate the probability and extent of flooding, to develop mitigation options to manage water and avoid environmental impact, as described in Section 3.7.2 and Appendix 4. These mitigations are incorporated into design features of the Project and include:

- Constructing the core yard and western soil stockpile on raised pads (Figure 4.12) above the 1% AEP peak flood levels with appropriate freeboard or using flood protection structures such as bunds (HED01).
- Constructing a diversion channel along the western side of the existing waste rock storage to reinstate the natural flow path and divert the natural catchment runoff into the existing Fountain Head Lake (Figure 3.15). A diversion is also proposed along the northern side of the evaporation pond as the proposed pond extension is located on the existing flow path connecting Fountain Head Lake to the unnamed creek (HED02).
- Diverting natural catchment runoff from upgradient of the processing area to flow to the unnamed creek (HED03).
- Installing culverts under the haul road to provide direct drainage from the lake and to reduce the frequency of flooding of the haul road (HED04).

7.4.2.2 Groundwater Levels

Groundwater Drawdown Due to Pit Dewatering

Pit dewatering prior to and during mining will cause a drawdown of groundwater levels around the pit, potentially reducing availability for any groundwater users or impact on other environmental values of groundwater, such as the maintenance of groundwater dependent ecosystems. Groundwater drawdown will commence during the construction phase and be greatest during mining but will also persist for a period post-closure until the pit refills and groundwater levels reach an equilibrium.

Groundwater Mounding Due to Seepage from Evaporation Pond

Water produced from pit dewatering will be pumped to the evaporation pond for forced and natural evaporation (see Section 3.7.2). With the filling of the evaporation pond, groundwater infiltration (seepage) will progressively increase as the wetted area and the water level in the pond increase. Depending on the rate of seepage, this may raise the water table in the vicinity of the pond causing waterlogging of soils and surface expression of groundwater.

7.4.3 Mitigation and Management Measures

The measures to mitigate impacts on surface water hydrological regimes are embedded in the Project design, as described in Section 7.4.2.1. No additional mitigation and management measures are proposed.

7.4.4 Residual Impacts

This section describes the outcomes of the residual impact assessment, assuming the successful implementation of proposed mitigation and management measures.

7.4.4.1 Altered Hydrological Regime Due to Project Infrastructure

Given the installation of surface flow diversions, no significant change is expected in the volume of water reporting to surface waters downstream of Project infrastructure, and the hydrological regime of the unnamed creek and Margaret River is expected to be unaltered.

Modelling has been undertaken to assess the impact of Project infrastructure on flooding (Appendix 4). As shown in Figure 7.2 for a 1% annual exceedance probability (AEP) event, the modelling[12] predicts there to be up to a 0.1 m increase in the water level of Fountain Head Lake compared to existing conditions. No increase in flood level is expected to occur along the existing railway line to the south of the site. The modelling shows that, under existing conditions (and with no culverts in the causeway), Fountain Head Lake overflows and discharges over the causeway to the north of the lake every year during the wet season. Flood water levels downstream of Fountain Head Lake, west of the evaporation pond, are predicted to increase by up to 0.9 m during a 1% AEP (without culverts in the causeway). This is due to the proposed extension to the evaporation pond (which is located on the existing flow path) restricting the flow conveyance. Only very minor flood impacts are expected north of the evaporation pond compared to existing conditions, increasing up to 0.05 m.

Flow velocities are predicted to increase along the western toe of the IWL and north of the evaporation pond where erosion control measures are proposed to be installed to provide protection from scouring. Similar protection would also be installed as required at any other susceptible locations such as bends and outlets of diversion channels.

The magnitude of impact of Project infrastructure on the hydrological regime during operations is therefore categorised to be ***Low***, since the impact is short term (occurring only after significant rain events and for the duration of mining), localised in extent (occurring only within the upper catchment of the unnamed creek) and the intensity and frequency of the impact is expected to be within the range of natural variability. The environmental value of surface waters, i.e., support of

[12] The reporting locations shown in the figure are the key locations for model outputs of flood levels and velocities.

aquatic ecosystems, is not expected to be affected. A similar magnitude of impacts is expected post-closure, with there also being the potential to remove the causeway that forms Fountain Head Lake to further reduce impacts on natural hydrological regimes.

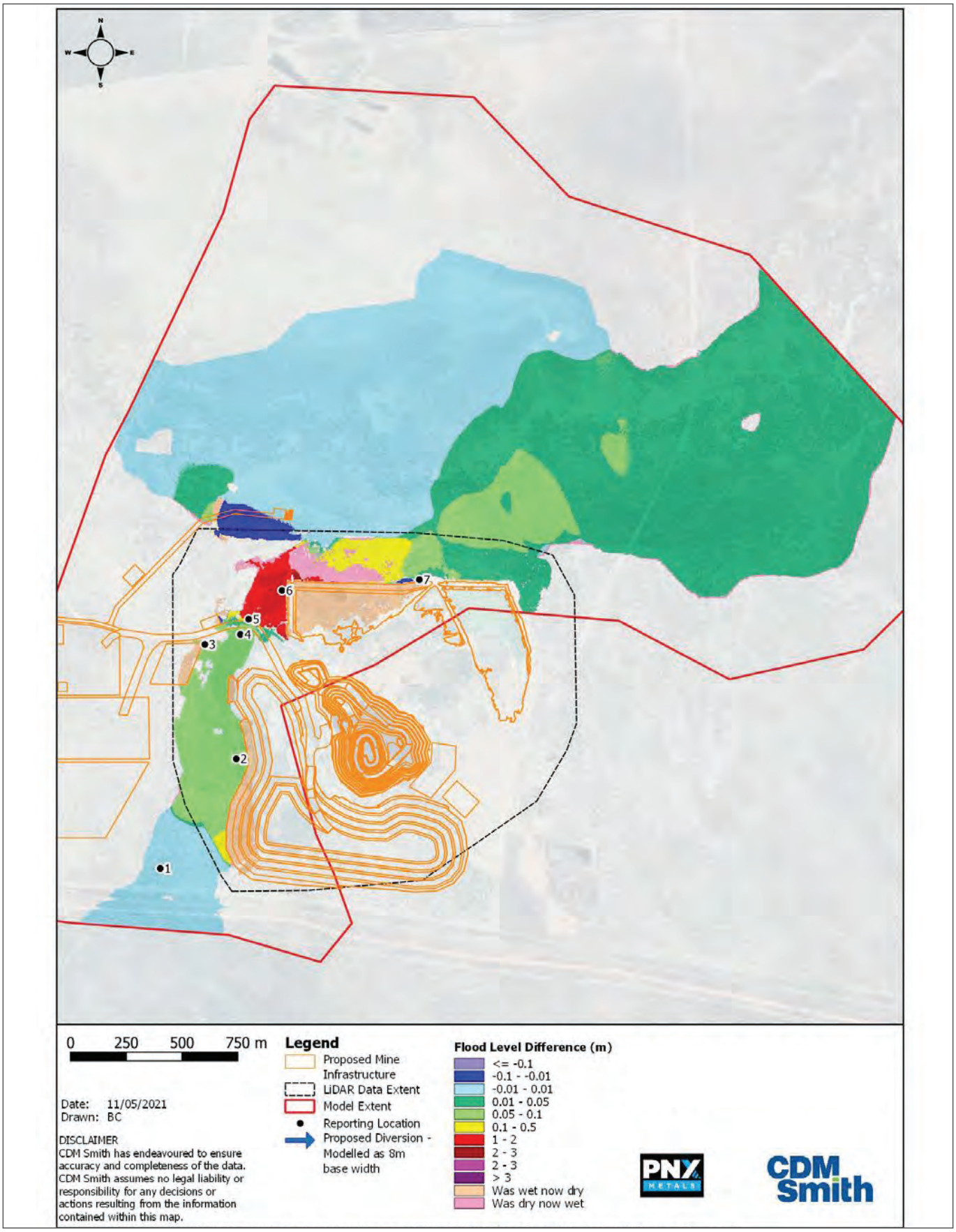
As described in Section 7.4.1, the sensitivity of surface water in the Project area with regard to hydrological processes is categorised as ***Low***, with the natural regime in the area of the mine modified by the installation of a causeway forming Fountain Head Lake.

The overall impact significance is therefore assessed to be ***Negligible*** during both operations and post-closure.

MODELLED PEAK FLOOD LEVEL DIFFERENCE FOR 1% AEP EVENT

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FIGURE 7.2



Source: CDM Smith

7.4.4.2 Groundwater Levels

Groundwater Drawdown Due to Pit Dewatering

Modelling has been undertaken to assess the expected extent of groundwater drawdown due to pit dewatering, and the period for groundwater levels to rebound following completion of mining (Appendix 3). Drawdown of greater than 100 m at the base of the pit is predicted at the end of mining but is relatively steep, with the cone of depression largely restricted to the near vicinity of the pit (Figure 7.3). Groundwater drawdown is predicted to be less than 0.1 m within 2 km of the pit.

Following completion of mining and cessation of dewatering, water levels in Fountain Head pit are predicted to stabilise at around 93 m Australian Height Datum (AHD) 40 years post-mining (Figure 7.4). The predicted drawdown of groundwater associated with the pit void at this stage is shown in Figure 7.5. Groundwater levels in the vicinity of the pit are predicted to rebound to be less than 5 m below existing groundwater levels. The pit lake is therefore expected to act as a groundwater sink due to the local depression in groundwater levels in the vicinity of the pit.

The magnitude of impact of groundwater drawdown is categorised to be Low, since it is localised in extent (to within 2 km of the pit) and the environmental value of the groundwater is not impacted, with no groundwater dependent ecosystems (such as monsoon vine forest habitat) located in this area (see Section 4.6.2). As shown in Figure 7.3, the groundwater drawdown cone is also not expected to extend to bore RN024290, which is periodically used for stock watering by Ban Ban Springs Station. Baseline data will be collected on groundwater levels at this bore in order to determine a trigger level for action in the circumstance that groundwater availability is impacted. Bore RN026344 is within the drawdown cone; however, this bore is not used and will be covered by the proposed IWL. This categorisation of magnitude of impact is relevant to construction, operations and post-closure phases, with recovery to a steady state groundwater equilibrium expected 40 years post-closure, when the magnitude of impact will be negligible.

As described in Section 7.4.1, the sensitivity of groundwater in the Project area with regard to hydrological processes is categorised as ***Low***. The overall impact significance of groundwater drawdown due to pit dewatering is therefore assessed to be ***Negligible*** during construction, operations and post-closure.

Groundwater Mounding Due to Seepage from Evaporation Pond

The amount of water infiltrating to groundwater from the evaporation pond is dependent on the hydraulic properties of the materials beneath the pond, in which regard there is considerable uncertainty (Appendix 3). Notwithstanding, the groundwater drawdown modelling shows that groundwater from the area of the evaporation pond is largely captured within the cone of depression created by pit dewatering during construction and operations (Figure 7.3). Water seeping from the evaporation pond is therefore expected to be drawn to the pit, rather than to mound which would result in waterlogging of soils and possible expression to the surface. Monitoring will be undertaken for any waterlogging of soils and surface seepages.

The magnitude of impact of groundwater mounding is categorised to be ***Low*** during construction and operations since it is short term (less than five years), localised in extent (within close proximity to the evaporation pond) and the environmental value of the groundwater is not

impacted. At the end of mining, the evaporation pond is expected to be mostly empty due to the use of the evaporators (Appendix 3). Seepage to groundwater is therefore expected to be minimal post-closure and the magnitude of impact is categorised to be ***Negligible***.

The overall impact significance is therefore assessed to be ***Negligible*** during construction, operations and post-closure.

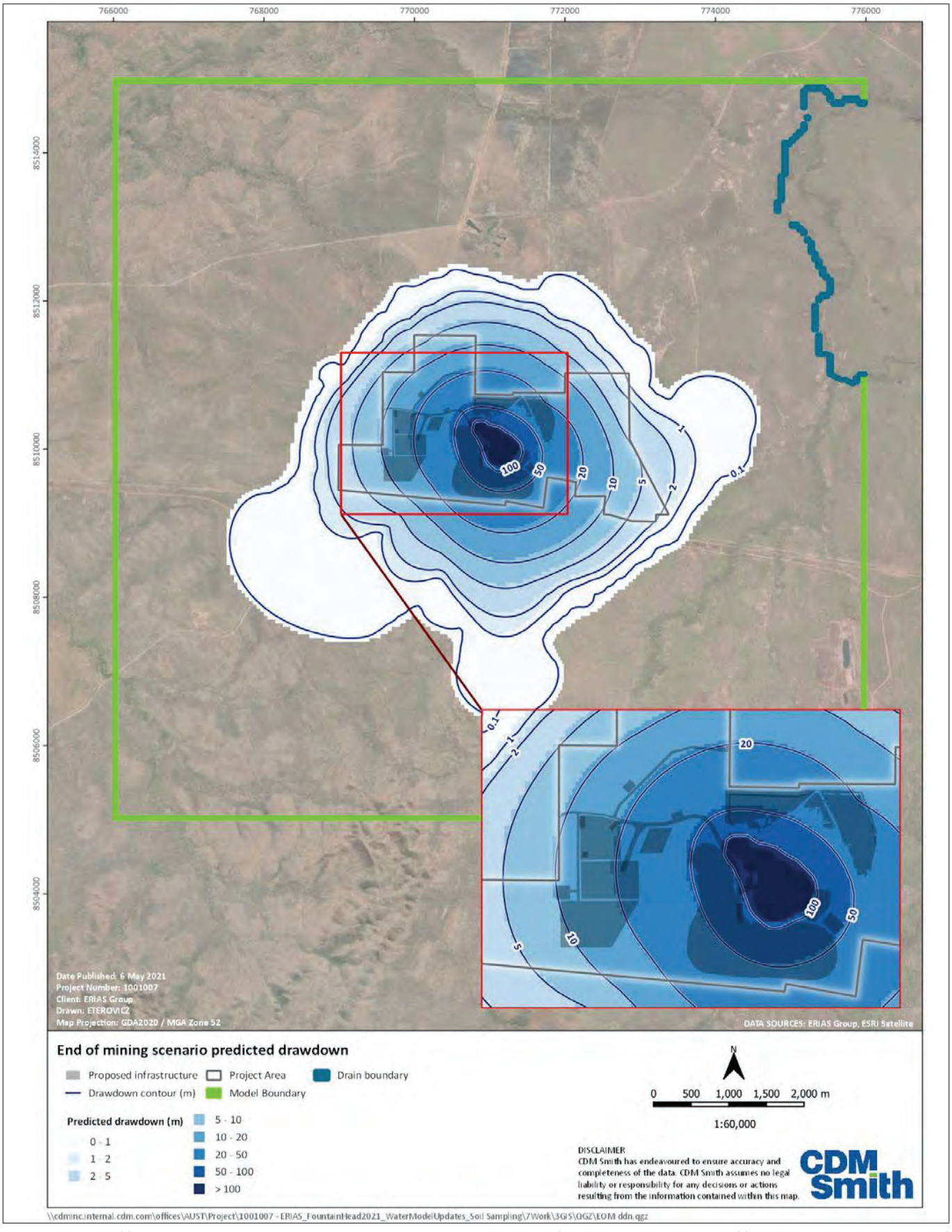
7.4.4.3 Summary of Residual Impacts

A summary of the hydrological processes impact assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.16.

PREDICTED GROUNDWATER DRAWDOWN AT END OF MINING

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FIGURE 7.3

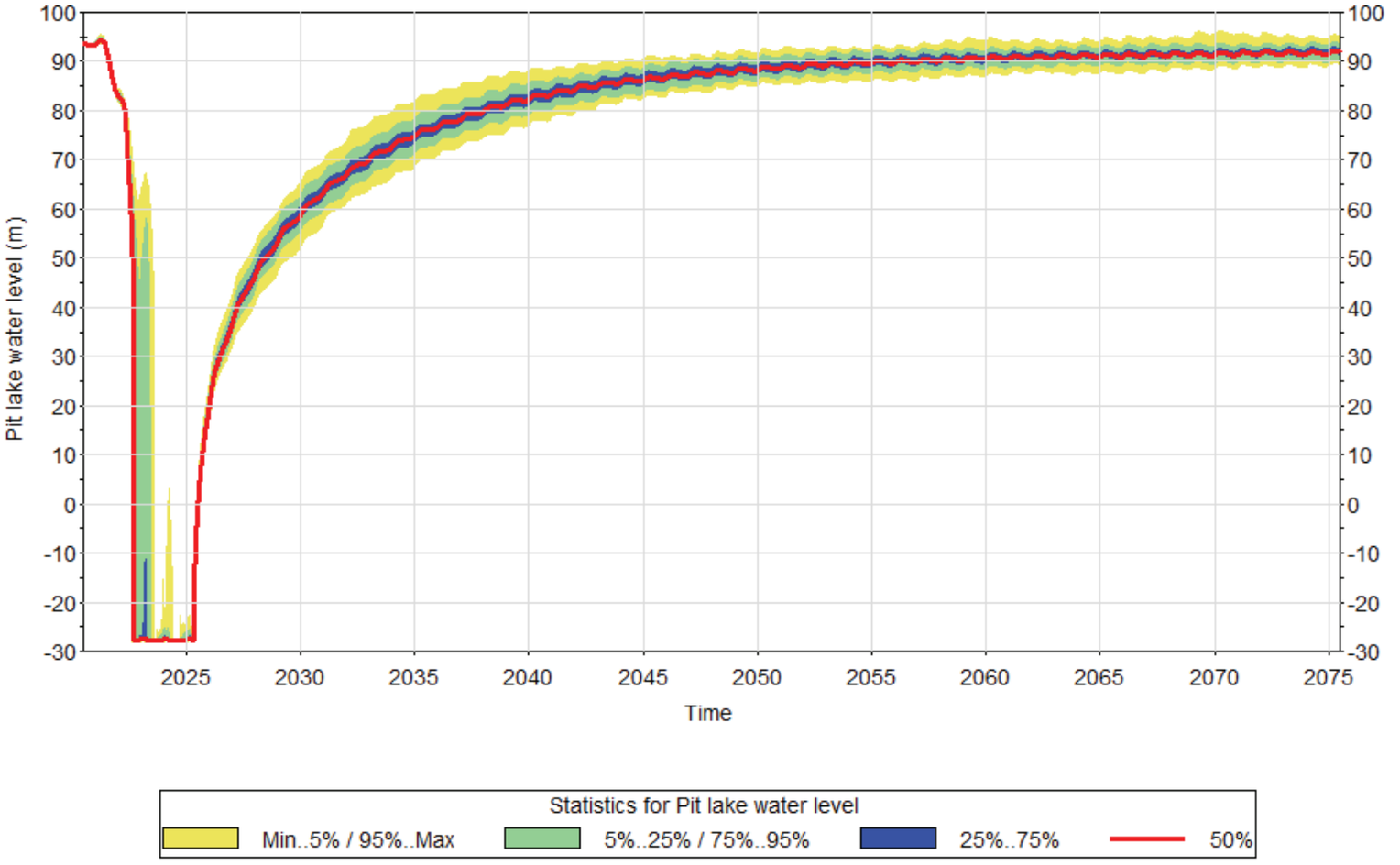


Source: CDM Smith

PREDICTED RECOVERY IN FOUNTAIN HEAD PIT WATER LEVELS

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FIGURE 7.4

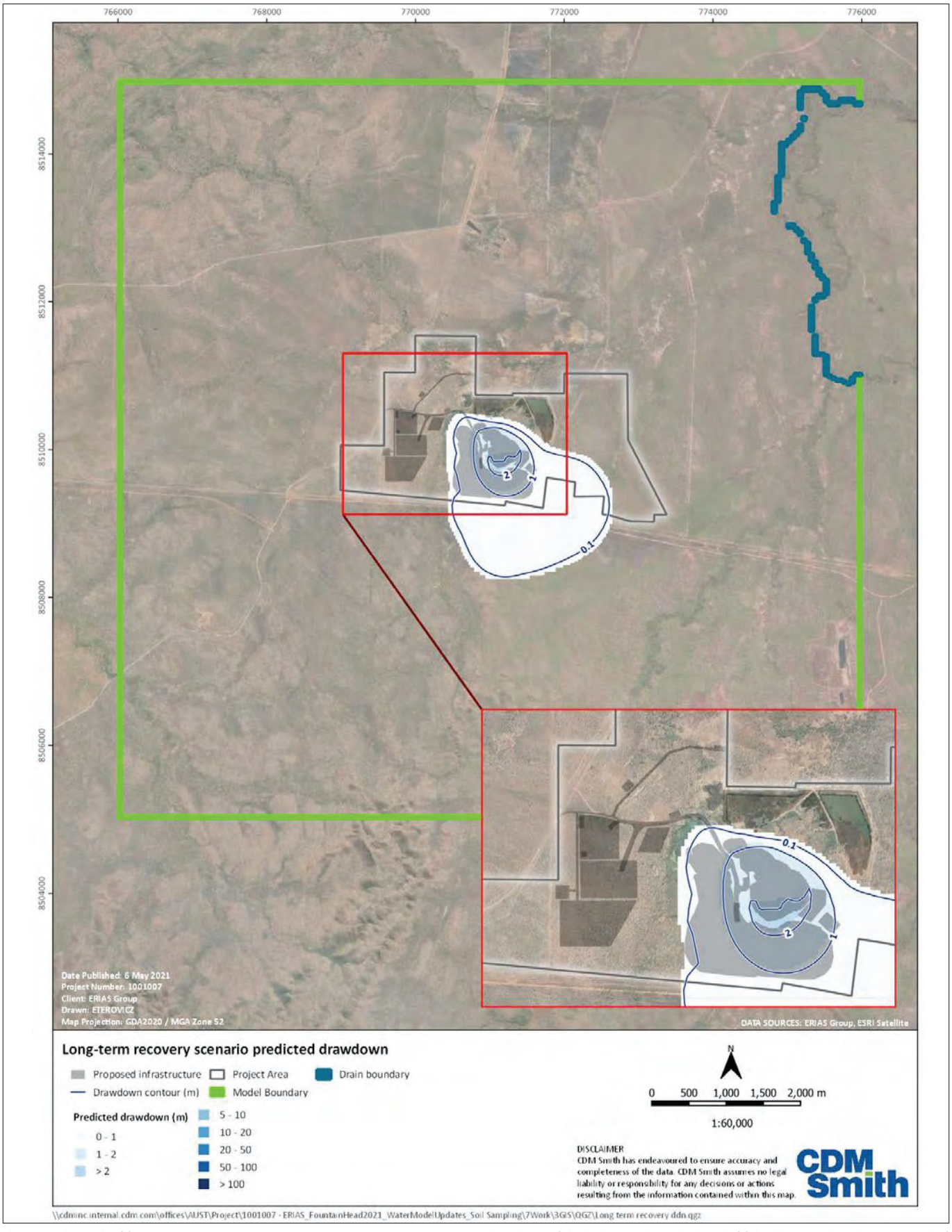


Source: CDM Smith

PREDICTED GROUNDWATER DRAWDOWN 40 YEARS POST-CLOSURE

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FIGURE 7.5



Source: CDM Smith

Table 7.16 – Hydrological Processes Impact Assessment

Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Project Phase	Sensitivity/ Magnitude	Residual Impact Significance
Surface water	Altered surface water hydrological regime	Project infrastructure footprint	Embedded design controls will include: • HED01 • HED02 • HED03 • HED04	Operations and closure	Low/Low	Negligible
Groundwater	Groundwater drawdown	Pit dewatering	None proposed	Construction, operations and closure	Low/Low	Negligible
	Groundwater mounding	Evaporation pond seepage	None proposed	Construction, and operations	Low/Low	Negligible
				Closure	Low/Negligible	Negligible

7.4.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to hydrological processes are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

7.5 Surface Water Quality

7.5.1 Discipline-specific Approach

The significance assessment method described in Chapter 6 was used to qualitatively assess impacts relevant to surface water quality, which is one component of the environmental factor of inland water environmental quality. This considers the sensitivity of the resource/receptor and magnitude of impact on that resource/receptor as defined in Table 6.3 and Table 6.4, respectively, and the significance assessment matrix shown in Table 6.5.

The sensitivity of surface water quality is considered with regard to the NT EPA objective of maintaining surface water quality so that environmental values, which include ecological health, land uses, and the welfare and amenity of people, are protected. This section specifically addresses potential impacts to surface water quality. The implications of changes to surface water quality on ecological health are considered in Section 7.7 and 7.8, while implications from changes in surface water quality on land uses and the welfare and amenity of people are considered in Section 7.9.

The impact assessment addresses potential impacts to surface water quality outside of the mine lease (e.g., surface water environments described in Section 4.5.2). While there are surface waters within the mine lease, e.g., the Fountain Head Lake and the existing dam/proposed evaporation pond, these man-made mine waterbodies are associated with past mining activities. Impacts to the water quality of these waterbodies have not been considered in the impact assessment; however, potential impacts from these man-made water bodies on downstream surface water quality have been considered.

As discussed in Section 4.5.2, surface water quality in the unnamed tributary creek, to the north of the mine lease, and the Margaret River is generally typical of ephemeral freshwater systems of northern Australia but with widespread microbial contamination and elevated concentrations of some metals, namely aluminium, chromium, copper and zinc, observed at sites both upstream and downstream of the Project area. Considering this, surface waters that may be potentially impacted by the Project, including the Margaret River and its tributary creeks are considered to have a ***Medium*** sensitivity, given the long history of mining and agricultural activities in the area and because surface waters are considered to be moderately disturbed.

7.5.2 Potential Impacts

This section describes the potential impacts to surface water quality due to the Project that have been considered in the impact assessment. Impacts to surface water quality may potentially occur due to:

- Surface runoff mobilising sediment from exposed surfaces, stockpiles and mine material (i.e., ore, waste rock and tailings).

- Surface runoff from waste rock, ore and tailings mobilising metals and metalloids, salts, ions and or producing acidic drainage.
- The accidental release of cyanide-containing process solution.
- The accidental release of hydrocarbons or chemicals.

These potential impacts are summarised in Table 7.17 and described in more detail in the following sections.

Table 7.17 – Summary of Potential Impacts on Surface Water Quality

Project Phase	Activity/Aspect	Project Component	Potential Impact
Construction, Operation and Closure	Earthworks/ ground disturbance, topsoil stripping and stockpiling	Pit expansion; IWL expansion; construction of process plant, power station, laydown areas, access roads and infrastructure; ROM pads; topsoil stockpiles	Increased turbidity/sedimentation in downstream surface waters due to erosion of soils/exposed surfaces
Operations and Closure	Mining and processing	ROM pads; IWL	Increased turbidity/sedimentation in downstream surface waters due to rainfall runoff from ore, tailings and waste rock
Construction, Operation and Closure	Mining and processing	ROM pads; IWL	Contamination of downstream surface waters from rainfall runoff of ore, tailings and waste rock
Construction, Operation and Closure	Chemical and fuel storage and use	Mine machinery, plant, vehicles and equipment; explosive magazine, chemical silos, reagent storage area	Contamination of downstream surface waters due to accidental release of hydrocarbons and chemicals

Figure 3.3 (Section 3.3) shows the Project layout in relation to surface waters. The unnamed tributary creek to the north is located approximately 400 m north of the existing dam. The confluence of this tributary creek with the Margaret River is approximately 7 km downstream of the site.

There is a surface flow path from the south which flows under Mount Wells Road into the mine lease to Fountain Head Lake (Figure 3.3). Under current conditions water from Fountain Head Lake overflows the existing haul road during the wet season and drains towards the north, flowing along a drainage line to the unnamed tributary creek of the Margaret River. Some minor alterations to the existing drainage lines within the mine lease are proposed to divert water around the mine processing area and along the western toe of the IWL, to reinstate the natural flow path and to divert natural catchment runoff to the Fountain Head Lake. A diversion is also proposed along the northern side of the evaporation pond as the expanded footprint includes the existing flow path.

Apart from stormwater, discharge of water from the mining lease is not proposed. While the existing pit water has been assessed as being of suitable quality for irrigation use

(Section 4.5.3.1) potential impacts from irrigation have not been considered in the impact assessment.

The proposed expanded evaporation pond has been designed to contain water from extreme rainfall events and pumping of pit water to the evaporation pond will cease if the operational limits of the pond are reached, to prevent overflow. As such, water from the pit and evaporation pond will not be discharged to the downslope catchment under normal operations and so potential impacts to surface water quality from the release of water in the pit and the evaporation pond have not been considered in the impact assessment. Uncontrolled releases of water from the evaporation pond due to a failure of the embankment or flooding and from the potential flooding of the pit lake (post-closure) are considered in the Project Risk Register (Appendix 23).

Sewage, including grey water (i.e., effluent from sinks and washing facilities) and black water (i.e., toilet effluents) produced from the ablutions of temporary buildings and mobile ablution blocks will be collected into storage tanks, which will be regularly emptied with the waste taken offsite for disposal at a licensed facility. For permanent buildings (e.g., crib room or offices) sewage will be collected in subsurface septic tanks. Solids will be removed and disposed of at a licensed facility, while wastewater will flow to a subsurface drainage field. Discharge of sewage at the surface will not occur; therefore, impacts to surface water quality from sewage management are not considered in the surface water quality impact assessment (but are considered in the groundwater quality impact assessment in Section 7.6).

7.5.2.1 Decline in Surface Water Quality from Increased Suspended Sediment and Turbidity

Approximately 75 hectares of the mine lease will be cleared of existing sparse vegetation (primarily open woodland) and the topsoil removed for the construction of mine infrastructure (e.g., ROM pads, crushing facilities, processing plant and supporting infrastructure), the expansion of the IWL and topsoil management areas. The exposure and disturbance of soil during earthworks and ground disturbance could cause soil to be eroded by rainfall and mobilised to nearby surface water bodies.

Topsoil will be stockpiled in a minimum of two locations (Figure 3.3) for reuse during rehabilitation works. Stockpiles will be present from the construction phase and used during progressive rehabilitation and closure. Exposed stockpiles could be eroded by rainfall.

The Project will primarily utilise existing roads; however, once constructed, new and or upgraded roads will create newly exposed, unsealed surfaces, which could be prone to rainfall erosion.

During operations, ore will be hauled to the ROM for stockpiling and subsequent crushing, grinding and processing. While stockpiled and exposed, rainfall runoff could mobilise fine material associated with the ore which could report to surface water bodies. Similarly, tailings and waste rock removed from the pit will be placed at the IWL and rainfall runoff could mobilise fine material associated with this material.

Rainfall erosion of exposed or disturbed surfaces, topsoil stockpiles, roads and from the ROM pads and IWL could lead to a decline in surface water quality from increased suspended sediment loads and turbidity reporting to nearby surface waters.

Modifying existing drainage channels and hydrological regimes due to the installation of diversions and the presence of Project infrastructure could lead to scouring from increased flow velocities or from exposure of the drainage channel substrate. Scouring could mobilise sediment to waterways and lead to a decline in surface water quality from increased suspended sediment loads and turbidity.

A number of embedded design controls address impacts on surface water from increased suspended sediment and turbidity. Such design controls will include:

- Installing approximately six appropriately sized sediment dams according to the best practice erosion and sediment control guidelines (IECA, 2008) to capture surface runoff from the IWL, processing plant, ROM pad, mining contractor yard and hardstand areas to allow suspended sediment to settle out prior to overflowing to the downslope catchment (Figure 3.15). Prior to the installation of the sediment dams (i.e., during the construction phase), rainfall runoff will flow through existing drainage lines either into Fountain Head Lake or towards the unnamed tributary creek to the north (SWED01).
- Constructing a dam designed to contain a 1 in 100 year 72 hour rainfall event to capture runoff from PAF material stockpile (during operations) (SWED11).
- Diverting natural catchment runoff from upstream of the processing area, diverting the existing drainage line around the north of the evaporation pond (which is located on the existing flow path) and installing a bund around the Fountain Head pit to direct surface water away from operational areas (Figure 3.15) (SWED02).
- Installing erosion protection, e.g., rock armour around the western soil stockpile, adjacent the haul road at the northern extent of Fountain Head Lake and along the western and northern toes of the evaporation pond to minimise scour from surface water drainage (Figure 3.15) (SWED04).
- Installing culverts under the haul road to provide direct drainage from the lake and to reduce the frequency of flooding of the haul road (SWED05).
- Constructing the core yard and western soil stockpile on raised pads (Figure 4.12) above the 1% AEP peak flood levels with appropriate freeboard or flood protection structures (SWED06).

The presence of the Fountain Head Lake will also restrict transport of sediment to downstream surface waters by acting as a sediment retention basin. Fountain Head Lake will receive natural catchment runoff from the southern part of the site adjacent the processing area and the western extent of the IWL. While the lake currently overflows during the wet season, culverts will be installed in the causeway to provide drainage and to reduce the frequency of flooding of the haul road. Once the lake reaches capacity, overflow water will discharge to the downslope catchment via the culverts; however, some suspended sediment is likely to have settled out prior.

7.5.2.2 Surface Water Contamination from Waste Rock, Ore and Tailings

Existing waste rock may be used for construction of the evaporation pond embankment and haul roads, hardstand for workshops and laydown areas, blast hole stemming and as aggregate for concrete.

Non-acid forming and PAF-LC waste rock from the Fountain Head pit will be placed in the IWL, with PAF waste rock to be stockpiled adjacent the Fountain Head pit during operation and pushed back into the pit at closure, where it will be eventually inundated to prevent further oxidation (Section 3.7).

Ore will be hauled to the ROM pad for stockpiling and subsequent processing where ore will be crushed, screened, ground and processed through the CIP plant. Rainfall runoff could mobilise metals and other components of the ore (e.g., salts or ions) and produce acidic drainage, if PAF material is present in the ore, while the material is exposed during storage. This may report to surface waters and degrade surface water quality.

The tailings produced by processing of the ore will be dewatered in a tailings thickener and filtered to produce a filter cake, which is washed to remove residual cyanide. Thickener overflow, filtrate and wash water is returned to the processing plant circuit. The tailings filter cake (with a contained moisture content of 10%) will be dry stacked in a dedicated storage cell within the IWL.

Rainfall runoff from the IWL and other areas on the site where waste rock is utilised has the potential to produce acidic drainage, if PAF material is present, and mobilise metals and salts which may report to surface waters and degrade water quality.

A number of embedded design control measures will mitigate impacts on surface water due to runoff from stockpiled ore, waste rock and tailings, including:

- Placing the tailings within a clay-lined cell within the IWL and capturing rainfall runoff that has been in contact with the tailings within one decant well (during operations) for reuse at the process plant (SWED08).
- Installing an under drainage system below the IWL to capture seepage from the clay liner. The water will be collected in two sumps and will be pumped to the process plant (SWED12).
- Washing of tailings filter cake to remove residual cyanide prior to placement in IWL, and return of wash water to processing plant circuit (SWED09).
- Capping the tailings with a 0.5 m layer of clay and 1.5 m layer of NAF waste rock to prevent rainfall infiltrating the tailings following closure (SWED10).
- Constructing a dam designed to contain a 1 in 100 year 72 hour rainfall event to capture runoff from PAF material stockpile (during operations) (SWED11).

7.5.2.3 Surface Water Contamination from Accidental Hydrocarbon or Chemical Releases

The Project will require bulk diesel fuel and oil storage and dispensing areas, chemical storage silos (for lime and cement), a cyanide reagent mixing and handing facility, explosives magazine with chemical stores, workshops and service bays. Diesel will be stored in self-bunded 110 kL storage tanks in a dedicated fuel farm facility (Figure 3.3) that will service light and heavy vehicles. A vehicle maintenance workshop and washdown facility will be located within the mining contractor yard while the explosives magazine is located north of the haul road (Figure 3.3). These fuel and chemical handling and storage areas are located over 500 m from the unnamed tributary creek to the north and around 400 m from the Fountain Head Lake (which has seasonal connectivity to the tributary creek). All fuel and chemical handling will be undertaken within hardstand areas.

Outside of fuel storage, workshop and refuelling areas, leaks and spills of hydrocarbons from vehicles, plant and machinery could occur from leaks in hoses, fittings and fuel storage tanks. Such leaks or spills could occur more broadly within the Project area and along transport roads and could lead to a reduction in water quality of receiving waters.

Hydrocarbons (e.g., fuels, lubes and oils) and chemicals required for mine processing (e.g., lime and NaCN) may be accidently spilt or could leak during handling (e.g., refuelling or dosing) or storage and could be mobilised during rainfall events and report directly to surface waters or indirectly via seepage to groundwater and subsequent discharge where the water table allows for surface expressions. Hydrocarbons and chemicals can degrade receiving water quality.

7.5.2.4 Surface Water Contamination from Flooding or Seepage from Evaporation Pond

As described in Section 3.3, water produced from pit dewatering will be pumped to the evaporation pond for evaporation. The pond has been designed to contain water from extreme rainfall events, with operational limits set on water levels to prevent overflow from the pond. As discussed in Section 7.4.4.2, seepage from the proposed evaporation pond is expected to be drawn to the pit rather than to mound and express to surface. As such, there is unlikely to be a pathway for water from the proposed evaporation pond to interact with surface water. No impacts on surface water are therefore expected to occur due to pit dewatering and from the use of the proposed evaporation pond, and this issue is not further considered in the impact assessment. Note that a large-scale failure of the evaporation pond wall or flooding of the evaporation pond associated with major natural hazards and unplanned events are considered in the Project Risk Register (Appendix 23).

7.5.3 Mitigation and Management

7.5.3.1 Increased Suspended Sediment and Turbidity

In addition to the embedded design controls described in Section 7.5.2.1, which are primarily applicable to the operation phase, measures to minimise impacts to surface water quality from increased suspended sediment and turbidity will include:

- If deemed appropriate, using hay bales, geotextile silt fencing, or silt socks to contain sediment runoff during construction and closure earthworks and ground disturbance activities (SW01).
- Rehabilitating disturbed areas as soon as practicable to minimise areas of potentially erodible soil (SW02).
- Controlling sediment runoff from stockpiles by installing sediment control structures to intercept sediment laden-surface runoff to reduce sediment delivery to watercourses (SW03).
- Avoiding stockpiling spoil and/or topsoil close to existing and proposed drainage lines, maintaining a minimum distance of approximately 50 m, where practicable (SW04).
- Undertaking earthworks and ground disturbance activities during the drier months, wherever practicable, when exposed surfaces will be less prone to rainfall erosion (SW05).

7.5.3.2 Surface Water Contamination from Waste Rock, Ore and Tailings

In addition to the embedded design controls described in Section 7.5.2.2, measures to minimise impacts on surface water from waste rock, ore and tailings will include:

- Conducting further testing to quantify the distribution of PAF materials from the Fountain Head pit (SW06).
- Validating the assumption that operational blending of NAF and PAF-LC material will buffer the acid forming potential of PAF-LC and conducting column leach testing to further understand the potential for acidic drainage from PAF-LC material placed in the IWL (SW07).
- Testing the sulphur content of waste rock and segregating PAF waste rock, using a <0.4% Total S cutoff for NAF material and returning PAF material to the open pit at completion of mining for permanent submersion (SW08).
- Routine monitoring of water quality in the sediment dams that overflow to the downslope catchment to confirm that runoff from the operational areas is of suitable quality in line with downstream receiving environmental objectives. Where water in the sediment dams does not meet relevant receiving water quality criteria, it will be directed to the evaporation pond or process plant (SW21).
- Monitoring of surface water quality in the unnamed tributary creek and Margaret River to detect potential contamination and to initiate remedial action (SW09).

7.5.3.3 Surface Water Contamination from Accidental Hydrocarbon or Chemical Releases

Measures to mitigate impacts to surface water from hydrocarbon and chemical releases will include:

- Implementation of standard international cyanide management codes (SW10).
- Storing fuels, lubricants and process reagents in covered areas or in bunded and lined areas. Bunding will be implemented in accordance with relevant standards and guidelines including *AS 1940 Storage and handling of flammable and combustible liquids* and the *Australian Dangerous Goods Code* (SW11).
- Collection of oil waste from the washbay at the vehicle maintenance workshop with an oil separator and water underflow reporting to a soakage or storage pit for reuse. Waste oil will be collected and stored in drums in bunded and lined area for removal off site by a licensed contractor (SW12).
- Refuelling on impermeable hardstand areas with spill prevention and spill containment kits available in close proximity (SW13).
- Providing spill kits appropriate to the spill risk at the Project site and within vehicles as necessary. All fuel tankers and those tankers transporting hazardous materials shall carry appropriate spill kits (SW14).
- Inspecting, maintaining and repairing fittings, pipes and hoses regularly (SW15).
- Training personnel in the handling, transportation and storage of hazardous materials and providing training to an appropriate number of staff in the handling of emergency response and release scenarios (SW16).
- Clearly labelling vessels with name or description of hazardous material with accompanying material safety data sheets (MSDS) to be stored in close proximity and readily available in case of a spill or leak (SW17).
- Use of bunds and sumps to collect and return any spills from the CIP plant internally (SW18).
- Testing permanent storage vessels and enclosures intended for hazardous materials storage for leaks prior to installation and operation (SW19).
- Routinely inspecting vessels, tanks and secondary containment for leaks. If a leak is identified activate appropriate actions as per the spill response plan (or similar) (SW20).
- Developing and implementing a service and maintenance schedule according to manufacturer's specifications (SW22).

7.5.4 Residual Impacts

7.5.4.1 Increased Suspended Sediment and Turbidity from Rainfall Erosion

Clearing around 75 ha of sparse vegetation and topsoil will be required for the construction of the Project. Topsoil will be stockpiled in a minimum of two locations (Figure 3.3).

Surface water monitoring results show that the Margaret River and tributary creeks experience large fluctuations in suspended sediment concentrations and turbidity, with high levels occurring due to rainfall events primarily during the wet season (Section 4.5.2).

During construction, erosion and sediment control structures, siting stockpiles away from natural drainage lines and undertaking construction activities during the drier months wherever practicable, will minimise sediment loads reporting to surface water bodies from rainfall runoff. During periods of heavy rainfall, sediment control measures may not completely contain sediment and so increased sediment may report to surface water bodies under such conditions. This would likely coincide with periods of naturally increased suspended sediment and turbidity as a result of rainfall runoff in the broader catchment. Impacts may be detectable with respect to natural variability but are expected to be short term (i.e., limited to construction and particularly following high rainfall events) and would be limited to the unnamed tributary creek (i.e., localised). As such, the magnitude of the impact for construction is assessed as ***Low***.

Once constructed, the sediment dams will provide for settling of suspended solids in sediment-laden water from operational areas prior to discharging to the downslope catchment. Runoff from the PAF stockpile will be captured and contained in a runoff dam designed to contain a 1 in 100 year 72 hour rainfall event, with the captured water to be directed to the evaporation pond if required. There will be no overflow from the PAF runoff dam to the downslope catchment. Diversion drains will also ensure natural drainage is diverted away from operational areas to either discharge directly to the downslope catchment or to the Fountain Head Lake. Erosion control along the western and northern side of the proposed evaporation pond and along the western toe of the IWL will minimise the potential for scouring effects. Erosion protection around the western soil stockpile and adjacent the haul road will also reduce the potential mobilisation of sediment to the downslope catchment. With these measures in place, impacts to surface water quality from increased suspended sediment and turbidity during operations are expected to be within the range of natural variability (i.e., will be undetectable); therefore, the magnitude of the impact for operations is assessed as ***Negligible***.

Post-closure, the site will be rehabilitated which will include topsoil reinstatement and removal of topsoil stockpiles and rehabilitation of cleared areas, while the modified drainage channels will most likely remain. Impacts to surface water from increased suspended sediment and turbidity are not expected outside of natural variability; therefore, the magnitude of the impacts post-closure is assessed as ***Negligible***.

Given the sensitivity of surface water is ***Medium***, the overall impact significance rating for increased suspended sediment and turbidity from rainfall erosion and scouring is assessed as ***Low*** for construction and ***Negligible*** for operations and closure.

7.5.4.2 Surface Water Contamination from Waste Rock, Ore and Tailings Runoff

Existing Waste Rock

As discussed in Section 4.5.3, the evidence from surface water monitoring is that the existing waste rock is non-acid forming and is not generating acidic or neutral metalliferous drainage. This is further supported by geochemical testing of the existing waste rock which indicates this material is unlikely to generate any acidity, with all but one sample tested classified as clearly NAF (Appendix 6). Testing of material from the existing waste rock stockpile which will be moved during construction to allow for the pit to be cut back, and may be used for construction of the evaporation pond embankment, haul roads and hardstand areas, indicated that this material is NAF (Appendix 6). The acid neutralising capacity/maximum potential acidity (ANC/MPA) ratios indicate this material is unlikely to produce acidic drainage and presents low environmental risk. Leach testing (using water extracts) of material from the existing waste rock stockpile produced extracts with a neutral pH, low salinity and very low or non-detectable concentrations of metals and metalloids. Considering this, the magnitude of the impact for contamination of surface water from runoff from the existing waste rock (which may be used as a construction material) is assessed as ***Negligible***. Given the sensitivity of surface water is ***Medium***, the overall impact significance rating for surface water contamination from existing waste rock is ***Negligible*** for construction, operations and closure.

Waste Rock from the Fountain Head Pit

Initial testing of the waste rock to be removed from the Fountain Head pit indicated that most samples (80%) were NAF, while 15% were PAF-LC and 5% were PAF, indicating that pyritic rock is not widespread (Appendix 6). Further testing was done to estimate the volume of PAF material to be contained within fresh waste rock and ore using Total S assays (Appendix 25). The results indicate that around 95% of fresh waste rock sampled from within the proposed expanded Fountain Head pit are classified as NAF (Total S <0.2%), 4% are PAF-LC (Total S ≥0.2% and <0.4%) and 1%PAF (Total S ≥0.4%). The results indicate that only a very minor proportion of fresh waste rock will be PAF. The majority of waste rock is expected to have sufficient neutralising capacity to prevent acid generation. Overall, its estimated that around 60,000 m^3 (150,000 t) of fresh waste rock will be PAF (Total S ≥0.4%). Based on the testing undertaken, all oxide and transitional material is assumed to be NAF.

Leach testing of waste rock to be removed from the Fountain Head pit was undertaken using water extracts and accelerated oxidations with hydrogen peroxide (Appendix 6). Water extractions on waste rock included testing of PAF, PAF-LC and NAF materials. All water extracts produced circumneutral to alkaline solutions with low salinity. With the exception of aluminium, metal concentrations in water extracts for NAF samples (≤0.2%S) were significantly lower than PAF/PAF-LC (>0.2%S) samples; however, metal concentrations in all water extracts were generally very low to non-detectable.

Peroxide testing of waste rock was also undertaken on PAF, PAF-LC and NAF materials. This test provides an indication of metal and metalloid concentrations associated with acidic runoff from waste rock subject to oxidation processes following exposure and surface storage. The results showed a correlation between the total sulphur content of a sample and the amount of metal and metalloids dissolved in peroxide extracts, particularly iron, copper, cobalt, nickel and

arsenic. It was noted however that samples with a relatively low total sulphur content (<0.35%) also had elevated concentrations of some metals (Al, Co, Mg, Ni, Pb and Zn) in peroxide extracts. The results indicate that runoff from oxidised waste rock containing more than 0.2% sulphur (i.e., PAF material) may contain elevated concentrations of some metals and metalloids.

Runoff from the NAF waste rock to be removed from the Fountain Head pit and placed in the IWL is considered to pose minimal risk to surface waters as it is predicted to be circumneutral with low salinity and with low to non-detectable concentrations of metals and metalloids. Once oxidised, PAF-LC, which will also be placed in the IWL is unlikely to produce acidic drainage, but runoff may contain elevated concentrations of some metals (Appendix 6). Slightly less than 5% of the estimated 4.84 Mm^3 of waste rock to be placed in the IWL will be PAF-LC. As described in Section 3.7.1.3, PAF-LC material will be identified using a Total S cutoff of Total S ≥0.2% and <0.4% and disposed of in such a way as to minimise potential infiltration of rainfall runoff. It is therefore expected that there will be minimal runoff from PAF-LC material, which may contain elevated concentrations of metals; however it is noted that until further column leach testing is completed there is some uncertainty regarding the quality of drainage from the IWL.

Predictive modelling of arsenic concentrations in the Fountain Head Lake, which will receive runoff from sediment dams E3, W2 and W3 (Figure 3.15) was undertaken to understand the potential risk to the downstream environment during annual overflow events (Appendix 3). Predictions were made using highly conservative assumptions considering leach testing results provided in Appendix 6. Using an arsenic runoff concentration of 150 µg/L for waste rock and ore (a conservative over-estimate of realistic concentrations) it is predicted that arsenic concentrations in the Fountain Head Lake will remain below the 80% aquatic ecosystems protection limit of 140 µg/L for As (V), with a flow-weighted average concentration of approximately 11 µg/L, which is below the 95% aquatic ecosystems protection limit of 13 µg/L for As(V). While there are some uncertainties associated with the predictions, due to a lack of time-series water level or flow data from the Fountain Head Lake to calibrate the rainfall-runoff model used to make the predictions, given the conservative values used, water from the Fountain Head Lake, which will receive runoff from the IWL, is expected to pose minimal risk to the downstream catchment during overflow events.

Considering the available information, the magnitude of the impact for waste rock to be placed in the IWL is assessed as ***Low*** for operations and closure. Given the sensitivity of surface water is ***Medium***, the overall impact significance rating is ***Low*** for operations and closure.

During mining, the sulphide content of waste rock will be assessed with a cut off of <0.4% Total S proposed for segregation. Applying a Total S cutoff of 0.4%, there will be an estimated 60,000 m^3 or 150,000 t of waste rock to be classified as PAF and managed separately (Appendix 25). Waste rock with a sulphur content above 0.4% will be considered PAF and will be temporarily stockpiled adjacent the pit. Runoff from the PAF stockpile will be captured and contained in a runoff dam designed to contain a 1 in 100 year 72 hour rainfall event, with the captured water to be directed to the evaporation pond or the processing plant, if required. As such, overflow from the PAF runoff dam to the downslope catchment is not expected. The evaporation pond has similarly been designed with sufficient capacity to contain extreme rainfall events. Water within the evaporation pond will be evaporated or drawn to the pit via groundwater seepage and is not expected to report to the downstream catchment (Section 7.4.4.2). PAF waste rock material will be returned to

the open pit at completion of mining for permanent submersion. Potential impacts from acidic drainage would be limited to the period when the PAF material is stockpiled (i.e., less than five years) and potential impacts would be completely mitigated once the material is backfilled into the pit and permanently submerged.

Only a small percentage of waste rock to be excavated from the Fountain Head pit is expected to be PAF, with runoff from the stockpile to be contained in the dam or the evaporation pond (should the dam reach capacity). No impacts to downstream surface waters are therefore expected during the short-term operational period (i.e., three to five years). The magnitude of the impact from PAF waste rock to be removed from the Fountain Head pit is therefore assessed as ***Negligible*** for operations. Given the PAF material will be returned to the open pit at completion of mining for permanent submersion (once the pit refills) the magnitude of impact following closure is also assessed to be ***Negligible***. Given the sensitivity of surface water is ***Medium***, the impact significance rating for surface water contamination from PAF waste rock is ***Negligible*** for operations and closure.

Ore

It is estimated that around 59% of fresh ore samples will be classified as NAF (Total S <0.2%), 38% PAF-LC (Total S ≥0.2% and <0.4%) and 3% PAF (Total S ≥0.4%). It is estimated that there will be 20,000 m^3 (70,000 t) of fresh ore classified as PAF (Appendix 25). The results suggest that fresh ore stockpiled during mining would be unlikely to produce significant amounts of low pH drainage during operations; however, long-term fresh low-grade stockpiles may have risk of low pH drainage once oxidised, but with relatively low capacity (Appendix 25). Low grade ore will however be used for blending or to make up production shortfalls and all low grade ore remaining at the end of mine life will be processed. As such, potential impacts are assessed for operations only.

Testing (using water extracts) of one ore sample indicated that leachate was mildly alkaline with low salinity and low to undetectable metal and metalloid concentrations (Appendix 6). Based on these testing results, rainfall runoff from ore on the ROM pad during operations presents minimal risk for producing acid or saline drainage or mobilising metals. This assumption will be confirmed by conducting routine monitoring of water quality in the sediment dams collecting runoff from the operational areas as well as monitoring water quality in the unnamed tributary creek and Margaret River. If the water quality in the sediment dams is deemed unsuitable for draining to the downstream catchment, then it will be redirected to the process plant or evaporation pond.

As described in the previous section, predictive modelling of arsenic concentrations in the Fountain Head Lake, which will receive runoff from sediment dams W2 and W3, located to the east of the plan and ROM pad (Figure 3.15) was undertaken to understand the potential risk to the downstream environment during annual overflow events (Appendix 3). Based on the predictions, the Fountain Head Lake, which will receive runoff from ore stockpiled at the ROM pad is expected to pose minimal risk to the downstream catchment during overflow events.

The magnitude of the impact for contamination of surface water from runoff from ore on the ROM pad is therefore assessed as ***Low*** for operations. Given the sensitivity of surface water is ***Medium***, the impact significance rating is ***Low***.

Tailings

Testing of cyanide-leached ore was undertaken to understand the likely quality of runoff water from surface storage of tailings. The results are described in Section 3.6.3, In summary, in the absence of oxidation, fresh tailings may produce leachates containing elevated arsenic concentrations on contact with water, with results indicating concentrations of arsenic could be more than 100 times higher than the ANZG (2018) default guideline value for slightly to moderately disturbed aquatic ecosystems. Other metals including cobalt, copper, molybdenum, antimony and uranium were also elevated above guideline values for some tested samples. Peroxide leach testing indicates that once tailings are oxidised, leachate may contain high concentrations of arsenic, aluminium, cadmium, cobalt, chromium, copper lead and zinc. Arsenic is naturally enriched above average soil abundance in the tailings with a generally strong correlation with arsenic and sulphur concentrations, i.e., arsenic is likely associated with sulphides in the tailings.

While the drainage from non-oxidised and oxidised tailings presents a risk to the downstream environment during operations and closure, as described in Section 7.5.2.2, during operations runoff from the tailings deposited within the IWL will be captured by one decant well within a clay-lined cell and directed to the process plant or the evaporation pond. Seepage through the clay liner will also be collected by an under drainage system and will be collected and pumped to the process plant or evaporation pond. As previously noted, water in the evaporation pond is not expected to report to the downstream catchment, instead being evaporated or drawn to the pit via groundwater seepage. As such, there will be no surface water drainage that has been in contact with the tailings discharged from the mine lease during operations. The magnitude of the impact is therefore assessed as ***Negligible*** for operations.

At the completion of ore processing, the tailings placed in the IWL will be covered with 0.5 m thick layer of clay and an additional 1.5 m of NAF waste rock to create an impermeable layer. This will prevent the infiltration of rainfall, preventing the production of drainage from the tailings. The final landform design will be such (i.e., convex) that it directs runoff away from the tailings storage area. The clay liner will also remain post-closure. The magnitude of the impact is therefore assessed as ***Negligible*** for closure. Impacts to groundwater from seepage below the tailings post closure is considered in Section 7.6.4.2.

Given the sensitivity of surface water is ***Medium***, the overall impact significance rating for surface water contamination from tailings is ***Negligible*** for operations and closure.

7.5.4.3 Surface Water Contamination from Accidental Hydrocarbon or Chemical Releases

The assessment addresses leaks and spills that are typically incidental (but controllable) as part of construction, operations and closure. Large-scale spills associated with major natural hazards and unplanned events are considered in the Project Risk Register (Appendix 23) and Section 7.13.

For all phases of the Project, the primary source of potential contamination from hydrocarbons and chemicals is associated with the use, refuelling and maintenance of vehicles, plant and machinery. Bulk fuel storage and refuelling of light and heavy vehicles and plant will occur within

the mining contractor yard on hardstand areas located away from existing and proposed drainage lines and surface water bodies.

Additional potential sources of contamination from spills and leaks during operations, occur due to the use and storage of lime, NaCN and ammonium nitrate. These chemicals will be stored as solids and used in mining operations. If spilt and mobilised/dissolved by rainfall, they could report to surface water bodies where they are potentially toxic to aquatic biota. Chemical storages and the explosives magazine will be located away from existing surface water bodies and drainage lines. Chemicals and reagents will be securely stored undercover. NaCN will be stored in a dedicated undercover reagent storage area, lime will be stored in a silo and ammonium nitrate will be stored in a shed.

Hydrocarbons (i.e., fuels and oils) are dispersive in water as they are less dense and therefore lighter, meaning that they will be transported downstream on the water surface rather than mixing through the water column. Sodium cyanide is toxic to aquatic biota and highly soluble in water but would be more readily diluted through the water column compared to hydrocarbons, as would ammonium nitrate. Lime (calcium oxide) is relatively insoluble in water, and primarily remains in suspension and would also be diluted through the water column.

The mitigations measures listed in Section 7.5.3 require that fuels, oils and chemicals are stored and handled appropriately, that machinery is well maintained and regularly inspected, and that accidental leaks or spills are contained and remediated quickly.

Regular inspections and maintenance of equipment will aim to ensure leaks in hoses, fittings and fuel storage tanks are prevented or detected early. The contractor's Spill Response Procedure (or similar) will identify procedures for preventing and managing spills and relevant personnel will be appropriately trained in spill response measures. The required spill containment equipment will be maintained and readily available close to fuel and chemical storage and handling areas or within vehicles and machinery as necessary. With the implementation of the mitigation measures provided in Section 7.5.3, leaks or spills of fuels, oils and chemicals will either be prevented or detected early and contained locally and in a timely manner.

During construction, spills or leaks of hydrocarbons or chemicals which are not detected and contained would likely only report to surface water during rainfall events. Under such circumstances, dispersion or dilution in receiving surface water bodies would mean that impacts would be localised (i.e., limited to the unnamed tributary creek) and with surface water moderately affected in the short term. Therefore the magnitude of the impact is assessed as ***Low*** for construction.

During operations, accidental spills or leaks of hydrocarbons or chemicals that are not immediately contained are likely to report to either the sediment dams, or to Fountain Head Lake, where they will likely be substantially diluted before discharging to the downstream catchment. Impacts would be localised (i.e., limited to the unnamed tributary creek) and with surface water moderately affected in the short term. Therefore the magnitude of the impact is assessed as ***Low*** for operations.

Refuelling and maintenance of vehicles and machinery will still be required during closure, as will bulk fuel storage and refuelling of light and heavy vehicles. Unused chemicals may also need to

be removed from the site. Given the reduced number of vehicles and machinery required during closure, the short time period for closure activities and that there will be no long-term sources of hydrocarbon or chemical spills, the magnitude of the impact is assessed as ***Negligible*** for closure.

Given the sensitivity of surface water is ***Medium***, the overall impact significance rating for surface water contamination from accidental hydrocarbon or chemical release is ***Low*** during construction and operations and ***Negligible*** for closure.

7.5.4.4 Summary of Residual Impact Assessment

A summary of the surface water quality impact assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.18.

All residual impacts to surface water quality were assessed to be ***Negligible*** to ***Low***.

7.5.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to surface water quality are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

Table 7.18 – Surface Water Quality Impact Assessment

Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Project Phase	Sensitivity/ Magnitude	Residual Impact Significance
Surface water	Increased suspended sediment and turbidity.	Earthworks/ground disturbance, topsoil stripping and stockpiling	Embedded design controls will include: • SWED01 • SWED02 • SWED04 • SWED05 • SWED06 • SWED11 Mitigation measures will include: • SW01 • SW02 • SW03 • SW04 • SW05	Construction	Medium/Low	Low
		Ore stockpiling and processing; IWL; diversion channels, Project infrastructure		Operations	Medium/Negligible	Negligible
		Earthworks, rehabilitation		Closure	Medium/Negligible	Negligible
Surface water	Surface water contamination from waste rock, ore and tailings	Waste rock stockpiling (existing) /use of NAF material	Embedded design controls will include: • SWED08 • SWED09 • SWED10 • SWED11 Mitigation measures will include: • SW06 • SW07 • SW08	Construction, operations and closure	Medium/Negligible	Negligible
		Waste rock stockpiling (NAF and PAF-LC material)		Operations and closure	Medium/Low	Low
		Waste rock stockpiling (PAF material)		Operations and closure	Medium/Negligible	Negligible
		Ore stockpiling		Operations	Medium/Low	Low

Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Project Phase	Sensitivity/ Magnitude	Residual Impact Significance
		Tailings	• SW09 • SW21	Operations and closure	Medium/Negligible	Negligible
Surface water	Surface water contamination from accidental release of hydrocarbons and chemicals	Use of chemical reagents, vehicles, plant and equipment, fuel and chemical handling and storage	• SW10 • SW11 • SW12 • SW13 • SW14 • SW15 • SW16 • SW17 • SW18 • SW19 • SW20 • SW22	Construction and operations	Medium/Low	Low
				Closure	Medium/Negligible	Negligible

7.6 Groundwater Quality

7.6.1 Discipline-specific Approach

The significance assessment method described in Chapter 6 was used to qualitatively assess impacts relevant to groundwater quality, which is one component of the environmental factor of inland water environmental quality. This considers the sensitivity of the resource/receptor and magnitude of impact on that resource/receptor as defined in Table 6.3 and Table 6.4, respectively, and the significance assessment matrix shown in Table 6.5.

The sensitivity of groundwater quality is considered with regard to the NT EPA objective of maintaining groundwater quality so that environmental values, which include ecological health, land uses, and the welfare and amenity of people, are protected. This section specifically addresses potential impacts to groundwater quality. The implications of changes to groundwater water quality on ecological health are considered in Section 7.7 and 7.8, while implications from changes in groundwater quality on land uses and the welfare and amenity of people are considered in Section 7.9.

As discussed in Section 4.6, groundwater water quality in the region has natural high arsenic concentrations due to the regional geology. As such, groundwater is unsuitable for use as human drinking water. Monitoring bores from the Project site indicate that groundwater also has iron and manganese concentrations elevated above drinking water guidelines, aluminium concentrations elevated above livestock drinking water guidelines and iron concentrations elevated above irrigation guidelines. Arsenic, aluminium, chromium and copper concentrations have also been above ecological guideline values for slightly to moderately disturbed surface waters. Considering this, groundwater that may be potentially impacted by the Project, is considered to have a ***Low*** sensitivity, given it has been subject to influences from previous mining activities, is unsuitable for human drinking water, livestock drinking water and irrigation and does not meet surface water guidelines for slightly to moderately disturbed ecosystems and groundwater availability is quite extensive in the broader region.

7.6.2 Potential Impacts

This section describes the potential impacts to groundwater quality due to the Project that have been considered in the impact assessment. These potential impacts are summarised in Table 7.19 and described in more detail in the following sections.

Table 7.19 – Summary of Potential Impacts on Groundwater Quality

Project Phase	Activity/Aspect	Project Component	Potential Impact
Construction, Operation and Closure	Pit dewatering	Evaporation pond	Contamination of groundwater from seepage of evaporation pond water
Operation and Closure	Mining and processing	ROM pad; IWL	Contamination of groundwater from waste rock, ore and tailings
Construction and Operation	Chemical and fuel storage and use	Mine machinery, plant, vehicles and equipment; explosive magazine, chemical silos, reagent storage area	Contamination of groundwater due to accidental release of hydrocarbons and chemicals
Closure	Mining	Final pit lake	Contamination of groundwater from interaction with final pit water

Shallow groundwater is considered most vulnerable to impacts from the Project. The natural watertable level in the vicinity of the pit is estimated to be about 95 m AHD, ranging between 93 and 99 m AHD, with the water table sitting within 5 to 10 metres below ground surface (mbgs). Regional groundwater flows from the southwest towards the northeast.

Apart from stormwater runoff, there will be no surface discharges to the environment. While pit water has been assessed as suitable for irrigation (Section 4.5.3.1), the potential impacts of irrigation on shallow groundwater has not been considered in the impact assessment since such use is not proposed.

The primary pathway for impacts to groundwater quality is from surface water seepage, interactions with final pit water and mobilised contaminants infiltrating soils and reporting to groundwater. Potential sources of contaminants include waste rock, ore, tailings, process solutions, hydrocarbons and chemicals, seepage from the proposed evaporation pond and wastewater from septic systems. The potential impacts from these sources are discussed in the following sections.

7.6.2.1 Groundwater Contamination from Seepage from the Evaporation Pond

As described in Section 3.3, water produced from pit dewatering will be pumped to the evaporation pond for evaporation. The pond will be designed to contain water from extreme rainfall events, with operational limits set on water levels to prevent overflow from the pond. With the filling of the proposed evaporation pond, groundwater infiltration (seepage) will progressively increase as the water level in the pond increases. As discussed in Section 4.5.3, pit water has naturally elevated levels of arsenic, while contaminant concentrations in water within the existing dam are very low. Existing groundwater also has elevated levels of arsenic, as well as iron, manganese and aluminium. Concentrations of arsenic and other metals will increase in the proposed evaporation pond when pit water is pumped to the pond during pit dewatering. Depending on the amount of seepage from the base of the pond, this could result in an increase in contaminant concentrations in groundwater.

7.6.2.2 Groundwater Contamination from Waste Rock, Ore and Tailings

As discussed in Section 7.5.2.2, potential sources of contamination to surface water includes the rainfall runoff from waste rock, stockpiled ore and tailings. These same potential sources of contamination could also impact groundwater where a pathway for infiltration through soils exists.

The embedded design control measures provided in Section 7.5.2.2 to mitigate impacts on surface water from potential contamination will also mitigate impacts on groundwater.

7.6.2.3 Groundwater Contamination from Accidental Hydrocarbon or Chemical Releases

As discussed in Section 7.5.2.3, the Project will include bulk diesel fuel and oil storage and dispensing areas, chemical storage silos (for lime and cement), a cyanide reagent storage area, explosives magazine with chemical stores, workshops and service bays.

Diesel will be stored in self-bunded 110 kL storage tanks in a dedicated fuel farm facility (Figure 3.3) that will service light and heavy vehicles. A vehicle maintenance workshop and washdown facility will be located within the mining contractor yard while the explosives magazine is located north of the haul road (Figure 3.3). All of these areas will be constructed on hardstand to minimise the potential for spills or leaks to penetrate soils.

Outside of fuel storage, workshop and refuelling areas, leaks and spills of hydrocarbons from vehicles, plant and machinery could occur from leaks in hoses, fittings and fuel storage tanks which could also infiltrate soils, particularly where there is no hardstand, and report to groundwater.

Hydrocarbons (e.g., fuels, lubes and oils) and chemicals required for mine processing (e.g., lime and NaCN) may be accidently spilt or could leak during handling (e.g., refuelling or dosing) or storage and could percolate through soil and infiltrate groundwater, degrading water quality.

7.6.2.4 Groundwater Contamination from Septic Systems

During construction and operations, sewage, including grey water (i.e., effluent from sinks and washing facilities) and black water (i.e., toilet effluents) produced from the ablutions of temporary buildings and mobile ablution blocks will be collected into storage tanks, which will be regularly emptied with the waste taken offsite for disposal at a licensed facility. For permanent buildings (e.g., crib room or offices) sewage will be collected in subsurface septic tanks. Solids will be removed and disposed of at a licensed facility, while wastewater will flow to a subsurface drainage field. Septic wastewater could contain elevated nutrients and oxygen demand as well as microbes which could percolate through soils and degrade receiving groundwater quality. Leaks from the septic system could also degrade groundwater quality.

7.6.2.5 Groundwater Contamination from Final Pit Water

As discussed in Section 4.6, the existing Fountain Head pit may be drawing groundwater from the aquifer, but it may also be acting as a throughflow feature with regional groundwater flowing in from the southwest and out towards the northeast. Depending on the final pit water quality, it could therefore be a source of contamination to surrounding groundwater, particularly from metals and dissolved salts.

7.6.3 Mitigation and Management

7.6.3.1 Groundwater Contamination from Seepage from the Evaporation Pond

Based on the groundwater drawdown modelling results (Appendix 3) which show that groundwater from the area of the evaporation pond is expected to be drawn to the pit, no management measures are proposed to mitigate groundwater contamination from evaporation pond seepage. Baseline data will be collected at bore RN024290 to determine a trigger level for action in the circumstance that groundwater quality is impacted. Groundwater quality will be monitored at a proposed monitoring bore nearby to determine if impacts to the bore are occurring.

7.6.3.2 Groundwater Contamination from Waste Rock, Ore and Tailings

The measures embedded in Project design described Section 7.6.2.2 to mitigate impacts to surface water quality from waste rock, ore and tailings will also mitigate impacts to groundwater. Management measures to avoid and minimise impacts from waste rock, tailings and ore on surface water quality are listed in Section 7.5.3.2 and will also mitigate impacts to groundwater. In addition, monitoring of groundwater quality will be undertaken to detect potential contamination and to initiate remedial action (GW01).

7.6.3.3 Groundwater Contamination from Accidental Hydrocarbon or Chemical Releases

The management measures listed in Section 7.5.3.3 to mitigate impacts to surface water from hydrocarbon and chemical releases will also mitigate impacts to groundwater. No additional measures are proposed.

7.6.3.4 Groundwater Contamination from Septic Systems

Measures to minimise impacts on groundwater from septic systems will include:

- Locating, constructing and using septic systems according to the Northern Territory *Code of Practice for Onsite Wastewater Management* (NT Government, 2014) (GW02).
- Regularly pumping solids from the septic tank to prevent blockages (GW03).

7.6.3.5 Groundwater Contamination from Final Pit Water

No management measures are proposed to mitigate final pit water interacting with surrounding groundwater.

7.6.4 Residual Impacts

7.6.4.1 Groundwater Contamination from Seepage from the Evaporation Pond

Concentrations of metals and other parameters (e.g., salts and ions) will increase in the proposed evaporation pond during pit dewatering, due to the quality of pit water and the effects of evapoconcentration. Modelling predicts that salinity and metal concentrations in the proposed evaporation pond will reach a maximum in the dry seasons of 2022 and 2023 when forced and natural evaporation will result in minimal water being in the pond (Appendix 3). Seepage of water from the base of the evaporation pond may therefore increase dissolved salt and metal concentrations in underlying groundwater.

The amount of water that will infiltrate to groundwater from the evaporation pond is dependent on the hydraulic properties of the materials beneath the pond, in which regard there is uncertainty (Appendix 3). It is expected that seepage rates will increase as water levels in the pond increase. As such, while concentrations of metals and salts may be highest when there is minimal water in the pond, seepage rates may be lower at this time. Notwithstanding, the groundwater drawdown modelling shows that groundwater from the area of the proposed evaporation pond is within the cone of depression created by pit dewatering during construction and operations (Figure 7.3). Water seeping from the proposed evaporation pond to groundwater is therefore expected to be drawn to the pit rather than migrating away from the pond along the general groundwater water flow path towards the northeast, thus minimising the potential extent of impacts to groundwater.

After approximately five years post-mining, when inputs to the evaporation pond will be from rainwater only, concentrations of dissolved salts and metals in pond water are predicted to decrease below concentrations in groundwater. As such, potential impacts to groundwater from pond water seepage would be limited to construction (i.e., dewatering) and operations, and only initially during the first few years post-closure.

Given the uncertainties around the hydraulic properties of material underlying the evaporation pond, it is conservatively assumed that impacts to groundwater could occur, but these impacts are predicted to be highly localised because groundwater below the evaporation pond is expected to be drawn back to the pit due to the cone of groundwater depression created by pit dewatering. Considering the existing pit water quality, while pH and electrical conductivity (EC) are slightly higher than groundwater, concentrations of most metals and metalloids (except arsenic) are higher in groundwater, noting that evaporation in the pond will increase concentrations during dewatering. Given that groundwater will be drawn back to the pit, even if impacted, impacts would be highly localised. Such highly localised Impacts could occur over the medium term (i.e., up to around eight years) with impacts occurring during dewatering, operations and up to five years post-mining. Although impacts will be highly localised, the magnitude of the impact is assessed as ***Medium***, given the predicted duration of the impacts and the uncertainties. The sensitivity of groundwater is ***Low***, hence the overall impact significance rating for groundwater contamination from seepage in the proposed evaporation pond during construction, operations and closure is ***Low***.

7.6.4.2 Groundwater Contamination from Waste Rock, Ore and Tailings

Waste Rock and Ore

Detail of the geochemical testing of waste rock and ore is provided in Section 3.6.3. In summary, test results indicate that the existing waste rock, NAF waste rock from the Fountain Head pit and stockpiled ore (pre-processing) poses minimal risk to groundwater quality with respect to acidic or neutral metalliferous drainage. Impacts to groundwater from drainage off existing waste rock, NAF waste rock from the Fountain Head pit and ore (pre-processing) is therefore assessed as having a ***Negligible*** magnitude of impact and consequently a ***Negligible*** impact significance for all phases of the Project. Approximately 5% of the material placed in the IWL will be PAF-LC which upon oxidation may produce drainage contained elevated concentrations of some metals (Appendix 6) which could potentially infiltrate groundwater, where a pathway exists. Column leach testing will be conducted to further understand the quality of this drainage (and will inform additional management measures, if required) and PAF-LC material will be placed in the IWL in

such a way as to minimise the potential for infiltration. The magnitude of the impact from PAF-LC drainage is assessed as ***Low***. Given the sensitivity of groundwater is ***Low***, the overall impact significance for groundwater contamination from PAF-LC waste rock placed in the IWL is ***Negligible*** for operations and closure.

A small proportion of waste rock to be removed from the Fountain Head pit will be PAF, and runoff from this material has the potential to mobilise metals and low pH water which could infiltrate and degrade groundwater quality. Ore with a higher sulphur content than that tested may also be PAF; however, the low-sulphur ore material tested was NAF and considered to pose minimal risk to groundwater quality. PAF material will be segregated and runoff from the PAF area will be directed to a dam, designed for a 1 in 100 year 72 hour rainfall event. PAF material will be returned to the pit during closure. Rainfall infiltrating the PAF stockpile and runoff stored in the dam could infiltrate groundwater; however, given groundwater below this area will be drawn back to the pit, even if impacted, impacts to groundwater would be highly localised and limited to the period when the PAF material is stockpiled (i.e., less than three years) given the PAF material will be returned to the pit. Considering this, magnitude of the impact is assessed as ***Low*** for operations and ***Negligible*** for closure. Given the sensitivity of groundwater is ***Low***, the overall impact significance rating for groundwater contamination from PAF waste rock is ***Negligible*** for operations and closure.

Tailings

As described in Section 7.5.4.2, runoff from the tailings could contain elevated arsenic concentrations which could infiltrate groundwater. The tailings will be stored within a clay-lined cell within the IWL to prevent seepage of tailings drainage to groundwater. Runoff from the tailings will be captured within the lined cell in one decant well and used in the process plant or directed to the evaporation pond and will not be discharged to the environment. Additionally, seepage through the clay liner will be collected by a drainage network and directed to the process plant or evaporation pond. Further, any seepage to groundwater from the IWL is expected to be drawn to the pit. The magnitude of the impact for groundwater contamination from water contacting tailings in the IWL is therefore assessed as ***Negligible*** for operations.

During closure, the clay liner below the tailings will remain and the tailings will be covered with a 0.5 m thick layer of clay and an additional 1.5 m of NAF waste rock to create an impermeable layer. This will prevent the infiltration of rainwater which could report to groundwater, where there is seepage through the clay liner and surface soil in the long term. The estimated hydraulic conductivity of soils below the IWL and the vertical seepage flux from tailings stored in the IWL and potential solute transport pathways in shallow groundwater below the IWL were assessed (Appendix 5). While the hydraulic conductivity of soils were found to be highly variable, the results indicate that water seeping through the clay liner would flow towards the Fountain Head pit, with a groundwater mound potentially forming under the IWL, which could increase the horizontal hydraulic gradient towards the pit. The contribution of this seepage to the total groundwater input to the pit would be minimal, representing less than 5% of the annual groundwater influx (Appendix 5). Considering the quality of the seepage from below the IWL, while this water may have slightly higher concentrations of solutes compared to background conditions this is likely to have minimal impact on water quality in the pit due to the small volumes and dilution (Appendix 5). The magnitude of the impact is therefore assessed as ***Negligible*** for operations.

Given the sensitivity of groundwater is ***Low*** the impact significance rating for groundwater contamination due to drainage from the tailings is assessed as ***Negligible*** for operations and closure.

7.6.4.3 Groundwater Contamination from Accidental Hydrocarbon or Chemical Releases

The assessment addresses leaks and spills that are typically incidental (but controllable) as part of construction, operations and closure. Large-scale spills associated with major natural hazards and unplanned events are considered in the Project Risk Register (Appendix 23) and Section 7.13.

Migration of contaminants to groundwater is dependent upon their physical and/or chemical characteristics and the local hydrogeological regime. It will also depend on the volume of any spill or leak and the response and remediation measures initiated.

From a groundwater perspective, contaminants released at the surface will migrate down through the ground under the influence of gravity. Some hydrocarbons would be adsorbed onto soil and retained, whereas others would reach the water table and continue to migrate along the direction of groundwater flow.

Standard good industry practices will be adopted to prevent and protect against ground pollution due to accidental hydrocarbon and chemical spills or leaks during construction, operation and closure activities, and to promptly remediate where it occurs.

With the implementation of these measures, the pathway for contaminants to enter groundwater is expected to be limited and some dilution would be expected to occur in receiving groundwater where a pathway exists (i.e., a minor spill or leak goes undetected). Potentially impacted groundwater would likely be drawn to the pit, due to the cone of depression created by pit dewatering during construction and mining, meaning impacts would be highly localised should they occur. Impacts to groundwater quality are therefore unlikely to be detectable and the magnitude of impact is assessed as ***Negligible***. Given the sensitivity of groundwater is ***Low***, the overall impact significance rating for groundwater contamination from accidental release of hydrocarbons and chemicals during all phases of the Project is ***Negligible***.

7.6.4.4 Groundwater Contamination from Septic Systems

Sewage management will be required during construction and operations. Solids from septic systems will be removed once or twice a year to prevent blockages of the septic tanks. Septic systems will be designed, located and operated in accordance with the Northern Territory *Code of Practice for Onsite Wastewater Management* to minimise potential impacts to groundwater. Considering this, no impacts to groundwater quality from septic systems are expected so the magnitude of the impact is assessed as ***Negligible***. Given the sensitivity of groundwater is ***Low***, the overall impact significance rating for groundwater contamination from septic systems during construction and operations is ***Negligible***.

7.6.4.5 Groundwater Contamination from Final Pit Water Quality

Modelling has been undertaken of water quality expected in the pit following completion of mining, when the pit will be allowed to fill from groundwater inflows (Appendix 3). Water quality in the pit as it refills is therefore expected to be similar to existing quality of groundwater flowing into the pit. A steady-state equilibrium with groundwater inflows is expected 40 years post-closure.

In subsequent years, solutes are predicted to concentrate in the pit lake due to the dominance of evaporation over rainfall, with concentrations predicted to reach about four times existing concentrations in groundwater 500 years post-closure. It is to be noted that this predicted outcome would be the same for the existing pit lake, i.e., without the Project occurring. Due to this evaporative loss of water, the pit lake is expected to act as a long-term groundwater sink drawing surrounding groundwater into the pit lake (Appendix 3).

Given these considerations, pit lake water quality is not expected to notably affect the quality of surrounding groundwater post-closure, and the magnitude of the Project impact is assessed as ***Negligible***. As previously described, the sensitivity of groundwater is ***Low***, the overall impact significance rating for groundwater contamination from pit water post-closure is ***Negligible***.

7.6.4.6 Summary of Residual Impact Assessment

A summary of the groundwater quality impact assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.20.

7.6.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to groundwater quality are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

Table 7.20 – Groundwater Quality Impact Assessment

Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Project Phase	Sensitivity/ Magnitude	Residual Impact Significance
Groundwater	Groundwater contamination from seepage from the evaporation pond	Pit dewatering	None proposed	Construction, operations and closure	Low/Medium	Low
Groundwater	Groundwater contamination from waste rock, ore and ore processing	Waste rock stockpiling/use of NAF material and ore stockpiling	Embedded design controls will include: • SWED08 • SWED09 • SWED10 • SWED12 Mitigation measures will include: • SW06 • SW07 • SW08 • GW01 • SW21	Construction, operations, closure	Low/Negligible	Negligible
		Waste rock stockpiling (PAF-LC)		Operations and Closure	Low/Low	Negligible
		Waste rock stockpiling (PAF material)		Operations	Low/Low	Negligible
		Waste rock stockpiling (PAF material)		Closure	Low/Negligible	Negligible
		Tailings		Operations and Closure	Low/Negligible	Negligible
Groundwater	Groundwater contamination from accidental hydrocarbon or chemical releases	Use of chemical reagents, vehicles, plant and equipment, fuel and chemical handling and storage	• SW10 • SW11 • SW12 • SW13 • SW14 • SW15 • SW16 • SW17	Construction, operations and closure	Low/Negligible	Negligible

Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Project Phase	Sensitivity/ Magnitude	Residual Impact Significance
			• SW18 • SW19 • SW20 • SW22			
Groundwater	Groundwater contamination from septic system	Wastewater management	• GW02 • GW03	Construction and Operations	Low/Negligible	Negligible
Groundwater	Groundwater contamination from final pit water quality	Refilling of Fountain Head pit	None proposed	Closure	Low/Negligible	Negligible

7.7 Terrestrial Ecology

7.7.1 Discipline-specific Approach

The impact assessment approach for terrestrial ecology is consistent with the Project impact significance assessment method adopted in Chapter 6. The assessment of terrestrial ecology is based primarily on desktop and field investigations by Low Ecological Services (LES), detailed in the assessment report attached (Appendix 8). LES (Appendix 8) conducted an assessment to identify which flora and fauna species had a moderate or high likelihood of occurring within the study area, including Matters of National Environmental Significance listed under the *Environment Protection and Biodiversity Conservation (EPBC) Act* and threatened species. This impact assessment identifies threatened flora and fauna with a moderate or high likelihood of occurring in the Project area as environmental values, and addresses the Project potential impacts on these environmental values. No threatened ecological communities as defined under the *EPBC Act* exist in the area and are therefore not assessed.

Terrestrial ecology was not identified as a key environmental factor by the NT EPA, however, impacts to terrestrial flora and fauna have been assessed for completeness.

7.7.2 Potential Impacts

This section describes the potential impacts on terrestrial ecology values that may occur due to Project activities. The Project components and potential impacts are summarised in Table 7.21.

Table 7.21 – Potential Impacts on Terrestrial Ecology

Project Phase	Activity/Aspect	Project Component	Potential Impact
Construction	• Clearing of vegetation • Use of machinery and equipment	Pit expansion; WRS expansion; construction of the gold processing plant, power station, laydown areas, access roads and infrastructure	Habitat loss and degradation: • Direct loss or disturbance of native vegetation and/or fauna habitat • Reduction in native flora species abundance, density and diversity • Reduction in abundance of threatened flora species and their likelihood of recovery • Reduction in native fauna species abundance density and diversity as a result of habitat loss and fragmentation • Reduction in habitat for threatened fauna species and their likelihood of recovery • Reduction in habitat for migratory species, resulting in disruption of migration patterns
Construction, Operation, Closure	Dust emissions	Pit expansion; WRS expansion; construction of the gold processing plant, power station,	Excessive dust deposition resulting in damage to flora and degradation of vegetation, and therefore habitat for fauna

Project Phase	Activity/Aspect	Project Component	Potential Impact
Construction, Operation, Closure		laydown areas, access roads and infrastructure general vehicle movements; haulage of material; mining and processing of ore; drilling and blasting	Adverse health impacts to fauna
Operation	Light emissions	Vehicles; operation of the gold processing plant; administration, crib and supporting facilities	Altered fauna behaviour and use of local habitat as a result of increased artificial light
Construction, Operation, Closure	Noise and vibration	Vehicles; machinery and equipment; blasting; operation of the gold processing plant	Altered fauna behaviour and use of local habitat
Construction, Operation	Water extraction and flow	Mining; dust suppression; construction of the gold processing plant; power station, laydown areas, access roads and infrastructure	Changes in surface water and groundwater quantity and flow patterns impacting riparian vegetation
Construction, Operation, Closure	Clearing of vegetation, use of machinery and equipment, general vehicle movements	General vehicle movements; haulage of material; pit expansion; WRS expansion; construction of the gold processing plant; power station, laydown areas, access roads and infrastructure	Increased density and distribution of weeds already present, which compete with native flora, resulting in reduced species and abundance of native species
Construction, Operation, Closure			Introduction of new weed species, which compete with native flora, resulting in reduced native species diversity and abundance
Construction Operation	Clearing of vegetation, domestic waste	Pit expansion; WRS expansion; operation of the gold processing plant; power station, laydown areas, access roads and infrastructure; operation of crib and administration facilities	Increase in introduced fauna leading to reduction in population sizes of native species, from increased predation pressures
Construction, Operation, Closure	Project vehicle movements	Transport of Project personnel, machinery, and equipment; haulage of material	Injury or death of fauna as a result of vehicle collision
Operation, Closure	Rehabilitation/ revegetation	Rehabilitation of WRS; areas disturbed during construction and operations	Ongoing localised reduction in vegetation health or structural diversity if site rehabilitation is unsuccessful

7.7.2.1 Habitat Loss and Fragmentation

Clearing of native vegetation can impact threatened flora and fauna species due to habitat loss or disturbance, involving the modification, destruction, removal or isolation, or a decrease in habitat availability or quality (Appendix 8). Disturbance or loss of important fauna breeding habitat can

also potentially disrupt the breeding cycle of a population (Appendix 8). The direct removal of individual flora species can also result in a decline in species abundance, diversity, density or distribution. Vegetation clearing and disturbance of habitat can result in the fragmentation of habitat for fauna, preventing dispersal of an existing population between areas of remnant suitable habitat (Appendix 8; Fahrig, 2003). The Project will involve the clearing of vegetation for the expansion of the existing pit, the WRS expansion and construction of the gold processing plant, power station, laydown areas, access and on-site haul road and other supporting infrastructure. The Project area is surrounded by intact vegetation, however the site itself is highly disturbed from previous mining and pastoral activities.

Native Vegetation and Habitat Types

Five habitat and land classifications occur in the Project area (Section 4.7). The habitat within the Project area is predominantly open woodland on sandstone plain, comprising 64.74% of the vegetation in the Project area (Table 7.22), however it should be noted that this habitat is not intact and has been disturbed for previous mining and pastoral activity. Previously disturbed areas used for mining, tracks, pit lakes and water storage dams are the second most common (25.99% of the Project area). The proposed clearing of vegetation for Project infrastructure is 74.46 ha, of which the majority is open woodland on sandstone plain (71.08 ha). Open forest on alluvial floodplain (1.35 ha to be cleared) and creek lines and riparian zones (2.03 ha) will also be impacted by the vegetation clearing.

Table 7.22 – Extent of Habitat Types and Area to be Cleared

Habitat and Land Classification	Extent of Habitat Type – Project Area		Area to be Cleared
	ha	%	ha
Open forest on alluvial floodplain	43.85	6.91	1.35
Open woodland on sandstone plain	410.82	64.74	71.08
Creek lines and riparian zones	14.99	2.36	2.03
Disturbed area* (pastoral, mining, tracks, pit lakes and tailing dams)	164.92	25.99	-
Total	**634.58**	**-**	**74.46**

Source. Appendix 8.
* Proposed clearing of vegetation within existing disturbed areas is not calculated as vegetation area to be cleared.

Threatened Flora

Threatened flora species present in the study area may be directly or indirectly impacted through the clearing of vegetation during the construction phase of the Project, either through the direct removal of individual species or the clearing or fragmentation of potential habitat. Two flora species listed as threatened under the *EPBC Act*, *S. ensatum* and A*. praetermissa*, were assessed as potentially occurring within the study area, although neither were identified during targeted surveys (Section 4.7). Suitable habitat for *A. praetermissa* has been identified within the study area, and the species can resprout from a perennial root base and therefore may not have been detectable at the time of the surveys (Appendix 8). As such the species may still occur within the Project area, and the residual likelihood of occurrence of *A. praetermissa* was assessed as moderate (Appendix 8).

Although also not detected during ground-surveys, potential habitat for *S. ensatum* was identified in the Project area, north of the Fountain Head production area, within the open forest on alluvial plains habitat type. *S. ensatum* inhabits areas with a continual supply of moisture, either on the surface or near the surface of moist organic soils that are typically clayey (Appendix 8). Ground-surveys did not indicate that such areas existed during the dry season. Therefore the residual likelihood that *S. ensatum* occurs within the study area was assessed as low (Appendix 8). Furthermore, of the open forest on alluvial plains habitat type, only 1.35 ha will be cleared, equal to approximately 3% of its total extent of the habitat type within the Project area.

Given the residual potential for both threatened flora species to occur in the area, the clearing of potential habitat, although minor in regard to the loss of overall existing vegetation, may result in the loss of undetected individuals of *A. praetermissa* and *S. ensatum*, or the loss of vegetation that provides suitable habitat for these species. Clearing of vegetation will be minimal, and mitigation measures will be implemented to reduce the potential for the loss of threatened flora and will minimise disturbance to habitat.

Threatened Fauna

The Merten's water monitor (vulnerable under the *Territory Park and Wildlife Conservation (TPWC) Act*) was the only threatened fauna species identified as occurring within the Project area, having been anecdotally recorded prior to site surveys, close to the Fountain Head Lake. The water monitor is semi-aquatic and inhabits natural water bodies and watercourses, and human-made water bodies such as dams or pits (Appendix 8). As described in Section 4.5, all natural watercourses near the Project area such as the Margaret River and associated tributaries are ephemeral or intermittent, in addition to the flow paths on site. However some watercourse sections retain water in deeper pools or stands of water which can remain for longer periods of time. Given the number of human-made pit lakes and dams in the Project area, in addition to the natural water sources, the Merten's water monitor is considered highly likely to be a resident species throughout the study area (Appendix 8) opportunistically utilising the Fountain Head Lake and nearby waterways, which are located very close to the Project area, in particular the stream running to the north. As such, it is considered likely that the Merten's monitor occurs in the Project area (Appendix 8).

Project activities resulting in the reduction in the Merten's water monitor's opportunistic utilisation of the existing Fountain Head Lake would not be considered as habitat loss for this species, as the lake is not a natural feature but remnant infrastructure from past mining activities. In addition, the key threatening process for the Mertens water monitor in the Northern Territory is the introduction of the invasive cane toad (discussed in Section 7.7.2.7). Furthermore, habitat loss has not been identified as a threat to the Merten's water monitor in the specialist ecology study (Appendix 8).

Other EPBC and NT listed threatened fauna that may occur within the study area, having been assessed as having a moderate or high likelihood of occurring within the study area, are presented in Table 4.29 (Section 4.7) and Appendix 8, however none of these species were recorded during site surveys. Potential impacts to each species will most likely occur in relation to the total area cleared for each habitat type, and the habitat each threatened species typically utilises. Species that inhabit open woodland are most likely to be impacted given open woodland on sandstone plains comprises the majority of new vegetation clearance (71.08 ha). Clearing of

open forest on alluvial plain (1.35 ha) and riparian vegetation (2.03 ha) will be minimal, and as such species that inhabit these areas have lower potential to be impacted. In regard to riparian vegetation, clearing is not expected to occur within close proximity to the waterway running through the north of the Project lease area (Figure 3.3), reducing the potential impact to threatened species that inhabit these areas.

Species with a high likelihood of occurring in the study area most likely to be impacted by the clearance of 71.08 ha of open woodland or 1.35 ha open forest include the eastern subspecies of the Partridge pigeon, and the masked owl. The Partridge pigeon predominantly inhabits lowland eucalypt open forest and woodland with grassy understorey (Appendix 8, Woinarski 2006), while the northern subspecies of the masked owl mainly inhabits eucalypt tall open forest (Appendix 8, Woinarski & Ward, 2012a). The pale field rat, which typically inhabits dense vegetation occurring alongside creeks, and the Mitchell's water monitor, which inhabits edge areas of watercourses and waterbodies (Appendix 8), also are species with a high likelihood of occurring in the study area and have potential to be impacted by the clearing of 2.03 ha of riparian vegetation.

For species with a moderate likelihood of occurring in the study area, the northern brush-tailed phascogale (Appendix 8) is most likely to be impacted by the clearance of open forest, as most of the limited number of records of the species are from tall open forest dominated by eucalyptus species *E. miniata* and *E. tertodonta* (Appendix 8, Woinarski & Ward, 2012b). The red goshawk inhabits tall open eucalypt forest and riparian areas, and is therefore potentially impacted by the combined clearing of both habitat types. The critically endangered (*EPBC Act*) curlew sandpiper inhabits coastal and brackish lagoons, intertidal mud and sand flats, estuaries, saltmarshes and at times inland freshwater wetlands, (Appendix 8) and is most likely to be most impacted by the clearing of riparian vegetation. The floodplain monitor inhabits coastal beaches, floodplains, grasslands and woodlands (Appendix 8), and is therefore potentially impacted by the clearance of open woodlands and riparian vegetation. Ghost bats may occur in caves, rocky areas or suitable mining infrastructure such as mine shafts (Appendix 8), however no suitable habitat was identified within the Project area, nor is any remnant infrastructure suitable for inhabitation by the Ghost bat.

Migratory Species

The clearing of native vegetation has the potential to result in the direct loss or disturbance to habitat that supports migratory species, and the fragmentation of suitable habitat over the broader region. This has the potential to result in a decrease in the abundance and distribution of migratory species utilising the Project area. A total of 18 listed migratory species were identified as potentially occurring in in the Project area (EPBC Protected Matters Search Tool (PMST)) although none were observed during ground surveys. Only non-listed migratory species were recorded in the Project area, specifically the rainbow bee-eater and the great egret (Section 4.7).

Of the listed-migratory species, the curlew sandpiper (moderate likelihood of occurrence) is the only listed migratory species also listed as threatened. As above, the curlew sandpiper will be mostly likely impacted by the clearing of riparian vegetation, although this is expected to be minimal. The eastern curlew typically inhabits mangrove areas and can also occur within intertidal flats and saltmarshes, and as such the habitat of the species would not be expected to be impacted by the Project. As the site is already highly disturbed (see Table 7.22) potential habitat for migratory species is already somewhat degraded or fragmented from previous land clearing.

7.7.2.2 Increased Dust Emissions

The Project has the potential to cause increased dust emissions from Project activities such as, vegetation clearing, increased vehicle movements, drilling and blasting, handling and haulage of waste rock and ore, excavation and wind erosion from exposed surfaces. Vegetation clearing during construction will result in soil previously covered by vegetation being exposed to erosion from wind, and no longer bound by roots or protected by vegetative matter. Disturbance of areas not currently vegetated may also lead to increased wind erosion as the protective surface crust is removed. Increased dust emissions can lead to increased dust deposition on vegetation, reducing conditions favourable for plant growth, and subsequently reducing the health of vegetation. Dust deposition on vegetation can reduce the amount of light reaching photosynthetic pigments on leavers (Appendix 8) and allow the penetration of phytotoxic gaseous pollutants and increase leaf temperature (Appendix 8). These affects can decrease the productivity of plants and result in changes to plant community structure (Appendix 8, Sharifi, et al., 1997, Farmer, 1993). Reduced growth of vegetation, and reduced seed sets, can be caused by dust deposition levels as low as 0.2 g/m and can also exacerbate impacts from insects, pathogens or drought (Farmer, 1993, Appendix 8).

Increased dust emissions can also impact the health of fauna through the inhalation of excessive or contaminated dust (Appendix 8). Predicted ground-level concentrations of PM_{10}, $PM_{2.5}$ and dust deposition at a distance of 5.5 km east of the Project are expected to comply with respective guidelines for human exposure, as discussed in the impact assessment to air quality (see Section 7.2). While there is no relevant guideline value for fauna, it is likely that dust emission concentrations much lower than guideline values for humans will be required to prevent health impacts to fauna (Appendix 8). Fauna have a higher rate of inhalation per unit body mass than humans (Appendix 8, Newman & Schreiber, 1988), and as such impacts can be considered be of a higher magnitude than human receptors. The predicted ground-level concentration of dust deposition is 0.05 g/m^2 per month, however predicted concentrations are considered conservative and do not account for dust depletion from rainfall or wind dispersal.

7.7.2.3 Increased Noise, Vibration and Light

Noise and Vibration

The Project will generate noise and vibrations, which can disturb species and lead to their avoidance of the Project area. Noise and vibration will be generated during both construction and operations. Potential sources will include the operation of fixed and mobile sources, such as vehicles and their reversing alarms, machinery including drills, loaders, haul trucks, and excavators, blasting, and gold processing plant including crushers, vibrating screens, mills and compressors. Impacts of increased noise levels vary by species, and are dependent on the duration, volume and regularity of the noise emissions (Appendix 8, Shannon, et al., 2016). While for some species recurring exposure to additional noise can result in tolerance or habituation, this is not always the case for other species which may respond with avoidance (Appendix 8; Shannon, et al., 2016). Fauna responses to noise have been reported to begin at approximately 40 dB(A) (Shannon, et al., 2016), while noise modelling estimated noise levels at the nearest receptor, the Grove Hill Hotel, for both construction and operations at lower than this level, at 31 dB(A) (see Section 7.3).

Additional potential impacts from noise include changes in vocal behaviour, changes in predator avoidance and foraging behaviours, sensory degradation, distraction from, or inability to detect, cues within the environment such as predators or prey, direct pain, and elevated stress levels (Appendix 8). Increased noise levels may also provide shelter from more noise-sensitive predators (Appendix 8, Shannon, et al., 2016). Once blasting activities commence, species are likely to disperse and avoid the area in which blasting is occurring. Seismic waves from blasting activities can be experienced at long distances, although no reports on impacts to fauna from vibrations are available in literature (Appendix 8). Modelled blasting and vibration levels are all predicted to be below the relevant criteria, as shown in Table 7.14.

Light Emissions

Light emissions will increase in the area as a result of the Project, and this can impact fauna by disturbing their natural sleep patterns, or their natural daily activity patterns (Appendix 8). As such, increased emissions of artificial light can result in the degradation of habitat for fauna, and the altered use of habitat, or displacement of, impacted fauna. Fauna predation success, increased exposure of nocturnal prey to predators, attraction of or long-term decline in insect populations, changes to bird calling behaviour, and interference with the navigation of migratory or nocturnal species all can occur as a result of increased artificial light (Appendix 8 , Perry, et al., 2008, Longcore & Rich, 2004). Potential sources of light pollution will occur during the operations phase only, as construction activities will be limited to day shift only, and no accommodation will occur on site. Operations will occur 24-hours per day, with artificial light being used during the night shift. Artificial lighting will be largely concentrated around the production area, including the crib, administration building, gold processing plant and other supporting infrastructure and facilities. Artificial light emissions will also occur along the on-site haul road from vehicles; however this is expected to be temporary only and minimal as haulage of ore will not occur during the night (Appendix 8). Artificial lighting along the existing access road may increase as a result of increased Project traffic; however light emissions along this route will already be an existing impacting factor.

7.7.2.4 Invasion or Increase in Weeds and Introduced Fauna

Introduced Weeds

The Project has the potential to impact native flora and fauna through the introduction of weeds from outside the Project area, and the additional spread of weeds already within the Project area. The spread or introduction of weeds may occur as a result of an increase in machinery and equipment entering the Project area, vegetation clearing and construction activities, from vehicle transport of personnel, and the movement of equipment and material throughout the Project life. Seeds or vegetation material may be attached to vegetation clearing equipment, vehicles wheels, tracks or other machinery parts. Introduced weeds have the potential to result in the loss and disturbance of native vegetation, the degradation of habitat for native and threatened fauna, and the reduction in abundance, density and distribution of threatened flora species. Specifically, introduced weeds can result in changes to existing habitat structure, the availability of food and shelter for native fauna, and alterations in the natural fire regime of the area (Appendix 8). As described in Section 4.7, five introduced flora species have been identified within the Project area; gamba grass, rubber bush, grader grass, couch grass and wild passionfruit, all of which are declared weeds under the *NT Weed Management Act* (Table 4.27). The invasion of introduced

grasses in northern Australia is listed as a key threatening process under the *EPBC Act* as introduced grasses often outcompete native understorey species and result in the thickening of midstorey vegetation (Appendix 8), altering habitat structures.

Gamba grass, which is prevalent within the Project area, is likely the introduced weed of most significant threat to existing native vegetation and habitat for native fauna, given it is the only identified weed species in the Project area declared as a WoNS and classified as invasive under the *EPBC Act*. Gamba grass is concentrated around the existing pit, along the fence adjacent to the train line, and spread within already disturbed areas. As such, the potential spread of these introduced weeds will most likely be associated with the expansion of the existing pit, and the movement of vehicles, machinery and equipment through pre-existing disturbed areas where weeds are already present.

Introduced Fauna

Project construction and operations also have the potential to create conditions favourable for increased abundances of introduced fauna. The introduction or increase of introduced fauna has the potential to result in degradation of habitat of native fauna, or the direct loss of conservation significant fauna and flora species as a result of the spread of diseases, damage to habitat, increased competition, and predation of native species. Numerous introduced fauna species are already present within the area and include feral pigs, cattle and cane toads were recorded during field surveys (see Section 4.7). Feral dogs, house mice, Asian house geckos, flowerpot blind snakes and rock doves, while not recorded during site surveys, could be present or have the potential to occur in the Project area. As such, the Project area is considered to have already been disturbed by existing introduced fauna or pests.

Project activities may exacerbate existing conditions for introduced fauna, or present new opportunities for the introduction of additional pests. Cane toads, which are already present in the Project area, and are widespread throughout the Northern Territory (Appendix 8), are a key threatening process to native species, including the Merten's water monitor, Mitchell's water monitor and the floodplain monitor, which can ingest cane toads resulting in death. Existing cane toad populations may be further dispersed as a result of Project traffic and transport, and as such, the ecological issue may become exacerbated if not appropriately managed.

If not well managed, domestic waste (mostly food) can provide food and habitat for introduced fauna (Appendix 8), as introduced species such as feral pigs or black rats may be attracted to increased resource availability. An increase in the supply of such food or habitat can result in greater reproductive success of introduced fauna (Appendix 8) leading to increased introduced fauna populations and an increase in the magnitude of impacts from existing introduced species, including the spread of disease, alterations to habitat, or predation and competition with native fauna. Feral pigs can spread diseases such as leptospirosis, which can infect native fauna, and *Phytophthora cinnamomi* (NT Government, 2020b), a fungus listed as a key threatening process under the *EPBC Act* which can result in dieback of native vegetation.

Feral pigs also degrade native habitat through the trampling of vegetation, and amongst other introduced herbivores, also consume native vegetation which results in the direct mortality and loss of native flora and can create changes in habitat structure (Appendix 8).

Domestic waste generated by the site crib and administration office has the potential to further encourage introduced fauna species into the Project area, or to increase existing introduced fauna abundance and impacts. Mitigation measures to be implemented to minimise this potential impact will be required, and are provided in Section 7.7.3 below.

The clearing of vegetation during construction may increase the pathways of introduced predators, such as feral cats, through the Project area, providing access to more areas than prior to the Project (Appendix 8). An increase in abundance of feral cats in the Project area is likely to increase predation pressure on native bird, reptile and mammal species, leading to a reduction in their population size. Predation by introduced cats is also listed under the *EPBC Act* as a key threatening process, and is recognised as one of the most significant threats to native fauna (Appendix 8). Mitigation measures for reducing the potential impact of increased predation on native fauna as a result of Project activity are provided in Section 7.7.3.

7.7.2.5 Vehicle Collisions

Increased traffic from Project vehicles transporting machinery and equipment during construction, and supplies, materials and personnel during operations, has the potential to result in an increase in vehicle collisions with native fauna, and therefore increased fauna injury or death. Impacts will be contained to the existing transport route, access road, and to a much lesser extent production areas. Collisions are considered more likely along the access road than production areas given vehicles will be traveling at higher speeds along these roads. The potential for vehicle collisions is also especially high at night when visibility is reduced (Appendix 8). Slow-moving, nocturnal and easily startled animals are considered particularly at-risk from vehicle strikes, while species that interact in large groups are most at risk of population level impacts due to the potential for the death of multiple individuals in a single collision (Appendix 8). Vehicle strikes may increase the number of carcasses in the Project area, resulting in an increase of predators and increased predation on native fauna.

7.7.3 Mitigation and Management Measures

7.7.3.1 Clearing of Vegetation and Use of Machinery and Equipment

Measures to minimise habitat loss and degradation impacts due to clearing of vegetation and use of machinery and equipment will include:

- Location of Project infrastructure in previously disturbed areas where practicable (TE001).
- Implementation of vegetation clearing approvals process (LS01).
- Training of environmental staff to recognise threatened flora species: *A. praetermissa* and *S. ensatum* (TE004).
- Site walkover prior to clearing to ensure threatened flora are not present (TE048).
- Reporting of *A. praetermisssa* and *S. ensatum* to the DENR if found in the Project area (TE047).
- Avoid clearing of mature trees more than 15 cm DBH where practically feasible (TE003).

- Site walkover prior to clearing by experienced personnel to prevent direct mortality of fauna (TE005).

7.7.3.2 Dust, Light and Noise Emissions

Measures to minimise impacts due to Project dust, light and noise emissions will include:

- Sustainable use of water to control dust emissions in production areas (TE006).
- Implement speed limits in accordance with the Project traffic management plan (TE007).
- Use of water spray on screening and crushing (TE008).
- Progressive rehabilitation of the WRS (TE011).
- Progressively rehabilitate areas as activities cease (TE012).
- Location of Project infrastructure in previously disturbed areas where practicable (TE001).
- Implement minimum lighting requirements required for safe operation (TE015).
- Angle lighting towards the ground where possible to minimise light pollution outside of the proposal area (TE016).
- Vehicles and equipment creating noise to be turned off when not in use (TE017).
- Noise reduction measures implemented on machinery where available and practically feasible (TE018).
- Operations producing loud noises to be kept to the minimum required for operations to occur (TE019).
- Vehicles and equipment creating vibrations to be turned off when not in use (TE020).
- Operations producing vibrations to be kept to the minimum required for operations to occur (TE021).

7.7.3.3 Invasion or Increase in Weeds and Pest Animals

Measures to minimise impacts due to an increase or invasion in weeds and introduced fauna will include:

- Develop and implement weed management plan, including weed identification guides with photos for common weeds on-site and register for reporting any sightings of weeds or potential weeds (TE022).
- Inspection and wash-down of all vehicles, machinery and equipment that enters the proposal area for weeds, vegetation material and introduced fauna such as cane toads (TE023).

- Inspection and wash-down of all vehicles, machinery and equipment that travel from an area within the proposal area where a weed infestation occurs into an area where it does not (TE024).
- Implementation of vegetation clearing approvals process (LS01).
- Minimise the time between vegetation being cleared and the area being used for proposal requirements (TE026).
- Implementation of accepted weed control measures where weeds have established in areas previously identified as being weed free. Obtain expert advice from the NT Government Weeds Branch or a qualified ecologist (TE027).
- Regular monitoring and weed control where the density of weeds is increasing (TE028).
- Stockpiles to be monitored for weeds and control programs implemented as required (LS15).
- Remove weeds prior to seeding where practically feasible (TE030).
- Rehabilitation of disturbed areas as soon as possible, and is possible, prior to the subsequent wet season, to minimise the likelihood of weeds becoming established (TE031).
- Develop a no tolerance policy to the introduction of weeds by contractors, suppliers and personnel (TE032).
- Regular monitoring of the proposal area to identify any new weed species present on-site (TE033).
- Control of existing and new feral predator populations by licensed personnel (TE034).
- Implement no tolerance policy for the introduction and feeding of introduced species by contractors, suppliers or personnel (TE036).
- Removal of food waste from site on a regular basis where practically feasible (TE038).
- Perimeter fencing to prevent introduced species and livestock access to the production areas (TE039).

7.7.3.4 Increased Traffic and Project Vehicles

Measures to minimise impacts due to an increase in traffic and Project vehicles will include:

- Develop and implement a Project traffic management plan and induct all staff, contractors and suppliers in accordance with the plan (TE001).
- Implement speed limits in accordance with the Project traffic management plan (TE007).
- Prohibit off-road driving from non-designated routes (TE041).

- Develop and maintain a fauna register to be kept on-site that includes reporting of vehicle strike (TE042).

7.7.3.5 Rehabilitation / revegetation

Measures to minimise failed rehabilitation success/revegetation efforts will include:

- Minimise areas impacted by mining activities (TE045).
- Minimise area of clearing as far as practicable (AQ008).
- Progressive rehabilitation of the WRS (TE011).
- Progressively rehabilitate areas as activities cease (TE012).

7.7.4 Residual Impact Assessment

This section describes the outcomes of the residual impact assessment, assuming the successful implementation of recommended avoidance and mitigation measures (detailed in Section 7.7.3).

7.7.4.1 Impacts to Threatened and Migratory Species

The terrestrial ecology environmental values identified as being the most sensitive to Project activities are threatened flora and fauna, and migratory fauna, occurring, or potentially occurring, within the Project area. All threatened flora and fauna, and migratory fauna, have been ranked with a high sensitivity given their listing under the *EPBC* and *TPWC acts*.

Threatened Flora

Threatened flora species potentially occurring in the Project area included *S. Ensatum* and *A. praetermissa*. These species were not recorded within the Project area during targeted surveys. *S. ensatum* was assessed as having a low residual likelihood of occurring in the Project area, and only 0.42 ha of potential habit for *S. ensatum* species is proposed to be cleared, approximately 1% of the existing area of this habitat type. *S. ensatum* can resprout from a perennial root base and therefore may not have been detectable during these surveys (Appendix 8). *A. praetermissa* was assessed as having a moderate residual likelihood of occurring in the Project area. Both species, if found on site during walkovers will require a permit from DENR to be relocated, in consultation with the NT Herbarium. With the implementation of this procedure if species are located and management measures described in Table 7.23, vegetation clearing, and habitat loss or disturbance will have a Low impact magnitude on threatened flora. The significance of residual impacts to these sensitive receptors is therefore considered ***Moderate***.

Threatened Fauna

Threatened fauna may occur within the Project area, despite no threatened fauna species being identified during targeted surveys. The habitat types within the Project area could potentially support these species, although the area is already considerably disturbed, and these habitats may no longer be suitable. Further clearing of the disturbed site will be minimal and will consist of one habitat type predominantly: open woodland on sandstone plain habitat (71.08 ha). The loss of this habitat is not significant given that more intact, or less disturbed habitat is available adjacent to the Project area, as such the magnitude of the impact to threatened fauna is assessed as ***Negligible*** and the overall significance of the impact ***Negligible***.

Listed or Threatened Migratory Fauna

No listed-migratory species were recorded during site surveys, although migratory species may still utilise the area. The habitat types within the Project area could potentially support these migratory species, although as the area is already considerably disturbed, and these habitats may no longer be suitable. Further clearing of the disturbed site will be minimal and more adequate intact habitat is available adjacent to the Project area, as such, the magnitude of the impact to threatened fauna is also assessed as ***Negligible*** and the overall significance of the impact considered to be ***Negligible***.

7.7.4.2 Impacts to Native Vegetation and Habitat

In addition to clearing of vegetation, degradation of habitat and native vegetation, may occur through the impacting process of increased dust emissions and potentially unsuccessful rehabilitation. Existing vegetation and habitat types in the Project area are largely disturbed or already fragmented, with invasive species present and no threatened or migratory species recorded inhabiting the area during site surveys. As such the sensitivity of native vegetation and habitat is ranked as ***Low***. This sensitivity rating has been applied for the following impacts.

Increased Dust Emissions

Dust emissions and dust deposition volumes on vegetation are expected to be reduced via the mitigation measures in Section 7.7.3.2 and high rainfall, characteristic of the region. As such, dust deposition is expected to be short-term and localised, and the magnitude of impacts to vegetation and habitat is considered to ***Negligible***. The residual impact significance of increase dust emissions to vegetation and habitat will therefore be ***Negligible***.

Unsuccessful Rehabilitation

The magnitude of impacts to vegetation as a result of unsuccessful rehabilitation are considered to be ***Negligible*** given the minimal clearing of vegetation proposed, the disturbed nature of the site, the progressive approach of rehabilitation to be implemented, and the short term and localised nature of the impacts. The residual impact of unsuccessful rehabilitation to native vegetation is therefore ***Negligible***.

7.7.4.3 Native Flora and Fauna

Native flora and fauna including migratory (i.e., those not listed as threatened or listed or threatened migratory) are considered to have a ***Low*** sensitivity given they do not have a statutory listing and absence of presence during the surveys. This sensitivity rating has been applied for the following impacts.

Introduction and Spread of Weeds

The magnitude of potential impacts from the spread of existing and new weed species is considered ***Medium***, given the presence and density of existing weeds in the area, mitigated through management measures such as vehicle inspections, residual significance has been assessed as ***Low***. The impact magnitude for the introduction of new weeds is ranked ***Medium***. If effectively controlled, the introduction of new weed species could be short term, however the impacts may not be localised if they were to spread further than where they were initially established as a result of Project activity. As such the significance of residual impacts of the introduction of new weed species is assessed as ***Low***.

Introduced Fauna

The impact magnitude for the introduction of introduced animals is ranked ***Medium*** given the recording of several species within the Project area during ground surveys. Introduced fauna already exist across the Project area, and therefore the negative impacts to native flora and fauna species such as the spread of disease, habitat damage, increased competition and predation, are already a current condition in the area. Introduction of further individuals is unlikely to have further negative impact; however the introduction of new introduced fauna species could present new stresses to native flora and fauna. As such, the significance of residual impacts has been assessed as ***Low***.

Clearing of Vegetation and Habitat

The magnitude of impacts to native fauna and flora from the clearing of vegetation and habitat are considered to be ***Low***. Further clearing of the disturbed site will be minimal and will consist of one habitat type predominantly: open woodland on sandstone plain habitat (71.08 ha). The loss of this habitat is not significant given that more intact, or less disturbed habitat is available adjacent to the Project area. The residual impact of vegetation clearing to native vegetation is therefore ***Negligible***.

Increased Dust Emissions

Dust emissions are likely to be short term, and are predicted to be below expected air quality criteria for human exposure, although fauna are likely to be more susceptible. The implementation of mitigation measures such as watering of haul roads, stockpiles and ore and progressive rehabilitation, is expected to be sufficient to manage dust emissions as a result of Project activity. With the successful implementation of these measures the impact magnitude is assessed as ***Negligible*** and the residual impact significance is also therefore ***Negligible***.

Light Emissions

Light emissions at night will be localised to the production area during Project operations. With the implementation of mitigation measures described in Section 7.7.3.2, the magnitude of the impact is considered ***Negligible*** and the residual impact significance is therefore assessed as ***Negligible***.

Noise and Vibration

Project noise for construction and operation (combined for worst case scenario) predicts that at the nearest receptor (approximately 5 km from the Project area) noise levels will be 31 dB(A). Fauna responses to increases in ambient noise are reported at approximately 40 dB(A). Predicted blasting and ground vibration levels are also below the relevant criteria. As such the impacts will be localised and not significantly above existing levels, and the impact magnitude is therefore considered ***Low***. The residual impact significance is therefore also considered to be ***Negligible***.

Vehicle Strikes

Vehicle strikes to fauna will be limited to areas in which vehicles operate, and will be mitigated through the implementation of the Project traffic management plan. Hauling of ore will all occur on site, reducing the likelihood of the impact occurring, as such the impact magnitude is considered ***Negligible*** and as such the residual impact is also ***Negligible***.

7.7.4.4 Summary of Impact Assessment

A summary of the terrestrial ecology impact assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.23.

7.7.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to terrestrial ecology are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

Table 7.23 – Terrestrial Ecology Residual Impact Assessment Summary

Project Phase	Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Sensitivity/ Magnitude	Residual Impact Significance
Construction	Native vegetation and habitat for fauna	Direct loss or disturbance of native vegetation and/or fauna habitat	Clearing of vegetation; use of machinery and equipment	• TE001 • LS01 • TE004 • TE048 • TE047 • TE003 • TE005	Low/Low	Negligible
	Native flora	Reduction in native flora species abundance, density and diversity	Clearing of vegetation; use of machinery and equipment		Low/Low	Negligible
	Threatened flora	Reduction in abundance of threatened flora species and their likelihood of recovery	Clearing of vegetation; use of machinery and equipment		High/Low	Moderate
	Native fauna	Reduction in native fauna species abundance density and diversity as a result of habitat loss and fragmentation	Clearing of vegetation; use of machinery and equipment		Low/Low	Negligible
	Threatened fauna	Reduction in habitat for threatened fauna species and their likelihood of recovery	Clearing of vegetation; use of machinery and equipment		High/ Negligible	Negligible
	Listed or threatened migratory fauna	Reduction in habitat for migratory species, resulting in disruption of migration patterns	Clearing of vegetation; use of machinery and equipment		High/ Negligible	Negligible

Project Phase	Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Sensitivity/ Magnitude	Residual Impact Significance
Construction, Operation, Closure	Native vegetation and habitat for fauna	Excessive dust deposition resulting in to damage to vegetation and fauna habitat	Dust emissions	• TE006 • TE007 • TE008 • TE009 • TE011 • TE012 • TE001	Low/Negligible	Negligible
Construction, Operation	Native fauna	Adverse health impacts to fauna from increased dust emissions	Dust emissions		Low/Negligible	Negligible
Operation	Native fauna	Altered fauna behaviour and use of local habitat as a result of increased artificial light	Light emissions	• TE015 • TE016	Low/Low	Negligible
Construction, Operation, Closure	Native fauna	Altered fauna behaviour and use of local habitat as a result of increased noise and vibrations	Noise and vibration	• TE017 • TE018 • TE019 • TE020 • TE021	Low/Low	Negligible
Construction, Operation, Closure	Native vegetation and habitat for fauna Native flora	Increased density and distribution of weeds already present, which compete with native flora, resulting in reduced species and abundance of native species	Use of machinery and equipment; general vehicle movements	• TE022 • TE023 • TE024 • LS001 • TE026 • TE027 • TE028	Medium/Low	Low

Project Phase	Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Sensitivity/ Magnitude	Residual Impact Significance
Construction, Operation, Closure	Native vegetation and habitat for fauna Native flora	Introduction of new weed species, which compete with native flora, resulting in reduced native species diversity and abundance	Use of machinery and equipment; general vehicle movements	• LS15 • TE030 • TE031 • TE032 • TE033	Medium/Low	Low
Construction, Operation, Closure	Native fauna	Increase in introduced fauna leading to reduction in population sizes of native species, from increased predation pressures	Use of machinery and equipment; domestic waste	• TE033 • TE034 • TE036 • TE038 • TE039	Medium/Low	Low
Construction, Operation, Closure	Native fauna	Injury or death of fauna as a result of vehicle collision	General vehicle movements	• TT01 • TE007 • TE041 • TE042	Low/Negligible	Negligible
Operation, Closure	Native vegetation and habitat for fauna Native flora	Ongoing localised reduction in vegetation health or structural diversity if site rehabilitation is unsuccessful	Rehabilitation / revegetation	• TE045 • AQ008 • TE011 • TE012	Low/Negligible	Negligible

7.8 Aquatic Ecosystems

7.8.1 Discipline-specific Approach

The significance assessment method described in Chapter 6 was used to qualitatively assess impacts relevant to the environmental factor of aquatic ecosystems. This considers the sensitivity of the resource/receptor and magnitude of the impact on that resource/receptor as defined in Table 6.3 and Table 6.4, respectively, and the significance assessment matrix shown in Table 6.5.

The sensitivity of aquatic ecosystems is considered with regard to the NT EPA objective of protecting aquatic ecosystems to maintain the biological diversity of flora and fauna and the ecological functions they perform. This also inherently considers the environmental value of ecological health, associated with the environmental factor inland water environmental quality discussed in Sections 7.4, 7.5 and 7.6).

The impact assessment addresses potential impacts to aquatic ecosystems but does not consider potential impacts to aquatic ecology within man-made mine-associated water bodies constructed within the Project area (i.e., the Fountain Head pit, the proposed expanded evaporation pond and the Fountain Head Lake). While these legacy man-made waterbodies may support aquatic biodiversity, they are not assigned a specific value for protection.

As discussed in Section 4.6.2, groundwater dependent-ecosystems such as monsoon vine forests do not occur near the study area with the closest such ecosystems located approximately 15 km away from the mine lease. As such, impacts to groundwater-dependent ecosystems are not considered.

As described in Section 4.8, the Margaret River and the unnamed tributary creek north of Fountain Head support a low diversity and richness of aquatic fauna and the aquatic ecosystem is subject to existing impacts from agricultural activities. No sensitive species, ecosystems or habitat features were recorded in the study area; however, three threatened elasmobranchs have potential to occur downstream of the Project area within the Margaret River. Despite the low diversity and richness of aquatic fauna and existing pressures, aquatic ecosystems are in a moderate to good condition and support the key elements of aquatic biodiversity, e.g., macrocrustaceans, macroinvertebrates and fishes. Considering this, aquatic habitats and species in the unnamed tributary creek and Margaret River are assessed as having a ***Medium*** sensitivity.

The impact assessment for aquatic ecosystems draws on the impact assessments for hydrological processes (Section 7.4) and surface water quality (Section 7.5). Much of the information used to assess pathways for impacts to aquatic ecosystems is provided in those sections, and is referenced in this section.

7.8.2 Potential Impacts

This section describes the potential impacts to aquatic ecosystems due to the Project that have been considered in the impact. These potential impacts are summarised in Table 7.24 and described in more detail in the following sections.

Table 7.24 – Potential Impacts on Aquatic Ecosystems

Project Phase	Activity/Aspect	Project Component	Potential Impact
Construction, Operation and Closure	Earthworks/ ground disturbance, topsoil stripping and stockpiling	Pit expansion; IWL expansion; construction of process plant, power station, laydown areas, access roads and infrastructure; ROM pad; topsoil stockpiles	Habitat degradation or modification from increased turbidity/ sedimentation in downstream surface waters due to erosion of soils/exposed surfaces
Operation and Closure	Mining and processing	ROM pad; IWL	Habitat degradation or modification from increased turbidity/ sedimentation in downstream surface waters due to rainfall runoff from ore and waste rock
Operation and Closure	Project infrastructure footprint	Process plant; ROM pad, mining contractors yard access roads; evaporation pond; IWL	Habitat degradation or modification from altered hydrological regimes
Construction, Operation and Closure	Pit dewatering	Open pit; evaporation pond	Habitat degradation or modification from altered hydrological regimes
Operation and Closure	Mining and processing	ROM pad; IWL	Sub-lethal or lethal toxicity effects to aquatic biota due to contamination from rainfall runoff of waste rock, ore and tailings
Construction and Operation	Chemical and fuel storage and use	Mine machinery, plant, vehicles and equipment; explosive magazine, chemical silos, reagent storage	Sub-lethal or lethal toxicity effects to aquatic biota due to accidental release of hydrocarbons and chemicals
Construction, Operation and Closure	Use of vehicles, machinery and equipment	Diversion channels; evaporation pond	Introduction of aquatic weeds

Figure 3.3 (Section 3.2) shows the Project layout in relation to surface waters. The unnamed tributary creek to the north is located approximately 400 m north of the existing dam. The confluence of this tributary creek with the Margaret River is approximately 7 km downstream of the site.

Also shown in Figure 3.3 is the drainage line (southern flow path) that flows under and across Mount Wells Road into the mine lease to Fountain Head Lake. During the wet season, water from Fountain Head Lake overflows the existing haul road and drains towards the north, flowing along a drainage line to the unnamed tributary creek of the Margaret River. Some minor alterations to the existing drainage lines within the mine lease are proposed to divert water around the mine processing area and along the western toe of the IWL, to reinstate the natural flow path and to divert natural catchment runoff to the Fountain Head Lake. A diversion is also proposed along the northern side of the evaporation pond as the expanded footprint includes the existing flow path.

Impacts to aquatic ecosystems may potentially occur due to habitat degradation and modification resulting from a decline in water quality from increased suspended sediment and turbidity due to soil erosion, or, from the introduction of contaminants from rainfall runoff, seepage and spills and

leaks of hydrocarbons and chemicals. In addition, altered hydrological regimes due to surface water management could modify aquatic habitats. There is also the potential for the introduction or spread of aquatic weeds and pests. These potential impacts are discussed in the following sections.

7.8.2.1 Habitat Degradation or Modification

Increased Suspended Sediment and Turbidity from Soil Erosion

As discussed in Section 7.5.2.1, clearing of approximately 75 hectares of existing sparse vegetation for the construction of mine infrastructure (e.g., ROM pad, crushing facilities, process plant and supporting infrastructure) will result in the exposure and disturbance of soils. Soils could then be eroded by rainfall and mobilised to nearby surface waters.

During operations, erosion of unsealed roads and rainfall runoff from topsoil stockpiles, ore and waste rock could also mobilise sediment to nearby surface waters. During closure, depending on the final landform design, rainfall runoff could mobilise soils from the capped tailings area in the IWL and fine material associated with the waste rock. The mobilisation of sediment could lead to increased suspended sediment in surface water, i.e., increased turbidity and reduced light, and sedimentation. These processes can affect the survival, behaviour and health of aquatic biota.

Increased turbidity could reduce water clarity, thereby affecting the ability of fauna to detect predators or prey. Increased turbidity can also reduce the availability of light in the water column, which can lead to reduced phytoplankton and benthic microalgae productivity. This could impact the availability of food sources for fish, crustaceans and macroinvertebrates and change habitat and water quality (e.g., reduced dissolved oxygen). Suspended sediment can also cause physiological stress by clogging respiratory or feeding structures. The mobilisation of sediment from increased sedimentation (i.e., deposition of sediment) could alter benthic habitat, whereby fine sediment can smother coarse substrate such as gravel and cobbles as well as sedentary benthic species such as benthic invertebrates and benthic microalgae. This smothering could lead to a decline in abundance and diversity and the health of fish, macroinvertebrate and algal assemblages.

Surface water monitoring results show that the Margaret River and tributary creeks experience large fluctuations in suspended sediment concentrations and turbidity, with high levels occurring following rainfall events, particularly during the wet season. Aquatic biota in the unnamed tributary creek and the Margaret River are therefore expected to be tolerant of short-term increases in turbidity and suspended sediment concentrations. Aside from microalgae, no aquatic plants were observed in the surface waters of the study area. Long-term changes in turbidity could cause the loss of some species in the impacted area, with low light or sediment-tolerant species potentially replacing existing assemblages.

There are a number of embedded design controls which address potential impacts on aquatic habitats and species from increased suspended sediment and turbidity. These are provided in Section 7.5.2.1, as they relate to managing impacts to surface water quality.

Altered Hydrological Regime

The potential impacts to altered hydrological regimes are considered in Section 7.4. Changes to hydrological regimes can alter habitat availability and connectivity, affect aquatic faunal movement patterns and change reproductive processes and aquatic productivity.

As discussed in Section 7.4, changes to hydrological regimes from Project infrastructure, which could alter existing flow direction, volumes and velocities, could occur due to:

- Changes in topography (i.e., cut and fill).
- Construction of infrastructure and spoil disposal sites in drainage depressions, floodplains and waterways.
- Installation of stream diversions, surface runoff diversion drains and sediment dams.
- Decreased vegetation and increased impervious surfaces.

In addition, discharges or seepage from the proposed evaporation pond could increase volumes of water reporting to the downslope catchment. Drawdown of groundwater associated with pit dewatering could also reduce surface water flows where there are surface expressions of groundwater reporting to surface waters.

There will be no extraction of surface water to supply Project water demands and hence there will be no impacts to hydrological regimes from water extraction.

7.8.2.2 Sub-lethal or Lethal Toxicity Effects on Aquatic Biota

Contamination of Surface Water from Runoff from Waste Rock, Ore and Tailings

As discussed in Section 7.5.2 there are a number of pathways for contamination of surface water from runoff associated with stockpiling and disposing of mining material which could lead to sub-lethal or lethal toxicity effects on aquatic fauna. This includes runoff from waste rock, ore and tailings.

Rainfall runoff from waste rock, ore and tailings could produce acidic drainage if PAF material is present and mobilise metals and salts. Metals can have lethal or sub-lethal toxic effects for aquatic fauna or may bioaccumulate in biota. Changes to pH, electrical conductivity and general water quality parameters associated with acidic drainage could also alter surface water quality and effect the survival or health of aquatic biota.

Contamination of Surface Water from Accidental Hydrocarbon or Chemical Releases

Accidental release of fuel and other chemicals to the environment has the potential to have toxic effects on aquatic biota where these contaminants are mobilised to surface waters. Key potential contaminants are polycyclic aromatic hydrocarbons, metals, metalloids and a range of other synthetic compounds, which may have lethal or sub-lethal toxic effects or may bioaccumulate in biota.

The potential risk to aquatic biota depends on several factors, most notably the spatial extent of contamination, the duration of exposure, the contaminant type and the hydrological (flushing)

characteristics of the affected waterway. Many contaminants are persistent in the environment, particularly when present in sediments, and can have long-term impacts if remediation is not undertaken. Aquatic environments with poor flushing (i.e., smaller tributary creeks with low flow) and waterholes are most at risk of chemicals persisting in the environment.

Oils and petroleum hydrocarbons are less dense than water and are biodegradable. The most toxic fractions of oils to aquatic biota are lighter fractions that contain higher proportions of aromatic hydrocarbons; however, exposure of aquatic organisms to such fractions is usually limited due to their high volatility. Apart from direct toxic effects to aquatic biota, oils and hydrocarbons can also cause tainting of fish flesh, loss of invertebrates and food sources, and increase in algal growth (ANZECC/ARMCANZ, 2000).

7.8.2.3 Introduction of Aquatic Weeds

Project construction materials and vehicles, machinery and equipment will be brought from outside the Margaret River catchment, and may come from interstate or overseas. These could contain seeds or other fragments of aquatic weeds which may be lodged or attached to vehicles, equipment and machinery. If released to the aquatic environment, such seeds or fragments could establish viable populations. Aquatic weeds can smother waterways, reducing light availability and oxygen availability, displace native biota, affect the availability of food for aquatic fauna, alter hydrological regimes and change the structure of aquatic assemblages.

The construction of the diversion channels and the proposed evaporation pond are the key activities with potential to result in the introduction of aquatic weeds as it requires earthworks within, or in close proximity to, surface water bodies or drainage channels which have some connection to downstream surface water environments. Seeds or fragments of aquatic weeds introduced or mobilised to site water bodies could report to the downstream unnamed tributary creek during the seasonal overflow of the Fountain Head Lake.

As described in Section 4.8.6, no introduced or invasive aquatic fauna species were recorded in the study area and much of northern Australia remains free of introduced and invasive species, with known incursions limited to isolated areas. There are nine declared aquatic weed species in the Northern Territory of which only two are known to currently occur. These are cabomba, established in the Darwin River, and salvinia, which is widely planted as an ornamental plant in garden ponds and is found throughout the Northern Territory, including Alice Springs. Although it is highly unlikely that vehicles, machinery and equipment brought to site from elsewhere in the Northern Territory would have been in contact with aquatic weeds because of their isolated occurrences in the Northern Territory, machinery and equipment brought from interstate or overseas may have been in contact with aquatic weeds. As no known aquatic weeds occur within the study area, impacts from the spread of weeds are not considered.

While the Siamese fighting fish (*Betta splendens*) is known to occur in large numbers in the downstream Adelaide River and floodplains near Darwin, there is no credible pathway for the introduction of this species from Project activities. Impacts from the introduction of invasive or pest fauna is therefore not considered.

7.8.3 Mitigation and Management

7.8.3.1 Habitat Degradation and or Modification

Increased Suspended Sediment and Turbidity from Rainfall Erosion

Embedded design controls are described in Section 7.5.2.1, which are primarily applicable to the operations phase. Measures to minimise impacts to surface water quality and subsequently aquatic biota from increased suspended sediment and turbidity are described in Section 7.5.3.1. No additional measures specific to mitigating impacts to aquatic ecosystems are proposed.

Altered Hydrological Regimes from Project Infrastructure, Pit Dewatering and Evaporation Pond Seepage

The measures to mitigate impacts on surface water hydrological regimes from Project infrastructure are embedded in Project design and are described in Section 7.4.2.1. No additional measures specific to mitigating impacts to aquatic ecosystems are proposed.

7.8.3.2 Sub-lethal or Lethal Toxicity Effects on Aquatic Biota

Contamination of Surface Water from Runoff from Waste Rock, Ore and Tailings

Measures to minimise impacts on surface water quality from waste rock, ore and tailings are described in Section 7.5.3.2. No additional measures specific to mitigating impacts to aquatic ecosystems are proposed.

Contamination of Surface Water from Accidental Hydrocarbon or Chemical Releases

Measures to mitigate impacts to surface water quality from hydrocarbon and chemical releases are provided in Section 7.5.3.3. No additional measures specific to mitigating impacts to aquatic ecosystems are proposed.

7.8.3.3 Introduction of Aquatic Weeds

Measures to mitigate impacts due to the introduction of aquatic weeds will include:

- Inspection and wash-down of all vehicles, machinery and equipment coming from within the Northern Territory prior to arrival on site, or if washed-down on site, ensure material washed from machinery and equipment is collected and either treated prior to discharge or disposed of appropriately (AE01).
- Ensuring all vehicles, machinery and equipment brought from interstate or overseas are verified to be weed-free before arrival on site (AE05).
- Prohibiting washing of equipment, vehicles or machinery near or within drainage channels and water bodies (AE02).
- Limiting work vehicles and machinery to designated access and work site areas (AE03).
- Implementing accepted weed control measures where weeds are established. Obtain expert advice from the NT Government Weeds Branch or a qualified aquatic ecologist (AE04).

- Provide training to relevant personnel in weed prevention and management protocols (AE06).

7.8.4 Residual Impacts

7.8.4.1 Habitat Degradation and Modification

Increased Suspended Sediment and Turbidity from Rainfall Erosion

Clearing of 75 hectares of sparse vegetation and topsoil will be required for the construction of the Project, with topsoil to be stockpiled in a minimum of two locations. During construction, rainfall runoff from exposed surfaces could mobilise sediment to surface water bodies which could increase turbidity and suspended sediment and affect aquatic fauna behaviour and health and ecosystem productivity and structure.

As discussed in Section 7.5.4.1, considering the mitigation measures, which will minimise sediment loads reporting to the downslope catchment, increased turbidity and suspended sediment concentrations would most likely occur during periods of high rainfall and would be short term (i.e., construction period in the wet season) and localised within the unnamed tributary creek. Given the large fluctuations naturally occurring in the unnamed tributary creek, aquatic biota in this environment are expected to be tolerant of short term increased turbidity and suspended sediment concentrations. Given the short construction period and the localised extent of potential changes to water quality, the magnitude of the impact from increased suspended sediment and turbidity during construction to aquatic species and habitats is assessed as ***Low***. Since the sensitivity of aquatic habitat and species in the unnamed tributary creek is ***Medium***, the overall impact significance rating for construction is assessed as ***Low***.

As discussed in Section 7.5.4.1, with the embedded design controls and the implementation of mitigation measures which includes the installation of sediment dams to collect water from operational areas, impacts to water quality from increased turbidity and suspended sediment from rainfall erosion of roads, waste rock and ore are predicted to be within the range of natural variability during operations and post-closure. Consequently, no detectable impacts to aquatic habitat and species are predicted. The magnitude of the impact is assessed as ***Negligible***, resulting in a residual impact significance of ***Negligible*** for operations and closure.

Altered Hydrological Regimes from Project Infrastructure

Impacts to hydrological regimes due to Project infrastructure are assessed in Section 7.4.4.1. Short-term (i.e., only after significant rain events), localised (i.e., limited to the unnamed tributary creek) changes to existing hydrological regimes may occur during operations and closure and minor flood impacts are expected north of the proposed evaporation pond compared to existing conditions, increasing up to 0.05 m. The impact significance for changes to hydrological regimes from Project infrastructure was assessed as negligible for operations and closure. Considering this, the magnitude of the impact to aquatic ecosystems from altered hydrological regimes from Project infrastructure is also assessed as ***Negligible*** for operations and closure.

Impacts to hydrological regimes from drawdown of groundwater due to pit dewatering and groundwater mounding from seepage in the evaporation pond are assessed in Section 7.4.4.2. Surface expressions of groundwater are thought to contribute to water volumes in the Fountain

Head Lake, which overflows during the wet season. This overflow reports to the downstream unnamed tributary creek. Dewatering of the pit will cause localised (i.e., within 2 km of the pit) drawdown of groundwater, but given the major contributor to water in the lake is surface runoff from the catchment, this is not anticipated to have a noticeable impact on flows in the unnamed tributary creek. The lake is still predicted to overflow during the wet season and is not a major input for water in the unnamed tributary creek. It is unknown if surface expressions of groundwater contribute to existing flows in the unnamed tributary creek, but this potential input is likely to be negligible in comparison to surface runoff in the catchment. Flows in the unnamed tributary creek are therefore unlikely to be reduced due to groundwater drawdown. Considering this, the magnitude of the impact to aquatic ecosystems from altered hydrological regimes from pit dewatering is assessed as ***Negligible*** for all phases of the Project.

Water from the evaporation pond will infiltrate groundwater during pit dewatering. This could cause groundwater mounding and surface expressions of groundwater, which could increase water reporting to the downslope catchment. Modelling shows that groundwater around the evaporation pond is within the cone of depression created by pit dewatering and so groundwater is expected to be drawn to the pit rather than to mound and express to the surface. There is however some uncertainty regarding the hydraulic properties of the material beneath the evaporation pond. Groundwater monitoring and visual inspections for signs of seepage will provide an indication of potential changes to groundwater regimes. The magnitude of the impact to aquatic ecosystems is assessed as ***Negligible*** for all phases of the Project.

The impact significance rating for altered hydrological regimes from project infrastructure, pit dewatering and seepage from the evaporation pond considering aquatic habitat and species is assessed as ***Negligible*** for all phases of the Project.

7.8.4.2 Sub-lethal or Lethal Toxicity Effects on Aquatic Biota

Contamination of Surface Water from Runoff from Waste Rock, Ore and Tailings

Detail of the geochemical testing of waste rock and ore is provided in Section 3.6.3. In summary, test results indicate that the existing waste rock stockpile, NAF waste rock from the Fountain Head pit poses minimal risk to downstream surface water quality with respect to acidic or neutral metalliferous drainage. Impacts to aquatic fauna from runoff of existing waste rock stockpile and NAF waste rock from the Fountain Head pit are not expected to impact aquatic fauna.

As described in Section 7.5.4.2, predictive modelling of arsenic concentrations in the Fountain Head Lake was undertaken. Runoff from the industrial hardstand areas and from the IWL, which will report to the lake via the sediment dams, is not expected to result in concentrations of arsenic in the lake above the 80% aquatic ecosystems protection limit of140 µg/L for As (V), with a predicted flow-weighted average concentration of approximately 11 µg/L, which is below the 95% aquatic ecosystems protection limit of 13 µg/L for As(V). Notwithstanding, the lake will contribute additional loads of arsenic to the unnamed tributary creek and the downstream environment during overflow events.

Approximately 5% of the material placed in the IWL will be PAF-LC which upon oxidation may produce drainage containing elevated concentrations of some metals (Appendix 6) which could be toxic to aquatic fauna if reporting to the downstream catchment. Column leach testing will be

conducted to further understand the quality of this drainage (and will inform additional management measures, if required) and PAF-LC material will be placed in the IWL in such a way as to minimise the potential for infiltration.

Given the dilution of PAF-LC and ore drainage that is expected to occur in the Fountain Head Lake and the downstream receiving environment, but acknowledging the uncertainty with the volume and quality of drainage, the magnitude of the impact is assessed as ***Low***.

Given the sensitivity of aquatic fauna in the unnamed tributary creek (where impacts could occur) is ***Medium***, the overall impact significance rating for lethal or sub-lethal toxicity effects on aquatic fauna from drainage from the waste rock and ore is ***Low*** for operations and closure.

A small proportion of waste rock to be removed from the Fountain Head pit will be PAF, and runoff from this material has the potential to mobilise metals and low pH water to receiving water bodies, which could have lethal or sub-lethal toxic effects on aquatic fauna. Ore with a higher sulphur content than that tested may also be PAF; however, the low-sulphur ore material tested was NAF and considered to pose minimal risk to surface water quality and therefore aquatic fauna.

As discussed in Section 7.5.4.2, runoff from oxidised waste rock containing more than 0.4% sulphur (i.e., material to be considered PAF) may contain elevated concentrations of some metals and metalloids. Runoff from PAF material during operations could contaminate downstream surface waters and have toxic effects on aquatic fauna. PAF material will be stockpiled adjacent the pit and runoff from the PAF area will be directed to a dam, designed for a 1 in 100 year 72 hour rainfall event. If the dam reaches capacity, water will be directed to the evaporation pond. PAF material will be returned to the open pit at completion of mining for permanent submersion.

Potential impacts on aquatic fauna from acidic drainage at the PAF storage area, which is likely to contain elevated concentrations of some metals and metalloids, will be mitigated by capturing this drainage and preventing release to the downslope catchment. Post-closure the risk associated with the PAF drainage will be completely mitigated once the material is backfilled into the pit and permanently submerged. Potential impacts on aquatic fauna from runoff from PAF material are therefore not expected during operations or closure. The magnitude of the impact from PAF waste rock is therefore assessed as ***Negligible*** for operations and closure. Given the sensitivity of aquatic fauna in the unnamed tributary creek (where impacts could occur) is ***Medium***, the impact significance rating for lethal or sub-lethal toxicity effects on aquatic fauna from drainage of PAF waste rock is ***Negligible*** for operations and closure.

As described in Section 7.5.4.2, drainage from non-oxidised and oxidised tailings placed in the IWL presents a risk the downstream environment, including aquatic biota, during operations and closure. To mitigate this potential impact, runoff from the tailings will be captured within a clay-lined cell in one decant well and directed to the process plant or the evaporation pond during operations. At the completion of ore processing, the tailings placed in the IWL will be covered with a 0.5 m thick layer of clay and an additional 1.5 m layer of NAF waste rock to create an impermeable layer. This will prevent the infiltration of rainfall, preventing the production of drainage from the tailings. The magnitude of the impact is therefore assessed as ***Negligible*** for operations and closure. Given the sensitivity of aquatic fauna is ***Medium***, the impact significance

rating for lethal or sub-lethal toxicity effects on aquatic fauna due to contaminated runoff from the tailings is therefore assessed as ***Moderate*** for closure.

Contamination of Surface Water from Accidental Hydrocarbon or Chemical Releases

Impacts to surface water quality from accidental hydrocarbon or chemical releases are considered in Section 7.5.4.3. During operations and construction, short term, localised impacts (i.e., limited to the unnamed tributary creek), outside of the range of natural variability may occur where surface water quality may be moderately affected. Impacts to aquatic fauna could therefore occur within the unnamed tributary creek, but such impacts would also be short term and localised (i.e., limited to the unnamed tributary creek). While flows in the unnamed tributary creek are generally low, flows increase substantially following heavy rainfall events and this is likely to flush, dilute and or disperse contaminants in the system. The magnitude of the impact to aquatic fauna is therefore assessed as ***Low*** for construction and operations. During closure, no detectable impacts to surface water quality are predicted (see Section 7.5.4.3) given the limited use of vehicles and machinery and chemical handling and storage and that there will be no long term sources of hydrocarbon or chemical spills. The magnitude of the impact to aquatic fauna is therefore assessed as ***Negligible*** for closure.

Given the sensitivity of aquatic fauna in the unnamed tributary creek (where impacts could occur) is ***Medium***, the overall impact significance rating is assessed as ***Low*** for construction and operations and ***Negligible*** for closure.

7.8.4.3 Introduction of Aquatic Weeds

Construction activities, particularly construction of diversion channels and earthworks for the proposed evaporation pond, and the general use of vehicles, machinery and equipment could result in the introduction of aquatic weed seeds or fragments to site waters if attached to materials, vehicles, machinery and equipment. These aquatic seeds or fragments could establish and spread to the downstream catchment. Considering there are only two known aquatic weed species currently established in the Northern Territory and that vehicles, equipment and machinery will be weed-free prior to undertaking works on the site, an incursion is highly unlikely to occur.

The wash-down and inspection of vehicles, machinery and equipment and general weed management measures will further reduce the likelihood of an introduction. Prevention is key to managing aquatic weeds since, once established, they can spread quickly and be difficult to eradicate. Although highly unlikely, given the potential severity of an introduction, which could degrade downstream aquatic habitat and alter aquatic species composition and populations, and the difficulty with eradication, the magnitude of the impact is assessed as ***Low*** for construction and closure when the largest numbers of vehicles, machinery and equipment will be required, and works will be required within or in close proximity to site drainage channels on water bodies. With good quarantine procedures and by implementing weed control measures early, impacts should be short-term and localised with aquatic ecosystems only slightly impacted.

For operations, there will be fewer vehicles, machinery and equipment brought from outside the Project area and minimal works required within or in close proximity to drainage channels. Therefore the magnitude of the impact for operations is assessed as ***Negligible***.

Given the sensitivity of aquatic habitats and species in the unnamed tributary creek and Margaret River is ***Medium***, the overall impact significance rating for the introduction of aquatic weeds is ***Low*** during construction and closure and ***Negligible*** during operations.

7.8.4.4 Summary of Residual Impact Assessment

A summary of the aquatic ecosystems impact assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.25.

7.8.5 Objectives, Targets and Monitoring

The key objectives, standards and measurement criteria that PNX will use to ensure that the environmental impacts related to soil quality are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

Routine monitoring (for detection of potential impacts to aquatic fauna and flora) is not proposed given the short-term nature of the Project and the difficulty in establishing a robust baseline in ephemeral and intermittent streams, which experience large fluctuations in natural variability. Surface water monitoring will however be conducted as per the water management plan (i.e., monitoring early, mid and late wet season) to detect potential impacts on downstream surface water quality. The performance targets, monitoring and contingency measures provided in Table 9.2 for surface water and hydrological processes will inherently protect aquatic ecosystems by maintaining surface water quality and hydrological regimes. Where surface water quality and hydrological processes performance targets are not met, e.g., there is an exceedance of the applicable ANZG (2018) trigger values, as a result of a release of hydrocarbons or chemicals or impacts to downstream flows, this may trigger an investigation into potential effects on aquatic ecosystems. The requirements and parameters of such an investigation would be determined on an incident-specific basis considering the potential risks to aquatic fauna and flora and in consultation with the NT EPA if required.

Visual monitoring for signs of introduced aquatic weed species will be conducted during the surface water monitoring program.

Additional monitoring requirements related to surface water quality and hydrological processes, but which are also relevant to protecting aquatic ecosystems are listed in Section 9.4.1, Table 9.2.

Table 7.25 – Aquatic Ecosystems Impact Assessment

Environmental Value	Potential Impact		Activity/Aspect	Mitigation Measures	Project Phase	Sensitivity/ Magnitude	Residual Impact Significance
Aquatic ecosystems	Habitat degradation or modification	Increased turbidity and suspended sediment	Earthworks/ground disturbance, topsoil stripping and stockpiling	Embedded design controls will include: • SWED01 • SWED02 • SWED04 • SWED05 • SWED06 • SWED11 Mitigation measures will include: • SW01 • SW02 • SW03 • SW04 • SW05	Construction	Medium/Low	Low
			Ore stockpiling and processing; IWL; diversion channels, Project infrastructure		Operations	Medium/Negligible	Negligible
			Earthworks, rehabilitation		Closure	Medium/Negligible	Negligible
		Altered hydrological regimes from Project infrastructure, pit dewatering and evaporation pond seepage	Project infrastructure footprint; pit dewatering; open pit; evaporation pond	Embedded design controls will include: • HED01 • HED02 • HED03 • HED04	Construction, operations and closure	Medium/Negligible	Negligible
	Sub-lethal or lethal toxicity effects on aquatic biota from waste	Contamination of aquatic ecosystems from runoff from the existing waste	IWL; haul roads; hardstand; ore stockpiling (ROM pad)	Embedded design controls will include: • SWED08 • SWED09	Construction, operations and closure	Medium/Low	Low

Environmental Value	Potential Impact		Activity/Aspect	Mitigation Measures	Project Phase	Sensitivity/ Magnitude	Residual Impact Significance
	rock and ore runoff	rock, NAF and PAF-LC waste rock from the Fountain Head pit and ore (pre-processing)		• SWED10 • SWED12 Mitigation measures will include: • SW06 • SW07 • SW08 • SW09 • SW21			
		Contamination of aquatic ecosystems from PAF waste rock runoff	Waste rock stockpiling (PAF)		Operations and closure	Medium/Negligible	Negligible
		Contamination of aquatic ecosystems from tailings runoff	Tailings disposal		Operations and closure	Medium/Negligible	Negligible
		Contamination of aquatic ecosystems from accidental hydrocarbon and chemical releases	Use of chemical reagents, vehicles, machinery and equipment, fuel and chemical handling and storage	• SW10 • SW11 • SW12 • SW13 • SW14 • SW15 • SW16 • SW17 • SW18 • SW19 • SW20 • SW22	Construction, operations and closure	Medium/Low	Low

Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Project Phase	Sensitivity/ Magnitude	Residual Impact Significance
	Introduction of aquatic weeds	Earthworks, rehabilitation, use of vehicles, machinery and equipment	• AE01 • AE05 • AE02 • AE03 • AE04 • AE06	Construction, and closure	Medium/Low	Low
				Operations	Medium/Negligible	Negligible

7.9 Socio-economic

7.9.1 Discipline-specific Approach

The socio-economic impact assessment approach is consistent with the impact significance assessment adopted in Chapter 6, in which the residual significance of an impact is determined through the assessment of the sensitivity of a social value or receptor (see Table 6.3) and the magnitude of the potential impact (see Table 6.4). The information for this section has been drawn from the SIA report prepared by ERIAS Group (2021) (Appendix 11).

The scope of the socio-economic impact assessment considers:

- Proposed Project activities that could result in predictable direct and indirect impacts and benefits.
- Project phases; covering all stages of the Project, including, planning, construction, operations, closure and rehabilitation.
- The Project area of influence (PAOI), or the geographic locations (e.g., which include both local and regional towns/cities) that Project activities could potentially impact.
- The people, organisations, social structures, infrastructure and values in the Project area of influence. This may also include transient users (e.g., transportation businesses and visitors who do not permanently reside in local communities and supply chains e.g., contractors, suppliers and related services).
- The regional and national economies and industries in which the Project will operate.

The PAOI for socio-economic impacts is outlined in Figure 7.6.

The assessment considers the potential Project impacts on socio-economic values or receptors, which are the individuals, organisations, groups or resources that can be affected by Project activities. The sensitivity of a value is determined on the basis of its intrinsic value as well as its susceptibility or vulnerability to threatening processes. Key attributes that define sensitivity of the socio-economic context include:

- Formal status: this may be assigned by statutory or regulatory authorities or by appropriately recognised national or international organisations. For example requirements under the *Mineral Titles Act 2010* or the *NT Heritage Act 2011*.
- Replacement potential: an assessment of the potential for any losses of the environmental value used or important to a community to be replaced by an equivalent or representative example.
- Resilience to change: an assessment of the capacity of social systems, communities or heritage objects or places to adapt to change.
- Importance: it's worth to local communities and society, its iconic or symbolic importance to cultural value systems.

The magnitude of a potential impact reflects the predicted size and nature of change based on several key factors. For the purposes of this assessment these key factors are defined as follows:

- Duration: the timescale of the effect, whether short (6-12 months), medium (1-5 years) or long term (i.e., effectively permanent).
- Geographical extent: the spatial extent of the impact where this is defined as site (i.e., the Project area), local (extending to the towns of Pine Creek and Adelaide River), regional (i.e., the Katherine region) or widespread (i.e., NT-wide or national in scale).
- Severity: the scale or degree of change (both positive and negative) from the existing condition, as a result of the environmental impact.

7.9.2 Potential Impacts

This section describes the potential impacts and their mechanisms of change that may affect socio-economic values as a result of the Project. Potential impacts have been considered for all Project phases (construction, operation and closure).

7.9.2.1 Economy and Regional Development

Economic Benefits to the NT Government

The *NT Mineral Royalty Act 1982* imposes a royalty on all minerals extracted in the NT except for uranium, petroleum and some extractive minerals. Payment of royalties is a condition of a mining tenement. From July 2019, royalties are calculated on the gross production value of mineral commodities obtained from a production unit and is equal to either (whichever is greater) 20% of the net value, less $10,000.

As discussed in Section 4.9.2, the largest industry (by employment) in the Victoria Daly Local Government Area (LGA) is mining (id, undated(a)), demonstrating the importance of the mining industry to the regional and local economies. The Project will contribute to the regional and local economies primarily through the provision of local employment opportunities and operating and capital expenditure which includes the purchase of the plant, infrastructure, materials, equipment and services, particularly during the Project construction phase. Businesses within NT (and local business where practicable) are likely to provide a significant proportion of these products and services.

Stimulation of the Regional and Local Economy

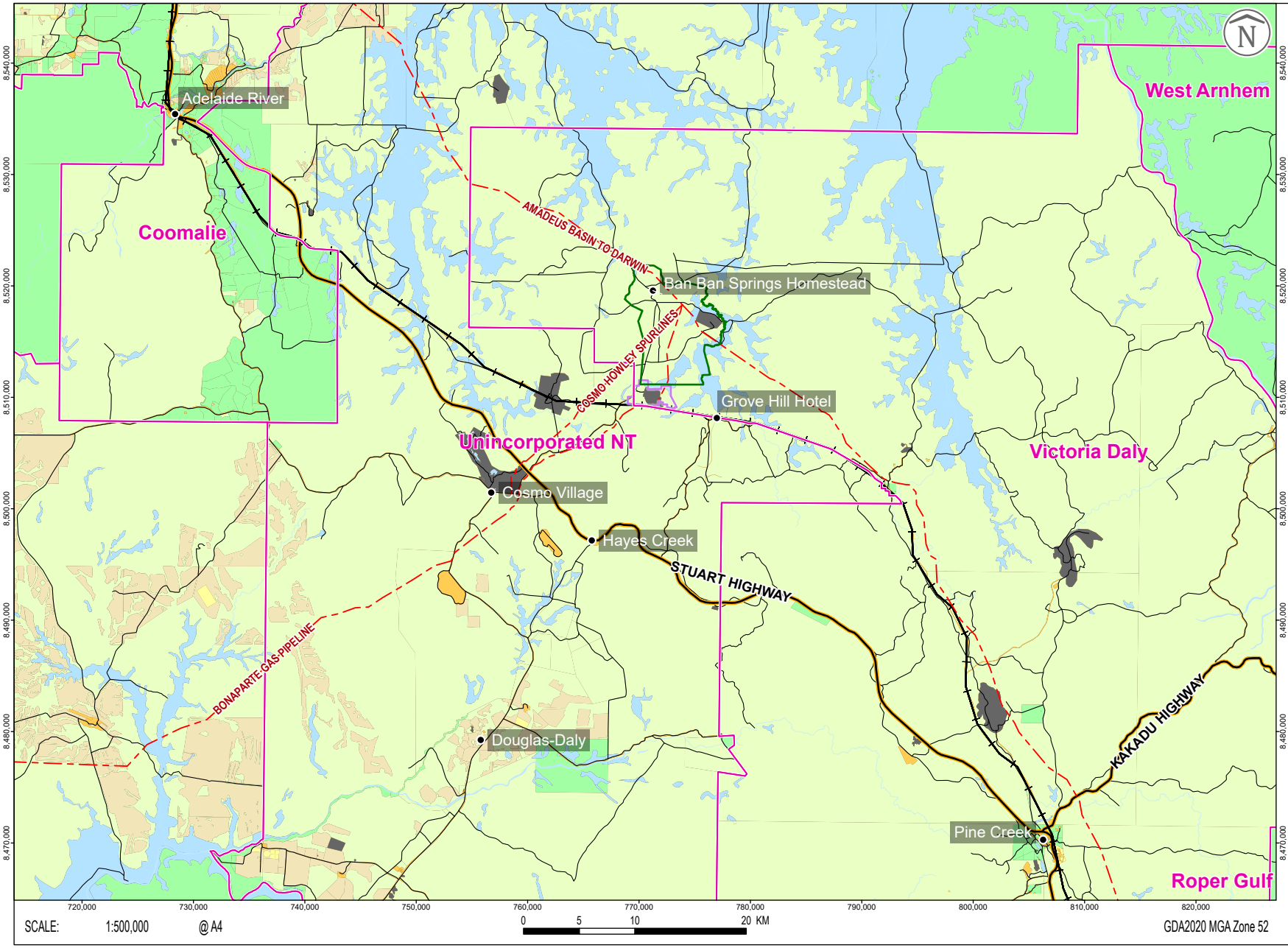
The NT economy experiences fluctuations due to the mining and construction sectors being significant drivers. This process is exacerbated in regional areas, where many of the mining and construction jobs are located. Pine Creek in particular has experienced growth and decline since gold was first discovered due to the fluctuations in mining (Appendix 11)).

While the Project is likely to contribute in the short-term to the local economy, due to the small size and duration of the Project, the increase in employment and income will invariably end at the completion of mine operations.

SOCIAL SETTING AND THE PROJECT AREA OF INFLUENCE

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 7.6



- Populated place
- Major road
- Minor road
- Railway
- Gas pipeline
- Watercourse
- Project area
- Local government area
- Ban Ban Springs

Land use

- Conservation and natural environments
- Production from relatively natural environments
- Production from dryland agriculture and plantations
- Production from irrigated agriculture and plantations
- Intensive uses
- Water
- Mining

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Map ID: 01238D_EIS_GIS019_v0-d

Figure Number: 01238D_EIS_F07.6_GIS_v0-d

ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.
Imagery © ESRI, DigitalGlobe and Partners, 2021.

Further, a sufficiently sized and appropriately skilled labour pool is often not available in regional towns to meet Project construction needs, creating the need for non-resident workers to be sought from elsewhere. As these workers do not tend to become permanent residents of the area, they do not contribute to the longer-term economic prosperity of the town or region, and in some cases can inflate local prices of housing, goods and services.

7.9.2.2 Employment and Training

Increased Employment and Training Opportunities

PNX expects to employ an estimated 134 workers during the 3.5-year Project life, with up to 50 operating at the site at any one time. It is expected that a proportion of this workforce will be sourced from local communities and/or within the NT, particularly as there are likely to be skilled workers available who have recently been made redundant from the Cosmo Gold Mine.

Many of the roles required for the Project are well-suited to the skills present in Pine Creek and Adelaide River reported during the 2016 census, with the most common occupations including labourers, technicians and trade workers (Appendix 11).

The roles required include excavator, loader, dozer, grader and dump truck operators, as well as drillers, workshop trades, fitters, electricians and process plant operators. In addition, there will be secondary staff requirements for servicing of the accommodation camp, such as cleaners, cooks and maintenance crews.

The Project will offer training and development opportunities to workers, including on-job skills development and health, safety and environment training (e.g., weed and threatened species identification, blasting near sensitive receptors, 4WD driver training, personnel development for professionals in mine planning, scheduling and geology).

Community Expectations Are Not Met

The recent retrenchment of 250 workers from the Cosmo Gold Mine and Union Reefs processing plant and the resulting impacts to local businesses in Pine Creek has meant that the employment benefits associated with the Project are likely to be eagerly anticipated.

While the Project will provide direct and indirect employment opportunities (with the Company, suppliers and service providers) and new business opportunities, there is also the potential for community expectations about local content not to be met, particularly given the modest number of jobs that will be required and the short Project duration.

7.9.2.3 Local Industry and Land Users

There are a number of industry sectors operating in the region, including mining and energy projects, agriculture and service industries, such as tourism and accommodation (see Section 4.9.4). The Project activities that could potentially negatively impact on other industry sectors are Project transport (which is covered in Section 7.11), hazardous material use, blasting, and an expansion of the mining footprint.

Disruption of Local Energy and Tourism Operations

Blasting will be required to mine the majority of material from the pit. Within close proximity to the pit crest is the buried high-pressure Bonaparte Gas pipeline (BGP), which is owned and operated by Australian Pipeline Group (APA). At the closest point, the pipeline is 370 m from the pit crest to the east and 480 m to the south. Section 7.13.4 discusses the potential impact of blasting on the gas pipeline.

Approximately 540 m to the south of the operation is the Alice Springs Darwin railway line, which has intermittent passenger (the Ghan) and freight services passing by day and night. There is potential for blasting to negatively impact rail line users amenity and safety (which is discussed in Section 7.9.3.6).

Reduction in Land Suitability for Pastoral Activities

The Project is located on an operating cattle station on pastoral lease PL 1111. The Project footprint area has previously been used for mining activities, reducing its suitability for livestock, which are currently excluded from the mine area. The Project will involve the expansion of the existing mine footprint (164.7 ha) through the expansion and mining of the existing open pit, and the expansion of the waste rock storage (WRS), (which will become an integrated waste landform (IWL) within which filtered tailings will be stored within a dedicated cell), processing plant and supporting infrastructure. The new land clearance for the expanded footprint is 80.6 ha. The total footprint comprises just 0.12% of the Ban Ban Springs pastoral lease. Therefore, the potential for an expansion of the existing mining footprint to result in a reduction in the land available for pastoral use is considered negligible and not assessed.

There is some potential for Project activities to contaminate soil and surface water resources on site. If localised soil or water contamination were to occur, there is the potential for this to reduce the productivity of the land used for pastoral activities on Ban Ban Springs (i.e., producing beef cattle for domestic and international markets), with potential for reduced income for the landowner. Sections 7.1 and 7.5 describe the potential for contamination of soils and surface water through the accidental release of hydrocarbons and chemicals or from waste rock, ore or tailings runoff. These residual impacts are assessed as ***Negligible*** to ***Low***. Given infrastructure design, management controls proposed, the hydrology of the Project area, no proposed discharge to waterways and the dispersal and dilution that would occur, the potential for the Project to indirectly impact Ban Ban Springs Station's pastoral activities, neighbouring pastoral properties or other land users is considered negligible and is not assessed.

Groundwater drawdown modelling (resulting from dewatering of the pit lake to recommence mining) shows drawdown of greater than 100 m is predicted at the end of mining but is relatively steep, with the cone of depression largely restricted to the near vicinity of the pit. Groundwater levels are predicted to be drawdown less than 0.1 m within 2 km of the pit (see Section 7.4.4.2). This has occurred previously when the pit was mined from 2007 to 2009. Elevated levels of arsenic and iron make it unsuitable for use as human drinking water and it has been subject to considerable variation in groundwater levels and influences from previous mining activities. The groundwater drawdown cone is not expected to extend to bore RN024290, which is periodically used for stock watering by Ban Ban Station (see Section 7.4.4.2). Therefore loss of water available from bore RN024290 is considered negligible and is not assessed.

There is some potential (residually assessed as ***Low***) for highly localised but medium-term reduction in groundwater quality as a result of seepage from the evaporation pond resulting from pit dewatering, increasing dissolved salt and metal concentrations in underlying groundwater (see Section 7.6.4.1). Any deterioration of groundwater quality could potentially affect landowner extraction from bore RN024290 which is periodically used by Ban Ban Station for stock watering.

Station owners have also reported using the Fountain Head lake as a water source, which will not be available during mining. Therefore, the loss of access of water for stock watering is a potential impact associated with the recommencement of mining.

Noise and Vibration Disturbance to Nearby Landholders

Noise and vibration modelling for construction and operational activities was undertaken to determine whether Project activities could potentially impact on any nearby sensitive receptors. The Grove Hill Hotel is the closest receptor, which is approximately 5.5 km away from the Project location. The modelling determined that under the worst-case model, noise criteria outlined in the NT Noise Management Framework Guideline (NT EPA, 2018) will be met under both construction and operations, and that predicted levels of air blast overpressure and ground vibration will also comply with the relevant criteria at the sensitive receptors (see Section 7.3.4). Therefore, noise and vibration impacts on nearby residents is not assessed.

7.9.2.4 Infrastructure and Services

Section 7.11 considers the potential for impacts to the road network and road users, therefore impacts to public roads are not assessed in this section.

Increased Pressure on Workforce Accommodation and Schools

The Project workforce will be provided with accommodation, transport (to and from Darwin and to and from the camp), food and medical and emergency services. Workers will be bus-in bus-out (BIBO) unless they already live locally, so there is unlikely to be additional pressure placed on local schools, nor on local housing (due to provision of camp accommodation), with no predicted flow-on effects to housing availability or affordability. Therefore, the potential for the Project workforce to negatively impact on accommodation and schools is negligible, and not assessed.

Increased Pressure on Local Emergency Services

Limited impact is expected on other emergency services except in the event of a major incident that needs to be attended by the NT Police, Fire and Emergency Services (PFES) or by St John Ambulance. As there are no planned activities expected to increase bushfire frequency, the potential for increased pressure on local fire services is considered negligible and not assessed.

However, any increase in accidents and injuries as a result of Project activities could place pressure on local police, ambulance and medical services, which are already limited in and around the Project area.

7.9.2.5 Social Cohesion and Amenity

Potential traffic-related impacts on amenity are considered in Section 7.11 and are therefore not discussed in this section.

Changes in Social Cohesion

Transient workforces can negatively impact on the social cohesion and general 'way of life' of small and regional towns, particularly where they are accommodated in, or spend significant time in these towns (SIHFNT, 2018). Further, transient workforces are often male-dominated, and can result in an increase in assault and alcohol abuse, which can make residents feel less safe. The Project workforce is BIBO from Darwin (returning to Darwin once a shift rotation is complete) and will be accommodated in a camp, unless they already live locally. Therefore, interaction with local communities will be negligible and this impact is not assessed.

The re-opening of the mine site and associated local employment opportunities could produce positive changes to economic and social activity in Pine Creek and Adelaide River, including more income to spend on social events and entertainment, which could in turn help strengthen social cohesion.

Changes to Amenity

As mining is not a new industry in the region, nor is mining in the Project area new (as it is already a mine site), and the site is on private land, there are no predicted adverse impacts on the visual amenity of the surrounding area as a result of the Project. As the Project moves into the closure and remediation phase, the existing unrehabilitated IWL will be reshaped and rehabilitated, potentially improving the visual amenity of the Project area.

Section 7.2.4.1 describes the residual impacts of particulate matter and dust resulting from Project activities. Dust emissions as a result of clearing and earthworks and later operations (e.g., crushing and grinding, haulage of ore and overburden) is predicted to comply with relevant criteria for ground-level concentrations of total suspended particulates, particulate matter $(PM)_{10}$ (annual averaging period) and deposited dust within 5.5 km (the nearest sensitive receptor). The predicted concentrations of $PM_{2.5}$ (annual averaging period) is expected to exceed the relevant air quality criteria at the nearest sensitive receptor (the Grove Hill Hotel), however existing natural background levels already exceed these criteria (Appendix 1), therefore, the impact of dust on amenity is considered negligible and not assessed.

Emissions of HCN may occur as a result of the use of sodium cyanide (NaCN) in the CIP processing however predicted HCN is below the relevant air quality criteria (Section 7.2.2.1) and therefore the impact of HCN on amenity is considered negligible and not assessed.

7.9.2.6 Community Health and Safety

This section describes the potential impacts of the Project on community health and safety, which excludes workforce occupational health and safety, unless it has been identified that the Project workforce may contribute to or cause community health and safety impacts. Potential impacts related to increased traffic and/or changed road conditions due to Project activities are considered in Section 7.11 and are not discussed in this section.

Reduced Safety of Rail Users

Blasting will be required to mine the majority of material from the pit, which is approximately 540 m from the Alice Springs Darwin railway line, which has intermittent passenger (the Ghan) and freight services passing by day and night. If blasting practices were not well-managed, there

could be some potential for blasting to cause fly rock to be ejected from the pit during blasting and collide with passing freight and passenger trains, adversely impacting on their operation or passenger and staff safety.

Increased Risk to Public Health and Safety

There are minimal risks to public health and safety as a result of Project activities (due to the lack of interaction between the workforce and community, as a result of workers being BIBO and the proposed camp accommodation, and small-scale nature of the Project). However, there is some potential for any increase in local income to indirectly exacerbate existing health concerns in local communities, such as drug and alcohol abuse. While alcohol and drug use are known issues in many remote regional communities throughout Australia, the potential impact of additional income sustaining or encouraging this issue, coupled with PNX Metals' zero drug and alcohol tolerance policy, is considered negligible and not assessed.

7.9.2.7 Summary of Potential Impacts

Potential impacts and benefits to socio-economic values associated with the Project and that are assessed in Section 7.9.4 are summarised in Table 7.26.

Table 7.26 – Potential Socio-economic Impacts

Project Phase	Activity/Aspect	Project Component	Potential Impact
Economy and Regional Development			
Construction, Operation, Closure	Royalties and mining levy payments	Whole of Project	Economic benefits (royalties and mining levy payments) to the NT government
	Project employment and procurement		Stimulation of the regional and local economy via payments made to workers and support for local business
Employment and Training			
Construction, Operation, Rehabilitation	Project employment and training	Project workforce	Increased employment and training opportunities for local communities
			Community expectations regarding employment (and Project benefits in general) are not met
Local Industry and Land Users			
Operation	Blasting (Vibration)	Mining	Disruption to operations of the BGP and the Alice Springs Darwin railway line
Construction, Operation, Closure	Pit dewatering, exclusion of cattle from mine operations area	Mining	Reduction in land suitability for pastoral activities due to: • Loss of access to the Fountain Head lake for stock watering • Reduction in groundwater quality
Infrastructure and Services			
Construction, Operation, Closure	An increase in workers on site and localised traffic movements	Project workforce, logistics and transport	Increased pressure on local health and emergency services
Social Cohesion and Amenity			

Project Phase	Activity/Aspect	Project Component	Potential Impact
Construction, Operation, Rehabilitation	Project employment and procurement	Project workforce	Strengthened social cohesion
Closure, Rehabilitation	Reshaping and rehabilitation of the WRS/IWL	Mine site rehabilitation	Improved visual amenity
Community Health and Safety			
Operation	Blasting (fly rock)	Mining	Reduced safety of freight trains and passengers travelling the Alice Springs Darwin railway line

7.9.3 Mitigation and Management Measures

Measures to mitigate impacts on socio-economic values to be adopted during the Project's construction, operations, closure and rehabilitation phases are presented in the following sections.

7.9.3.1 Economy and Regional Development

- PNX will pay royalties and levies in accordance with legislative requirements (SEM01).
- PNX will ensure transparency in reporting surrounding the payment of royalties and levies (SEM02).
- Package tenders in a way that suits local businesses, where this is commercially feasible (SEM03).
- Raise awareness and manage local business and community expectations surrounding increased business activity through regular communications and engagement on Project activities and upcoming opportunities (SEM04).
- Where possible, maximise work opportunities for local community members, including through specifying preference for local service and supply requirements in agreements with contractors (SEM05).
- Where possible, maximise work opportunities for local Aboriginal people, including through contractor agreements (SEM06).
- Work in partnership with industry and government groups on business growth and work readiness programs (SEM07).

7.9.3.2 Employment and Training

- Where possible, maximise work opportunities for local community members, including through specifying preference for local service and supply requirements in agreements with contractors (SEM05).

- Where possible, maximise work opportunities for local Aboriginal people, including through contractor agreements (SEM06).
- Continue to engage with local communities about the types of employment opportunities available, including timing, recruitment policies and training and development (SEM08).
- Engage with local Aboriginal organisations as appropriate to support, enhance and facilitate Aboriginal employment and training opportunities (SEM09).
- Enhance employee's skills base through on-job training and development programs (SEM10).
- Implement culturally appropriate work practices, including leave, rosters and flexible recruitment (SEM11).
- Implement a grievance mechanism to capture community issues and concerns and facilitate timely and appropriate action to address (SEM12).
- Continually update and implement the stakeholder engagement plan to support the management of community issues or concerns (SEM13).

7.9.3.3 Local Industry and Land Users

- Blasting activities will be restricted to daylight hours only, all days of the week (NO13).
- A site based trained blasting professional will design each blast (NO07).
- Blasting professional to ensure ground vibration will not exceed 20 mm/sec at any time at the BGP (NO12).
- Undertake a SMS involving a risk assessment to determine allowable ground vibration limits that will be enforced on the blasting operation to ensure that no disruption is caused to the flow of gas through the BGP. Ground vibration levels to comply with "Standard conditions for works near APA Gas Transmission Pipelines" document. Blasting operations will adhere to the outcome of the SMS (MH11).
- Continue to engage with APA to conduct a risk assessment for blasting near the gas pipeline, and negotiate an access agreement for the pipeline corridor (SEM15).
- Design blasting operations in accordance with good industry practice (e.g., APA, 2019), including ensuring that workers are appropriately trained (SEM16).
- Communicate the blasting schedule to local land users (including local traffic) to help maximise awareness and minimise disturbance (SEM17).
- Continue to work with AustralAsia Railways to develop a blasting procedure and notification regime that results in no impact to the railway network (SEM18).
- Negotiate agreements (under the *Mineral Titles Act*) with pastoral landowner(s) who are impacted by the Project (SEM19).

- Continue to engage with pastoral landowners to identify potential impacts and appropriate management approaches (such as the provision of alternative water sources if required) over the life of the Project (SEM20).
- Perimeter fencing to prevent introduced species and livestock access to the production areas (TE039).
- Comply with the *Mineral Titles Act* regarding any landowner grievances relating to loss of income and compensation (SEM22).
- Monitoring of groundwater quality will be undertaken to detect potential contamination and to initiate remedial action (GW01).
- Site contamination assessment and clean-up to be conducted at closure (MH10).

7.9.3.4 Infrastructure and Services

- Prepare (and implement as required) an Emergency Response Plan in collaboration with local emergency services (SEM24).
- Ensure that workers on site have emergency response capabilities and that there are first aid facilities available on site (SEM25).
- Implement the management measures in the Traffic Impact Assessment (TIA) (Appendix 12) and Traffic Management Plan (TMP) (Appendix 13) to minimise traffic-related accidents (SEM26).
- Encourage BIBO workers to access health services in Darwin or their place of origin (SEM27).

7.9.3.5 Social Cohesion and Amenity

- Where possible, maximise work opportunities for local community members. Contractors to maximise opportunities (SEM05).
- Where possible, maximise work opportunities for local Aboriginal people. Contractors to maximise opportunities (SEM06).
- Continue to engage with local communities about the types of employment opportunities available, including timing, recruitment policies and training and development (SEM08).
- Implement the Mine Closure Plan (Appendix 22) (SEM28).

7.9.3.6 Community Health and Safety

- Blasting operations will have a zero-ejection policy for fly rock leaving the pit area to avoid any incidents with trains or other site infrastructure (SEM29).
- Consult with railway users about the timing of blasting and train passage to avoid coinciding the two activities if practicable (SEM30).

7.9.4 Residual Impacts

The significance of the residual impacts of the Project, assuming the successful implementation of recommended avoidance and mitigation measures (Section 7.9.3), was assessed against the following socio-economic receptors:

- Territory, regional and local economies.
- Local communities.
- Local industry and other land users.
- Local infrastructure and services.
- Railway line users (passengers and staff).

All potential residual impacts were assessed as ***Negligible***, ***Low*** or ***Positive***, as discussed in the following sections.

7.9.4.1 Economy and Regional Development

Economic Benefits to the NT Government

The history of the NT's economic development has largely been driven by the resources sector and the mining, energy and manufacturing sector is one of a number of significant contributors to the overall NT economy. Due to the size of the NT economy and the reliance on mining, the sensitivity of the NT economy to an increase in revenue derived from mining royalties is rated as ***Medium***. The impact magnitude of the Project's modest contribution to NT royalties is rated as ***Positive***. This results in a residual impact assessment of ***Positive***.

Stimulation of the Regional and Local Economies

The sensitivity of regional and local economies to increased income is rated as ***Medium***, as mining is an important sector for both employment (particularly in Pine Creek) and businesses providing related products and services. This is coupled with the fact that the Cosmo Gold Mine has recently reduced operations (and therefore spend) in the local area.

While an estimate of capital and operating expenditure that will be spent with local businesses is not possible, PNX will endeavour to procure goods and services locally, and employ workers from local communities, which will contribute further to local spend (e.g., through food, beverages and entertainment etc). Therefore, the impact magnitude of increased income associated with indirect increased business activity stimulating the regional and local economies is rated as ***Positive***, acknowledging that the stimulus will be short term. This results in a residual impact assessment of ***Positive***.

7.9.4.2 Employment and Training

Increased Employment and Training Opportunities

Communities around the Project area have unemployment figures higher than the NT average, particularly in Pine Creek where unemployment is more than double the NT. There may also be increased availability of some skilled workers around the Project area due to the recent closure of

the Cosmo Gold Mine. In Adelaide River, the level of attainment is comparable with the NT, however, Pine Creek residents have lower training attainment levels as reported during the 2016 census, so on-job training and professional development could benefit Pine Creek residents in particular. Therefore, the sensitivity of local communities to changes in employment or training opportunities is rated as ***Medium***.

PNX will endeavour to source workers from local communities wherever possible and will support contractors to source and train locals. Organisations such as Kybrook Farm (Aboriginal Advancement Association Inc) may also be engaged to help identify employment and training opportunities for Aboriginal people around Pine Creek. The Project is likely to bring ***Positive*** impacts to local communities through the increased opportunity for employment, supporting businesses and training and development over the ~3-year life of the mine. Therefore, the residual assessment for increased employment and training opportunities is ***Positive***.

Community Expectations Are Not Met

PNX will continue to engage with local communities about the types of employment opportunities available, including timing, recruitment policies and training and development, supported by the stakeholder engagement plan. This will facilitate community understanding of what is available and how to access those opportunities. Further, where possible, PNX and its contractors will maximise work opportunities for local community members, particularly in Pine Creek. With these management measures, the magnitude of the potential impact is assessed as ***Negligible***, providing a residual assessment of ***Negligible***.

7.9.4.3 Local Industry and Land Users

Disruption of Local Energy and Tourism Operations

The sensitivity of other identified land uses (i.e., of the gas pipeline and railway line) close to the Project's proposed blasting operations, and associated vibration, is rated as ***Medium*** as basting has occurred in the past at this mine site, demonstrating some level of exposure to this impact being experienced prior to the Project commencing. The impact magnitude of blasting disrupting operations of the gas pipeline and/or the railway line adjacent to mining activities is rated as ***Low***, assuming that blasting will be conducted in accordance with the outcomes of the planned risk assessment and SMS, and that all mitigation measures outlined in Section 7.9.3.3 are adopted. Therefore, the residual impact assessment for disruption of identified land uses is ***Low***.

Reduction in Land Suitability for Pastoral Activities

Loss of Access to the Lake for Stock Watering

The pastoral land proposed to be used for the Project has previously been used for mining activities, reducing its suitability for livestock (noting however that in general the water in the Fountain Head lake meets relevant Livestock Drinking Water Guidelines; refer to Section 4.5.3.3). Therefore, the sensitivity of the value (land suitability of pastoral activities) is rated as ***Low***. However, Ban Ban Springs Station owners have identified that the recommencement of mining activities will remove this source of water used periodically for stock watering. The Fountain Head Lake is not the only water source available or in use, and the mine footprint comprises less than 1% of the station's area. The Project proposes to work with the landholder to determine stock water needs and identify and provide, if necessary, an alternative water source to the Fountain

Head Lake, therefore the magnitude of the impact is assessed as ***Low***. Therefore, the residual assessment for a loss of access to the Fountain Head lake for stock watering causing a reduction in land suitability for pastoral activities is ***Negligible.***

Reduction in Groundwater Quality

Monitoring bores on the Project site indicate that groundwater has aluminium concentrations elevated above livestock drinking water guidelines (see Section 7.6.1). Arsenic, aluminium, chromium and copper concentrations have also been above ecological guideline values for slightly to moderately disturbed surface waters, and groundwater sensitivity is assessed as ***Low***. Section 7.6.4 assesses the residual impact of groundwater contamination resulting from pit dewatering as ***Low.*** Given the current uncertainties of the potential change in groundwater quality, the unknown extent of use of the bore by Ban Ban Station, the high availability of groundwater more broadly (see Section 7.4.1), and proposed mitigation measures (i.e., supply of alternatives of water sources if required), the magnitude of the impact is assessed as ***Low***. Therefore, the residual assessment for a reduction in groundwater quality from pit dewatering to cause a reduction in land suitability for pastoral activities is ***Negligible***.

7.9.4.4 Infrastructure and Services

Increased pressure on local health and emergency services could result from increased local workforce and traffic movements associated with mine construction and operations. The sensitivity of local infrastructure and services is rated as ***Medium***, as emergency services are limited due to the rural nature of the region and small size of local towns along with the level of 'exposure' to mining operations (there are or have been several operating in the area in recent years). The impact magnitude of increased accidents increasing pressure on local emergency services is rated as ***Low*** given the mitigation measures proposed. This results in a residual impact assessment of ***Low***.

7.9.4.5 Social Cohesion and Amenity

Social Cohesion

The sensitivity of the local communities of Pine Creek and Adelaide River to changes in economic and social activity associated with the recommencement of mining is rated as ***Low***. This assessment was made because the local economies (particularly of Pine Creek) are closely tied with mining and construction projects, and local communities are accustomed to the 'boom and bust' cycle of employment opportunities. The magnitude of the potential for an increase in economic and social activity to support an increase in social cohesion is rated as ***Positive***, therefore the residual impact assessment is ***Positive***.

Visual Amenity

The sensitivity of the Project area with respect to visual amenity is rated as ***Low***, as the area is an existing mine site located in a remote area not viewed by many people (excepting tourists on the Ghan). There is the potential for an improvement in visual amenity as a result of the recommencement of mining and eventual mine closure and rehabilitation. The magnitude of this impact is rated as ***Positive***, therefore the residual impact assessment is ***Positive***.

7.9.4.6 Community Health and Safety

The sensitivity of staff and passenger safety on freight trains and the Ghan railway is rated as ***High***. The potential for fly rock to occur is rated as ***Low*** (Appendix 23). The potential for this rock to collide with a passing passenger train during blasting activities, causing delays or injuries, is rated as ***Negligible*** as the potential for fly rock leaving the pit area will be minimised by the implementation of best practice and planning of blast timing to avoid incidents with passing trains. Therefore the residual impact assessment of blasting adversely impacting railway passenger or staff safety is ***Negligible***.

7.9.4.7 Summary of Impact Assessment

A summary of the socio-economic impact assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.27.

7.9.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to socio-economic values are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

Table 7.27 – Socio-economic Impact Assessment

Sensitive Receptor	Potential Impact	Activity/Aspect	Mitigation Measures	Sensitivity/ Magnitude	Residual Impact Significance
NT economy	Economic benefits (royalties and mining levy payments) to the NT government	• Royalties and mining levy payments • Project employment	• SEM01 • SEM02	Medium/Positive	Positive
Regional and local economies	Stimulation of the regional and local economy via payments made to workers and support for local business	• Project employment and procurement	• SEM03 • SEM04 • SEM05 • SEM06 • SEM07	Medium/Positive	Positive
Local communities	Increased employment and training opportunities for local communities	• Project employment and training	• SEM05 • SEM06 • SEM08 • SEM09 • SEM10 • SEM11	Medium/Positive	Positive
	Community expectations regarding employment (and Project benefits in general) are not met		• SEM05 • SEM08 • SEM12 • SEM13	Medium/Negligible	Negligible
Local industry and land users	Disruption to operations of the Bonaparte Gas pipeline (BGP) and the Alice Springs Darwin railway line	• Blasting (Vibration)	• NO13 • NO07 • NO12 • MH11 • SEM15 • SEM16	Medium/Low	Low

Sensitive Receptor	Potential Impact	Activity/Aspect	Mitigation Measures	Sensitivity/ Magnitude	Residual Impact Significance
			• SEM17 • SEM18		
	Reduction in land suitability for pastoral activities, from: • Loss of access to the Fountain Head lake for stock watering	• Exclusion of cattle from mine operations area	• SEM19 • SEM20 • TE039 • SEM22 • GW01 • MH10	Low/Low	Negligible
	Reduction in land suitability for pastoral activities, from: • Reduction in groundwater quality	• Pit dewatering		Low/Low	Negligible
Local infrastructure and services	Increased pressure on local health and emergency services	• An increase in workers on site and traffic movements	• SEM25 • SEM26 • SEM27	Medium/Low	Low
Local communities	Strengthened social cohesion	• Project employment and procurement	• SEM05 • SEM06 • SEM08	Low/Positive	Positive
	Improved visual amenity	• Reshaping and rehabilitation of the WRS/IWL	• SEM28	Low/Positive	Positive
Railway line users	Reduced safety of freight trains and passengers travelling the Alice Springs Darwin railway line	• Blasting (fly rock)	• SEM29 • SEM30	High/Negligible	Negligible

7.10 Cultural Heritage

7.10.1 Discipline-specific Approach

The approach adopted for the cultural heritage impact assessment is consistent with the impact significance assessment adopted in Chapter 6, in which the residual significance of an impact is determined through the assessment of the sensitivity of a social value or receptor (see Table 6.3) and the magnitude of the potential impact (see Table 6.4). The methodology aligns with the NT EPA regulatory requirements for an EIS under the *Environmental Assessment Act 1982*. The information for this section has been drawn from the Archaeology Assessment (Appendix 10) and the Cultural Heritage Management Plan (Appendix 24) prepared by In Depth Archaeology.

A significance assessment of archaeological places and objects is required under the *NT Heritage Act 2011*. Martin-Stone (Appendix 10) outlines the criteria used to determine archaeological and cultural significance. The results of the significance assessment indicate that all places and objects identified in the 2019 survey are culturally significant. Objects are rated low archaeological significance, whereas Aboriginal places are considered archaeologically significant, as they inform our understanding of Aboriginal resource use across the landscape, are important to the course of the NT's cultural history and have the potential to provide an insight into the manufacturing, trade and of artefacts from the region.

The cultural and archaeological significance were used to determine the sensitivity of cultural heritage values. Key attributes that define sensitivity of the cultural heritage context include:

- Formal status: this may be assigned by statutory or regulatory authorities or by appropriately recognised national or international organisations. For example requirements under the *NT Heritage Act 2011* or the *Northern Territory Aboriginal Sacred Sites Act 2013*.
- Replacement potential: an assessment of the potential for any losses of the value used or important to a community to be replaced by an equivalent or representative example.
- Resilience to change: an assessment of the capacity of values or receptors (i.e., objects, places or Aboriginal peoples) to adapt to change.
- Importance: it's worth to local Aboriginal communities and Traditional Owners, its iconic or symbolic importance to cultural value systems.
- Cultural and archaeological significance: an assessment of cultural heritage significance of places and objects using criteria under Section 11 of the *NT Heritage Act 2011*.

The magnitude of a potential impact reflects the predicted size and nature of change based on several key factors. For the purposes of this assessment these key factors are defined as follows:

- Duration: the timescale of the effect, whether short (6-12 months), medium (1-5 years) or long term (i.e., effectively permanent).

- Geographical extent: the spatial extent of the impact where this is defined as site (i.e., the Project area), local (extending to the towns of Pine Creek and Adelaide River), regional (i.e., the Katherine region) or widespread (i.e., NT-wide or national in scale).
- Severity: the scale or degree of change (both positive and negative) from the existing condition, as a result of the impact.

7.10.2 Potential Impacts

This section describes the potential impacts and their mechanisms of change that may affect cultural heritage values as a result of the Project. Potential impacts have been considered for all Project phases (construction, operation and closure).

7.10.2.1 Loss or Damage to Known Cultural Heritage Objects/artefacts or Aboriginal Places

As discussed in Section 4.10.2, there are no sacred sites in the mining tenement; the closest recorded site being 2 km from the tenement boundary, therefore there will be no direct impacts on sacred sites as a result of Project activities.

The cultural heritage survey found no non-Aboriginal heritage sites or objects within the Project area and recorded six archaeological places (or sites) and five archaeological objects (or artefacts), as defined under the *NT Heritage Act 2011*. Seven sites (comprising three Aboriginal places and four historic sites), were recorded during previous surveys (Crassweller, 2006).

Correspondence with the AAPA (2021) notes that custodians consulted for the Project Authority Certificate indicated that there are tall termite mounds in the vicinity of the Project area (un-mapped) that are of cultural significance to them[13].

Figure 7.7 highlights the known sites and objects overlaid with the proposed Project footprint expansion. Of the known sites and objects within the Project area, only one object (201910221220; a flaked piece of feldspathic metagreywacke (FMG)) will be directly impacted by the expanded Project footprint. The three Aboriginal places that are located in the centre of existing operations (i.e., EBPFH BSArch & His2, EBPFH BSArch8 and EBPFH 1) may also need to be salvaged, as they are located within the mine operations area[14]. All other places and objects will not be impacted by Project activities, including the one sacred site recorded in the vicinity.

7.10.2.2 Loss or Damage to Unknown Cultural Heritage Objects/Artefacts

There is also the potential for chance finds of archaeological objects in the expanded footprint area (e.g., where the CIP plant site, ROM, crushing facilities and associated infrastructure will be developed), although as described in Figure 4.28, this area is described as a ‘low probability area’ due to the nature of the landscape, comprising low hills with preferred stone resources, in relatively close proximity to the Yam Creek seasonal watercourses (Appendix 10).

13 Custodians requested that where possible, mounds 3 meters or higher are not disturbed (AAPA, 2021).
14 Note: HAS5 represents the centre point for the Fountain Head mine site.

7.10.2.3 Reduction in Traditional Access

As the Project area is on pastoral land and has been used for mining activities, the land is unlikely to currently be used for traditional access or practices. Further, consultation with Traditional Owners during the archaeological survey did not identify any contemporary use of the land.

Therefore, the potential for the Project to cause a reduction in traditional access is considered negligible and is not assessed further.

7.10.2.4 Summary of Potential Impacts

Potential impacts to cultural heritage values due to the Project that have been considered in the impact assessment are summarised in Table 7.28.

Table 7.28 – Potential Cultural Heritage Impacts

Activity/Aspect	Project Component	Potential Impact
Expansion of the mining footprint	CIP plant site, PAF stockpile	Loss or damage to known cultural heritage objects/artefacts or Aboriginal places
		Loss or damage to unknown cultural heritage objects/artefacts

7.10.3 Mitigation and Management Measures

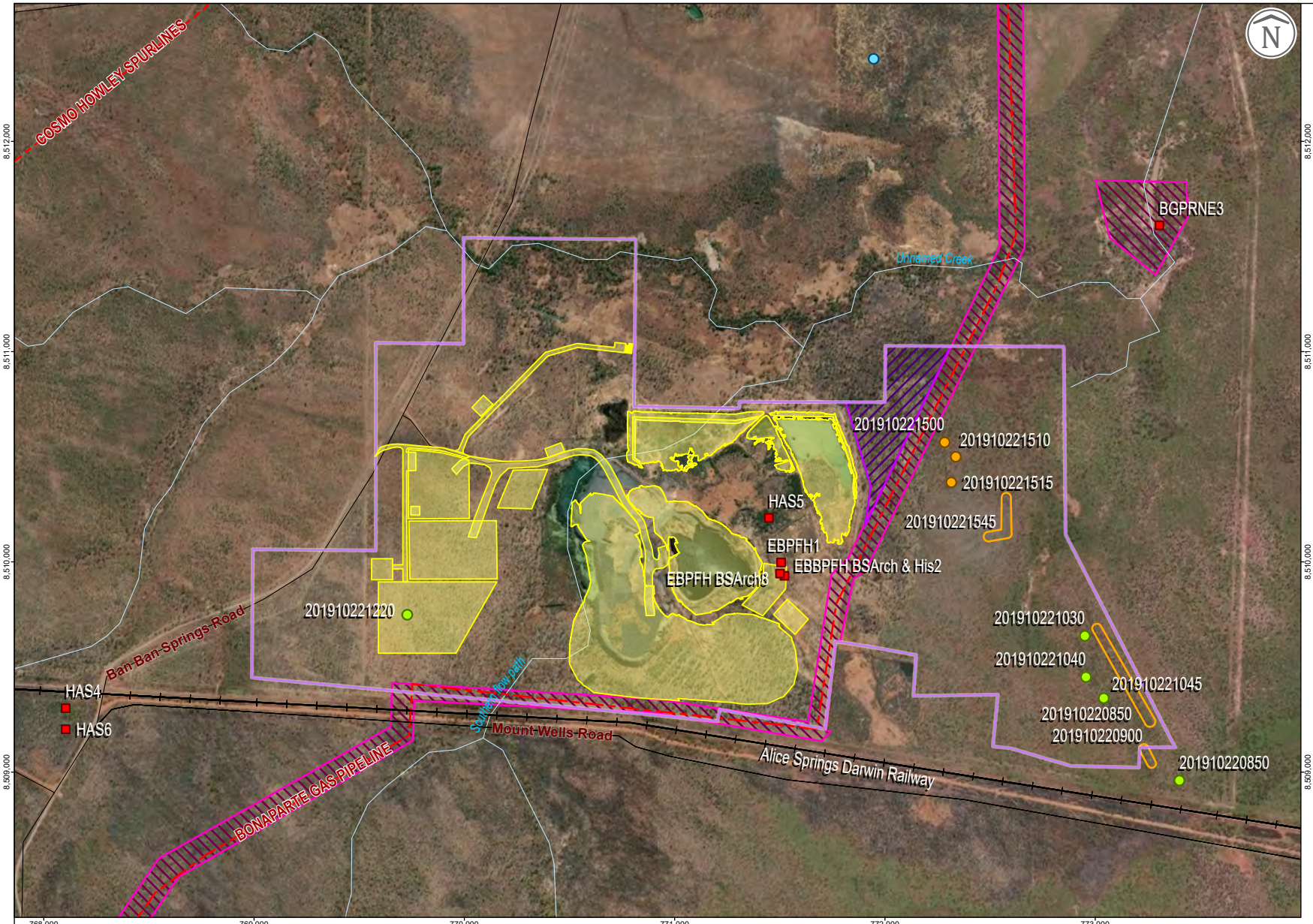
Measures to mitigate impacts on cultural heritage values to be adopted during the Project's construction, operations and decommissioning phases are presented in the following sections.

- Implement a 100 m buffer around known places and a 50 m buffer around objects that are not to be disturbed, and clearly identify locations (SEM31).
- Implement cultural heritage awareness training for all site staff, including the locations of known sites, legislative requirements and chance finds procedures (SEM32).
- Salvage 201910221220 with an appropriate permit under the *NT Heritage Act 2011*, and with agreement from Traditional Owners regarding ongoing care of the object (SEM33).
- If Aboriginal places require salvage, conduct a cultural heritage assessment in consultation with Traditional Owner representatives to determine significance, condition and management (SEM35).
- Develop a chance finds procedure to manage any unknown objects uncovered during disturbance activities (SEM36).
- Develop a salvage protocol in consultation with Traditional Owners to manage the salvage of chance finds (SEM37).
- Notify the Department of Tourism, Sport and Culture (DTSC) of any chance finds, and record of all new finds in a cultural heritage database. Manage according to SEM36 and SEM37 (SEM38).

CULTURAL HERITAGE SITES AND THE PROPOSED PROJECT FOOTPRINT

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 7.7



- Aboriginal object
- Aboriginal place
- Previously recorded archaeological site
- Recorded sacred site
- Road
- Railway
- Gas pipeline
- Watercourse
- Project area
- Infrastructure layout
- Extensive Aboriginal place
- Area not surveyed
- Restricted work area

Issue Date: 2021.05.26

Map ID: 01238D_EIS_GIS018_v0-f

Figure Number: 01238D_EIS_F07.7_GIS_v0-f

ERIAS, 13-25 Church Street
Hawthorn VIC 3122, Australia

DATA SOURCES:
Project data from PNX Metals, 2021.

Imagery © ESRI, DigitalGlobe and Partners, 2021.

- Cultural heritage surveys will be conducted prior to any change in the proposed Project footprint that may impact on previously unsurveyed areas (SEM39).
- Where possible, termite mounds 3 meters or greater will not be disturbed (SEM40).

7.10.4 Residual Impacts

The significance of the residual impacts of the Project, assuming the successful implementation of recommended avoidance and mitigation measures (Section 7.10.3), was assessed against the following socio-economic receptors:

- Local Aboriginal communities.
- Tangible heritage values (i.e., objects and places).

Potential residual impacts were assessed as ***Low*** or ***Moderate***, as discussed in the following sections.

7.10.4.1 Loss or Damage to Known Cultural Heritage Objects/artefacts or Aboriginal places

The sensitivity of the Aboriginal places and objects identified in 2019 and in previous surveys is rated as ***High*** for the six Aboriginal places recorded in the Project area, as they are significant both culturally and archaeologically and are protected under NT legislation. While the three Aboriginal places recorded in Crassweller (2006) are not assigned a significance value, as a precautionary measure, they are assumed to have the same significance as the other places recorded on site (i.e., ***High***).

The sensitivity of the five objects are rated as ***Low***, as they are archaeologically of low significance, but culturally of high significance; however can be readily salvaged if necessary (i.e., they are movable).

The Project may require the salvage of the three Aboriginal places located in the centre of mine operations (i.e., EBPFH BSArch & His2, EBPFH BSArch8 and EBPFH 1). If this were to be required, a cultural heritage survey would be conducted with Traditional Owner representatives and appropriate salvage/management measures developed. Therefore, the impact magnitude of the expansion of the Project footprint on these places is rated as ***Low***, and the residual impact assessment to these places is ***Moderate***.

The expanded footprint does impact one object, requiring it's salvage. The impact magnitude of an expansion of the Project footprint on (201910221220; a flaked piece of FMG) is rated as ***Low***, as a permit for the salvage and ongoing care of the object will be applied for in consultation with Traditional Owners. Therefore, the residual impact assessment to this object is ***Low***.

7.10.4.2 Loss or Damage to Unknown Cultural Heritage Objects/artefacts

There is the possibility that during construction or operations, Project personnel will come across unrecorded objects (or chance finds). However, Figure 7.7 shows that the archaeological sites recorded are concentrated in the eastern portion of the Project area. This is primarily due to the nature of the landscape in this area, comprising low hills with preferred stone resources, in close

proximity to watercourses. Due to the nature of the land system in this western area, there is a low probability of finding more archaeological places and objects in the area.

As described in Section 7.10.1 objects are rated as ***Low*** sensitivity, given their low archaeological significance and movability. Given the disturbed nature of the site, the survey effort to-date, the low likelihood that objects will be found in the west of the Project area and the chance find procedure proposed to avoid impacting objects if found during Project construction or operations, the impact magnitude of loss or damage to unknown objects is rated as ***Low***. The NT Heritage Branch will be notified of any chance finds uncovered during Project activities. Therefore, the potential residual impact on unknown objects is ***Low***.

7.10.4.3 Summary of Impact Assessment

A summary of the terrestrial ecology impact assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.29.

7.10.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to cultural heritage values are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

Table 7.29 – Cultural Heritage Impact Assessment

Sensitive Receptor	Potential Impact	Activity/Aspect	Mitigation Measures	Sensitivity/ Magnitude	Residual Impact Significance
Tangible heritage values, local Aboriginal communities	Loss or damage to known cultural heritage objects/ artefacts	Expansion of the mining footprint	• SEM31 • SEM32 • SEM33 • SEM35	Low/Low	Low
	Loss or damage to known Aboriginal places			High/Low	Moderate
	Loss or damage to unknown cultural heritage objects/ artefacts		• SEM36 • SEM37 • SEM38 • SEM39 • SEM40	Low/Low	Low

7.11 Traffic and Transport

7.11.1 Discipline-specific Approach

The significance assessment method described in Chapter 6 was adopted to qualitatively assess impacts relevant to traffic and transport. This considers the sensitivity of sensitive receptors associated with traffic and transport and the magnitude of impact on those receptors. Local road users have been identified as the receptors sensitive to Project activities in relation to traffic and transport. The assessment of traffic impacts for construction and operations is based on desktop assessments undertaken by GHD Australia (Appendices 12 and 13).

The existing road network, traffic volumes and current road users is described in Section 4.11. The roads in the Project area are currently used by other mining operations or for agricultural purposes (e.g., Ban Ban Springs Station). The road network is not considered rare or unique and is easily replaceable and resilient to change. The sensitivity of the receptor of local road users is therefore categorised as ***Low***.

7.11.2 Potential Impacts

The potential impacts on traffic and transport are summarised in Table 7.30.

Table 7.30 – Potential Traffic and Transport Impacts

Project Phase	Activity/Aspect	Project Component	Potential Impact
Construction	Traffic associated with Project vehicles	Transport of staff, supplies, machinery and equipment to/from the Project site	Increased traffic during construction: • Increased demand on existing transport networks • Inconvenience to other road users and local communities (e.g., longer travel times, slower moving traffic)
Operation			Increased traffic during operations: • Increased demand on existing transport networks • Inconvenience to other road users and local communities (e.g., longer travel times, slower moving traffic)
Construction, Operation, Closure			Reduced safety of road users due to Project vehicles using public roads

The potential for a collision between a Project vehicle and a train at the Alice Springs Darwin Rail level crossing has been assessed in the Project Risk Register. The results of the risk assessment, and mitigation and management measures are discussed in Section 7.13.

7.11.2.1 Increased Traffic During Construction

An increase in traffic as a result of Project activity has the potential to increase traffic congestion, which may result in lost time or opportunity cost for other road users. Impacts to amenity from air emissions (e.g., dust, vehicle emissions) are assessed in Section 7.2. Impacts from noise are assessed in Section 7.3.

Project traffic will be greatest during construction (a ten-month period) and will relate to:

- Delivery of all mobile plant required for civil works, mining equipment, infrastructure (e.g., workshops, offices and processing plant) and supplies to site.
- Staff transportation to/from the Cosmo Village by staff bus and light vehicle.

Project traffic will be the greatest during construction as mining equipment and vehicles will arrive on site. Mining equipment and operational vehicles required are listed in Section 3.4.5.2. Project vehicles are not expected to be larger than the vehicles currently using the roads, with the largest vehicles associated with the delivery of crushing and screening equipment, excavators and dump trucks (up to 25 m in length). The mining fleet will be used to undertake some construction tasks like hauling bulk fill for road and dam construction as a part of the early works prior to mining. This will avoid the need to mobilise additional equipment to site.

It is estimated that Project traffic will generate an additional 46 trips (shown in Table 7.31) will be generated on the road network each day. The breakdown of the types of trips generated during construction are shown in Table 7.31.

Table 7.31 – Daily Project Traffic Generation During Construction

Month	AM Peak		PM Peak		Total
	LV	HV	LV	HV	
1 to 10	20	3	20	3	46

LV = Light vehicles, HV = Heavy vehicles. Heavy Vehicles are defined as vehicles with distance of > 3.2m between the first and second axel, or have more than two axels.

7.11.2.2 Increased Traffic During the Operations Phase

The duration of the Project operations phase is estimated to be three years. Project-related traffic will decrease compared with the construction phase during operations.

The dayshift and nightshift crews will travel to and from site (from Cosmo Village) daily using light vehicles and a staff bus. The preference is that all personnel use the company-provided bus service. This will minimise the number of additional vehicle movements each day.

Operations will also require delivery trucks each day for consumables (e.g., fuel and explosives) and other deliveries. Heavy haulage vehicles will not be used by the Project during operations as all ore processing will occur on site. The breakdown of the types of trips generated during operations are shown in Table 7.32. The operations vehicle trips equate to an additional 32 trips per day on Fountain Head Road and six trips on the Stuart Highway. Traffic impacts are not

anticipated to continue during mine closure and rehabilitation as Project-related traffic will diminish significantly at the completion of operations.

Table 7.32 – Daily Project Traffic Generation During Operations

AM Peak		PM Peak		Total
LV	HV	LV	HV	
13	3	13	3	32

LV = Light vehicles, HV = Heavy vehicles. Heavy Vehicles are defined as vehicles with distance of >3.2m between the first and second axel, or have more than two axels.

7.11.2.3 Reduced Safety of Road Users due to Project Vehicles Using Public Roads

Project traffic using public roads has the potential to reduce the safety for other road users at two key intersections:

- Stuart Highway/Fountain Head Road: Project vehicles will have to reduce speed to exit the Stuart Highway. Heavy vehicles (such as those that will be arriving on site during construction) will need to brake and slow significantly to turn off the Stuart Highway safely. As there is no slip-lane for vehicles turning from the Stuart Highway onto Fountain Head Road (east), this means that vehicles trailing behind Project heavy vehicles, that wish to continue on the Stuart Highway beyond the Fountain Head Road intersection, will also need to reduce their speed.
- Fountain Head Road (east)/Mount Wells Road: This is a skewed (i.e., not 90°), uncontrolled, T-intersection with Mount Wells Road being the minor road. It is not known how many vehicles currently use Mount Wells Road. Project vehicles will travel along Fountain Head Road (east) past this intersection and public vehicles will need to give way to Project traffic when exiting Mount Wells Road onto Fountain Road (east).

Increased traffic due to Project vehicles has the potential to increase the number of accidents, particularly along the Stuart Highway and at the Fountain Head Road intersection.

7.11.3 Mitigation and Management Measures

7.11.3.1 Increased Traffic During Construction

Measures to minimise impacts due to an increase in traffic from Project vehicles during construction are:

- Develop and implement a Project traffic management plan and induct all staff, contractors and suppliers in accordance with the plan (TT01).
- Use mining fleet for construction works, where practicable, to minimise additional vehicle trips required (TT02).
- Minimise truck movements on the Project transport route during AM and PM peak traffic times (TT03).

- Transport employees from the Cosmo Village to the Project site using the staff bus, where practicable (TT04).
- Consult relevant stakeholders regarding any changes in the Project that will affect the public road network (TT05).
- Consult with the National Heavy Vehicle Regulator as necessary to ensure safe and efficient truck movements (TT06).

7.11.3.2 Increased Traffic during Operations

Measures to minimise impacts due to an increase in traffic from Project vehicles during operations are:

- Develop and implement a Project traffic management plan and induct all staff, contractors and suppliers in accordance with the plan (TT01).
- Minimise truck movements on the Project transport route during AM and PM peak traffic times (TT03).
- Transport employees from the Cosmo Village to the Project site using the staff bus, where practicable (TT04).
- Consult relevant stakeholders regarding any changes in the Project that will affect the public road network (TT05).
- Consult with the National Heavy Vehicle Regulator as necessary to ensure safe and efficient truck movements (TT06).

7.11.3.3 Reduced Safety of Road Users due to Project Vehicles using Public Roads

Measures to minimise impacts to road safety from Project vehicles are:

- Develop and implement a Project traffic management plan and induct all staff, contractors and suppliers in accordance with the plan (TT01).
- Display safety signage at appropriate intervals on Stuart Highway approach to the Fountain Head Road and at the Mount Wells Road intersection, in accordance with Northern Territory Department of Infrastructure, Planning and Logistics (DIPL) requirements (TT07).
- Transport employees from the Cosmo Village to the Project site using the staff bus, where practicable (TT04).
- Obtain all relevant permits for any oversize/overmass vehicles prior to movement of vehicles (TT09).
- All hazardous substances including explosives and cyanide will be transported to the site via public roads. All substances will be transported using the *Australian Dangerous Goods Code* (Edition 7.4) (TT10).

- Prepare a site access procedure for employees to outline and encourage safe and appropriate travel to and from Cosmo Village to the site (TT11).
- Liaise with DIPL and local road authorities to ensure access to Project roads are to be suitable for the purpose of haulage of equipment and materials for construction (TT12).

7.11.4 Residual Impacts

This section describes the outcomes of the residual impact assessment, assuming the successful implementation of recommended avoidance and mitigation measures (Section 7.11.3).

7.11.4.1 Increased Traffic during Construction

The predicted increase in traffic volume on public roads during construction are shown in Table 7.33.

Table 7.33 – Predicted Increase in Traffic Volume During Construction

Road	Predicted AADT in 2022	Predicted Daily Project Traffic*	% Increase
Stuart Highway (RDVDP003)			
Inbound	719	23	3.20
Outbound	725	23	3.17
Stuart Highway (RDVDP005)			
Inbound	660	23	3.48
Outbound	630	23	3.65
Fountain Head Road (east) (RDVDC057)			
Inbound	11	23	209.09
Outbound	11	23	209.09

See Figure 4.29 for location of traffic monitoring stations. *Predicted traffic for months 2 and 3 was used to estimate a 'worst-case' scenario.

The Project will increase the Annual Average Daily Traffic (AADT) along Fountain Head Road (east) and the Stuart Highway by 209.09% and 3.38% respectively (average of inbound and outbound traffic). Austroads (2016) indicate that traffic increases of 5 to 10% may warrant further assessment. The increase in traffic on Fountain Head Road (east) is greater than 5% of the current AADT with an increase of 209.09%. This increase represents the low existing traffic numbers on the road. The impact of Project traffic is low as the road has sufficient capacity for the additional traffic. Austroads considers roads such as Fountain Head Road to have a capacity of approximately 900 vehicles per hour (Austroads, 2020). The Project will increase the daily trips by 48, this is considered to be well within the capacity of Fountain Head Road (east) (Austroads, 2020). The increase in traffic on the Stuart Highway of 3.38% is considered insignificant. The existing heavy vehicle split on the Stuart Highway and Fountain Head Road (east) is 26.4% and 20.3% respectively. By comparison, the predicted heavy vehicle split for the construction is 16.67%. Hence, Project traffic is not expected to cause a major change to the existing vehicle use of the roads.

The duration of increased traffic is considered short-term as construction is only expected to take four months. The geographical extent of the increasing traffic is not expected to extend beyond

the local area (i.e., not beyond the Project transport route). The magnitude of the impact is therefore categorised as ***Low***, providing a residual significance of ***Negligible***.

7.11.4.2 Increased Traffic During Operations

The predicted increase in traffic volume on public roads during operations are shown in Table 7.34.

Table 7.34 – Predicted Increase in Traffic Volume During Operations

Road	Predicted AADT in 2025	Predicted Daily Project Traffic	% Increase
Stuart Highway (RDVDP003)			
Inbound	769	2	0.26
Outbound	794	2	0.25
Stuart Highway (RDVDP005)			
Inbound	690	2	0.29
Outbound	651	2	0.31
Fountain Head Road (east) (RDVDC057)			
Inbound	9	14	155.56
Outbound	9	14	155.56

See Figure 4.29 for location of traffic monitoring stations.

Operations traffic will be lower than construction. The primary sources of traffic will be consumable deliveries and the staff bus from Cosmo Village. Similar to construction, the increase in traffic on Fountain Head Road (east) will be greater than 5%, however the increase is not considered to be outside the overall traffic capacity of the road (Austroads, 2020). The increase in traffic on the Stuart Highway is considered insignificant. The heavy vehicle split for Project traffic during operations will be 23.53%, which is similar to the split already existing on the Stuart highway and Fountain Head Road (east).

The duration of increased traffic will be longer than for construction (approximately 4 years), although with fewer vehicles there will be less daily traffic. The geographic extent of the impact will not extend beyond the local area (the Project transport route). The magnitude of the impact is therefore categorised as ***Low***, providing a residual significance of ***Negligible***.

7.11.4.3 Reduced Safety of Road Users due to Project Vehicles Using Public Roads

The turn-off from the Stuart Highway onto Fountain Head Road (east) is the area where an accident is most likely to occur due to the high volume of traffic using the Stuart Highway. Analysis of the crash history on the Stuart Highway (within 3 km north and south of the Fountain Head Road turn-off) found no clear safety issues in relation to the road in the causes of traffic accidents (Appendices 12 and 13). This indicates that there are no inherent known safety issues with the road network immediately surrounding the Fountain Head Road (east) turn-off. GHD Australia (Appendices 12 and 13) undertook a sight-line assessment for visibility at the turn-off from the Stuart Highway onto Fountain Head Road (east). The assessment determined sufficient visibility both northbound and southbound to accommodate the Project traffic without reducing safety. A swept path assessment was conducted based on how a B-Double approximately 25 m in length (the largest expected Project vehicle) would typically turn from the Stuart Highway into

the northbound lane of Fountain Head Road (east), without encroaching into the southbound lane. The assessment determined that the existing pavement isn't wide enough for this to occur and that widening of the turn to safely accommodate the largest Project vehicle to enter Fountain Head Road (east) is required. As stated in Section 4.11.4, the largest vehicles currently using the turn off include cattle road trains (approximately 52 m long), which are expected based on the swept path analysis to be utilising the entire pavement width to turn into Fountain Head Road (east). Considering that larger vehicles are already safely using the turn off, the widening of the pavement is unlikely to be required. This will ultimately be determined by DIPL based on the safety risks associated with the increase in traffic.

Project vehicles will not differ from the vehicles that are currently using the Project transport route roads, hence the degree to which the Project will change the existing condition is not expected to be more than that of any other road user. The duration of the impact to road users is medium, in that it will be present for construction, operations and closure. The geographical extent will not extend beyond the intersection of Stuart Highway and Fountain Head Road. The magnitude of the impact is therefore categorised as ***Low***, providing a residual significance of ***Negligible***.

7.11.4.4 Summary of Impact Assessment

A summary of the traffic and transport impact assessment, including proposed mitigation and management measures to minimise impacts, is provided in Table 7.35.

7.11.5 Objectives, Targets and Monitoring

The key objectives, standards, measurement criteria and monitoring that PNX will use to ensure that the environmental impacts related to traffic and transport values are managed in compliance with applicable guidelines and standards are listed in Section 9.4.1, Table 9.2.

Table 7.35 – Traffic and Transport Impact Assessment

Project Phase	Environmental Value	Potential Impact	Activity/Aspect	Mitigation Measures	Sensitivity/ Magnitude	Residual Impact Significance
Construction	Local road users	Increased traffic during construction	• Increased traffic as a result of Project vehicles	• TT01 • TT02 • TT03 • TT04 • TT05 • TT06	Low/Negligible	Negligible
Operations	Local road users	Increased traffic during operations	• Increased traffic as a result of Project vehicles	• TT01 • TT03 • TT04 • TT05 • TT06	Low/Negligible	Negligible
Construction, Operations, Closure	Local road users	Reduced safety of road users due to Project vehicles using public roads	• Increased traffic as a result of Project vehicles	• TT01 • TT07 • TT04 • TT09 • TT10 • TT11 • TT12	Low/Low	Negligible

7.12 Cumulative Impacts

The Project terms of reference (ToR) requires an assessment of potential cumulative impacts associated with the Project. Cumulative impacts can be defined as the total impact arising from the Project in conjunction with other current or future activities (e.g., by that of developers, local communities or government). The analysis of the Project's incremental impacts combined with the effects of other known activities will provide a holistic understanding of the likely impacts of the Project's presence as opposed to considering the Project's impacts only in isolation. The Project's impact is therefore one part of the total cumulative impact on the environment. To assess the cumulative impacts associated with the Project, the residual impacts of the current proposal were assessed in the context of impacts associated with current and future activities.

7.12.1 Discipline-specific Approach

The approach for assessing the cumulative impact associated with the Project is outlined in Chapter 6. The cumulative impact assessment includes potential residual Project impacts that may be contributing factors (i.e., where there is likely to be a residual impact of Moderate or higher). Project impacts identified as potential contributing factors to cumulative impacts, have been assessed in the context of other current and future developments based on available information.

7.12.2 Scoping the Assessment

The cumulative impact assessment scope was determined by identifying credible projects based on the following criteria:

- The spatial boundaries, or geographical connections between Project activities and the identified environmental and social values. Projects that are known to or are likely to come within 50 km of the Project area were considered, as they have the potential to add significant stress on traffic and other infrastructure in the area. This distance also encompasses the closest townships (i.e. Adelaide River and Pine Creek).
- The temporal boundaries, or the timeframe over which the analysis takes place. Projects that are currently underway or are planned to commence during the Project life (three years) were assessed, if they fall within the previously stated spatial boundaries.
- Credible projects, which are defined as those that are existing, planned or reasonably anticipated based on publicly available information and are:
  - Currently operating or are expanding.
  - Under construction or being commissioned.
  - Undertaking detailed feasibility studies or a small-scale pilot project in preparation for the full-scale project.
  - Approved by State government and awaiting final investment decision or are in the final design stages.
  - Midway through their environmental approvals process and are likely to proceed if a permit is granted.

The scoping process identified two existing, planned or reasonably anticipated projects as 'credible' based on the criteria above; the Cosmo Gold Mine, 13 km away, and the Union Reefs North Underground Mine (URNUM), 35 km away, developed underneath the existing Union Reefs Mine. Both mines are wholly owned by Kirkland Lake Gold.

Kirkland Lake Gold suspended their NT operations in early 2020, including those at Cosmo Gold Mine and URNUM. These sites have been under care and maintenance for over a year, with rehabilitation activities underway.

The URNUM EIS was submitted to NT EPA for assessment late 2019, with NT EPA providing a response assessment report in June 2020. The assessment report provided a number of recommendations to be implemented for the development. However, Kirkland Lake Gold have indicated that NT operations will remain suspended for the foreseeable future. Due to the uncertainty around both developments a conservative approach will been used and they will be assessed as credible projects under this section.

7.12.3 Significant Project Impacts

Assessment of potential impacts of the Fountain Head Gold Project to environmental and social values or receptors determined the residual impact significance of each potential impact. The significance rating for the residual impacts ranged from Positive to Severe. Residual impacts assessed as Moderate or higher were determined to be potential contributing factors to cumulative impacts. These potential contributing factors include:

- Reduction in threatened flora species and their likelihood of recovery (Moderate).
- Loss or damage to known Aboriginal places (Moderate).

7.12.3.1 Reduction in Threatened Flora Species

Vegetation clearing and habitat loss as well as the introduction or spread of weeds a result of Project activities has the potential to impact threatened flora species. Two threatened flora species (*S. ensatum* and *A. praetermissa*) were identified as potentially occurring in the Project area due to suitable habitat, however neither species were recorded within the Project area during targeted surveys (Appendix 8). Although a majority of Project activities are planned to take place on previously disturbed areas, vegetation clearance of habitat suitable for the threatened flora species will be required.

The Cosmo Gold and URNUM Projects are not currently operating, therefore it is highly unlikely any vegetation removal will take place. Kirkland Lake Gold has indicated that the introduction and/or the spread of weeds was a concern for the Cosmo Gold Project (Kirkland Lake Gold, 2018). Rehabilitation works are currently underway at the site which will revegetate areas and manage the introduction and spread of weed species.

Cumulative impacts from the two projects resulting in the reduction of threatened flora species by the introduction or spread of weed species is not expected as both currently have weed infestations on site that are being managed. The Fountain Head Gold Project will remove approximately 74 ha of vegetation, however environmental staff will be trained to recognise flora and will complete a walk over prior to clearing to ensure threatened flora are not present. With

effective management and control measures such as the implementation of a weed management plan, the likelihood of cumulative impacts is unlikely.

7.12.3.2 Loss or Damage to Known Aboriginal Places

A total of six Aboriginal places have been recorded in the Project area, which have all been identified as having High significance. The Project may require the salvage of three of the six places, which are located in the centre of mine operations. This would require guidance from an archaeologist to manage the process and consultation with Traditional Owner representatives. This process will include appropriate salvage/management measures, which will significantly reduce any potential impacts to the places, however as the places are highly significant the residual impact is still ranked as Moderate.

Neither the Cosmo Gold Mine or URNUM have indicated any known Aboriginal places that occur across their individual project areas that have the potential to be impacted by project operations (Kirkland Lake Gold, 2019; Kirkland Lake Gold, 2018). Collectively, the likelihood of the Project, the Cosmo Gold Mine and URNUM impacting Aboriginal places that are known to occur within the proposed Project areas is virtually impossible with the implementation of management measures, industry guidance and consultation with Traditional Owners.

7.12.4 Proposed Mitigation and Management Measures

The implementation of mitigation and management measures listed in the impact assessment (Chapter 7) will sufficiently mitigate the potential impacts of the contributing factors identified. These are listed in the following sections of the impact assessment:

- Impacts to threatened flora from vegetation clearing and habitat loss or disturbance (refer to Section 7.7.3).
- Impacts to threatened flora from the spreading of weeds (refer to Section 7.7.3).
- Impacts to known Aboriginal places from damage or loss (refer to Section 7.10.3).

7.12.5 Summary

Across the Northern Territory multiple projects are in various stages of planning, exploration and operation. This cumulative impact assessment identified three significant potential contributing factors arising from the Project and two credible projects. Both credible projects remain suspended and therefore are not expected to contribute to cumulative Project impacts for the duration of the Project.

The Project impacts identified in Section 7.12.3 are highly localised, and are not likely to interact with other developments, or have a cumulative impact on the environmental values or receptors of the surrounding area beyond the extent assessed in the Project impact assessment.

7.13 Major Hazards

7.13.1 Introduction

Major hazards are aspects of the Project which could cause significant environmental and social impacts during an unplanned event or incident. Unplanned events are typically caused by

extreme natural events (e.g., uncontrolled fire, major flood or cyclones). While rare, such events may result in significant loss of life, serious environmental harm and asset and reputation damage. These are essentially events that are not expected to occur over the life of the Project, and are anticipated as possibilities, for which either preventative action or reactive responses, or both are required. These incidents are well documented in the industry. As a result, embedded design controls and standard operating procedures have evolved over several decades to reduce the occurrences of such events and incidents.

The identification of major hazards and potential unplanned incidents or events relating to the Project was undertaken in a HAZID workshop (see Section 6.2.8.1). The assessment was undertaken considering risks to environment, health and safety and community. The risk assessment assumed the effective implementation of the proposed mitigation measures that PNX will implement for the Project and examined the residual likelihood of a credible impact occurring as a result of the event. The consequence of the impact remains unchanged.

The following sub sections describe the incidents and unplanned events that were assessed to present a risk greater than a low, the consequences of those events and mitigation and management strategies to be adopted by the Project. The complete list of identified major hazards and incidents and events is detailed in the Major Hazards Risk Register (Appendix 23).

7.13.2 Uncontrolled Fire

Uncontrolled fires can be ignited accidentally by Project activities or sources and wildfire. Fire can occur during normal operating conditions from accidental ignitions, sparks or radiant heat from the operation of vehicles, machinery and equipment, hot works, electrical equipment such as transformers or high voltage power, and Project personnel (i.e., cigarette butts). Uncontrolled fires can also be caused by natural occurrences (e.g., lightning strike) or from third parties, such as prescribed burn escapes, cigarettes, campfires or arcing from powerlines. Fire is an unplanned event that could occur during any phase of the Project.

Uncontrolled fires can cause damage to the environment (including flora and fauna), Project assets and cultural heritage sites and significant injury or loss of life to Project personnel or the public.

Measures to minimise the risk of an uncontrolled fire include:

- Develop and implement the Bushfire Management Plan (MH01), which will contain measures such as:
  - Conducting seasonal prescribed burning if required in consultation with surrounding pastoral properties.
  - Daily checking of bushfire alerts and weather conditions.
  - Constructing and maintaining fire breaks.
  - No ignition sources outside of designated areas unless hot works permit is approved.
  - Firefighting equipment on-site, readily accessible and appropriate to potential sources of ignition on site.

  - Minimising additional sources of ignition (e.g., vehicles to be turned off when not driving, vehicles not to be parked over dry grass).
  - Personnel inductions to include fire awareness.
- Refuelling of machinery and vehicles undertaken on cleared areas away from standing or slashed vegetation where practicable (MH02).
- Store and transport flammable materials as per relevant SDS (MH03).
- Slash vegetation around the Project area to reduce fire risk (MH04).
- Do not undertake vegetation clearing with machinery when fire danger rating is 'Very High' or above (MH05).
- Prepare (and implement as required) an Emergency Response Plan in collaboration with local emergency services (SEM24).

7.13.3 Major Spill or Leak of Chemicals, Fuels, Reagents or Explosives

This section describes the impacts of and control measures for large spills (i.e., spills that warrant a report to be submitted to the NT EPA). Smaller incidental spills are discussed in the Project impact assessment (Section 7.5). In the case of an environmental incident (e.g., a spill), staff will be required to follow the PNX Environmental Incident Flowchart (Figure 9.2, Ch 09).

Generally, spills need to be reported to the NT EPA if the spill has:

- Entered a waterway (including a drain).
- Spread more than three metres, or
- Left the site or in this case the Project mining lease (NT EPA, 2020).

The Project will require large volumes of hazardous materials (e.g., fuel, chemicals, reagents and explosives). Large scale spills or mishandling of hazardous materials could occur from loss of containment during refuelling or incorrect storage practice. Such a spill could result in adverse impacts to soil, groundwater and surface water quality, aquatic and terrestrial biota and land users. Large spills are an unplanned event that could occur during any phase of the Project.

Both proactive and reactive measures will be used to minimise the risk of spills of hazardous materials and their potential impacts.

Measures to minimise the risk of spills include:

- Storage of fuels in secure self-bunded above ground tanks in accordance with Australian Standard AS1940 (LS06).
- All plant, equipment and vehicles to be refuelled within specified refuelling area (LS07).
- Collection of oil waste from the washbay at the vehicle maintenance workshop with an oil separator and water underflow reporting to a soakage or storage pit for reuse. Waste oil

will be collected and stored in drums in bunded and lined area for removal off site by a licensed contractor (SW12).

- Prepare (and implement as required) an Emergency Response Plan in collaboration with local emergency services (SEM24).
- Providing spill kits appropriate to the spill risk at the Project site and within vehicles as necessary. All fuel tankers and those tankers transporting hazardous materials shall carry appropriate spill kits (SW14).
- Site contamination assessment and clean-up to be conducted at closure (MH10).

In the case of a spill, the following reactive measures should be implemented:

- Removing/shutting of the source of the leak.
- Determining relevant personnel and equipment required for clean-up.
- Reporting the spill to the NT EPA to determine the next steps in spill response.

7.13.4 Railway Collision with Project Vehicles

A collision at the Alice Springs Darwin Rail level crossing was the highest rated risk in the Project Risk Register with a residual rating of ***High*** (Appendix 23). The Alice Springs Darwin Rail level crossing was the site of a collision in 2006 between a double road-train and a Ghan passenger train travelling north on the railway (ATSB, 2008). Although relatively unlikely once sufficient controls are in place, a collision between Project vehicles and trains could cause catastrophic impact to other road/rail users and in the worst-case scenario, multiple fatalities, and reputational and economic harm to the Project and Company. The risk of collision could occur during any Project phase, but the greatest risk is during construction when traffic numbers are predicted to be the highest over the Project life.

Measures to minimise the risk of a collision at the railway include:

- Develop and implement a traffic management plan and induct all staff, contractors and suppliers in accordance with the plan (TT01).
- Transport employees from the Cosmo Village to the Project site using the staff bus, where practicable (TT04).
- Obtain all relevant permits for any oversize/overmass vehicles prior to movement of vehicles (TT09).
- Prepare a site access procedure for employees to outline and encourage safe and appropriate travel to and from Cosmo Village to the site (TT11).
- Undertake an assessment of the level crossing in accordance with ALCAM (Australian Level Crossing Assessment Model) once the train and road traffic numbers are confirmed to determine if controls are adequate to handle the increase in traffic (MH14).
- Implement recommendations of the ALCAM assessment (MH15).

8. Ecologically Sustainable Development

The Northern Territory's environmental impact assessment process requires project proponents to demonstrate how their proposal aligns with and contributes to the guiding principles of ecologically sustainable development (ESD). This chapter describes the application of ESD principles to Project design, development and impact assessment.

The definition of ESD adopted in the Northern Territory is:

> Using, conserving and enhancing the communities' resources so that ecological processes, on which life depends, are maintained, and the total quality of life now and in the future can be increased. ESD is development that aims to meet the needs of Australians today, while conserving our ecosystems for the benefit of future generations.

Ecologically sustainable development acknowledges that economic and social progress depends on the services provided by ecosystems and a healthy environment. Ecosystem services, as they are known, are the contributions of ecosystems to human wellbeing. These may be provisioning (e.g., goods and services such as food, fibre and freshwater), regulating (climate regulation and disease control), cultural (recreational, spiritual and aesthetic enjoyment) and supporting (e.g., primary production, nutrient cycling etc that help maintain the other services) (Landsberg et al. 2013).

Ecologically sustainable development provides an approach to development that considers and accounts for the economic, social and environmental consequences of the decision being made. It supports the protection of ecosystem services and acknowledges that the benefits and opportunities of a healthy environment, and economic development, should be distributed equitably within and between present and future generations.

The Northern Territory (NT) government have adopted a set of ESD principles consistent with the National Strategy for Ecologically Sustainable Development (ESDSC,1992). The objectives of the strategy are to:

- Enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations.
- Provide for equity within and between generations.
- Protect biological diversity and maintain essential ecological processes and life-support systems.

The principles to which this proposal must align are outlined in Table 8.1 and a description of how the proposal complies with these principles is provided in the sections below.

Table 8.1 – Principles of Ecologically Sustainable Development

Principle	Description	Application to Project Decision-making
Precautionary Principle	Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation	The precautionary principle acknowledges that often decisions are made where there is incomplete knowledge and, accordingly, it demands precaution, or a risk-based approach, to decision-making In the application of the precautionary principle to project decision-making, decisions are guided by the mitigation hierarchy, which establishes the preferential order for applying management measures to most effectively reduce the magnitude of an impact as far as practicable. The precautionary principle is inherent to the impact assessment process which identifies and assesses the potential impacts based on the best available technical information, environmental standards and scientific knowledge A proactive approach to avoidance or prevention of serious or irreversible damage to environmental or cultural values is the preferred option wherever practicable. In some instances, mitigation can be incorporated into the Project design to avoid or reduce negative impacts, or to enhance the positive effects
Inter-generational and Intra-generational Equity	The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. Intra-generational equity involves consideration of equity within the present generation	The principle acknowledges the need to promote a collaborative approach to protecting the environment and requires the consideration of both short and long-term impacts and benefits of development In the application of this principle to project decision-making, this involves consultation and shared responsibilities with governments, the community, landholders and Indigenous peoples and considers opportunities for investment to deliver environmental and social benefit for future generations
Conservation of Biological Diversity and Ecological Integrity	The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making	This principle recognises that community wellbeing depends on maintaining biological diversity and ecological integrity. Maintaining ecological integrity involves maintaining ecosystem health, function and services An ecosystem approach to evaluation of impacts of a project on the environment is required under this principle and should be supported by research and community consultation
Improved Valuation, Pricing and Incentive Mechanisms	This includes recognition of the principles that the costs of environmental externalities should be internalised and that the polluter should bear the costs associated with environmental pollution	This principle requires accounting for both short and long-term external environmental costs (externalities) in project decision-making. The principle aims to ensure that the true cost of developments remain unrealised and that the loss of ecosystem services and the benefits they provide to humans are not borne by future generations

These four principles are inter-related and are considered both individually and collectively in assessing whether the Project contributes to ESD.

The strategy (ESDSC,1992) also sets out additional objectives specifically for the mining sector, which have also been considered in this chapter. They are:

- Ensure mine sites are rehabilitated to sound environmental and safety standards, and to a level at least consistent with the condition of surrounding land.
- Provide appropriate community returns for using mineral resources and achieve better environmental protection and management in the mining sector.
- Improve community consultation and information, improve performance in occupational health and safety and achieve social equity objectives.

Consideration of the mining objectives, where relevant, is integrated into the following sections.

8.1 The Precautionary Principle

Compliance with the precautionary principle requires the proactive anticipation and prevention of serious or irreversible environmental harm rather than reactively addressing issues as they arise. Further, where there is risk of serious or irreversible harm, a proponent should establish whether there is adequate scientific knowledge available to adequately evaluate the potential impact.

This principle is inherent to the environmental impact assessment process, which is a public process that assesses the uncertainty about the environmental impacts or benefits of a development prior to a project proceeding.

PNX has met the intent of the precautionary principle through the following measures:

- Undertaking specialist studies in line with advice provided by the NT EPA in the terms of reference (ToR) to gain an understanding of the existing environment and socio-economic context to inform design and management decisions.
- Assessing options and alternatives, and the least impactful selected where possible (see Section 3.10).
- Using best-practice technologies wherever practicable.
- Avoiding known sensitivities (i.e., potentially occurring threatened flora species and cultural heritage objects and places) (see Sections 7.7 and 7.10).
- Undertaking air emissions modelling and noise assessments based on ‘worst-case scenarios’ (see Sections 7.2 and 7.3).
- Assessing impacts relating to all phases of the Project, including, construction, operations, closure and rehabilitation.
- A comprehensive impact assessment process was adopted for the Project, which considered a significance-based method for planned activities, a risk-based approach for unplanned events and a compliance method that uses quantifiable measures and thresholds to assess compliance with relevant guidelines and standards (see Section 6.2).

Where the specialist studies have identified uncertainties, for example in the hydraulic properties of the underlying material in the proposed evaporation pond, the impact assessment has adopted

a conservative approach in identifying and assessing the potential impacts. Further, management measures detail adaptive monitoring that will be undertaken to identify whether unplanned impacts are occurring, and appropriate action would be taken if necessary, to avoid serious or irreversible environmental damage.

Based on the above measures, the Project meets the intent of the precautionary principle.

8.2 Inter-generational and Intra-generational Equity

Inter-generational equity requires that the Project is managed so that ecosystems and their human benefits are maintained or enhanced so that future generations are not disadvantaged by long-term adverse impacts. Intra-generational equity requires that the economic and social benefits of the Project are equitably distributed among all members of the community.

PNX has met the intent of the principle of inter- and intra-generational equity through the following measures:

- Historical mining activities have resulted in significant disturbance at the Fountain Head site. In selecting the location for Project infrastructure the Company's preference has been to locate infrastructure on land that has already been disturbed, so far as reasonably practicable, thereby avoiding clearing areas of undisturbed native vegetation (see Chapter 3).
- The Project footprint requires minimal use of land that would otherwise be used for pastoral activities (less than 1% of the Ban Ban Springs pastoral lease), avoiding economic impacts on the pastoral industry (see Section 7.9).
- The Project will avoid using groundwater bores, instead utilising existing water sources on site such as the pit, and will minimise the potential for surface and groundwater contamination through the implementation of best practice management controls (see Sections 7.5 and 7.6). No water is proposed to be discharged offsite to waterways, instead it will be evaporated and stored in an evaporation pond on site.
- Materials will be reused wherever possible. For example, existing waste rock will be reused for construction material for haul roads, workshops, and laydown areas. Some of the waste rock may also be crushed and screened during site establishment for blast hole stemming and aggregate for concrete (see Section 3.10).
- The provision of economic benefits to the NT, regional and local economies, through the generation of royalties, employment and procurement and the potential associated benefits, flow-on to service industries and to social cohesion in the local communities of Pine Creek and Adelaide River (see Section 7.9).
- The provision of employment and training opportunities to Aboriginal and Torres Strait Islander communities in Pine Creek, Adelaide River in particular (see Section 7.9).
- The conducting of an archaeological assessment, supporting the recording and sharing of cultural heritage values (see Section 4.10).

- The Project will generate negligible greenhouse gas emissions in comparison with broader industry and NT emissions (see Section 7.2).
- The Project will continue to engage with local communities to support Project awareness, including of potential impacts and how they will be avoided or managed and potential employment, business and training opportunities, supporting the growth of local economies and communities (see Section 7.9).
- Designing a mine closure and rehabilitation program for a previously disturbed and unrehabilitated area, including reshaping of landforms ensuring future stability and weed management during operations (see Sections 3.9, 7.9 and Appendix 22).

All planned activities have impacts which are highly localised to the immediate Project area. None of the potential Project impacts are predicted to last longer than the rehabilitation period.

Based on the above measures, the Project meets the intent of the principle of inter- and intra-generational equity. Alignment with the principle of inter- and intra-generational equity also meets the three objectives outlined in (ESDSC, 1992) specific to the mining sector.

8.3 Conservation of Biological Diversity and Ecological Integrity

This principle recognises that future economic development and human health is dependent on health, functioning ecosystems; incorporating their biotic and abiotic components, and the interrelationships between them.

Australia's Strategy for Nature 2019 – 2030 states that the conservation of biological diversity is most effectively achieved by the maintenance of functioning ecosystems and the biodiversity they contain in a healthy state (CoA, 2019c). The maintenance of ecological integrity involves preserving ecosystem health, function and services, including the processes which influence the global climate, provide clean air and water, regulate water flow, recycle essential elements, create and regenerate soil and enable ecosystems to renew themselves (NT EPA, 2010).

PNX has met the intent of the principle of conservation of biological diversity and ecological integrity through the following measures:

- Project design has considered minimising impacts on fauna and flora, through the location of infrastructure on land that is already highly disturbed from land clearing and pastoral activities, and within the existing mine site footprint wherever possible and avoidance of sensitive features (see Section 7.7).
- Ecosystem functions and inter-relationships have been considered in the baseline characterisation (Chapter 4) and in the development of management and mitigation measures (Chapter 7). The Project will not adversely impact on ecosystem function or ecosystem services.
- The Project will not adversely impact on listed threatened fauna or on migratory species (see Section 7.7).

- During operations, weed management will be undertaken to control invasive species already present on the property, which may support the reintroduction of native flora species.
- No contaminated water e.g., process water or PAF water storage dam water is proposed to be discharged off site. This will avoid mine impacted water from reaching nearby waterways and aquatic ecosystems (see Section 7.8).
- Areas of pre and post Project disturbance will be rehabilitated by native revegetation or returned to its previous land use, which will improve the site from its current pre-Project condition where little to no rehabilitation had been undertaken.
- A small number of potential impacts on biological diversity or ecological integrity resulting from the Project were ranked as ***Moderate*** or higher and have been assessed further under cumulative impacts (see Section 7.12).

Further, PNX maintains an Environmental Management System (discussed in Chapter 9) that supports an integrated and comprehensive approach to identifying and managing environmental risks, and which will support the implementation of the management measures and commitments in this environmental impact statement (EIS).

Based on the above measures, the Project meets the intent of the principle of biological diversity and ecological integrity.

8.4 Improved Valuation, Pricing and Incentive Mechanisms

Whilst assigning a value to ecological systems and processes is notoriously difficult (Small et al. 2017), the principle of improved valuation, pricing and incentive mechanisms requires that project proponents consider and factor into their project the full cost (which external environmental costs) of a development. Cost-benefit analyses help reach decisions objectively by allowing the costs of proceeding with a proposal to be assessed against the benefits arising from the proposal.

Historically, the full environmental and social costs of developments have not been considered in project decision-making. However, the consequences of this omission are that decisions are made without a full cost-benefit analysis, and that third parties (e.g., the government and/or local communities) not the developer, are forced to ‘pay’ for these externalities at some point in the future.

The environmental impact assessment process is one way that governments can support the ‘internalisation’ of externalities, by requiring project proponents to detail the potential impacts and how they will be effectively mitigated over the life of the project.

PNX has identified avoidance, minimisation and management strategies to mitigate potential social, cultural and environmental impacts and to return the site to a rehabilitated condition on mine closure. When implemented, these measures will form part of the total Project cost, thereby ensuring that social, cultural and environmental values and their protection are considered and reflected in this cost.

8.5 Summary of Findings

The Project has been designed to minimise adverse impacts to the local environment and communities and to generate benefits to regional and local communities. Further, the Project is a significant commitment to improve a site through rehabilitation which has a history of over 100 years of mining activity with no completed rehabilitation conducted to date other than care and maintenance activity.

The Project has been developed and designed in accordance with four principles of ESD (see Table 8.1) and in consideration of the three ESD objectives for the mining sector. The EIS outlines the specialist studies (see Chapter 4) that have been undertaken to minimise uncertainties and appropriate management measures that will effectively mitigate or minimise environmental and social impacts (see Chapter 7).

Based on the analyses in this chapter, undertaking the Project meets the intent of the ESD objectives outlined in the National Strategy for Ecologically Sustainable Development (ESDSC,1992).

9. Environmental Management, Monitoring and Reporting

9.1 Company Environmental Policy

PNX Metals' Environmental Policy (Box 9.1) outlines Company commitment to identifying and managing environmental and social impacts and risks associated with the proposed Project activities. This policy will guide the development of environmental management systems (EMS), processes, plans and procedures for the Fountain Head Gold Project. It also establishes the principles and goals for environmental performance against which the effectiveness of the EMS will be evaluated. PNX, as Project proponent and operator, holds full and ultimate responsibility for the implementation of this policy and is committed to managing and delivering this Project in accordance with the statutory requirements and commitments within this EIS.

The framework described here is intended to be used for developing the Mining Management Plan (MMP) and more detailed management plans beyond the environmental impact statement (EIS) process to obtain authorisation under the *Mining Management Act*.

Box 9.1 – PNX Metals' Environmental Policy

Environmental Policy

PNX Metals Ltd is committed to protecting the environment in areas where the company is conducting exploration and mining related activities during design, planning, operation and decommissioning phases through a best practice environmental approach.

The company is committed to achieving the highest standards of environmental management in all its activities by complying with and, where possible exceeding all applicable Commonwealth, State and Territory government laws and regulations for the protection of the environment.

To achieve this objective PNX has a commitment to the following policies:

- Encourage environmental stewardship and responsibility amongst all employees, contractors and joint venture partners through education, training and management actions.
- Develop a culture of continuous improvement and pursuit of excellence in environmental practice.
- Set and meet environmental objectives and targets based on the prevention or minimisation of pollution, including greenhouse gas emissions.
- Minimise waste disposal through waste avoidance, recycling and resource recovery.
- Ensure that disturbed areas are progressively rehabilitated as early as possible and in conformance with the site-specific environmental management and closure plans.
- Communicate freely and openly with relevant authorities, stakeholders, local communities, special interest groups and the public at large to ensure that the company clearly understands its environmental expectations.
- Continuously monitor environmental impact and rehabilitation performance to ensure long term success.
- Regularly prepare, review and update site specific environmental management and closure plans and publicly report and showcase the company's environmental achievements.
- At least annually review and maintain our Environmental Policy and Procedures performance.

James Fox
Managing Director and CEO
PNX Metals Limited
29 April 2021

9.2 Organisational Structure and Responsibilities

PNX holds a significant base and precious metals tenement portfolio, primarily in the Northern Territory (NT) but also in South Australia. PNX does not have dedicated environmental personnel but rather engages consultants to provide environmental advice and assist in meeting environmental monitoring obligations. An overview of the Company organisational chart is provided in Figure 1.1.

PNX will have overarching responsibility to ensure compliance with all approval, permit and license conditions. PNX believes that high standards of environmental and social management begin with clear responsibilities amongst managers, supervisors, employees and contractors. The organisational responsibility hierarchy is as outlined in Table 9.1.

Table 9.1 – Roles and Responsibilities

Level with organisation	Responsibilities
Responsible Officer (CEO & Managing Director)	• Ensure that the organisation meets its obligations to provide a healthy and safe workplace as required by the NT *Workplace Health and Safety Act* and the implementation of PNX Health, Safety and Welfare policies and programs • Ensure the organisation meets its environmental obligations as required by the *Mining Management Act* • Monitor, audit and review Occupational Health and Safety (OHS) and environmental policies • Drive positive and cooperative culture within the company
Operations Manager	• Ensure that the Fountain Head Gold Project meets its obligations as required by the NT *Workplace Health and Safety Act* and the implementation of PNX Health, Safety and Welfare policies and programs • Ensure the Fountain Head Gold Project meets its environmental obligations as required by the *Mining Management Act* and that the operation is managed in accordance with the approved Mining Management Plan • Ensure that appropriate measures are implemented to plan, control, monitor and remediate risks to health, safety and the environment • Ensure incident and accident reporting and investigation occur promptly, are reported to the relevant authorities, and that any control measures are implemented as soon as practicable
Managers	• Communicate to employees the commitments outlined in the Mining Management Plan and monitor for compliance • Provide employees with the necessary skills, training and equipment to safely undertake their work (e.g., First Aid courses) • Ensure incident and accident reporting and investigation occur promptly, are reported to the relevant authorities, and that any control measures are implemented as soon as practicable
Supervisors	• Ensure that work is done in accordance with any health, safety and environmental procedures and in a manner which controls the risks to health, safety and the environment • Implement relevant health, safety and environment policies and procedures in their areas of control • Be familiar with and implement commitments outlined in the MMP • Provide the necessary information, instruction and training to employees under their control

Level with organisation	Responsibilities
	• Ensure employees carry out their jobs effectively and safely • Carry out incident and accident reporting and investigation as per Company policies and the responsible regulatory framework
Employees/Contractors	• Employees and contractors are required to complete their work in a manner that does not put themselves, others or the environment at risk • They are to follow reasonable instructions and use any training, personal protective equipment or tools provided with regard to health, safety or the environment • Report any incident or hazards at work to management as soon as possible after the event • Ensure that all equipment provided for health, safety and environmental purposes is used correctly and is maintained in good operating condition • Obey all instructions, such as policies and procedures issued to protect their own personal health and safety, and the health and safety of others • Report or make recommendations to management to avoid, eliminate or minimise any hazards of which they are aware regarding working conditions or methods • Employees will abide by the zero tolerance to the taking of drugs and presenting to work with any alcohol in their system • Ensure that they are fit for work, being in a physical, mental and emotional state to perform assigned tasks in a manner that does not threaten the safety or health of themselves or others • Keep their work area tidy

9.3 Environmental Management System Overview

PNX uses an integrated EMS to ensure a consistent approach to management of environmental risks. The EMS is comprised of a series of management system standards which are supported by a suite of discipline-specific Environmental Management Plans (EMPs), which will incorporate the commitments, objectives and targets outlined in the environmental impact statement (this document). A full list of commitments is provided in the Commitments Register in Appendix 22. The EMS utilises the 'plan, do, check, act' cycle of continual improvement (Figure 9.1) and has been established in accordance with ISO 14001:2016 standards (Standards Australia, 2016). PNX plans to continue to develop its EMS for the Fountain Head Gold Project to support the Company's Environmental Policy (see Box 9.1).

Project management plans that have been, or will be required to be developed include:

- Water Management Plan (Appendix 16).
- Cultural Heritage Management Plan (Appendix 24).
- Traffic Management Plan (Appendix 13).
- Project Traffic Management Plan – site specific.
- Mine Closure Plan (Appendix 18).

- Rehabilitation Management Plan.
- Weed Management Plan.
- Waste Management Plan.
- Bushfire Management Plan.

Processes and procedures will also be developed.

9.4 Environmental Performance

Performance against commitments made in this EIS and associated management plans will be assessed and presented in Company internal monthly reports or reports submitted to PNX by Project contractors. These reports will detail whether the Project is meeting the identified objectives and targets and results from monitoring programs (Section 9.4.1). Assessment of performance will also be documented in an operational performance report submitted to the Department of Primary Industry and Resources (DPIR), in line with the *Mining Management Act*. This report will assess the Project's compliance with the commitments made in the Mining Management Plan.

9.4.1 Environmental Performance Objectives, Standards and Measurement Criteria

This section presents the environmental performance objectives, standards and measurement criteria used to address the Project impacts and risks identified.

Table 9.2 below lists the key objectives, management and mitigation measures, targets and monitoring that PNX will use to ensure that the environmental impacts and risks are managed. Objectives and targets have been developed for each of the identified environmental risks and impacts and have been based around the identified management controls from the impact assessment. For each objective and target, monitoring has been developed in conjunction with the mitigation and management measures. Contingency measures have also been identified for implementation if thresholds/targets are not achieved.

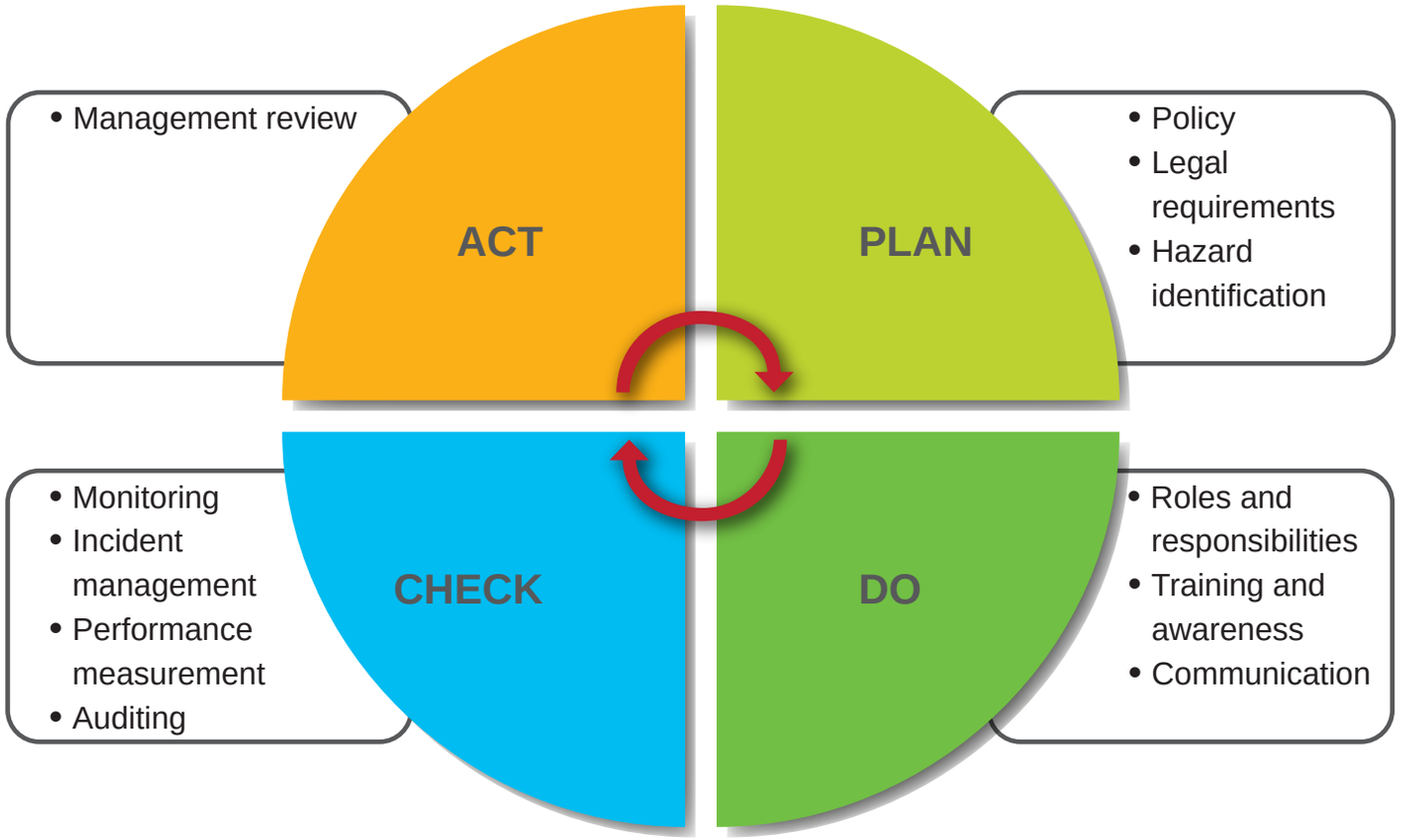
9.4.1.1 Performance Definitions

- Environmental Performance Objectives: a statement of the objectives or goals for protecting the environment relevant to the specific proposed activity.
- Environmental Performance Target: verifiable indicator of achieving the objectives, or of progress toward achieving the objectives, within specific parameters.
- Environmental Monitoring: measurement methods used to determine whether the objectives and performance standards are met.

PNX METALS CONTINUOUS IMPROVEMENT CYCLE

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 9.1



Source: ERIAS Group, 2020

Table 9.2 – Objectives, Targets and Monitoring

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
Land and Soils						
Reduction in flora establishment as a result of erosion and soil compaction	Prevent erosion and soil compaction of areas outside of the production area	• Implement vegetation clearing approvals process • Where possible, Project infrastructure will be located in areas previously disturbed • Progressively rehabilitate areas as activities cease • Ensure Project vehicles remain on Project roads and tracks as far as reasonably practical	Uncleared or planned disturbed areas not impacted by erosion or soil compaction	Monitor area of land clearing to ensure areas are not being disturbed outside of the production area	Cease land clearing activities and evaluate significance of habitat	Report incidents relating to impacts to land not within the production area
Contamination of soils by hazardous and non-hazardous materials	Prevent contamination of soils by hazardous and non-hazardous materials	• Storing fuels, lubricants and process reagents in covered areas or in bunded and lined areas. Bunding will be implemented in accordance with relevant standards and guidelines including AS 1940 Storage and handling of flammable and combustible liquids and the *Australian Dangerous Goods Code* • Processing additives such as cyanide and lime to be stored in secure	• Hazardous material handling, use and storage is compliant with relevant Work Health and Safety Regulations • Septic system managed in accordance with the Northern Territory *Code of Practice for Onsite Wastewater Management*	Regular inspection of hazardous material storage areas	n/a	• Record inspection of hazardous material storage areas • Record spills or discharge of potential contaminants

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		undercover reagent storage area • All plant, equipment and vehicles to be refuelled within specified refuelling area • Develop and maintain a Standard Work Procedure for hydrocarbon and chemical spill response • Locating, constructing and using septic systems in accordance with the Northern Territory *Code of Practice for Onsite Wastewater Management* (NT Government, 2014) • Regularly pumping solids from the septic tank to prevent blockages				
Rehabilitation failure as a result of loss of topsoil structure and seedbank in topsoils stored for rehabilitation	Prevent failed rehabilitation of disturbed areas and IWL	• Develop and adhere to the topsoil management procedure, which will include the following: – Strategic placement of stockpiled soils, i.e. to protect from prevailing wind and drainage lines – Minimise the timeframe between area no longer being used for	Rehabilitation expectations have been met in accordance with the rehabilitation management Plan	• Monitoring of stockpiles in accordance with the weed management plan • Monitoring for erosion events	Cease rehabilitation efforts and revaluate how to utilise stored topsoil for rehabilitation	• Reporting of erosion events • Records of erosion control structure inspections demonstrating integrity is maintained

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		Project requirements and rehabilitation to reduce the likelihood of weeds becoming established – Locate soils in areas where soils were previously removed – Minimise stockpile height to maximum 3 m – Stockpiles to be revegetated with native vegetation to minimise loss of soil quality – Stockpiles to be monitored for weeds and control programs implemented as required				
Deterioration of soil quality due to the dispersion of arsenic and heavy metal particulate matter	Avoid contamination of soils by arsenic and heavy metals as a result of airborne particulate matter	• Shutting off evaporators during wind conditions that place sensitive receptors downwind, based on measured or forecast wind conditions if required	• No decline in soil quality in the vicinity of the pit and evaporation pond	• Baseline soil quality data to be collected on site prior to dewatering activity • Annual monitoring of soil quality on site, in particular within 500 m of the pit and evaporation pond until operations cease	If soil quality has declined in the vicinity of the pit or evaporation pond: • Review shutdown windspeed limits • Review placement of the evaporators • Prepare plan for soil remediation upon closure	n/a
Air Quality and Greenhouse Gas						

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
Deterioration in receiving air quality and adverse impacts to human health and amenity of area	Minimise emissions of dust from the Project	• Sustainable use of water for supressing dust on haul roads, topsoil, ore and overburden stockpiles, crushing areas and active mining areas • Sustainable use of water for supressing dust on crusher hoppers, transfer chutes and drops • Sustainable use of water for to maintain moisture of tailings within the IWL • Progressive rehabilitation of the waste rock storage • Progressive rehabilitation of production areas as mining and operations cease • Implement speed limits to minimise dust creation • Use of water spray on screening and crushing • Minimise area of clearing as far as practicable • Minimise areas exposed to wind erosion • Crushing to predominantly occur during the day shift	• Compliance with air quality criteria for particulate matter and dust deposition	• Monitoring of community complaints in relation to air quality (dust emissions) if received	If a complaint is recorded: • Immediate inspections for potential non-compliant source of emissions • Review air quality management measures and procedures, and implement corrective actions to reduce likelihood of incident recurrence	• Records of reported grievances and responses maintained • Reporting and records of non-compliances and corrective actions taken

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
Deterioration in receiving air quality due to volatilisation of HCN resulting in adverse impacts to human health	Minimise volatilisation to air of HCN	• Leaching solution to be dosed with lime to maintain a pH of 10, to minimise volatilisation of HCN	• Compliance with air quality criteria for cyanide • Leaching solution maintains a pH of 10	• Monitoring of leaching solution pH		
Increased levels of greenhouse gases and changes to climate as a result of land clearing	Minimise greenhouse gases from the Project	• Taking an approach of continuous improvement, implemented through ongoing monitoring, reporting GHG emissions and identifying opportunities to reduce emissions • Minimise area of clearing as far as practicable • Progressive rehabilitation of the waste rock storage • Progressive rehabilitation of production areas as mining and operations cease	• Compliance with approved vegetation clearing and disturbance areas • Progressive rehabilitation is undertaken	n/a	• Non-compliance reported as an incident under PNX Metals Procedures • Stop work until clearing area defined • Identify root cause of non-compliance • Actions implemented to correct root cause and reduce likelihood of incident recurrence • Report to relevant government authorities if require	• Records of the amount of each habitat type cleared for the proposal • Reporting and records of non-compliances and corrective actions taken
Increased levels of greenhouse gases and changes to climate as a result of fuel combustion	Minimise greenhouse gases from the Project	• Compliance with emissions and energy use reporting obligations, as required under the NGER Scheme	• Compliance with energy use NGER reporting requirements	• Monitoring of energy use and reporting under the NGER Scheme	n/a	• Records of regular inspection and maintenance of equipment

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Utilisation of best practice technologies in the mining and minerals processing operations to ensure that energy efficiency and associated GHG emissions are optimised • Taking an approach of continuous improvement, implemented through ongoing monitoring, reporting GHG emissions and identifying opportunities to reduce emissions • Using low energy lighting (e.g., LED lighting systems), where practicable • Reduce mining equipment diesel consumption through equipment selection, load optimisation, route optimisation and production scheduling and reduced idle time • Maintain and operate equipment based on manufacturer/supplier guidelines and recommendations		• Monitoring of GHG emissions		• Reporting or non-compliances and records of corrective actions • Reporting of annual energy use as required under the NGER Scheme • Reporting estimated GHG emissions annually as required under the NGER Scheme

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Reduce generator diesel consumption through selecting a flexible configuration that allows for electricity output to be adjusted in line with demand • Scheduling of production to ensure energy efficient operations of processing equipment • Adjusting peak demand through production scheduling to allow for optimal use of electricity				
Noise						
Increase in noise levels with adverse impact on human health and amenity	Prevent adverse impacts on human health or amenity at sensitive receptors	• All reasonable and practicable measures will be taken to reduce noise during construction and any activities that cannot be attenuated sufficiently are to be conducted during standard hours only • If complaints are received, monitoring at the closest sensitive receptor (i.e., the Grove Hill Hotel) will be done to ensure noise levels do not exceed the background noise levels by more than 10 dB during	The NT EPA – *Northern Territory Noise Management Framework Guideline*: • Operational Noise: 35 dB(A) • Construction Noise: 37 dB(A)	• Monitoring of noise levels at sensitive receptors if complaints are received	• Reduce noise emitting operations and re-evaluate operation design	• Record noise levels at sensitive receptors for compliance if complaint are received

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		standard hours, and no more than 5 dB at all other times • All reasonable and practicable measures will be taken to reduce noise during operations and any activities that cannot be attenuated sufficiently are to be conducted during standard hours only • If complaints are received, monitoring at the closest sensitive receptor (i.e., the Grove Hill Hotel) will be done to ensure operation noise levels will not exceed 40 dB during the day, 40 dB during the evening and 35 dB at night. Slight exceedances of these values will be acceptable when weather conditions are conductive. Day is between 7 am and 6 pm (Monday to Saturday), 8 am and 6 pm (Sunday and public holidays). Evening is between 6pm and 10pm (all days). Night is between 10 pm and 8 am (if the following day is a Sunday				

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		or public holiday), 10 pm and 7 am (all other days)				
Air blast overpressure causing annoyance and/or discomfort to persons at sensitive receptors	Prevent annoyance and discomfort to sensitive receptors	• Blasting activities will be restricted to daylight hours only, all days of the week • A site based trained blasting professional will design each blast • If complaints are received, blasting professional will revaluate blast design and check air blast overpressure levels do not exceed 115 dB (Lin, Peak) for more than 5% of the total number of blasts over a period of 12 months at the closest sensitive receptor (i.e., the Grove Hill Hotel) • If complaints are received, blasting professional will revaluate blast design and check air blast overpressure levels do not exceed 120 dB (Lin, Peak) at any time at sensitive receptors (i.e., the Grove Hill Hotel)	ANZECC – *Technical Basis for Guidelines to Minimise annoyance due to Blasting Overpressure and Ground Vibration*: • 115 dB	• Monitoring of noise levels at sensitive receptors if complaints are received • Monitoring of air blast overpressure at sensitive receptors if complaints are received • Blasting contractor to monitor blasting to ensure compliance with relevant criteria	• Cease blasting activities and re-evaluate blast design	• Record air blast overpressure levels at sensitive receptors for compliance if complaints are received • Record-keeping of number of blast and blast level
Ground vibrations causing annoyance and/or discomfort	Prevent annoyance and discomfort to	• Blasting activities will be restricted to daylight hours only, all days of the week	ANZECC – *Technical Basis for Guidelines to*	• Monitoring of vibrations at sensitive receptors if	• Cease blasting activities and re-	• Record vibration levels at sensitive receptors for

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
to persons at sensitive receptors	sensitive receptors	• A site based trained blasting professional will design each blast • If complaints are received, blasting professional will revaluate blast design and check ground vibrations do not exceed 5 mm/sec (ppv) for more than 5% of the total number of blasts over a period of 12 months at the closest sensitive receptor (i.e., the Grove Hill Hotel) • If complaints are received, blasting professional will revaluate blast design and check ground vibrations do not exceed 10 mm/sec at any time at sensitive receptors (i.e., the Grove Hill Hotel)	*Minimise annoyance due to Blasting Overpressure and Ground Vibration*: • 5 mm/sec ppv	complaints are received • Blasting contractor to monitor blasting to ensure compliance with relevant criteria	evaluate blast design	compliance if complaints are received • Review blasting monitoring data for compliance with relevant criteria • Record-keeping of number of blast and blast level
Ground vibrations damaging the integrity of the buried BGP Pipeline	Prevent damage to existing infrastructure	• A site based trained blasting professional will design each blast • Blasting professional to ensure ground vibration will not exceed 20 mm/sec at any time at the BGP	APA – *Standard conditions for works near APA Gas Transmission Pipelines*: • 20 mm/sec ppv	• Monitoring of vibrations at sensitive receptors if complaints are received • Blasting contractor to monitor blasting to ensure compliance with relevant criteria	• Cease blasting activities and re-evaluate blast design by blast specialist	• Recorded vibration levels at sensitive receptors for compliance if complaints are received • Reviewing blasting monitoring data

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
						for compliance with relevant criteria • Record-keeping of number of blast and blast level
Hydrology						
Altered surface water hydrological regime	Avoid flooding or erosion of Project infrastructure Minimise impacts on flows to downstream surface waters	Embedded design controls will include: • Constructing the core yard and western soil stockpile on raised pads above the 1% AEP peak flood levels with appropriate freeboard or using flood protection structures such as bunds • Constructing a diversion channel along the western side of the existing waste rock storage to reinstate the natural flow path and divert the natural catchment runoff into the existing Fountain Head Lake . A diversion is also proposed along the northern side of the evaporation pond as the proposed pond extension is located on the existing flow path connecting	• No flood damage to Project (or other) infrastructure • No impacts on downstream flows	• Visual inspection of infrastructure, diversion channels and downstream flow behaviour following rainfall events	• Install additional or alternative hydrological/ erosion controls	Visual inspection of infrastructure, diversion channels and downstream flow behaviour following rainfall events

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		Fountain Head Lake to the unnamed creek • Diverting natural catchment runoff from upgradient of the processing area to flow to the unnamed creek • Installing culverts under the haul road to provide direct drainage from the lake and to reduce the frequency of flooding of the haul road				
Groundwater drawdown	Minimise impacts on other groundwater users	None proposed	No complaints from groundwater users	• Complaints received	• Investigate cause of reduced groundwater availability and provide alternative water source if mine-related	Complaints register
Groundwater mounding	Avoid waterlogging of soil and surface expression of evaporation pond seepage	None proposed	No surface expression of groundwater or waterlogging of soils	• Regular groundwater level monitoring and visual inspections of seepage from evaporation pond	• Action measures to prevent seepage to the downstream catchment (e.g., interception trenches/ bores)	Maintain records of visual inspections
Surface Water						
Increased suspended sediment and turbidity from rainfall runoff	Minimise impacts from rainfall runoff, erosion	Embedded design controls will include:	No detectable change from background	• Surface water monitoring as per	• Investigate potential sources of excess	Annual reporting as required for the

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
	and scouring on surface water quality	• Installing approximately six appropriately sized sediment dams according to the best practice erosion and sediment control guidelines (IECA, 2008) to capture surface runoff from the IWL, processing plant, ROM pad, mining contractor yard and hardstand areas to allow suspended sediment to settle out prior to overflowing to the downslope catchment. Prior to the installation of the sediment dams (i.e., during the construction phase), rainfall runoff will flow through existing drainage lines either into Fountain Head Lake or towards the unnamed tributary creek to the north • Diverting natural catchment runoff from upstream of the processing area, diverting the existing drainage line around the north of the proposed evaporation pond (which is located on the existing flow path) and	conditions in downstream water quality beyond the unnamed tributary creek	the water management plan • Verification that sediment control structures are installed during construction and as required for closure (i.e., once sediment dams have been removed) • Monitoring the success of rehabilitation works in accordance with the rehabilitation management plan	sediment, inspect for signs of erosion and implement corrective actions to reduce sediment loads • Install additional or alternative sediment control structures • Inspections of unsuccessful rehabilitation site to identify root cause	mine management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		installing a bund around the Fountain Head pit to direct surface water away from operational areas • Installing erosion protection, e.g., rock armour around the western soil stockpile, adjacent the haul road at the northern extent of Fountain Head Lake and along the western and northern toes of the evaporation pond to minimise scour from surface water drainage • Installing culverts under the haul road to provide direct drainage from the lake and to reduce the frequency of flooding of the haul road • Constructing the core yard and western soil stockpile on raised pads above the 1% AEP peak flood levels with appropriate freeboard or flood protection structures Mitigation measures will include: • If deemed appropriate, using hay bales, geotextile				

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		silt fencing, or silt socks to contain sediment runoff during construction and closure earthworks and ground disturbance activities • Rehabilitating disturbed areas as soon as practicable to minimise areas of potentially erodible soil • Controlling sediment runoff from stockpiles by installing sediment control structures to intercept sediment laden-surface runoff to reduce sediment delivery to watercourses • Avoiding stockpiling spoil and/or topsoil close to existing and proposed drainage lines, maintaining a minimum distance of approximately 50 m, where practicable • Undertaking earthworks and ground disturbance activities during the drier months, wherever practicable, when exposed surfaces will be less prone to rainfall erosion				

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
Surface water contamination from waste rock, ore and tailings	Prevent impacts to surface water quality from NAF waste rock and ore at the ROM	• Validating the assumption that operational blending of non-acid forming (NAF) and potentially acid-forming low capacity (PAF-LC) material will buffer the acid forming potential of PAF-LC and conducting column leach testing to further understand the potential for acidic drainage from PAF-LC material placed in the IWL • Routine monitoring of water quality in the sediment dams that overflow to the downslope catchment to confirm that runoff from the operational areas is of suitable quality in line with downstream receiving environmental objectives. Where water in the sediment dams does not meet relevant receiving water quality criteria, it will be directed to the evaporation pond or process plant	No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in downstream surface waters (i.e., the unnamed tributary creek or Margaret River)	• Surface water monitoring as per the water management plan	• Where testing shows operational blending is unable to buffer the acid forming potential of PAF-LC, implement appropriate management measures to reduce potential acidic drainage from PAF-LC (e.g., temporary segregation and subsequent submersion)	Annual reporting as required by the mine management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
	Minimise impacts to surface water quality from PAF waste rock	Embedded design controls will include: • Constructing a dam designed to contain a 1 in 100 year 72 hour rainfall event to capture runoff from PAF material stockpile (during operations) Mitigation measures will include: • Conducting further testing to quantify the distribution of PAF materials from the Fountain Head pit • Testing the sulphur content of waste rock and segregating PAF waste rock, using a ≤0.2% Total S cutoff for NAF material and returning PAF material to the open pit at completion of mining for permanent submersion	No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in downstream surface waters (i.e., the unnamed tributary creek or Margaret River)	• Surface water monitoring as per the water management plan • Verify PAF material distribution • Verify that testing of sulphur the content of waste rock is being conducted and PAF material is segregated • Visual inspections to verify that silt and water catchment ponds are effectively containing runoff from PAF material	Review PAF management procedures and implement corrective action	Annual reporting as required by the mine management plan
	Minimise impacts to surface water quality from tailings	Embedded design controls will include: • Placing the tailings within a clay-lined cell within the IWL and capturing rainfall runoff that has been in contact with the tailings within one decant well	No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in downstream surface waters (i.e., the	• Surface water monitoring as per the water management plan	• Investigate sources of contamination and implement remedial action • Develop appropriate long term management	• Annual reporting as required by the mine management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		(during operations) for use at the process plant or directing it to the evaporation pond • Washing of tailings filter cake to remove residual cyanide prior to placement in IWL, and return of wash water to processing plant circuit • Capping the tailings with a 0.5-m layer of clay and 1.5-m layer of NAF waste rock to prevent rainfall infiltrating the tailings following closure • Installing an under drainage system below the IWL to capture seepage from the clay liner. The water will be collected in two sumps and will be pumped to the process plant Mitigation measures will include: • Monitoring of surface water quality in the unnamed tributary creek and Margaret River to detect potential	unnamed tributary creek or Margaret River)		strategy (if required)	

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		contamination and to initiate remedial action				
Surface water contamination from accidental release of hydrocarbons and chemicals	Prevent or minimise contamination of surface water from the accidental release of hydrocarbons and chemicals	• Implementation of standard international cyanide management codes • Storing fuels, lubricants and process reagents in covered areas or in bunded and lined areas. Bunding will be implemented in accordance with relevant standards and guidelines including AS 1940 Storage and handling of flammable and combustible liquids and the *Australian Dangerous Goods Code* • Collection of oil waste from the washbay at the vehicle maintenance workshop with an oil separator and water underflow reporting to a soakage or storage pit for reuse. Waste oil will be collected and stored in drums in bunded and lined area for removal off site by a licensed contractor • Refuelling on impermeable hardstand areas with spill	• No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in downstream surface waters (i.e., the unnamed tributary creek or Margaret River) • No undetected or uncontained release of hydrocarbons or chemicals	• Surface water monitoring as per the water management plan • Incident-triggered surface water monitoring where release of hydrocarbon or chemicals occurs and may impact downstream surface water either due to the size of the release or the time taken to contain/remediate it • Visual monitoring for signs of leaks or spills from vehicles, plant and machinery • Inspect bunds, sumps and storage pits designed to contain hydrocarbons or chemicals and remove water and dispose offsite using a licensed contractor	• Investigate potential source of hydrocarbon or chemical releases (if unknown) • Investigate potential environmental impacts of a known release (if considered a reportable incident) • Review management measures and procedures, and implement corrective actions to reduce likelihood of incident recurrence • Remove from use vehicles, plant or machinery which have not been serviced in accordance with the service and maintenance	• Incident reporting and investigation of release of hydrocarbons or chemicals as required by the NT EPA and PNX procedures • Maintain service and repair records of vehicles, plant and machinery • Maintain personnel training records • Annual reporting as required by the mine management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		prevention and spill containment kits available in close proximity • Providing spill kits appropriate to the spill risk at the Project site and within vehicles as necessary. All fuel tankers and those tankers transporting hazardous materials shall carry appropriate spill kits • Inspecting, maintaining and repairing fittings, pipes and hoses regularly • Training personnel in the handling, transportation and storage of hazardous materials and providing training to an appropriate number of staff in the handling of emergency response and release scenarios • Clearly labelling vessels with name or description of hazardous material with accompanying material safety data sheets (MSDS) to be stored in close proximity and readily		where operational limits are reached • Verify spill containment kits are located on site at required locations (e.g., at refuelling areas) within vehicles (as necessary) and within tankers transporting fuel or hazardous materials • Verify personnel have received appropriate training in handling, transportation and storage of hazardous materials and emergency response and spill response procedures • Inspect vessels, tanks and secondary containment for leaks and activate appropriate actions as per the spill response procedure(or similar)	schedule and only return to service once servicing has been completed • Provide training to untrained personnel in handling, storage and transport of hydrocarbons and chemicals and spill response and containment measures	

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		available in case of a spill or leak • Use of bunds and sumps to collect and return any spills from the CIP plant internally • Testing permanent storage vessels and enclosures intended for hazardous materials storage for leaks prior to installation and operation • Routinely inspecting vessels, tanks and secondary containment for leaks. If a leak is identified activate appropriate actions as per the spill response plan (or similar) • Developing and implementing a service and maintenance schedule according to manufacturer's specifications		• Verify service and maintenance schedule developed and adhered to		
Groundwater						
Groundwater contamination from seepage from the evaporation pond	Minimise impacts to groundwater quality from evaporation pond seepage	None proposed	No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in	• Groundwater monitoring as per the water management plan	• Investigate extent of potential contamination	Annual reporting as required by the mine management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
			groundwater monitoring bores, or detectable change from background concentrations (e.g., for arsenic, aluminium and other already elevated metals and metalloids)			
Groundwater contamination from waste rock, ore and tailings	Prevent impacts to groundwater quality from NAF waste rock and ore at the ROM	• Validating the assumption that operational blending of NAF and PAF-LC material will buffer the acid forming potential of PAF-LC and conducting column leach testing to further understand the potential for acidic drainage from PAF-LC material placed in the IWL	No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in groundwater monitoring bores, or detectable change from background concentrations (e.g., for arsenic, aluminium and other already elevated metals and metalloids)	• Groundwater monitoring as per the water management plan	• Where testing shows operational blending is unable to buffer the acid forming potential of PAF-LC, implement appropriate management measures to reduce potential acidic drainage from PAF-LC (e.g., temporary segregation and subsequent submersion)	Annual reporting as required by the mine management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
	Minimise impacts to groundwater quality from PAF waste rock	• Conducting further testing to quantify the distribution of PAF materials from the Fountain Head pit • Testing the sulphur content of waste rock and segregating PAF waste rock, using a ≤0.2% Total S cutoff for NAF material and returning PAF material to the open pit at completion of mining for permanent submersion	No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in groundwater monitoring bores, or detectable change from background concentrations (e.g., for arsenic, aluminium and other already elevated metals and metalloids)	• Groundwater monitoring as per the water management plan • Verify further testing conducted to quantify PAF material • Visual inspection of segregated material and verify that runoff is contained in ponds	• If testing estimates larger quantity of PAF material than expected (i.e., >5%), review PAF material management strategy to ensure adequacy • Investigate sources of contamination and implement remedial action	Annual reporting as required by the mine management plan
	Minimise impacts to groundwater quality from tailings	Mitigation measures will include: • Placing the tailings within a clay-lined cell within the IWL and capturing rainfall runoff that has been in contact with the tailings within one decant well (during operations) for use at the process plant or directing it to the evaporation pond • Washing of tailings filter cake to remove residual cyanide prior to placement in IWL, and return of wash	No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in groundwater monitoring bores, or detectable change from background concentrations (e.g., for arsenic, aluminium and other already elevated metals and metalloids)	• Groundwater monitoring as per the water management plan	• Investigate sources of contamination and implement remedial action • Develop appropriate long term management strategy (if required)	Annual reporting as required by the mine management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		water to processing plant circuit Mitigation measures will include: • Monitoring of groundwater quality will be undertaken to detect potential contamination and to initiate remedial action				
Groundwater contamination from accidental release of hydrocarbons and chemicals	Prevent or minimise contamination of groundwater from the accidental release of hydrocarbons and chemicals	• Implementation of standard international cyanide management codes • Storing fuels, lubricants and process reagents in covered areas or in bunded and lined areas. Bunding will be implemented in accordance with relevant standards and guidelines including *AS 1940 Storage and handling of flammable and combustible liquids* and the *Australian Dangerous Goods Code* • Collection of oil waste from the washbay at the vehicle maintenance workshop with an oil separator and water underflow reporting to a soakage or storage pit	• No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in groundwater monitoring bores, or detectable change from background concentrations (e.g., for arsenic, aluminium and other already elevated metals and metalloids) • No undetected or uncontained release of hydrocarbons or chemicals	• Groundwater monitoring as per the water management plan • Visual monitoring for signs of leaks or spills from vehicles, plant and machinery • Inspect bunds, sumps and storage pits designed to contain hydrocarbons or chemicals and remove water and dispose offsite using a licensed contractor where operational limits are reached • Verify spill containment kits are located on site at required locations	• Investigate potential source of hydrocarbon or chemical releases (if unknown) • Investigate potential environmental impacts of a known release (if considered a reportable incident) • Review management measures and procedures, and implement corrective actions to reduce likelihood of incident recurrence	• Incident reporting and investigation of release of hydrocarbons or chemicals as required by the NT EPA and PNX procedures • Maintain service and repair records of vehicles, plant and machinery • Maintain personnel training records • Annual reporting as required by the mine management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		for reuse. Waste oil will be collected and stored in drums in bunded and lined area for removal off site by a licensed contractor • Refuelling on impermeable hardstand areas with spill prevention and spill containment kits available in close proximity • Providing spill kits appropriate to the spill risk at the Project site and within vehicles as necessary. All fuel tankers and those tankers transporting hazardous materials shall carry appropriate spill kits • Inspecting, maintaining and repairing fittings, pipes and hoses regularly • Training personnel in the handling, transportation and storage of hazardous materials and providing training to an appropriate number of staff in the handling of emergency response and release scenarios		(e.g., at refuelling areas) within vehicles (as necessary) and within tankers transporting fuel or hazardous materials • Verify personnel have received appropriate training in handling, transportation and storage of hazardous materials and emergency response and spill response procedures • Inspect vessels, tanks and secondary containment for leaks and activate appropriate actions as per the spill response procedure (or similar) • Verify service and maintenance schedule developed and adhered to	• Remove from use vehicles, plant or machinery which have not been serviced in accordance with the service and maintenance schedule and only return to service once servicing has been completed • Provide training to untrained personnel in handling, storage and transport of hydrocarbons and chemicals and spill response and containment measures	

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Clearly labelling vessels with name or description of hazardous material with accompanying MSDS to be stored in close proximity and readily available in case of a spill or leak • Use of bunds and sumps to collect and return any spills from the CIP plant internally • Testing permanent storage vessels and enclosures intended for hazardous materials storage for leaks prior to installation and operation • Routinely inspecting vessels, tanks and secondary containment for leaks. If a leak is identified activate appropriate actions as per the spill response plan (or similar) • Developing and implementing a service and maintenance schedule according to manufacturer's specifications				

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Monitoring of groundwater quality will be undertaken to detect potential contamination and to initiate remedial action				
Groundwater contamination from septic system	Prevent contamination of groundwater from septic system	• Monitoring of groundwater quality will be undertaken to detect potential contamination and to initiate remedial action • Locating and constructing septic systems according to the Northern Territory *Code of Practice for Onsite Wastewater Management* (NT Government, 2014) • Regularly pumping solids from the septic tank to prevent blockages	• No exceedances of the applicable ANZG (2018) Trigger Values for nutrients and dissolved oxygen	• Groundwater monitoring as per the water management plan • Visual/odour monitoring for signs of septic leaks	• Investigate potential source of septic leak	• Annual reporting as required by the mine management plan • Maintain records of septic pumping and repairs (if required)
Groundwater contamination from final pit water quality	Minimise impacts to groundwater quality from final pit water	None proposed	No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in groundwater monitoring bores, or detectable change from background concentrations (e.g., for arsenic, aluminium and	• Groundwater monitoring as per the water management plan	• Investigate extent of potential contamination	• Annual reporting as required by the mine management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
			other already elevated metals and metalloids)			
Terrestrial Ecology						
Direct loss or disturbance of native vegetation and/or fauna habitat	Minimise the temporary and permanent loss or disturbance of native vegetation and fauna habitat	• Location of Project infrastructure in previously disturbed areas where practicable • Implementation of vegetation clearing approvals process • Training of environmental staff to recognise threatened flora species: *A. praetermissa* and *S. ensatum* • Site walkover prior to clearing to ensure threatened flora are not present • Reporting of *A. Praetermisssa* and *S. ensatum* to the Department of Environment and Natural Resources (DENR) if found in the Project area • Avoid clearing of mature trees more than 15 cm DBH where practically feasible	• Zero direct loss of threatened flora individuals • System of approval for vegetation clearing developed and adhered to • No exceedance of approved areas of vegetation clearing	• Biennial monitoring program for vegetation, flora and fauna	• Non-compliance reported as an incident under PNX Procedures • Stop work until clearing area defined • Assess significance of impact from clearing (i.e., clearing of non-approved vegetation, threatened species, trees more than 15 cm DBH) • Identify root cause of non-compliance • Actions implemented to correct root cause and reduce likelihood of incident recurrence	• Records of amount habitat types cleared • Records confirm clearing does not exceed minimum area required for operations • Records of vegetation clearing regulatory approvals maintained • Records maintained of mature trees on site with DBH >15 cm • Signed induction/training records demonstrating environmental staff received training in identification if *A.*
Reduction in native flora species abundance, density and diversity						
Reduction in abundance of threatened flora species and their likelihood of recovery	Minimise the loss of native, threatened, and migratory fauna and/or flora					
Reduction in native fauna species abundance density and diversity as a result of habitat loss and fragmentation						
Reduction in habitat for threatened fauna species and their likelihood of recovery						
Reduction in habitat for migratory species, resulting in disruption of migration patterns						

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Site walkover prior to clearing by experienced personnel to prevent direct mortality of fauna			• Report to relevant government authorities if require	*praetermissa* and *S. ensatum* • Fauna sighting register maintained • Records of completed site walkover maintained, including native fauna and threatened flora identified
Excessive dust deposition resulting in to damage to vegetation and fauna habitat	Minimise dust emissions to air			• Monitoring of complaints through	If non-compliance of air quality procedures or criteria	

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
Adverse health impacts to fauna from increased dust emissions	generated by the Project	• Sustainable use of water to control dust emissions in production areas • Implement speed limits in accordance with the Project traffic management plan • Use of water spray on screening and crushing • Progressive rehabilitation of the WRS • Progressively rehabilitate areas as activities cease • Location of Project infrastructure in previously disturbed areas where practicable	• Zero complaints through grievance mechanism • Zero non-compliances with procedures relevant to dust emissions	grievance mechanisms	occurs, or a complaint is recorded: • Reported as an incident under PNX procedures • Immediate inspections of non-compliant source of emissions • Significance of impact of non-compliance assessed • Review air quality management measures and procedures, and implement corrective actions to reduce likelihood of incident recurrence • Report to relevant government authorities if required	• Records of non-compliances maintained
Altered fauna behaviour and use of local habitat as a result of increased artificial light	Minimise light spill outside production areas	• Implement minimum lighting requirements required for safe operation • Angle lighting towards the ground where possible to	• Zero records of animals attracted to artificial light sources	• Monitoring of animals attracted to artificial light sources in fauna sighting register	If non-compliance occurs:	• Records of non-compliances maintained

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		minimise light pollution outside of the proposal area			• Reported as an incident under PNX procedures • Immediate inspections of non-compliance • Significance of impact of non-compliance assessed • Review management measures and procedures, and implement corrective actions to reduce likelihood of incident recurrence • Report to relevant government authorities if required	• Fauna sighting register maintained
Altered fauna behaviour and use of local habitat as a result of increased noise and vibrations	Minimise disturbance to fauna from noise and vibration generated during the Project	• Vehicles and equipment creating noise to be turned off when not in use • Noise reduction measures implemented on machinery where available and practically feasible • Operations producing loud noises to be kept to the minimum required for operations to occur • Vehicles and equipment creating vibrations to be turned off when not in use • Operations producing vibrations to be kept to the minimum required for operations to occur	• Records maintained of the timing of blasting	None		• Records of non-compliances maintained • Records maintained of the timing of blasting
Increased density and distribution of weeds already present, which compete with native flora, resulting in reduced species and abundance of native species	No spread of existing weed species	• Develop and implement weed management plan, including weed identification guides with photos for common weeds on-site and register for reporting any sightings of weeds or potential weeds	• Zero new spread of existing weeds infestations throughout Project area	• Regular monitoring of any new infestations of weeds in the proposal area • Biennial monitoring program for vegetation, flora and fauna	If non-compliance with weed management plan and procedures occurs: • Reported as an incident under PNX procedures	• Records of non-compliances maintained • Records of reports or monitoring results of increasing infestations of weeds

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Inspection and wash-down of all vehicles, machinery and equipment that enters the proposal area for weeds, vegetation material and introduced fauna such as cane toads • Inspection and wash-down of all vehicles, machinery and equipment that travel from an area within the proposal area where a weed infestation occurs into an area where it does not • Implementation of vegetation clearing approvals process • Minimise the time between vegetation being cleared and the area being used for proposal requirements • Implementation of accepted weed control measures where weeds have established in areas previously identified as being weed free. Obtain expert advice from the NT Government Weeds		• Vehicle wash down inspections	• Immediate inspections of non-compliant vehicle or equipment • Weed surveys in impact areas conducted • Weed eradication controls implemented as required • Review weed management plan and procedures and implement corrective to reduce likelihood of incident recurrence • Report to relevant government authorities if required	• Register for sightings or potential sightings of weeds • Vehicle wash down inspections records demonstrate adherence to weed management plan and inspection requirements • Records of vegetation clearing area and date • Records of signed induction records demonstrating appropriate training of no tolerance policy for weed introduction and weed management plan requirements • Records kept of introduced weeds controlled on site

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		Branch or a qualified ecologist • Regular monitoring and weed control where the density of weeds is increasing • Stockpiles to be monitored for weeds and control programs implemented as required • Remove weeds prior to seeding where practically feasible • Rehabilitation of disturbed areas as soon as possible, and is possible, prior to the subsequent wet season, to minimise the likelihood of weeds becoming established • Develop a no tolerance policy to the introduction of weeds by contractors, suppliers and personnel • Regular monitoring of the proposal area to identify any new weed species present on-site				• Records kept of control measures used for introduced weeds demonstrate adherence to accepted weed control measures
Introduction of new weed species, which compete with native flora, resulting in reduced native species diversity and abundance	No introduction of new weed species onto the site		Zero new weed species introduced during the Project	• Regular monitoring conducted to identify any new weed species present on-site • Biennial monitoring program for vegetation, flora and fauna • Vehicle wash down inspections		
Increase in introduced fauna leading to reduction in population sizes of native	No introduction of new introduced	• Control of existing and new feral predator	• Zero introduction of new introduced fauna to site	• Regular site inspections demonstrate	If introduced fauna control procedures or waste management	• Records kept of predator and introduced fauna

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
species, from increased predation pressures	fauna species onto the site	populations by licensed personnel • Implement no tolerance policy for the introduction and feeding of introduced species by contractors, suppliers or personnel • Removal of food waste from site on a regular basis where practically feasible • Perimeter fencing to prevent introduced species and livestock access to the production areas		integrity of fences are maintained	plan non-compliance occurs: • Reported as an incident under PNX procedures • Immediate inspections of location/potential source of infestation • Introduced fauna surveys in impact areas conducted • Introduced fauna controls implemented as required • Review waste management plan and introduced fauna procedures and implement corrective actions to reduce likelihood of incident recurrence • Report to relevant government authorities if required	populations in the proposal area • Records kept of introduced fauna control measures used • Records kept of numbers of introduced fauna controlled on site • Records kept of licenses for personnel undertaking pest control

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
Injury or death of fauna as a result of vehicle collision	Minimise vehicle collisions with fauna	• Develop and implement a Project traffic management plan and induct all staff, contractors and suppliers in accordance with the plan • Implement speed limits in accordance with the Project traffic management plan • Prohibit off-road driving from non-designated routes • Develop and maintain a fauna register to be kept on-site that includes reporting of vehicle strike	• Zero fauna deaths as a result of vehicle strikes	• Monitoring of number of fauna deaths from vehicle strikes	If the event of a reported fauna injury or death: • Reported as an incident under PNX procedures • Investigation of root causes conducted • Actions implemented to correct root cause and reduce likelihood of incident recurrence • Report to relevant government authorities if required	• Fauna sighting register maintained, including records of fauna injured or killed by vehicle strike • Records of signed induction records demonstrating appropriate training/awarenes s of traffic management plan
Ongoing localised reduction in vegetation health or structural diversity if site rehabilitation is unsuccessful	Avoidance of unsuccessful rehabilitation	• Minimise areas impacted by mining activities • Minimise area of clearing as far as practicable • Progressive rehabilitation of the WRS • Progressively rehabilitate areas as activities cease	• Zero occurrences of unsuccessful rehabilitation	• Biennial monitoring program for vegetation, flora and fauna	If non-compliance with rehabilitation management plan, or incident involving unsuccessful rehabilitation, occurs: • Reported as an incident under PNX procedures • Immediate inspections of unsuccessful	• Records of the amount of each habitat type cleared for the proposal • Records confirm that clearing does not exceed the minimum area required for operations

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
						rehabilitation site to identify root cause • Significance of impact of non-compliance assessed • Review bushfire management plan and procedures and implement corrective actions to reduce likelihood of incident recurrence • Report to relevant government authorities as required	• Records confirm rehabilitation undertaken progressively
Aquatic Ecology							
Habitat degradation or modification	Increased turbidity and suspended sediment	Minimise impacts to aquatic biota from rainfall runoff, erosion and scouring	Embedded design controls will include: • Installing approximately six appropriately sized sediment dams according to the best practice erosion and sediment control guidelines (IECA, 2008) to capture surface runoff from the IWL, processing plant, ROM pad, mining contractor yard and	No detectable change from background conditions in downstream water quality beyond the unnamed tributary creek	• Surface water monitoring as per the water management plan • Verification that sediment control structures are installed during construction and as required for closure (i.e., once sediment	• Investigate potential sources of excess sediment, inspect for signs of erosion and implement corrective actions to reduce sediment loads • Install additional or alternative	Annual reporting as required for the mine management plan

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
			hardstand areas to allow suspended sediment to settle out prior to overflowing to the downslope catchment. Prior to the installation of the sediment dams (i.e., during the construction phase), rainfall runoff will flow through existing drainage lines either into Fountain Head Lake or towards the unnamed tributary creek to the north • Diverting natural catchment runoff from upstream of the processing area, diverting the existing drainage line around the north of the evaporation pond (which is located on the existing flow path) and installing a bund around the Fountain Head pit to direct surface water away from operational areas • Installing erosion protection, e.g., rock armour around the western soil stockpile, adjacent the haul road at the northern extent of Fountain Head		dams have been removed) • Monitoring the success of rehabilitation works in accordance with the rehabilitation management plan	sediment control structures • Inspections of unsuccessful rehabilitation site to identify root cause	

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
			Lake and along the western and northern toes of the evaporation pond to minimise scour from surface water drainage • Installing culverts under the haul road to provide direct drainage from the lake and to reduce the frequency of flooding of the haul road • Constructing the core yard and western soil stockpile on raised pads above the 1% AEP peak flood levels with appropriate freeboard or flood protection structures Mitigation measures will include: • If deemed appropriate, using hay bales, geotextile silt fencing, or silt socks to contain sediment runoff during construction and closure earthworks and ground disturbance activities • Rehabilitating disturbed areas as soon as practicable to minimise				

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
			areas of potentially erodible soil • Controlling sediment runoff from stockpiles by installing sediment control structures to intercept sediment laden-surface runoff to reduce sediment delivery to watercourses • Avoiding stockpiling spoil and/or topsoil close to existing and proposed drainage lines, maintaining a minimum distance of approximately 50 m, where practicable • Undertaking earthworks and ground disturbance activities during the drier months, wherever practicable, when exposed surfaces will be less prone to rainfall erosion				
	Altered hydrological regimes from Project infrastructure, pit dewatering and evaporation	Minimise impacts to aquatic biota from changes to flows in downstream surface waters	Embedded design controls will include: • Constructing the core yard and western soil stockpile on raised pads above the 1% AEP peak flood levels with appropriate freeboard or using flood protection structures such as bunds	• No impacts on downstream flows • No surface expression of groundwater	• Visual inspection of infrastructure, diversion channels and downstream flow behaviour following rainfall events	• Action measures to prevent seepage to the downstream catchment (e.g., interception trenches/ bores)	Maintain records of visual inspections

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
	pond seepage		• Constructing a diversion channel along the western side of the existing waste rock storage to reinstate the natural flow path and divert the natural catchment runoff into the existing Fountain Head Lake. A diversion is also proposed along the northern side of the evaporation pond as the proposed pond extension is located on the existing flow path connecting Fountain Head Lake to the unnamed creek • Diverting natural catchment runoff from upgradient of the processing area to flow to the unnamed creek • Installing culverts under the haul road to provide direct drainage from the lake and to reduce the frequency of flooding of the haul road		• Visual inspections of seepage from evaporation pond		
Sub-lethal or lethal toxicity effects on aquatic biota from waste	Contamination of aquatic ecosystems from runoff from the	Minimise impacts to aquatic biota from runoff of mine material	• Validating the assumption that operational blending of non-acid forming (NAF) and potentially acid-forming low capacity (PAF-	• No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline	• Surface water monitoring as per the water management plan	• Investigate sources of contamination and	Annual reporting as required by the mine management plan

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
rock, ore and tailings runoff	existing waste rock, NAF waste rock from the Fountain Head pit and ore (pre-processing)		LC) material will buffer the acid forming potential of PAF-LC and conducting column leach testing to further understand the potential for acidic drainage from PAF-LC material placed in the IWL • Routine monitoring of water quality in the sediment dams that overflow to the downslope catchment to confirm that runoff from the operational areas is of suitable quality in line with downstream receiving environmental objectives. Where water in the sediment dams does not meet relevant receiving water quality criteria, it will be directed to the evaporation pond or process plant	Trigger Values in the sediment dams draining to the downslope catchment and downstream surface waters (i.e., the unnamed tributary creek or Margaret River)		implement remedial action	
	Contamination of aquatic ecosystems from PAF waste rock runoff		Embedded design controls will include: • Constructing a dam designed to contain a 1 in 100 year 72 hour rainfall event to capture runoff from PAF material	• No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in downstream surface waters (i.e., the unnamed	• Surface water monitoring as per the water management plan	• Investigate sources of contamination and implement remedial action	Annual reporting as required by the mine management plan

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
			stockpile (during operations) Mitigation measures will include: • Conducting further testing to quantify the distribution of PAF materials from the Fountain Head pit • Testing the sulphur content of waste rock and segregating PAF waste rock, using a ≤0.2% Total S cutoff for NAF and returning PAF material to the open pit at completion of mining for permanent submersion	tributary creek or Margaret River)			
	Contamination of aquatic ecosystems from tailings		Embedded design controls will include: • Placing the tailings within a clay-lined cell within the IWL and capturing rainfall runoff that has been in contact with the tailings within one decant well (during operations) for use at the process plant or directing it to the evaporation pond • Washing of tailings filter cake to remove residual cyanide prior to placement	• No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in downstream surface waters (i.e., the unnamed tributary creek or Margaret River)	• Surface water monitoring as per the water management plan	• Investigate sources of contamination and implement remedial action	Annual reporting as required by the mine management plan

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
			in IWL, and return of wash water to processing plant circuit • Capping the tailings with a 0.5-m layer of clay and 1.5-m layer of NAF waste rock to prevent rainfall infiltrating the tailings following closure • Installing under drainage below the IWL to capture seepage from the clay liner. The water will be collected in two sumps and will be pumped to the process plant Mitigation measures will include: • Monitoring of surface water quality in the unnamed tributary creek and Margaret River to detect potential contamination and to initiate remedial action				
	Contamination of aquatic ecosystems from accidental hydrocarbon and	Minimise impacts to aquatic biota from accidental hydrocarbons and chemical releases	• Implementation of standard international cyanide management codes • Storing fuels, lubricants and process reagents in covered areas or in	• No exceedances of the applicable ANZG (2018) Australian Water Quality Guideline Trigger Values in downstream	• Surface water monitoring as per the water management plan • Incident-triggered surface water monitoring where	• Investigate potential source of hydrocarbon or chemical releases (if unknown) • Investigate potential	• Incident reporting and investigation of release of hydrocarbons or chemicals as required by the NT EPA and PNX

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
	chemical releases		bunded and lined areas. Bunding will be implemented in accordance with relevant standards and guidelines including *AS 1940 Storage and handling of flammable and combustible liquids* and the *Australian Dangerous Goods Code* • Collection of oil waste from the washbay at the vehicle maintenance workshop with an oil separator and water underflow reporting to a soakage or storage pit for reuse. Waste oil will be collected and stored in drums in bunded and lined area for removal off site by a licensed contractor • Refuelling on impermeable hardstand areas with spill prevention and spill containment kits available in close proximity • Providing spill kits appropriate to the spill risk at the Project site and within vehicles as necessary. All fuel tankers and those tankers transporting hazardous	surface waters (i.e., the unnamed tributary creek or Margaret River) • No undetected or uncontained release of hydrocarbons or chemicals	release of hydrocarbon or chemicals occurs and may impact downstream surface water either due to the size of the release or the time taken to contain/remediate it • Visual monitoring for signs of leaks or spills from vehicles, plant and machinery • Inspect bunds, sumps and storage pits designed to contain hydrocarbons or chemicals and remove water and dispose offsite using a licensed contractor where operational limits are reached • Verify spill containment kits are located on site at required locations (e.g., at refuelling areas) within vehicles (as necessary) and	environmental impacts of a known release (if considered a reportable incident) • Review management measures and procedures, and implement corrective actions to reduce likelihood of incident recurrence • Remove from use vehicles, plant or machinery which have not been serviced in accordance with the service and maintenance schedule and only return to service once servicing has been completed • Provide training to untrained personnel in handling, storage and transport of hydrocarbons and	Metals procedures • Maintain service and repair records of vehicles, plant and machinery • Maintain personnel training records • Annual reporting as required by the mine management plan

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
			materials shall carry appropriate spill kits • Inspecting, maintaining and repairing fittings, pipes and hoses regularly • Training personnel in the handling, transportation and storage of hazardous materials and providing training to an appropriate number of staff in the handling of emergency response and release scenarios • Clearly labelling vessels with name or description of hazardous material with accompanying material safety data sheets (MSDS) to be stored in close proximity and readily available in case of a spill or leak • Use of bunds and sumps to collect and return any spills from the CIP plant internally • Testing permanent storage vessels and enclosures intended for hazardous materials storage for leaks		within tankers transporting fuel or hazardous materials • Verify personnel have received appropriate training in handling, transportation and storage of hazardous materials and emergency response and spill response procedures • Inspect vessels, tanks and secondary containment for leaks and activate appropriate actions as per the spill response procedure (or similar) • Verify service and maintenance schedule developed and adhered to	chemicals and spill response and containment measures	

Environmental Impact		Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
			prior to installation and operation • Routinely inspecting vessels, tanks and secondary containment for leaks. If a leak is identified activate appropriate actions as per the spill response plan (or similar) • Developing and implementing a service and maintenance schedule according to manufacturer's specifications				
Introduction of aquatic weeds		Minimise the potential for the introduction of aquatic weeds	• Inspection and wash-down of all vehicles, machinery and equipment prior to arrival on site, or if washed-down on site, ensure material washed from machinery and equipment is collected and either treated prior to discharge or disposed of appropriately • Prohibiting washing of equipment, vehicles or machinery near or within drainage channels and water bodies	No introduction of aquatic weeds from Project activities	• Visual monitoring for signs of aquatic weeds (e.g., rapid growth or smothering of waterways) during surface water monitoring • Vehicle wash-down inspections • Verify that vehicles, machinery and equipment have been washed-down prior to arrival on site or wash-down water is contained	• Report as an incident under PNX Metals procedures • Weed eradication controls implemented as required • Report suspected introduction of aquatic weed species to NT Government Weeds Branch if required • Review weed management plan	• Register for sightings or potential sightings of weeds • Vehicle wash down inspections records demonstrate adherence to weed management plan and inspection requirements • Records of signed induction records demonstrating appropriate

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Limiting work vehicles and machinery to designated access and work site areas • Implementing accepted weed control measures where weeds are established. Obtain expert advice from the NT Government Weeds Branch or a qualified aquatic ecologist • Ensuring all vehicles, machinery and equipment brought from interstate or overseas are verified to be weed-free before arrival on site • Provide training to relevant personnel in weed prevention and management protocols		and treated prior to discharge	and procedures and implement corrective action to reduce likelihood of incident recurrence	training of no tolerance policy for weed introduction and weed management plan requirements
Socio-economic						
Economic benefits (royalties and mining levy payments) to the NT government Stimulation of the regional and local economy via payments made to workers and support for local business	Maximise the economic benefits to the NT, regional and local economies	• PNX Metals will pay royalties and levies in accordance with legislative requirements • PNX Metals will ensure transparency in reporting surrounding the payment of royalties and levies	• Capital and operating expenditure with NT businesses • 100% compliance with the *NT Mineral Royalty Act 1982*	• Expenditure with NT businesses • Local supplier specifications and targets in contracts • Compliance with legislation	• Support local business capacity-building programs	Financial records

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Package tenders in a way that suits local businesses, where this is commercially feasible • Raise awareness and manage local business and community expectations surrounding increased business activity through regular communications and engagement on Project activities and upcoming opportunities • Where possible, maximise work opportunities for local community members, including through specifying preference for local service and supply requirements in agreements with contractors • Where possible, maximise work opportunities for local Aboriginal people, including through contractor agreements • Work in partnership with industry and government groups on business growth	• Quarterly updates provided to businesses and local communities about Project economic opportunities • Zero grievances lodged; any that are lodged are acknowledged with one week of receipt	• Stakeholder grievances • Stakeholder engagement activities		

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		and work readiness programs				
Increased employment and training opportunities	Maximise employment of local residents	• Where possible, maximise work opportunities for local community members, including through specifying preference for local service and supply requirements in agreements with contractors • Where possible, maximise work opportunities for local Aboriginal people, including through contractor agreements • Continue to engage with local communities about the types of employment opportunities available, including timing, recruitment policies and training and development • Engage with local Aboriginal organisations as appropriate to support, enhance and facilitate Aboriginal employment and training opportunities • Enhance employee's skills base through on-job	• Percentage of the Project workforce hired from local communities • Percentage of the Project workforce hired who identify as Aboriginal or Torres Strait Islander • 100% of workforce receive training and/or professional development • Zero grievances lodged; any that are lodged are acknowledged with one week of receipt	• Number of employees from the Katherine Region and the NT • Number of employees who identify as Aboriginal or Torres Strait Islander • Number of workers who received on-the-job training • Stakeholder grievances	• Support local employment and/or training programs	Employment records Workforce training records Stakeholder grievances

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		training and development programs • Implement culturally appropriate work practices, including leave, rosters and flexible recruitment • Implement a grievance mechanism to capture community issues and concerns and facilitate timely and appropriate action to address • Continually update and implement the stakeholder engagement plan to support the management of community issues or concerns				
Community expectations regarding employment (and Project benefits in general) are not met		• Where possible, maximise work opportunities for local community members, including through specifying preference for local service and supply requirements in agreements with contractors • Continue to engage with local communities about the types of employment opportunities available, including timing,			• Support local employment and/or training programs	Stakeholder grievances

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		recruitment policies and training and development • Implement a grievance mechanism to capture community issues and concerns and facilitate timely and appropriate action to address • Continually update and implement the stakeholder engagement plan to support the management of community issues or concerns				
Disruption to operations of the Bonaparte Gas pipeline (BGP) and the Alice Springs Darwin railway line	Avoid or minimise impacts to local industry and land users	• Blasting activities will be restricted to daylight hours only, all days of the week • A site based trained blasting professional will design each blast • Blasting professional to ensure ground vibration will not exceed 20 mm/sec at any time at the BGP • Undertake a SMS involving a risk assessment to determine allowable ground vibration limits that will be enforced on the blasting operation to ensure that no disruption is caused to the	• Blasting procedure delivered • Zero incidents involving fly rock leaving the blasting zone • No disruption to operations of the gas pipeline or rail line due to blasting activities • Zero grievances lodged; any that are lodged are acknowledged with one week of receipt	• Compliance with procedures • Blasting-related incidents • Stakeholder communications • Stakeholder grievances	n/a	Blasting-related incidents Stakeholder engagement Stakeholder grievances

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		flow of gas through the BGP. Ground vibration levels to comply with "Standard conditions for works near APA Gas Transmission Pipelines" document. Blasting operations will adhere to the outcome of the SMS • Continue to engage with APA to conduct a risk assessment for blasting near the gas pipeline, and negotiate an access agreement for the pipeline corridor • Design blasting operations in accordance with good industry practice (e.g., APA, 2019), including ensuring that workers are appropriately trained • Communicate the blasting schedule to local land users (including local traffic) to help maximise awareness and minimise disturbance • Continue to work with AustralAsia Railways to develop a blasting procedure and notification regime that results in no				

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		impact to the railway network				
Reduction in land suitability for pastoral activities due to: • Loss of access to the Fountain Head lake for stock watering • Reduction in groundwater quality	Avoid or minimise impacts to land users	• Negotiate agreements (under the *Mineral Titles Act*) with pastoral landowner(s) who are impacted by the Project • Continue to engage with pastoral landowners to identify potential impacts and appropriate management approaches (such as the provision of alternative water supplies if required), over the life of the Project • Perimeter fencing to prevent introduced species and livestock access to the production areas • Comply with the *Mineral Titles Act* regarding any landowner grievances relating to loss of income and compensation • Monitoring of groundwater quality will be undertaken to detect potential contamination and to initiate remedial action	• 100% compliance with the *Minerals Titles Act 2010* • Agreements negotiated with pastoral landowners • 100% compliance with landowner agreements • 100% compliance with hazardous materials procedures	• Compliance with legislation • Compliance with procedures • Compliance with agreements • Stakeholder communications • Stakeholder grievances • Groundwater monitoring as per the water management plan	• Investigate cause of reduced groundwater quality and provide alternative water source if mine-related	Spill-related incidents Hazardous substance registers Stakeholder engagement Stakeholder grievances

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Site contamination assessment and clean-up to be conducted at closure				
Increased pressure on local health and emergency services	Avoid or minimise impacts to local health and emergency services	• Prepare (and implement as required) an Emergency Response Plan in collaboration with local emergency services • Ensure that workers on site have emergency response capabilities and that there are first aid facilities available on site • Implement the management measures in the TIA and TMP to minimise traffic-related accidents • Encourage BIBO workers to access health services in Darwin or their place of origin	• Emergency Response Plan developed • 100% compliance with the Emergency Response Plan • TIA and TMP management measures implemented	• Compliance with the Emergency Response Plan • Records of testing and review of ERP undertaken.	n/a	Emergency incidents
Strengthened social cohesion	Support strengthened social cohesion and amenity	• Where possible, maximise work opportunities for local community members. Contractors to maximise opportunities also • Where possible, maximise work opportunities for local Aboriginal people.	• Percentage of the Project workforce hired from local communities • Percentage of the Project workforce hired who identify as Aboriginal or	• Number of employees from the Katherine Region and the NT • Number of employees who identify as Aboriginal or Torres Strait Islander	• Support local employment and/or training programs	Employment records Stakeholder grievances

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		Contractors to maximise opportunities also • Continue to engage with local communities about the types of employment opportunities available, including timing, recruitment policies and training and development	Torres Strait Islander • Zero grievances lodged; any that are lodged are acknowledged with 1 week of receipt	• Stakeholder grievances		
Improved visual amenity		• Implement the Mine Closure Plan	• Mine Closure Plan implemented	• Compliance with the Mine Closure Plan	n/a	Stakeholder grievances
Reduced safety of freight trains and passengers travelling the Alice Springs Darwin railway line	Minimise risks to the health and safety of the public	• Blasting operations will have a zero-ejection policy for fly rock leaving the pit area to avoid any incidents with trains or other site infrastructure • Consult with railway users about the timing of blasting and train passage to avoid coinciding the two activities if practicable	• Blasting procedure delivered • Zero incidents involving fly rock leaving the blasting zone • Zero grievances lodged; any that are lodged are acknowledged with 1 week of receipt	• Compliance with procedures • Blasting-related incidents • Stakeholder communications • Stakeholder grievances	n/a	Blasting-related incidents Stakeholder engagement Stakeholder grievances
Cultural Heritage						
Loss or damage to known cultural heritage objects/artefacts or Aboriginal places	Avoid or minimise damage to heritage values	• Implement a 100 m buffer around known places and a 50 m buffer around objects that are not to be disturbed, and clearly identify locations	• 100% compliance with the *NT Heritage Act 2011* • 100% of objects salvaged in agreement with	• Compliance with legislation	• Implement chance finds procedure	Heritage sites register

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Implement cultural heritage awareness training for all site staff, including the locations of known sites, legislative requirements and chance finds procedures • Salvage 201910221220 with an appropriate permit under the *NT Heritage Act 2011*, and with agreement from Traditional Owners regarding ongoing care of the object • If Aboriginal places require salvage, conduct a cultural heritage assessment in consultation with Traditional Owner representatives to determine significance, condition and management	Traditional Owners • 100% of the Project workforce receive cultural heritage awareness training			
Loss or damage to unknown cultural heritage objects/ artefacts		• Develop a chance finds procedure to manage any unknown objects uncovered during disturbance activities • Develop a salvage protocol in consultation with Traditional Owners to	• 100% compliance with chance finds procedure	• Compliance with the chance finds procedure	n/a	Chance finds Heritage sites register

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		manage the salvage of chance finds • Notify the DTSC of any chance finds, and record of all new finds in a cultural heritage database. Manage according to SEM36 and SEM37 • Cultural heritage surveys will be conducted prior to any change in the proposed Project footprint that may impact on previously unsurveyed areas • Where possible, termite mounds 3 meters or greater will not be disturbed				
Traffic and Transport						
Increased traffic during construction	Avoid or minimise traffic congestion on Project roads	• Develop and implement a Project traffic management plan and induct all staff, contractors and suppliers in accordance with the plan • Use mining fleet for construction works, where practicable, to minimise additional vehicle trips required	No community complaints related to traffic congestion or degradation on Project roads	n/a	• Update and review traffic management plan	• Record community complaints

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Minimise truck movements during peak traffic times to minimise congestion • Transport employees from the Cosmo Village to the Project site using the staff bus, where practicable • Consult relevant stakeholders regarding any changes in the Project that will affect the public road network • Consult with the National Heavy Vehicle Regulator as necessary to ensure safe and efficient truck movements				
Increased traffic during operations	Avoid or minimise traffic congestion on Project roads	• Develop and implement a Project traffic management plan and induct all staff, contractors and suppliers in accordance with the plan • Minimise truck movements during peak traffic times to minimise congestion • Employees shall be transported from the Cosmo Village to the Project site using the staff bus, where practicable	No community complaints related to traffic congestion or degradation on Project roads	n/a	• Update and review traffic management plan	• Record community complaints

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		• Consult relevant stakeholders regarding any changes in the Project that will affect the public road network • Consult with the National Heavy Vehicle Regulator as necessary to ensure safe and efficient truck movements				
Reduced safety of road users due to Project vehicles using public roads	Minimise risks to the safety of the public	• Develop and implement a Project traffic management plan and induct all staff, contractors and suppliers in accordance with the plan • Display safety signage at appropriate intervals on Stuart Highway approach to the Fountain Head Road and at the Mount Wells Road intersection. The signage shall be in accordance with DIPL requirements • Transport employees from the Cosmo Village to the Project site using the staff bus, where practicable • Obtain all relevant permits for any oversize/overmass	No Project-related traffic incidents	• Monitor compliance with traffic management plan	• Update and review traffic management plan	• Record non-compliance with traffic management plan

Environmental Impact	Environmental Performance Objective	Mitigation and Management Measures	Environmental Performance Target	Monitoring	Contingency	Reporting and Record Keeping
		vehicles prior to movement of vehicles • All hazardous substances including explosives and cyanide will be transported to the site via public roads. All substances will be transported using the *Australian Dangerous Goods Code* (Edition 7.4) • Prepare a site access procedure for employees to outline and encourage safe and appropriate travel to and from Cosmo Village to the site • Liaise with DIPL and local road authorities to ensure access to Project roads are to be suitable for the purpose of haulage of equipment and materials for construction				

9.5 Reporting and Record Keeping

9.5.1 Incident Reporting

Environmental incidents will be reported to the site manager/supervisor who will then undertake an investigation and inform the PNX Management team according to the PNX Metals environmental incident flowchart (Figure 9.2). In the case of a serious accident or critical incident causing material environmental harm, it is the responsibility of PNX management to file the incident report and investigation to the Chief Executive Officer of the Department of Primary Industry and Resources (DPIR) in accordance with Section 29 of the *Mining Management Act*. The site supervisor may carry out the investigation, yet the responsibility for a full investigation rests with PNX management.

9.5.2 Internal Reporting

Internal reporting (i.e., between Company and contractor) will be designed to capture the overarching effectiveness of the EMS. Specific reporting requirements (including the form and frequency of reports) will be agreed between PNX and the contractor. Reports may include:

- Number of inspections/audits and key findings.
- Results and trends of monitoring programs.
- Assessments of overall compliance with Project approval requirements.
- Assessments of the efficiency of current objectives and targets.
- Details of any environmental incidents and corrective action taken.

9.5.3 External Reporting

PNX will be required to report to the DPIR or other external stakeholders (e.g., Department of Environment, Parks and Water Security) as required by the granted authorisation. These reports may include:

- Statistics about workers on the site including competencies.
- Standards of construction of infrastructure on the site.
- Occurrences of environmental incidents.
- The environmental performance of the Project against its objectives and targets.

9.5.4 Record Keeping

Records form a critical component of evidence of environmental management on site. At a minimum, the following records will be maintained:

- An incidents and complaints register. The register will record details of the complainant or incidents, required corrective action and any close-out details. In the case of stakeholder grievances, records of communication with stakeholders will be maintained.

- Results of monitoring programs, audits and inspections.
- Records of toolbox talks, site inductions and training.
- Correspondence with regulators and other stakeholders.

9.6 Inductions and Training

All new Project personnel (e.g., contractors, unaccompanied visitors) will be required to complete a site induction which details the key commitments from this EIS and the MMP. Records of personnel who have completed site inductions will be held electronically on site. Inductions will be regularly reviewed to ensure they contain information relevant to the stage of the project (i.e. construction, operation and closure) and current procedures.

Relevant staff will be provided with sufficient training to enable them to undertake their duties required by the EMS. Regular toolbox meetings will keep employees up to date on environmental issues and current procedures.

9.7 Management Review

The Project EMS will be continually updated and reviewed to identify any deficiencies or areas for improvement. The PNX management team will review and evaluate the system annually. Reviews will include:

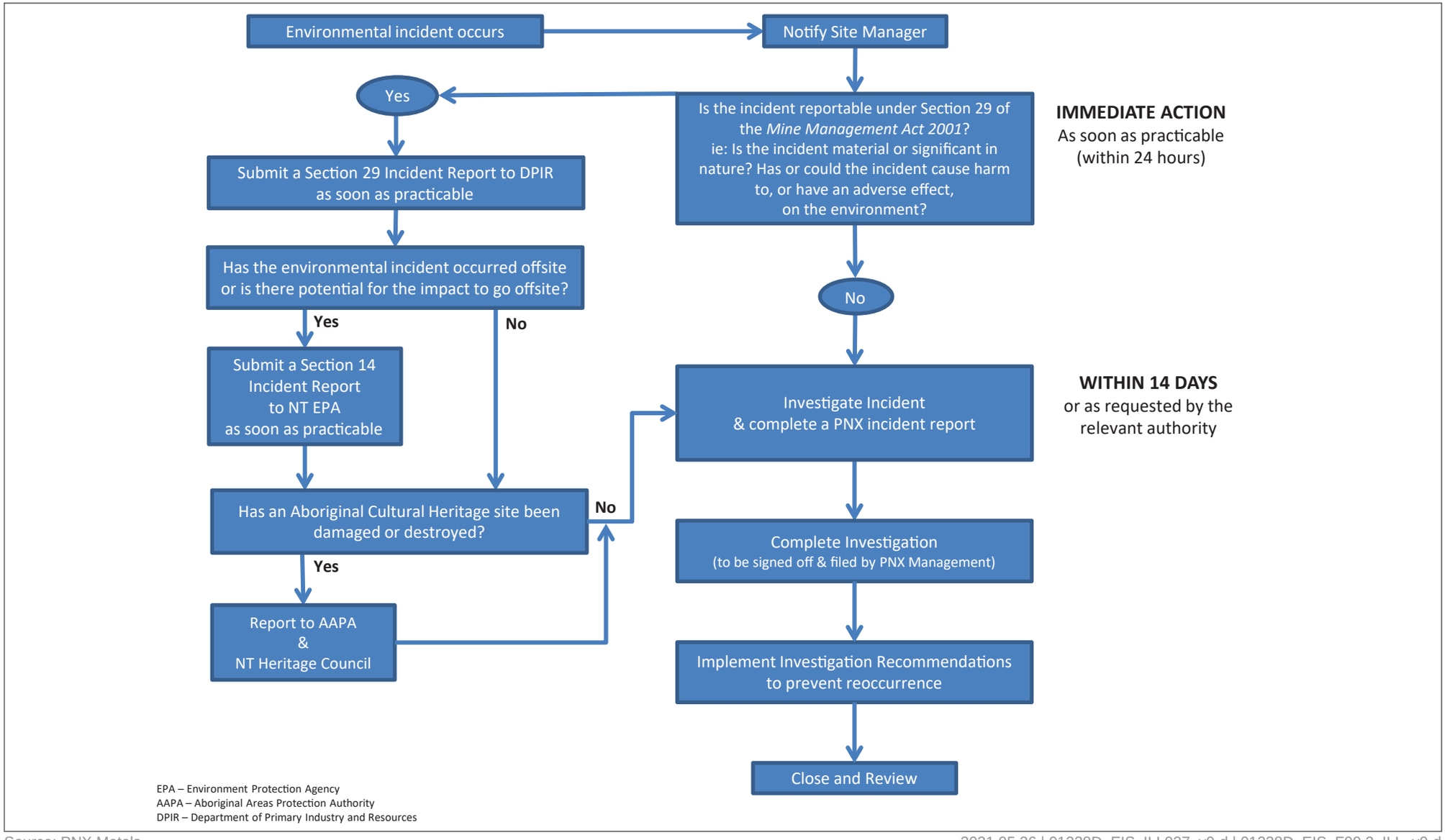
- Review of Environmental Policy.
- Assessments of the need for an update of the EMS in response to changes in Project design or processes, environmental permit conditions or regulatory requirements.
- A review of the incident and complaints register with changes to other system elements as needed.
- The extent to which current targets and objectives have been met.
- Follow-up actions from previous management reviews.

The Project EMS is dynamic and will be continually updated as the Project develops.

PNX METALS ENVIRONMENTAL INCIDENT FLOWCHART

Fountain Head Gold Project | Environmental Impact Statement

FIGURE 9.2



Source: PNX Metals

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11. Glossary and Abbreviations

11.1 Glossary

Term	Definition
A-weight	a frequency filter, the intention of which is to approximate the subjective response of human hearing. A-weighted sound pressure levels are designated as dB(A)
Abundance	(biological and other sciences) the quantity or amount of something present in a particular area, volume, or sample e.g., total numbers of individual animals or of taxonomic groups of animals
Abiotic	of or relating to the non-living components of an ecosystem; physical rather than biological; not involving biological activity
Acid neutralising capacity (ANC)	Natural resistance of soils or rock to acid generation. It is the number of moles of protons per unit mass of soil required to raise the pH of the soil by one pH unit. ANC is measured as percentage $CaCO_3$
Acid sulfate soil (ASS)	A soil containing iron sulfides deposited during either the Pleistocene or Holocene geological epochs (Quaternary aged) as sea levels rose and fell
Acidify	to make acid; convert or change into an acid. To become acid; turn acidic
Alluvial	describes material deposited by, or in transit in, flowing water
Ambient noise	environmental background noise not of direct interest during a measurement or observation
Aquifer	A rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit quantities of water to wells and springs
Background	The circumstances, situation, or levels of a particular parameter prevailing at the time of assessment; natural or pre-existing level of a variable
Base metal	A general term applied to relatively less expensive metals, such as copper, zinc, nickel, lead, tin, iron and aluminium
Baseline	an initial value of a measure, parameter or variable used as a starting point for comparison
Benthic zone	The ecological region at the lowest level of a body of water, including the sediment surface and some sub-surface layers
Berm	A cross-slope earthen bank constructed on reshaped spoil areas, typically at horizontal intervals of approximately 50 m and 1 to 1.5% longitudinal gradient, to reduce the effective slope length and control the runoff flow rate
Bioaccumulation	A process of concentration or accumulation within a ‘food chain’ of organisms
Biodiversity	biological diversity; the variety of species (of plants, animals, etc.), their genes, and the ecosystems they comprise, in relation to a particular habitat. A high level of biodiversity is usually considered to be desirable and/or important
Bioremediation	The use of naturally occurring micro-organisms for the restoration of polluted environments, in particular of contaminated land, and/or the groundwater associated with it
Bore	A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or extraction (or injection) of groundwater. Also known as a well, monitoring well or piezometer, although piezometers are typically of small diameter and only used for measuring the groundwater elevation or potentiometric surface

Term	Definition
Borehole	An uncased well drill hole
Buffer	(Chemistry) a solution which resists changes in pH when acid or alkali is added to it. An ionic compound, usually a salt of a weak acid or base, added to a solution to resist changes in its acidity or alkalinity and thus stabilise its pH
Catchment area	A recharge area or drainage basin and all areas that contribute water to it. The area that contributes water to a particular watercourse; a watershed
Clay	A fine-grained soil material composed of particles finer than 0.002 mm. When used as a soil texture group such soils contain at least 35% clay
Commissioning	process of testing, checking and inspecting all systems and components of a newly constructed facility, plant or piece of equipment to verify that it is installed and functioning according to design specifications and operational requirements
Composite sample	(Soil, sediment or water sampling) a technique that combines a number of discrete samples collected from a body of material (one sampling location) into a single homogenised sample for the purpose of analysis, in order to represent the average conditions in the sampled body of material
Concentrate	The product of the milling process, enriched in the valuable metal or mineral relative to the ore; typically a fine powder. The waste product of the concentration process is typically discarded as tailings
Conductivity (EC)	Conductivity, or electrical conductivity (EC), is the degree to which a specified material (such as water) conducts electricity. This property is related to the ionic content of the sample, which is in turn a function of the total dissolved (ionisable) solids (TDS) concentration
Confined aquifer	An aquifer that is confined between two low-permeability aquitards. The groundwater in these aquifers is usually under hydraulic pressure, i.e., its hydraulic head is above the top of the aquifer
Confining layer	A layer with low vertical hydraulic conductivity that is stratigraphically adjacent to one or more aquifers. A confining layer is an aquitard. It may lie above or below the aquifer
Contaminant	Something which contaminates, i.e., renders impure via pollution. In ecology, a substance which may degrade an environment (e.g., soil or water) due to toxicity to humans, animals or plants, or detriment to beneficial uses
Contamination	Making or being made contaminated; to pollute a substance with another, unwanted, substance. Considered to have occurred when the concentration of a specific element or compound is established as being greater than the normally expected (or actually quantified) background concentration
Controlled discharge	Release of a substance (e.g., wastewater) from a project area onto/into receiving land/water under conditions that meet a predetermined quality standard
Cover material	Soil, alluvium, weathered basalt or other suitable plant growth medium placed on reshaped spoil surfaces; typically non-crusting and low salinity
Cumulative impact	an impact that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones
Decommissioning	a project phase that comprises the removal, disposal or reuse of an installation when it is no longer required for its current purpose
Direct impacts	Impacts that result from primary planned interactions between a planned Project activity and environmental, social and cultural heritage receptors, e.g., a Project will have discharges resulting in increased river turbidity
Diversion channel	Structures for the controlled diversion of drainage lines and watercourses around open cut pits and infrastructure areas

Term	Definition
Discrete sample	(Soil, sediment or water sampling) samples collected from different locations and/or depths that will not be composited but analysed individually
Dispersion	The act of dispersing; the state of being dispersed. A mixture of one substance dispersed in another medium, such as water or air. Ecology: the movement of individual animals, plants, etc., between sites; the pattern of distribution of individuals within a habitat
Dissolved oxygen (DO)	The level of oxygen in the gaseous phase dissolved in water (and available to aquatic organisms). Measured either as a concentration in mg/L or as a percentage of the theoretical saturation point, which is inversely related to temperature
Disturbance	The interruption of a settled condition. Ecology: a temporary change in environmental conditions causing a change or impact to an ecosystem
Diversity	The state of being diverse. A diversity index is a quantitative measure that reflects how many different types (e.g., species) there are in a dataset, and takes into account how evenly the individuals are distributed among those types. Biological diversity (biodiversity) is the variety of species (of plants, animals, etc.), their genes, and the ecosystems they comprise, in a particular habitat
Drawdown	Lowering of hydraulic head
Environmental aspect	An element of an organisation's activities, products or services that can interact with the environment
Environmental factor	Aspects of the environment, defined by the NT EPA, that provide a framework for EIA in the Northern Territory
Environmental impact	The change that takes place from occurrence of any given environmental aspect. A marked effect or influence. Negative or positive effect/s caused directly or indirectly by an event or activity, or by the release of a substance into the environment, causing a change in the biological, physical and/or socio-economic environment
Environmental value	An aspect of the environment that is important or serves an important function. An environmental value may require protection due to its importance, sensitivity, vulnerability and/or worth
Flow path	The direction in which groundwater is moving
Fluvial	A material deposited by, or in transit, in streams or watercourses
Groundwater	The water held in the pores in the ground below the water table
Groundwater elevation	The elevation of the groundwater surface measured relative to a specified datum such as the Australian Height Datum (m AHD) or an arbitrary survey datum onsite, or 'reduced level' (m RL)
Hazard	Something that can cause harm; a situation that poses a level of threat to the environment, life, health or property
Heavy metal	A metal of relatively high density, or of high relative atomic weight. There is no universally agreed definition, however, heavy metals commonly include (among others) cadmium (Cd), copper (Cu), lead (Pb), tin (Sn) and zinc (Zn)
Hydraulic conductivity	A coefficient describing the rate at which water can move through a permeable medium. It has units of length per time. The units for hydraulic conductivity are typically $m^3/day/m^2$ or m/day
Hydraulic head	A measure of liquid pressure above a geodetic datum, typically measured as a liquid surface elevation above a fixed datum, such as sea level. A measure of the mechanical energy that causes groundwater to flow
Hydrocarbon	Any of the class of organic compounds containing only hydrogen and carbon, such as any of those which are the chief compounds in petroleum and natural gas

Term	Definition
Indirect impacts	Impacts that are subsequent to the primary planned interactions between the Project and its environmental, social and cultural heritage receptors, e.g., a Project will have discharges resulting in increased river turbidity with subsequent potential impact on health of fish species and economic livelihood of fishing dependent villagers
Infiltration	The passage of water, under the influence of gravity, from the land surface into the subsurface
Ion	An electrically charged atom or molecule formed as a result of loss or gain or one or more electrons. Positively charged ions are called cations (+), while negatively charged ions are called anions (-). The major aqueous ions are those that dominate total dissolved solids (TDS). These include: Cl^-, SO_4^{2-}, HCO_3^-, Na+, Ca^{2+}, Mg^{2+}, K^+, NH_4^+, NO_3^-, NO_2^-, F^- and PO_4^{3-}, and the heavy metals
Leachate	Water that has percolated through a solid or semi-solid material (e.g., soil or mine waste) and leached out some of the constituent impurities
Lease Area	The Fountain Head Lease Area is composed of the following mining leases: MLN4, 1020, 1034 and ML31124
Lysimeter	A device for collecting drainage passing through overlying material. The term lysimeter is primarily used for field test apparatus. Lysimeters are installed in waste rock to measure the quality and/or quantity of drainage
Massif	A large mountain mass or compact group of connected mountains forming an independent portion of a range
Metalloid	A class of elements chemically intermediate in properties between metals and non-metals including boron, silicon, germanium, arsenic and tellurium
Micro-organism	A microscopic organism; includes viruses, bacteria, yeasts and fungi, and others
Mitigation	Action(s) taken to avoid or reduce the impact of an activity on the environment, cultural and/or socio-economic interests
Net acid generation potential (NAGP)	The difference between the maximum potential acidity and acid neutralisation capacity reported on a kilogram H_2SO_4 production per tonne of soil or rock
Operations	A project phase that comprises the operation of a facility or installation, when the core business or purpose of that asset is realised
Organics	Chemical compounds comprising atoms of carbon, hydrogen and others (commonly oxygen, nitrogen, phosphorous, sulfur). Opposite is inorganic, referring to chemical species not containing carbon
Oxidation	The act or process of being oxidised; loss of electrons or increase in oxidation state by a molecule, atom or ion; particularly used to refer to the addition of oxygen to elements
piezometric or potentiometric surface	A surface that represents the level to which water will rise in cased bores. The water table is the potentiometric surface in an unconfined aquifer
pH	A figure expressing the acidity or alkalinity of a solution on a logarithmic scale on which 7 is neutral, lower values are more acid and higher values more alkaline
Precipitation (chemical)	The precipitating of a substance from a solution; the condensation of a solid from a solution during a chemical reaction
Production area	The production area refers to the extent of the project infrastructure layout or footprint only
Putrescible waste	Food waste, waste consisting of animal matter (including dead animals or animal parts) or biosolids
Remediation	The action of remedying something, in particular of reversing or stopping environmental damage. Ecology: the restoration of an environment, land or

Term	Definition
	groundwater contaminated by pollutants, to a state suitable for other, beneficial uses
Residual impact	Those impacts that remain after the effective implementation of avoidance, mitigation and management measures, which are designed to reduce the likelihood, consequence, magnitude or severity of the impact
Sediment dam	Natural or constructed drainage impoundment used to reduce the concentration of suspended particles in surface run-off water or mine effluent prior to re-use or discharge to the environment
Silt	Sediment with particles finer than sand and coarser than clay (comprised of particles between 0.002 and 0.075 mm in size)
Species richness	The number of different species represented in a sample, taxonomic group, ecological community, landscape or region. Species richness is simply a count of species, and it does not take into account the abundances of the species or their relative abundance distributions
Standing water level (SWL)	The depth to the groundwater surface in a well or bore measured below a specific reference point – usually recorded as metres below the top of the well casing or below the ground surface
Study area	Refers to the area surveyed for a particular study that may differ to the Project area, e.g., water quality site off lease
Stratigraphy	A branch of geology dealing with the classification, nomenclature, correlation, and interpretation of stratified rocks, i.e., the order and relative position of strata and their relationship to the geological timescale. The structure of a particular set of strata or sequence of geological units
Subsidence	The downward settling of material with little horizontal movement
Subsoil	Subsurface material comprising the B and C horizons of soils which lies below the topsoil or A horizon. The subsoil is not enriched with organic material as is the topsoil and often has higher clay content
Sulfide oxidation	Exothermic oxidation of chemically reduced sulfide (S^{2-}) to a partially or fully oxidized form, such as sulfate (SO_4^{2-}). One indication of sulfide oxidation is elevated sulfate concentrations in mine site drainage
Sump	Temporary excavation for the storage of water
Suspended solids (SS)	Small solid particles which remain in suspension in water as colloids or due to the motion of the water. Used as one indicator of water quality
Topsoil	Part of the soil profile, typically the A1 horizon, usually containing more organic matter than the underlying layers
Total dissolved solids (TDS)	A measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionised or micro-granular suspended form
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism
Transmissivity	The rate at which water is transmitted through a unit width aquifer under a unit hydraulic gradient
Turbidity	A measure of the relative clarity of a liquid, particularly water, as a result of the amount of suspended particulate matter present, such as sediment particles, algae, plankton, microbes, and other substances. One indicator of water quality
Waste rock	Rock with insufficient amounts of economically valuable elements to warrant its extraction, but which has to be removed to allow physical access to the ore.
Water balance	A term used in the context of mining to describe an inventory of drainage inputs and outputs, water volumes and the rate of flow

Term	Definition
Water quality criteria	Maximum or minimum values of physical, chemical or biological characteristics of water, biota or sediment whose exceedance under specified conditions may result in detrimental effects to a water use
Water table	The interface between the saturated zone and unsaturated zones. The surface in an aquifer at which pore water pressure is equal to atmospheric pressure
Well	A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a bore

11.2 Abbreviations

Abbreviation	Definition
AAPA	Aboriginal Areas Protection Authority
ABCC	Acid-buffering characteristic curve
ANZECC/ARMCANZ	Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand
AEP	annual exceedance probability
AMD	acid, metalliferous and saline drainage or acid mine drainage
ANC	acid neutralisation capacity
ANE	ammonium nitrate emulsion
ANCOLD	Australian National Committee on Large Dams
ANZECC	Australian and New Zealand Environment Conservation Council
APA	Australian Pipeline Group
ARD	Acid Rock Drainage
ARI	average recurrence interval
As	arsenic (element)
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
Au	gold
BCM	bank cubic metre, representing the content of a cubic metre of material in place, before it is drilled and blasted
BGP	Bonaparte Gas pipeline
BIBO	Bus-in bus-out
BLS	barren solution
BPEM	best practice environmental management
C	carbon (element)
Cd	cadmium (element)
CCL	compacted clay liner
CE	Critically Endangered (EPBC/TPWC species ranking)
CIL	carbon in leach
CIP	Carbon in pulp

Abbreviation	Definition
Cn	cyanide
Cu	copper (element)
Cr	Critical (EPBC/TPWC species ranking)
CR	Critically Endangered (IUCN ranking)
DD	Data deficient (EPBC/TPWC species ranking)
DENR	Northern Territory Department of Environment and Natural Resources
DEPWS	Department of Environment, Parks and Water Security
DIPL	Northern Territory Department of Infrastructure, Planning and Logistics
DITT	Northern Territory Department of Industry, Trade and Tourism
DTSC	Northern Territory Department of Tourism, Sport and Culture
EA Act	*Environmental Assessment Act*
EAAP	Environmental Assessment Administrative Procedures
EC	Electrical conductivity
EIS	Environmental Impact Statement
EN	Endangered (EPBC/TPWC species ranking)
EMP	environmental management plan
EMS	environmental management system
EMU	Environmental Monitoring Unit
EA Act	*Environmental Assessment Act 1982*
EP Act	*Environment Protection Act 2019*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESD	Ecologically Sustainable Development
FIFO	Fly-in fly-out
GM	gravel-silt mixtures and gravel-silt-sand mixtures
GC	gravel-clay mixtures and gravel-sand-clay mixtures
GHG	greenhouse gas
GRP	Gross regional product
HAZID	Hazard identification
HDPE	High Density Polyethylene
IWL	Integrated Waste Landform
LC	Least Concern (IUCN ranking)
LGA	Local Government Area
LiDAR	light detection and ranging
ML	Mining Lease
MLN	mining lease number
Mn	Manganese (element)
MNES	Matters of National Environmental Significance
MMA	*Mining Management Act*
MMP	Mining Management Plan
MPA	maximum potential acidity
MPC	maximum permitted concentration

Abbreviation	Definition
MRE	Mineral resource estimate
Mt CO_2-e	million tonnes of carbon dioxide equivalent
Mtpa	million tonnes per annum
NaCN	sodium cyanide
NAF	non-acid-forming
NAG pH	net acid generation pH
NAGP	net acid generation potential
NAPP	net acid production potential
NEPM	National Environment Protection Measure
NOI	Notice of Intent
NPR	Neutralisation potential ratio
NT	Not threatened (EPBC/TPWC species ranking)
NT EPA	Northern Territory Environment Protection Authority
pa	per annum
PAF	potentially acid-forming
PAF(HC)	potentially acid-forming rock (high capacity)
PAF(RE)	potentially acid-forming rock (reactive)
Pb	lead (element)
PM_{10}	particulates with aerodynamic diameter less than 10 µm
$PM_{2.5}$	particulates with aerodynamic diameter less than 2.5 µm
PMST	Protected Matters Search Tool
PNX Metals	PNX Metals Limited
PPE	personal protective equipment
ppm	parts per million
PSD	particle size distribution
PWC	Power & Water Corporation
RC	Reverse circulation
ROM	run of mine
SAR	sodium adsorption ration
SC	sand-clay mixtures
SM	sand-silt mixtures
SMS	Safety Management Study
SoCS	sites of conservation significance
SoBS	sites of botanical significance
SoR	Statement of Reasons
STV	Short-term trigger value
TDS	total dissolved solids
ToR	Terms of Reference
TSP	total suspended particulates
TPWC Act	*Territory Parks and Wildlife Conservation Act 2014*
Vu	Vulnerable (EPBC/TPWC species ranking)

Abbreviation	Definition
WDL	waste discharge license
WoNS	Federally listed Weeds of National significance.
WRS	Waste Rock Storage

ERIAS

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