WARATAH WYNYARD COUNCIL

NOTICE OF PROPOSED DEVELOPMENT

Notice is hereby given that an application has been made for the following development:-

NO:	**DA 54/2024**
LOCATION:	**Mine Road & Keith River Road** **SAVAGE RIVER**
APPLICANT:	**Pitt & Sherry**
SCHEME:	**Tasmanian Planning Scheme – Waratah-Wynyard**
ZONING:	**Rural**
USE CLASS:	**Extractive Industry**
PROPOSAL:	**SAVAGE RIVER MINE NORTH PIT UNDERGROUND OPERATIONS (NPUG)**

The application and associated plans and documents are available for inspection on Council website https://www.warwyn.tas.gov.au/planning-and-development/advertised-permits/ and at Council offices, located at 21 Saunders Street Wynyard during normal office hours for a period of 28 days from the date of this notice.

Any person may make a representation relating to the above proposal and the supporting documentation, during the 28-day period.

Representations in writing will be received by the General Manager, PO Box 168, Wynyard, 7325, or email council@warwyn.tas.gov.au by **Tuesday 23 April 2024.**

Dated Saturday 23 March 2024.

Shane Crawford
GENERAL MANAGER

WARATAH WYNYARD COUNCIL

APPLICATION FOR PLANNING APPROVAL

SECTION 51 LAND USE PLANNING & APPROVALS ACT 1993

PERMITTED APPLICATION - Assessment and determination of permit application under *S58 Land Use Planning and Approvals Act 1993*	$280.00 plus $1.35 per $1,000 of value for use or development
DISCRETIONARY APPLICATION -- Assessment and determination of a permit application under *S57 Land Use Planning and Approvals Act 1993*	$450.00 plus $1.75 per $1,000 of value for use or development plus advertising fee
SUBDIVISION APPLICATION – Assessment and determination of a subdivision application for 1 to 5 lots under s57 or s58 *Land Use Planning & Approvals Act 1993*	$450.00 plus $1.75 per $1,000 of value for use or development plus advertising fee
SUBDIVISION APPLICATION – Assessment and determination of a subdivision application for more than 5 lots under s57 or s58 *Land Use Planning & Approvals Act 1993*	$815.00 plus $175 per lot plus advertising fee
ADVERTISING FEE	$280.00
Level 2 Environmental Activity – Additional charge to permit application	$530.00 + advertising fee by quote
Please refer to www.warwyn.tas.gov.au (Council Services – Planning Services – Planning Fees) for all other fees	

Is a hard copy of planning permit and endorsed documents required? Yes …………… No …X…

1. Value of work (inc GST) $416,135,570..................Contract Price ……………Estimate X……..……

2. Development Address Kieth River Road/Mine Road - Savage River

3. Full Name of Applicant(s) pitt&sherry obo Grange Resources (Tasmania) Pty Ltd

Contact Details: Address: Level 4, 113 Cimitiere Street TAS 7250

Email Address khill@pittsh.com.au Telephone 03 6323 1978

For requests in hardcopy format all correspondence in relation to this application, will be sent to the contact address, otherwise all correspondence will be forwarded to the email address

4. Would you like the contact address recorded above to be applied for all future Council correspondence? **(including rates/animal control etc)**? Yes……No…X…

5.

Where the Applicant is not the Owner

In accordance with Section 52 of the *Land Use Planning and Approvals Act 1993* if the applicant for the permit is not the owner of the land in respect of which the permit is required, the applicant must include in the application for the permit, a declaration that the applicant has notified the owner of the intention to make the application.

In the event that the property is owned or managed by the Crown or Council, this application is to be signed by the relevant Crown Minister responsible, or General Manager of the Council, and accompanied by written permission of the Minister/General Manager to the making of this application.

Owners Full Name Sustainable Timbers Tasmania (Forestry Tasmania) & PWS (Mineral Resources Tasmania)

Address GPO BOX 207 Hobart 7001 & PO Box 56 Rosny Park 7018 Telephone Work/Business ……………………………

Crown Minister/General Manager Signature. As the proposal is for mining operations on a mining lease, under Section 52(1H) of the Land Use Planning and Approvals Act 1993, Crown Land Consent is not required to lodge the planning permit application.

Applicant's Notification to Owner

I Katrina Hill under Section (1A) subsection (1) does not apply - mining lease has been issued

Full Name of Applicant(s)

of pitt&sherry - Level 4, 113 Cimitiere Street TAS 7250

Applicant's Address

Declare that I/we have notified the owner(s) of the property(ies) of the intention to make this application.

I/We understand that in accordance with Section 52(2) of the *Land Use Planning and Approvals Act 1993* a person must not obtain or attempt to obtain a permit by wilfully making, or causing to be made, any false representation or declaration either orally or in writing.

Applicant's Signature(s) KHill 29/02/24

6. Proposed Development (Fully describe intended use of land or premises)

Extractive Industry - North Pit (underground mine)

………

See the attached documentation for details ……………………………………………………………

7. Supporting Information if necessary to explain special features of the proposal. (Attach separate sheet if required)

See attached documentation

………

………

To include –

a. One Copy (electronic copy if available) of any plan(s) and/or specification(s) for the proposed development, showing where applicable:

- ☐ i. Sufficient information to demonstrate compliance with all applicable standards, purpose statements in applicable zones and codes, any relevant local area objectives or desired future character statements;
- ☐ ii. a full description of the proposed use or development;
- ☐ iii. a full description of the manner in which the use or development will operate;
- ☐ iv. a site analysis and site plan at an acceptable scale;
- ☐ v. a detailed layout plan of the proposed buildings with dimensions at a scale of 1:100 or 1:200;
- ☐ vi. a plan of the proposed landscaping;
- ☐ vii. car parking facilities and capacity;
- ☐ viii. area of clearing of trees and bushland;
- ☐ ix. size, position, colour, illumination, fixing or support and other design details of advertising sign(s).

b. A full copy of your title shall also accompany the application. No titles (PID 3388485 and 3389517)

Title Certificate ☐ Title Plan ☐ Schedule of Easements ☐

c. Relevant engineering pre-lodgement approvals

Access ☐ Stormwater ☐

8. Present use of site and/or buildings – full description

Extractive Industry (existing mining lease)

………

………

9.

Car Parking		Floor Area	
Existing on site	……………	Existing	………………
Total no. proposed	………………	Proposed	………………

Site Area……………..m² ……………….Total ……………….m²

See attached documentation

Questions 10 to 13 relate to Commercial and industrial Uses and Development ONLY

10.	What days and hours of operation are proposed? 24/7 (mine operations) Monday to Friday: From ....a.m. to .... p.m. Saturday From ....a.m. to ....p.m. Sunday From ....a.m. to ....p.m.		
11.	Number of Employees? see attached documentation Existing.. Proposed..		
12.	Vehicles visiting or delivering to or from the site? Type No. See the attached TIA for details	Trips per day	
13.	What type of machinery is to be installed or used Type / No. See attached documentation		

Declaration By Applicant (Mandatory)

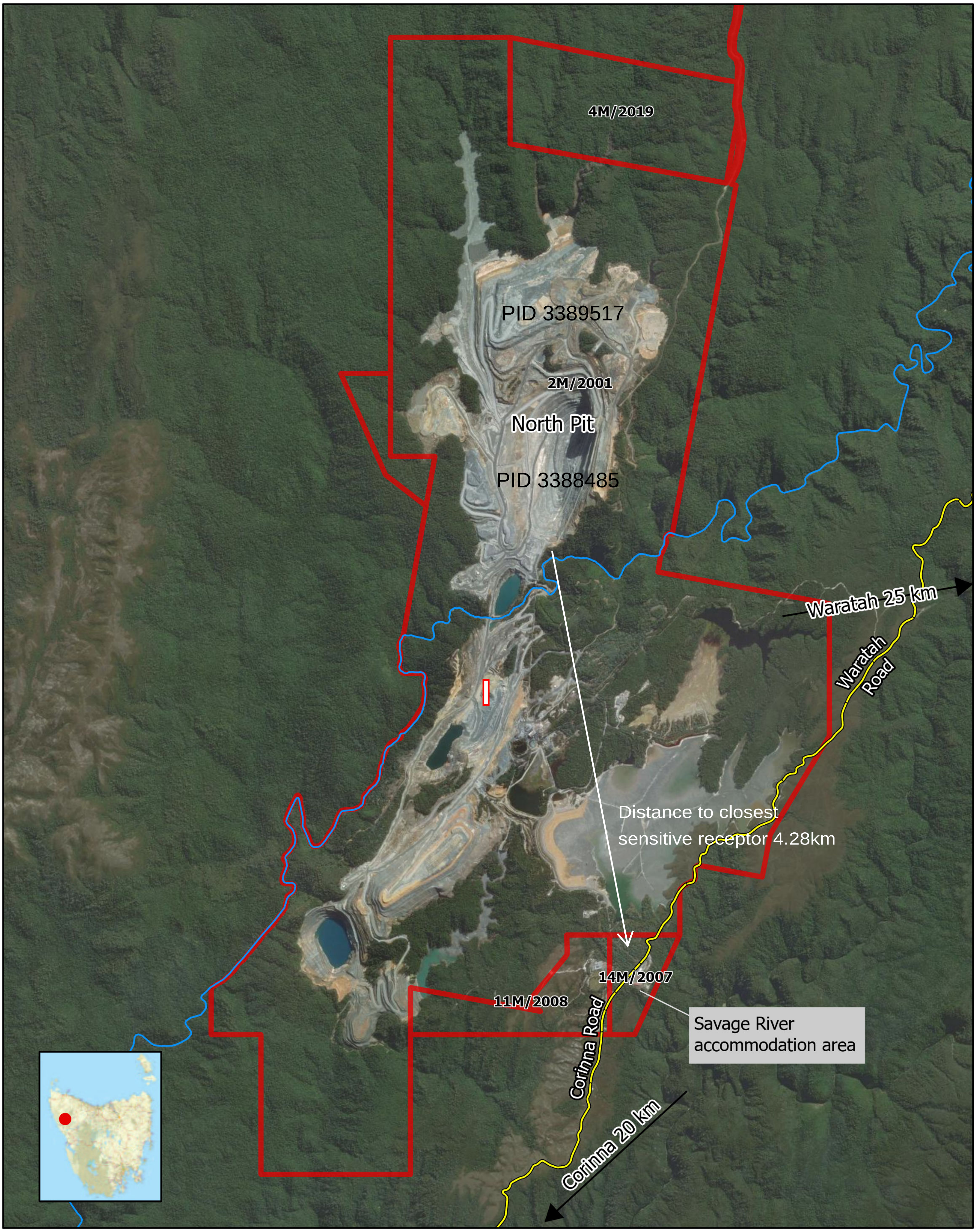
I declare that the information given is a true and accurate representation of the proposed development. I understand that the information and materials provided with the development application may be made available to the public. I understand that the Council may make such copies of the information and materials as in its opinion are necessary to facilitate a thorough consideration of the Permit Application. I have obtained the relevant permission of the copyright owner for the communication and reproduction of the plans accompanying the development application for the purposes of assessment of that application. I indemnify the Waratah-Wynyard Council for any claim or action taken against it in respect of breach of copyright in respect of any of the information or material provided.

I/We hereby acknowledge that Section 20(a) of the *Local Government Act 1993* provides the power for persons authorised by the General Manager to enter land without notice in relation to an application by the owner or occupier for a licence, permit or other approval given by the council.

Signature(s) RHill ....
(all applicants to sign)
. ...

Date 29/02/24 ....

PO Box 168, WYNYARD 7325
Email: council@warwyn.tas.gov.au



Grange Resources (Tasmania) Pty Ltd

General Site Location

pitt&sherry

N

0 0.5 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

1:50,000 When Printed at A4

MAP REF	P.23.0059
AUTHOR	JB
REVISION	RevD
DATE	28/02/2024

DATA SOURCES Base data and map from The LIST Tasmanian Government, Minerals Resources Tasmania

Legend

- Mining lease
- Road access
- Savage River

Savage River Mine: North Pit Underground Operations

Report to Support a Planning Permit Application

Prepared for
Grange Resources

Client representative
Ben Maynard

Date
29 February 2024

Rev00

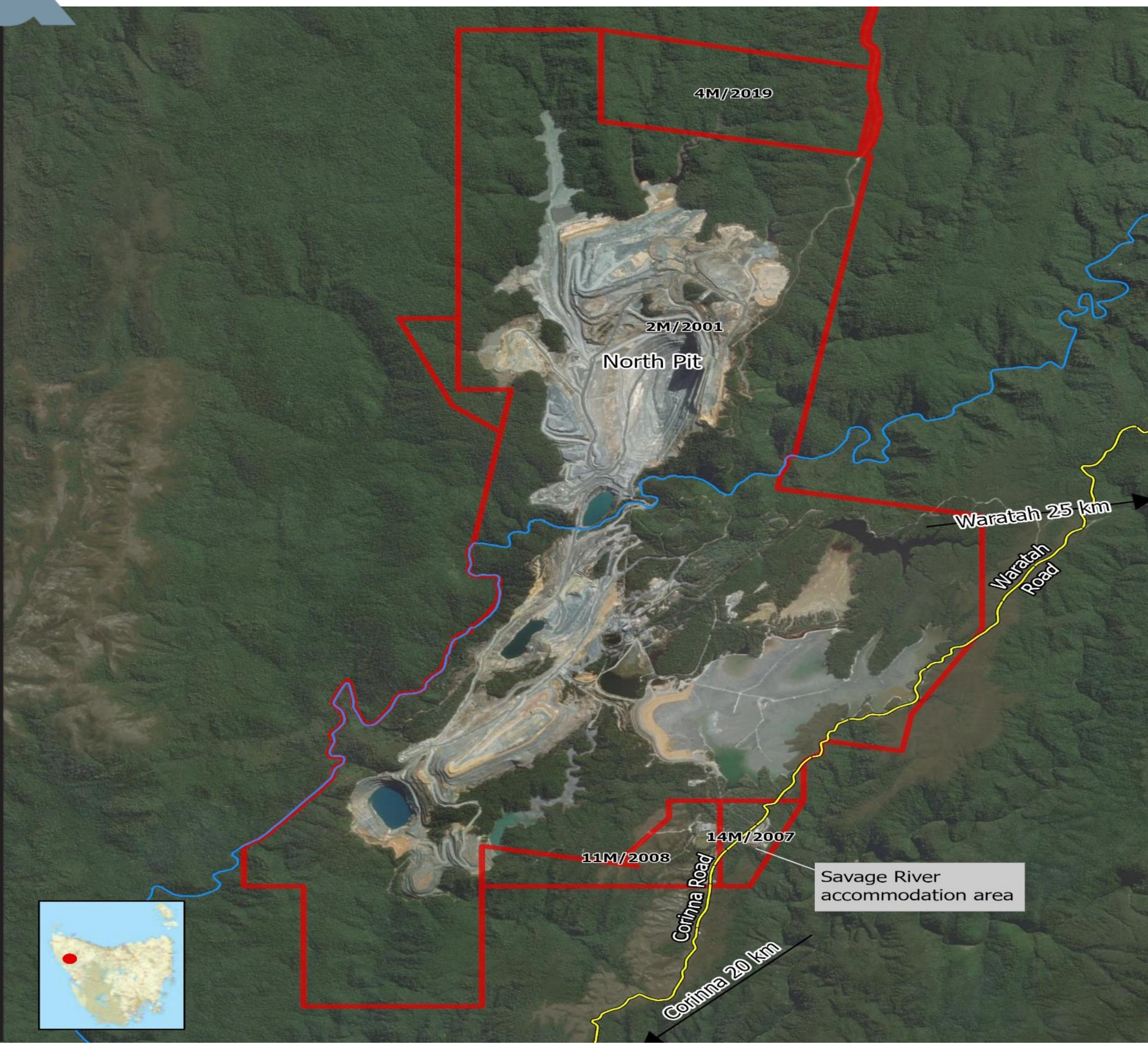


Table of Contents

List of figures

Appendices

Prepared by — Katrina Hill		**Date —** 29 February 2024
Reviewed by — Lucas Paterno		**Date —** 29 February 2024
Authorised by — Katrina Hill		**Date —** 29 February 2024

Revision History

Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
A	Draft client review	K Hill	L Paterno	K Hill	29/02/24
00	Final	K Hill	L Paterno	K Hill	29/02/24

1. Introduction

This report has been prepared by pitt&sherry for Grange Resources (Tasmania) Pty Ltd (or 'Grange'), the proponent, to support a planning permit application which proposes works associated with an Extractive Industry. The project is known as Savage River Mine, North Pit Underground (NPUG).

This report demonstrates that the proposal complies with the applicable provisions of the *Tasmanian Planning Scheme – West Coast Local Provisions Schedule* (the planning scheme) and that a planning permit may be issued by the planning authority, West Coast Council (the Council).

The proposal is ancillary to an existing Level 2 Activity (the mining operations). Grange was advised that the activity will be assessed by the Environment Protection Authority Tasmania (EPA) Board as a Class 2B assessment under the *Environmental Management and Pollution Control Act 1994* (EMPCA). The Class 2B assessment process involves the preparation and submission of a Development Application (DA) and an associated Environmental Impact Statement (EIS) to Waratah-Wynyard Council, and the subsequent referral of that documentation to the EPA for assessment. As part of the assessment process, the DA and EIS are subject to a public notification period of 28 days. During this time, the EPA and the Council may receive and consider public representations.

The proposed underground operations will be within the existing footprint of North Pit. The location of the Savage River mine, including the mine's North Pit is shown below in Figure 1. A Site Plan is located at Appendix A.

1.1 Proponent Background

Grange owns and operates an integrated iron ore mining and pellet production business located in the northwest region of Tasmania. The company is Australia's oldest and most experienced magnetite producer, and a proven and reliable commercial producer of magnetite pellets in Australia combining both mining and pellet production expertise.

Open cut magnetite mining has been undertaken at the Savage River Mine site since 1967. This was initially operated by Savage River Mines (SRM) which, between 1990 and 1996, was owned and operated by Pickands Mather & Co. International (PMI) and Cleveland Cliffs. In April 1996, all mining ceased except for disestablishment and rehabilitation. Goldamere Pty Ltd, trading as Australian Bulk Minerals (ABM) and later to become Grange (Tasmania) Pty Ltd, recommenced mining in 1997 with cutbacks to South Lens, North Pit, Centre Pit North and Centre Pit South, and a new pit at South Deposit commencing in 2001.

The Savage River magnetite iron ore mine, 100 km southwest of the city of Burnie, is a long-life mining asset set to continue operation beyond 2038. At Port Latta, 70 kms northwest of Burnie, is Grange's wholly owned pellet plant and port facility producing approximately two million tonnes of premium quality iron ore (hematite) pellets annually with plans to increase annual production in the coming years to 2.7 million tonnes. Grange holds long term supply contracts for one million tonnes of its annual production and offers the balance of its production to market via a spot sales tendering/contracting process. All production is shipped to major steel producers in Australia and internationally.

2. Site Context

Savage River Mine is located in north-west Tasmania (latitude 41°29’25 S, longitude 145°12’03 E), adjacent to Corinna Road, 45 km west of the Murchison Highway. The nearest localities are Corinna, 24 km to the southwest and Waratah, 38 km to the northeast. The locality of the Savage River mine with the footprint of the proposed activity is shown in Figure 1.

The proposed NPUG operation at the location of the ‘North Pit’, the site subject to assessment, is within the existing Savage River Mining Lease(s) (as per Figure 1): ML 2M/2001 – 4987 ha, ML 14M/2007 – 91 ha, ML 11M/2008 – 108 ha; and ML 4M/2019 – 235 ha.

There is no certificate of title, but the NPUG is located across two land parcels identified with PID 3388485 and 3389517, with the relevant authority listed as Sustainable Timber Tasmania and Department of Natural Resources and Environment Tasmania (NRE Tas) (Future Potential Production Forest) respectively (as per Figure 1).

There are no easements or conservation covenants within or in the vicinity of the Savage River Mine site.

As the proposal is for mining operations on a mining lease, under Section 52(1H) of the *Land Use Planning and Approvals Act 1993*, Crown Land Consent is not required to lodge the planning permit application.

A number of reserves cross the Savage River Mine, including the Savage River Regional Reserve. North Pit is located within two informal reserves, an Informal Reserve on Permanent Timber Production Zone Land or STT managed land as well as Future Potential Production Forest, refer Figure 1. Other reserves in the area include the Donaldson River Nature Recreation Area to the west and the Meredith Range Regional Reserve to the east. The Savage River National Park is located approximately 10 km to the northeast.

The Savage River accommodation area is located approximately 2 km south of the mine site, and approximately 4 km south of North Pit.

The site is remote and apart from the accommodation area, there is little public access to the area or adjoining lands.

2.1 Property Details

Table 1: Property details. As the proposal is for mining operations on a mining lease, under Section 52(1H) of the Land Use Planning and Approvals Act 1993*, Crown Land Consent is not required to lodge the planning permit application.*

Address	Property ID	Title Ref	Owner Name	Tenure
KEITH RIVER RD MEUNNA TAS 7325	3388485	N/A	Sustainable Timber Tasmania	Permanent Timber Production Zone Land
MINE RD SAVAGE RIVER TAS 7321	3389517	N/A	NRE Tas (Future Potential Production Forest)	Future Potential Production Forest (Crown)

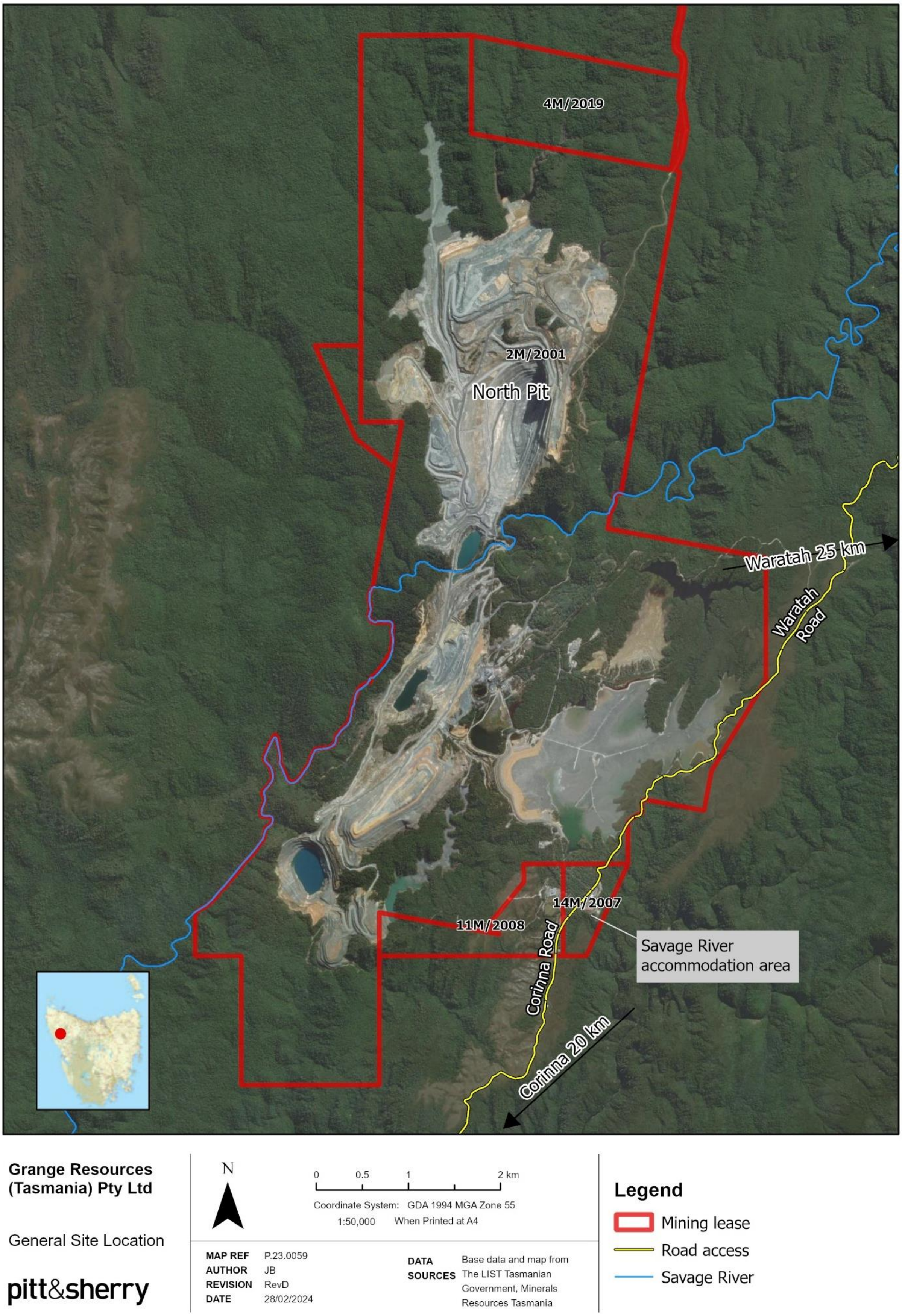


Figure 1: Site locality aerial

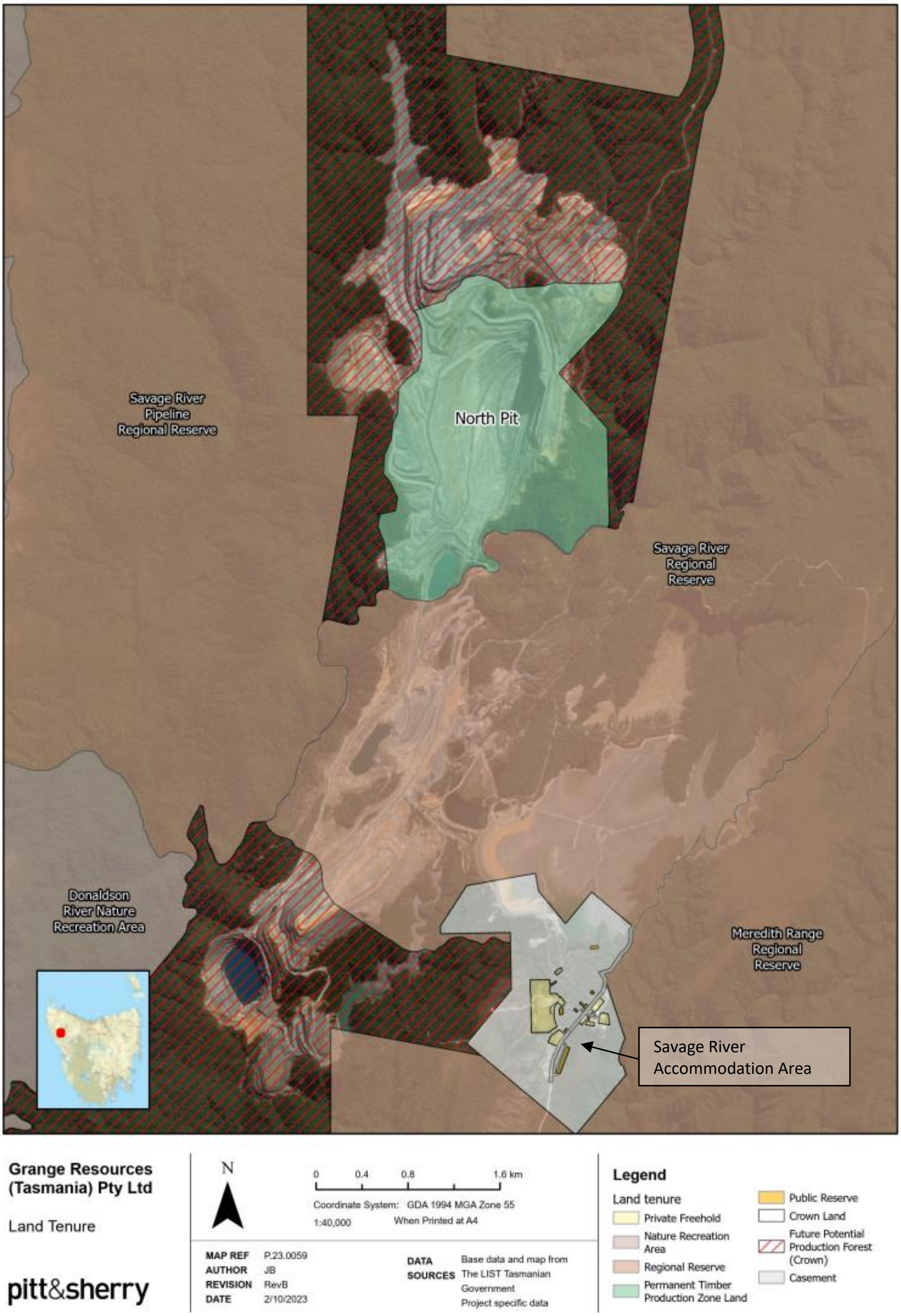


Figure 2: Land Tenure

3. Site Description

The Savage River mine is located along Corinna Road/ Waratah Road, north of the Savage River township. Corinna is located approximately 20 km east of the site while Waratah is located approximately 25 km west. The site and the Savage River township have been designed and constructed to support the mining operations.

The mine site currently accommodates the tailing storage facilities, site offices, associated parking and access roads connecting the various components within the mine site. The township accommodates the ancillary facilities including but not limited to accommodation, additional site offices, cafeteria and associated parking.

3.1.1 Operations

The site is not open to the public and is only accessible to Grange staff and approved contractors. Access is restricted by boom gates and swipe access. The site operates 24 hours a day, 7 days a week.

The existing workforce averages up to 150 employees and contractors at any one time on site and up to 100 employees and contractors at any one time in the camp facilities. The site receives a range of deliveries each day, including but not limited to, fuel, food, materials and waste disposal. Deliveries are equivalent to approximately 2 semi-trailers a day and 4 rigid trucks a day. Additional wide load semi-trailers also access the site to deliver mining truck parts, cranes, drills and other equipment as required.

3.1.2 Staffing

The existing workforce on-site averages up to 150 Grange personnel (day shift), 100 Grange personnel (night shift) and an additional 100 contractors at any one time during a 24-hour period. This results in approximately 350 personnel attending the site in an average 24-hour period.

All site staff work on rotational shifts with varying work patterns, including 7/7, 4/4, 8/6 and 5/2 (note that the X/Y represents the work schedule where the X signifies days on-site and the Y indicates the consecutive days off). On working days, site staff reside in the township. On non-working days, site staff return to their homes. Additional Grange Staff and approved contractors (including but not limited to deliveries, waste disposal, cleaning, camp related activities) also access the site as required each day using private vehicles.

While staff generally drive to the township using their own, private, vehicles, Grange also provides a coach from Burnie on major shift changes. Travel between the site and the campsite generally occurs using transfer buses.

3.1.3 Site Access & Circulation Roads

The site has a single access onto Waratah Road that is used by all vehicles accessing the mine. This access has a separate entry and exit with a width of 15 m and 19 m respectively. The entry and exit are separated by a 2 m wide splitter island that is offset from the intersection by 5 m. Within the site, vehicles travel along marked circulation roads. All circulation roads are a minimum 10 m wide with additional widening provided to support the turn paths of larger vehicles as required. See Appendix B for details relating to access to the mine site and camp site.

3.1.4 Natural Values & Biodiversity

The proposed development is within previously disturbed areas of the mine. No threatened vegetation communities listed under the Tasmanian *Nature Conservation Act 2002* (NCA) or the Commonwealth EPBCA were identified within the proposed expansion area. No threatened flora species listed under either the Tasmanian *Threatened Species Protection Act 1995* (TSPA) or the Commonwealth EPBCA were recorded within the area. There will be no direct impact to threatened fauna species listed under the TSPA or the EPBCA, although threatened fauna species may occur or have habitat within the mining lease. See Appendix C for further details.

4. Proposal

The underground operations (or NPUG) will be within the existing footprint of North Pit (see Figure 3). Therefore, pre-construction works, such as vegetation clearance and stockpiling will not be required; with the exception of an area of 480 m^2 required for clearance for an access track near the NPUG portal.

Underground construction activities will be required prior to the NPUG operations (Transition and BC mining) commencing. These will require an extension of the existing exploration decline and development of underground infrastructure as outlined in section 2.3.4 of the EIS (Appendix C).

No new off-site infrastructure is required as part of the proposed underground operations at North Pit, with the exception of an increase in accommodation at Savage River camp. Any development/works at the Savage River camp will be covered under a separate development application.

4.1 Development Summary

Existing operational plant and infrastructure used to process the ore from the underground operations will include:

- Primary crusher, concentrator and slurry pipeline
- Run of mine (ROM) and stockpile areas
- The South Lens water treatment system
- Tailings storage facilities, specifically the SDTSF; and
- Waste rock dumps including Centre Pit Dump and Broderick Creek Dump Complex, and the Mill Dump and South Deposit Backfill Dump.

There will be limited new surface infrastructure required as part of the proposed underground operations. New and upgraded surface infrastructure will include:

- Ventilation raises
- Potential relocation of the existing concrete batch plant closer to the NPUG portal
- A new access track and associated drainage
- A new rock waste dump created by the backfilling of the North Pit void, refer section 5.2.2
- Upgrades to compressed air and power, and the maintenance workshop
- Upgrades will also be required for underground dewatering.

The new access track (for details refer to Figure 12 of the EIS, Appendix C) will be approximately 160 m long and 3 m wide, with an area of vegetation clearance of 480 m^2 required. All run-off will be managed by the cross fall to the west and then a cut off drain which will report to a sediment pond. The purpose of the track is to improve safety by providing vehicle access to the underground portal that does not interact with haul trucks.

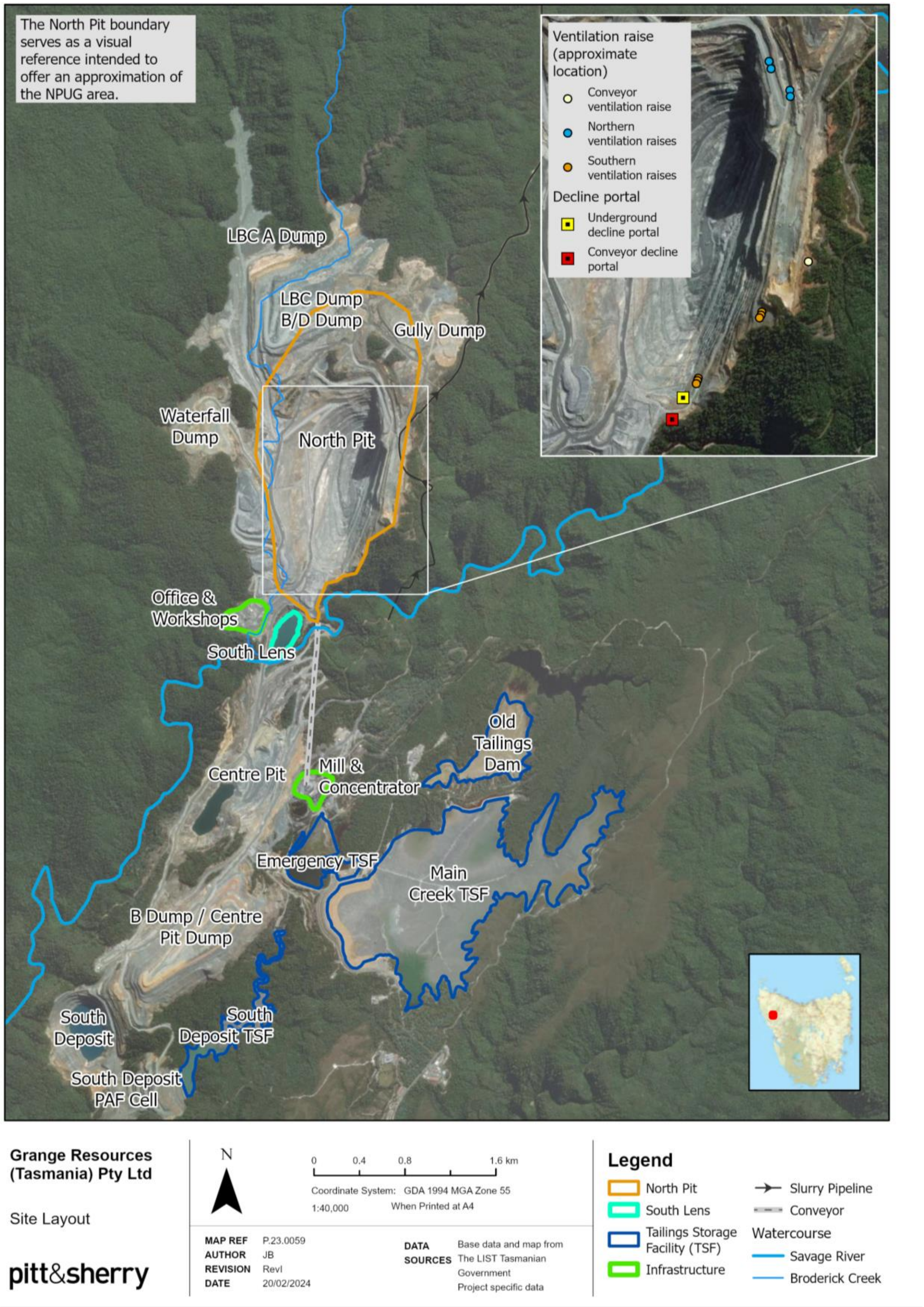


Figure 3: Site Layout with NPUG area (in insert)

4.2 Staged Mine Development

Underground construction activities will be required prior to the NPUG operations (Transition and BC mining) commencing. This will require an extension of the existing exploration decline and the development of underground infrastructure as outlined in the EIS (Appendix C). The following schedule for NPUG is anticipated:

- Year 1 - office buildings, ablution block crib rooms, surface workshop, portal substation (22 kV to 11 kV) and underground substation (11 kV to 1 kV)
- Year 2 - upper pump station and raising mains, underground ventilation with ventilation fans and brattice, and conveyor portal
- Year 3 - ventilation raises and primary ventilation fans, underground workshop, crib room and ablutions, and underground magazine. Surface power upgrade (additional 22 kV Transformer and reticulation)
- Year 4 - conveyor system, surface stacker, surface tramp removal system and lower pumping station; and
- Year 5 - crushing and underground tramp removal system, flood mitigation stopes and satellite pumping system.

4.3 Environmental Management

An Environmental Impact Statement (EIS) in Appendix C has been prepared for the NPUG project. The EIS is used to demonstrate that the proposal complies with the requirements of the Natural Assets Code and the Attenuation Code.

The Environmental Rehabilitation Plan (ERP) for the site is reviewed every three years, with the latest review occurring in 2023. The ERP was submitted to the Director, EPA in October 2023. The ERP covers the final rehabilitation and closure of the entire Savage River mine site, including the decommissioning of plant and equipment after cessation of operations.

The Goldamere Agreement (refer to EIS, Appendix C) was created to indemnify owners of the mine against responsibility for legacy pollution which occurred in the Savage River as a result of earlier mining activities. This encouraged continued investment and employment at the mine. The support for operations on site, and the positive impact that it has to the economy and workforce, continues under the agreement and the Savage River Rehabilitation Project (SRRP). Significant improvements in downstream water quality, since the commencement of the SRRP, over the past two decades, have progressed throughout the river system to areas accessed by the public, providing a positive recreational and social outcome.

Refer to the EIS (Appendix C) for further details.

5. Referral is required to the Environmental Protection Authority (EPA) Tasmania

Because the proposal is a Level 2B activity under Schedule 2 of the *Environmental Management and Pollution Control Act 1994* (EMPC Act); an Environmental Impact Statement (EIS) accompanies this submission (refer to Appendix C). It will be referred to the EPA for assessment and approval. The EIS demonstrates that the environmental impacts of the proposal are acceptable and that the EPA may approve it under the EMPC Act.

6. Planning Assessment

6.1 Planning Scheme

The applicable planning scheme is the *Tasmanian Planning Scheme – West Coast Local Provisions Schedule* (the 'Planning Scheme').

6.2 Heritage Matters

As the proposed development is not located in a place listed in the Tasmanian Heritage Register, the *Historic Cultural Heritage Act 1995* does not apply.

As there are no Places of Archaeological Potential listed under the planning scheme, Aboriginal Cultural Heritage is not a consideration for this planning permit application. This matter is dealt with separately under the *Aboriginal Heritage Act 1975*. Please note that the Environmental Impact Assessment includes an Aboriginal Heritage Assessment.

6.3 Planning Exemptions

Use or development listed in Tables 4.1 – 4.6 (of the Planning Scheme) is exempt from requiring a permit provided it meets the corresponding requirements (as per clause 4.0.1). Proposed works have been classed as "internal building and works", "maintenance and repair" and "minor alterations" to existing buildings which are all exempt under Table 4.3.

6.4 Planning zone(s)

The project site is zoned Rural, Environmental Management and Utilities. Surrounding land uses include Rural to the west and Environmental Management to the north, south and east. The North Pit is entirely within the Rural zone as shown in Figure 4.

6.5 Land use

Under the planning scheme, the proposed land use is Extractive Industry, which means:

> *use of land for extracting or removing material from the ground, other than Resource Development, and includes the treatment or processing of those materials by crushing, grinding, milling or screening on, or adjoining the land from which it is extracted. Examples include mining, quarrying, and sand mining.*

The Use Class is Extractive Industry and as North Pit sits within the Rural zone, the use is permitted.

6.6 Planning Overlay(s)

The proposed development is located in the following overlays:

- Waterway and Coastal Protection Area (see Figure 5)
- Priority Vegetation Area (See Figure 6)
- Bushfire-Prone Areas (See Figure 7)
- Landslip Hazard Areas (See Figure 8)

Figure 4: Planning Zones

Grange Resources (Tasmania) Pty Ltd

Tasmanian Planning Scheme Code Overlay - Waterway and Coastal Protection Areas

pitt&sherry

N

0 0.2 0.4 0.8 km

Coordinate System: GDA 1994 MGA Zone 55

1:20,000 When Printed at A4

MAP REF	P.23.0059
AUTHOR	JB
REVISION	RevA
DATE	28/02/2024

DATA SOURCES Base data and map from The LIST Tasmanian Government
Project specific data

Legend

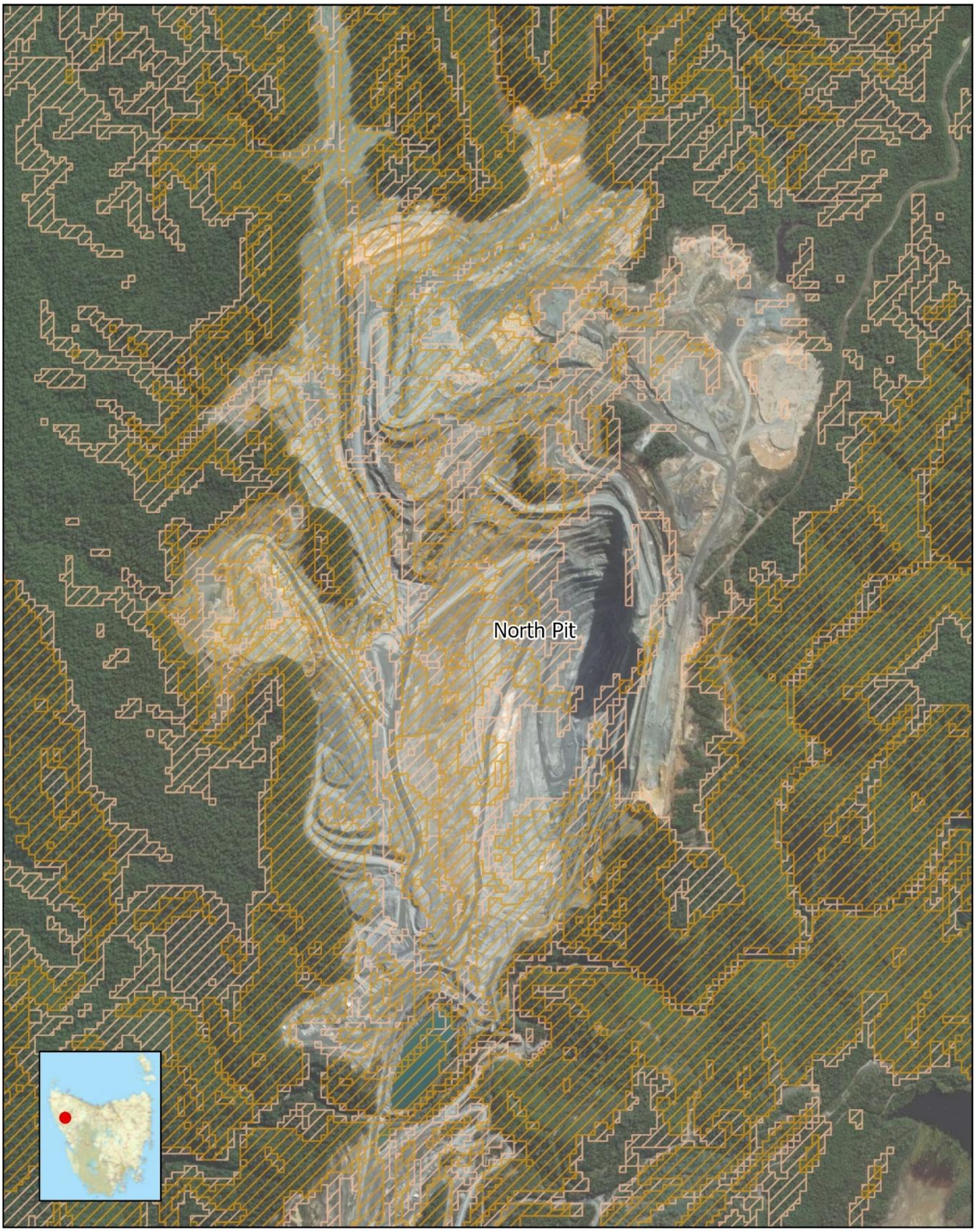
Tasmanian Planning Scheme Code Overlay

Waterway and coastal protection area

Figure 5: Waterway and Coastal Protection Area

Figure 6: Priority Vegetation Area

Figure 7: Bushfire Prone Area



Grange Resources (Tasmania) Pty Ltd

Tasmanian Planning Scheme Code Overlay - Landslip Hazard

pitt&sherry

N

0 0.2 0.4 0.8 km

Coordinate System: GDA 1994 MGA Zone 55

1:20,000 When Printed at A4

MAP REF	P.23.0059
AUTHOR	JB
REVISION	RevA
DATE	28/02/2024

DATA SOURCES Base data and map from The LIST Tasmanian Government
Project specific data

Legend

Tasmanian Planning Scheme Code Overlay

- Low landslip hazard band
- Medium landslip hazard band

Figure 8: Landslip Hazard Area

6.7 Planning Codes

The table below demonstrates which planning scheme codes apply to the proposed development.

Code	Comment
C1.0 Signs Code	Not applicable – no signage proposed which is assessable.
C2.0 Parking and Sustainable Transport Code	Not applicable – the use is existing, and the development will not modify the parking requirements nor are any parking or access ways being modified or created.
C3.0 Road and Railway Assets Code	**Applicable** as there are no exemptions from this Code (see subsection 6.10 below).
C4.0 Electricity and Transmission Infrastructure Protection Code	Not Applicable.
C5.0 Telecommunications Code	Not applicable.
C6.0 Local Historic Heritage Code	Not applicable.
C7.0 Natural Assets Code	Exempt - under Clause C7.4.1 (b) the proposed activity is assessed as a Level 2 Activity.
C8.0 Scenic Protection Code	Not applicable.
C9.0 Attenuation Code	Exempt - under Clause C9.4.1 (a) the proposed activity is assessed as a Level 2 Activity.
C10.0 Coastal Erosion Hazard Code	Not applicable.
C11.0 Coastal Inundation Hazard Code	Not applicable.
C12.0 Flood-Prone Area Hazards Code	Not applicable.
C13.0 Bushfire-Prone Areas Code	Not applicable – the proposal is exempt under Clause C13.2.1, as it does not include subdivision, and is not categorised as a vulnerable or hazardous use.
C14.0 Potentially Contaminated Land Code	Not applicable – see section 4.4 and the EIS (Appendix C) for further details.
C15.0 Landslip Hazard Code	Exempt - under Clause C15.4.1 (b) because the proposed use is not a hazardous use and the proposal is for an Extractive Industry where a mining lease under the *Mineral Resources Development Act 1995* is in force.
C16.0 Safeguarding of Airports Code	Not applicable.

6.8 Requirement for a Planning Permit

The proposal requires a planning permit for the following reasons:

- The Use is Permitted
- the proposal relies on an assessment against the provisions within Code(s); and
- the proposal relies on compliance with various performance criteria, as demonstrated in the subsections below.

6.9 Rural Zone [20.0]

The planning assessment below demonstrates that the proposed use and development is able to comply with the requirements of this zone.

6.9.1 Zone Purpose

The assessment below demonstrates that the proposal is consistent with the purpose of the zone.

Purpose	Assessment
20.1.1 To provide for a range of use or development in a rural location: (a) where agricultural use is limited or marginal due to topographical, environmental or other site or regional characteristics; (b) that requires a rural location for operational reasons; (c) is compatible with agricultural use if occurring on agricultural land; (d) minimises adverse impacts on surrounding uses.	As the proposed use and development is ancillary to the existing Extractive Industry use, the proposal is consistent with 20.1.1.
20.1.2 To minimise conversion of agricultural land for non-agricultural use	As the land is not classified as being agricultural land and is not being used for agricultural purposes, the proposal is consistent with 20.1.2.
20.1.3 To ensure that use or development is of a scale and intensity that is appropriate for a rural location and does not compromise the function of surrounding settlements.	As the proposed use and development are ancillary to the existing Extractive Industry use and does not in any way alter the distance of existing and approved operations from the nearest part of the camp settlement, the proposal is consistent with 20.1.3.

6.9.2 Use Standards

The following standards do not apply:

- 23.3.1 Discretionary use (as the proposed Extractive Industry use is a Permitted use).

There are no other use standards.

6.9.3 Development Standards

The following standards do not apply:

- 20.4.1 Building height (the proposal does not include buildings)
- 20.4.2 Setbacks (the proposal does not include buildings)
- 20.4.3 Access for new dwellings (the proposal does not include dwellings); and
- 20.5 Development Standards for Subdivision (the proposal does not include subdivision).

There are no other development standards

6.10 Road and Railway Assets Code C3.0

6.10.1 Zone Purpose

The planning assessment below demonstrates that the proposal complies with the applicable standards. As it complies with these standards, it can reasonably be considered to be consistent with the purpose of the code, which is:

- C3.1.1 To protect the safety and efficiency of the road and railway networks; and
- C3.1.2 To reduce conflicts between sensitive uses and major roads and the rail network.

6.10.2 Use Standards

The following use standard(s) apply:

C3.5.1 Traffic generation at a vehicle crossing, level crossing or new junction	
Objective: To minimise any adverse effects on the safety and efficiency of the road or rail network from vehicular traffic generated from the site at an existing or new vehicle crossing or level crossing or new junction.	
Acceptable Solutions	**Performance Criteria**
A1 A1.1 For a category 1 road or a limited access road, vehicular traffic to and from the site will not require: (a) a new junction; (b) a new vehicle crossing; or (c) a new level crossing. A1.2 For a road, excluding a category 1 road or a limited access road, written consent for a new junction, vehicle crossing, or level crossing to serve the use and development has been issued by the road authority. A1.3 For the rail network, written consent for a new private level crossing to serve the use and development has been issued by the rail authority. A1.4 Vehicular traffic to and from the site, using an existing vehicle crossing or private level crossing, will not increase by more than: (a) the amounts in Table C3.1; or (b) allowed by a licence issued under Part IVA of the Roads and Jetties Act 1935 in respect to a limited access road. A1.5 Vehicular traffic must be able to enter and leave a major road in a forward direction.	P1 Vehicular traffic to and from the site must minimise any adverse effects on the safety of a junction, vehicle crossing or level crossing or safety or efficiency of the road or rail network, having regard to: (a) any increase in traffic caused by the use; (b) the nature of the traffic generated by the use; (c) the nature of the road; (d) the speed limit and traffic flow of the road; (e) any alternative access to a road; (f) the need for the use; (g) any traffic impact assessment; and (h) any advice received from the rail or road authority.

Assessment

The proposal complies with Acceptable Solution **A1.1**, **A1.2**, **A1.3** and **A1.5** and satisfies Performance Criteria **P1** in place of A1.4

This Code is applicable as there will be an initial increase in light and heavy vehicle movements as part of the development of NPUG, with vehicle numbers reducing once NPUG is operational. It is anticipated that there will be an increase of 66 additional light vehicles per shift change on Waratah Road, currently, the site roster is 7:7. Increases in heavy vehicles are considered minimal with a single additional semi-trailer per day during the development and a maximum of 16 semi-trailer loads per year to transport plant and equipment to the site during development. Survey data from May 2021 indicates a total of 257 vehicle movements per day on Waratah Road, with 12.8% of this traffic-heavy vehicle.

The proposed change complies with Acceptable Solutions as follows:

A1.1 Corinna Road/ Waratah Road in the vicinity of the site is not a Category 1 or limited access road.

A1.2 No new junctions are proposed as part of the proposed change.

A1.3 There is no rail network in the vicinity of the site.

A1.5 All vehicular traffic can enter and leave the site in a forward direction.

As the proposed change is unable to comply with Acceptable Solution **A1.4**, it has been assessed again Performance Criteria **P1**.

To assist with this performance-based assessment a Traffic Impact Assessment (TIA) has been prepared.

a) The traffic increase from the proposed development is not anticipated to result in a detrimental impact on the safety or function of the road network

b) The proposed development is expected to generate vehicle types that are currently catered for on the road network

c) All roads in the vicinity of the site have spare capacity to accommodate the expected generation of the proposed development

d) It was observed during the site visit that traffic flows well along the surrounding road network

e) There are no alternative accesses to the road

f) The proposed development will allow the site to commence underground mining

g) This Traffic Impact Statement has been prepared for the proposed change and identifies that the proposed change is not expected to have any negative impact on the safety and operation of the road network; and

h) The Department of State Growth owns and maintains the local road network in the vicinity of the site. State Growth has provided written advice that a Traffic Impact Statement addressing the impact of the proposed change on the surrounding road network be undertaken. This Traffic Impact Statement has been prepared for the proposed change and identifies that the proposed change is not expected to have any negative impact on the safety and operation of the road network.

6.10.3 Development Standards for Subdivision

The following development standard(s) do not apply:

- C3.6.1 Habitable buildings for sensitive uses within a road or railway attenuation area (no habitable buildings for a sensitive use proposed); and
- C3.7.1 Subdivision for sensitive uses within a road or railway attenuation area (no subdivision is proposed).

There are no other development standards.

7. Conclusion

The proposal has been considered against the applicable development standards and the proposal generates the following discretions under the *Tasmanian Planning Scheme – West Coast Local Provision Schedule*:

- C3.5.1 Traffic generation at a vehicle crossing, level crossing or new junction.

As the proposal complies or can be conditioned to comply, with the applicable provisions of the planning scheme, the permit application should be approved.

Site Plan

Appendix A Site Plan

pitt&sherry

Traffic Impact Assessment

Appendix B

pitt&sherry

Environmental Impact Assessment

Appendix C

pitt&sherry

Report to support a planning permit application.

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Hobart
Launceston
Newcastle
Devonport

Savage River Mine: North Pit Underground Operations

Environmental Impact Statement

Prepared for
Grange Resources

Client representative
Ben Maynard

Date
15 March 2024

Rev04

Table of Contents

List of figures

List of tables

Appendices

Prepared by — Tonia Robinson	[signature]	**Date – 15th** March 2024
Reviewed by — Cath Ford	[signature]	**Date – 15th** March 2024
Authorised by — Delia Sidea	[signature]	**Date – 15th** March 2024

Revision History					
Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
A	Draft EIS for Grange Resources	TR	DL	DL	15/08/2023
B	Draft EIS for Grange Resources	TR	DL	DL	11/09/2023
C	Draft EIS to Grange Resources	TR	DL	DL	21/09/2023
00	EIS to Grange Resources	TR	DL	DL	04/10/2023
01	EIS to EPA for review	TR	DL	DL	10/10/2023
02	EIS to Council as part of DA submission	TR	CF	DS	29/02/2024
03	EIS to EPA	TR	CF	DS	5/03/2024
04	EIS to EPA	TR	CF	DS	15/03/2024

List of Abbreviations

AADT	Annual Average Daily Traffic
ABS	Australian Bureau of Statistics
AHT	Aboriginal Heritage Tasmania
AMD	Acid Mine Drainage
ANC	Acid Neutralising Capacity
ANCOLD	Australian National Committee on Large Dams
BC	Block Cave
BCFT	Broderick Creek Flow Through
BFMP	Bush-Fire Management Plan
Board	Board of the EPA
DCCEEW	Commonwealth Department of Climate Change Energy, Environment and Water
DFS	Definitive Feasibility Study
DRP	Decommissioning and Rehabilitation Plan
DTR	David Tube Recovery
EC	Electrical Conductivity
ETD	Emergency Tailings Dam
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EL	Exploration License
EMP	Grange Resources (Tasmania) Pty Ltd, 2022, *Environmental Management Plan 2022-2024, Savage River and Port Latta*
EMPCA	Tasmanian *Environmental Management and Pollution Control Act 1994*
EPA	Environment Protection Authority Tasmania
EPBCA	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPN	Environmental Protection Notice
ESCP	Erosion and Sediment Control Plan
FAR	Fresh Air Rise
Grange	Grange Resources (Tasmania) Pty Ltd
HRT	Hydraulic Retention Time
ISO	International Organisation for Standardisation
Km/hr	Kilometre per hour

L/s	Litres per Second
LGA	Local Government Area
LOM	Life of Mine
LUPAA	Tasmanian *Land Use Planning and Approvals Act 1993*
MCTD	Main Creek Tailings Dam
m	Metre
mm	Millimetre
ML	Mineral Lease
MLA	Mineral Lease Application
MPA	Maximum Potential Acidity
mRL	Metres Reduced Level
MRT	Mineral Resources Tasmania
NAF	Non-Acid Forming
NAGpH	pH of Net Acid Generation liquor
NAPP	Net Acid Producing Potential
NBES	North Barker Ecosystem Services Pty Ltd
NCA	Tasmanian *Nature Conservation Act 2002*
NDD	North Dump Drain
NPUG	North Pit Underground
NRE	Department of Natural Resources and Environment Tasmania
PAF	Potentially Acid Forming
PCE	Permit Conditions Environmental
PSGs	Project Specific Guidelines
ROM	Run Of Mine
RPMS	Resource Management and Planning System
SDTSF	South Deposit Tailings Storage Facility
SEMS	Safety Environmental Management System
SLC	Sub Level Cave
TSF	Tailing Storage Facility
TSPA	Tasmanian *Threatened Species Protection Act 1995*
WWC	Waratah-Wynyard Council
WRMP	Waste Rock Management Plan
WWDS	Western Wall Dewatering System

Executive summary

Grange Resources (Tasmania) Pty Ltd (Grange) operates the Savage River iron ore (magnetite) mine 100 km southwest of Burnie, located in northwest Tasmania. The mine commenced operations in 1967, extracting magnetite from multiple open pits. The mine includes several pits, working deposits, water treatment body, tailings dam and storage, rock dumps and process facilities. Magnetite concentrate is pumped via an 85 km pipeline to a pelletising plant at Port Latta, west of Burnie, for processing and transport to international and Australian markets via bulk cargo vessel.

Grange is proposing to commence underground mining below the Savage River Mine's North Pit. The North Pit Underground (NPUG) will proceed as a Sub Level Cave (SLC) Transition mine prior to, or possibly at the same time as, Block Cave (BC) mining. As the NPUG operation develops, it may eventuate that surface operations, that being extraction of ore from the open pits, will eventually cease operating.

A Notice of Intent was submitted to the Environmental Protection Authority (EPA) on 2 March 2020. Grange was advised that the activity will be assessed by the EPA Board as a Class 2B assessment under the *Environmental Management and Pollution Control Act 1994* (EMPCA). To commence the commercial operation, Grange is required to attain a new planning permit from Waratah-Wynyard Council (WWC). Project Specific Guidelines (PSGs) for the proposed activity were issued by the EPA on 24 April 2020 and the key issues to be addressed in this Environmental Impact Statement (EIS) include waste rock and tailings management, as well as impacts from underground operation dewatering and onsite water management.

The Class 2B assessment process involves the preparation and submission of a Development Application (DA) and an associated EIS (this document) to WWC, and the subsequent referral of that documentation to the EPA for assessment. As part of the assessment process, the DA and EIS are subject to a public notification period of 28 days. During this time, the EPA and WWC may receive and consider public representations.

The proposed underground operations at North Pit will proceed as a combination of the Transition mine which will likely be developed using SLC mining methods and the BC mine. The Transition mine is designed to recover the ore left in the walls of the remaining pit shell. The proposed BC design will target a significant proportion of the ore body below the North Pit, increasing mine life and reducing operating cost and securing a long-life operation.

The BC will require the expansion of the North Pit exploration decline as well as underground infrastructure. There will be limited new surface infrastructure required as part of the proposed underground operations, although backfilling of North Pit with waste rock from NPUG is proposed. Upgrades will be required for some surface infrastructure, including compressed air and power and maintenance workshop. Upgrades will also be required for underground dewatering.

The philosophy for the proposed underground dewatering system is to effectively capture water on the extraction level or allow it to overflow to lower levels in the case of high intensity rainfall events. In the event of a high intensity rain event, it is expected that controlled flooding of the underground workings would occur. This is considered manageable if water is diverted away from critical infrastructure so that the system can easily recover following a controlled flooding event. The water balance simulations forecast <1% exceedance probability that the available water storage capacity below the Extraction level would be exceeded during the life of the mine.

It is not practical to design the pumping system for peak water inflow rates, therefore underground bulk water storage is included in the mine design. Grange proposes developing a dewatering system capable of achieving 750 L/s with a bulk water storage dam capacity of 95,000 m^3 which will reduce the likelihood of total mine inflows exceeding the storage capacity to less than 10%. There will also be a second 85,000 m^3 void above the primary bulk storage water dam which can act as secondary containment, giving a total storage capacity of approximately 180,000 m^3.

Based on the increased dewatering flow rate and increased storage capacity, the NPUG water balance will be sustainable.

Key components of the current operation that will remain unchanged are as follows:

- Water will be discharged and managed through the existing water treatment systems (South Lens) on site
- Waste rock will be managed in accordance with current management practices and any potentially acid forming material will be encapsulated or placed under water to prevent oxidation
- Waste rock will be disposed of at the existing dumps and/or backfilled into the existing North Pit void
- Tailings will be deposited within the existing tailings dams, specifically the South Deposit Tailings Storage Facility (SDTSF), no new tailings storage will be required; and
- Ore processing and management once ore is brought to the surface will remain the same.

The proposed underground operations will be within the existing footprint of North Pit. Therefore, pre-construction works, such as vegetation clearance and stockpiling will not be required. There will be limited surface construction modifications as part of the underground operations, including:

- Upgrades to the existing maintenance workshop
- Exhaust ventilation fan stations
- Possible relocation of the concrete batch plant, so that it is closer to the NPUG portal; and
- Development of a small access track and associated drainage, which will require approximately 480 m^2 of vegetation clearance.

With the exception of the new access track, these minor changes will be within existing cleared areas.

Existing operations ensure North Pit run-off is directed to the base of the pit prior to being pumped to South Lens for treatment. For the underground operations all run-off will be collected in sumps and pumped to South Lens, with minimal change to water volumes or water quality as a result. The proposed change in water flow from the North Pit open pit to the proposed underground operations is considered to be negligible with all flows captured and directed to South Lens as currently occurs on site.

The water quality results show that the water discharged from the underground of North Pit into South Lens has pH>7.5, elevated alkalinity, low acidity, low dissolved metals, moderate sulphate and high TSS. The alkalinity in the underground water would contribute to the neutralisation of acid drainage entering South Lens, and the TSS would provide surface area for precipitation of metal oxy-hydroxides and promote settlement. The low dissolved metal concentrations would not significantly alter the alkali demand within the pit. This will ensure that there will be no increases in toxicants of concern, such as copper and other metal concentrations, with water quality in South Lens expected to remain within the range presently occurring in the pit.

Current management of water flows at the Savage River Mine will continue to be implemented to ensure that water quality and treatment capacity of South Lens is not affected. This will include, in relation to North Pit operations:

- The current diversion of surface waters surrounding North Pit
- Existing dewatering of North Pit, including the interception of Broderick Creek water
- Proposed dewatering of North Pit Underground to intercept all seeps and flows; and
- On-going water quality monitoring of NPUG.

The key management issue for waste rock at Savage River Mine is the presence of legacy potentially acid forming (PAF) material that has the potential to oxidise and form acid when exposed to air. This acid can be taken up by water moving through the site. The acid alters the chemistry of surface and drainage waters on site which, if untreated, or poorly managed, can have serious ecological consequences if discharged to natural environments. Grange Resources implements a Waste Rock Management Plan (WRMP – November 2021, **Appendix C**) to ensure all waste rock is managed in an appropriate manner to prevent acid formation.

Waste rock management during underground operations of North Pit will continue to be handled in accordance with the WRMP, with procedures followed to ensure appropriate waste rock classification. This will include:

- Defining waste rock material with field and laboratory testing
- Both the drill hole survey and the logged geological data are uploaded into mining software. The boundaries of the ore and different waste types are digitised into three-dimensional coordinates from the plan. Based on the logging data, the waste areas are subdivided into the different waste categories, i.e. 'A', 'B', 'C' or 'D' type. The digitised data is used to identify the boundaries of the mining blocks; and
- Any waste rock material that is uncertain will be treated as PAF and managed accordingly.

Tailings produced from the processing of ore will be deposited into South Deposit Tailings Storage Facility (SDTSF). There is adequate capacity in the approved tailings storage facilities to contain the tailings produced from ore processing. Current tailings placement is sub-aerial with recovering of tailings as required to ensure continuing saturation. All tailings will be managed in accordance with current site practice.

Current operating procedures relating to other environmental issues at Savage River, including air and noise emissions, biodiversity management, dangerous goods and waste management will continue to be implemented in accordance with the approved Environmental Management Plan[1]. All site operations will be managed in accordance with Grange's Safety Environmental Management System (SEMS).

The mine operates under the *Goldamere Pty Ltd (Agreement) Act 1996* (refer section 1.10) which provides that the works on site be undertaken in accordance with best practice environmental management. This EIS details the measures to be undertaken to ensure the best ecological, social and economic outcomes are achieved using best accepted practice. Many of the management actions proposed are currently implemented on site in accordance with existing licenses and requirements.

[1] Grange Resources (Tasmania) Pty Ltd, 2022, *Environmental Management Plan 2022-2024, Savage River and Port Latta*

1. Introduction

Grange (Tasmania) Pty Ltd (Grange) operates the Savage River iron ore (magnetite) mine 100 km southwest of Burnie, located in northwest Tasmania. The mine commenced operations in 1967, extracting magnetite from a series of open pits. The mine includes several pits, working deposits, water treatment body, tailings dam and storage, rock dump and process facilities. Magnetite concentrate is pumped via an 85 km pipeline to a pelletising plant at Port Latta, west of Burnie for processing and transport to international and Australian markets via bulk cargo vessel.

Grange is proposing to commence underground development at the eastern edge of the Savage River Mine's North Pit – North Pit Underground Mine (NPUG). The NPUG will proceed as a Transition mine sub level cave (SLC) prior to, or possibly at the same time as, Block Cave (BC) mining below the pit.

Current mining operations comprises two active open pits, North Pit and Centre Pit, which are elongated and orientated north-south. The Savage River runs between Centre Pit and North Pit. North Pit is approximately 360 m in depth with future cutbacks and extensions having the potential to deepen it to approximately 600 m below the natural land surface. North Pit is the primary ore source and it is expected to complete mining of the current cut back in 2027.

Operation of the pit has been impacted by difficult geotechnical conditions in the past, although this has significantly improved from operations during the most recent cut back stage. With over 55 years of open pit mining the operation continues to face an increasing strip ratio and increasing geotechnical complexity, these have placed rising pressure on costs. As a result, in 2019 the company commissioned a prefeasibility study (PFS) into underground mining below North Pit and a definitive feasibility study (DFS) in 2021. The feasibility studies have identified that transitioning to underground is technically possible and is forecast to lead to a reduction in costs, a reduction in the exposure to PAF rock waste and a reduction in carbon emissions.

An exploration decline was developed from March 2019 to September 2020 and included 2,423 m of development, including development in the ore body, and 11,341 m of resource drilling. The decline portal is located in the south-east corner of the North Pit with the decline developed in the Eastern Wall of the pit, traversing from the southern end of the resource to the north. The exploration decline was developed to provide drill platforms to complete the required resource and geotechnical drilling for technical studies. The development also provided essential data on the geotechnical conditions of tunnel development in the east wall and through the ore body.

As a result of the PFS, the development of a Transition SLC and BC mine, with a materials handling system of loader transfer to underground crusher and inclined conveyor, was progressed to the Feasibility Study phase.

1.1 Title of the proposal

Savage River Mine: North Pit Underground Operations

1.2 Proponent details

Name of proponent (legal entity)	Grange Resources (Tasmania) Pty Ltd
Name of proponent (trading name)	Grange Tasmania
Registered address of proponent	34a Alexander Street Burnie Tasmania 7320
Postal address of proponent	PO Box 659 Burnie Tasmania 7320
ABN number	30 073 634 581
ACN number (where relevant)	N/A
Contact person's name	Ben Maynard
Telephone	03 6430 0222
Email	environment@grangeresources.com.au
Consultant person's name	Tonia Robinson
Telephone	03 6210 1485
Email	trobinson@pittsh.com.au

1.3 Activity operator details

The proponent will be the operator.

1.4 Proponent's background information

Grange owns and operates an integrated iron ore mining and pellet production business located in the northwest region of Tasmania. The company is Australia's oldest and most experienced magnetite producer, and a proven and reliable commercial producer of magnetite pellets in Australia combining both mining and pellet production expertise.

Open cut magnetite mining has been undertaken at the Savage River Mine site since 1967. This was initially operated by Savage River Mines (SRM) which, between 1990 and 1996, was owned and operated by Pickands Mather & Co. International (PMI) and Cleveland Cliffs. In April 1996, all mining ceased except for disestablishment and rehabilitation. Goldamere Pty Ltd, trading as Australian Bulk Minerals (ABM) and later to become Grange (Tasmania) Pty Ltd, recommenced mining in 1997 with cutbacks to South Lens, North Pit, Centre Pit North and Centre Pit South, and a new pit at South Deposit commencing in 2001.

The Savage River magnetite iron ore mine, 100 km southwest of the city of Burnie, is a long-life mining asset set to continue operation beyond 2038. At Port Latta, 70 kms northwest of Burnie, is Grange's wholly owned pellet plant and port facility producing approximately two million tonnes of premium quality iron ore (hematite) pellets annually with plans to increase annual production in the coming years to 2.9 million tonnes. Grange holds long term supply contracts for one million tonnes of its annual production and offers the balance of its production to market via contract and a spot sales tendering/contracting process. All production is shipped to major steel producers in Australia and internationally.

1.5 Proposal's background

1.5.1 Current status of the proposal

A Notice of Intent was submitted to the Environmental Protection Authority (EPA) on 2 March 2020 and Grange was advised that the activity will be assessed by the EPA Board as a Class 2B assessment under the *Environmental Management and Pollution Control Act 1994* (EMPCA). To commence the commercial operation, Grange is required to attain a new planning permit from Waratah-Wynyard Council (WWC).

Project Specific Guidelines (PSGs) for the proposed activity were issued by the EPA on 24 April 2020 and the key issues to be addressed in this EIS are:

- Waste rock and tailings management; and
- Impacts from underground operation dewatering and onsite water management.

An extension to respond to the PSGs was granted on 8 August 2022, allowing Grange to submit an EIS by December 2023. An additional extension to June 2024 has been requested.

1.5.2 Overview of the principal components of the proposal

The proposed underground operations at North Pit will proceed as a Transition mine which may be developed using sub-level caving (SLC) mining methods and the development of a BC mine. There is a possibility that the Transition and BC mine may start concurrently depending on the completion of the open pit. Refer to section 2.3.1 for further details.

An exploration decline has been developed under and to the east of North Pit (approved under EPN No. 10006/2), refer section 1.7. Drilling has been undertaken from key locations along the decline to define the underground resource and optimise the mining method. Grange ultimately plans to extract the underground resource through BC mining.

There will be limited new surface infrastructure required as part of the proposed underground operations, with the exception of exhaust ventilation fan stations, potential relocation of the concrete batch plant, a new access track and associated drainage and a new rock waste dump created by backfilling the North Pit void. Upgrades will be required for some surface infrastructure, including compressed air and power, and upgrades at the maintenance workshop. Upgrades will also be required for underground dewatering. These upgrades will be within existing areas of site, with the exception of the access track, refer Figure 12. Refer section 2.3.4 for further details.

Key components of the current operation that will remain unchanged are as follows:

- Water will continue to be processed through the existing water treatment systems (South Lens and SDTSF) on site
- Water discharge points to the receiving environment and key monitoring points will be unchanged
- Waste rock will be managed in accordance with current management practices and any potentially acid forming material will be encapsulated or placed under water to prevent oxidation
- Waste rock will be disposed of at the existing dumps and/or backfilled into the existing North Pit void; and
- Tailings will be deposited within the existing tailings dams and storage facility.

1.5.3 The proposal location

Savage River Mine is located in north-west Tasmania (latitude 41°29'25"S, longitude 145°12'03"E), adjacent to Corinna Road, 45 km west of the Murchison Highway. The locality of Savage River with the footprint of the proposed activity is shown in Figure 1. The nearest localities are Corinna, 24 km to the southwest and Waratah, 38 km to the northeast. The proposed NPUG operation is within the existing Savage River Mining Leases. Refer to Figure 11.

1.5.4 Anticipated establishment costs

Construction works will be required prior to the commencement of underground mining, with some new minor infrastructure requiring installation to facilitate transition from open pit to underground operations. Pre-production costs for the project are estimated at $450 million.

1.5.5 Likely markets for the product

The product will continue to be shipped to existing markets.

1.5.6 Possibilities for future expansion

Depending on the success of the Transition and the BC mining, further expansion may be undertaken in the future. Any further expansion would not proceed without the appropriate approvals.

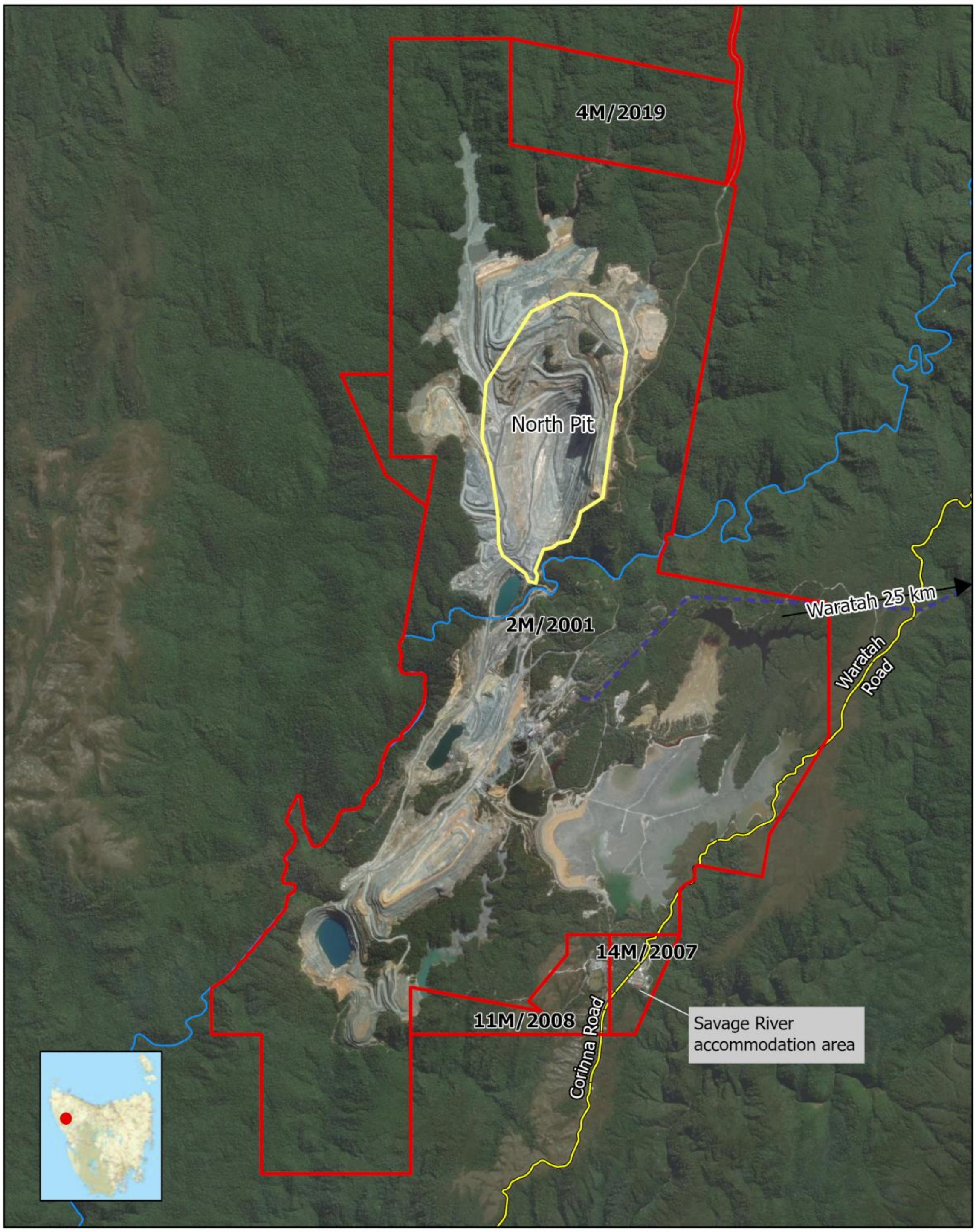
1.6 Relationship to any other proposals

The site is remote and there are no known projects on other operating sites within proximity. The existing facility at Port Latta will continue to be used for pelletising and export and is not altered by this proposed activity.

1.7 North pit exploration decline

Approval for the exploration decline in North Pit was provided in January 2020 by the EPA (Environment Protection Notice [EPN] No. 10006/2). Initially, this provided approval for the construction of a portal and the development of a 1,780 m decline. An extension to the decline of approximately 1,700 m to the south, as well as the installation of the northern and southern ventilation raises were subsequently approved.

Currently the site has completed 2,423 m of underground exploration. Refer to Figure 5, which illustrates the existing development decline, in grey.



Grange Resources (Tasmania) Pty Ltd

General Site Location

pitt&sherry

N

0 0.5 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

1:50,000 When Printed at A4

MAP REF P.23.0059
AUTHOR JB
REVISION RevC
DATE 24/01/2024

DATA SOURCES Base data and map from The LIST Tasmanian Government, Minerals Resources Tasmania

Legend

Mining lease
North Pit
Savage River
Road access
Transmission line

Figure 1 – Site location

1.9 Applicable environmental legislation, standards and guidelines

1.9.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth Government's EPBC Act, the proponent must determine whether the project requires referral to the Commonwealth Department of Climate Change, Energy, Environment and Water (DCCEEW) for a decision as to whether it is a 'controlled action'. An action will require approval from the Minister if the action has, will have, or is likely to have a significant impact on Matters of National Environmental Significance (MNES), which encompass all species and communities listed under the EPBC Act, certain activities and places of national importance. A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity.

The proposed activity does not increase the area of the existing mine disturbance and is unlikely to have significant impacts to species listed under the EPBC Act and therefore approval under the EPBC Act is not required.

1.9.2 State legislation

Tasmanian Resource Management and Planning System

All environmental and land management legislation in Tasmania is underpinned by the Resource Management and Planning System (RPMS). This was introduced in 1993 and provides the following common objectives which are included as a schedule in each relevant act:

- To promote the sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity
- To provide for the fair, orderly and sustainable use and development of air, land and water
- To encourage public involvement in resource management and planning
- To facilitate economic development in accordance with the objectives set out in the above paragraphs; and
- To promote the sharing of responsibility for resource management and planning between the different spheres of government, the community and industry in the state.

***Environmental Management and Pollution Control Act 1994* (EMPCA)**

This Act establishes the processes for assessment of activities considered to have the potential to cause environmental harm. It also relates to the management of pollution and remediation. Schedule 2 of EMPCA lists those activities (Level 2 activities), and any relevant production or process thresholds, which are required to be referred to the EPA for a decision as to whether the application requires assessment by the Board of the EPA.

The proposed activity is a Level 2 activity as described under Schedule 2 of the EMPCA, falling in to item 5 Extractive industries, which includes (c) Mines: the extraction of any minerals producing 1,000 tonnes or more of minerals per year. This EIS presents the information requested by the EPA to allow assessment of potential impacts of the proposal.

Goldamere Pty Ltd (Agreement) Act 1996

The Goldamere Agreement was created in 1996 and indemnifies the owners of the mine (from that date onward) against responsibility for legacy pollution which occurred in the Savage River as a result of mining from the 1960's to the 1990's.

This Act provides that EMPCA, the *Land Use Planning and Approvals Act 1993 (LUPAA)*, the *Resource Management and Planning Appeal Tribunal Act 1993* and any other environmental legislation is to be applied to the site, however, the operators (now Grange) are not responsible, and is not to be held responsible, for any contamination, pollutant or pollution which resulted from previous operations. The Agreement states:

> *(c) a term, condition or restriction imposed in any Authorisation given to ABM (now Grange) in relation to the Project must not require ABM to meet measurable environmental standards in respect of water quality, soil contamination or any other criterion which may be affected by contamination or pollution caused or introduced to the Leased Land before the commencement of the Agreement, but should impose management requirements which are based on the principles in paragraph (a) , Best Practice Environmental Management and the principles in clause 5 of the Agreement .*

Best Practice Environmental Management is defined in EMPCA as “management of the activity to achieve an ongoing minimization of the activity's environmental harm through cost-effective measures assessed against the current international and national standards applicable to the activity”. Accordingly, some typically set parameters and legislative requirements are not applicable to this proposed activity.

Mineral Resources Development Act 1995

Mining leases are administered through the *Minerals Resources Development Act 1995*. Grange currently holds the following leases for mining operations at Savage River:

- ML 2M/2001 (2001) - Amalgamated lease of ML 11M/1997 to which the Goldamere Agreement applies and ML 7M/2000
- ML 14M/2007 (2007) – an extension to the mining lease to cover the township and Broderick Creek dump areas
- ML 11M/2008 (2008) – an extension covering the South Deposit tailings storage facility (SDTSF); and
- ML 4M/2019 (2019) – an extension for the Broderick Creek catchment.

No new leases are required, and all works will occur within existing lease areas.

Water Management Act 1999

This Act deals with licencing the taking of water from watercourses and wells, management of water districts and dam approvals. Large dams require consideration of the Australian National Committee on Large Dams (ANCOLD) guidelines and possibly registration. No new dams are proposed under the proposed activity.

State Policy and Projects Act 1993

This is the Act under which Tasmanian state policies are made and the National Environmental Protection Measures (NEPMs) are given effect (recognised as state policies). Only one state policy given effect under this act is relevant, the State Policy on Water Quality Management 1997 (discussed below).

Threatened Species Protection Act 1995

This Act is designed to provide for the protection and management of threatened native flora and fauna and to enable and promote the conservation of native flora and fauna. Natural values assessments have been previously undertaken by North Barker Ecosystem Services (NBES) which address the implications of this act.

Nature Conservation Act 2002

This Act makes provision with respect to the conservation and protection of the fauna, flora and geological diversity of the State, to provide for the declaration of national parks and other reserved land and for related purposes. Natural values assessments have been previously undertaken by NBES which address the implications of this act.

Workplace Health and Safety Act 2012, Workplace Health and Safety Regulations 2022, Mines Work Health and Safety (Supplementary Requirements) Act 2012 and Mines Work Health and Safety (Supplementary Requirements) Regulations 2012

This legislation provides for a balanced and consistent framework to secure the health and safety of workers and mining workplaces in Tasmania. Workers and other persons should be given the highest level of protection against harm to their health, safety and welfare from hazards and risks arising from work or from specified types of substances or plant as is reasonably practicable. Grange will operate the Project in accordance with our established environmental, health and safety systems and procedures (SEMS), ISO aligned systems that cover the reference legislation for mining in Tasmania.

Land Use Planning and Approvals Act 1993

Under LUPAA, Councils are required to administer the development and use of land within their municipal boundary. The relevant local planning authority is Waratah-Wynyard Council, and a planning permit application will be lodged for this project. There are no further obligations under this Act.

1.10 Other relevant policies, strategies and management plans

Savage River Rehabilitation Project and SRRP Strategic Plan 2020-2023

The Goldamere Agreement established the legal foundation for the SRRP funding arrangements and the formation of a joint management committee. The SRRP commenced in 1997 when Australian Bulk Minerals (ABM) acquired the Savage River and Port Latta sites and aims to achieve ongoing remediation on a co-operative basis. Grange has continued this relationship since merging with ABM in 2009.

State Policy on Water Quality Management 1997

The policy allows for the establishment of water quality objectives; however, these are largely over-ridden in this instance by the effect of the Goldamere Agreement. The objectives of this state policy are to:

a. Focus water quality management on the achievement of water quality objectives which will maintain or enhance water quality and further the objectives of Tasmania's Resource Management and Planning System
b. Ensure that diffuse source and point source pollution does not prejudice the achievement of water quality objectives and that pollutants discharged to waterways are reduced as far as is reasonable and practical using best practice environmental management
c. Ensure that efficient and effective water quality monitoring programs are carried out and that the responsibility for monitoring is shared by those who use and benefit from the resource, including polluters, who should bear an appropriate share of the costs arising from their activities, water resource managers and the community
d. Facilitate and promote integrated catchment management through the achievement of objectives (a) to (c) above; and
e. Apply the precautionary principle.

Clause 37 of the state policy relating to Acid drainage from mines, contains provisions requiring that actions to reduce the emission or environmental effects of acid drainage should be included in proposals for mine rework. The current proposal is consistent with that requirement in that systems and processes are established on site to manage and reduce the acidic qualities of discharges from the site.

It should be noted that the Goldamere Agreement prescribes that no limits will be imposed if there is input from operations pre-dating the Agreement. This applies to Broderick Creek, South Lens, Main Creek and Savage River.

Environment Protection Policy (Air Quality) 2004

This policy provides a framework for the management and regulation of point and diffuse sources of emissions to air for pollutants with the potential to cause environmental harm. Assessment of potential air quality impacts, proposed management and mitigation measures for the Project are included in section 5.4.

Environment Protection Policy (Noise) 2009

This policy sets a strategic framework for noise management by focussing on objectives and principles for noise control, with human health as a value to be protected. It does not include implementation measures, which are dealt with through other instruments such as regulations and planning schemes. Assessment of potential noise impacts, proposed management and mitigation measures for the Project are included in section 5.5.

2. Proposal description

The main characteristics of the proposed activity are summarised in the table below. A detailed description is provided in section 2.3.

2.1 Summary table

Location and Planning Context

Item	Detail
Location	Savage River Mine is located in northwest Tasmania, 45 km west of the Murchison Highway. The nearest localities are Corinna, 24 km to the south-west and Waratah, 38 km to the north-east. The proposed NPUG operation is located within the existing Savage River Mine footprint, Figure 11.
Land zoning	Under the Tasmanian Planning Scheme – Waratah-Wynyard (Planning Scheme): • The project site is zoned 'Rural', 'Environmental Management' and 'Utilities'; and • North Pit sits within the Rural zone. Refer Figure 13.
Land tenure	The land tenure of the project site includes: • Permanent Timber Production Zone Land • Future Potential Production Forest (Crown); and • Regional Reserve.
Use Class and Permissibility	The Use Class is Extractive Industry. As North Pit sits within the Rural zone, the use is permitted.
Mining lease and area	• ML 2M/2001 – 4987 ha • ML 14M/2007 – 91 ha • ML 11M/2008 – 108 ha; and • ML 4M/2019 – 235 ha.
Bond	Bonds are in place with MRT and the EPA for rehabilitation. NPUG operations rehabilitation requirements are considered insignificant relative to the rehabilitation requirements of the open cut operations.

Existing Site

Item	Detail
Land use	Existing mine site.
Topography	Savage River mine is located at an elevation of between 100 m and 350 m in a valley incising the eastern most extension of the Western Ranges. The area is characterised by erosional and depositional glacial landforms.
Geology	Savage River mine is located within the Arthur Metamorphic Complex and exploits a series of magnetite-rich lenses which extend from north of the Savage River to north of the Pieman River. The Arthur Metamorphic Complex, also known as the Arthur Lineament, is a listed geoconservation site, however there is no geoconservation reserve over this feature. Potentially acid forming (PAF) waste material is currently encountered as a result of the existing operation.
Soils	Soils at the Savage River mine are classified as 'Soils on Precambrian Dolomite' and depending on the parent rock are either 'sandy' or 'clayey'. Sandy soils are developed to depths of about 0.1 m on quartzite, while clay soils are well developed to depths of up to tens of metres. Topsoils are generally thin. Acid sulphate soils and/or contaminated soils are not encountered throughout the existing operation.
Hydrology	The Savage River mine is dissected by the Savage River, which flows between Centre Pit and South Lens (Figure 11). The river at this location is effectively flowing across a man-made 'pillar', elevated above the existing base of Centre Pit and South Lens. The Savage River flows into the Pieman River approximately 16 km upstream from the coast. Two main tributaries of the Savage River flow through the mine site; Broderick Creek which forms part of the Broderick Creek Flow Through and enters the Savage River just downstream of South Lens, and Main Creek, of which the Main Creek Tailing Dam and Old Tailings Dam are located at its headwaters, with South Deposit Tailings Storage Facility located approximately 1 km further downstream. Significant volumes of rainfall run off to the existing open pits. Surface water is currently managed via a combination of diversion of water around the open pit and in pit management of water inflows. Dewatering of operational pits is always required due to the high rainfall of the area. Inflows are pumped to the South Lens pit for treatment before discharge to the Savage River. Groundwater inflows to the existing pits also occur and are largely because of pseudo-radial groundwater flow through the low permeability basement rocks and fault structures.
Natural values	The proposed development is within previously disturbed areas of the mine. No threatened vegetation communities listed under the Tasmanian *Nature Conservation Act 2002* (NCA) or the Commonwealths EPBCA were identified within the proposed expansion area. No threatened flora species listed under either the Tasmanian *Threatened Species Protection Act 1995* (TSPA) or the Commonwealth EPBCA were recorded within the area. There will be no direct impact to threatened fauna species listed under the TSPA or the EPBCA, although threatened fauna species may occur or have habitat within the mining lease, refer section 5.8.1.

Local Region

Item	Detail
Climate	Mean annual rainfall for Savage River Mine is 1,947 mm. Average monthly rainfall is highest during late autumn and early spring. July, the coldest month, has a mean daily temperature of 9.4 °C and February, the warmest month, has a mean daily temperature of 20.1 °C. Predominant wind direction for Waratah (Mount Read weather station, 26.6 km away) is: • 9 am: South-west; and • 3 pm: South-west.
Surrounding land zoning, tenure and uses	The northern and north-western boundaries of the lease border Savage River Pipeline Regional Reserve. Refer Figure 14. The south-western boundary of the lease borders the Donaldson River Nature Recreation Area. The Meredith Range Regional Reserve borders the mine to the east and south. West of this reserve, and to the south of the mine is an area of Future Potential Production Forest managed by the Parks and Wildlife Service. The North Pit Underground Operation is located approximately 4 km from the privately-owned Savage River accommodation area.
Species, sites or areas of conservation significance	The following listed species are known to occur in the local area: • Spotted-tailed quoll • Tasmanian devil • Wedge-tailed eagle • Australian grayling • Azure kingfisher; and • Tateid snail (*Beddomeia bowryensis* and *B. trochiformis*).

Proposed Infrastructure

Item	Detail
Major equipment	Existing plant/machinery to be utilised includes: • Trucks, loaders and excavators • Primary crushers, grinding, and ball mills and magnetic separators • Concentrator; and • Slurry pipeline. Additional equipment will be required for underground mining operations, including underground crushers, conveyor and underground facilities, refer section 2.3.4.
Other infrastructure	Existing infrastructure to be used includes: • ROM and stockpile areas • South Deposit Tailings Storage Facility (SDTSF) • South Lens water treatment system; and • Waste rock dumps, including Broderick Creek Dump Complex, Centre Pit Dump, South Deposit Backfill Dump.

Item	Detail
	Additional infrastructure will be required for underground mining operations, including ventilation, dewatering and communication systems, refer section 2.3.4. New above ground infrastructure will be limited, although backfilling of the North Pit void is proposed. Refer section 2.3.4.

Inputs

Item	Detail
Water	No additional water input is required.
Energy	Current energy requirements include fuel for extraction vehicles, trucks and processing systems. Increases in electricity will be required as part of the proposed expansion, with a subsequent decrease in diesel use. It is anticipated that electricity usage will increase by an estimated 50% for both Transition and BC mining, however this will be offset by an estimated 90% decrease in diesel use at the site once the BC is in operation.
Other raw materials	No additional raw materials are required.

Wastes and Emissions

Item	Detail
Liquid	Effluent emissions will result from dewatering of the underground operation. Other ongoing mine emissions include waste rock dump run-off and seepage, tailings dam seepage, and stormwater runoff from the ROM pad, roads, stockpile areas and other infrastructure areas. Tailings will continue to be generated as part of operations.
Atmospheric	Dust from excavation, material haulage, blasting and blow-off from stockpiles and disturbed areas.
Solid	Waste rock and other general mining waste (e.g., general refuse, metal waste, waste tyres, machinery servicing waste etc, including controlled waste).
Noise	From excavators, heavy mine vehicles, front end loaders, overland conveyor, processing plant (crushers) and blasting.
Greenhouse gases	Greenhouse gases are anticipated to decrease significantly over the life of the underground operations with the replacement of diesel machinery with electrical equipment.

Construction, Commissioning and Operations

Item	Detail
Proposal timetable	Due to the established nature of the site, there will be on-going operations during the underground development phase. Construction of major underground infrastructure is anticipated to commence immediately following project approval by the EPA and the Grange Board and is expected to be completed by July 2027. The NPUG operations is proposed to be mined over a period of 15 years.
Operating hours (ongoing)	24 hours per day, seven days per week.

Other Key Characteristics

Item	Detail
Other	There will be an initial increase in both light and heavy vehicle movements both on and off-site during the construction period and ramp up phase of underground production. Long term there will be a decrease in traffic movements, both on and off-site, following the commencement of underground production from the BC mine.

2.2 Definition of the Land

The Land falls within the area defined by mining leases, refer Figure 2:

- ML 2M/2001 - 4987 ha
- ML 14M/2007 - 91 ha
- ML 11M/2008 - 108 ha; and
- ML 4M/2019 - 235 ha.

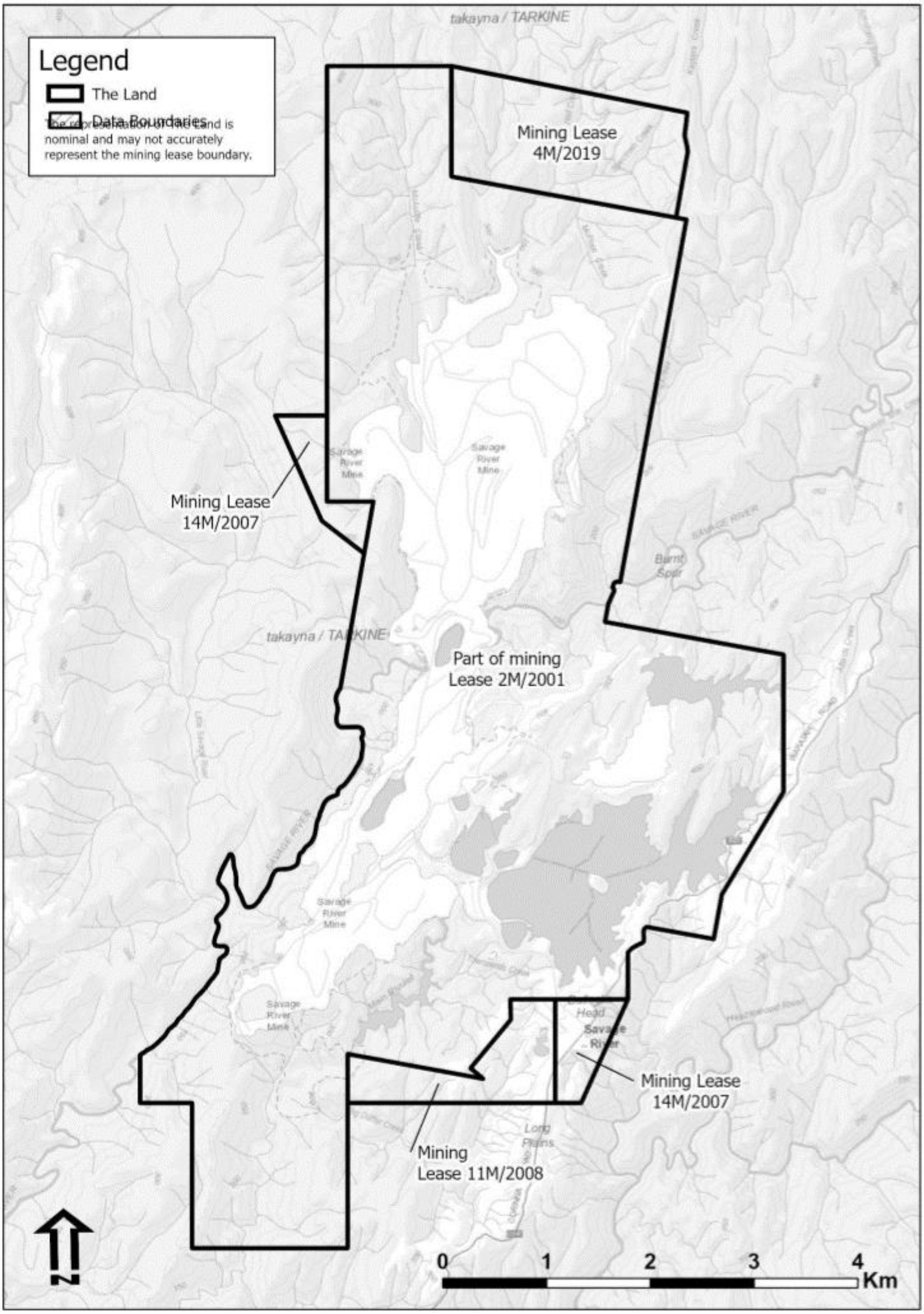


Figure 2 - the Land of the proposed activity

2.3 Detailed description of proposal

2.3.1 Project components

Grange proposes to commence NPUG operations with a Transition mine which is likely to use sub-level caving (SLC) mining methods, and then continue with BC mining. There is a possibility that the Transition mine and BC mine may commence at the same time. Production from the Transition mine will not commence until open cut mining in North Pit has ceased.

At this stage it is proposed that the Transition mine will provide contingency ore during the BC mine ramp up. Current schedules have a range of 38 to 41 months of simultaneous production from both underground mines. This will be further refined in future schedule optimisations as part of the Life of Mine integration planning between the open pit and underground mines.

Production from the Transition mine will stop once the production ramp-up from the BC is achieved. This is currently scheduled at 30 months. However, as a worst case scenario, the Transition mine production could continue for 8 to 11 months beyond this scheduled ramp-up.

The proposed mining operations would continue to operate 24 hours per day, 365 days per year.

Transition Mine

The purpose of the Transition mine is to provide ore during the transition from open pit mining to underground caving. It is likely to be a sub-level cave (SLC) mine designed to recover the ore left in the walls of the open pit shell.

The Transition mine will be developed through one or more progressively deeper levels of multiple parallel drives into the orebody beginning from the northern end of the exploration decline. This is generally known as Sub Level Caving. Once the drives have been excavated and reinforced, a series of blast hole fans will be drilled vertically, or near vertically from the drives and into the overlying rock. Material will then be produced from each of the drives by blasting out cuts of the overlying rock and excavating the resulting broken and caved ore.

In summary, the following aspects of the Transition mine will be analysed to optimise the design for the BC.

- Rock mass behaviour, for the BC design
- Stability of workings through the Eastern Contact Fault and the ore body
- Interaction between the cave and faults
- Brow wear, stability of brow and pillars
- Potential challenges associated with drill and blast in poor ground, which will be used for risk assessments
- Recovery models associated with fragmentation and recovery will be calibrated with production records
- Optimise methods of ore handling, i.e. fines, mud, water, inrush potential etc.; and
- Mine dewatering to understand water inflow and dewatering requirements.

Block Cave

A BC is initiated by undercutting a large section of rock. The rock section collapses under its own weight into the undercut, creating an underground cave filled with rubble. The rubble then flows through a series of preconstructed draw points and tunnels underneath the cave before it is collected by loaders, crushed (for oversize material) and transported to the surface. As the broken rock is removed from the cave, the support the broken rock provided to the top of the cave is also removed. Consequently, the cave progressively collapses upwards as the rock is removed and eventually reaches the surface. The BC design proposed for Savage River mine will target a significant proportion of the ore body and could increase mine life and reduce operating cost, securing a long-life operation.

The BC will require the extension of the North Pit exploration decline as well as underground infrastructure as outlined in section 2.3.4. The total overall development is anticipated to be approximately 54 km.

Mining Waste

The two main waste streams resulting from mining operations are tailings and waste rock.

Tailings

Grange's forecast tailings production, which is based on current operations and projected open pit mining only, equates to approximately 45 Mt between 2024 and 2038. The proposed open cut with transition to underground mine is anticipated to produce approximately 52 Mt of tailings. This volume can be accommodated within the operation's current and projected tailings capacity schedule. Refer to section 5.2.3.

Waste Rock

The current projections of waste rock production from continued open pit mining of Centre Pit and North Pit equate to approximately 201 million BCM (Bank Cubic Metres) between 2024 and 2038. The proposed underground mine will reduce total waste rock production to over the same period to 46 million BCM, an approximate 80% reduction.

Waste rock production is forecast to commence declining from 2025 as open pit activities scale down. Although the site's existing waste rock storage facilities are expected to provide sufficient storage capacity, it is anticipated that some waste rock from NPUG will be managed through backfill dumping directly into North Pit. Refer to section 5.2.2.

Existing ore processing and management once ore is brought to the surface will remain the same, refer section 2.3.2.

Proposed dewatering

The key philosophy for the dewatering system is to effectively capture water on the extraction level or allow it to overflow to lower levels. In the event of a high intensity rain event, it is expected that controlled flooding of the underground workings would occur. This is considered manageable if water is diverted away from critical infrastructure so that the system can easily recover following a controlled flooding event. The design of the extraction drives grades away from critical infrastructure, i.e. crusher stations and lower pump station, with drain holes positioned off the western perimeter drive of the extraction level down to the drainage level. The underground dewatering system is therefore designed to facilitate underground storage as it is not considered practical to design the pumping system for peak water inflows.

The NPUG mine will have dedicated bulk water storage dams of sufficient capacity to store inflow water in a predicted 1 in 100-year flood event. The extraction level and ventilation horizon are graded so that all water reports to these bulk water storage dams. Based on total mine inflows, the probability of total mine inflows exceeding the storage capacity of the bulk water storage dams (i.e., 95,000 m^3) with 750 L/s installed pumping capacity is less than 10% over the life of the project.

During mine development, a staged pumping system will be used to remove mine water. This is through a series of collection sumps with submersible pumps which then transfer water to collection tanks and mono pumps (cavity pumps). The upper pump station and associated dewatering system will be commissioned prior to production commencing at the Transition Mine, and the lower pump station and underground dewatering system will be commissioned prior to production commencing at the BC Mine. Refer to Figure 3. The progression of the dewatering system is expanded below.

Each pump station will consist of three pump trains. During normal operation only one pump train will be in operation with discharge at a flow rate of up to 250 L/s (nominal flow rate is 150 L/s). In a flooding event with all three pump trains running there will be a maximum discharge of 750 L/s. The pumps will operate in a standby arrangement based on water levels in the feed tanks. Refer to Figure 3.

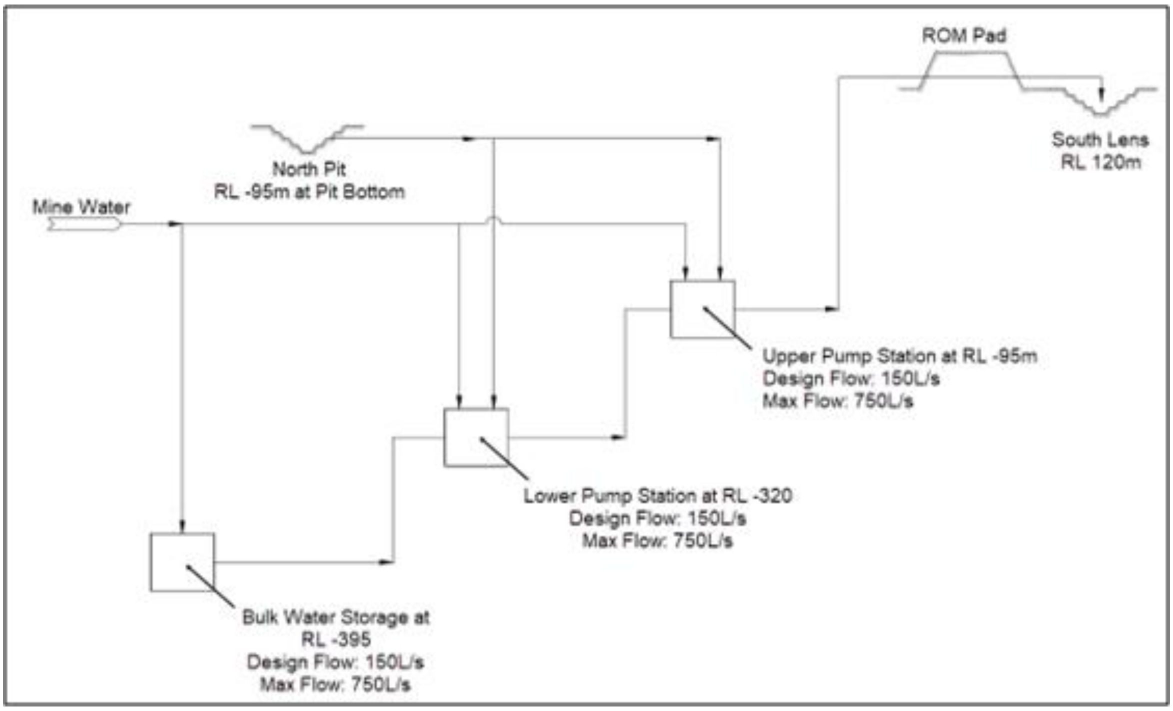


Figure 3 – Dewatering system – general flow diagram

Stage 1 of the dewatering system will continue using the established methodology for the decline development where sumps are developed at 200 m intervals. Water from the decline face will be pumped by submersible pump to the nearest sump and then pumped from sump to sump in series to the surface and then to South Lens. Similarly, sumps will be developed along the conveyor drive at 200 m intervals with water pumped in series to the decline using the staged pumping system. Water at the incline face (development graded up) will report to the drainage ditch in the side of the drive and gravity flow to the nearest sump.

Stage 2 will include commissioning of the Upper Pump Station, refer Figure 3. The mine water will report to the Upper Pump Station, following its commissioning, and discharge to a temporary 400 mm line up the decline and to the surface. This line will be temporary as the conveyor drive development is not scheduled to be completed at this time; permanent pumping lines will be located in the conveyor drive.

Stage 3 will include commissioning of the Lower Pump Station and rising mains, which will occur in early 2027 at the earliest. At this time, water will report to the lower pump station via a series of sumps with submersible pumps. When the bulk water storage dam excavations are complete, water from the BC Mine will instead gravity drain to the drainage level and the bulk water storage dams. Water will then be pumped from the storage dams to the lower pump station. Refer Figure 4.

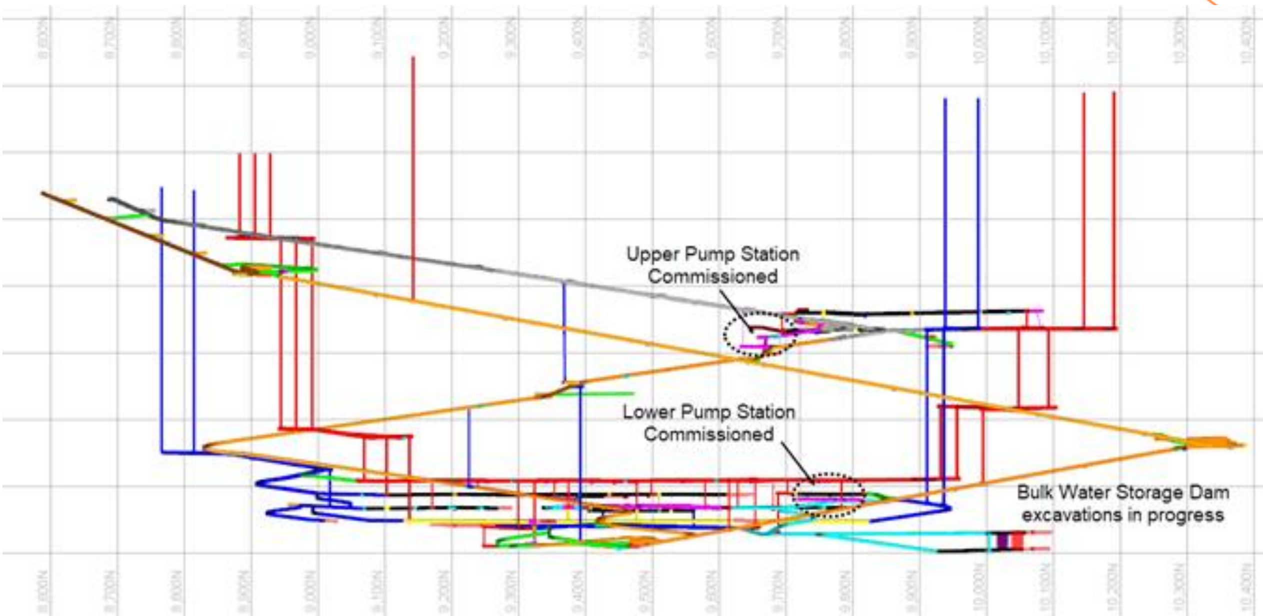


Figure 4 – Dewatering system – Upper and Lower Pump Station locations

The BC mine's dedicated flood storage is located below the extraction, haulage and drainage levels, refer to Figure 5 and Figure 8. The bulk water storage dams are scheduled to be commissioned prior to BC production, but after commencement of production in the Transition Mine. To mitigate the risk of water inundation into the mine prior to the establishment of the BC bulk storage water dams, the lowest levels of the Transition mine (those elevated below the pit floor) were designed to be isolated from critical mine infrastructure and development. Any flooding event that occurs after the commencement of production in the Transition Mine and prior to commissioning of the BC flood dams will be captured in the pit floor (when mining Transition Mine levels above the pit floor) or in the bottom levels of the Transition Mine. It is expected that normal water inflows into the Transition Mine will be captured and pumped by the Transition Mine de-watering infrastructure without impacting on production.

The moderate depth of the proposed mine will allow the use of conventional, staged centrifugal slurry type pumps. This provides a simple and robust solution. The application of a 'dirty' water pumping system simplifies the dewatering system, by not requiring residence time for the settlement of solids and ensures that suspended solids are continually discharged into South Lens.

Breakthrough/subsidence

The exact timing of the cave breakthrough is uncertain, although it is conservatively estimated that breakthrough to the North Pit will occur 12 months after the first drawbell firing. The earliest breakthrough would occur in August 2028 with the latest scenario, September 2029.

Once breakthrough occurs, water from North Pit will report to the underground mine, with modelling assuming little or no lag time. The underground dewatering system will be commissioned prior to the planned cave breakthrough.

Currently an in-pit sump and pumping system is used to manage the inflow of surface water to North Pit by pumping collected water to South Lens. This system is expected to remain in place until access to the in-pit sump is lost, when undercutting of the BC commences (April 2027 at the earliest and February 2028 at the latest). Remotely operated in-pit dewatering systems will be installed (sequential ramp sumps) to collect and remove as much water entering the pit and flowing down the ramp, as possible, after access to the in-pit sump via the North Pit ramp is lost.

However, dewatering of the North Pit sump will continue from underground, via the Transition Mine Drainage drive (see definition below). Refer Figure 7. The Drainage drive will be developed in closest proximity with the North Pit sump, from which drain holes will be drilled to break through into the North Pit.

In relation to subsidence and potential interaction between the North Pit south wall and South Lens, it is noted that over the LOM the accumulation of plastic strain from mining NPUG is forecast to be negligible (<0.4%) outside of the existing North Pit shell at both the northern and southern end of North Pit. Both underground portals, which sit near the pit rim on the southernmost extents of North Pit, are forecast to experience negligible (<0.4%) plastic strain. NPUG induced plastic strain is not forecast to occur within approximately 400 m of South Lens. Any geotechnical instability or deformation of South Lens caused by mining NPUG is considered extremely low risk.

De-watering controls will include the following:

- Surface diversions - All surface drainage systems will be subject to planned inspections and maintenance. All catchment areas that have their water diverted away from the cave will have suitable water measuring systems (e.g., v-notch weir, flow metres) installed to quantify changes in flow. These will be subject to regular review and the values calibrated against forecast flows. All effort will be made to reduce the catchment area associated with the subsidence zone, e.g., surface drainage away from the edge of the pit
- Dewatering open pit - North Pit will continue to be dewatered prior to initiation of the BC undercut, with water levels kept as low as possible. Any dewatering systems located outside the pit will remain in service and be maintained, unless deemed unnecessary. Remotely operated in-pit dewatering systems will be installed (sequential ramp sumps) to collect and remove as much water entering the pit and flowing down the ramp as possible. Once breakthrough occurs, all water entering the pit will report to underground
- Underground dewatering – Any existing potential inflows that intersects either the cave or underground excavations have been identified, and their likely inflows forecasted. These inflows, seeps or aquifers will be actively dewatered or decompressed in the case of pit wall drains. The existing dewatering program for NPUG is being monitored, with the results subject to review. The dewatering monitoring program will continue
- Underground drainage of workings – Any abandoned underground working during the NPUG development that intersect the cave will be barricaded and drained to minimise water flow into the cave; and
- Underground mine water balance – All of the flowmeters installed on the dewatering system will have back-ups available. The system will be subject to regular calibration and will have a maintenance schedule. The flowmeters will be able to be read remotely from the surface. The surface catchment areas, climate data, inflows, dewatering rates, water storage curves will all be used to aid in the assessment of the mine water balance. Flow meters will be installed at the upper and lower pump stations, including discharge from pumps from the bulk water storage dams. Water inflows into the bulk water storage dams (water levels) will be tracked, with monthly water balance conducted. This is required for cave management (inrush hazard management) as well as environmental management of water flows.

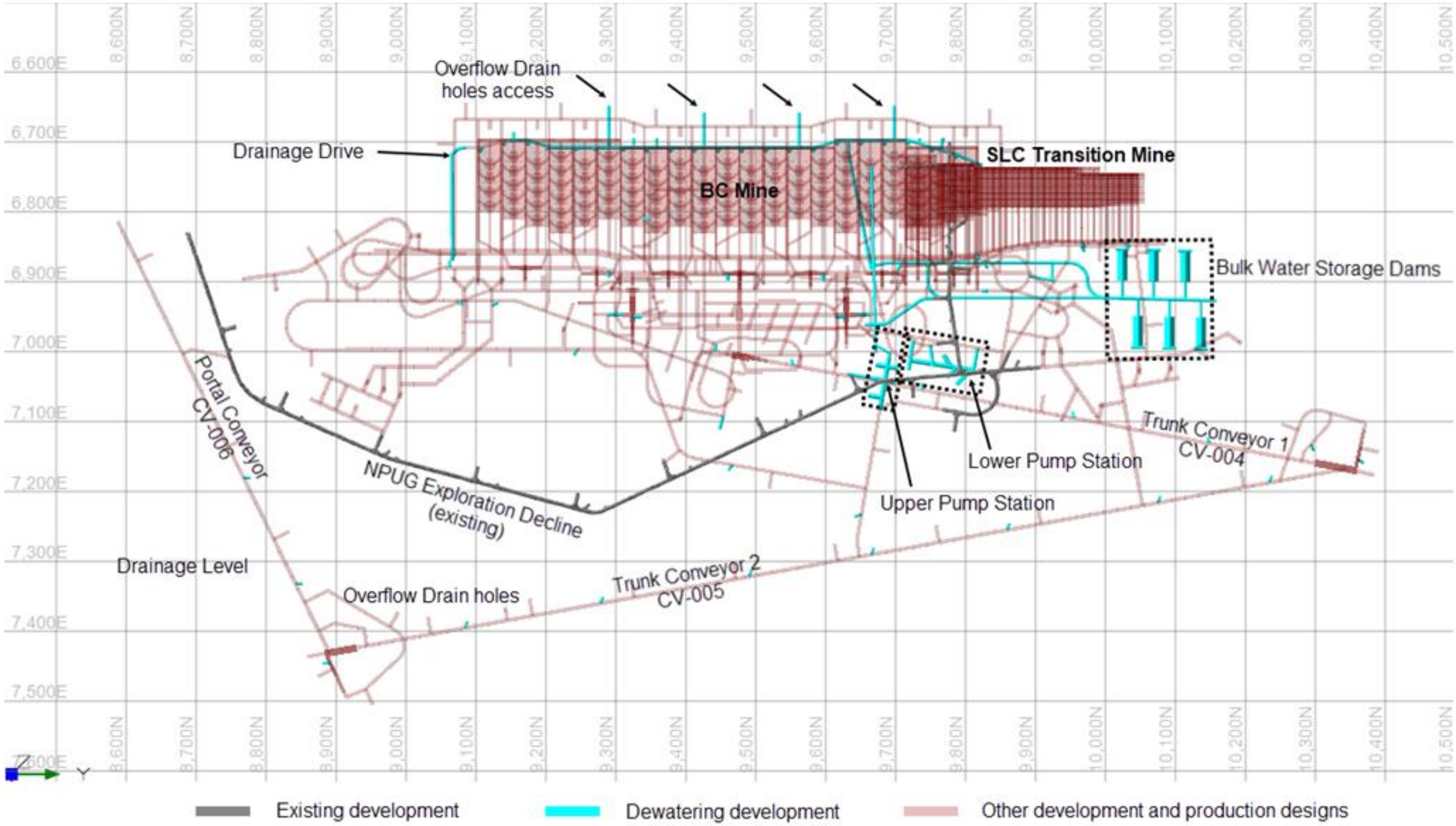


Figure 5 – BC and SLC Transition Mine Dewatering Infrastructure (Plan View)

Note:

Drainage drives are the main accesses which the sumps, drainholes access drives and bulk water storage dams are connected to. The first drainage drive is required to continue draining the North Pit sump once the BC undercutting has started and there's no longer access to the North Pit ramp. The Drainage drive will be developed within close proximity to the pit sump, with drain holes drilled to intersect the pit and provide opening for water to drain back to the upper pump station.

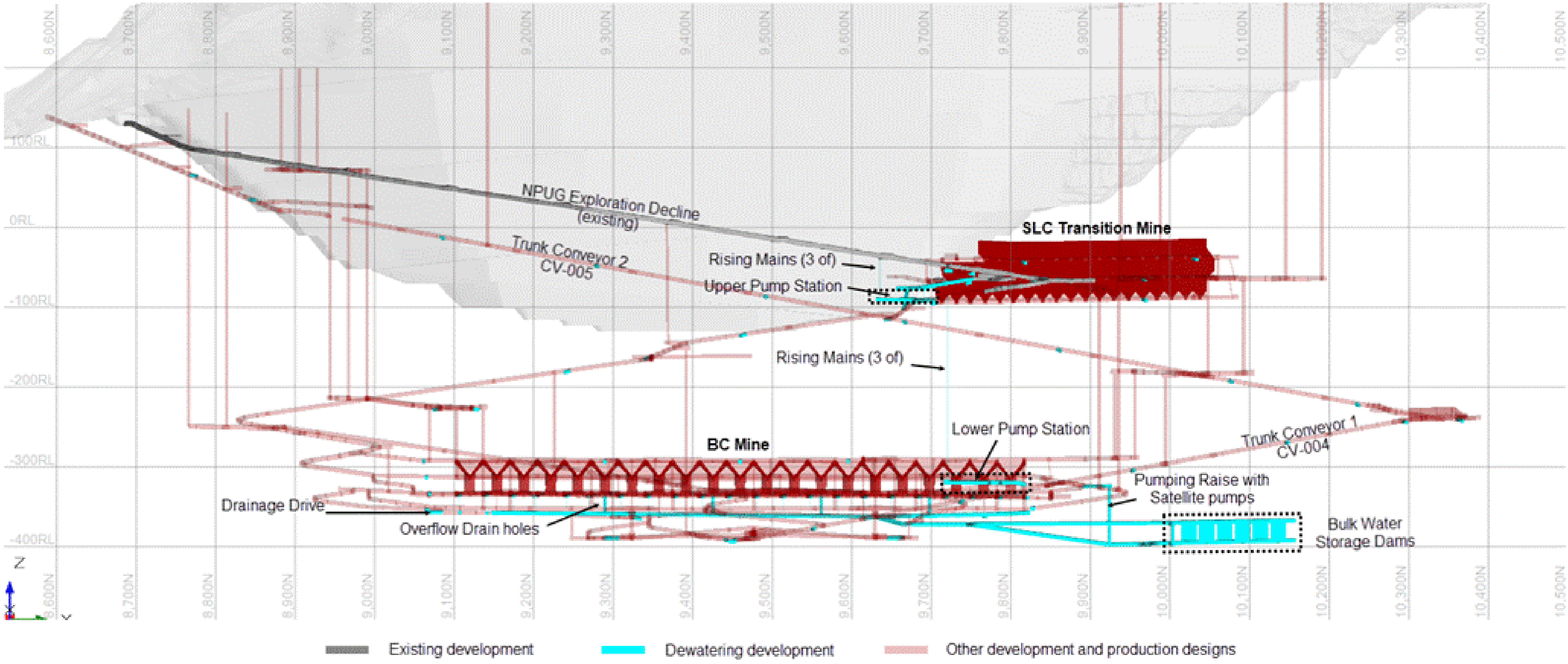


Figure 6 – BC and SLC Transition Mine Dewatering Infrastructure (Vertical View)

Traffic movements

There will be an initial increase in light and heavy vehicle movements both on and off-site as part of the development of NPUG, with vehicle numbers reducing once the underground mine is in production. It is anticipated that there will be an increase of 66 additional light vehicles per shift change on Waratah Road, currently the site roster is 7:7. Increases in heavy vehicles are considered minimal with an average of a single additional semi-trailer per day during the construction period and up to an additional 18 semi-trailer loads per year to transport plant and equipment. Survey data from May 2021[2] indicates a total of 257 vehicle movements per day on Waratah Road, with 12.8% (33) of this traffic heavy vehicle. The increase in light vehicles will be 25% per shift change, which is one day a week (a 4% increase averaged over the week). Shift changeover currently occurs around midday on Wednesday, i.e. in daylight hours. The increase in heavy vehicles is considered negligible (3%).

Traffic movements during shift change at the mine site, i.e., from the Savage River township to the mine occur at 6 am and 6 pm, which includes a changeover in day and night shift crews. There are currently approximately 60 vehicles movements in total at changeover during the week (120 movements a day) and approximately 48 vehicles movements at changeover on the weekend (96 movements a day on weekends).

The proposed construction phase will result in an additional crew mini bus and approximately five private vehicles each way (a total of ~12 additional traffic movements per shift change and a total of ~24 movements per day). This will result in an increase of 20% in traffic movements during the dusk to dawn period for approximately 6 months of the year (over winter), during construction of the underground development period.

Over the long term a reduction in diesel usage and reduction in large open cut mining equipment will likely see a significant decline in b-double and oversize loads needing to access the mine site and using Waratah Road.

2.3.2 Mining methods

The proposed mining methods for the underground mine includes sub-level caving for the Transition mine and Block Caving (BC).

Block caving is *a mass mining system that uses the action of gravity to fracture a block of unsupported ore, allowing it to be extracted through preconstructed drawpoints. By removing a relatively thin horizontal layer at the base of the ore columns using standard mining methods, the vertical support of the ore column above is removed and the ore then caves by gravity. As broken ore is removed from the ore column, the overlying ore continues to break and cave by gravity*.[3]

Sub-level caving is *a top-down mining method allowing earlier production than sublevel stopping with less upfront development than traditional block caving. Horizontal slices of in-situ ore are progressively blasted and extracted, with blasted ore and caved rock filling the void created by ore extraction. Dilution can be managed and minimized by disciplined draw control. As this process progresses, caving propagates upward to create surface subsidence.*[4]

The Transition mine is designed to recover the remaining ore in the walls of the open pit shell and will provide early access to ore as the BC ramps up to full production. The timing of completion of mining North Pit open pit will be a key input to the Transition mine schedule. The Transition mine ceases production as the BC ramps up to the required production rate. The Transition mine may contain three or more levels depending on the BC ramp up, with access from the NPUG exploration decline, refer Figure 7.

All ore and waste from the Transition mine will be transported to the surface via haulage trucks.

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[2] Reference - [Site (drakewell.com)]
[3] SME Mining Engineering Handbook, 3rd Edition, 2011
[4] Ibid

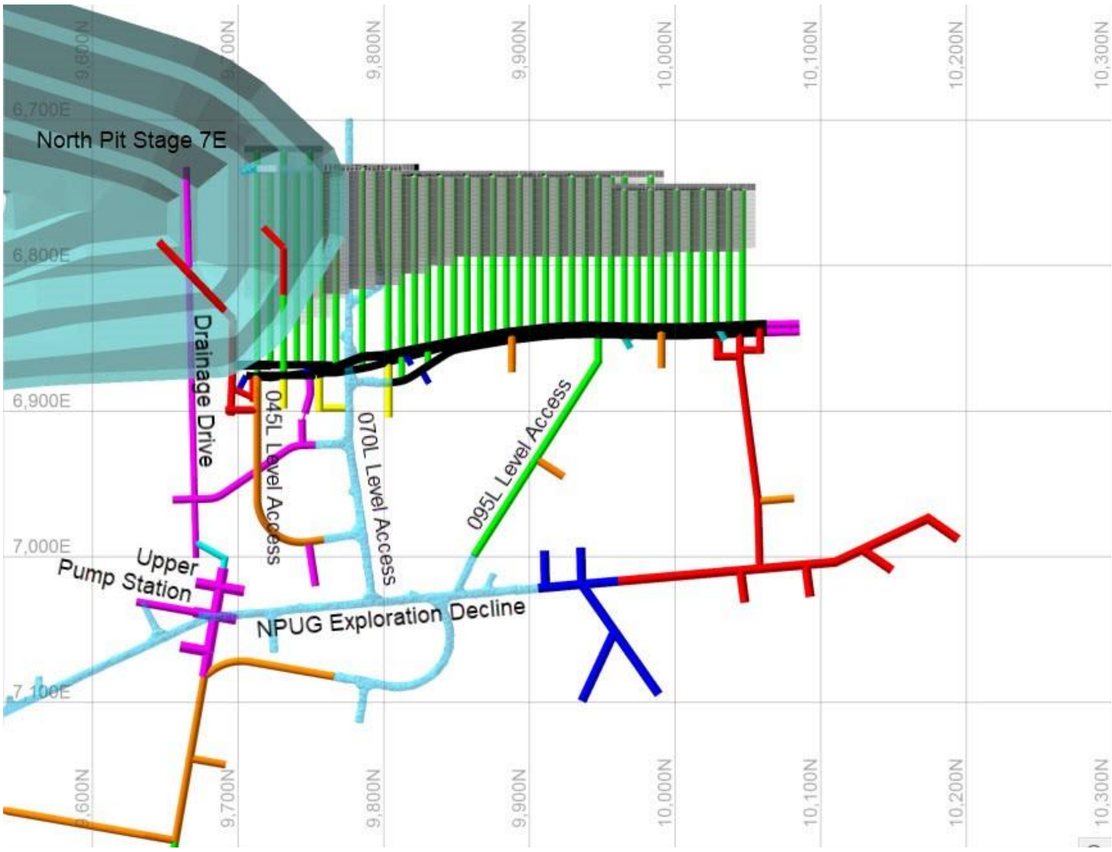

Figure 7 – Transition mine plan (plan view)

Underground development for BC mining is based on extending and expanding the existing exploration decline development within North Pit from -82 mRL to -330 mRL. The existing exploration decline has a length of 2,423 m and has been excavated to 5.5 m wide by 5.8 m high, with a -1:7 gradient. The decline will continue to be excavated to 5.5 m wide by 5.8 m high, and at a -1:7 gradient. The total length of underground development is anticipated to be approximately 54 km. Refer Figure 8 which illustrates the existing development (in grey) as well as all proposed development.

The proposed haulage associated with the BC mine will include truck and conveyor haulage. Underground configurations and underground and surface infrastructure will include:

- Underground crushing station with tramp removal
- Inclined conveyor to the surface
- Surface tramp removal of the Transition mine ore; and
- Surface stacker feeding the processing plant.

The conveyor portal is in the south-east corner of North Pit, adjacent to the existing exploration decline portal. The primary ventilation circuit includes five exhaust raises and four intake raises. The exploration decline and conveyor decline provide additional intakes. Refer to Figure 8 and Figure 9.

The exploration decline has been designed to provide access to:

- Exploration drilling platforms, for initial ore body delineation and ongoing resource definition
- Primary ventilation circuit; and
- Material handling systems.

Stockpiles are spaced at approximately 150 m intervals and have been designed with capacity to minimise any impact on the mining cycle due to material movement. The stockpile areas will be utilised for what is required, so could be used as ore and/or waste rock stockpiles. These stockpiles can be used as drilling platforms, infrastructure locations and consumables storage where required once they are no longer required for use as active stockpiles for rehandling material.

Refer to Figure 8 for the mine layout.

The BC and Transition Mine design and schedule are based on the geotechnical design criteria including (Grange Resources, 2023):

- BC Extraction level elevation (floor) is -335 mRL
- BC height will be between 200 and 230 vertical m
- BC Extraction level layout is offset herringbone with drawbell spacing 34 m x 20 m to maximise pillar size and is considered the upper limit for drilling and blasting of the undercut level
- BC production rate ramps up to 6 Mt over 30 months, and then increases to 6.66 Mt after 72 months (a point at which the head grade was expected to begin dropping due to dilution entry)
- BC cut-off grade of 30% DTR; and
- SLC Transition Mine maximum production is 1.9 Mtpa.

The SLC Transition Mine was designed with the following parameters:

- Three sublevels
- The SLC starts adjacent to the North Pit (-45 mRL)
- 25 m sublevel spacing
- 18 m crosscut spacing (centre to centre)
- Ore drive profiles - 4.7 m (W) and 4.7 m (H) cross cuts with an arched profile for stability
- Ring spacing of 3.0 m
- The production sequence advances from west to east; and
- Infrastructure must be located to the east of the orebody.

The power demand over the life of the NPUG project is estimated at 290 MWh. The power demand in the first few years builds from 2 to 19 MWh, with power demand averaging around 20 MW per year with a maximum demand estimated at less than 22 MWh.

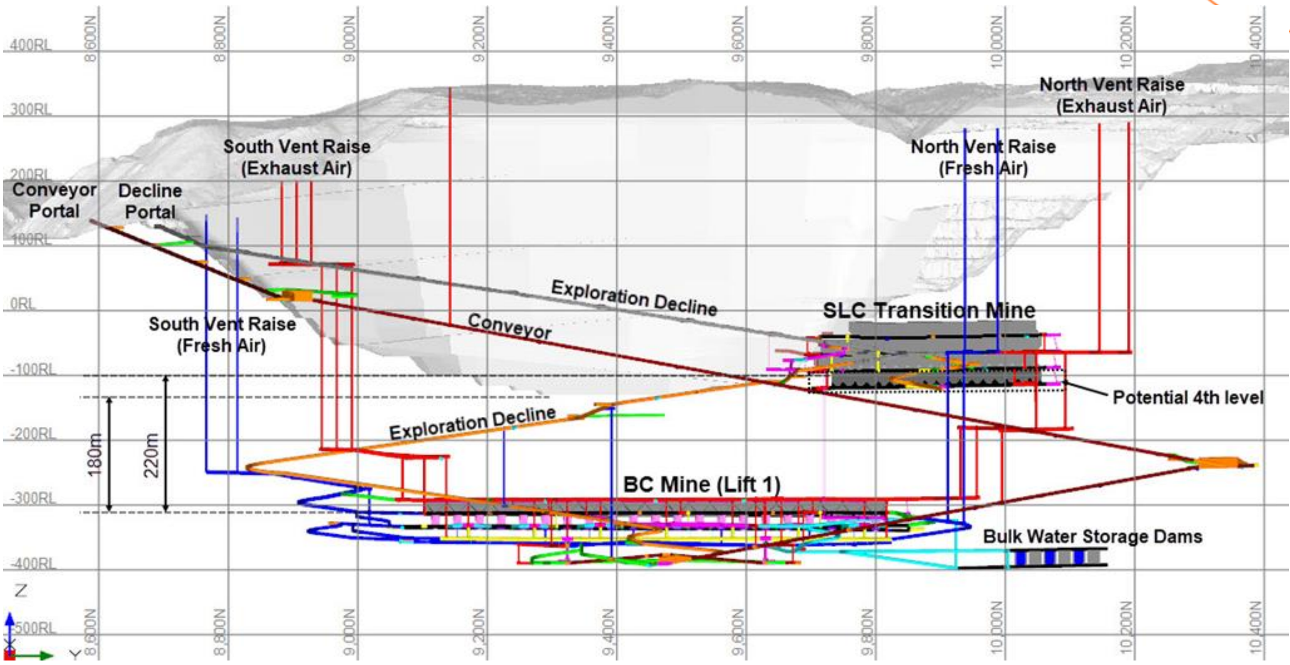

Figure 8 - North Pit, BC and Transition Mine, vertical section looking west (FS)

Figure 9 – Underground Conveyors layout (plan view)

Note:
CV-001A and B are apron feeders that transfer crushed ore from the crushers onto conveyors CV-002A and 002B and are not visible in this view.

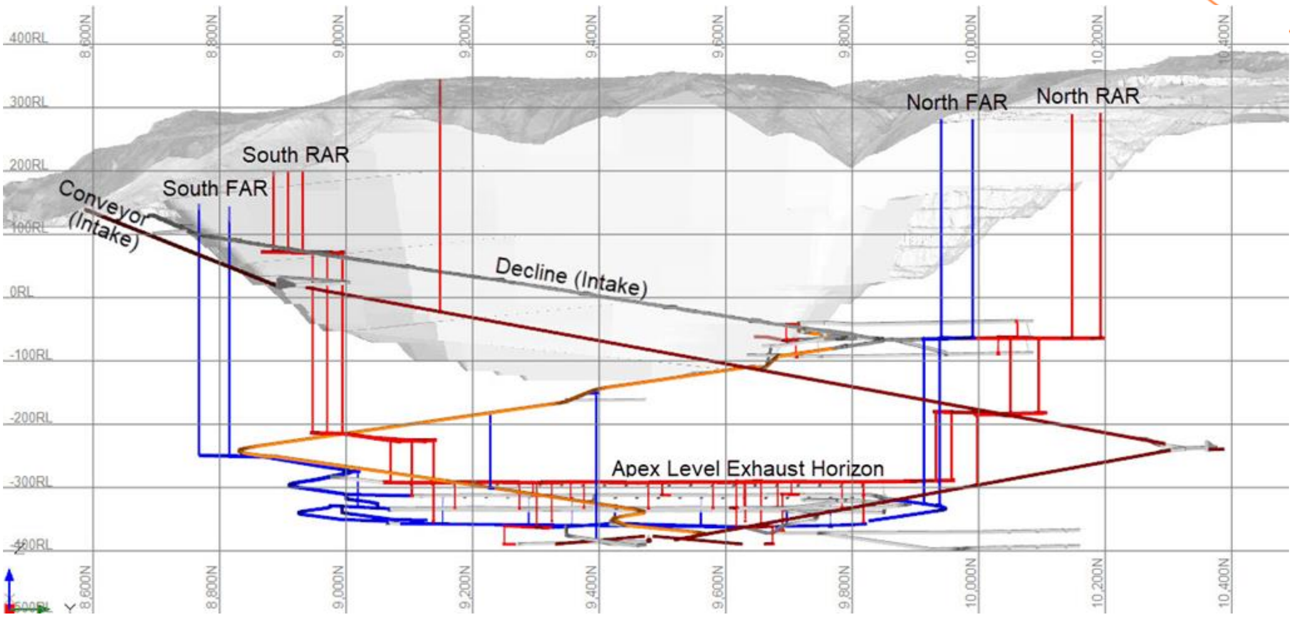

Figure 10 – Underground primary ventilation system

Note:
Red lines are exhaust (RAR) and blue lines are intake (FAR)
RAR – return air raise and FAR – fresh air raise
The conveyor drive is shown in brown, and intake from the conveyor portal will only provide ventilation to this drive and will not mix with the rest of the ventilation circuit.
The existing developed decline is dark grey, with the proposed decline in orange.

Ore processing

There will be no change to the existing processing plant operations as a result of the underground mining operations. The processing plant will process up to a maximum of approximately 6.66 million dry tonnes per annum (pa), generating 2.9 million tonnes pa of concentrate.

Crushing

At Savage River, the ore comprises magnetite with accompanying sulphide and silicate minerals. It is crushed, ground, and then concentrated using magnetic separation as the primary mineral separation technology.

Ore mined from North Pit will be transported to High-Grade or Low-Grade Stockpiles within the existing ROMs. These are located between South Lens and the North Pit. Ore from these stockpiles will be fed into the crushers (at the same site) using a front-end loader and truck operation. Ore from North Pit is currently tipped into gyratory primary crusher. When the iron ore has been crushed to a maximum size of 200 mm, it is transported to the crushed ore stockpile at the concentrator currently via overland conveyor. Water runoff from the ROM is captured and drained to the South Lens prior to discharge.

Concentrator

Crushed ore from the stockpile is reclaimed via a tunnel system and fed into the concentrator. It is initially ground by two autogenous grinding mills, then by two ball mills. Magnetic separators then separate the magnetite from the gangue, which is then pumped to the tailings dam.

The concentrated slurry from the concentrator is pumped through a nominal 229 mm internal diameter slurry pipeline to the pellet plant at Port Latta. This takes approximately 14 hours to move the material 85 km.

Waste rock

Waste rock from production activities is split into four geochemical groups. These are discussed in section 5.2.1 and include:

- A Type – non-acid forming (NAF) material which may be suitable for use in construction of flow through or for erosion protection and buttress construction
- B Type – neutral material presenting as friable, weak rock units
- C Type – NAF material, essentially clay; and
- D Type – Potentially acid forming (PAF) material.

The nature of the rock types is identified during geological exploration and drilling programs and during grade control inspections and determines the end use of the material. It also allows for identification of any specific management actions related to the potential for acid generation and the availability for NAF for use on site.

During North Pit open cut operations, all waste rock from the extension of the exploration decline will continue to be managed in accordance with the Waste Rock Management Plan (WRMP) and will be placed in existing approved waste rock dumps in accordance with their classification, refer section 5.2.2.

Once North Pit open cut operations cease, it is proposed that waste rock from the Transition mine and BC mine will be managed through paddock dumping directly into North Pit. There is also the possibility that some waste rock will continue to go to existing approved waste rock dumps on site. Refer section 5.2.2.

Tailings

Tailings produced from the processing of ore from North Pit will be deposited within the SDTSF. There is adequate capacity in the tailings storage facilities to contain tailings from North Pit ore processing, refer section 5.2.3.

Refer to section 5.1 for management of on-site water management.

2.3.3 Staged mine development

The total production for the Transition mine is estimated at 5.3 million tonnes (Mt) of ore over six years of operation. The BC mine is estimated to produce a total of 59.1 Mt of ore during 15 years of operation. The current indicative volumes are provided in Table 1. Total underground ore production is 64.4 Mt over the life of mine. These figures include ore from both production and development.

At this stage it is proposed that the Transition mine will provide early access to ore as the BC ramps up to full production. The timing of completion of mining North Pit open cut will be a key input to the Transition mine schedule. The Transition mine will not commence operation until open cut mining in North Pit is complete and will cease production when the BC ramps up to the required production rate.

It is noted that the total volume of ore mined will not necessarily translate to the total volume of ore processed during the same period.

Table 1 – Preliminary ore and waste tonnes

Phase	Ore (Mt)	Waste (Mt)	Total (Mt)
Transition mine	5.3	0.5	5.8
Block Cave	59.1	3.7	62.8

Annual production rates for the Transition and BC mines are included in Table 2 and Table 3.

Table 2 - Transition Mine annual ore tonnes

Year	Ore (Mt)	Waste (Mt)
1	0	0.07
2	0.01	0.14
3	0.16	0.07
4	1.10	0.14
5	1.99	0.04
6	1.6	0
7	0.48	0

Table 3 – Block Cave annual ore tonnes mined

Year	Ore tonnes	Waste tonnes
1	0.004	0.04
2	0.02	0.44
3	0.01	1.10
4	0.06	1.11
5	0.33	0.64
6	2.61	0.26
7	5.0	0.07
8	6.12	0.03
9	6.09	0.04
10	6.01	-0.001
11	6.42	-
12	6.66	-
13	6.66	-
14	6.66	-
15	5.64	-

2.3.4 Infrastructure – existing and proposed

Mining Infrastructure – Underground

The main infrastructure development in NPUG operations will be the extension of the existing exploration decline, with the total development anticipated to be in the order of 54 km. Additional underground infrastructure to be developed includes:

- Primary Crushing – Run-of-mine (ROM) ore bin, primary crusher, crushed ore bin and conveyor transfers
- Tramp metal removal
- Ore handling - Inclined conveying to surface
- Ventilation, including regulators and secondary fans
- Mine Dewatering, refer section 1.5.2

- Mine Services – raw water (estimated 25 L/s from South Lens), fire water, compressed air
- Electrical HV distribution
- Electrical LV distribution within the facility areas
- Control and communications systems; and
- Underground mine facilities – workshop, crib room, ablution facilities, explosive storage, emergency egress and refuge chambers.

Transition mine will include ventilation, dewatering, mine services, electrical HV and LV distribution control and communications, refuge chambers and escapeways. The remaining infrastructure will be in place prior to the BC mine.

Mining Infrastructure – Above ground

Existing operational plant and infrastructure used to process the ore from the underground operations will include:

- Primary crusher, concentrator and slurry pipeline
- Run of mine (ROM) and stockpile areas
- The South Lens water treatment system
- Tailings storage facilities, specifically the SDTSF; and
- Waste rock dumps including Centre Pit Dump and Broderick Creek Dump Complex, and the Mill Dump and South Deposit Backfill Dump.

There will be limited new surface infrastructure required as part of the proposed underground operations. New and upgraded surface infrastructure will include:

- Exhaust ventilation fan stations
- Potential relocation of the existing concrete batch plant closer to the NPUG portal
- A new access track and associated drainage
- A new rock waste dump created by the backfilling of the North Pit void, refer section 5.2.2
- Upgrades to compressed air and power, and the maintenance workshop; and
- Upgrades will also be required for underground dewatering.

These upgrades will be within existing areas of the site, with the exception of the access track, refer Figure 12.

The new access track, as shown on Figure 12, will be approximately 160 m long and 3 m wide, with an area of vegetation clearance of 480 m^2 required. All run-off will be managed by the cross fall to the west and then a cut off drain which will report to a sediment pond. The purpose of the track is to improve safety by providing vehicle access to the underground portal that does not interact with haul trucks.

Mining equipment

A summary of the indicative fleet numbers is provided in Table 4. The truck and loader fleet are based on proven electric tethered and diesel models, however a battery and electric load and haul fleet, particularly loaders operating within the cave footprint at modest grades may be considered with future technology improvements.

Table 4 – Mobile mining equipment for underground operations

Plant	Number
Jumbo (rock drilling/tunnelling machine)	5
Development loader	2
Dump truck	5
Development charge-up	2

Plant	Number
Cabolter (cable bolter)	1
Interchangeable tool loader (IT)	3
Spraymec (wet concrete sprayer)	3
Agitator truck	5
Boxhole boring machine	1
Production drill	3
Production loader	4
Production loader - electric	6
Production loader – ore transfer	4
Production charge up	2
Mobile rock breaker	2
Water cannon	1
Single boom jumbo (rock drilling machine)	1
Grader	1
Stores truck	1
Water truck	1
Fuel truck	1
Stores IT	1
Batch plant IT	1
Workshop forklift	1
Roller	1

Existing machinery such as trucks, loaders and excavators currently utilised within the site, will also continue to be utilised.

2.3.5 Construction, commissioning and operation

Construction

The underground operations will be within the existing footprint of North Pit. Therefore, pre-construction works, such as vegetation clearance and stockpiling will not be required. A pre-clearance survey for natural values will be undertaken prior to clearance of a 480 m^2 area of vegetation required for construction of a new access track (160 m in length) for vehicles to access the underground portal. No other vegetation clearance with be required with upgraded infrastructure to occur within the existing mine footprint.

Underground construction activities will be required prior to the NPUG operations (Transition and BC mining) commencing. This will require an extension of the existing exploration decline and development of underground infrastructure as outlined in section 2.3.4. Refer to 2.3.1 for infrastructure required as part of the proposed dewatering. Production from the underground mine cannot commence until North Pit open cut mining activities have ceased. The current site integration plan is for the North Pit to stop mining activity in mid to late 2027, with the SLC Transition Mine production commencing August 2027 in order to continue ore production. SLC Transition Mine production is required during the ramp-up of the BC mine which is forecast over 30 months. The duration of the SLC Transition Mine production is dependent on the Block Cave ramp-up. In the best-case scenario, where 6 Mtpa production is achieved earlier than 30 months, mining from the Transition Mine will stop. In the worst case, the SLC Transition Mine will need to continue for longer and potentially go to a fourth mine level. Refer Figure 8.

The following construction schedule for NPUG is anticipated:

- Year 1 - office buildings, ablution block crib rooms, surface workshop, portal substation (22 kV to 11 kV) and underground substation (11 kV to 1 kV)
- Year 2 - upper pump station and raising mains, ventilation raises and surface ventilation exhaust fans and conveyor portal
- Year 3 - ventilation raises and primary ventilation fans, underground workshop, crib room and ablutions, and underground magazine. Surface power upgrade (additional 22 kV Transformer and reticulation)

  The Transition mine is likely to commence in Year 3, subject to open cut in North Pit winding up
- Year 4 - conveyor system, surface stacker, surface tramp removal system and lower pumping station; and
- Year 5 - crushing and underground tramp removal system, flood mitigation stopes and satellite pumping system.

Workforce

The proposed development workforce will primarily involve contractors with mine management and technical staff provided by Grange. The contractor positions include underground operators, supervisors and management, safety staff and management, electricians and maintenance personnel. Due to the existing underground mine workforce in the Tasmanian community hiring experienced underground mining personnel is expected to be achievable. There is also opportunity to train and transition operators from the open pit to the underground mine.

Current site accommodation for the NPUG project consists of contractor accommodation for approximately 30 personnel. This is sufficient for project start-up and will need to ramp up to approximately 80 beds in the first year and around 140 beds in subsequent years. There is budget for additional accommodation as part of the camp upgrade plans, prior to the commencement of underground mining. This will be covered under a separate development application to Waratah-Wynyard Council.

Contractor headcount initially peaks during the footprint development phases then subsequently drops when pre-production development is complete and undercutting commences, before increasing with the production ramp-up. It is estimated that the maximum contractor personnel will be in the order of 110 workers during pre-production.

Additional Grange staff positions in the construction phase will total 60-70.

Commissioning and operations

Due to the established nature of site, the ramp-up period can be defined as a transitional phase from open pit to underground. The ramp-up period will commence immediately after project approval, with NPUG mining proposed to be undertaken over a period of 15 years.

Operations will be 24 hours per day, seven days per week.

Details of the Savage River Mine underground operations for North Pit are provided in the sections above.

2.4 Maps, plans and figures

Refer to Figure 1 above for the site location the Savage River Mine and Figure 11 below for the layout of the site. Underground mine plans include:

- Figure 5 – BC and SLC Transition Mine Dewatering Infrastructure (Plan View)
- Figure 6 – BC and SLC Transition Mine Dewatering Infrastructure (Vertical View)
- Figure 7 – Transition mine plan (plan view)
- Figure 8 - North Pit, BC and Transition Mine, vertical section looking west (FS)
- Figure 9 – Underground Conveyors layout (plan view); and
- Figure 10 – Underground primary ventilation system.

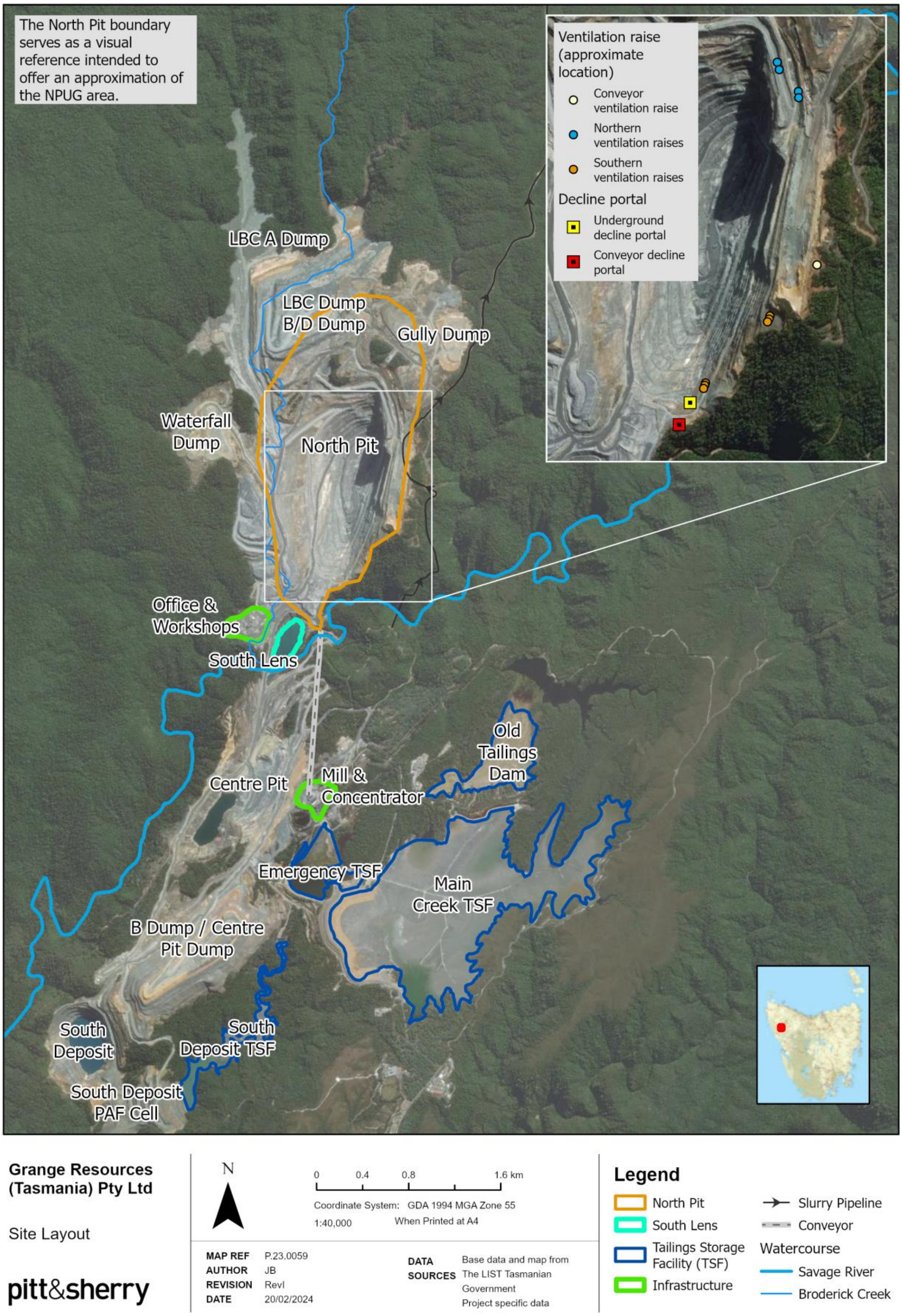

Figure 11 – Site layout

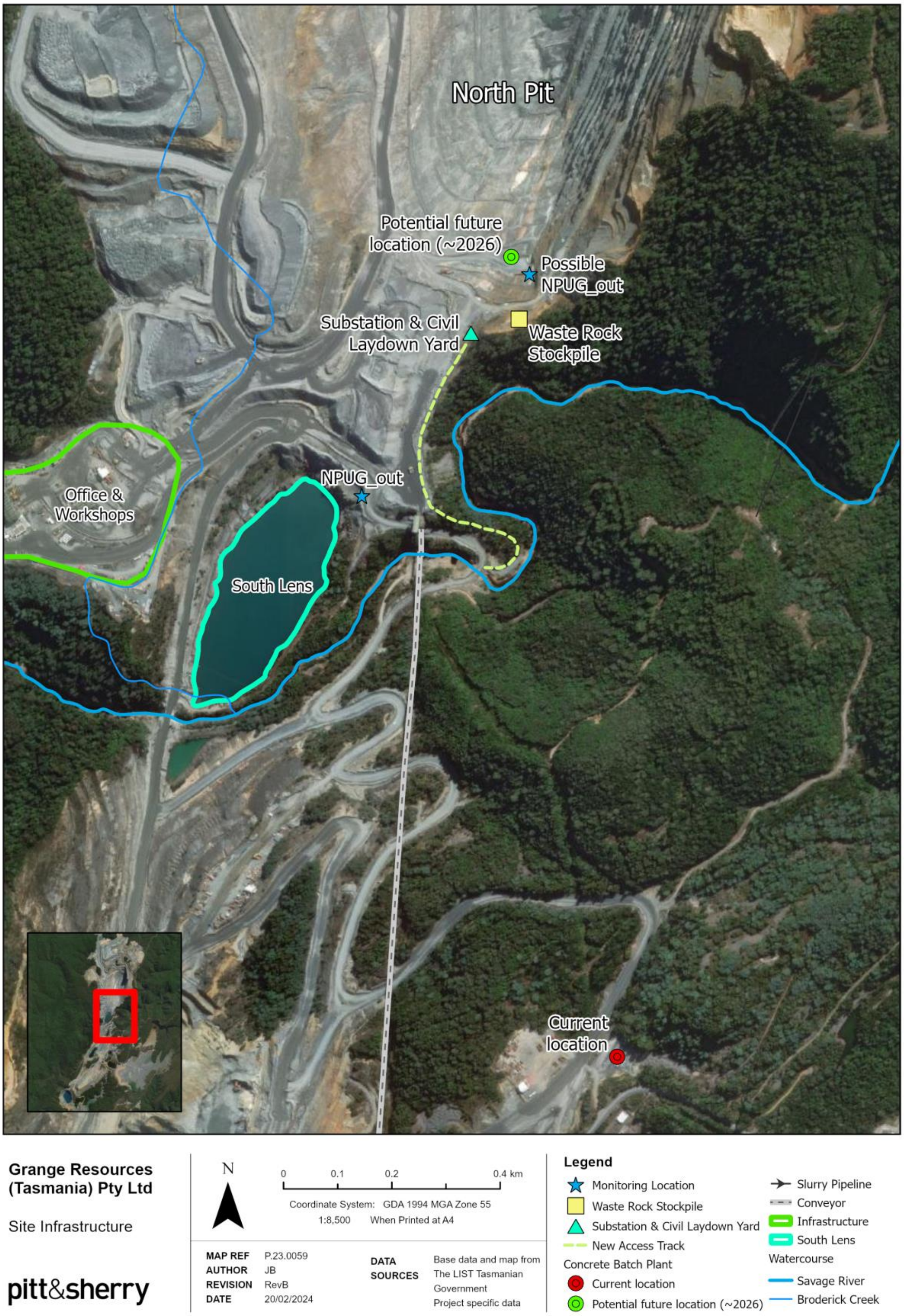

Figure 12 – Site Infrastructure locations

2.5 Planning aspects

The relevant planning provision is the Waratah-Wynyard Local Provisions Schedule. The Savage River mine site is zoned Rural and Environmental Management, with NPUG all within the Rural zone, as shown on Figure 13. Mining falls under the following Planning Scheme use class:

> *Extractive industry - use of land for extracting or removing material from the ground, other than Resource development, and includes the treatment or processing of those materials by crushing, grinding, milling or screening on, or adjoining the land from which it is extracted.*

Extractive industries are a Permitted Use in the Rural zone.

This EIS will support a development application to Council and assessment of the application by the EPA. A Planning Report which addresses the relevant Planning Scheme matters will be attached to the development application.

Information on land tenure, zoning and surrounding land use is outlined in section 2.1.

There is no certificate of title, but the North Pit is located across two land parcels identified with PID 3388485 and 3389517, with the relevant authority listed as Sustainable Timber Tasmania and Department of Natural Resources and Environment Tasmania (NRE Tas) (Future Potential Production Forest) respectively.

There are no easements or conservation covenants within or in the vicinity of the Savage River Mine site.

A number of reserves cross the site, including the Savage River Regional Reserve. North Pit is located within two informal reserves, an Informal Reserve on Permanent Timber Production Zone Land or STT managed land as well as Future Potential Production Forest, refer Figure 14.

Other reserves in the area include the Donaldson River Nature Recreation Area to the west and the Meredith Range Regional Reserve to the east. The Savage River National Park is located approximately 10 km to the northeast.

The Savage River accommodation area is located approximately 2 km south of the mine site, and approximately 4 km south of North Pit. The site is remote and apart from the accommodation area, there is little public access to the area or adjoining lands.

2.6 Socio-economic context

The Savage River Mine sits within the Waratah-Wynyard local government area, and the Statistical Area of Waratah, according to the Australian Bureau of Statistics (ABS), 2021. The Waratah Region has a total population of 3,934, with a working age (aged 15-64 years) population of 62.7%, compared with the Australian average of 64.7%. The region has a total of 319 Aboriginal and Torres Strait Islander peoples and 440 persons born overseas. The median total income is $44,476, with a median weekly total household income of $846.

The Waratah-Wynyard Council Municipality is predominantly rural, with small townships across the local government area. Rural land is used largely for dairy farming, vegetable growing, horticulture and timber production. Mining and tourism are also considered important industries.

The main industries of employment in the Waratah region (ABS 2016) include agriculture, forestry and fishing (17.2%), health care and social assistance (12%), education and training (8.7%), manufacturing (7.4%) with mining seventh at 4.9%. The unemployment rate in the region was 7% (ABS 2016).

The Goldamere Agreement (refer section 1.9) was created to indemnify owners of the mine against responsibility for legacy pollution which occurred in the Savage River as a result of earlier mining activities. This encouraged continued investment and employment at the mine. The support for operations on site, and the positive impact that makes to the economy and work force, continues under the agreement and the Savage River Rehabilitation Project (SRRP). Significant improvements in downstream water quality, since the commencement of the SRRP, over the past two decades, have progressed throughout the river system to areas accessed by the public, providing a positive recreational and social outcome.

There will be changes to on-site processes from open pit to underground operations and there will be changes to the workforce. There will be an increase in workers required on site for the construction phase of the Transition and BC mining. There will also be increased capital expenditure during the construction phase. Extracted mineral will continue to be pumped to Port Latta for pelletisation and shipment to established markets. Refer to section 5.10 for further details.

The existing workforce on-site averages up to 150 Grange personnel (day shift), 100 Grange personnel (night shift) and an additional 100 contractors at any one time during a 24 hour period.

2.7 Off-site infrastructure

No new off-site infrastructure is required as part of the proposed underground operations at North Pit, with the exception of an increase in accommodation at Savage River camp. This will be covered under a separate development application.

2.8 Current approvals or regulatory conditions

Current environmental permits, Environment Protection Notices (EPN) and mining lease numbers are listed in Table 5.

Table 5 - Environmental approvals

EPN / ML	Application	Year	Notes
PCE 10995	Centre Pit expansion	2022	Applies to the dewatering and mining of Centre Pit
EPN 10006/2	North Pit Exploration Decline	2020	Permit to extend the previously approved exploration decline from 1.3 km to 3 km from the portal located at the southern extent of North Pit
EPN 8748/4	South Deposit	2014	Applies to the dewatering and mining of South Deposit
EPN 8994/1	Main Creek Tailings Dam (MCTD)	2013	Applies to the 336 RL and 338 RL raises of the Main Creek Tailings Dam and maintenance of the dam to ANCOLD
PCE 8808	South Deposit Tailings Storage Facility	2013	Applies to the construction and operation of the South Deposit Tailings Storage Facility (SDTSF)
EPN 7984/1	Main Creek Tailings Dam	2010	MCTD lift from RL 331 to 333
EPN 248/2	Savage River Mine	2001	Applies to operations at Savage River
ML 2M/2001	Savage River Mine	2001	Main Mine Lease
ML 14M/2007	Savage River Mine	2007	Supplementary Mine Lease
ML 11M/2008	Savage River Mine	2008	Supplementary Mine Lease
ML 4M/2019	Savage River Mine	2019	Supplementary Mine Lease

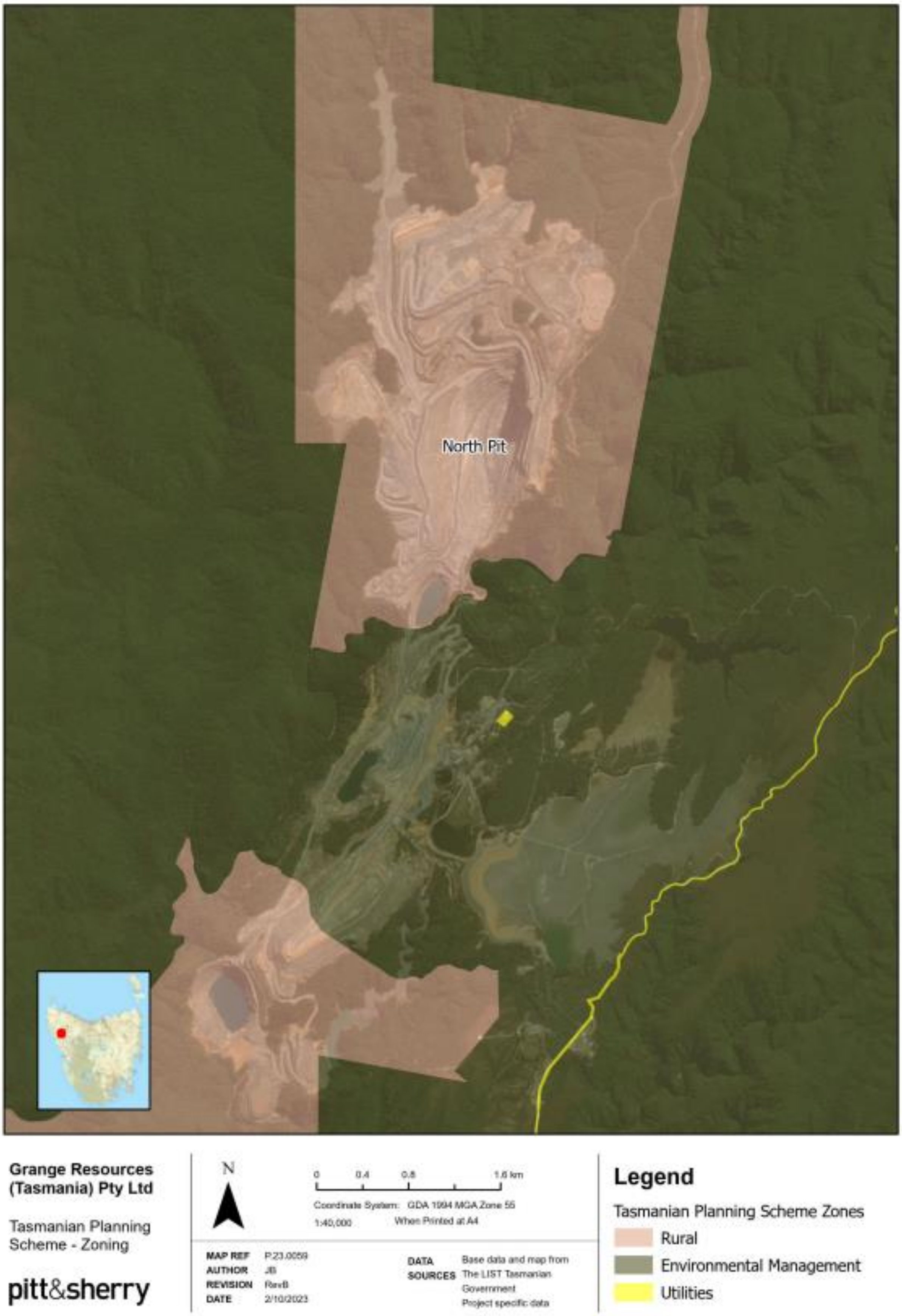

Figure 13 - Land zoning

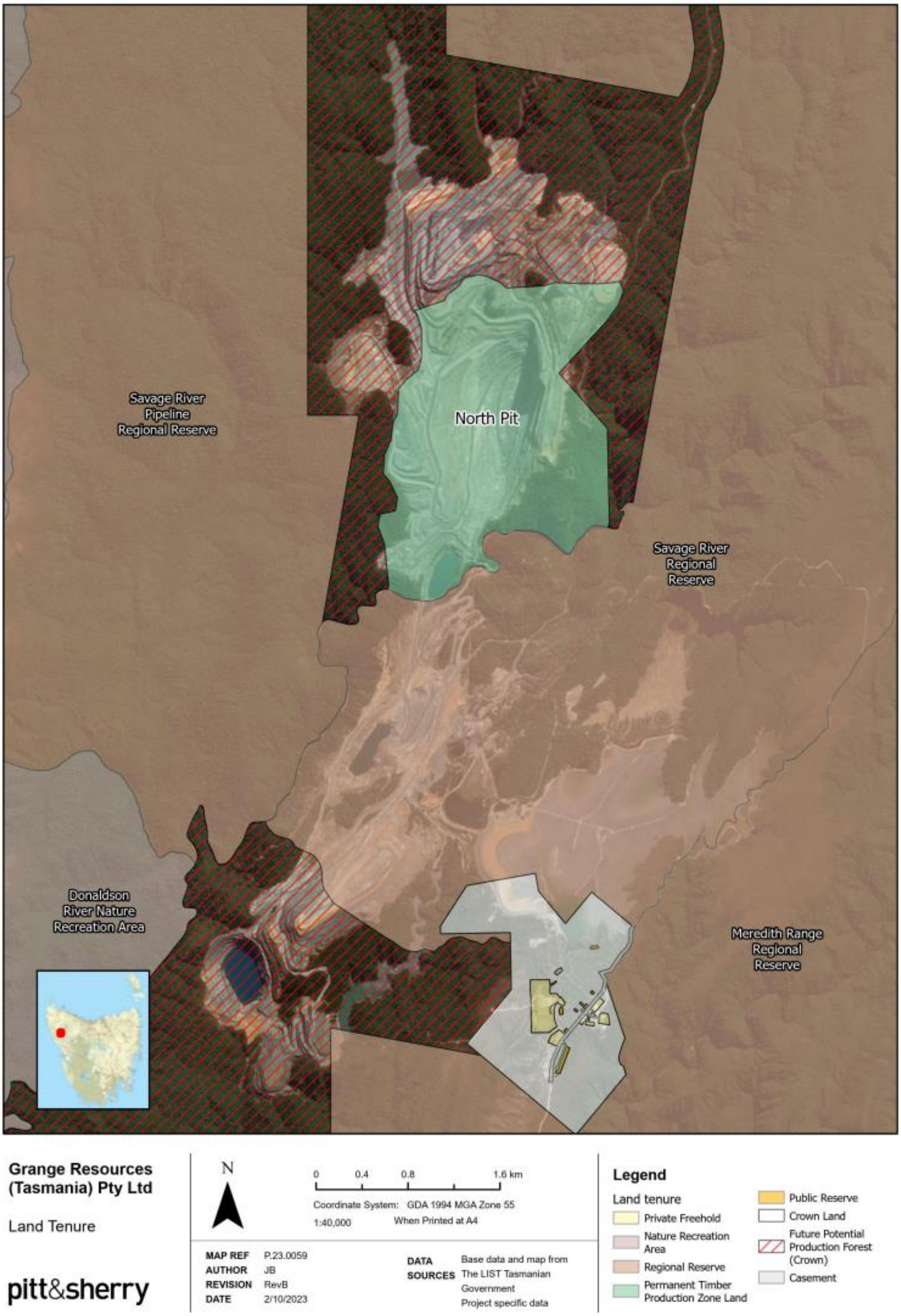

Figure 14 - Land Tenure

3. Project alternatives

3.1 Rationale for the project

The expansion of the Savage River Mine to include an underground operation under North Pit is a practical proposal to continue to obtain identified resources on site. The proposed underground developments are located on the eastern edge of the North Pit. The development of this underground resource will use new and existing infrastructure while minimising impacts on natural values surrounding the site. Continued extraction at this mine advances the intent of the Goldamere Agreement and ensures continued support of the SRRP. This has benefits for environmental management and facilitates continued remediation of previous impacts.

The proposed underground operations will be developed using a Transition Mine, which will utilise sub-level caving (SLC) mining methods as well as BC mining. The Transition Mine and the BC mine may progress sequentially or both at the same time, depending on the completion of the open pit. An exploration decline has been developed under and to the east of North Pit (approved under EPN No. 10006/2). Drilling has been undertaken from key locations along the decline to define the underground resource and optimise the mining method.

3.2 Alternative sites

The proposal relates to continuing to mine by underground methods the orebody currently mined by open cut methods. No sites outside the mine boundary were considered. The intention is to continue extraction from the existing site rather than expand into previously undisturbed areas. This development can accommodate tailings within the operation's current and projected tailings capacity schedule and waste rock within the site's existing waste rock storage facilities, with no new tailings storage facilities required as part of the proposal. It is proposed that waste rock from underground will also be deposited back into the North Pit void. South Lens will continue to be used for settlement of solids and neutralisation by combining with alkaline water sources prior to discharge to the Savage River.

3.3 Other available technologies

The proposed mining method is the most effective means of extraction of the mineral resource and makes best use of the systems and infrastructure currently used on site.

4. Public consultation

No specific public consultation has been undertaken for the proposed activity. Grange has been continually involved in the SRRP, and the proposed activity is consistent with the objectives and suggested actions of SRRP Strategic Plan. The EIS will undergo a public consultation process as part of the assessment and any representations will be forwarded to the EPA and Waratah-Wynyard Council for consideration.

Grange understands the importance of stakeholder consultation. Through the company's Social Responsibility Policy, Grange is committed to consulting with the community on its concerns, aspirations and values regarding the development, operational and closure aspects of mineral projects, recognising that there are links between economic, social and cultural issues.

It is proposed to consult with the following stakeholder groups through the EPA assessment process:

- Community members and interest groups
- Adjoining landowners
- Local government
- State government, agencies and NGOs; and
- Federal government, for any Commonwealth-related issues, that may arise during the project.

5. Potential impacts and management

Key environmental issues identified in the Project Specific Guidelines (PSGs) for the proposed underground operations include:

- Waste rock and tailings management; and
- Impacts from underground operation dewatering and onsite water management.

These key issues and other potential environmental issues and their management are discussed in the sections below.

5.1 Water quality (surface and discharge)

5.1.1 Existing environment

The proposed project is located within the Savage River catchment, a tributary of the Pieman River that traverses the site between South Lens and Centre Pit Figure 11.

The historical causes of degradation of water quality in Savage River included elevated sediment loads and legacy acid mine drainage (AMD) from mining operations. There has been considerable improvement in water quality in the last 10-15 years, with the diversion of North Dump Drain (NDD) and the utilisation of South Lens for passive treatment of AMD and sediment, drawing on the passive alkalinity generated by Grange's mining operations. Additional decreases in total cobalt, copper and manganese loadings have also occurred since the commissioning of the South Deposit Tailings Storage Facility (SDTSF) in 2014, and the increase in alkalinity from the Broderick Creek and SDTSF flowthroughs. This increase in alkalinity generated by mining processes has ensured the water quality objectives in Savage River are met.

South Lens is a pit lake used for passive treatment of site water prior to entering the Savage River via a constructed outflow channel. It is the central water treatment facility for the site and acts as a sediment retention pond for site workings' run-off. South Lens receives the following inputs:

- AMD from NDD and Brett's Drain seepage
- Alkaline inputs from North Pit and Centre Pit; and
- Machinery washdown and site runoff.

Retention of water within the South Lens promotes neutralisation of acid drainage and the precipitation of metal hydroxides.

Ongoing monitoring of South Lens, by both SRRP and Grange is a critical part of the AMD treatment strategy at the site.

Dewatering of operating pits is always required at the Savage River Mine with the mean annual rainfall of 1,947 mm. Refer Table 6 for a summary of statistic of monthly rainfall data.

Table 6 - Monthly rainfall statistics 1966 to 2023[5]

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Lowest	7.5	15.2	20.8	46.2	57.0	24.2	87.4	101.5	64.3	13.0	26.0	27.0	1529.4
Highest	206.0	207.8	232.0	311.5	439.8	404.0	385.8	447.6	382.0	392.4	335.4	299.0	2828.0
Mean	93.3	77.8	110.9	150.4	203.7	193.8	239.4	234.7	198.3	168.0	126.6	120.8	1947.0

[5] Bureau of Meteorology, Savage River Mine, station number 97047.

Description of the existing and proposed water management practices

Surface water for the existing open pit operations is managed via a combination of diversion of water around the open pit and in pit management of water inflows.

AQ2 Pty Ltd were engaged by Grange to undertake a Mine Water Management Study (2023), refer **Appendix A**. The following is a summary from the report.

Local hydrology

The surface water catchment which currently reports to the North Pit is assumed to report to the proposed underground mine workings, via subsidence cracking. The catchment area of North Pit has been estimated from site topography information (digital terrain model) and site observations. The catchment has an estimated area of 1.7 km^2. The majority of the catchment is the pit footprint (85%), with the remainder being a small amount of ex-pit catchment located to the north of the pit. Runoff to the pit is primarily driven by winter rainfall events.

Water levels within the Broderick Creek Flow Through (BCFT), built along/over the Broderick Creek valley, also respond to seasonal rainfall events. Water levels in the BCFT can increase to the point that seepage into North Pit occurs. The existing West Wall Dewatering System (WWDS) captures this seepage and transfers it out of the pit to the South Lens Pit via a gravity drainage pipeline.

Existing dewatering

The inflow of surface water to North Pit is currently managed by an in-pit pumping system to the South Lens Pit, which is used to store and treat all mine inflows, prior to discharge to the Savage River. Estimated annual flows from the existing North Pit Stage 6c from 2022-2023 (surface dewatering) include:

- May to November: 200 L/s, 20 hours per day, 7 days per week; and
- December to April: 200 L/s, 20 hours per day, 4 days per week.

There is the availability to increase this to 320 L/s, if required. The existing North Pit water management is shown in Figure 15.

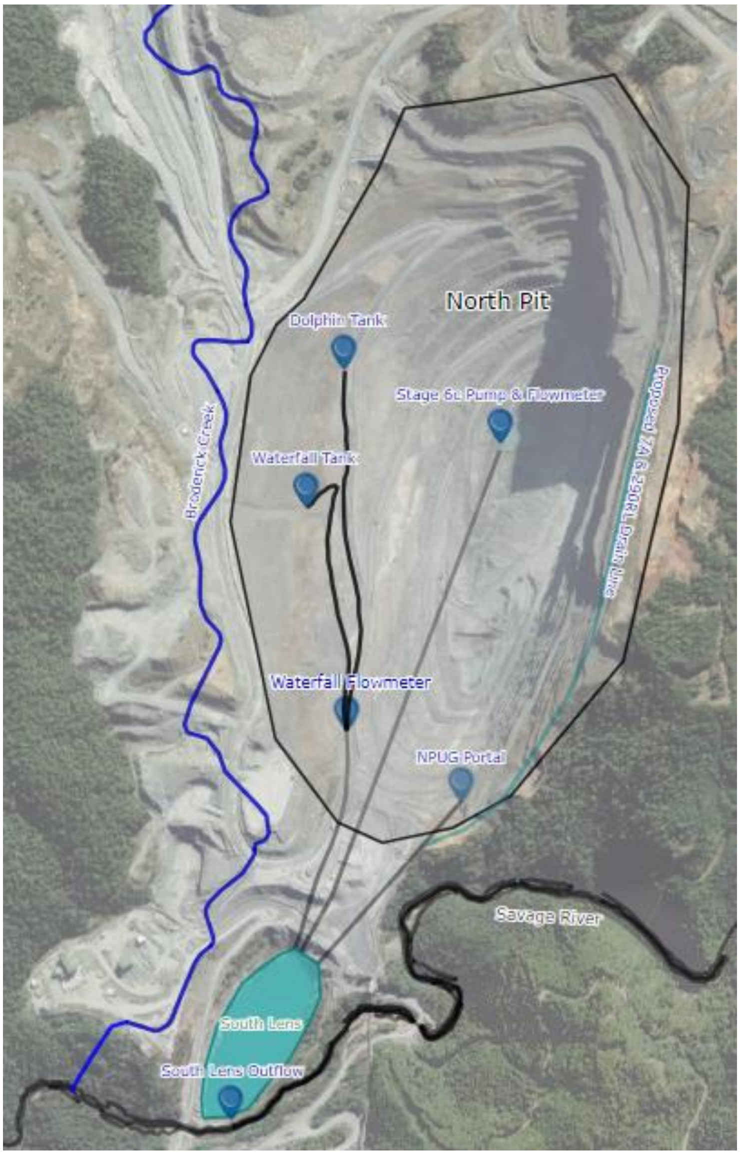

Figure 15 - Existing North Pit water management

Note – All lines are indicative only to provide a conceptual overview of water management.
The light grey lines running centrally to South Lens are approximate only as the actual pipes are buried.
The light blue line along the eastern wall is currently under construction.

The West Wall Dewatering System (WWDS) includes two tanks located along the western side of North Pit, the Dolphin Tank and Waterfall Tank, which intercept Broderick Creek seeps entering North Pit when high flow in the creek can cause water to backup and find alternate pathways at higher RLs in the wetter seasons.

The Dolphin Tank, located furthest north, collects seeps from the 169-175 RL, the collected water runs in a 600 mm pipe to a manifold. The Waterfall Tank collects seeps from the 179 RL and discharges via a 400 mm pipe to the manifold. The manifold combines the two pipes into one and this pipe is fitted with a flowmeter. This pipe gravity feeds to South Lens. Water flow rates for this line is highly seasonal, refer Figure 16. Flow rates of up to 500 L/s have been recorded during the wetter months, with negligible flow in drier months.

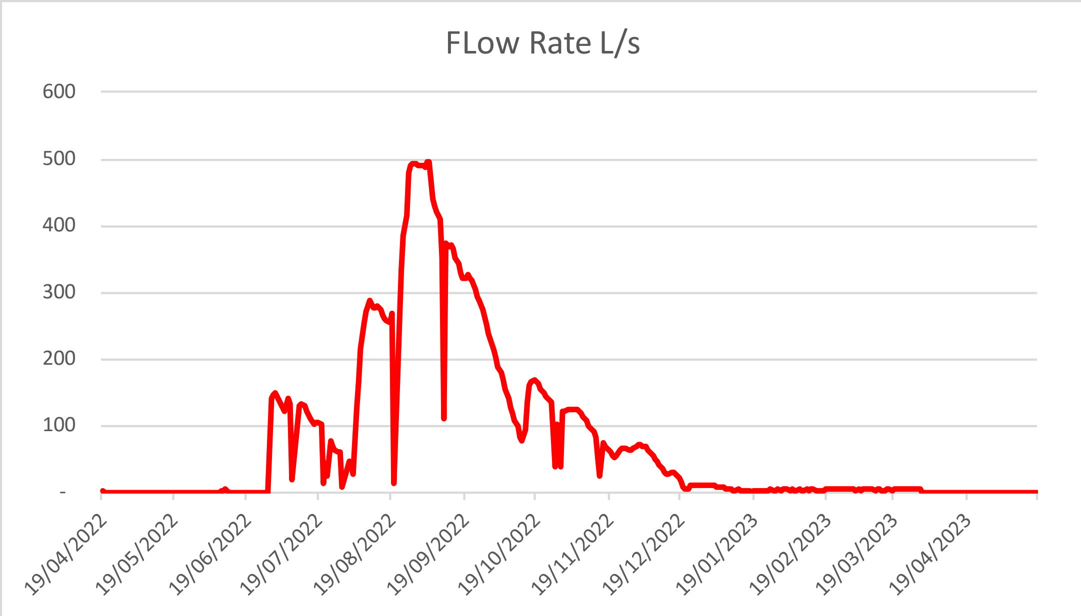

Figure 16 – Waterfall flow rate

A pipe on the eastern side of North Pit which will intercept run-off and drainage above the 290 RL from entering North Pit is currently under construction, refer Figure 15. This pipe will direct run-off directly to South Lens. There will be a flowmeter installed on this line when it is installed.

Groundwater

According to the AQ2 2023, hydrogeology in and around Savage River is complex. Apart from shallow river alluvium and some Tertiary basalts, the aquifers are generally low permeability basement rocks where aquifer properties are associated with fractures/joints/shears and some deep weathering of carbonate rocks along fracture planes.

In general, these aquifers are recharged by infiltration of rainfall runoff where fractures/joints outcrop or sub-crop beneath surface water drainages (streams, creeks and rivers). The aquifers naturally discharge as baseflow to the major creeks and rivers. The aquifers also discharge as groundwater inflows to the pit(s) with inflows subsequently pumped to the South Lens pit (for treatment) before discharge to the Savage River.

The hydrogeology in and around North Pit can be represented by a simple block model, with the key components (aquifer units) of the model including:

- East Wall Block
- Eastern Contact Fault Zone
- Ore Zone Block
- Western Boundary Fault Zone
- West Wall Block
- LeFroy Fault Zone; and
- Broderick Creek Block.

Refer to section 2.2.2 and 2.2.3 (Appendix A) for further details on aquifer permeability. Groundwater is likely to be encountered through faults only, including the Eastern Contact Fault Zone, Western Boundary Fault Zone, Hawkies faults and Whitlam fault. This was established during previous development work (under EPN 10006), which provided an understanding of the geological structures present in NPUG. Diamond drilling through the faults have supported this. Refer to Figure 17 for the hydrogeological block model aquifer units, for north-south trending faults.

As permeability appears to be strongly controlled by strike oriented structures, it is assumed that north-south oriented permeability in broad aquifer units is one order of magnitude higher than east-west oriented permeability (AQ2, 2023).

Groundwater inflows to the existing pit are largely a result of pseudo-radial groundwater flow through low permeability basement rocks and fault structures.

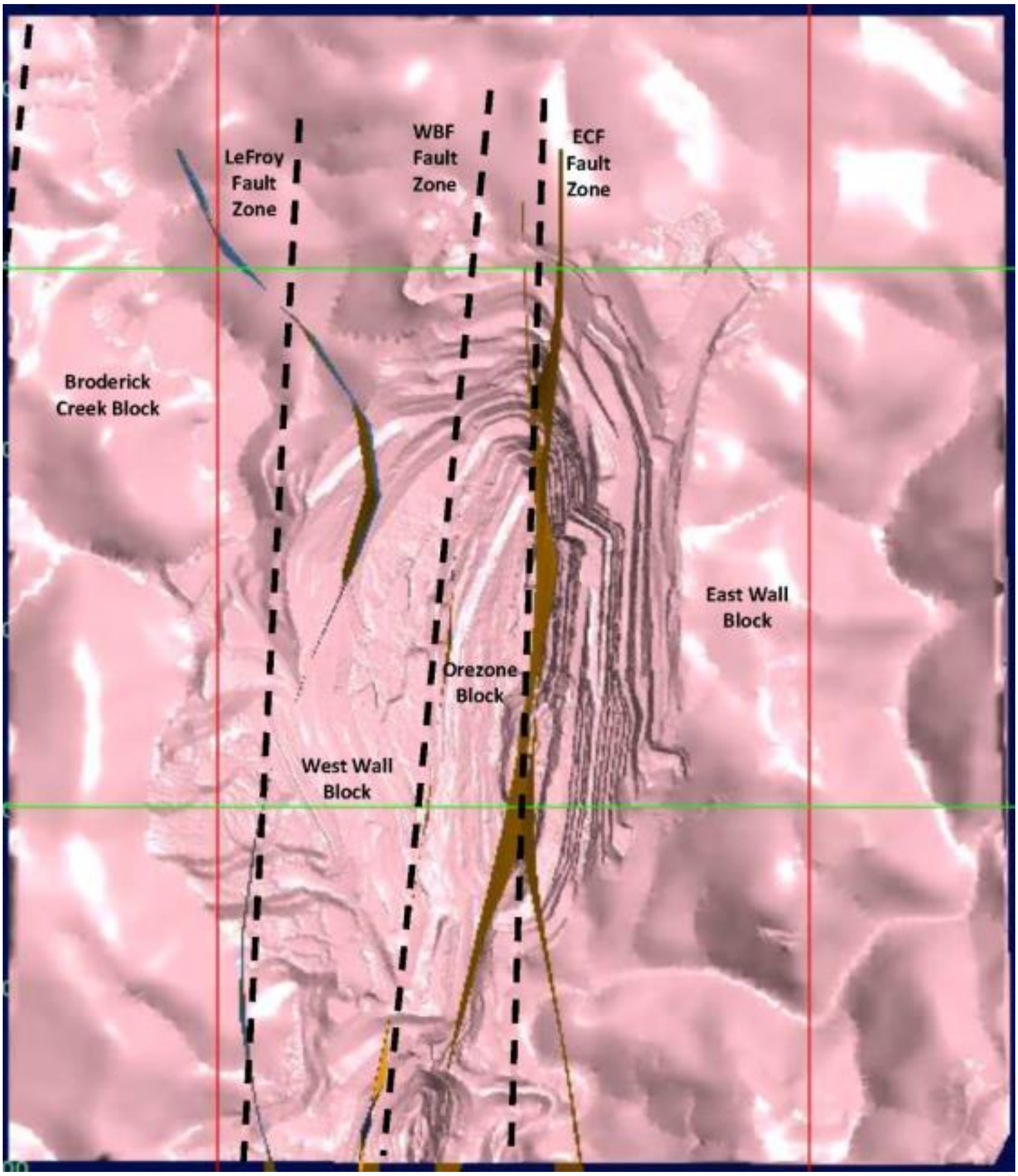

Figure 17 – Hydrogeological Block Model Aquifer Units (AQ2, 2023)

Groundwater Inflow Model

Refer to section 4.2, 4.3 and 4.4 (Appendix A) for the details of the analytical groundwater flow model. The key features of the prediction model set up were:

- The base of the BC is at -330 mRL
- The margins of the cave zone and 0.4% plastic strain envelope will be roughly parallel but extend laterally further than the final pit walls
- The base of the aquifer remains at – 100 mRL. The model simulates groundwater inflows to the upper half of the cave only. This is considered realistic as permeability in fractured rock aquifers typically decreases with depth and is minimal at depths of 400 m below natural surface; and
- Inflows were simulated from the west, east, north and south.

The model was run to predict total inflows at the end of the BC. The model predicted 40 L/s groundwater inflows to the cave zone and 15 L/s groundwater inflows to access declines.

Broderick Creek Flow Through System

The Grange BCFT was developed in 1998 to convey stream flow from the Upper Broderick Creek beneath the western waste dump to a discharge point on Lower Broderick Creek close to its confluence with the Savage River. This flow-through extended an existing flow-through developed by PMI in the lower reaches of Broderick Creek.

Currently, under “normal” rainfall and flow conditions, leakage/seepage from the BCFT into underlying weathered and fresh rocks (of the West Wall Block and Broderick Creek Block aquifer zones) is controlled by the low permeability of these units and would be minimal. As such, while the BCFT might contribute some seepage to groundwater, it is not likely to form a groundwater recharge boundary. However, the BCFT could form a recharge boundary (even if only a partial recharge boundary) if deformation around the cave zone results in direct hydraulic connection between the BCFT and the cave (refer section 2.3, **Appendix A**).

It is noted that, in 2018 following periods of prolonged high rainfall, water levels within the BCFT rose to the top of the Type A fill and significant volumes of water “overflowed” to North Pit at three low points (“West Wall waterfalls”) where the current pit wall cutback intersects the waste dump. It was estimated that up to 600 L/s flowed from the BCFT to the pit during this period. The WWDS has since been implemented to manage the potential for this to occur, including:

- A flow interception scheme to catch any future inflows and direct the water to South Lens
- Six monitoring bores have been installed to monitor water levels; and
- A Trigger Action Response Plan (TARP) has been developed, which includes monitoring rainfalls and water levels in the BCFT and readiness checks of the inflow interception scheme.

Significant overflows occurred again in the 2019 following periods of high rainfall and, while some minor refinement of the WWDS was required around piping, the scheme continues to effectively manage these overflows.

Table 7 - Summary of North Pit Water Inflows

Location	Winter season flows	Summer season flows	Capacity
Surface water runoff from external catchments[6] (captured Stage 6c flowmeter)	May to November 200 L/s, 20 hours per day, 7 days per week	December to April 200 L/s, 20 hours per day, 4 days per week	Can be increased to 320 L/s
Groundwater (modelled AQ2)	55 L/s	55 L/s	
BCFT – during high flow events West Wall Dewatering System (Waterfall flow rate)	Up to 600 L/s peak flow	Negligible	600 L/s

[6] It is assumed all runoff to North Pit reports instantly to NPUG (AQ2, 2023)

Water quality

Water quality monitoring of the North Pit underground area has been undertaken at five seepage inputs to the underground workings and three sites where flows are collected and combined. Monthly monitoring has been undertaken since 2021. Flow rates are not recorded at the sites so the relative input of the monitored seepage to the total flow is unknown. Some of the seeps are very slow, estimated at <1 L/s. Existing sump pumps are quite small with dewatering at NPUG currently around 10 L/s. Refer to Technical Advice on Water, 2023, *North Pit Underground Water Quality 2021-2022,* 27 March 2023 for the full report (**Appendix B**). A summary is provided below.

Water quality monitoring sites are shown in Table 8 as well as the type of sample, i.e. 'inflow' or 'composite'. Inflow samples reflect one discrete input within the underground whereas the composite samples are collected from sumps which collect more than one water source.

Table 8 - Summary of NPUG water quality monitoring sites

Site	Source or Composite site
BSD2 RH Wall	Input
BSD2 Face	Input
BSD Flow to Sump	Composite
Whitlam Fault	Input
South Decline Hose RH Wall	Input
Mono 2 Pump	Composite
SP1 Diamond Drill Hole	Input
NPUG_out	Composite

Note:

BSD – Bulk Sample Drive, SP1 – Stockpile 1, NPUG – North Pit Underground

A schematic of the underground workings and water monitoring locations are shown in Figure 18.

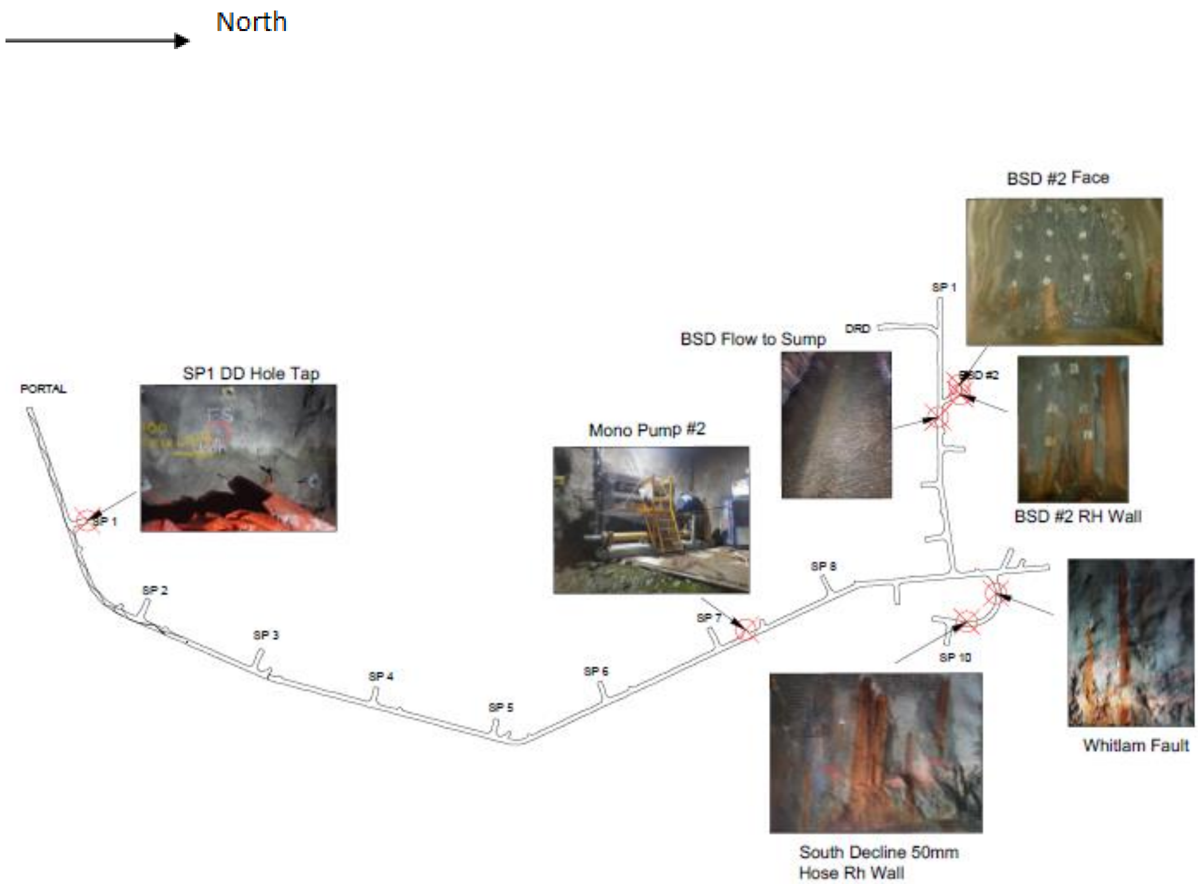

Figure 18 – North Pit underground water monitoring locations

The results of the water quality monitoring undertaken during 2021-2022 show:

- The composition of seepage inputs to the underground workings varies, with the South Decline (SD) RH Wall input having the lowest pH (7.2-7.6) and highest sulphate (1400-1600 mg/L) and dissolved iron concentrations of any of the measured inputs. Refer to Figure 3-2, Appendix B
- The water entering the Bulk Sample Drive at BSD2 RH Wall and BSD2 Face are similar to each other, and to the quality of water at the Mono 2 and NPUG_out, which are characterised by pH >7.5 and elevated alkalinity (100-150 mg/L) and low acidity (6 mg/L or less). This could be the result of most of the water being derived from the Bulk Sample Drive, or that water entering the underground along the decline has similar quality to the Bulk Sample Drive inflow. Refer to Figure 3-1 and Figure 3-3, Appendix B
- TSS increases as the flow progresses through the underground towards the portal, with the variable input likely related to traffic movements and drilling activity. Refer Figure 19; and
- Dissolved metal concentrations in all the samples are low with the exception of zinc in the NPUG_out site, which had a maximum value of 800 mg/l and median of 41 mg/l. Total metals are also low when normalised to the TSS concentrations. Refer Figure 20.

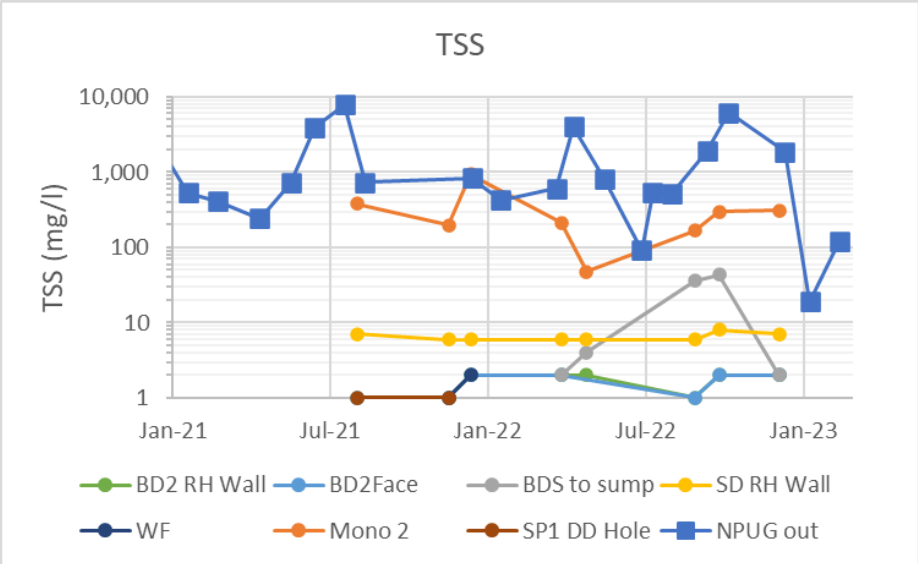

Figure 19 – Total suspended solids (TSS) in the underground monitoring sites

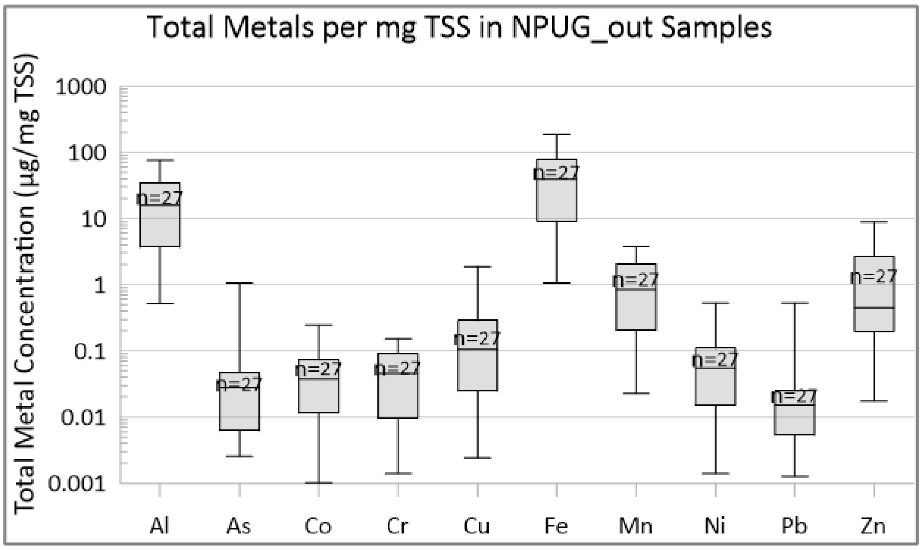

Figure 20 - Total metal concentrations per mg of TSS (μg metal/mg TSS, equivalent to mg/kg solid) in NPUG_out samples

Note - the box encompasses the 20th to 80th percentile values, and the 'whiskers' indicate the minimum and maximum values.
N = number of samples.

The water quality results show that the water discharged from the underground of North Pit into South Lens has pH>7.5, elevated alkalinity, low acidity, low dissolved metals, moderate sulphate and high TSS. The alkalinity in the underground water will contribute to the neutralisation of acid drainage entering South Lens, and the TSS will provide surface area for precipitation of metal oxy-hydroxides and promote settlement, similar to the present contributions from North Pit. The low dissolved metal concentrations would not significantly alter the alkali demand within the pit.

Existing operations ensure North Pit run-off is directed to the base of the pit prior to being pumped to South Lens for treatment. For the underground operations all run-off will be collected in the sump areas and pumped to South Lens, with minimal change to water volumes or water quality as a result.

Water quality monitoring across the remainder of the site continues as required by permit conditions.

Grange and the SRRP undertake real time monitoring at a number of key monitoring sites within the mining lease, as well as water quality monitoring at a number of surface and groundwater locations. Surface water monitoring occurs daily, weekly, monthly and quarterly depending on the location and with parameters also dependent on the location.

Surface water quality monitoring across the site is extensive, monitoring locations sampled by Grange include:

- Savage River at Pump Station (SRaPS)
- South Lens Outlet (SLO)
- Broderick Creek below Waste Rock Dump (BCbWRD)
- Savage River below South West Rock Dump (SRbSWRD)
- South Deposit Pit (SD)
- North Dump Drain (NDD)
- Centre Pit North (CPN)
- North Pit Underground Outflow (NPUG_O); and
- Centre Pit South Dewatering Tank.

The SRRP also undertake surface water monitoring at the following locations:

- Old Tailings Dam North (OTDN)
- Main Creek Tailings Dam outflow (MCTD); and
- Main Creek below South Deposit (MCbSD).

Groundwater monitoring is undertaken quarterly.

Surface water monitoring locations downstream of North Pit, including South Lens Outlet, and BCbWRD, are monitored daily for pH, conductivity and turbidity, and monthly for physicochemical and metal parameters. The Savage River at Smithton Road (SRaSR) site located outside of the mine lease, near Corinna is monitored monthly for pH, conductivity, turbidity, DO, nutrients, physicochemical, sulphate and metal parameters.

Proposed water management

Proposed dewatering and dewatering controls for NPUG are outlined in section 2.3.1. The proposed capacity of the underground dewatering system has been designed for 750 L/s installed pumping capacity. The designed pumping capacity for NPUG will be well above the recommended 490 L/s capacity modelled to ensure a margin of safety and conservatism.

As previously stated, the key philosophy for the dewatering system is to effectively capture water on the extraction level or allow it to overflow to lower levels in the case of high intensity rainfall events. In the event of a high intensity rain event, it is expected that controlled flooding of the underground workings would occur. This is considered manageable if water is diverted away from critical infrastructure so that the system can easily recover following a controlled flooding event.

The moderate depth of the proposed mine will allow for the use of conventional, staged centrifugal slurry type pumps. This provides a simple and robust solution. The application of a ‘dirty’ water pumping system simplifies the dewatering system, by not requiring residence time for the settlement of solids and provides a continuous input of suspended solids to South Lens, similar to the present situation.

The following philosophies have been adopted for the dewatering system:

- Capture water at highest level possible
- Controlled overflow to lower levels
- Dirty water pumping systems
- Flooding of the drainage level during ‘high’ rainfall events
- All critical infrastructure above flooded levels; and
- Bulk water storage dams and drainage level provide sufficient storage capacity during flooding event.

There will be no treatment of water underground. Sumps and drainage drives will be bogged out with underground loaders and trucked to the surface, as is standard underground mining practice. The pumping system is designed for dirty water, and with a velocity between 2.5 m/s (to avoid solids settling) and 3.0 m/s (to minimise friction losses and wear). All critical pump spares will be available on site, if required for replacement.

5.1.2 Assessment

AQ2 Pty Ltd were commissioned (**Appendix A**) to investigate potential water inflows to the underground mining operations. A conceptual hydrological model was developed based on current mine survey data and on information and data included in a number of historical reports (refer section 8, **Appendix A**). The following is a summary of the results. Refer to **Appendix A** for details of the model description and approach.

The water inflows into NPUG will be primarily derived from water flowing into North Pit. This is mostly from rainfall, groundwater inflows, and additional inflow from deformation of BCFT. Rainfall is, however, the principal inflow. The predicted flows are based on the following:

- Rainfall runoff to the North Pit and then directly to the BC extraction level, through the cave zone will fluctuate on a daily basis depending on rainfall and rainfall patterns. The maximum instantaneous inflow rates to the BC are predicted to be up to 2,500 L/s, with mean inflow rates ranging from 0 L/s to 150 L/s. The model also predicted that over the 15-year underground mine life, the estimated probability of inflow to mine exceeding different runoff rates is as follows:
    - 50% probability that a flow exceeding 1,300 L/s will occur
    - 25% probability that a flow exceeding 1,400 L/s will occur
- Groundwater inflows, including groundwater inflows from the surrounding low permeability basement rocks to the cave zone and surrounding 0.4% (plastic strain) deformation envelope, and inflows to access declines, are predicted to be up to 55 L/s; and
- There is the risk (albeit low) that deformation along the west wall of the pit might result in the failure of the current West Wall Dewatering System (WWDS) which could result in up to 600 L/s of additional inflow into the pit and BC following high rainfalls.

Broderick Creek Flow Through System Overflow Risk

There are two potential risks to the underground operations from the BCFT system. These risks have been identified as a very low likelihood of occurrence but are included as a matter of completeness.

- Overflow to the pit wall during high rainfall and high BCFT for periods which result in the WWDS being overwhelmed, and subsequent overflow to the pit; and
- High leakage through the base. However, deformation modelling (Beck Engineering 2022) indicated this is unlikely and the risk relates to leakage from the base of the BCFT into a zone of enhanced permeability that might be connected laterally to the pit crest. Such flows are not likely to result in increased daily total inflows to the WWDS but may result in flows occurring over longer periods.

These risks will be managed by:

- Upgrading the current WWDS with modifications to make it more robust under minor deformation conditions, refer section 6.3 (Appendix A) for details; and
- Implementing an Upper Broderick Creek Diversion Scheme, refer section 6.3 (Appendix A). It is noted that this scheme may not be required to operate at all, and if it was required there would be sufficient lead time to install the scheme as it is unlikely to develop early in the life of the BC. Relevant approvals would be sought in the event this system needed to be designed and commissioned.

The following measures will be implemented to aid in the management of these risks:

- Detailed monitoring of water levels in the BCFT monitoring bores and overflows from the BCFT waterfalls (duration and flow rates) to develop empirical relationships between rainfall and BCFT water levels and overflows; and
- Deformation monitoring in and around the BCFT waterfalls and the WWDS and development of trigger levels for the implementation of the Upper Broderick Creek Diversion Scheme.

In summary:

- An Upper Broderick Creek interception scheme is not required at the commencement of NPUG
- It would only be required if -
  a) There was breakthrough of the subsidence zone to the BCFT which resulted in flow from the BCFT to the pit; and also
  b) The WWDS failed; and
- Ongoing deformation monitoring during operations, as proposed above, should provide adequate warning that the above might occur.

Mine Inflow Water Management Plan

The concept mine inflow management plan, developed by AQ2 (**Appendix A**), has two major objectives:

- Managing inflows from rainfall runoff to the North Pit catchment (and hence into the cave zone) and base groundwater flows to the cave/subsidence zone including some enhanced leakage from the BCFT through minor connected cracking associated with deformation at the margins of the cave/subsidence zone; and
- Managing potential overflows from the BCFT during high rainfall periods.

A water balance approach was used to develop the optimum dewatering system pumping rates for various assumed buffer storage volumes in the bulk water storage dams. This assessment was restricted to the BC Lift 1 development[7] (from 2024 to 2038).

The concept water management plan includes:

- The use of purpose developed underground void space below the BC active mine workings (bulk water storage dams) to create buffer storage, which will smooth out dewatering pumping requirements. Probabilistic water balance modelling indicates that the inclusion of the following buffer storage volumes (bulk water storage dams) in conjunction with a 750 L/s underground pumping system would reduce the risk of flooding of the active mine workings:
  - 95,000 m^3 storage (bulk water storage dams) would result in a 10% chance of flooding above the top of the dams
  - 180,000 m^3 storage below the western perimeter of the Extraction Level would result in less than 1% chance of flooding the Extraction Level
- Upgrading the existing WWDS to cushion it against minor settlement and to reduce the potential for erosional scouring, so that it can continue to divert overflows from the BCFT System; and
- Possible installation of additional underground pumping capacity or installation of the Upper Broderick Creek Diversion Scheme if deformation exceeds current predictions and the WWDS fails. This scenario is considered unlikely to occur but will be monitored during operations. Refer above.

There are no predicted impacts of mine inflows and dewatering on groundwater and surface water outside the immediate mine area.

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[7] In block caving, the lift height is the vertical height between the extraction level and the top of the cave, in this case the bottom of North Pit. This is a single block cave so this block cave design is "Lift 1". There is potential for a second lift below this mine design, this would be known as BC Lift 2.

The proposed mine water management plan will result in:

- No additional rainfall runoff to the NPUG than is currently experienced
- Runoff to the North pit (and underground) will be returned to Savage River via South Lens Pit so runoff interception by mining will have little to no impact on regional river flows
- Groundwater inflows from surrounding aquifers will be sustained by leakage from the aquifer boundaries (Savage River, Broderick Creek, Upper Broderick Creek and Armstrong Creek). Groundwater inflows will also be returned to the Savage River via South Lens Pit. Due to the high permeability of the surrounding rock there will be limited inflow from surrounding aquifers. Therefore, groundwater inflows will have little to no long-term impact on regional river flows
- Drawdowns in groundwater levels, as a result of mine inflows, will be constrained to the immediate mine area and are not likely to be measurable beyond the aquifer recharge boundaries (Savage River, Broderick Creek, Upper Broderick Creek and Armstrong Creek)
- Overflows from the BCFT System to North pit (and underground) will also be returned to Savage River via South Lens Pit and so runoff interception by mining will have little to no impact on existing regional river flows
- Any water pumped from the Broderick Creek Diversion Scheme (if required) will be returned directly to the Savage River at the existing BCFT System discharge point and will have little to no impact on regional river flows; and
- Discharge from the Broderick Creek Diversion Scheme will have the same water quality as the Upper Broderick Creek. This will be somewhat different to current discharge from the BCFT system which is alkaline due to passage through the magnesite material that makes up the Type A fill (main flow pathway). As such, the pH of overall discharge from Broderick Creek to the Savage River will be closer to neutral. This is not considered to be an impact, but merely a minor change. A large portion of flow will continue to drain through the flow-through.

Overall, according to AQ2 2023, the potential impacts of the mine water management are considered to be negligible.

Grange accept the AQ2 conclusions, which are considered conservative, and do not propose to install additional underground pumping capacity as a result of the very low risk that the WWDS fails. Any increases in flow rate above the predicted have been modelled to be extremely unlikely. The proposed storage volume and the 750 L/s pumping rate will allow for some failure of the WWDS out of conservatism only. Nevertheless, if the flow rate does increase above 600 L/s on a sustained basis then Grange would divert any additional flow from BCFT, with any required approval sought from the EPA.

Description of potential impacts to South Lens and Savage River from dewatering operations

Previous water quality investigations, undertaken by L. Koehnken and D. Ray (2020), and as reported in *Grange Resources, Centre Pit Expansion Savage River Mine Environmental Impact Statement,* identified a number of inputs to South Lens, including Centre Pit North pond, North Dump Drain and water derived from Broderick Creek via North Pit.

According to the report (*Water quality implications of dewatering Centre Pit - Update V1.1 20 November 2020*), the North Dump Drain is the major source of metals, sulphate and acidity, with water from North Pit, Broderick Creek via Bretts Drains and North Pit providing the majority of neutralisation capacity. This water is characterised by neutral pH, low metal concentrations, elevated alkalinity and moderate sulphate.

A summary of water quality trends in South Lens from 2017 to 2020 was reported as follows:

- Water quality in the discharge from South Lens did not show an increase in metal concentrations or loads following a substantial increase in flow through the water body. The previous correlation between copper removal and hydraulic retention time is no longer observable in the monitoring data
- Input from North Dump Drain has not changed substantially and cannot account for the maintenance of good water quality in the South Lens discharge despite the reduction in residence time
- Input from North Pit contains high concentrations of alkalinity and sediment which have increased the alkalinity load into South Lens and may have increased metal removal through increased surface area provided by the suspended solids

- Water quality results since 2017 suggest that the metal removal in South Lens has been maintained, and likely increased since the increase in inflow from North Pit, despite a reduction in residence time; and
- A multiple-lines of evidence approach suggests that increased surface area due to increased suspended solids in South Lens has increased the rate of metal removal by increasing available surface area for metal precipitation and adsorption.

According to L. Koehnken and D. Ray (2020), the alkaline inflows to South Lens include water derived from Broderick Creek (Bretts Drain, North Pit discharge) and Centre Pit. Discharges derived from Broderick Creek will continue to enter South Lens. The North Pit inflow is not monitored but would be expected to be similar to Broderick Creek, with inflows characterised by neutral pH, low metal concentrations, elevated concentrations of alkalinity, and moderate (~300-400 mg/L) sulphate. Refer Table 9. It is these inflows that provide the majority of the neutralisation capacity within South Lens.

Table 9 - Broderick Creek water samples collected below Waste Rock Dump between October 2017 to October 2020

Broderick Creek water samples - 2017 - 2020				
Statistic	**Mean**	**80th Percentile**	**Median**	**20th Percentile**
Al Tot (mg/L)	76	57	31	20
Co Tot (mg/L)	3	3	3	3
Cu Tot (mg/L)	8	11	7	5
Fe Tot (mg/L)	106	84	40	20
Mn Tot (mg/L)	33	38	21	10
Ni Tot (mg/L)	10	10	10	10
Zn Tot (mg/L)	3	4	3	2
pH	7.46	7.56	7.465	7.34
Acidity (mg/L)	10	12	10	8
Total Alkalinity (mg/L)	190	219	183	166
Ca (mg/L)	131	148	127	113
Sulphate (mg/L)	364	408	354	294

As reported above (AQ2 2023), the proposed change in water flow from the North Pit open pit to the proposed underground operations is considered to be negligible with all flows captured and directed to South Lens as currently occurs on site. This includes a substantial sediment load, as the pumped water will not be settled prior to discharge to South Lens.

Water quality sampling of the NPUG has also shown similar water quality results, characterized by pH>7.5, elevated alkalinity, low acidity, low dissolved metals, moderate sulphate and high TSS. The alkalinity in the underground water will contribute to the neutralisation of acid drainage entering South Lens, and the TSS will provide surface area for precipitation of metal oxy-hydroxides and promote settlement. This will ensure that there will be no increases in toxicants of concern, such as copper and other heavy metal concentrations, leaving South Lens with water quality levels remaining stable.

Based on monitoring data over the past 26 years (1998 – 2024) the following water quality observations have been established:

- There has been a material improvement in Savage River water quality over time; and
- Baseline total alkalinity (mg $CaCO_3$/L equivalent) in Savage River has ranged from 2 mg/L to 59 mg/L, averaging 8 mg/L. There is a general seasonal trend that alkalinity in the Savage River is higher during the dry season (approximately November to March) and lower in the wet season, most likely attributable to natural organic acids in the river from tannins.

Total alkalinity is added to the river system via South Lens and acts as a key metric for observing any potential acid mine drainage impact. Therefore, it is important that total alkalinity from the South Lens outlet is generally in-line, or higher in concentration than the natural baseline Savage River concentration. This also assists in maintaining river health further downstream. The total alkalinity (mg $CaCO_3$/L equivalent) from South Lens Outflow over the same 26-year observation period has ranged from 8 mg/L to 158 mg/L, averaging 114 mg/L. The South Lens total alkalinity concentration is generally stable in nature and continues to prove effective as an onsite water neutralisation source.

It is noted that during development of the exploration decline, approximately 18,000 L to 30,000 L of shotcrete washout water is added to the system per day, with the total alkalinity of this water averaging approximately 15,000 mg/L. With 18,000 L of shotcrete washout water at 15,000 mg/L this provides 270 kg of total alkalinity per day, a 12% w/w relative addition. This level of alkalinity provides a suitable control in terms of neutralisation of acid forming materials within South Lens. The latest South Lens Outflow sample (1 February 2024) recorded a total alkalinity of 145 mg/L, which is also representative of total alkalinity over the long-term average. The average flow rate at the time was 180 L/s, indicating a total daily flux of total alkalinity of 2,255 kg. The addition of supplemental alkalinity adds further assurance to the continuation of South Lens' buffering capacity. This control serves to somewhat offset the potential loss of alkalinity through open cut machinery grinding carbonaceous rocks through traffic movement which provides alkalinity to South lens via overland flow.

***Proposed water quality triggers*[8]**

The aim of Grange in the ongoing day to day management of the Savage River site, and the SRRP is to improve water quality such that the Savage River and other waterways will support a healthy but modified ecosystem. Recent biological monitoring has demonstrated that there has been substantial recovery of the ecosystem, and the focus of Grange and the SRRP is, at a minimum, to maintain this improvement whilst identifying and implementing additional remediation activities where possible.

A key component of the success of the remediation program has been the diversion of historic, metalliferous acid drainage from North Dump into South Lens. The acid drainage is neutralised by alkalinity generated by Grange's ongoing mining activities and conveyed to South Lens via Grange's infrastructure. This collaborative relationship has persisted for almost two decades and prevented the release of tonnes of metals into the environment.

The metal removal mechanism(s) in South Lens are only generally understood, and the SRRP is initiating a comprehensive scientific investigation into quantifying the important processes occurring within South Lens. The existing conceptual model for metal removal in the pit is that alkalinity increases the pH of the inflowing historic acid drainage promoting the precipitation of metals. The surface area provided by the elevated levels of TSS in the North Pit inflow provides surface area for metal precipitation and enhances metal removal through settlement of the solids in the pit.

The SRRP South Lens investigation is a high priority because it is recognised there are many factors that contribute to or may contribute to metal removal and the final water quality discharged from South Lens. There is a need to better understand the role of each to guide future management and to plan for ultimate mine closure. These processes affecting water quality in South Lens include:

- Quality and quantity of acid drainage inflow from North Dump Drain
- Quality and quantity of alkaline, sediment-rich inflow from North Pit
- Quality and quantity of inflow from Centre Pit (north and south)
- Quantity and pattern of rainfall / runoff that affects:
  - Inflows from NDD
  - Inflows from North Pit
  - Inflows from Bretts Drains and surrounding catchment

[8] This section has been prepared by Lois Koehnken, Technical Advice on Water, 2023.

- ○ Residence time within South Lens
- ○ Flow rate in the Savage River
- Seasonal stratification within South Lens that can affect circulation and dissolved oxygen levels; and
- Metal sequestration and / or release from sediments under changing oxygen conditions.

The complexity of the South Lens system makes it difficult, if not impossible, to identify the impact of altering one input on the overall discharge quality to Savage River. Recent experience with the derivation of 'trigger' values for draw down of water within Centre Pit demonstrated that the existing water quality data base is not sufficient to use as a basis for identifying change. This is largely because of the changing nature of the inputs and outflow over time, so there is limited data that reflect the present conditions, refer Figure 21.

For example, during the dewatering of Centre Pit, seasonal trigger values were established based on fewer than ten data points per season. During dewatering, the rainfall conditions on the West Coast were drier than previously recorded by the SRRP, and changes to water quality in Savage River were attributable to the extreme low flows, rather than any change to the water quality processes within South Lens.

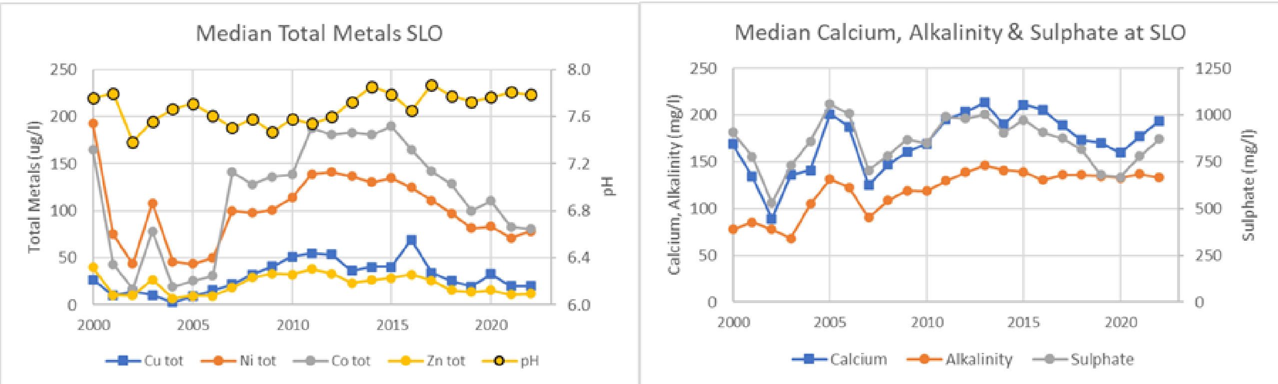

Figure 21 - Time-series of median metal, calcium, alkalinity and sulphate results at South Lens Outfall (SLO) showing variability over the past two decades due to changing conditions

The processes occurring in South Lens are complex and require greater understanding, which leads to some uncertainty on how inputs may change due to a shift in operations to underground. However, as presented in this EIS, all available surface water, groundwater, and underground water quality results strongly suggest there will be little or no change relative to present conditions with respect to alkalinity, TSS and metal inputs. Continued monitoring of South lens outflow and its inputs will continue during the operation.

It is proposed that in lieu of 'trigger values' for South Lens outflow or the NPUG inflow, that the ongoing monitoring continue whilst the SRRP South Lens investigation be completed. The investigation will quantify the impact of each of the inputs, and a more holistic approach to managing South Lens can be collaboratively developed. This may include identifying trigger values for the historic acid drainage as well as or instead of the circum-neutral, alkaline rich inputs.

No change to South Lens chemistry is anticipated, especially in the short term, with continuous monitoring to identify any changes in alkalinity. This is supported by the 2022 findings by the University of Queensland[9] showing that the pH of North Pit BC material was circumneutral ranging from pH 6-7 after a 46 week column leach trail observation period (Appendix E). Neutralising capacity will be further supported through the large amounts of alkalinity added through the inflow of approximately 18,000 L to 30,000 L of shotcrete washout water added to the system per day. This level of additional alkalinity provides a suitable control in terms of neutralisation of acid forming materials within South Lens, whilst development continues. The addition of shotcrete washout water will continue until approximately February 2032. Monitoring will continue to ensure alkalinity levels are maintained. If changes in alkalinity are detected, then Grange will implement corrective actions, for example, supplementary alkalinity addition, in partnership with SRRP and in accordance with its responsibilities under the Goldamere Agreement and Act.

[9] The University of Queensland, 2022, Kinetic Trials, Savage River mine, Tasmania, Final Report for Grange Resources

Until further investigations by the SRRP are completed, Grange proposed to utilise the 'investigation trigger levels' for the South Lens Outflow, as described in Condition EM4, PCE 10995, as an indicative investigation level. The North Pit underground flow (NPUG_out), is however, more problematic, due to the relatively limited data set available. Grange therefore proposes to use the 80th percentile values of the monitoring undertaken to date (43 samples over 3 years) as an indicative investigation trigger level, until such time as further data is available or SRRP investigations can identify scientifically justifiable levels. These indicative levels are provided in Table 10.

Table 10 - Proposed investigation trigger levels North Pit Outflow (NPUG_out)

Parameter	Investigation trigger level
Copper (total)	383 µg/L
Nickel (total)	138 µg/L
Cobalt (total)	129 µg/L
Zinc (total)	2152 µg/L

5.1.3 Avoidance and mitigation measures

Grange already undertakes extensive water management across the site, from dewatering to water quality monitoring.

Current management of water flows at the Savage River Mine will continue to be implemented. This will include, in relation to North Pit operations:

- The current diversion of surface waters surrounding North Pit
- Existing dewatering of North Pit, including the interception of Broderick Creek water, including the monitoring of flow rates; and
- Underground water quality monitoring, refer Table 8.

Additional management measures proposed for NPUG will include:

- Proposed dewatering of NPUG to intercept all seeps and flows, including monitoring flow rates
- Installation of a drainage line along the east wall (Figure 15). This has commenced and is due for completion by 2024 winter
- Ongoing deformation monitoring during operations of the BCFT, with implementation of an Upper Broderick Creek Diversion Scheme, if required; although this is considered unlikely; and
- On-going water quality monitoring of NPUG (Table 8).

Water quality monitoring

Water quality monitoring for the NPUG will include the monitoring program as proposed in Table 11. This monitoring will be undertaken as part of the existing water quality monitoring at the site, and as required by Attachment 8 of PCE 10995.

It is proposed to continue monitoring NPUG underground seeps on a monthly basis for an initial period of six months. Then provided NPUG_out and South Lens outflow are within acceptable limits[10], these sites would remain as investigation sites only when NPUG_out and/or South Lens outflow show elevated concentrations.

[10] It is proposed to utilise the South Lens Outflow Investigation Trigger Levels, Condition EM4, PCE 10995, as indicative trigger levels until such time as the SRRP South Lens investigation is complete.

Table 11 - Water quality monitoring – NPUG

Location	Parameters	Frequency
Surface input from North Pit to South Lens[1]	pH, TSS, alkalinity, acidity, sulphate, total & dissolved metals (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Zn), cations (Ca, Mg, Na, K), anions (F, Cl)	Monthly
North Pit underground locations (Table 8)[2]	pH, TSS, alkalinity, acidity, sulphate, total & dissolved metals (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Zn), cations (Ca, Mg, Na, K), anions (F, Cl)	Monthly for 6 months
North Pit underground outflow (NPUG_out) (41.4764849 145.2066526)[11]	pH, TSS, sulphate, alkalinity, total & dissolved metals (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Zn)	Initially fortnightly (for 6 months), then monthly
South Lens outflow *(Already required by EPN248/2 and PCE 10995)*	TSS, alkalinity, acidity, sulphate, total & dissolved metals (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Zn), cations (Ca, Mg, Na, K), anions (F, Cl)	Fortnightly

Notes:

1 – The specific location for this monitoring point has not been determined, but it will likely be situated along the pipeline of the North Pit west wall. It is currently too dangerous to access the bottom of the pit. This location will be installed as part of the South Lens project; and

2 - These locations are underground, with no eastings and northings available.

Reporting

Reporting of water quality monitoring for the NPUG will include:

- Summary report of monitoring results and any management actions on a quarterly basis to the EPA for the first year following the commencement of approval, and then six monthly; and
- Provision of annual report with an analysis of results to the EPA, including a detail summary of the monitoring results, any exceedances and management actions implemented as a result of exceedances.

Table 12 - Water quality management measures

	Management measure	Timing for implementation	EIS section
1	Continuation of current surface water diversion around North Pit	ongoing	5.1.3
2	Continuation of existing dewatering of North Pit, including the interception of Broderick Creek water	ongoing	5.1.3
3	Dewatering of North Pit underground, refer 2.3.1 for details	ongoing	2.3.1, 5.1.3
4	Water quality monitoring of NPUG	ongoing	5.1.3
5	Reporting of water quality monitoring to the EPA. Quarterly for summary report and annually for analysis of results (as part of Annual Environmental Report)	As required	5.1.3

11 This location is the preferred location on the crusher road, NPUG_out on Figure 12.

5.2 Waste rock and tailings management

Large quantities of rock are extracted and crushed to obtain ore, leaving a volume of waste rock for disposal. The key management issue for waste rock at Savage River mine is the presence of PAF. Grange Resources implements a Waste Rock Management Plan (WRMP – November 2021, **Appendix C**) to ensure all waste rock is dumped in an appropriate manner to prevent acid formation. This plan is approved by the EPA and described in the current Environmental Management Plan[12] for the mine.

It is noted that the operation of the BC is likely to result in significantly lower volumes of waste rock generated compared with open cut. This is likely to expediate the closure of the existing waste rock dumps and bring forward rehabilitation of these areas.

Tailings produced from the processing of North Pit ore will be deposited into South Deposit Tailings Storage Facility (SDTSF). There is adequate capacity in the tailings storage facilities to contain the tailings produced from North Pit ore processing, with no operational changes required to accommodate the tailings from NPUG. Current tailings placement is sub-aerial with recovering of tailings as required to ensure continuing saturation.

5.2.1 Waste rock types

There are four main geochemical groups of waste types (A to D) at Savage River, refer Table 13 for mineral lithology, material character, flow through suitability, net acid producing potential, presence of sulphides and whether the waste type is acid forming.

Table 13 – Waste rock classification

Waste Type	Material Lithology	Material Character	Flow Through Suitability	Net Acid Producing Potential (NAPP)	Presence of Sulphides	Acid Forming
A	Fresh chlorite, carbonate, calcite schist, magnesite or dolomite	Hard weather resistant and durable	Yes	<-30 kgH_2SO_4/t alkalinity ≥ max acidity	No or minimal visible pyrite	NAF
	Weathered magnesite, dolomite or chlorite – carbonate schist	Soft liable to break down by weathering or compaction	No	<-30 kgH_2SO_4/t, alkalinity ≥ max acidity	No or minimal visible pyrite	NAF
	Metamorphosed gabbro, dolerite and basalt	Hard weather resistant and durable	Yes	<-30 kgH_2SO_4/t, alkalinity ≥ max acidity	No or minimal visible pyrite	NAF
B	Western stratigraphic units with albite / chlorite / muscovite.	Friable, weak rock units	No	Neutral, ANC = MPA	Some visible pyrite – sufficient capacity for self-neutralisation	Neutral
C	Schist, low sulphide serpentinite and clay	Soft liable to breakdown by weathering or compaction	No			NAF
D	Chlorite – sulphide schist, sulphide intrusives, serpentinite, talc schist, mixed waste rock and unidentified materials		No	>+30kg H_2SO_4/t, ANC < MPA	Significant visible pyrite	PAF

[12] Grange Resources (Tasmania) Pty Ltd, 2022, *Environmental Management Plan 2022-2024, Savage River and Port Latta*

The main waste rock type to be extracted from North Pit underground will be Waste Type A (NAF), with an estimated 82% of total waste rock being Type A. An estimated 12% of waste rock is type B (neutral) and 6% will be waste rock type D (PAF). The estimated quantities of waste rock to be extracted from the underground operations at North Pit from 2023 to 2040 are provided in Table 14.

Table 14 - Estimated volume of waste rock by type for Transition and BC

Material Type	Tonnes (Mt)	% of Material Tonnes
A Type (NAF)	3.6	82%
B Type (Neutral)	0.5	12%
C Type (NAF)	-	0%
D type (PAF)	0.3	6%
Total	**4.4**	

Given the comparative ratio of waste rock Type A to Type B/D, the acid neutralising capacity of Waste Type A material will far exceed any acid producing potential stemming from sulfide bearing main host assemblage[13] waste rock. The potential for sulphates reporting to South Lens from material derived from BC development is considered low due to the relative abundance of high-carbonate yielding Eastern Wall Assemblage waste rock (Waste A) acting as a buffer and neutralising any potential acidic conditions. From the diamond drilling undertaken to date, there has been no indication that there is a discernible change in the concentration of adverse elements grade with depth.

The geochemical summary of the waste rock type for North Pit are shown in Table 15. North Pit results are within the range reported for all rock types studied at Savage River (Table 15). The management of this type of waste rock and AMD generated by North Pit Underground can therefore be managed in accordance with existing waste rock management measured implemented at Savage River, refer section 5.2.2.

Table 15 - Waste rock geochemical indicators

	Paste pH	Total S (%)	NAG pH	NAPP	ANC
North Pit underground	8.9	2.6	5.6	-38	118
Centre Pit North	9	1.21	6.65	-16	53
Centre Pit South	9.2	3.2	2.6	78	21

As noted in section 5.1.2, the University of Queensland undertook Kinetic Trials in 2022 which included material from BC column (Appendix E). The scope of work included five column leach trials with pH and EC recorded weekly and monthly leachates analysed for metals and sulphates. A summary of the results is provided below. Refer to Appendix E for further details.

- The pH values over the 46 week period were circumneutral, ranging from pH 6-7
- Pyrite is present in greater abundance than carbonates, however, insitu mineralogical data collected demonstrates it is well capsulated
- In all column materials, copper appears to be the main potential contaminant of concern with values, from week 17 onwards, for many columns, measured above ANZECC (2000) 80% water quality protection guidelines
- Occasional exceedances above ANZECC (2000) 80% water quality protection guidelines and Livestock Drinking Water Levels for nickel, lead and zinc were measured, but were not consistent
- No obvious intermediate reaction products were observed in mineralogical studies; and
- Examination of the mineral chemistry of the sulfides may better inform future waste management options (i.e., confirm copper hosts and indeed, pyrite chemistry as it may report to tailings/ waste rock dumps).

[13] Main Host Assemblage is the waste rock that encapsulates the ore itself.

5.2.2 Waste rock management

Existing management

Waste rock management at Savage River is undertaken in accordance with the WRMP (2021) (**Appendix C**). The WRMP outlines the classification, excavation and transport procedures for waste rock material during operations as well as monitoring of waste rock materials and waste rock dump construction monitoring. The WRMP will be updated to prior to the development of the Transition and BC mine stages, to reflect the proposed underground mining and waste rock extraction methods.

Current waste rock management includes waste rock characterisation (MPA, ANC, NAPP and NAG), column leachate experiments and geotechnical monitoring of waste rock dumps.

Waste rock characterisation takes place during all stages of mine development, with the WRMP including validation sampling of dumps to ensure waste is placed in approved locations. Results of waste rock sampling and testing are provided in relevant monitoring reports.

Waste rock types are managed in accordance with the approved WRMP, as outlined in Table 16.

Table 16 – Waste rock type management

Waste rock type	Management
A	A-type waste is used for rock armouring completed during dump complexes. It is also used to build haul roads and flow-throughs.
B	B-type waste is segregated and generally dumped with D type waste (PAF).
C	C-type waste is segregated from other waste types and stockpiled on site for use in D-type dump encapsulation.
D	D-type waste is reactive PAF rock or rock of unknown classification which requires encapsulation to prevent oxidation.
Unclassified	Waste rock that cannot be classified through normal sampling and classification procedures should be classified as D-Type PAF waste.

There are a number of existing waste rock dumps approved for use at the site, refer Figure 11, with existing capacity available, refer Table 17.

Table 17 – Existing waste rock dump capacity

Waste rock dump	Capacity	
	Million loose m^3	Million Tonnes
South Deposit Backfill PAF dump	25.5	55
Current stage of Waterfall PAF complex	9.5	21
Current stage of Lower Broderick Creek PAF complex	6.2	14
Current stage of Lower Broderick Creek NAF complex	33.9	73

According to the WRMP (**Appendix C**), the designs of each waste rock dump are updated annually or as required to meet operational requirements. The disposal and encapsulation practices for each dump are provided in the WRMP. The current designs are contained within the Life of Mine Waste Dump Plan in accordance with MHS-16 Mining Planning Procedure.

Acid and Metalliferous Drainage (AMD)

Acid and Metalliferous Drainage (AMD) occurs when PAF material (D-type waste) and specifically sulphides are left exposed to oxygen. The oxidation of sulphide minerals in the rock results in products that are characterised by low pH (acidic), and high metal concentrations.

All dumps containing D-Type waste (PAF waste) are sealed through the use of C-type encapsulation to minimise oxygen diffusion through the barrier and maintain the percentage reduction of the Acid Sulphate Generation Rate (ASGR) at greater than 95%. To achieve this, all waste dumps at Savage River which contain Type D waste (PAF material) are constructed by:

- Covering the base and top of the D-type dump with a minimum of 2 m of C-type “clay”; and
- An outer layer of A-type armouring, at least 5 m thick, shall be placed over the layer of C-type capping to prevent erosion of the C-type, prevent during and maintain the required saturation level of the clay and provide stability.

Proposed waste rock management

Type A waste rock from North Pit underground will be managed through backfilling directly into the southern end of North Pit, refer Figure 22, or placed into existing approved waste dumps. Dumping into North Pit will only occur on completion of North Pit Open Cut operations. The total volumes of waste rock from each mining phase, and the capacity of the proposed North Pit waste dump, is provided in Table 18. Note, this includes all waste rock types, so this is a maximum of waste rock from NPUG development and not the maximum quantity that will be backfilled into North Pit.

Table 18 - Waste rock tonnes from North Pit Underground

North Pit waste rock dump capacity (Mt)	Total waste tonnes (Mt)	Block Cave (Mt)	Transition Mine (Mt)
5.4	4.3	3.8	0.5

Waste rock from the NPUG operation is development waste rock only. This results in the majority (80%) of the waste rock being extracted from the east wall assemblage. The east wall assemblage is a mafic carbonate chlorite schist of A-Type classification, refer Table 19. B and D-Type waste rock will be encountered as development approaches the Main Host Assemblage (MHA). Development through the MHA once above DTR 15%, will be sent to the crusher and will not report into North Pit as waste rock. Due to the significant mass of A-Type rock, any outflowing water from the waste rock mass is expected to be characterised as acid consuming. The indicative schedule for these waste tonnes, are provided in Table 19.

Table 19 – Indicative waste rock type in tonnes, after North Pit open cut operations cease

Material type	Indicative tonnes anticipated per year (Mt)						
	2027	2028	2029	2030	2031	2032	2033
A	0.49	0.54	0.5	0.04	0	0.01	0
B	0.05	0.17	0.17	0.04	0.02	0.01	0
C	0	0	0	0	0	0	0
D	0.02	0.08	0.08	0.02	0.01	0.03	0.001

Note: all development waste rock from underground will be managed as per the existing WRMP until such time that it is not feasible for open cut equipment to handle waste rock (estimated mid 2027). Therefore, it is anticipated that all waste rock will be backfilled into North Pit south from mid 2027 until the end of 2028. From January 2029, no D-Type waste rock will be backfilled into North Pit. Refer to Table 20.

Table 20 – Indicative waste rock type in tonnes, to be backfilled into North Pit

Material type	Indicative tonnes anticipated per year (Mt)						
	2027	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
A	0.49	0.54	0.5	0.04	0	0.01	0
B	0.05	0.17	0.17	0.04	0.02	0.01	0
C	0	0	0	0	0	0	0
D	0.02	0.08	0	0	0	0	0

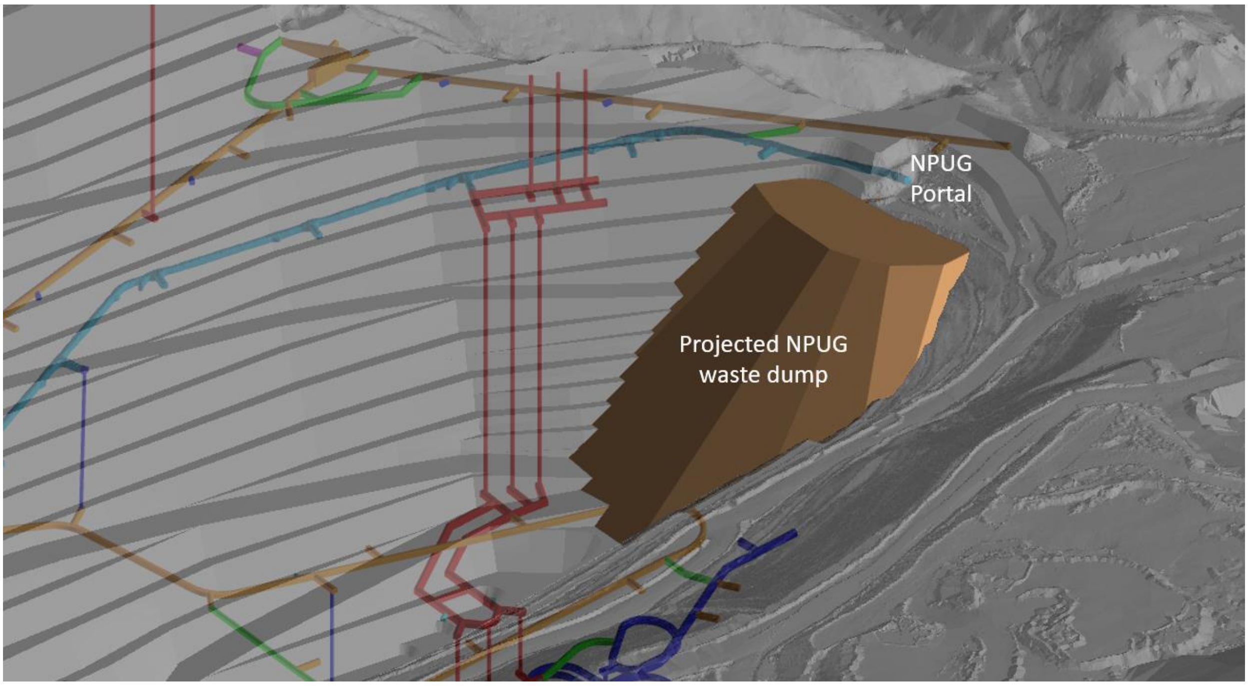

Figure 22 – Proposed waste rock dump location in North Pit

A recline angle of 37 degrees was assumed for the North Pit waste dump as per the site's current procedures when handling A-type waste. A-type waste is typically alkaline, thus no AMD issues have been considered when dumping into the pit. There are typically no asbestos minerals found in A-type.

Due to the concurrent schedules of the open pit and the NPUG BC, further work will be completed on the timing when NPUG operations can include tipping waste over the southern batter. However, sufficient volume exists in the current Savage River waste dumps for NPUG if tipping into North Pit is not feasible. Refer Table 17. At this stage December 2026 is the earliest tipping waste rock into North Pit would occur, with the latest schedule indicating that June 2027 is more likely.

Cave modelling estimates that there will be dilution (waste entry) from around the mid-point of the mine life. This waste will include fall-off from the North Pit walls and likely also from the waste dump, depending on how big the dump is, and the final cave shell. Estimates are using the worst case scenario in relation to the size of the waste dump. Refer to Figure 23 for an indicative vertical section.

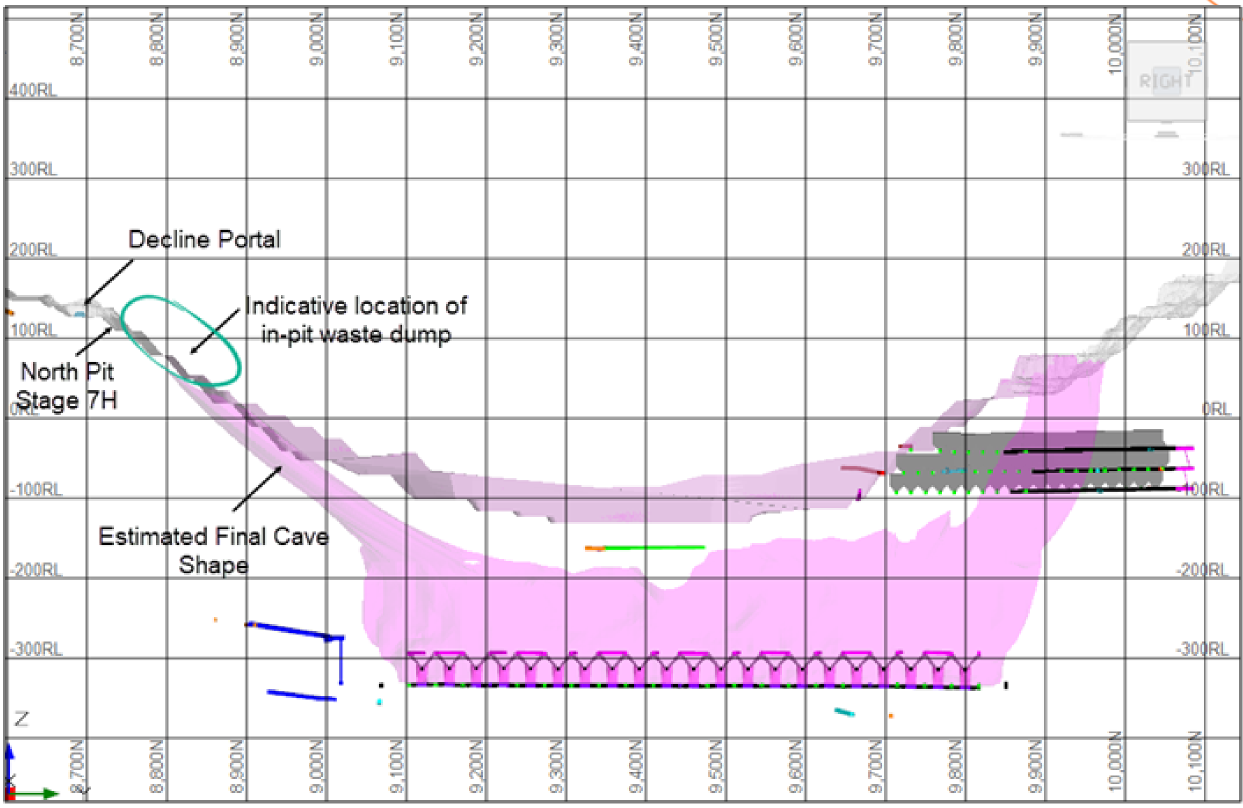

Figure 23 – Indicative vertical section through final cave shape and North Pit Stage 7H

Operational waste rock management

Waste rock management during underground operations of North Pit will continue to be handled in accordance with the approved WRMP, with procedures followed to ensure appropriate waste rock classification. This will include:

- Defining waste rock material during the drill and blast cycle, through logging of the drill cuttings at the hole collar. All blasted collars are visually assessed in the field for waste type and one sample from each discreet waste type identified in a blasted shot is sent for NAG testing to confirm the field assessment
- Where materials are free-dug, regular visual field assessment of waste type is required and in addition grab samples need to be taken frequently while free-digging is in progress and sent for NAG testing
- Both the drill hole survey and the logged geological data are uploaded into mining software. The boundaries of the ore and different waste types are digitised into three-dimensional coordinates from the plan. Based on the logging data, the waste areas are subdivided into the different waste categories, i.e. 'A', 'B', 'C' or 'D' type. The digitised data is used to identify the boundaries of the mining blocks; and
- Where there is uncertainty with waste rock material, it will be assumed to be PAF and treated accordingly.

Waste rock auditing practices

Grade control classifications are assessed against laboratory NAGpH analysis to verify accuracy and waste rock segregation. NAGpH is also assessed against full geochemical test results from NATA certified laboratories.

Performance of grade control classification against laboratory test results will be analysed over time by the Environmental and Geology Groups in Grange Resources and by suitably qualified external contractors. Variations between field classification and laboratory results will be addressed as soon as is practical. Quality control is carried out as per Table 21.

Table 21 – Waste rock quality control testing

Quality control	Type	Frequency	Parameter
Review results of NAGpH data	Grade control vs NAGpH	Weekly	Check grade control classification vs NAGpH classification to verify correct dumping.
Graph results of all waste rock classification data	NAGpH vs NAG & NAPP	Monthly	Determine variance between classifications
Review available publications	Knowledge base	Yearly	Update on AMD prevention current thinking and analytical methods
Attend workshops and conferences	Knowledge base	As Available	Update on AMD prevention current thinking and analytical methods
Review waste type availability against planned and required type	Waste types available and required	Yearly	Waste volumes

Grange will ensure the waste rock management system is audited no less than once every two years, ensuring compliance with the WRMP and EPA permit conditions. Independent auditing of waste rock selection, segregation, management and disposal will also be undertaken every 2 years during mining and construction of waste rock dumps, PAF cells, flow-throughs and filter faces.

5.2.3 Tailings

Tailings geochemistry

Geo-Environmental Management Pty Ltd were engaged to undertake a tailing leach column testing program for the Savage River mine, refer to Appendix D for the full report[14]. The report is an interim report which provides the results of the static testing and the first six months of leach column testing. A final report will be prepared following the full 12 months of testing. A summary is provided below.

Acid forming characteristics

The acid-base analysis, NAG test results and geochemical classification of NPUG tailings are provided in Table 22. For comparative purposes, Centre Pit North and Centre Pit South results are also included.

Table 22 – Acid forming characteristics of the Savage River Mine tailings samples

Location	Total %S	Sulfide %S	MPA	ANC	NAPP (total S)	NAPP (sulfide S)	NAGpH	Geochem class
North Pit Underground	6.09	4.48	186	118	68	19	8.2	UC (NAF)
Centre Pit North	8.68	7.28	266	74	192	149	2.1	PAF
Centre Pit South	13.8	11.4	422	69	353	280	2.2	PAF

Notes:

MPA - Maximum Potential Acidity (kg H_2SO_4/t)

ANC – Acid Neutralising Capacity (kg H_2SO_4/t)

NAPP – Net Acid Producing Potential (kg H_2SO_4/t)

NAGpH – pH of Net Acid Generation liquor

UC – Uncertain (expected class)

[14] Geo-Environmental Management Pty Ltd, 2023, *Tailings Leach Column Testing Program for the Savage River Mine, Tasmania, Interim Report, August 2023*, Draft.

The sulfide content is moderate for NPUG at 4.48%S in comparison to the high sulfide contents for Centre Pit samples. The ANC values are high for NPUG at 118 kg H_2SO_4/t. With a positive NAPP value of 19 H_2SO_4/t and a NAGpH of 8.2, the NPUG sample has an uncertain geochemical classification. An uncertain classification is used when there is apparent conflict between the NAPP and the NAG results. In this instance when the NAPP is positive (marginally) and the NAGpH is above 4.5. Refer Figure 24 and Figure 25 for comparative plots. The lower NAG capacity of the NPUG samples compared with the NAPP value is likely due to the presence of lower reactivity, crystalline sulfides, and therefore it is expected that the NPUG material will be NAF. Further leach column testing is being undertaken to confirm this.

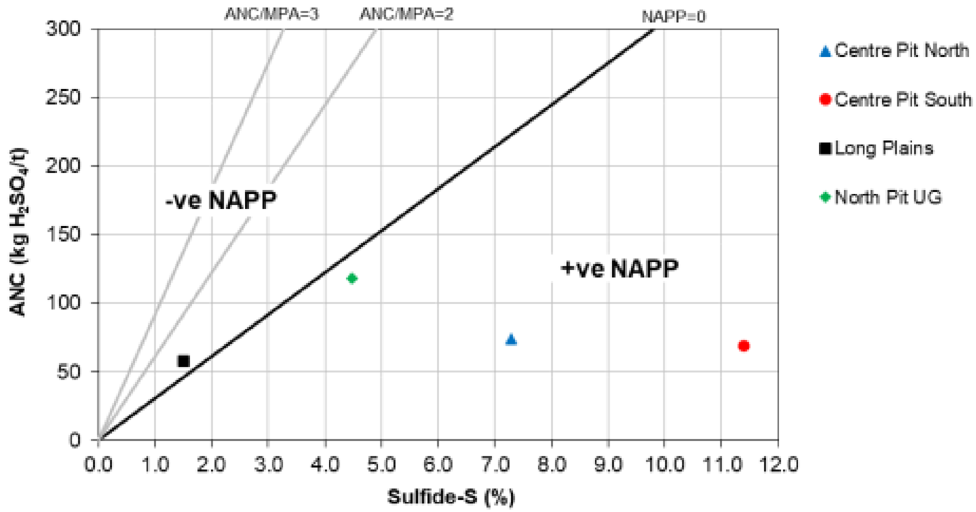

Figure 24 – Acid-based account plot for tailings

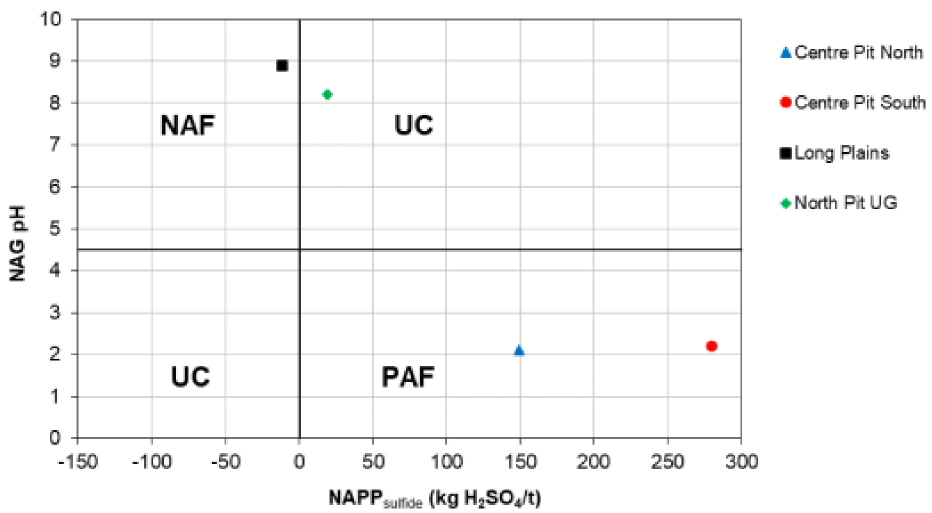

Figure 25 – Geochemical classification plot for tailings

Metal enrichment

The results of multi-element scans indicate that boron, cobalt and selenium are elevated in the NPUG tailings. Refer Table 3 of Appendix D for the full results. A summary table of elevated elements is provided in Table 23. These results show that the values in NPUG tailings will generally be lower than is currently occurring in the existing open cut material, with the cobalt, copper and selenium concentrations detected below the Centre Pit North and Centre Pit South tailings concentrations. Existing management measures are implemented on site to manage metal concentrations in tailings and no additional measures are expected to be required for NPUG tailings.

Table 23 - Tailings enrichment values

Geochemical Abundance Indices Enrichment Factor[15]			
Element	**NPUG**	**Centre Pit South**	**Centre Pit North**
Boron	3	3	2
Cobalt	3	4	4
Copper	2	5	4
Nickel	1	2	2
Selenium	5	6	6
Zinc	1	2	2

Existing tailings management

Three tailings storage facilities (TSFs) are currently in operation at the Savage River mine. The Main Creek Tails Dam (MCTD), the South Deposit Tailings Storage Facility (SDTSF) and the Emergency Tails Dam (ETD). All dams use a water cover to prevent long term oxidation of sulphide.

The SDTSF has been operational since November 2018 and is located downstream of the MCTD such that discharge from the MCTD enters and is discharged from the SDTSF. The SDTSF is a rockfill embankment with an upstream filter face. The filter face is designed to retain tailings in the storage while allowing passage of decant water. A flow-through rock drain is situated behind the filter face and continues beneath the embankment in the original path of Main Creek.

The flow-through drain conveys decant water from the filter face to the downstream toe. The SDTSF has a planned final height of 140 m with a crest level of RL 300 m. There is, however, small increases in turbidity following heavy rainfall events due to the entrainment of fine particulates and runoff from the catchment. Turbidity events that are not related to rainfall events are managed in accordance with the *Savage River SDTSF Operations, Maintenance and Surveillance Manual.* There will be no additional impact as a result of the proposed underground mine.

The MCTD is currently in a closure phase, with closure expected within the next two years. The final lift to RL 338 m has been completed.

The ETD operates as an emergency discharge point during plant failures or short-term maintenance activities.

To prevent the oxidation of tailings, Grange maintains the tailings in a saturated state, with fresh tailings covering older tailings at regular intervals. On closure of tailings storage facilities, water covers will be used to prevent long term oxidation. Testing has shown that tailings have a long lag phase before acid production commences due to inherent Acid Neutralising Capacity (ANC).

Operational management of tailings in the SDTSF includes:

- Tailings distribution is currently upstream with tailings moving down valley from the discharge towards the SDTSF filter face
- Fine tailings will eventually block the filter face of the SDTSF raising the water level to cover the tailings; and
- As the tailings build at the current discharge point the discharge will be moved downstream.

[15] Geochemical Abundance Indices is a measure of enrichment of elements. The results indicate how enriched the tailings are relative to average crustal abundance. Elements with a value >3 are considered significantly enriched, values 1-2 are considered to have minor enrichment, and values < 1 are considered to have no enrichment.

SDTSF will be completed to its current approved design including construction of the final spillway. Approval for further downstream tailings discharge points will be required throughout the life of the tailings dam.

The SDTSF is operated in accordance with the *Savage River SDTSF Operations, Maintenance and Surveillance Manual*, July 2023 and in accordance with PCE 8808.

Proposed tailings management

Tailings produced from the processing of North Pit ore will be deposited into the South Deposit Tailings Storage Facility (SDTSF), refer Figure 11 and Figure 26.

There is adequate capacity in the tailings storage facilities to contain the tailings produced from NPUG ore processing, with no operational changes required to accommodate the tailings from North Pit. It is anticipated that approximately 44 Mt of tailings will be produced from the Transition and BC mining operations between 2027 and 2040. This volume can be accommodated within the site’s current and projected tailings capacity schedule, which is in the order of 61 Mt between 2023 and 2040.

Current tailings placement is sub-aerial with recovering of tailings as required to ensure continuing saturation. The current downstream fall of the Main Creek valley aids in this.

As noted above, boron, cobalt and selenium are elevated in the NPUG tailings, and while metals are likely to be more mobile under acidic conditions, the SDTSF currently runs at between pH 7.00 and 7.50 indicating that mobilisation is less likely. Under these conditions current tailings management practices are considered suitable for tailings generated from NPUG with metal concentrations below or equal to concentrations in existing Centre Pit tailings.

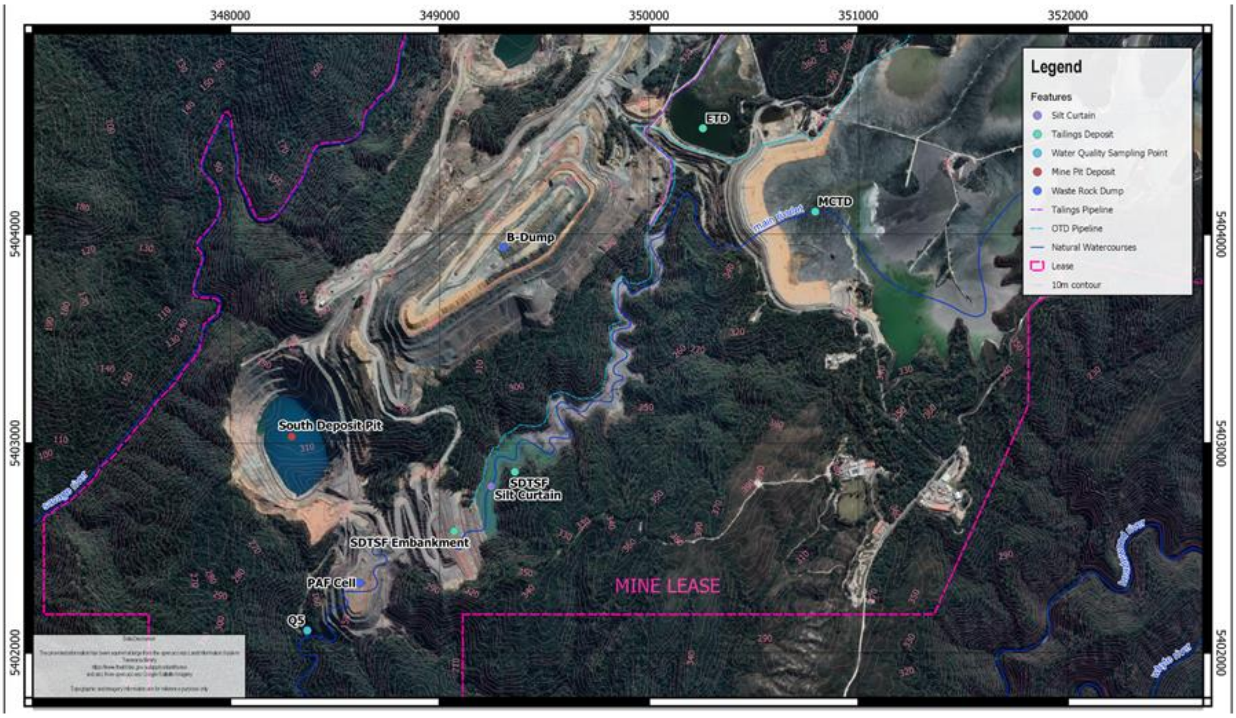

Figure 26 - SDTSF plan view

5.2.4 Monitoring, reporting and auditing

Monitoring of waste rock will be conducted in accordance with EPA permit requirements, the WRMP and geotechnical requirements including:

- Waste rock is first visually assessed during the grade control process via blast hole drill cones prior to blasting and mining
- Samples are gathered for laboratory testing and confirmation from each shot with at least one sample for each identified waste type per shot and at least 5 samples per week during active mining
- Samples are sent for laboratory testing at least for total S, total C and NAG and NAG pH analysis
- Where mining is to occur under 'free digging' conditions, daily visual inspections must be carried out and grab samples taken at comparable rates to cone sampling. Until identified as otherwise by laboratory testing 'free dug' materials will be considered as D type waste
- Waste rock types for each shot will be communicated through the daily meeting and via mining plans
- Active waste rock dumps shall be inspected daily for correct placement of waste rock type and sampled weekly for laboratory analysis confirmation
- Soil moisture, temperature and electrical conductivity probes will be installed at strategic dump locations across the site to monitor encapsulation efficacy
- Waste rock disposal facilities are inspected on a risk based schedule, documenting:
    - Water ponding on top of the waste rock disposal facility
    - Seepage from the toe
    - Adverse settlement, cracking or signs of instability; and
- Waste rock classification performance shall be reported on quarterly through the Technical Services Group and be externally audited.

Table 24 - Waste rock and tailings management measures

	Management measure	**Timing for implementation**	**EIS section**
6	Waste rock management will continue to be managed in accordance with the most recent Waste Rock Management Plan, which will be updated prior to underground mining commencement	ongoing	5.2.2
7	Monitoring of waste rock dumps will be conducted in accordance with the most recent Waste Rock Management Plan	ongoing	5.2.2
8	All tailings will be managed in accordance with current site practice	ongoing	5.2.3
9	The SDTSF will be operated in accordance with the *Savage River SDTSF Operations, Maintenance and Surveillance Manual*, July 2023 and in accordance with PCE 8808	ongoing	5.2.3
10	Reporting tailings dam monitoring to the EPA as required by PCE 8808.	ongoing	5.2.3

5.3 Groundwater

Discussion of potential impacts to groundwater as well as management of groundwater at the site in relation to the NPUG are included in section 5.1.

Grange has several open bores fitted with water level sensors along the Broderick Creek Flowthrough that are used to predict seepage from the West Wall. Fixed vibrating wire piezometers (VWPs) are installed in the various geological units around North Pit to aid in hydro-geological modelling for pit designs and water table management. Refer Figure 27. Note, some of these sensor locations have been subsequently mined out.

Figure 27 – Fixed vibrating wire piezometers (VWPs) locations

Three groundwater monitoring bores are monitored quarterly by Grange in accordance with PCE 8808 to monitor groundwater flows influenced by SDTSF, these are:

- Groundwater Monitoring Bore 1 (GWMB1), located below the PAF cell
- Groundwater Monitoring Bore 2 (GWMB2), located behind the school; and
- Groundwater Monitoring Bore 3 (GWMB3), located behind the school.

These are not related to the NPUG operations.

5.4 Air quality

5.4.1 Existing environment

Atmospheric emissions from the Savage River site are limited to dust from excavation, materials haulage, blasting and blow-off from stockpiles and disturbed areas.

This proposal relates to the underground operation at North Pit, within the existing Savage River mine. This site is an active mine site in a remote location with no sensitive receptors located within 2 km of the mine extent. There are limited existing emissions from the site and no perceivable odours are generated. Refer to Figure 28 which outlines the land boundary and nearest sensitive receptors.

Ore from stockpiles is fed into the crushers by a front-end loader and truck which also generates dust. The crushers used are gyratory crushers where material is crushed between an inner cone-shaped mantle and an outer casing. As this is an internalised process there is little potential for dust generation during crushing. Crushed ore is transported to the concentrator stockpile via an overland conveyor for further processing, mineral extraction and slurry generation. The slurry is pumped to Port Latta via an overland pipeline.

Access to the mine is via a sealed road. The only truck movements associated with extraction and processing are internal to the site. This is limited, to some degree, by the use of overland conveyors.

Savage River mine is operated under several EPNs issued for the operation of the mine and mineral works and various activities on site, as outlined in section 2.8. None of these refer specifically to management of dust on site or air quality.

5.4.2 Assessment

There are no new point sources of emissions from the proposed activity.

Dust generation on site is diffuse and there are no processes undertaken on site likely to result in emissions other than dust. It is likely that dust emissions will eventually decline at the site, following the completion of open pit mining.

There will be dust generation from the proposed expansion which will be consistent with the nature and level of dust generation currently occurring onsite.

Impacts of dust in this case are limited to potential harm to the health of workers and impacts on vegetation surrounding the mine. Employee health is managed under workplace health and safety (HSE) legislation and Grange Resources operates under approved systems. Excessive dust cover can impact plant health by reducing the plant’s ability to photosynthesize as a result of reduced sunlight exposure. Mean annual rainfall at Savage River is 1,961 mm with the lowest monthly average being 79 mm (in February). This consistent level of rainfall experienced is likely to prevent an accumulation of dust on plants, avoiding significant impacts.

This Tasmanian *Environment Protection Policy (Air Quality) 2004* deals primarily with the avoidance and management of emissions. The environmental values to be protected under the policy are:

- The health and well-being of humans
- The health and well-being of other life forms
- Visual amenity; and
- The useful life and appearance of assets.

There are no emissions from the proposed activity that will endanger human life. Employees on site are protected by adopted and successful HSE measures and operational safeguards on site. Residents at Savage River are over 2 km from the mine and are unlikely to be impacted by dust generated by extraction works. Plant life around the mine is sufficiently clear of active areas to avoid direct impacts and the high levels of rainfall experienced will ensure excessive dust does not accumulate on leaves, impacting plant health.

The mine site is remote, and any dust generated during operations is unlikely to be visible from any public places. Due to the remote nature of the site, there are no buildings or other features that are likely to be impacted or diminished. It is considered that the operation is operating in accordance with BPEM.

5.4.3 Avoidance and mitigation measures

As the proposed activity is unlikely to increase the nature or level of dust generation that currently occurs on site, no specific additional management measures are proposed.

Water carts and dust suppression sprays are operated on site when dry and windy conditions create a dust and/or visibility risk on site. This generally only occurs during the drier months, i.e., November to April.

5.5 Noise emissions

5.5.1 Existing environment

The site is an active mine site in an isolated location with the closest sensitive receptor, that being Grange's camp accommodation, located over 2 km from the mine extent. Refer Figure 28. The southern boundary of North Pit is over 4 km to the closest sensitive receptor. The site operates 24 hours a day, 7 days a week.

Previous noise monitoring[16] within the township indicated levels < 36 dB(A) which is not considered significant.

Noise generating activities on site include:

- Drilling and blasting
- Surface exhaust fans
- Haulage and dumping of ore and overburden
- Use of front-end loader and truck to feed ore from stockpiles into the crushers
- Operation of crushers
- Transport of crushed ore to the concentrator stockpile via an overland conveyor; and
- Pumping of slurry to Port Latta via an overland pipeline.

None of the processes outlined above will change and the noise levels on site are not expected to increase above existing levels.

Savage River mine is regulated under several EPNs issued for the operation of mining and mineral works and various activities on site, as outlined in section 2.8. None of these refer specifically to management of noise generated on site.

[16] Environmental Management Plan 2022

Figure 28 – Proposed works and closest sensitive receptors

5.5.2 Assessment

None of the processes outlined above will change and the noise levels on site are not expected to increase above existing levels as a result of the underground operations at North Pit.

The nearest sensitive premises are in excess of 2.3 km from the mine site. The required attenuation zone for open cut mines under the adopted State Planning provisions of the Tasmanian Planning Scheme is 2 km. The buffer to rock grinding works is 750 m. The proposed expansion will comply with these standards and is therefore considered to meet this best practice recommendation.

As the noise levels on site will not change, any fauna in the adjacent native vegetation communities will experience similar noise levels that currently occur and are unlikely to be disturbed by the proposed underground operation.

The environmental values to be protected under the Tasmanian Environment Protection Policy (Noise) 2009 are:

- The wellbeing of the community or a part of the community, including its social and economic amenity; or
- The wellbeing of an individual, including the individual's health and opportunity to work and study and to have sleep, relaxation and conversation without unreasonable interference from noise.

Residents at Savage River are over 2.3 km from the mine. If any noise is experienced those levels will not be increased by the proposed expansion. Employees on site are protected by adopted and successful HSE measures and operational safeguards on site.

5.5.3 Avoidance and mitigation measures

As the proposed activity is unlikely to increase the nature or level of noise emissions generated at the site, no specific management measures are proposed.

5.6 General waste management

5.6.1 Existing environment

Waste disposal programs are well established and maintained at the Savage River site. Reasonable and practicable efforts are made to segregate waste into different waste streams and disposed of accordingly, minimizing the volume of waste going to landfill and maximizing the amount of waste that can be reused or recycled.

All solid and liquid waste management on site is transported and disposed of by appropriately qualified and licensed transporters.

Operations manage solid and liquid waste in compliance with local, state and national legislation, as well as conditions set out in EPN's and PCE's.

Waste management is based on the waste management hierarchy of:

- Prevention (incorporating waste avoidance and waste reduction)
- Waste recycling (incorporating reuse, reprocessing and waste utilisation)
- Treatment; and
- Disposal as a last resort.

Wastes on site are currently managed by ensuring:

- All waste material is disposed of in designated bins and removed to a licensed landfill as required
- Any solid wastes that are contaminated with oil (oily rags, grease cartridges etc.) are put in the designated bins
- Loose material (paper, plastic etc.) does not blow around the site
- Material being removed from the site must be covered to prevent spillage
- No solid waste is to be washed into, or placed in or about the storm water or process drains; and
- Waste management must be fully integrated, dealing with waste from the point of generation to the point of disposal.

Existing waste management practices will continue to be implemented during underground operations.

5.6.2 Assessment

There will be no changes to the way wastes are managed on site as a result of the proposed NPUG operations. All management measures for solid and liquid waste at the site will be maintained in accordance with the Environmental Management Plan 2022, as submitted to the Director, EPA. No additional management measures are therefore proposed.

There will be a reduction in the amount of hydrocarbon waste as well as waste tyres once the operation is underground as a result of the reduction in haulage truck use.

Waste rock management and tailings management for the proposed operations are outlined in section 5.2.2 and 5.2.3.

5.7 Dangerous goods and environmentally hazardous materials

The proposed expansion to underground operations in North Pit is within an existing operational mine site. All dangerous or hazardous goods at the site are stored in accordance with Australian standards and approved operational systems. This will not change to accommodate the proposed underground operations which relates to reworking of mined surfaces north of all processing plant and facilities.

All hydrocarbon and chemical management on site is undertaken in accordance with the Environmental Management Plan.

No additional management measures are proposed.

5.8 Biodiversity and Natural Values

5.8.1 Existing environment

The proposed underground operations at North Pit are within the existing operational mine. With all proposed activities to be undertaken within the existing footprint of the site that has been previously disturbed by mining activity, with the exception of a new access track, refer Figure 12. Vegetation mapping in the vicinity of North Pit is shown in Figure 29.

Natural Values assessments have been undertaken for previous expansions at the site which have identified native vegetation communities in the vicinity of the existing mine. Refer to *Grange Resources, Savage River – Centre Pit Expansion – Environmental Impact Statement, 2021,* with reports prepared by North Barker Ecosystem Services (NBES) in 2018 and two addendums, in March 2020 and October 2020. These reports were based on the Centre Pit expansion to the south of the proposed underground operations.

Native vegetation communities were recorded to the east and west of the former Centre Pit North, adjacent to the South Lens, south of Centre Pit South and the Mill Dump area. None of these communities are listed as threatened under the *Nature Conservation Act 2002* (NCA) or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA).

According to TASVEG 4.0 mapping (theList), the area (480 m^2) of clearance required for the access track is classified as modified land (FUM) Extra-urban miscellaneous. This area is adjacent to the vegetation community (RMS) *Nothofagus - Phyllocladus* short rainforest, so it is likely that it is a modified version of RMS. This vegetation community is not listed as threatened. From previous Natural Values Assessments (NBES) the area was unclassified.

No threatened flora species listed under either the *Threatened Species Protection Act 1995* (TSPA) or the Commonwealth EPBCA were recorded or are considered likely to occur.

No threatened fauna species under state or Commonwealth legislation were recorded on site however, two listed species are considered likely to occur. The Tasmanian devil (*Sarcophilus harrisii*) and spotted-tailed quoll (*Dasyurus maculatus)* could utilise habitats present within the vicinity of the site. Potential foraging and nesting habitat for the state listed grey goshawk (*Accipiter novaehollandiae*) is present in the vicinity of the site, in riparian vegetation and Acacia community near Savage River, however, no nests or individuals were recorded in previous surveys.

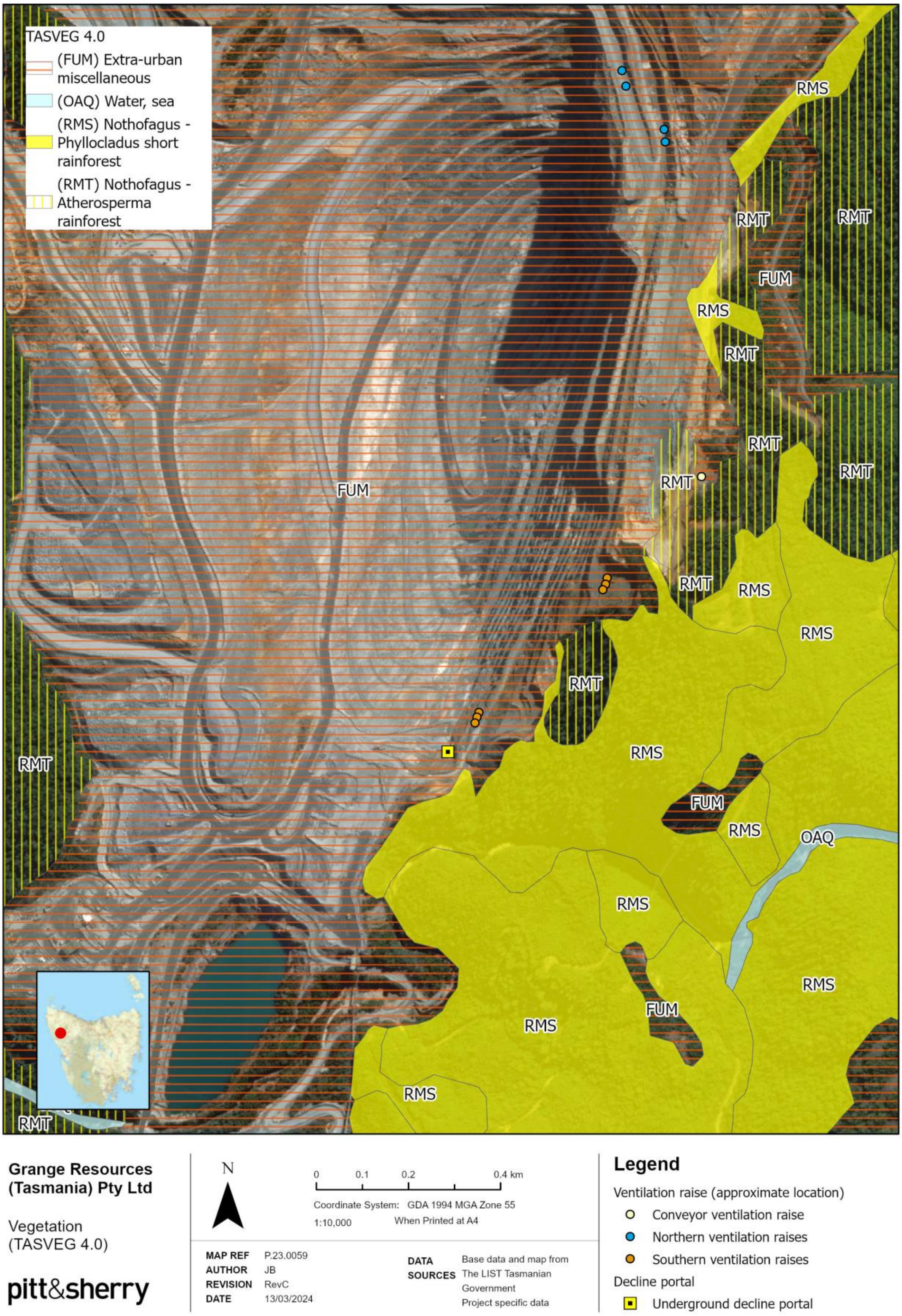

Figure 29 – Natural Values

5.8.2 Assessment

The proposed activity will require no clearing of native vegetation to accommodate the underground operations. An area of approximately 480 m^2 will however require clearing for a new access track.

A pre-clearance survey of this patch of vegetation will be undertaken prior to any works (survey proposed for late March 2024). This survey will clarify the vegetation community to be cleared and its condition, list of flora species present as well as the potential for habitat of any threatened fauna species, including the Tasmanian devil, spotted-tailed quoll and grey goshawk.

Considering the small area of modified habitat to be cleared in the context of extensive contiguous habitat in the surrounding area, the potential impact to any threatened fauna species is considered minimal. This area is immediately adjacent (i.e. within 20 m) to the main access road, the rock crusher and the active ROM which operates 24 hours a day. With such a high level of existing disturbance in close proximity, it is considered unlikely that fauna would nest within this patch of vegetation. Nevertheless pre-clearance surveys will be undertaken to confirm this.

There will be an increase in vehicle numbers, both on-site and off-site as a result of the construction phase of the development, although the increase is not considered significant. There will be an additional 66 light vehicles per shift change, currently once a week for off-site roads. This relates to an increase in traffic of 25% for one day a week, or an increase in 4% of light vehicle traffic averaged over the week. The shift changeover occurs around midday every Wednesday, during daylight hours.

Current traffic movements during shift change from the Savage River township to the mine occur at 6 am and 6 pm, which is the changeover in day and night shift crews. There are approximately 60 vehicles movements in total at changeover during the week (120 movements a day) and approximately 48 vehicles movements at changeover on the weekend (96 movements a day). The proposed construction phase will result in an additional crew mini bus and 5 private vehicles each way (total of 12 additional traffic movements per shift change and a total of 24 movements per day). This will result in an increase of 20% in traffic movements during the dusk to dawn period for approximately 6 months of the year (over winter), during construction of the underground development period.

Additional heavy vehicle numbers are likely to be minimal with one additional semi-trailer per day.

There is consequently potential for an increased risk of roadkill from additional light vehicle movements as well as heavy vehicle movements during the transport of construction equipment to site. Following construction there will be a decrease in vehicle numbers. Vehicle speed limits are already imposed on site (maximum of 40 km/hour) as well as from the Savage River accommodation to site (70 km/hour). As part of the approval for the SDTSF, Grange currently monitors and removes roadkill from the township to the mine to reduce the roadkill risk for Tasmanian devils. Monitoring also occurs on all site roads and generally includes the area in the immediate vicinity of the township, as well as the road between the township and the mine. This will continue to ensure there is minimal risk of roadkill from vehicles associated with the mine.

Savage River runs through the site between South Lens and the Centre Pit, to the south of the proposed operations. The river is not directly impacted by the proposed expansion and its course will not be altered. The existing operations discharge water to Savage River after processing on site. The SRRP and Strategic Plan establish standards and management objectives for the receiving waters. This is part of an ongoing process aimed at rehabilitation of aquatic ecosystems within Savage River and is discussed in detail in section 5.1.

The Arthur Metamorphic Complex, also known as the Arthur Lineament, is a listed geoconservation site which passes through the site. There is no geoconservation reserve over this feature.

No wilderness areas occur within the site or in vicinity of the site.

There are no conservation areas within 500 m of the mine. Savage River National Park is located approximately 10 km to the northeast of the mine and there will be no impacts as a result of the proposed underground operations. The mine is bordered to the north and south by informal reserves identified as future potential production forest managed by Natural Resources and Environment Tasmania (NRE).

The expansion works are proposed within an existing mine site. There are no sites of landscape significance present.

Current EPNs require procedures to be established to reduce the risk of introduction and spread of plant pathogens such as *Phytophthora cinnamomi* and declared and environmental weeds. Appropriate weed and hygiene management measures will be implemented in line with current site practices.

5.8.3 Avoidance and mitigation measures

Appropriate weed and hygiene management measures will be implemented in line with current site practices.

Monitoring and removal of roadkill to reduce the roadkill risk for Tasmanian devils, will continue on all site roads as well as between the Savage River township and the site.

Implementation of vehicle speed limits, 40 km/hour on site and 70 km/hour from Savage River accommodation to site, to minimise roadkill risk, will continue.

A pre-clearance survey will be undertaken for natural values, prior to clearance of 480 m^2 of native vegetation to allow construction of a new access track.

No additional management mitigation measures are proposed.

5.9 Greenhouse gases, ozone depleting substances and climate change

The Savage River Mine contributes substantial CO2-e emissions through the use of diesel in mining operations, with CO2-e emissions exceeding 100,000 t CO2-e per annum. Other minor sources of CO2-e emissions include light vehicle diesel and petrol consumption and electricity usage from the Tasmanian grid. Sodium hydroxide replaced soda ash use in 2020, reducing CO2-e emissions.

Grange Resources is proposing to significantly reduce CO2 emissions across the company, and specifically at the Savage River mine with a reduction in the use of diesel-powered plant and equipment. Refer to Figure 30.

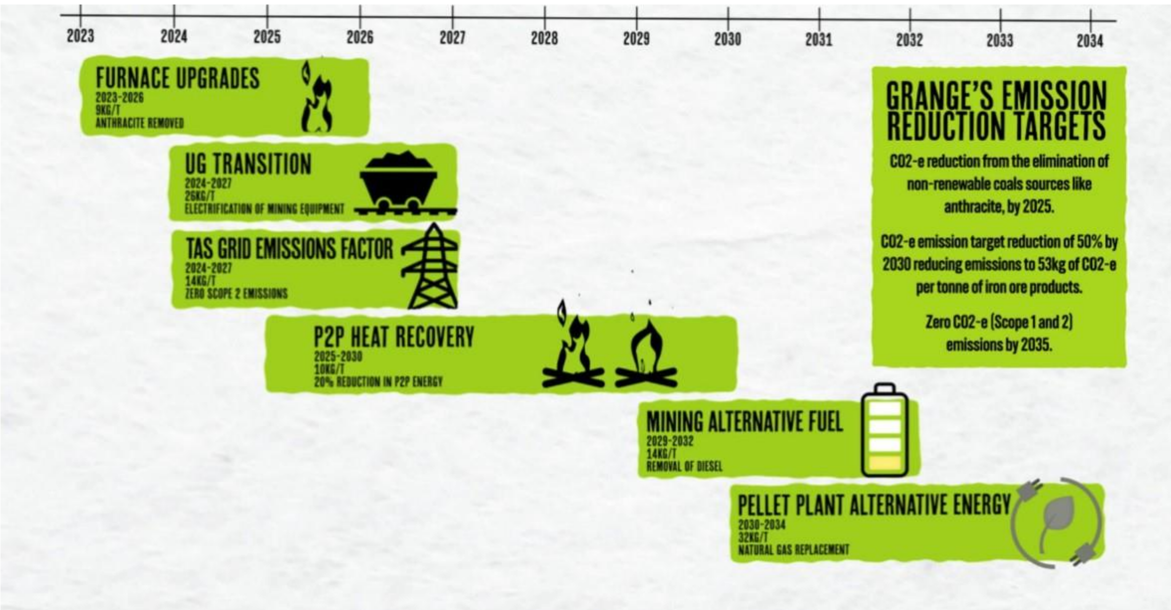

Figure 30 - CO2 emissions reduction timeline for all Grange operations

The implementation of underground electric mining equipment compared to the use of diesel mining equipment in open cut operations will result in a 25% reduction in Grange's total CO2-e emissions and 80% of its emissions at Savage River.

Following removal of all diesel powered surface fleet, and any remaining surface fleet on alternate fuels, there will be a 40% reduction in emissions.

The proposed underground project will aim to reduce greenhouse gas emissions significantly. Given current understanding of technology, it is estimated that over 10 years the proposal will potentially result in a 1 million tonne reduction in CO2-e compared to continuing with open pit mining and diesel equipment.

Climate change

The main climate drivers for Western Tasmania are the Southern Annular Mode, the El Nino Southern Oscillation and the Indian Ocean Dipole.

At Savage River with no reduction to emissions there is projected to be little change in annual rainfall and run-off amounts. Seasonally, rainfall is expected to decrease over summer and autumn and increase over winter and spring. Currently climate change is not expected to detrimentally affect the rehabilitation outcomes at Savage River. Increasing rainfall over winter and spring may increase the risk of increase erosion and turbidity. This will be picked up in ongoing water quality monitoring across the site.

It is anticipated that tailing dams and pits will maintain their flooded state and water cover level. The cover material on PAF wastes should also maintain the required moisture levels. Water quality with Savage River and Main Creek should remain within the required parameters.

The Savage River Mine is over 32 km from the coast and will not be impacted by sea level rises. The potential for more intense storm events and more severe fire weather will be managed as part of existing management plans at Savage River.

As outlined above the proposed underground operations will significantly reduce overall CO_2 emissions through the implementation of electric plant and machinery underground, as a result of a significant reduction in diesel use at the site.

Grange proposes to:

- Continue to monitor and report energy use and CO_2-e emissions as per legislated requirements
- Continue to review and research possible greenhouse gas reduction opportunities; and
- Seek to improve long-term operational climate change risk assessment and understanding.

5.10 Socio-economic issues

The Goldamere Agreement (refer section 1.9) was created to indemnify owners of the mine against responsibility for legacy pollution which occurred in the Savage River as a result of earlier mining activities. This encouraged continued investment and employment at the mine. The support for operations on site, and the positive impact that makes to the economy and work force, continues under the agreement and the Savage River Rehabilitation Project (SRRP). The improvements in downstream water quality, since the commencement of the SRRP, have progressed throughout the river system to areas accessed by the public, providing a positive recreational and social outcome.

There will be changes to on-site processes from open pit to underground operations and there will be changes to the workforce. There will be an increase in workers required on site for the construction phase of the Transition and BC mining. There will also be increased capital expenditure during the construction phase.

Extracted minerals will continue to be pumped to Port Latta for pelletisation and shipment to established markets.

The estimated total capital investment for the Transition and BC mine is in the order of $890 million, with pre-production capital around $450 million.

As previously indicated, it is likely that an underground mining contractor will be engaged for pre-production when higher rates of underground development advance are required. This period extends for approximately three years before reducing significantly. The contractor would also support the ramp-up and deliverables for the Transition Mine production targets. There will be an overlap between continuing surface operations and ramp-up of underground development, necessitating additional labour to be brought to site.

Current site accommodation for the NPUG project consist of contractor accommodation for approximately 30 personnel. This is sufficient for project start-up but will need to ramp to 80 beds in the first year and 140 beds in subsequent years.

The Savage River Mine has continually operated for 56 years, with the majority of the existing processes not expected to change as a result of the proposed NPUG operations. It is, therefore, anticipated that there is unlikely to be significant impacts on the local social amenity, community infrastructure or community demographics of the region.

5.11 Fire risk

Grange has a range of existing fire and emergency management procedures which will continue to be implemented throughout the change in operations. These plans and procedures have all been updated to include the proposed NPUG and include:

- Fire Prevention Procedure (MHS-02), 2022
- Savage River Emergency Management Plan, 2019; and
- NPUG Fire or Explosion Management Plan, 2019.

The *Fire Prevention Procedure* aims to control the risk of fire through effective prevention, detection, and emergency preparedness. The scope of this procedure addresses all aspects of the prevention and control of fire risks and includes identification of fire hazards and hot product, new projects and equipment, implementation of controls to minimise fire risk, fire protection equipment, training, inspections fire safety awareness and compliance with statutory requirements.

The purpose of the *Savage River Emergency Management Plan* is to effectively mitigate the consequences of emergencies, to minimise the losses and to systematically plan the post emergency recovery for foreseeable emergencies at the Savage River operation. This plan premeditates and coordinates emergency actions on the part of Grange Resources Savage River management and employees.

The *NPUG Fire or Explosion Management Plan* describes how the risk of fire or explosion at NPUG operations will be safely and efficiently managed. The purpose of this plan is to:

- Outline preventative and mitigating controls for the hazards associated with fire or explosion identified through risk assessment
- Ensure compliance with existing elements of Grange Resources' Major Hazard Standard (MHS) for Fire Prevention (MHS-02); and
- Ensure compliance with the Mines *Work Health and Safety (Supplementary Requirements) Act 2012* and the *Mines Work Health and Safety (Supplementary Requirements) Regulations 2012.*

These procedures and plans will ensure that any potential fire risk associated with the proposal is appropriately managed to reduce environmental impacts that could occur as a result of a fire.

5.12 Infrastructure and off-site ancillary facilities

No new off-site facilities are proposed as part of the change in operations from open pit to underground mining. With no impacts to off-site facilities considered likely.

There will be an increase in traffic numbers during the construction and establishment phase on local roads in the Savage River camp and the Waratah Road, although the traffic volumes are not considered to be significant.

6. Monitoring and review

Extensive monitoring of water discharges, water quality within the open pits, groundwater, waste rock and tailings is currently undertaken across the site, as required by a number of permit conditions and EPNs issued by the EPA. These monitoring programs will continue to be implemented and reported to the EPA.

Monitoring, pertaining to the NPUG will include:

- Water quality monitoring[17], as provided in the table below:

Location	Parameters	Frequency
Surface input from North Pit to South Lens	pH, TSS, alkalinity, acidity, sulphate, total dissolved metals (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Zn), cations (Ca, Mg, Na, K), anions (F, Cl)	Monthly
North Pit underground locations (Table 8)	pH, TSS, alkalinity, acidity, sulphate, total dissolved metals (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Zn), cations (Ca, Mg, Na, K), anions (F, Cl)	Monthly for 6 months
North Pit underground outflow (NPUG_out)	pH, TSS, sulphate, alkalinity, heavy metals (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Zn)	Initially fortnightly (for 6 months), then monthly
South Lens outflow *(Already required by EPN248/2 and PCE 10995)*	TSS, alkalinity, acidity, sulphate, total & dissolved metals (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Zn), cations (Ca, Mg, Na, K), anions (F, Cl)	Fortnightly

- Waste rock monitoring will continue to be undertaken in accordance with the current WRMP, 2021 or any revision as approved by the Director, EPA. The monitoring of the proposed North Pit waste rock dump will also be included in the revised WRMP; and
- No additional monitoring of the existing tailings dam, specifically the SDTSF are proposed.

Any additional monitoring to be implemented as a result of the NPUG will be reported at the frequency as outlined above.

[17] Monitoring of South Lens outflow is already required by EPN248/2 and PCE 10995 and hence is not included here.

7. Decommissioning and rehabilitation

The Environmental Rehabilitation Plan (ERP) for the site is reviewed every three years, with the latest review occurring in 2023. The ERP was finalised for submission to the Director, EPA in October 2023. The ERP covers final rehabilitation and closure of the entire Savage River mine site, including decommissioning of plant and equipment after cessation of operations.

NPUG will form part of the overall site's operation, as well as final rehabilitation and closure, although it will only be a small component of the site's decommissioning.

Unanticipated closure of the mine

NPUG currently consists of a surface portal and exploration decline located within the footprint of the existing North Pit open cut footprint. Closure scenarios for NPUG are currently limited to the works associated with the exploration decline only as approved under EPN10006/2. Sudden and unanticipated closure of the NPUG exploration decline will require:

- Submission of a decommissioning and closure plan for approval by the Director, EPA
- Engineered portal and conveyor plugs; and
- Capping of all vent rises.

Unanticipated closure would cover the removal of underground plant and infrastructure, the portal plug and shafts, with an estimated cost of $1.1 million. Cessation of dewatering is estimated at $100 / day, with a total cost of $36,500.

If there is an unanticipated or temporary closure of the mine, where there is uncertainty if the mine would re-open, dewatering of the underground operations would continue.

In relation to unanticipated, temporary or LOM closure, where there is certainty that the mine would not re-open, then dewatering would cease. Depending on the scenario, ie temporary or LOM closure, actions outlined in this section would be implemented.

Life of Mine (LOM) Closure

Following the full development of the Transition and BC mines, the following is expected to occur on closure:

- Removal and disposal of hazardous chemical and other wastes by licenced contractors to licenced waste facilities
- Removal of non-structural plant and equipment
- A barricade will be placed in the bulk sample drive as a safety measure to prevent access, with an additional barricade likely at the main portal to prevent access prior to flooding
- Capping of all vent rises
- Flooding of the workings that will submerge any exposed PAF waste and subgrade ore within the cave
- Signage will be erected with all seals to inform people of the potential hazard in the area; and
- Any other requirements to make the area safe.

Closure of the proposed NPUG would require flooding of all operational areas to prevent oxidation of any exposed ore or waste types. Some areas of the block cave designs are intended to subside.

As previously outlined in the EIS, modelling indicates the North Pit catchment and groundwater flows show a 50% probability of average inflows exceeding 1,300 L/s to the underground workings. The seasonal Broderick Creek Flowthrough seepages into North Pit would contribute an additional 600 L/s to this in peak flow if not intercepted as they currently are. It is conservatively estimated the proposed NPUG workings could be flooded to the main access decline within 12 months if dewatering activities ceased. If flooded, NPUG will not be exposed to evaporation and any remaining PAF surfaces should remain suitably submerged.

Full closure costs for NPUG are $1.5 million, which includes removal of underground plant and equipment, a portal plug, conveyor plug and shafts. Dewatering costs, as estimated above would be $36,500.

Equipment that is anticipated to stay behind in the underground pit following closure, will include:

- Structural steel work including walkways and railings etc
- Grizzly's and ore pass linings (steel)
- Stationary rock breakers (without the drive motors)
- Crusher feeder bins and wear plates (but not the crusher or drive motors or electrical panels)
- Conveyor steel frames and rollers etc (without motors)
- Overhead gantry cranes (without motors)
- Ladderways (steel)
- Ventilation control devices (steel louvers, shotcrete walls with steel doors)
- Concrete foundations and plinths (for crushers, pumps and fans)
- Ground support including brow beams (shotcrete and steel)
- Fibre optic cabling and communications nodes
- Piping (steel and poly)
- Some electrical conduits (note most of the copper cables will be stripped out); and
- Some ventilation bags (fabric).

The AQ2 supplementary report[18] states that it will take approximately 30 years for both NPUG and North Pit open cut to fill to invert level. The conclusions from the model indicate:

- The open pit is predicted to recover to the overspill elevation in approximately 30 years
- There is uncertainty related to a number of the inputs within the model. However, these will mostly impact the length of time taken for the pit to recover to the overspill level rather than the result that it will reach the overspill level. This is because the only water loss mechanism from the pit in the current conceptual model is evaporation losses, and the evaporation losses are an order of magnitude smaller than the rainfall inputs to the pit (average annual pan evaporation is approximately 900 mm, average annual rainfall is approximately 1,900 mm). Therefore, there would need to be a significant error to the input assumptions for the modelled evaporation losses to balance modelled rainfall inputs at a pit elevation which is below the overflow point
- The porosity of the subsidence zone, volume of void in the underground to be filled and the impact of BCFT overflow into the North Deposit are unlikely to impact the level that the North Deposit pit reaches; and
- The actual water level that the pit reaches is likely to be higher than that predicted in the model as the overflow channel linking the North Deposit and the South Lens pits has been backfilled and is likely to have a restricted capacity compared to the inflow rates during the peak winter periods. North Pit water will overflow south into South Lens, then into Savage River. The restricted capacity of the pathway may mean that the recovery height of North Pit water will be higher than RL 125 m, therefore it may take slightly longer for the pit to reach invert level and consequently may contain slightly more water volume.

[18] AQ2 Pty Ltd, 2023, Savage River North Pit Closure – Water Balance Assessment

8. Management measures

Specific management measures proposed for NPUG, in addition to existing measures already implemented at the site are provided in Table 25.

Table 25 - Management measures

	Management measure	Timing for implementation	EIS section
1	Continuation of current surface water diversion around North Pit	Ongoing	5.1.3
2	Continuation of existing dewatering of North Pit, including the interception of Broderick Creek water	Ongoing	5.1.3
3	Dewatering of North Pit underground, refer 2.3.1 for details	Ongoing	2.3.1, 5.1.3
4	Water quality monitoring of NPUG	Ongoing	5.1.3
5	Reporting of water quality monitoring to the EPA. Quarterly for summary report, and annually for analysis of results (as part of Annual Environmental Report)	As required	5.1.3
6	Waste rock management will continue to be managed in accordance with the most recent Waste Rock Management Plan, approved by the EPA	Ongoing	5.2.2
7	Monitoring of waste rock dumps will be conducted in accordance with the most recent Waste Rock Management Plan, approved by the EPA	Ongoing	5.2.2
8	All tailings will be managed in accordance with current site practice	Ongoing	5.2.3
9	The SDTSF will be operated in accordance with the *Savage River SDTSF Operations, Maintenance and Surveillance Manual*, July 2023 and in accordance with PCE 8808.	Ongoing	5.2.3
10	Reporting tailings dam monitoring to the EPA as required by PCE 8808.	Ongoing	5.2.3
11	A pre-clearance survey will be undertaken for natural values, prior to clearance of 480 m^2 of native vegetation to allow construction of a new access track	Prior to clearance	5.8.3

9. Conclusion

Savage River mine has been operating since 1967. Grange Resources has identified an opportunity to enhance and extend production through development of underground mining operations below North Pit. The proposal to move to underground mining in comparison to continuing with open pit operations will:

- Reduce the generation of PAF rock waste
- Reduce the CO2-e emissions over the life of the proposal; and
- Allow earlier rehabilitation of existing waste dumps.

The proposal will generate waste rock and alter water management; however the existing management procedures and proposed operations will result in little or no change to the quality or quantity of water discharged from site. These existing management measures within which the proposal will operate have seen:

- A major reduction in acidic rock drainage from dumps compared to the pre-existing legacy dumps on site, using proven methods for the assessment, disposal, reuse and encapsulation of waste rock
- Tailings management that has seen outflow quality from MCTD and the SDTSF greatly improved to that from the historic OTD; and
- Improvements in water quality within Savage River that have seen a return of aquatic life.

The proposed development is not estimated to have a detrimental impact on any of these outcomes. The EIS has not identified any material impacts to the environment and should result in continued improvement in the areas highlighted above.

The mine operates under the Goldamere Agreement which provides that the works on site be undertaken in accordance with best practice environmental management. This EIS details the measures to be undertaken to ensure the best ecological, social and economic outcomes are achieved using best accepted practice. Many of the management actions proposed are currently implemented on site in accordance with existing licenses and requirements. The proposal is consistent with the requirements of relevant Commonwealth and State legislation, policies, plans and strategies.

The SRRP established a strategic plan to achieve habitat restoration in Savage River. This included the establishment of a set of specific water quality objectives and water quality monitoring protocols. The current proposal builds upon those protocols for monitoring throughout the life of the mine. Existing operations at the mine have resulted in significant improvements in the water quality downstream of the site, resulting in an improvement in the aquatic environment of the Savage River. This will continue under the current proposal.

No threatened flora or vegetation communities will be impacted from the proposed development. There is a potential increase in roadkill risk due to an increase in traffic movements during the construction phase, however, existing measures implemented have ensured the risk to any threatened fauna species, namely the Tasmanian devil and spotted-tailed quoll will be limited. The site is remote and with large separation distances to sensitive premises.

10. References

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Beck Engineering, 2022, *Results of Cave Growth and Subsidence Modelling for R08 Mine Plan*. Results incorporated into Leapfrog Viewer Model by Grange Resources, 17 October 2022

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Technical Advice on Water, 2022, *Savage River Rehabilitation Project Water Quality Review 2017 – 2022*, Draft, November 2022

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Mine Water Management Study (AQ2 Pty Ltd, 2023)

Appendix A

pitt&sherry

North Pit Underground Project - Feasibility Study

Mine Water Management

Prepared for:

Grange Resources

August 2023

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EXECUTIVE SUMMARY

Potential inflows to the proposed underground mine have been assessed and a concept level mine water management plan has been developed. For the purposes of the Feasibility Study, this assessment has been restricted to the end of the first lift of the Block Cave.

Predicted water inflows are as follows:

- Groundwater inflows – up to 55L/s including groundwater inflows from the surrounding low permeability basement rocks to the cave zone and surrounding 0.4% (plastic strain) deformation envelope, and inflows to access declines.
- Rainfall runoff to the North Pit and then directly to the Block Cave Extraction Level, through the cave zone – this will fluctuate on a daily basis depending on rainfall and rainfall patterns, but probabilistic analysis indicates:
    - 50% probability of inflow exceeding 1,300L/s.
    - 25% probability of inflow exceeding 1,400L/s.
    - Maximum possible inflow of 2,500L/s.
- There is also the risk (albeit low) that deformation along the west wall of the pit might result in the failure of the current West Wall Dewatering System which could result in up to 600L/s of additional inflow to the pit and Block Cave following high rainfalls.

The concept water management plan to account for the above includes the following:

- The use of purpose developed underground void spaces below the Block Cave active mine workings to create buffer storage, which will smooth out dewatering pumping requirements. Probabilistic water balance modelling indicates that the inclusion of the following buffer storage volumes in conjunction with a 750L/s underground pumping system would reduce the risk of flooding of the active mine workings:
    - 95,000m^3 storage in the designed Flood Storage Dams – a 10% chance of flooding above the top of the Dams with 750L/s extraction rate.
    - 180,000m^3 storage below the western perimeter of the Extraction Level – <1% chance of flooding the Extraction Level.
- Upgrading of the existing West Wall Dewatering System to cushion it against minor settlement and to reduce the potential for erosional scouring, so that it can continue to divert overflows from the Broderick Creek Throughflow System.
- Possible installation of additional underground pumping capacity or installation of the Upper Broderick Creek Diversion Scheme if deformation exceeds current predictions and the West Wall Dewatering System fails.

There are no predicted impacts of mine inflows and dewatering on groundwater and surface water outside the immediate mine area.

TABLE OF CONTENTS

Tables

Figures

Appendices

1. INTRODUCTION

1.1 Project Background

Grange Resources Ltd, owners and operators of the Savage River magnetite mine in north-western Tasmania, is currently undertaking feasibility studies into the development of an underground mining operation below the North Pit (North Pit Underground Project – NPUG). The long-term mine plan under consideration is to develop a sub-level cave and a Block Cave mining operation which could extend down to around -330m RL.

The current phase of assessment is a Feasibility Study (FS), which is considering a transition mine (Sublevel Cave behind the north wall of the pit) and a Block Cave beneath the pit. Mining beyond the first lift of the Block Cave is not part of the current FS. Production is planned to commence after the completion of the Stage 7 Pit.

AQ2 Pty Ltd were commissioned by Grange Resources to assist them with investigating potential water inflows to the underground mining operations, developing a concept mine water management plan and assessing the net impacts on the local hydrogeological environment of the mine water management plan.

1.2 Key Water Management Issues

The key water management issues, identified during previous (PFS level) assessments of water risks to the Project, are:

- Significant volumes of rainfall runoff to the pit, which will then rapidly make its way down into the underground mine workings through the cave zone (sometimes referred to as the subsidence zone), which will develop below the pit base and adjacent to the pit walls.
- Groundwater inflows from the fractured basement rock aquifers, which host and surround the magnetite orebody. These are not expected to be as large as rainfall runoff volumes, but will contribute to total dewatering requirements.
- Possible inflows from the Broderick Creek Flow Through System, a specially designed high flow channel at the base of the western waste rock dumps to convey river flow from upstream reaches of Broderick Creek in the north to the Savage River in the south. Identified potential inflow pathways included direct seepage to the west wall of the pit (where the pit intersects the flow channel) during high flow periods, and leakage through enhanced permeability associated with deformation zones around the Block Cave if these extend beneath the flow channel.

Other identified water management issues relating to the overall Savage River mine water management plan, include:

- Maintenance of flows from the upper Broderick Creek to the Savage River, which have beneficial influence on water quality in the Savage River.
- Maintenance of discharge of all mine dewatering volumes to the South Lens pit for treatment and polishing before discharge to the Savage River.

1.3 This Report

This report describes the hydrological and hydrogeological investigations undertaken and presents the results. The rest of the report is structured in sections as follows:

- Section 2: Conceptual Hydrological Models
- Section 3: Surface Water Inflows
- Section 4: Groundwater Inflows

- Section 5: Inflows from Broderick Creek Flow Through System
- Section 6: Mine Inflow Management Plan
- Section 7: Potential Impacts of Mine Inflow Management Plan
- Section 8: Summary

This report is an updated version of our previous report (AQ2, 2021) which was based on the November 2020 mine plan and geotechnical model, and the results of deformation modelling at the time.

2. CONCEPTUAL HYDROLOGICAL MODELS

2.1 Surface Water

The following conceptual hydrological model is based on current mine survey data and on information and data included in a number of historical reports (see Section 8 – References).

2.1.1 Local Hydrology and Mine Inflows

It has been assumed that the surface water catchment which currently reports to the North Pit will report to the underground mine workings in the future, via subsidence cracking. The catchment area of the North Pit has been estimated from site topography information (digital terrain model) and site observations. The catchment is shown in Figure 1 and has an estimated area of $1.7km^2$. The majority of the catchment is the pit footprint (85%), with the remainder being a small amount of ex-pit catchment located to the north of the pit. Runoff to the pit is expected to be dominated by responses to winter rainfall events.

2.1.2 Existing Dewatering System

An in-pit sump pumping system is currently used to manage the inflow of surface water to the pit by pumping to the South Lens Pit, which is used to store and treat all mine inflows, prior to discharge to the Savage River.

Water levels within the Broderick Creek Flow Through System also respond to seasonal rainfall events. As discussed in Section 2.3, water levels in the Broderick Creek Flow Through System can increase to the point that seepage into the pit occurs. The existing West Wall Dewatering System captures this seepage and transfers it out of the pit to the South Lens Pit via a gravity drainage pipeline.

2.1.3 Key Hydrological Parameter

The key parameter for runoff and inflow prediction is the adopted runoff coefficient.

The following annual runoff coefficients have been adopted for this study (based on estimates by WRM 2007) for different areas of the pit catchment:

- Pit walls – 90%
- Ex-pit catchment – 77%

2.2 Groundwater

The following conceptual hydrogeological model is based on information and data included in a number of historical reports and investigation data sets (see Section 8 – References).

2.2.1 Local Hydrogeology

The hydrogeology in and around Savage River is complex. Apart from shallow river alluvium and some Tertiary basalts, the aquifers are generally low permeability basement rocks where aquifer properties are associated with fractures/joints/shears and some deep weathering of carbonate rocks along fracture planes.

In general, these aquifers are recharged by infiltration of rainfall runoff where fractures/joints outcrop or sub-crop beneath surface water drainages (streams, creeks and rivers). The aquifers naturally discharge as baseflow to the major creeks and rivers. The aquifers also discharge as groundwater inflows to the pit(s) with inflows then being pumped to the South Lens pit (for treatment/polishing) before discharge to the Savage River.

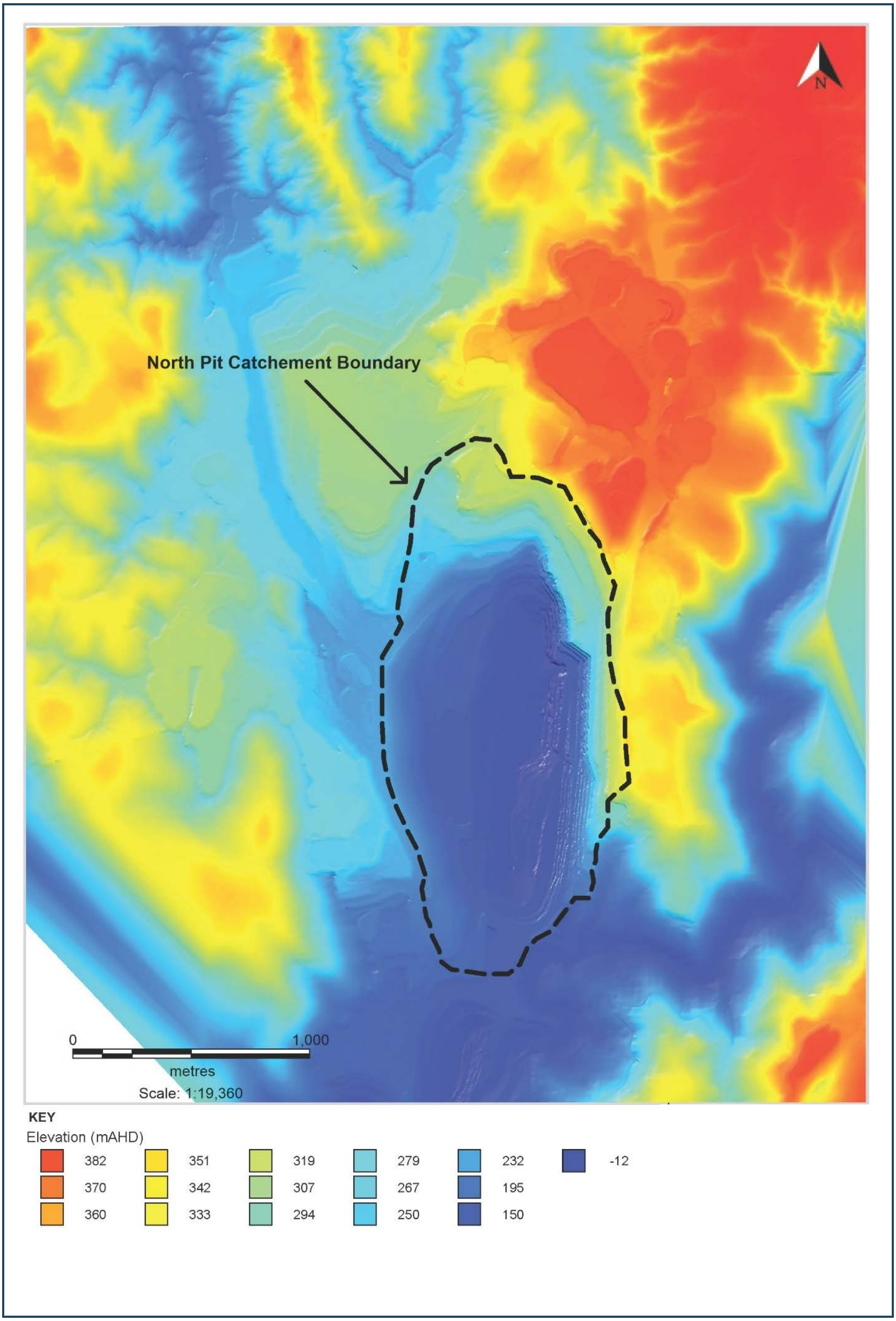

Figure 1 North Pit Catchment

2.2.2 Project Specific Hydrogeology

For the purposes of assessing groundwater inflows to the Project, the hydrogeology in around North Pit can be represented by a simple block model. The key components (aquifer units) of this block model are:

- East Wall Block – largely competent chlorite-carbonate schists that form the east wall of the North Pit. Available information suggests that bulk permeability is low and aligned along strike (north-south), although there is reference to some enhanced permeability in places associated with structure and weathering.
- Eastern Contact Fault Zone – which includes the EC Fault East and EC Fault West. Historical reports suggest that these faults are likely to form flow barriers, although anecdotal information indicates that there have been consistent (if only minor) groundwater flows from the exposure of these faults in the west wall.
- Ore Zone Block – interbedded mafic intrusives and magnetite ore. It is reported that the rock mass itself is tight, but that there is some permeability associated with north-south oriented structures.
- Western Boundary Fault Zone – this includes the Magnesite-Siderite Fault. The fault zone is reported to be sheared and clay filled, although significant short-term inflows (up to 100L/s) have been observed when this zone has been mined through, but that flows have largely ceased after a short time. This suggests that the fault zone may be acting as a partial barrier to the release of stored water behind the faults but there is only limited groundwater storage and permeability.
- West Wall Block – largely magnesite and chloritic schists. Like the East Wall Block, it is reported that permeability is low and aligned along strike.
- LeFroy Fault Zone – there is only minor available hydrogeological information for this fault zone. It is suspected that the fault zone acts as a flow barrier. However, for the purposes of the current assessment it will be assumed to have similar aquifer properties to the units either side of it.
- Broderick Creek Block – largely metasediments (sandstones and slates) and meta-basalt. Again, there is little to no available hydrogeological information for this unit. However, as outlined in Section 3, the unit largely lies to the west of an interpreted aquifer recharge boundary and so will have no influence of groundwater inflows to the Block Cave.

Figures 2 and 3 show the conceptual aquifer block model in plan and oblique section.

2.2.3 Aquifer Hydraulic Parameters

Based on data reported in historical reports and from recent geotechnical drilling/testing programmes for the North Pit and the NPUG (AQ2 2020, AQ2 2021b, Coffey 2000 and Mining One 2018), and calibration of an analytical groundwater inflow model (refer Section 4), estimates of bulk aquifer permeability for each aquifer unit have been derived.

As permeability appears to be strongly controlled by strike oriented structures, it is assumed that there is a strong X-Y aquifer anisotropy with north-south oriented permeability in broad aquifer units being one order of magnitude higher than east-west oriented permeability. It has also been assumed that the permeability in the Ore Zone Block is higher than in the East Wall and West Wall Blocks. The analytical groundwater inflow model (calibrated to dry season pit inflows) also adopted such north-south anisotropy.

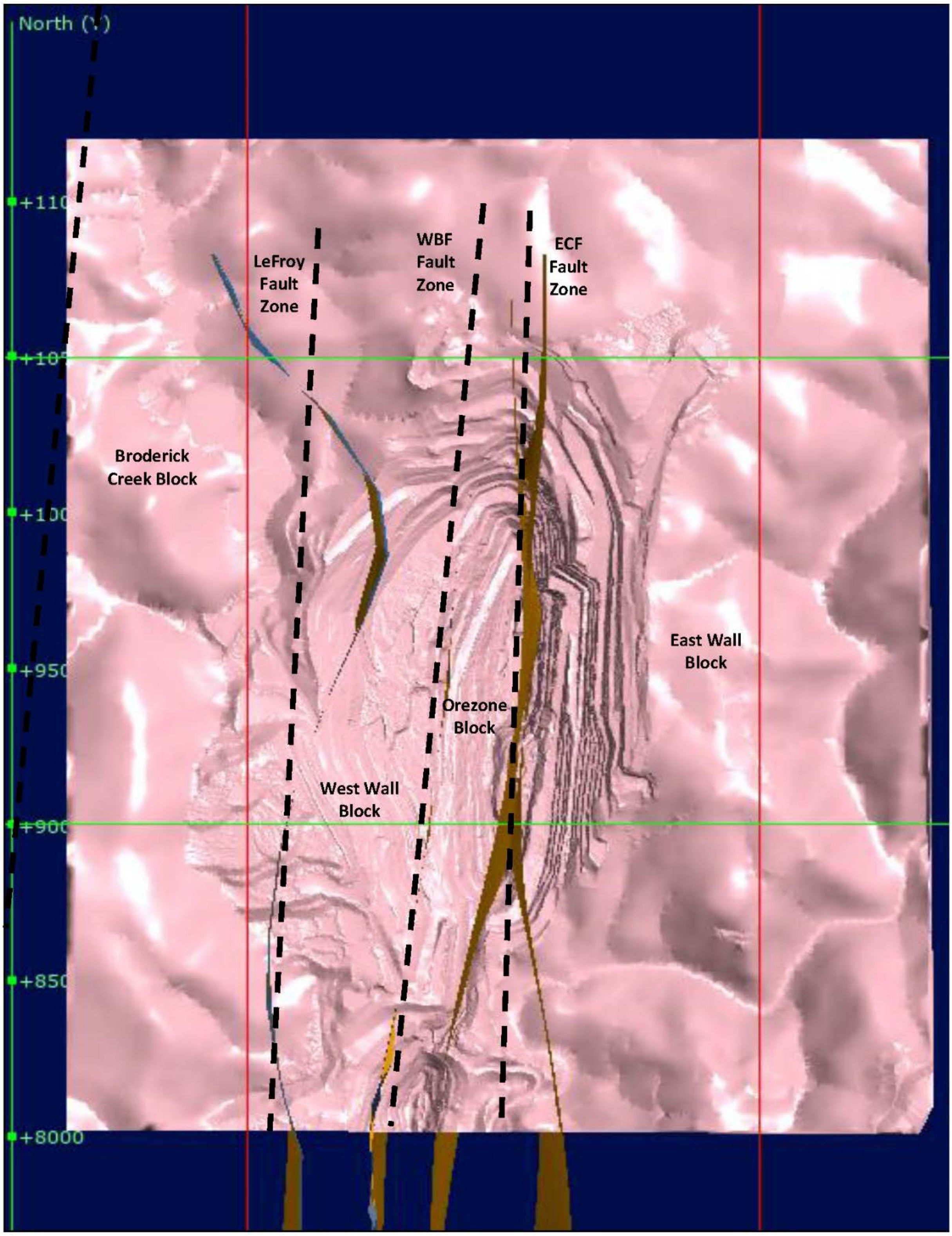

Figure 2 Hydrogeological Block Model Aquifer Units - Plan

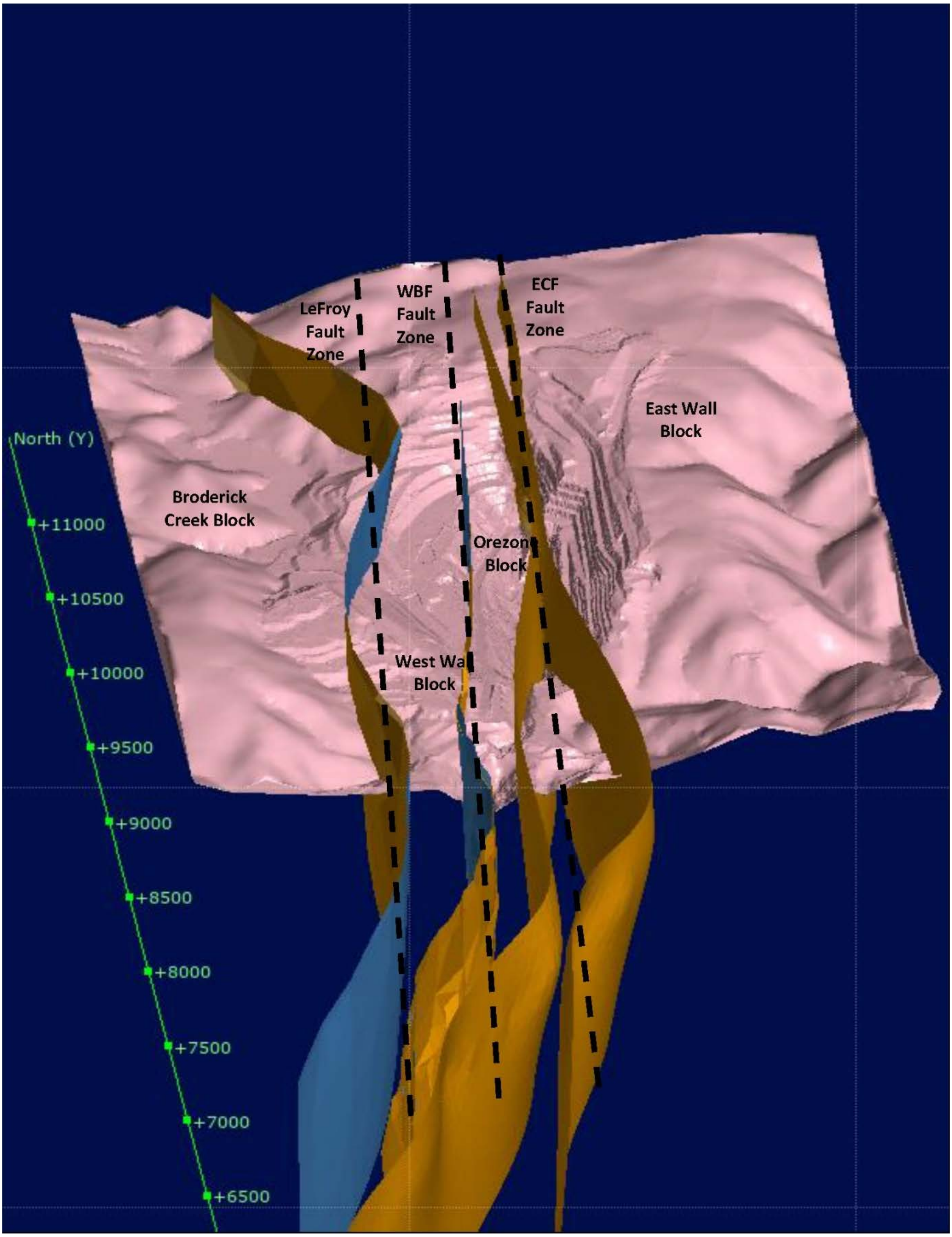

Figure 3 Hydrogeological Block Model Aquifer Units - Oblique View

The measured and adopted bulk permeability for each aquifer unit is listed in Table 1. A higher permeability for the ECF Fault Zone (than has been measured in limited tests) has been adopted to account for observed preferred flows along this structure.

Table 1 Adopted Bulk Permeability for Aquifer Units

Aquifer Unit	Derived Permeability (m/d)		Adopted Permeability for Conceptual Model (m/d)	
	Reported Historical Test Results	Test Results from 2018 to 2020	N-S	E-W
East Wall Block	0.001 to 0.8	0.003 to 0.007	0.005	0.001
ECF Fault Zone		0.001 to 0.1(?)	0.05	0.005
Ore Zone Block	0.003 to 0.1	0.002 to	0.01	0.001
WBF Fault Zone	NA	NA	0.01	0.001
West Wall Block	0.001 to 0.8	0.0005 to 0.005	0.005	0.001
LeFroy Fault Zone		0.002 to 0.08	0.005	0.005
Broderick Creek Zone	NA	0.002 to 0.007	0.005	0.001

In terms of aquifer storativity, a bulk specific yield (unconfined storativity) of 0.5% has been adopted for all units. Confined storativity is likely to be in the range 10^{-5} to 10^{-3}, however, this parameter has less influence on dewatering and a precise estimate is not required.

2.2.4 Aquifer Boundary Conditions

Aquifer recharge boundaries are important in that they can control the lateral extent of groundwater level drawdowns around the pit/underground and can also be the key driver of mine inflows. Recharge boundary conditions at Savage River are complex, as a result of the generally low bulk permeability. Prior to mining, the main aquifer boundaries would have been the Savage River (constant head recharge boundary to the south) and various groundwater flow divides beneath topographic ridges (no-flow boundaries to the north, east and west. The boundary heads at the no-flow boundaries would have been maintained by recharge.

However, boundary conditions will have changed since the commencement of mining and could change further (significantly) if there is any development of hydraulic connection between recharge sources and the Block Cave zone as a result of enhanced permeability associated with deformation zones around the cave. From parallel rock deformation modelling studies, it is predicted that some minor deformation (which will develop on the margins of the main cave zone) will sub-crop beneath some potential recharge sources.

In terms of prediction of inflows (refer Section 4), the following aquifer boundaries were adopted:

- Savage River and South Lens Pit lake to the south – with recharge heads based on the elevation of the river bed and the spillway level of South Lens Pit.
- Broderick Creek Flow Through System to the west – with recharge heads based on measured groundwater levels in the new monitoring bores in the Broderick Creek Flow Through System (refer Section 2.3).
- Armstrong Creek to the east – with recharge heads base on the elevation of the creek bed up to a maximum head (and then constant head above this to reflect perennial creek flow conditions in the upper catchment).

- Upper Broderick Creek and tributaries of Upper Broderick Creek and Armstrong Creek - with recharge heads base on the elevation of the creek beds up to a maximum head of 260mRL (and then a constant head of 260mRL upstream of this to reflect "perched flow" conditions above the water table in the upper catchments).

Figure 4 shows the proposed recharge boundaries surrounding the pit and SLC/Block Cave and the derived recharge heads.

2.3 Broderick Creek Flow Through System

The Broderick Creek Flow Through System (BCFT) was developed in 1998 to convey stream flow from the Upper Broderick Creek beneath the western waste dump to a discharge point on Lower Broderick Creek close to its confluence with the Savage River. In summary, the BCFT comprises:

- Selectively placed, high permeability coarse fill along the base of the Broderick Creek flow channel. The fill (referred to as Type A fill – alkaline rock sourced from the magnesite schists in the West Wall Block aquifer zone) was placed directly onto weathered basement within the creek valley.
- The Type A fill (essentially an alkaline high flow medium) is up to 30m thick along the deepest part of the creek valley. Clay material was placed along the top and sides of the Type A fill and then covered by various other types of waste rock.
- The BCFT conveys flows of up to 1,800L/s in winter, depending on rainfall patterns and the water level upstream of the BCFT in Upper Broderick Creek. In summer, flows decline to around 20L/s, depending on the dry season water level in Upper Broderick Creek.

Currently, under "normal" rainfall and flow conditions, leakage/seepage from the BCFT into underlying weathered and fresh rocks (of the West Wall Block and Broderick Creek Block aquifer zones) is controlled by the low permeability of these units, and is minimal. As such, while the Broderick Creek Flow Through System might contribute some seepage to groundwater, it is not likely to form a groundwater recharge boundary. However, as outlined in Section 2.2.4, the BCFT could form a recharge boundary (even if only a partial recharge boundary) if deformation around the cave zone results in direct hydraulic connection between the BCFT and the cave.

It is also noted that, in 2018 following periods of prolonged high rainfall, water levels within the BCFT rose to the top of the Type A fill and significant volumes of water "overflowed" to the pit at three low points ("West Wall waterfalls") where the current pit wall cutback intersects the waste dump. It was estimated that up to 600L/s flowed from the BCFT to the pit during this period. The West Wall Dewatering System (WWDS) has since been implemented to manage the potential for this to occur in the future:

- A flow interception scheme has been implemented to catch any future inflows in large tanks installed at the inflow points and direct water to the South Lens pit by gravity flow through large diameters HDPE pipes. Inflows flow down the pit wall and are initially captured in clay lines dams (constructed on the berm below the inflows points (also referred to as the "waterfalls") which then overflow to the tanks via multiple pipes.
- Six monitoring bores have been installed along the BCFT and water levels monitored on a regular monthly basis.
- A TARP (Trigger Action Response Plan) has been developed, as part of the open pit water management plan, which includes monitoring rainfalls and water levels in the BCFT and readiness checks of the inflow interception scheme.

Significant overflows have occurred since 2018 following periods of high rainfall (and runoff from the Broderick Creek catchment) and, while some minor refinement of the WWDS was required around piping, the scheme continues to effectively managed these overflows.

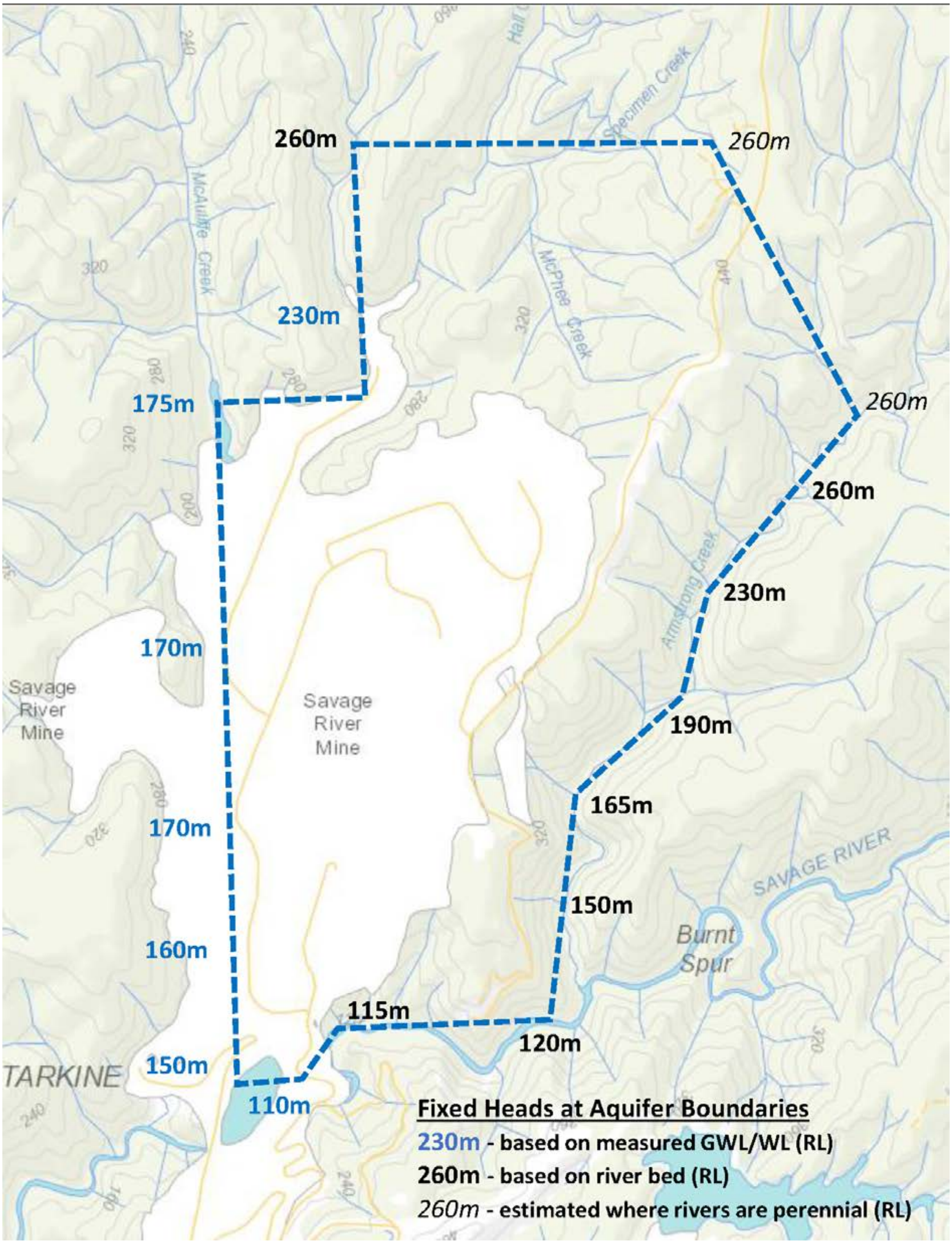

Figure 4 Aquifer Boundaries for Inflow Predictions

2.4 Mine Inflow Mechanisms

2.4.1 Current Pit Inflows

Groundwater inflows to the existing pit are largely as a result of pseudo-radial groundwater flow through the low permeability basement rocks and fault structures. As outlined in Section 2.2.3, there is a north-south anisotropy in aquifer permeability, which results in a preferred north-south oriented groundwater flow direction.

Groundwater level drawdowns in response to pit inflows (and the removal of inflows by pit sump pumping) will also have a preferred north-south orientation and will form an elliptical shape. Given the low permeability of the local aquifers, drawdowns will have been constrained to the local mine area only. The influence of potential recharge boundaries is not clear. However, depending on the vertical permeability beneath the potential recharge boundaries (compared with horizontal permeability), drawdowns could extend beneath and beyond some boundaries. Leakage from the potential recharge sources is likely to be occurring, but at rates insufficient to fully constrain the lateral extent of drawdowns.

In calibrating the mine inflow model used in this study (refer Section 4), both scenarios were simulated (i.e. radial flow from infinite aquifer and radial flow from fixed recharge boundaries).

2.4.2 Inflows to Block Cave

Following the commencement of Block Cave mining, a cave zone will develop above the mine workings. Recent deformation modelling (Beck Engineering, 2022) shows the margins of the cave zone to be largely vertical from the extraction level to the near the base of the pit and then becoming conical (inverted cone) in shape with the margins roughly parallel to and largely contained within a small area around the pit. The permeability within the main cave zone will be very high (likely to be greater than four orders of magnitude higher than the permeability of local aquifers). As such, the hydraulic driver for most future underground mine inflows would be similar to a deep open pit that envelops the main cave zone. That is, pseudo-radial flow to a large void extending down to the base of the mine workings. Such pseudo-radial inflows would be somewhat higher than current pit inflows, due to the increased mine depth and lateral area of the mine envelope.

As mentioned in Section 2.2.4, deformation modelling predicts that minor deformation zones will develop along the margins of the main cave zone. To the north, east and south this will merely result in a marginal increase in the effective hydraulic radius of the main cave zone. However, the modelling predicts that minor deformation will extend laterally from the pit crest (in a shallow deformation zone following the old topographic surface) to beneath parts of the BCFT. Current deformation results suggest that the degree of deformation (plastic strain) could result in an order of magnitude increase in local aquifer permeability in this fringe zone (Beck Engineering, 2016, 2019, 2020, 2022 and pers.com.).

This increase in permeability is likely to result in the potential for increased lateral seepage to the pit crest during periods of high water levels within the BCFT. This is likely to be more prevalent close to the existing West Wall waterfalls where deformation could result in the lowering of the spill levels from the BCFT to the pit. However, review of the deformation results indicates that there should be no direct hydraulic connection between the BCFT and the cave zone as a result of deformation enhanced permeability. Notwithstanding this prediction of future underground mine inflows (refer Section 4), adopted a constant head boundary approach along the BCFT to account for some hydraulic influence.

There is the potential for the overflow of water from the BCFT to the pit (which might be marginally enhanced by shallow deformation (refer above paragraph) and then to the cave zone, during periods of high rainfall and flow, as was observed several times since 2018. This is not considered a groundwater inflow (or direct surface water inflow) and is covered separately in the inflow predictions (refer Section 5) and the concept mine water management plan (refer Section 6).

2.4.3 Inflows to Sublevel Cave

The planned Sublevel Cave mining to scavenge residual ore behind the north wall of the pit (prior to the development of the Block Cave) will intercept some, if not all, of the groundwater inflow towards the pit from the north. That is, the Sublevel Cave mine will not result in any net increase in total mine inflows.

2.4.4 Inflows to Decline

The exploration decline and future main access and extraction declines will largely be contained within the East Wall Block aquifer zone (in the footwall of the Eastern Contact Fault – ECF), which has an interpreted very low bulk permeability. As such, bulk and long-term inflows are expected to be minimal. However, some measurable inflows could be encountered where the declines and other access workings intersect faults and jointed ground.

3. SURFACE WATER INFLOWS

3.1 Approach

A daily rainfall/runoff model was developed for the North Pit mine area using the following approach:

- Savage River rainfall records were used as an input to the e-Water program SCL (Stochastic Climate Library). The SCL program uses historic rainfall data as an input and produces a synthetic rainfall data set for the required duration, which is a statistical fit to all observed rainfall. For this project, recorded rainfall between 1967 and 2018 was used and a synthetic daily rainfall sequence over 500 years was generated.
- The current pit catchment was derived from the pit topographic plan provided by site (see Figure 1) and site observations. The measured catchment area is 1.7km^2.
- Annual average runoff coefficients were adopted (based on WRM, 2007) as follows:
    - Runoff from pit walls (1.44km^2) – 90%
    - Runoff from catchment areas outside the pit crest (0.26km^2) – 77%
- Surface water inflows to the pit were calculated within the GoldSim water balance model, which was set up to assess mine water management options (refer Section 6.1 for further information). GoldSim is a probabilistic simulation model (based on Monte Carlo simulation software) that allows users to create customised models based on built-in functions within the software. The software is well suited for water balance projects.
- The model was run for 100 iterations of rainfall-runoff using different, randomly selected 15-year rainfall sequences (equivalent to the mine life of the Block Cave), from within the synthetic rainfall data set. The rainfall data set was converted to runoff rates using the catchment areas and runoff coefficient described above to simulate possible rainfall runoff sequences over the 15-year period in each model iteration.

It is assumed that the runoff which is currently predicted to report to the base of the North Pit would report to the Block Cave, through the subsidence zone which will develop above the underground workings, with little to no lag time.

This model approach is considered the Base Case and assumes no inflow contribution from overflow from the BCFT as referred to in Section 2.3. The potential impact on total inflows to the pit (and subsequently the block cave) if the BCFT contributes flow is discussed further in Section 5.

3.2 Results

Runoff rates to the underground were simulated in the GoldSim model using Monte Carlo sampling of a synthetic rainfall data set. The GoldSim model uses daily precipitation values to estimate inflow rates to the pit assuming that each day's rainfall reports to the extraction point within the pit on the day the rain occurs, and the runoff is spread evenly over whole day (i.e. averaged over the day).

The results of runoff predictions are plotted in Figure 5. Figure 5 shows both the maximum inflow rate across all model iterations predicted on each day, plus the mean inflow rate across the model iterations. The maximum instantaneous inflow rates to the Block Cave are predicted to be up to 2,500L/s, with mean inflow rates ranging from 0L/s to 150L/s. Although not shown in Figure 5, the model also predicts that no run-off to the pit may occur on any given day (if no rainfall occurred on that day).

The model also predicts that over the 15-year underground mine life, the estimated probability of inflow to mine exceeding different runoff rates is as follows:

- 50% probability that a flow exceeding 1,300L/s will occur.
- 25% probability that a flow exceeding 1,400L/s will occur.
- Maximum predicted inflow rate of 2,500L/s.

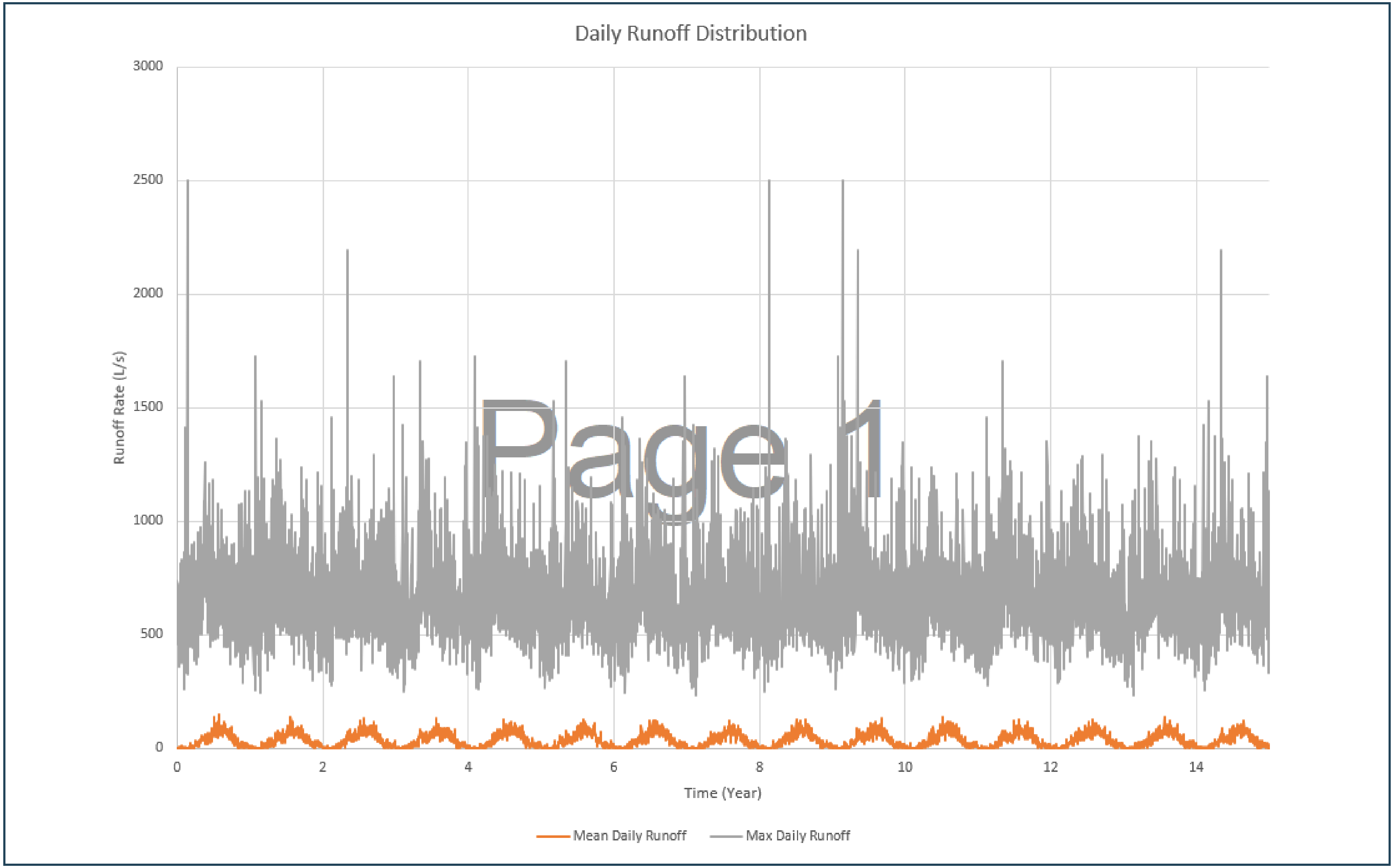

Figure 5 Predicted Rainfall Runoff to NPUG

4. GROUNDWATER INFLOWS TO BLOCK CAVE

4.1 Approach

A simple analytical modelling approach was adopted to provide FS level of confidence estimates of groundwater inflows to the underground mine. More complex modelling approaches (e.g. 3D numerical groundwater flow modelling) were considered, especially given that inflows will, in part, be influenced by the complex 3D geometry of the main cave/subsidence zone and potential flows from the BCFT.

However, our experience in recent years has been that there is rarely sufficient data on, or understanding of, specific hydrogeological features (that control groundwater flow) in fractured rock aquifers, to support the potential benefits of using numerical models. That is, while numerical models can simulate spatial and temporal variability in all model parameters and can simulate multiple lateral and vertical flow paths and the development of underground workings, there is insufficient data to validate/calibrate the models for these specific flows. As a result, and particularly where there is dewatering history available to support model calibration (as is the case with the North Pit) the numerical models are often no more reliable than more simplified analytical modelling approaches.

In fact, in a number of cases where limited data exists (as is the case at Savage River) and where both analytical and numerical models have been run, the results were comparable. There is also a wealth of published research data that supports the use of analytical models in fractured rock environments.

Another contributing factor to groundwater model selection was the expected relative proportion of groundwater and surface water inflows to total mine inflows. Historical data (and some preliminary modelling) indicated that surface water inflows would be one to two orders of magnitude higher than groundwater inflows. As such, uncertainties in the magnitude of groundwater inflows would have minimal impact on the reliability of total mine inflows.

The outcome of our assessment was that a lumped parameter analytical model would provide sufficient predictive reliability for the FS, especially given the available calibration data.

4.2 Groundwater Inflow Model

4.2.1 Description of Model

The model used is a simple analytical groundwater flow model based on the Dupuit-Forcheimer and Theim Equations for groundwater flow to a large diameter well. Key steps in the modelling are as follows:

- The mine, or various sections of the mine, is represented by a large diameter "equivalent well" (or sequence of wells) of similar base area and depth at various time steps, representing various stages of mine development.
- Average aquifer parameters are applied to the equivalent well(s).
- The model is used to calculate the pumping rate required to maintain pumping water levels in each equivalent well at or below the base of each equivalent well (mine base) at the end of each time step. This is the analogue equivalent of groundwater inflow to a dewatered mine.
- As the total volume of material to be mined and the specific yield (drainable porosity) of the material will be very low in comparison to the other inflows, the contribution of storage in the mined ore/waste can be ignored in this case.

The model makes a number of other simplifying assumptions including lumped (bulk average) aquifer parameters and radial flow from an aquifer of infinite areal extent. Recharge can either be simulated using boundary conditions or as a constant flux. As such, it cannot be considered as an exact model, but the model does allow for good approximations of bulk mine inflows. In this case, model reliability is improved by calibration data from anecdotal North Pit dewatering records.

4.2.2 Modelling Approach

A two phased approach to the inflow modelling was adopted, as follows:

- Phase 1 – Confirmation of bulk aquifer parameters: The model was set up to simulate the existing inflows to North Pit and the model was run to simulate historical groundwater inflow rates. Aquifer parameters were varied (within limits consistent with the conceptual hydrogeological model – refer Section 2.2.3) until a good match between predicted and observed dewatering was achieved. This process is sometimes called "inverse modelling" and is essentially model validation / calibration.
- Phase 2 – Prediction of Future Mine Inflows: Once bulk aquifer parameters had been derived, these were used in the model set-up to simulate inflows to the future underground mine for the development of the planned Block Cave.

4.3 Phase 1 – Calibration

The calibration model was set-up to simulate observed long-term inflows to the North Pit. Key features of the model set up are:

- The model extends from 200mRL (average pre-mining water table) down to -100mRL (100m below current base of pit and assumed to be the effective base of the aquifer).
- The pit was represented by a large diameter well extending down to 0mRL and with an equivalent well radius of around 320m (calculated from the average area of the current pit below water table).
- A bulk specific yield of 0.5% was adopted.
- The model was run to predict inflows to the pit after 10 years or mining below water table.
    - Two model scenarios were considered during calibration:
    - Transient bulk aquifer radial flow model with no influence from recharge boundaries. In this model, drawdowns were free to extend over time to the calculated radius of pumping (i.e. dewatering) influence in the broad aquifer.
    - Steady state, anisotropic model with flows influenced by recharge boundaries. In this model, the maximum extent of drawdown was fixed at the various identified potential aquifer recharge boundaries. This model also considered two flow components:
        - Flow from the northern and southern quadrants of the overall radial flow field influenced by one bulk permeability.
        - Flow from the eastern and western quadrants of the overall radial flow field influenced by a bulk permeability one order of magnitude lower.
- Both models were run for various adopted base case permeability values, until a match between predicted and observed inflows was achieved.
- The long-term pit inflow rate was assumed to be 15L/s based on reported (anecdotally) end of summer pit sump pumping requirements. That is, total dewatering when there was no direct rainfall runoff and only minor (if any) delayed interflow through the unsaturated zone above the water table.

Appendix A shows the model spreadsheet for the inflow calibration model, including schematic sections (plan and vertical sections) through the model.

Good model calibration was achieved with the following adopted bulk permeabilities:

- Transient radial aquifer model (with no recharge boundaries) – 0.015m/d.
- Steady state, anisotropic model (with recharge boundaries) – 0.02m/d (N-S); 0.002m/d (E-W).

These calibrated permeabilities are broadly consistent with the adopted values in the conceptual hydrogeological model (refer Table 1).

Deformation modelling for the current mine plan predicts that deformation (that might result in enhanced permeability) is constrained to a narrow halo around the cave zone and to a shallow zone beneath the BCFT, but does not provide a direct enhanced pathway from the BCFT to the cave zone. As such the cave and significant deformation zones can be represented by a simple void (defined by the deformation envelope) and either model would be suitable for inflow predictions to the current Block Cave.

However, deformation modelling for earlier mine designs showed the potential for some enhanced hydraulic connection between the BCFT and the cave zone and it is possible that future deformation modelling might also predict some enhanced hydraulic connection. For this reason, the steady state, anisotropic model is considered to be more practical (and reliable) as it can account for such hydraulic connection if required, and this model was carried forward for prediction modelling.

4.4 Phase 2 – Inflow Prediction

4.4.1 Inflows to Block Cave

As outlined above, the calibrated steady-state anisotropic model was carried forward for prediction of inflows to the planned Block Cave mining operation.

The calibration model (refer Appendix A) was modified to simulate the cave zone and the deformation zone around the cave zone. It was assumed that the predicted 0.4% plastic strain envelope would define a zone of sufficient high permeability that it would behave (hydraulically) like a large void. That is, groundwater inflows to this zone would instantaneously report to the mine workings and define dewatering requirements. The model spreadsheet for the prediction model (including schematic sections) is shown in Appendix B. Key features of the prediction model setup are:

- The base of the Block Cave is at -330mRL.
- The margins of the cave zone and 0.4% plastic strain envelope will roughly parallel but extend laterally further than the final pit walls. The margins of the overall pit and deformation zone in the steady state model were set at 600m wide (east-west) and 1,600m long (north-south). This resulted in an increase in the effective radius of the equivalent well (simulating the deformation zone) to 550m.
- The base of the aquifer remains at -100mRL. That is, the model simulates groundwater inflows to the upper half of the cave zone only. This is considered realistic as permeability in fractured rock aquifers typically decreases with depth and is minimal at depths of 400m below natural surface. However, a check model was also run to simulate possible deeper flows (refer Section 4.4.3).
- In summary, the model simulates the following inflows:
    - West – inflows from the BCFT to the cave/subsidence zone controlled by the bulk E-W basement rock permeability.
    - East – inflows from the recharge boundary along Armstrong Creek controlled by the bulk E-W basement rock permeability.
    - North – inflows from the assumed constant head boundary to the north of the mine controlled by the bulk N-S permeability of the basement rocks.
    - South - inflows from the Savage River controlled by the bulk N-S permeability of the basement rocks.

The model was run to predict total inflows at the end of the Block Cave (NB. the prediction model is a steady state model and, as such, is sensitive to the depth of the mine workings but not to the duration of mining). The model predicts around 40L/s inflows to the cave zone (which will then rapidly migrate to the draw works and extraction level below the Block Cave).

This is considered to be the base case prediction for the current mine plan (and predicted deformation around the cave zone). It is noted that, as outlined in Section 2.4.3, any inflows to the Sublevel Cave behind the north wall of the pit, would essentially intercept flows to the pit from the north and are therefore included in the predicted 40L/s total inflow to the pit and Block Cave subsidence zone. Assuming that the Sublevel Cave mine workings intercept all groundwater flows from the north, inflows to the Sublevel Cave could be as high as 8 to 9L/s (and inflows to the pit less by the same amount).

There is the possibility (if only minor) that some localised enhanced hydraulic connection might develop between the BCFT (or even South Lens or the Savage River) and the cave zone. Earlier mine inflow modelling (AQ2 2019a), based on the June 2019 mine plan and deformation modelling that indicated some enhanced permeability would develop between the BCFT and the cave zone, predicted up to 85L/s inflow. However, even this was considered a worst case prediction as it assumed continuous hydraulic connection along the full strike length of the cave zone.

4.4.2 Check Model (for deeper base of aquifer)

As outlined in Section 4.4.1, the inflow prediction model assumed that the effective base of the aquifers (surrounding the cave/subsidence zone) was at -100mRL. While this is considered to be appropriate, a simple check model was run to assess the potential inflows if a deeper aquifer base was adopted. The check modelling process was as follows:

- An aquifer base of -330mRL (base of Block Cave) was adopted.
- The calibration model was modified (for the deeper base of aquifer) and run to derive calibrated bulk permeabilities. The model calibrated to proportionally lower permeabilities as follows:
  - Around 0.007m/d for the transient model;
  - Around 0.009m/d (N-S) and 0006m/d (E-W) for the steady state anisotropic model.

The prediction model was for the deeper base of aquifer and the calibrated permeabilities listed above.

The check model predicts an inflows of around 55L/s at the end of the Block Cave, some 40% higher than for the Base Case model, but still insignificant when compared to surface water inflows (refer Section 3).

4.5 Groundwater Inflows to Access Declines

A simple analytical flow model was used to predict potential inflows to the current exploration decline. The model is based on the Goodman et all equations for steady state groundwater flow to a tunnel. Based on the aquifer parameters for the East Wall Block and ECF aquifer zones listed in Table 1, and depths below current water table scaled from mine plans, the following maximum inflows were predicted:

- Long-leg decline in the footwall of the ECF (East Wall Block) – up to 10L/s.
- Cross cut through the ECF – 5L/s.

That is, around 15L/s total inflows to the access declines.

However, these are predicted maximum inflows. As outlined in Section 2.4.3, inflows are likely to decline as immediate fault zones become dewatered and/or depressurised as result of inflows to the decline during development and later to the cave/subsidence zone during mining.

Peak inflows to the full Block Cave access and extraction declines might be marginally higher that the above predictions.

5. INFLOWS FROM BRODERICK CREEK FLOW THROUGH SYSTEM

5.1 General

There are two potential inflow mechanisms from the Broderick Creek Flow Through System (BCFT):

- Leakage through the base of the BCFT directly to the cave zone via deformation and connected cracking around the margins of the cave zone. While this was predicted to occur for earlier mine plans (and accounted for in earlier inflow predictions (AQ2, 2019a)), this is not considered to be an issue for the current mine plan based on the updated geotechnical model and most recent deformation modelling.
- Overflow from the upper parts of the BCFT during periods of high rainfall, flow and BCFT water levels. Overflows of around 600L/s have been observed during and following periods of high rainfall since 2018. This likely reflects the upper limit of overflows under current conditions.

5.2 Predicted Inflows from BCFT

As outlined in Section 2.3, overflow from the BCFT is being effectively managed by the WWDS and geotechnical and deformation modelling indicates little to risk of subsidence that might impact the operation of the WWDS. Never-the-less, there remains a finite (if low) possibility that the WWDS might fail.

As part of the overall assessment of water inflow risks to the block cave, potential contributions to total pit inflows from BCFT overflows (assuming a total failure of the WWDS) have been considered. This is referred to as the Uncertainty Case.

5.2.1 BCFT Inflow Model

Inflow from the BCFT into the pit void has been approximated on the assumption that during wet years, “spillage” (or subsurface overflow) from the BCFT to the open cut pit will occur. This inflow has been approximated based on anecdotal information provided by site staff as follows:

- Monthly rainfall totals from the synthetic rainfall data set were assessed to determine what depth of rainfall may constitute a large event to dictate when the BCFT may overtop.
    - The highest month’s rainfall total in each calendar year was extracted as a series.
    - From this series the 40th percentile and 60th percentile monthly rainfall depths were estimated to be:
        - P40 – 345mm
        - P60 – 360mm
- Within the model, each time step where the previous 30-days of rainfall exceeds the P40 or P60 rainfall depth triggers an inflow from the BCFT to the underground. The inflow rates assumed are as follows:
    - P40 – 300L/s
    - P60 – 600L/s

5.2.2 Total Pit Inflows for Uncertainty Case

The BCFT inflow model, outlined in the previous section, was used to predict the daily contribution (from the BCFT) to total pit inflows and added to the daily inflows from runoff from the pit catchment (as detailed in Section 3.

The results of total runoff predictions are plotted in Figure 6. Figure 6 shows both the maximum inflow rate across all model iterations predicted on each day, plus the mean inflow rate across the model iterations. The maximum instantaneous inflow rates to the Block Cave are predicted to be up to 2,500L/s, with mean inflow rates ranging up to around 200L/s.

Although not shown in Figure 6, the model also predicts that no run-off to the pit may occur on any given day.

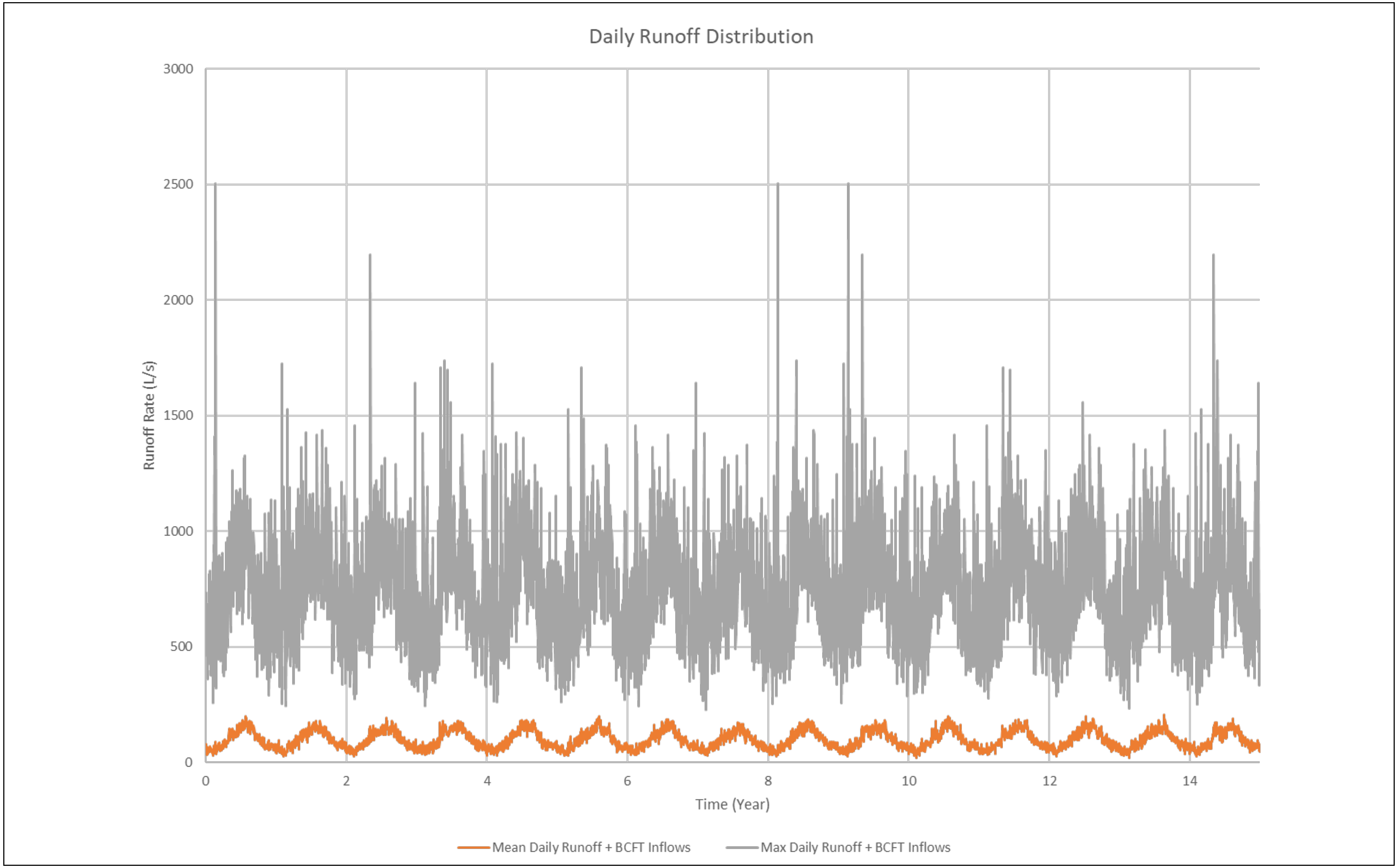

Figure 6 Predicted Rainfall Runoff and BCFT Inflow to NPUG

6. CONCEPT MINE INFLOW MANAGEMENT PLAN

A concept mine water management plan has been developed for the FS. This plan will be refined during the subsequent Detailed Design Stage of the project, and comprises two broad components:

- Managing inflows from rainfall runoff to the pit catchment (and thence into the cave zone) and base groundwater flows to the cave/subsidence zone including some enhanced leakage from the BCFT through minor connected cracking associated with deformation at the margins of the cave/subsidence zone.
- Potential overflows from the BCFT during high rainfall periods.

6.1 Base Case - Rainfall Runoff and Groundwater Inflows

Instantaneous (daily average) surface water inflow rates to the Block Cave range from nil (non-rainfall days) to up to 2,500L/s. It is not practical to design a dewatering system to account for instantaneous inflows of surface water. A "just in time" dewatering pumping system designed to manage peak inflows would require very large capacity pumps that would only operate at design rates for short periods of time. The more practical approach is to design some buffer storage into the underground mine void and use this storage to balance out required pumping rates. That is, the optimum dewatering system would be designed to run at a fixed maximum rate (much lower than the peak "just in time" rate) sufficient to maintain the buffer storage at full or less than full capacity.

A water balance approach was used to develop the optimum dewatering system pumping rates for various assumed buffer storage volumes.

6.1.1 Total Inflow Rates

For the purposes of this assessment, total inflows are assumed to be a combination of:

- The variable rainfall runoff as described in Section 3.2.
- Fixed groundwater inflows of 55L/s. This includes the 40L/s predicted groundwater inflows to the cave/subsidence (as described in Section 4.4) and the predicted 15L/s inflow to the decline and other access workings (refer Section 4.5).

6.1.2 Buffer Storages

The current mine design incorporates two levels of buffer storage:

- Flood Storage Dams – a series of excavated silos at around the -400mRL level. The volumes of these and associated access workings (up to 391.5mRL) is 95,000m^3.
- Drainage Level – a lateral drive located beneath the Extraction Level and connected to the Flood Storage Dams by a decline and to the Extraction level by a series of short rises with a storage volume of 85,000m^3 up to the base of the Extraction Level - west perimeter (up to -391.5mRL).
- The total storage volume up to the base of the Extraction Level West perimeter is, then, 180,000m^3. This is considered the maximum practical volume of buffer storage.

6.1.3 Inflow Water Balance Model

The GoldSim probabilistic water balance model (described in Section 3.1) was used to assess various dewatering options using the inflows discussed above (fixed groundwater inflow plus variable surface water runoff volumes discussed in Section 3.2). The model assumes that inflow to the Block Cave is stored within nominal storage voids and the volume of water stored is tracked within the water balance. Different model scenarios were run with pump out rates and storage capacity limitations applied.

The following scenarios were run:

- No buffer storage in the underground – sufficient pumping capacity is required to remove runoff and dewatering inflow to the underground instantaneously. This is the "just in time" dewatering case and is presented for reference only.
- The Flood Storage Dams and ancillary development can be flooded – 95,000m^3 buffer storage available underground to run the pump out system.
- Drainage Level and ancillary development up to the Extraction Level – west perimeter can be flooded – 180,000m^3 buffer storage available underground to run the pump out system.

The water balance was used to determine what pump out rate would be needed to prevent stored water volume exceeding the underground buffer storage capacities for each scenario. Required pump out rates were determined for different rainfall exceedance probabilities (50%, 75% and 95%) over the 15-year mine life.

The results are shown in Table 2, and graphically in Figures 7 and 8. To further explain the meaning of the results, the following examples are provided:

- For a 95,000m^3 buffer storage:
    - A 400L/s pump out rate is predicted to result in the buffer storage capacity being exceeded at least once during the 15-year mine life in 50% of the model iterations.
    - A 750L/s pump out rate is predicted to result in the buffer storage capacity being exceeded at least once during the 15-year mine life in 10% of the model iterations.
- For a 180,000m^3 buffer storage:
    - A 325L/s pump out rate is predicted to result in the buffer storage being exceeded during the 15-year mine life in 5% of the model runs.
    - While not shown in Table 2, a 750L/s pump is predicted to result in the buffer storage not being exceeded in any model run.

Table 2 Underground Pumping Rates Required to Maintain Buffer Storage Volumes

Buffer Storage Volume (m^3)	Required Pumping Rate (L/s) to Maintain Buffer Storage Below Capacity			
	50% Exceedance Probability	25% Exceedance Probability	10% Exceedance Probability	5% Exceedance Probability
95,000	400	475	750	1,150
180,000	260	275	315	325

6.2 Dewatering System Requirements

Based on discussion of the water balance results, Grange has adopted 750L/s as the design pumping capacity of the underground dewatering system. This pumping rate results in the following:

- A 10% exceedance probability that the available storage in the Flood Storage Dams (95,000m^3) would be exceeded at least once during the life of mine.
- A <1% exceedance probability that the available storage capacity below the Extraction Level - west perimeter (180,000m^3) would be exceeded during the life of mine.

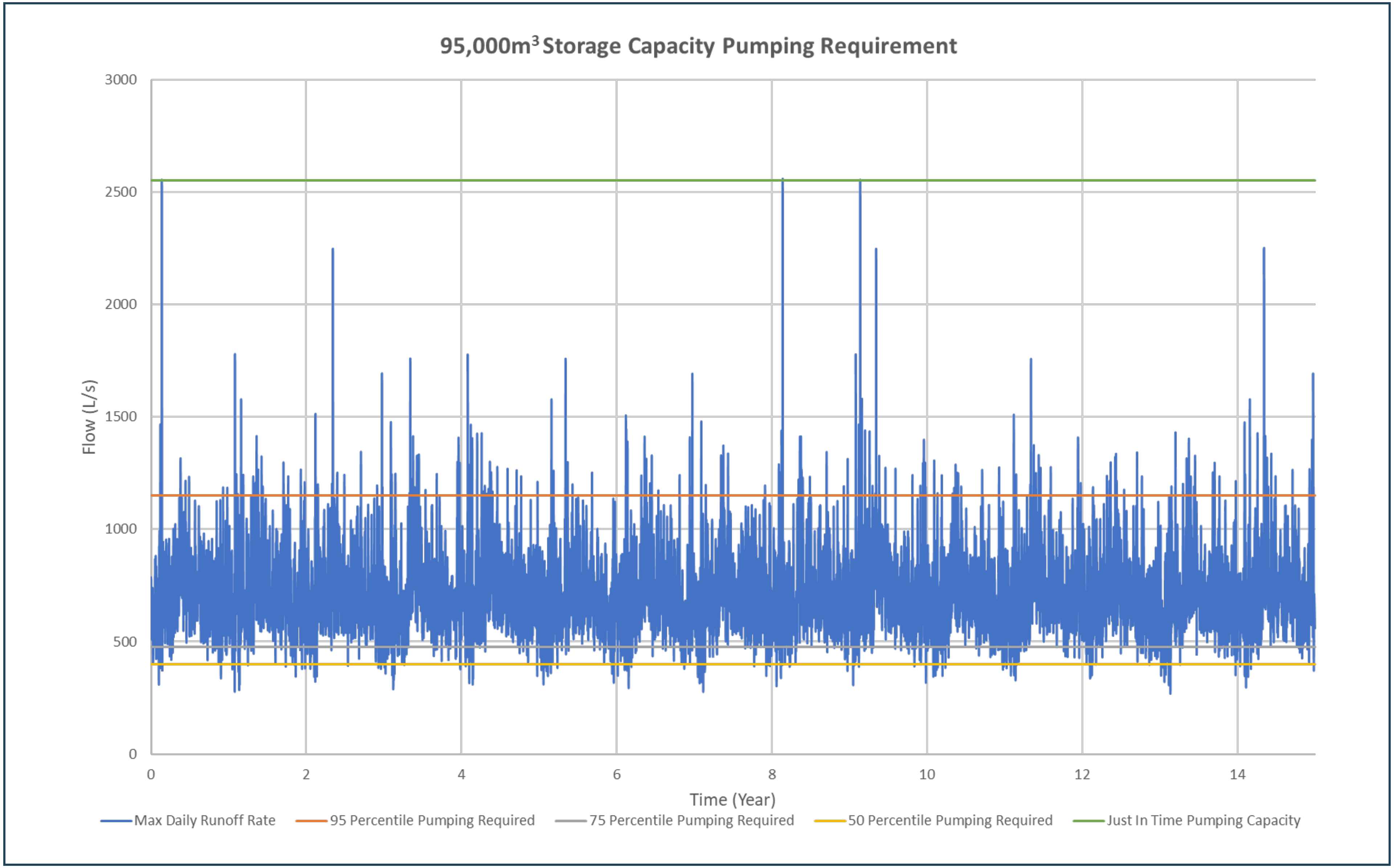

Figure 7 Base Case Water Balance Results: 95,000m³ Buffer Storage

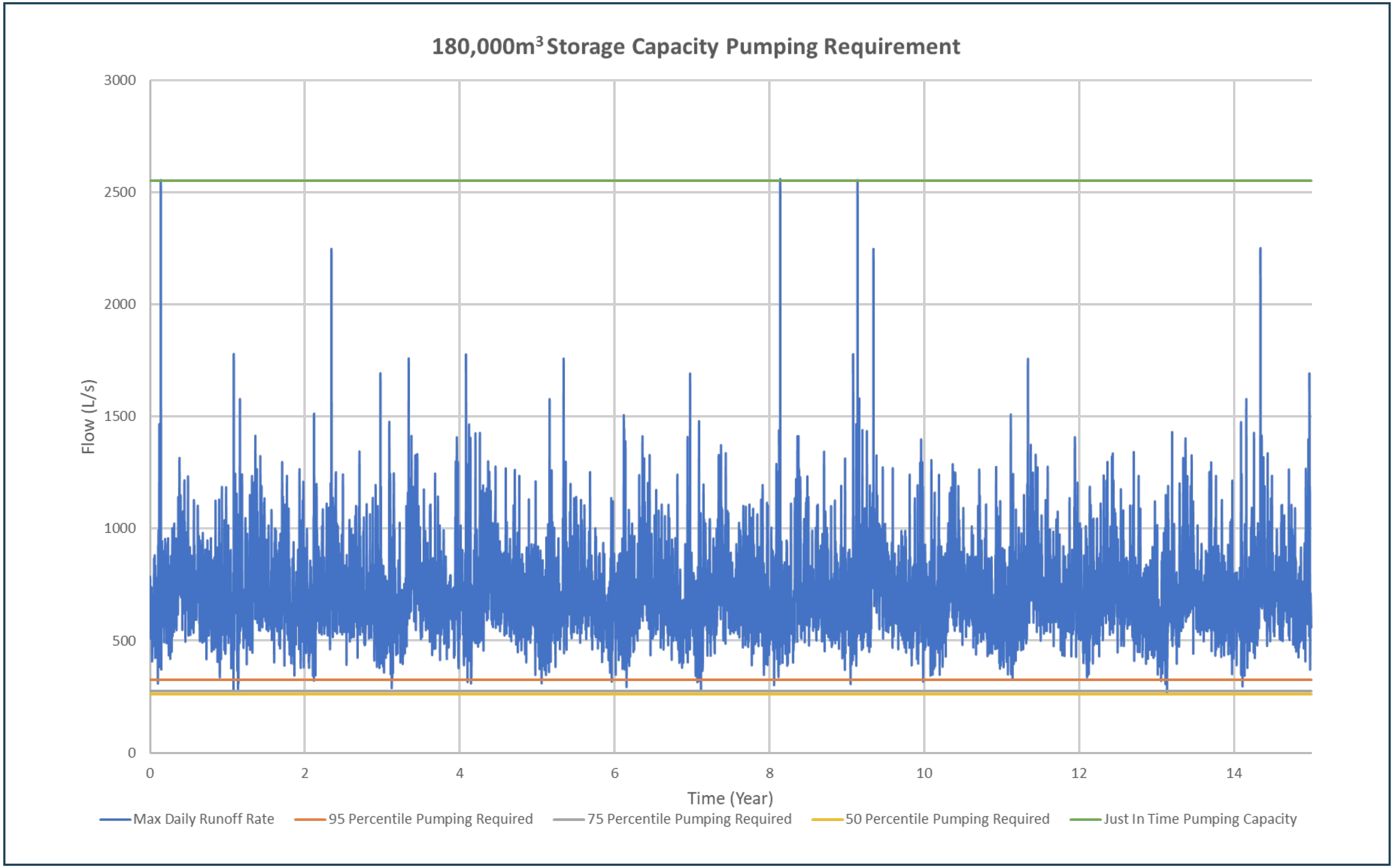

Figure 8 Water Balance Results: 180,000m^3 Buffer Storage

6.3 Overflows and/or High Leakage from Broderick Creek Flow Through System

6.3.1 Key Risks

There are two broad potential inflow risks to the underground operations to the Broderick Creek Flow Through (BCFT) system.

- Overflow to pit wall: During high rainfall and high BCFT flow periods, the BCFT can overflow to the pit as it has done since 2018. There is an interception system currently in place – West Wall Dewatering System (WWDS) but there is the possibility that the WWDS might get "damaged" by surface deformation and cannot be repaired because it is inside an exclusion zone. It is also noted that "inflows from the BCFT in 2019 resulted in the erosion of the pit wall above the WWDS and some undercutting of the lined collection berms occurred, which required some repair.
- High leakage through base: Earlier work (AQ2, 2019a) identified the longer-term (and potentially more serious) issue as the potential for enhanced hydraulic connection to develop between the BCFT and cave zone as a result of deformation. Recent deformation modelling indicates that this is now unlikely and that the risk relates to leakage from the base of the BCFT into a zone of enhanced permeability that might be connected laterally to the pit crest. These would likely be focussed on paleo-topographic lows along the pit crest with emergence points at/near the current "waterfalls". Such flows (which could be termed "underflows") are not likely to result in increased daily total inflows to the WWDS but may result in flows occurring over longer periods.

Concept level options to manage both these risks are outlined below.

6.3.2 Managing Overflow/Underflow to Pit Wall

There are two potential conditions that need to be considered, based on the ongoing performance of the West Wall Dewatering System (WWDS):

- The WWDS is not affected by deformation/subsidence and remains effective.
- The WWDS fails.

6.3.3 If WWDS Remains Effective

In this scenario, surface deformation in the area of the WWDS is only minor such that the WWDS remains largely effective and/or there remains safe access to allow for repairs. This is considered to be the Base Case given that current deformation modelling predicts deformation of 0.1% plastic strain (or less) in the area of the WWDS.

However, some preparation will be required prior to development of the Block Cave (while safe access is still available) to maintain operation, including:

- Stabilising the pit wall beneath the "waterfalls" to reduce erosion and the potential for undercutting the collection sumps. This could simply involve shot-creting, but might also require some increased level of stabilisation (e.g. mesh support to strengthen any shot-creting).
- Cushioning the tanks-pipework system against differential settlement. This would simply include providing adequate pipework and/or flexible couplings, so that any differential settlement does not result in the pipework or the pipe-tank connections parting.

As part of this assessment, other options were also considered including a lined open drain system from the catch sumps to South Lens Pit following a constructed even fall. However, it is considered that, if there is sufficient deformation/settlement to damage the current WWDS, it would also damage any open/lined drain system. In fact, the existing WWDS is considered to be more robust than a lined drain as water will continue to flow through pipework even if differential settlement/deformation results in localised low points along the flow path (whereas open drains could spill).

6.3.4 If WWDS Fails

If the WWDS fails (due to either settlement or excessive erosion) and there is no safe access for repairs to the WWDS, then some other form of overflow management will be required. It is noted that, based on deformation modelling results, this is considered unlikely (i.e. has a low risk) but is considered below as the Uncertainty Case.

Managing this potential risk would require either the pumping capacity of the underground dewatering system to be increased or some form of BCFT flow interception scheme would be required to reduce the flow of water to the pit during high rain fall/flow periods.

The water balance model was run to predict the exceedance probabilities of buffer storage being exceeded for the Uncertainty Case inflows described in Section 5.2.2 (i.e., rainfall runoff plus inflow from the BCFT), assuming a design underground pumping capacity of 750L/s. The model predicts:

- A 65% chance that the 95,000m^3 buffer storage would be exceeded in at least one year over the life of mine.
- A 25% chance that the 180,000m^3 buffer storage would be exceeded in at least one year over the life of mine.

Increased Pumping

In regards to increasing the pumping capacity of the underground dewatering system, overflow events from the BCFT are likely to occur during the wettest months at a time when the dewatering system will be operating at peak pumping levels. As such, to manage the potential risk of an uncontrolled overflow, the underground dewatering system peak capacity would need to be increased by the rate of peak overflow from the BCFT. Based on current estimates of peak overflow, the pumping system would need to be upgraded by 600L/s capacity to achieve the same level of reliability as the Base Case with 750L/s of pumping capacity.

BCFT Flow Interception

In regards to flow interception, two options were considered, although as outlined below, only one of these (Option 1) is considered practical. The options considered were:

- Option 1: Pumping from the creeks upstream of the BCFT. This scheme would involve:
  - Extracting water from natural ponds that form in the two tributaries of Broderick Creek upstream of the two arms of the northern BCFT.
  - Pumping water via a HDPE pipeline (nominally 600mm diameter pipe) up over the western waste-dump to a high point some 3km to the south and then by gravity drainage to the BCFT discharge point on the Savage River around 1km to the south of the high point.
- Operation of the system would be triggered by water levels in the existing (and new) BCFT monitoring bores and the required pumping rate would fluctuate depending on rainfall/streamflow and the bore water levels. However, the pumping capacity would need to be at least 600L/s based on observed inflows to the west wall of the pit from the BCFT since 2018.
- Figure 9 shows a concept plan for this option.

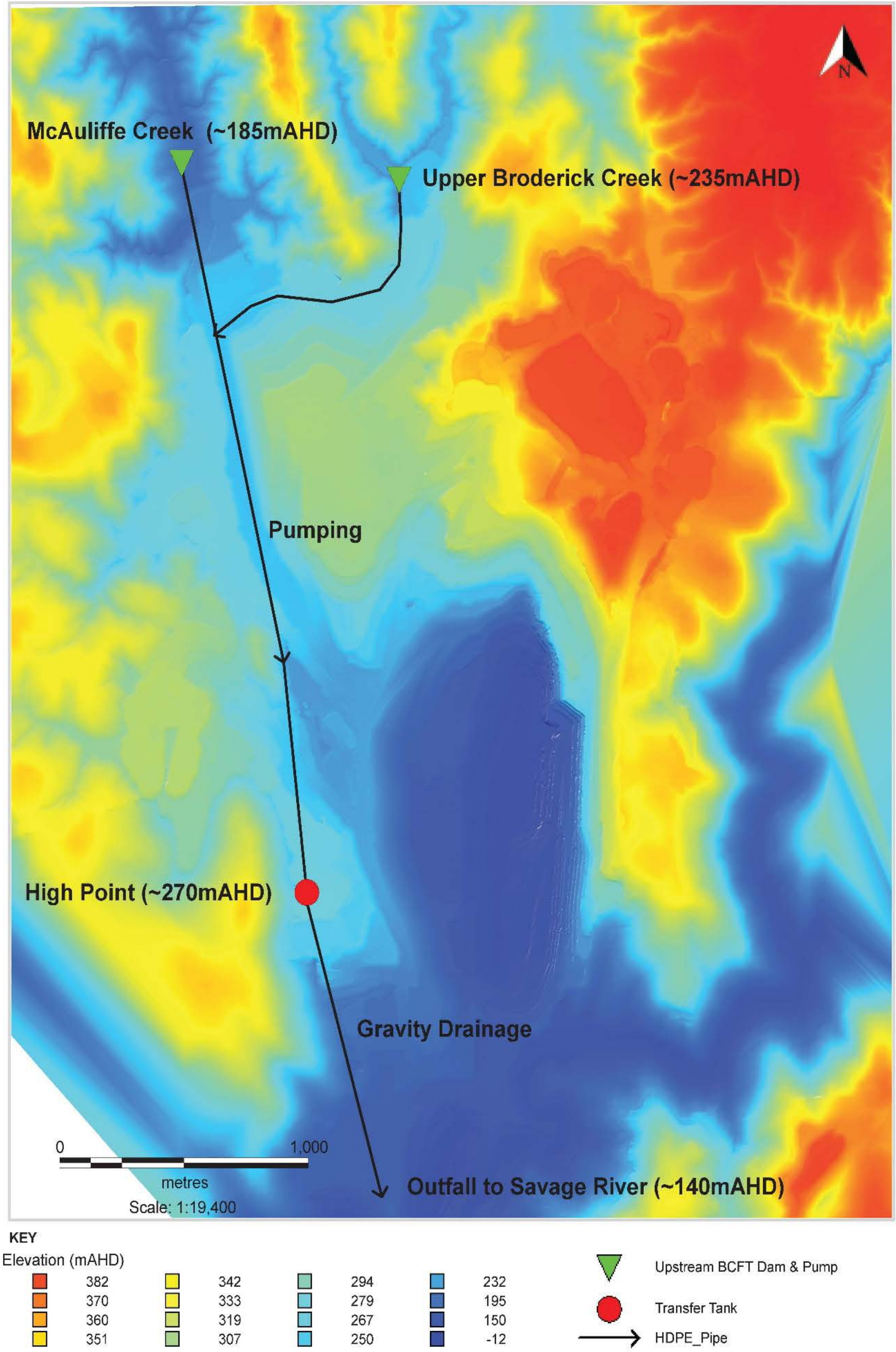

Figure 9 Broderick Creek Diversion - Option 1 (Schematic)

- Option 2: Installation of interception/dewatering wells into the BCFT adjacent to and just upstream of the “waterfalls”. However, this is considered impractical for the following reasons:
  - The system would need to have a minimum capacity of 600L/s.
  - The practical limit for submersible pumps is around 60 to 70L/s each (and the cost of such pumps, cables and controls is high).
  - This would require nine to ten large diameter bores/wells (300mm diameter cased bores as a minimum). Drilling costs through BCFT material would also be very high.
  - Target bore locations may also be subject to deformation (and damage to bores) in the longer term.

6.4 Recommended Mine Water Management Plan

The recommended concept mine water management scheme for the proposed underground mining operations scheme includes the following:

6.4.1 Rainfall Runoff and Groundwater Inflows from Surrounding Aquifers

The recommended scheme to cover all potential inflows from these sources includes:

- The development of buffer storage voids below the level of active ore extraction and movement.
- Dewatering pumps (and reticulation system) operating at semi-constant rates required to maintain water levels below the active mine workings at a confidence level determined by Grange Resources (i.e. what probability of flooding the lower mine workings and for how long, are acceptable following peak storm events).

It is noted that the current mine design includes up to 180,000m^3 of buffer storage below the Extraction Level and an underground pumping system capacity of 750L/s.

6.4.2 Broderick Creek Flow Through System

The recommended schemes to cover potential inflows from this source include:

- The current WWDS with some upgrade modifications to make it more robust under minor deformation conditions.
- Upper Broderick Creek Diversion Scheme if the WWDFS system fails for any reason or increased pumping capacity in the underground dewatering system.

It is noted that the design buffer storage and pumping system will have the capacity to manage some of the inflows from the BCFT if the WWDS fails, but there remains a 25% chance that a 180,000m^3 buffer storage would be exceeded over the life of mine. Upgrading the underground pumping system to remove such risk (by around 600L/s) is considered impractical, but could be implemented.

Upgrading the WWDS

The recommended upgraded WWDS, which covers the Base Case pit inflow scenario should be in place prior to the initiation of the Block Cave.

Implementing the Upper Broderick Creek Diversion Scheme

The implementation of this scheme (or increased underground dewatering capacity), which cover the Uncertainty Case, may not be required to operate at all and, even if they do, they would not be required until such time as the WWDS fails. Based on the results of geotechnical and deformation modelling, it is unlikely for the Uncertainty Case scenario to develop early in the life of the Block Cave and there should be sufficient lead time to install the Upper Broderick Creek Diversion Scheme or increase the underground dewatering capacity as required based on review of ongoing deformation monitoring data and validation/recalibration of deformation models.

Key water management recommendations in this regard are to:

- Maintain detailed monitoring of water levels in the BCFT monitoring bores; overflows from the BCFT waterfalls (durations and flow rates) and develop empirical relationships between rainfall, BCFT water levels and overflows (to determine trigger levels for expected overflows).
- Implement deformation monitoring in and around the BCFT waterfalls and the WWDS and develop trigger levels for the implementation of the Upper Broderick Creek Diversion Scheme.

It is noted that, if the Upper Broderick Creek Diversion Scheme is to be considered as part of the DFS, detailed civil engineering assessment would be required to confirm practical options for pumping from the two tributary creeks and more detailed hydrological analysis and water balance modelling would be required to confirm the optimum pump and pipeline capacity.

It is also noted that, if an increased underground dewatering capacity is to be considered as part of the DFS, a detailed hydrological model of upper Broderick Creek and the BCFT would be required to allow for more reliable (probabilistic) prediction of potential overflows. These would then form key input to the mine water balance model and allow for more reliable life of mine prediction of total underground pumping requirements.

7. POTENTIAL IMPACTS OF MINE INFLOW MANAGEMENT PLAN

The potential impacts of the recommended mine water management scheme on local and regional water resources are as follows:

- Rainfall runoff to the pit (and then underground) will be no more than currently experienced.
- Runoff to the pit (and underground) will be returned to Savage River via South Lens Pit and so runoff interception by mining will have little to no impact on regional river flows.
- Groundwater inflows from surrounding aquifers will be sustained by leakage from the aquifer boundaries (Savage River, Broderick Creek, Upper Broderick Creek and Armstrong Creek). Groundwater inflows will also be returned to the Savage River via South Lens Pit and so groundwater inflows will have little to no long-term impact on regional river flows.
- Drawdowns in groundwater levels as a result of mine inflows will be constrained to the immediate mine area and are not likely to be measurable beyond the aquifer recharge boundaries (Savage River, Broderick Creek, Upper Broderick Creek and Armstrong Creek).
- Overflows from the Broderick Creek Flow Through System to the pit (and underground) will also be returned to Savage River via South Lens Pit and so runoff interception by mining will have little to no impact on regional river flows.
- Any water pumped from the Broderick Creek Diversion Scheme (if required) will be returned directly to the Savage River at the existing Broderick Creek Flow Through System discharge point and will have little to no impact on regional river flows.
- Discharge from the Broderick Creek Diversion Scheme will have the same water quality as the Upper Broderick Creek. This will be somewhat different to current discharge from the Broderick Creek Flow Through System which is slightly alkaline due to passage through the magnesite material that makes up the Type A fill (main flow pathway). As such, the pH of overall discharge from Broderick Creek to the Savage River will be closer to neutral. This is not considered to be an impact, but merely a change.

Overall, the potential impacts of the mine water management scheme are considered to be negligible.

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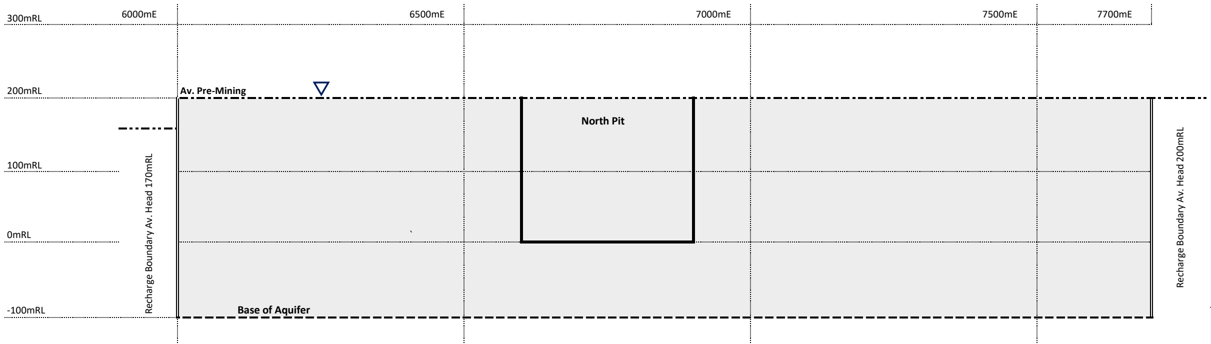
APPENDIX A
GROUNDWATER INFLOW CALIBRATION MODEL

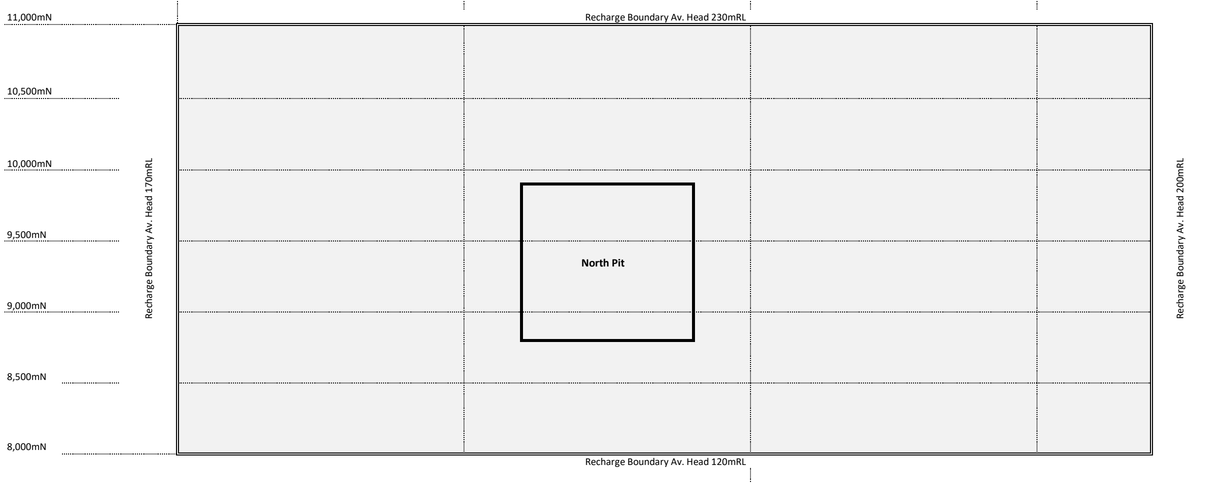
Conceptual Hydro Model and Calibration Model (Pit Inflows)

Conceptual Model

Section



Plan



Q=pi.k.(ho^2-hw^2)/ln(ro/rw)

Q=inflow or outflow from large diameter well or pit (kL/d)
k=hydraulic conductivity (m/d)
ho=height of SWL above base of aquifer (m)
hw=height of depressed water level in bore or pit (m)
rw=radius of well or equivalent radius of pit (m)
ro=radius of max extent of cone of drawdown (m)=SQRT(2.25.k.ho.t/Sy)
t=time since pumping or inflow started (days)
Sy=specific yield

SWL (mRL)	200	
Base Pit (mRL)	0	
Base of Aquifer (mRL)	-100	
Observed inflows (L/s)	20	"high" estimate only
Base area of effective pit (m2)	330,000	Pit is 300m (W) by 1,100m (L)

Bulk Aquifer Model

Basement Inflow Calcs - Bulk aquifer

Transient Model	k (m/d) =	0.015	Calibrated	
	ho (m) =	300		
	hw (m) =	100		
	rw (m) =	324		
	t (days) =	3650	(yrs)	10
	Sy=	0.005	Adopted	
	ro (m) =	2719	Calculated	
	Q (kL/d) =	**1773**		
	Q (L/s) =	**20.5**		

Anisotropic Aquifer Model

Steady State Model (N-S)	k (m/d)	0.018	Calibrated K
	ro (m) =	1500	Fixed - based on avereage distance to north-south recharge boundaries
	Q (kL/d) =	**1476**	50% flow from N and S boundaries
	Q (L/s) =	**17**	
Steady State Model (E-W)	**k (m/d)**	0.0018	0.1 x k (N-S)
	ro (m) =	850	Fixed - based on avereage distance to east-west recharge boundaries
	Q (kL/d) =	**235**	50% flow from E and W boundaries
	Q (L/s) =	**3**	Also assumes K (east-west) = 0.1 K(north-south)
Steady State Model (Total Inflow)			
	Q (kL/d) =	1711	
	Q (L/s) =	**20**	Estimated Flow - currently around 20L/s

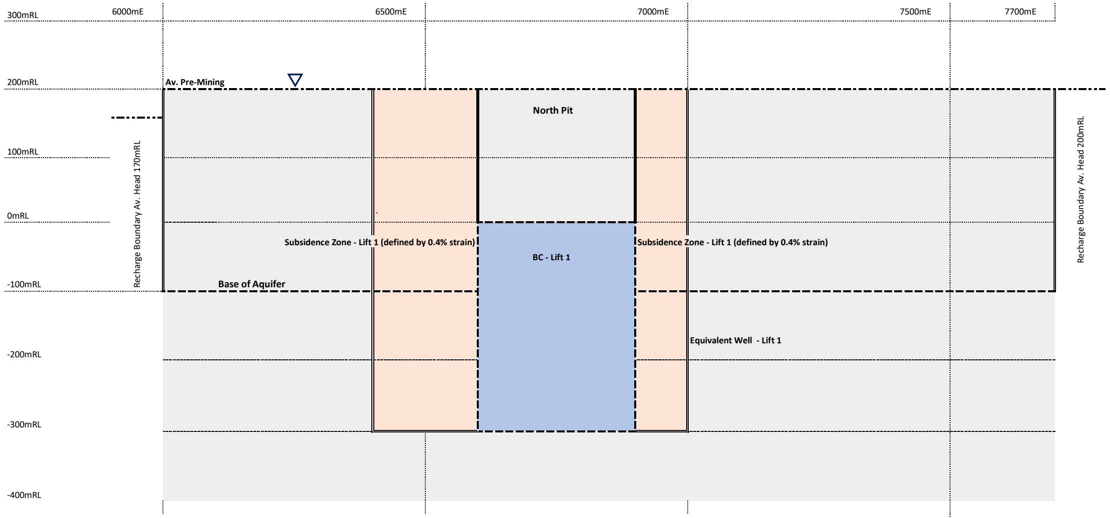
Notes

APPENDIX B
GROUNDWATER INFLOW PREDICTION MODEL
(BLOCK CAVE)

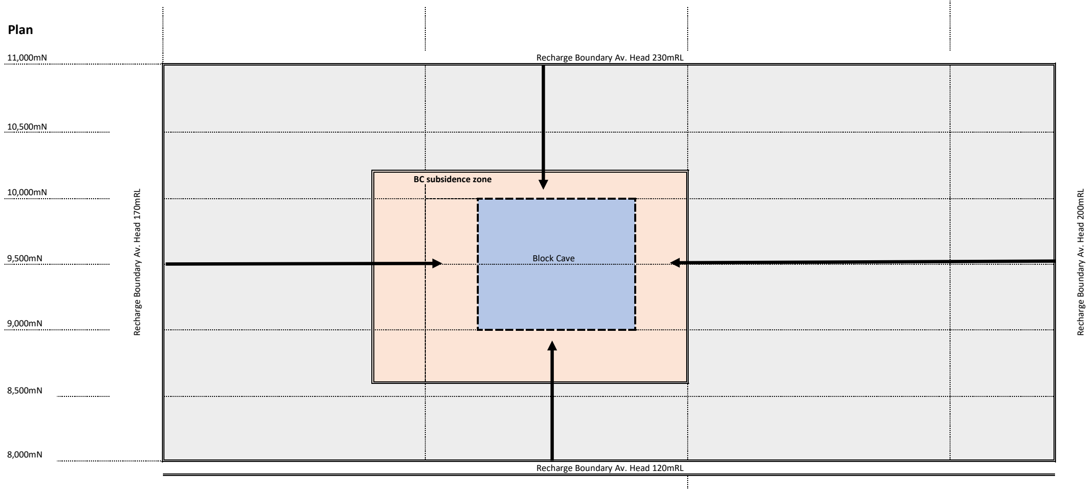
Conceptual Hydro Model and Prediction Model (Block Cave with deformation around cave)

Conceptual Model

Section



Plan



Western and Southern Boundaries of Subsidence Zone (0.4% PST) extended based on current Deformation Model.

Q=pi.k.(ho^2-hw^2)/ln(ro/rw)

Q=inflow or outflow from large diameter well or pit (kL/d)
k=hydraulic conductivity (m/d)
ho=height of SWL above base of aquifer (m)
hw=height of depressed water level in bore or pit (m)
rw=radius of well or equivalent radius of pit (m)
ro=radius of max extent of cone of drawdown (m)=SQRT(2.25.k.ho.t/Sy)
t=time since pumping or inflow started (days)
Sy=specific yield

SWL (mRL)	200	
Base Block Cave (mRL)	-100	Set at base of aquifer
Base of Aquifer (mRL)	-100	
Base area of effective well (BC + Enhanced	960,000	BC Well is is 600m (W) by 1,600m (L)

Bulk Aquifer Model - well radius increased to cover enhanced K zone, and assume enhanced K is infinite.

Basement Inflow Calcs for Lift 1 - Bulk aquifer

	k (m/d) =	0.015	Calibrated value		
	ho (m) =	300			
	hw (m) =	0			
	rw (m) =	553			Increased to simulate enhanced K zone
	t (days) =	4745	(yrs)	13	Assume BC Lift 1 from 2020 to 2024
	Sy=	0.005	Adopted		
	ro (m)=	3100	Calculated		That is, no recharge boundary
	Q (kL/d) =	2460			
Transient Model	**Q (L/s) =**	**28**	Does not account for flow from any recharge boundary		

Anisotropic Aquifer Model - modified to simulate flow from each side

Steady State Model (N-S)	K (m/d)	0.02	Calibrated value (rounded)
	ro (m) =	1500	Fixed - based on avereage distance to north-south recharge boundaries
	Q (kL/d) =	**2833**	50% of caslculated radial flow
	Q (L/s) =	**33**	Flow through calibrated K aquifer
Steady State Model (flow from E-W)	ro (m) =	850	Fixed - based on distance to west recharge boundary
	Q (kL/d) =	657	50% of calculated radial flow
	Q (L/s) =	**8**	Assumes natural K (east-west) = 0.1 K(north-south)
Total	Q (kL/d) =	3490	
Steady State Model (Total Inflow)	**Q (L/s) =**	**40**	

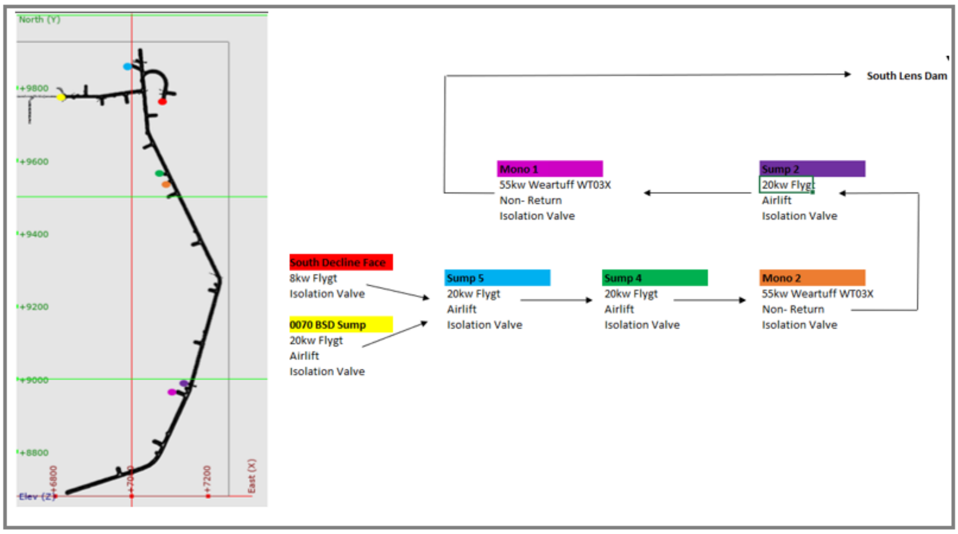
North Pit Underground Water Quality 2021-2022 (Technical Advice on Water, 2023)

Appendix B

pitt&sherry

North Pit Underground Water Quality

2021 - 2022



V1.1

27 March 2023

L. Koehnken

♦♦♦Technical Advice on Water♦♦♦

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TITLE:	North Pit Underground Water Quality 2021 - 2022	
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Executive summary

Grange Resources is investigating the development of an underground operation below North Pit (NPUG). The company has been monitoring water quality at discrete inflows to the underground area, and at the sumps and pumps which convey the combined inflow to South Lens. Previous investigations in 2020 sampled multiple inputs, but the results were difficult to interpret due to the recent use of fibrecrete and galvanised hardware that affected the alkalinity and zinc content of the water.

In 2021 and 2022 Grange monitored five seepage inputs to the underground workings (BDS2 RH Wall, BDS2 Face, Whitlam Fault, SD Hose RH Wall and SP1 DD Hole), and three sites where flows are collected and combined (BDS Flow to Sump, Mono 2 Pump, NPUG_out/Mono 1 Pump). Flow rates are not recorded at the sites so the relative input of the monitored seepage to the total flow is unknown, as is the total flow entering South Lens.

The composition of seepage inputs to the underground workings varies, with the SD RH Wall input having the lowest pH and highest sulphate and dissolved iron concentrations of any of the measured inputs. The water entering the Bulk Sample Drive at BD2 RH Wall and BD2 Face are similar to each other, and to the quality of water at the Mono 2 and NPUG_out, and characterised by pH>7.5 and elevated alkalinity and low acidity. This could be the result of the majority of water being derived from the Bulk Sample Drive, or that water entering the underground along the decline has similar quality to the Bulk Sample Drive inflow. Flow rates at each of the sites would be required to discern between these possibilities. TSS increases as the flow progresses through the underground towards the portal, with the variable input likely related to the number of truck movements and drilling activity. Dissolved metal concentrations in all of the samples are low with the exception of zinc in the NPUG_out site, which had a maximum value of 800 μg/l. (median = 41 μg/l). Total metals are also low when normalised to the TSS concentrations.

The results show that the water discharged from the underground into South Lens has pH>7.5, elevated alkalinity, low acidity, low dissolved metals, moderate sulphate and high TSS. The alkalinity in the underground water would contribute to the neutralisation of acid drainage entering South Lens, and the TSS would provide surface area for precipitation of metal oxy-hydroxides, and promote settlement. The low dissolved metal concentrations would not significantly alter the alkali demand within the pit.

Recommendations include the collection of flow rates or pump hours during future sampling, adopting a uniform monitoring frequency at the sites, and comparing the underground results with the surface discharge from North Pit into South Lens.

Contents

List of Figures

List of Figures

1 Introduction

Grange Resources are conducting water quality investigations related to future underground mining below North Pit (NPUG – North Pit Underground). An exploration drive and preliminary sampling of numerous inflows/seepages was completed in 2019 / 2020. The water quality results were difficult to interpret due to the low number of samples, the potential impacts on water quality from fibrecrete and galvanised metal work, and the variable and decreasing flow rates observed at the sties.

In 2021 and 2020, water quality monitoring focussed on fewer sites that showed more consistent flow rates. This report summarises and provides interpretation of the results.

2 Monitoring sites

A schematic of the underground workings and monitoring locations included in this review are shown in Figure 2-1. The Bulk Sample Drive (BSD) cuts through the Main Ore Zone as shown in Figure 2-2. Additional inputs are collected from the South Decline and along the main decline near the portal.

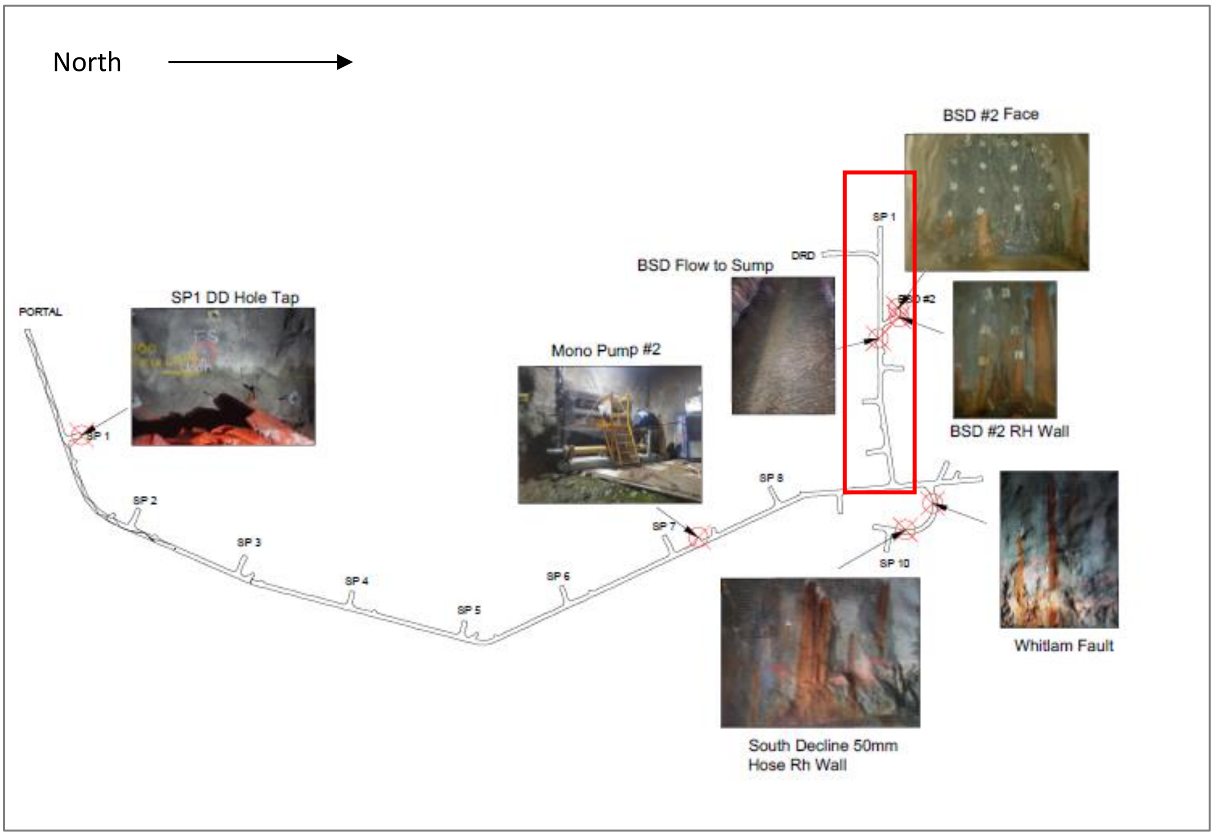


Figure 2-1. NPUG groundwater monitoring locations. The red box outlines the Bulk Sample Drive (BSD).

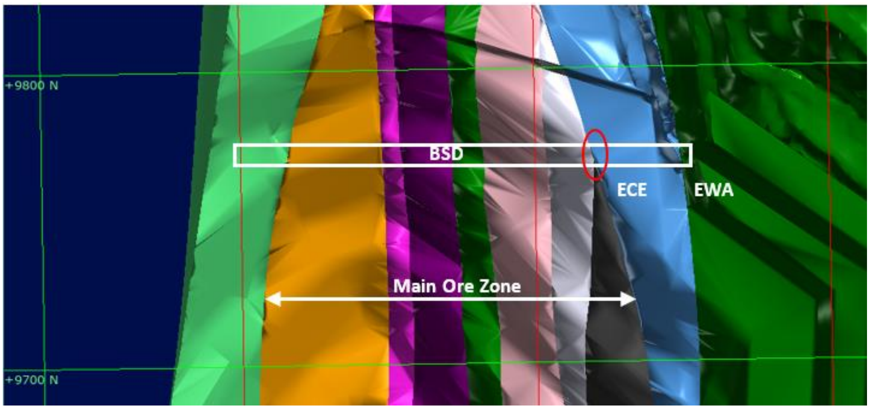


Figure 2-2. Geo-structural model of the Bulk Sample Drive showing sub-units of the Main Ore Zone (MOZ), Eastern Carbonate Envelope (ECE) and Eastern Wall Assemblage (EWA). Box shows approximate location of BSD2. Red circle indicates area where BSD#2 sites are located.

The configuration of underground pumps is shown in Figure 2-3. Water from sites BSD#2 Face and BSD#2 RH Wall report to the BSD Sump, and then to Sump 5. Water from the Southern Decline (Whitlam Fault and South Decline Hose Rh Wall) also report to Sump 5. From Sump 5, all water is pumped progressively to Sump 4, Mono 2 (a monitoring location), Sump 2 and ultimately Mono 1 where the NPUG_out sample is collected. All water from underground is discharged into South Lens. An additional water quality sample, SP1 DD Hole Tap, is collected from near the portal.

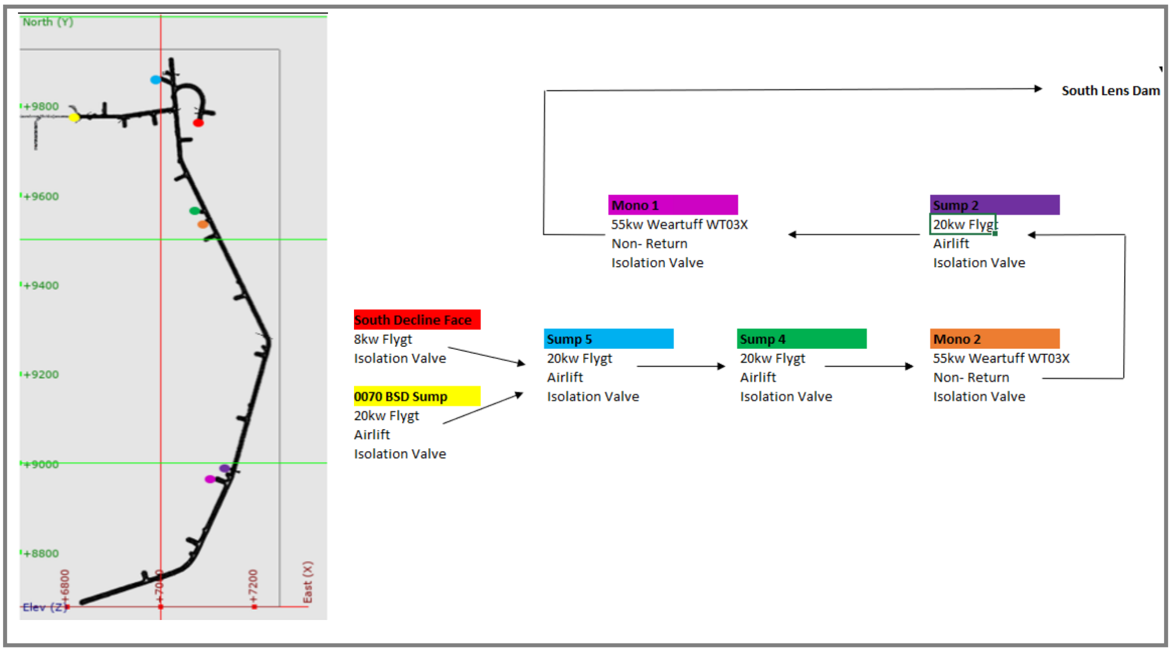


Figure 2-3. Schematic of underground pumps. Colored dots on underground diagram correspond to the colored boxes in the pump diagram.

Table 1 lists the water quality monitoring sites and shows whether they are an ‘inflow’ sample or a ‘composite’ sample. Inflow samples reflect one discrete input within the underground whereas the composite samples are collected from sumps which collect more than one water source (based on the monitoring schematic).

Table 1. Summary of NPUG water quality monitoring sites showing whether the sample is a 'source' or 'composite' sample and how many sample results are available in 2021 – 2022.

Site	'Source' or Composite site	Number of samples in 2021-2022
BSD2 RH Wall	Input	8
BSD2 Face	Input	7
BSD Flow to Sump	Composite	5
Whitlam Fault	Input	2
South Decline Hose RH Wall	Input	8
Mono 2 Pump	Composite	8
SP1 DD Hole	Input	2
NPUG_out	Composite	33 (2020 – 2023)

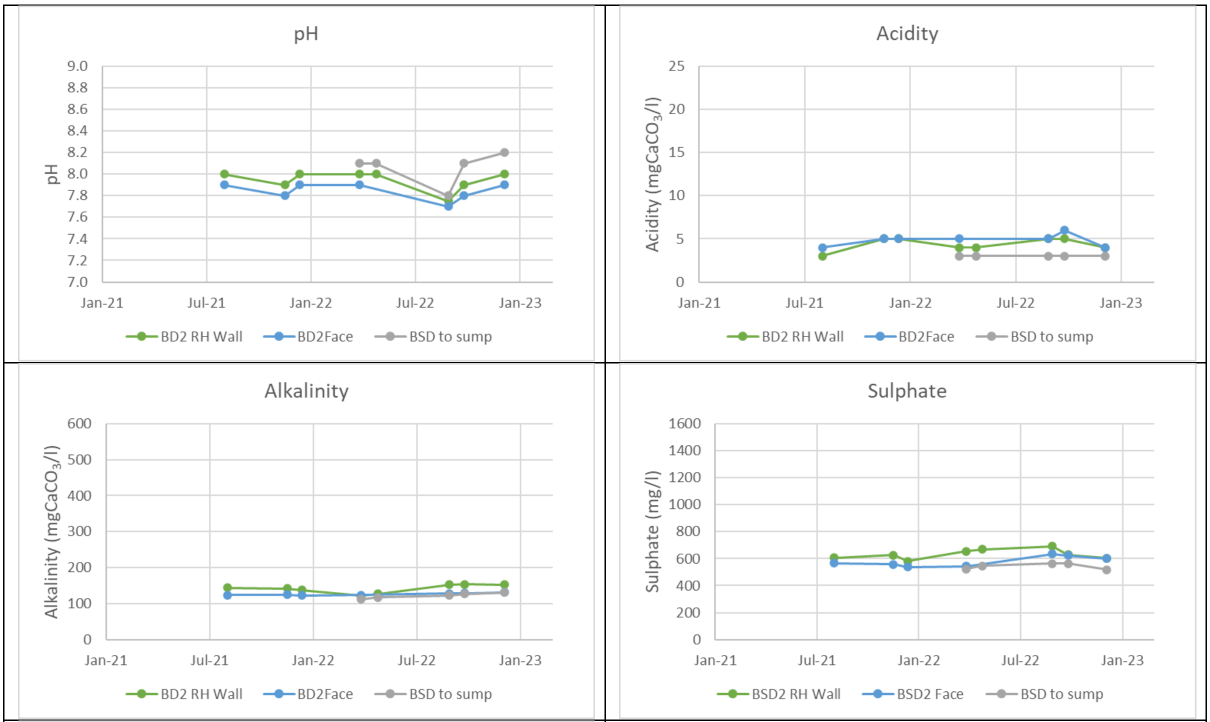
3 Water quality results

The water quality results are presented and analysed in three groups, in the same order as presented in Table 1, with the 'inflows' compared to the downstream 'composite' sample in each grouping. Note that there are no flow results available for the monitoring results, so the analysis is limited to water quality concentrations only.

The parameters that provide an indication of the overall quality of the water (pH, EC, acidity, alkalinity) and showed the greatest variability (sulphate, dissolved zinc, TSS) are presented in detail. The results for the other dissolved metals are summarised by site.

3.1 BDS sample group (BD2 RH Wall, BD2 Face, BDS Flow to Sump)

Water quality results for the BD2 Face and BD2 RH Wall samples are compared to the BDS Flow to Sump results in Figure 3-1 for pH, EC, sulphate, alkalinity and zinc. pH ranges from 7.6 to 8.2 in the samples, with the water flowing to the sump having the highest values. This suggest there are other inputs to the sump in addition to the BD2 seepage samples. The acidity results are low in all samples, 6 mg/l or less. In contrast, the alkalinity results are relatively elevated, with concentrations in the 100 – 150 mg/l range. This is consistent with the Bulk Sample Drive extending into the Eastern Carbonate Envelope. Sulphate concentrations are also elevated, but the pH and alkalinity levels indicate that any acid being produced through sulphide oxidation is being neutralised. Dissolved zinc is at or near the Limit of Laboratory Reporting (LoR) in the BD2 Face samples, and in the range of 20 – 40 μg/l in the other sites. Overall the three sites have similar water quality, although the higher pH, lower sulphate and higher dissolved zinc in the Flow to Sump sample as compared to the two inputs suggests that other water is also entering the sump system.



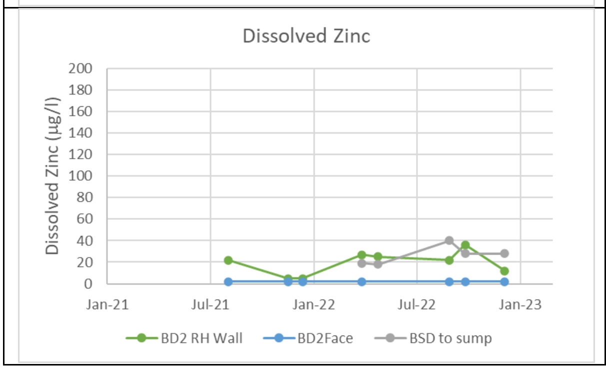
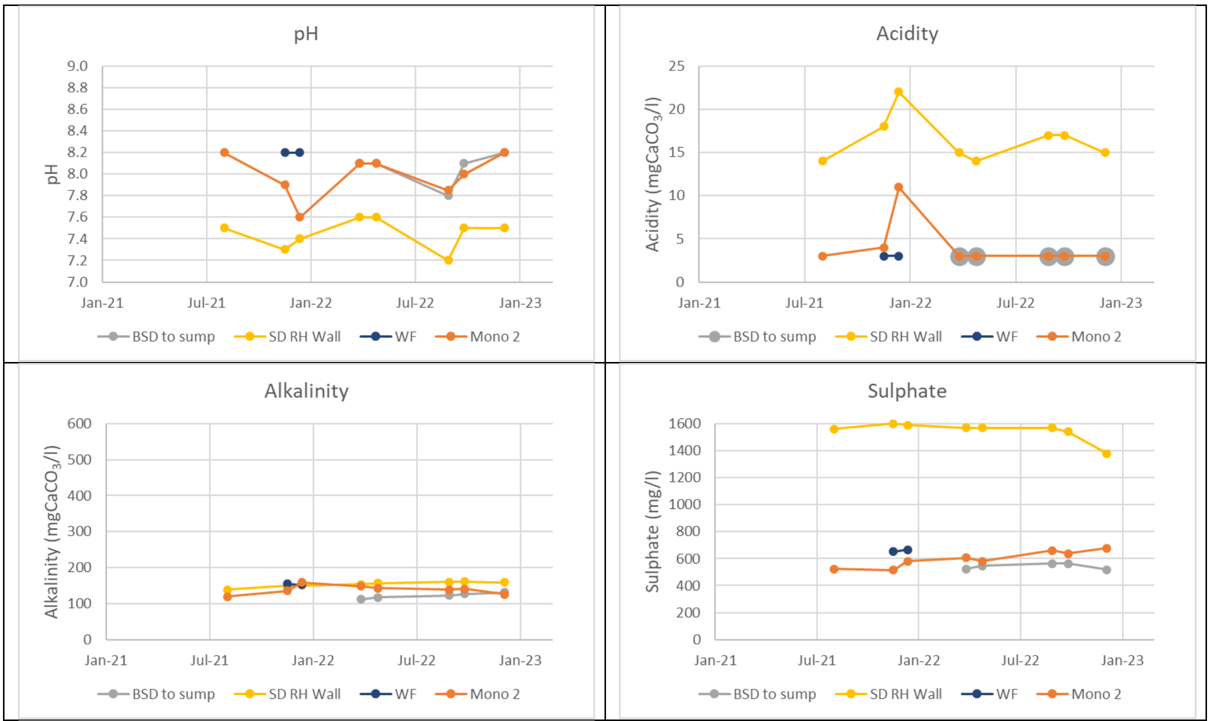


Figure 3-1. Water quality results from the Bulk Sample Drive.

3.2 Inputs to Mono2 Sump (BDS to Sump, South Decline RH Wall, Whitlam Fault)

The two inputs to the Mono2 sump, SD RH Wall and Whitlam Fault, show markedly different water quality. The Whitlam Fault inflow has pH~8, and low acidity (<5 mg/l) as compared to the SD RH Wall, which has the highest acidity and lowest pH of all of the sampling locations. The two inputs have similar levels of alkalinity, but SD RH Wall has much higher sulphate, the highest of any of the samples (~1,600 mg/l). Both sites have lower dissolved zinc as compared to the water flowing to the BDS sump.

The sulphate concentration in the Mono 2 samples is slightly higher as compared to the BDS flow to Sump samples, and the dissolved zinc concentrations are slightly lower, which is consistent with the SD RH Wall and Whitlam Fault input, although flow data would be required to verify these inputs can account for the change. With respect to pH, alkalinity and acidity the BDS to Sump and Mono 2 results are similar, suggesting that general groundwater inflows, rather than discrete seeps are dominating the water quality in the underground.



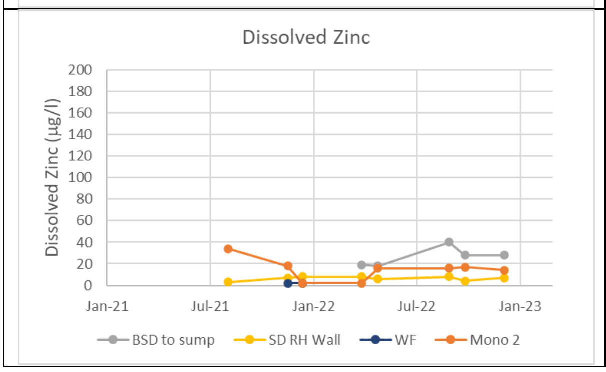


Figure 3-2. Water quality results for inflows to the Mono 2 pump, and at the Mono 2 pump.

3.3 Inputs to NPUG_out (Mono 2, SP1 DD Hole, Mono 1)

The most downstream monitoring site is NPUG_out at the Mono 1 pump. Inputs to this pump include the Mono 2 pump, and local drainage including the seep at SP1 DD Hole. The results for these sites are shown in Figure 3-3. Although the results from the SP1 DD Hole show lower pH, higher acidity, lower sulphate and dissolved zinc as compared to the Mono 2 results, the inflow does not substantially affect the quality at the NPUG-out site, which is very similar to the Mono 2 results. NPUG_out shows more variability as compared to the other sites, but there are more sample results for this site, which may account for the observed variability. The NPUG_out results are also affected by the timing of sampling relative to the timing of operation of the pump, and local activities such as truck movements. The dissolved zinc concentrations at NPUG_out were elevated in 2019-2020, but concentrations have decreased over time. This is likely related to the loss of available zinc from galvanised pipes and hardware used in the construction of underground.

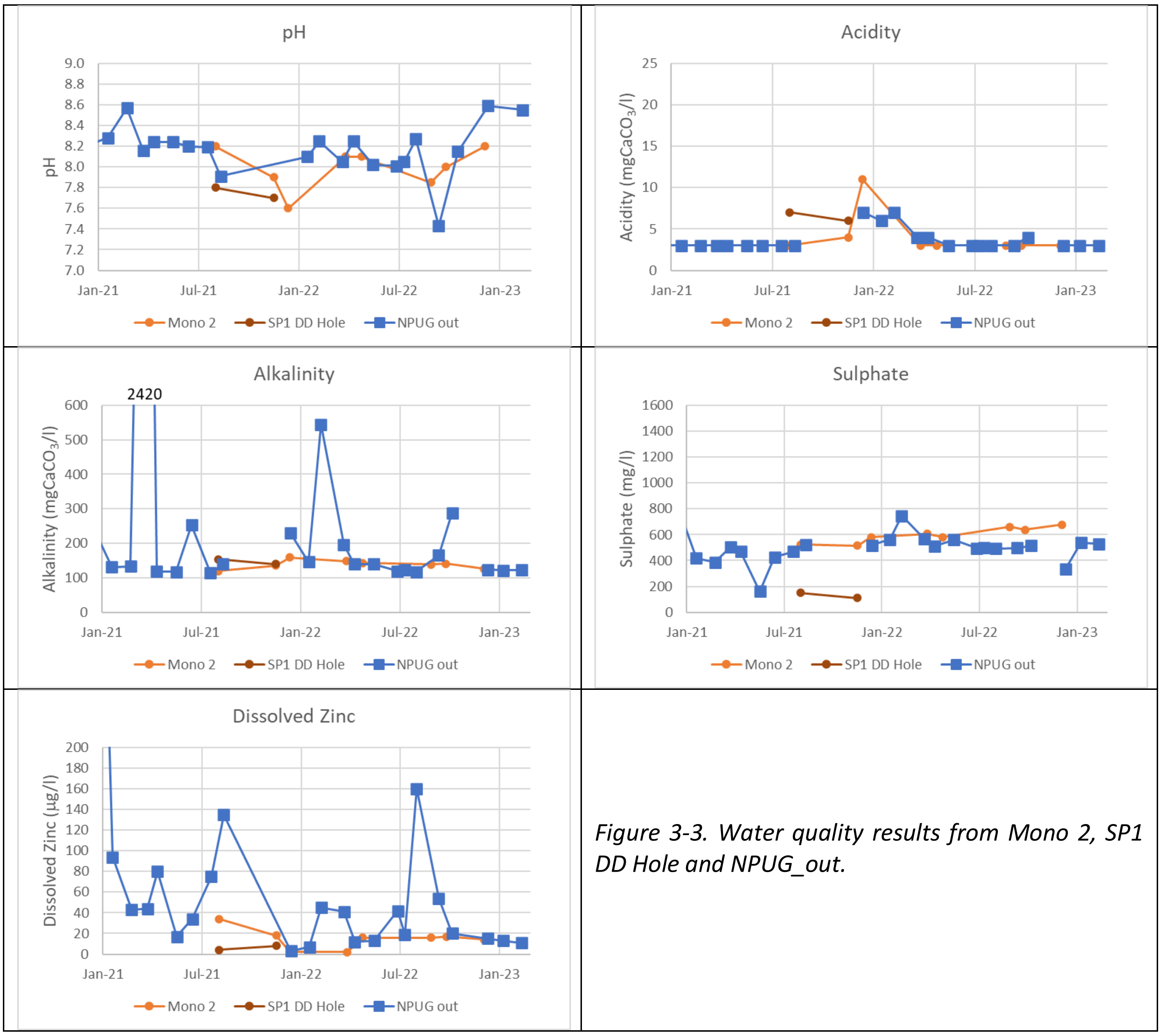


Figure 3-3. Water quality results from Mono 2, SP1 DD Hole and NPUG_out.

3.3.1 Total suspended solids

The concentration of total suspended solids in the water quality samples (Figure 3-4), shows that the individual seepage sites contribute low concentrations of solids to the underground discharge. The concentration of solids generally increases between the Mono 2 pump site and the final NPUG_out site, where TSS values vary over several orders of magnitude (20 mg/l – 8,000 mg/l, median = ~700 mg/l). This input of solids is due to traffic movements and other activities.

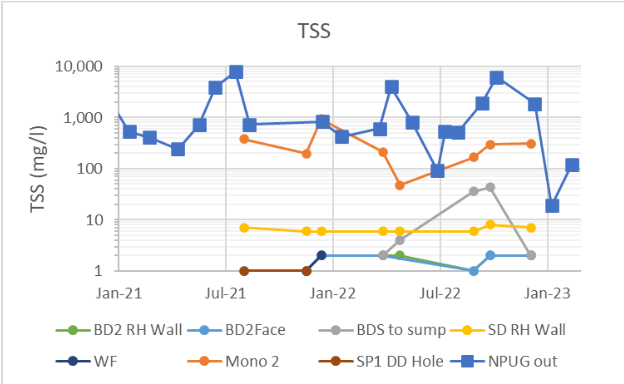


Figure 3-4. Total suspended solids (TSS) in the Underground Monitoring sites.

The concentration of total metals in the NPUG_out samples is shown in Figure 3-5, and shows that aluminium and iron are present in the highest concentrations (10,000 – 100,000 µg/l), with manganese and zinc the next most common metals which are present in the 100 to 1,000 µg/l range. All other metals are present in concentrations <100 µg/l.

The same results are normalised to the concentration of TSS (e.g. [Total metal]/ [TSS]) in Figure 3-6. The results show the same overall pattern of metal concentrations as in Figure 3-5, but the concentrations are much lower, indicating that the sediment contains low concentrations of easily liberated metals.

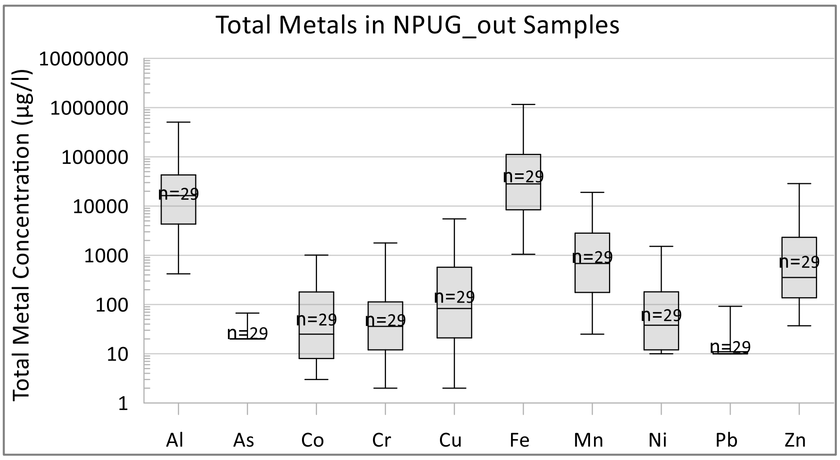


Figure 3-5. Total metal concentrations (µg/l) in NPUG_out samples. The box encompasses the 20th to 80th percentile values, and the 'whiskers' indicate the minimum and maximum values. N= number of samples.

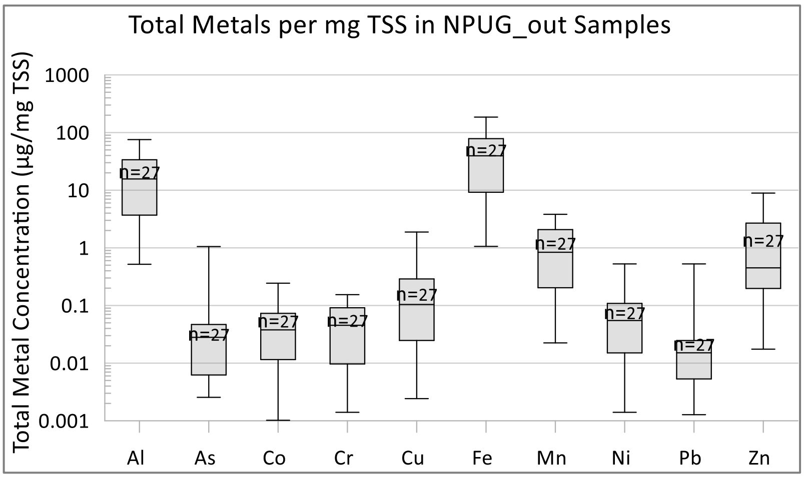


Figure 3-6. Total metal concentrations per mg of TSS (µg metal/mg TSS, equivalent to mg/kg solid) in NPUG_out samples. The box encompasses the 20th to 80th percentile values, and the 'whiskers' indicate the minimum and maximum values. N= number of samples.

3.3.2 Dissolved metals

The dissolved metal concentrations from the samples are summarised in Table 2. In the Table, sites where all samples were below the LoR for a given parameter are highlighted in green. For sites where dissolved metals were above the LoR, the number of samples where the result was greater than the LoR is shown, and the maximum concentrations is listed. The number of samples collected at each site is shown in the first row of the Table.

Lead and selenium were below the LoR in all samples at all sites. Aluminium, chromium, cobalt and nickel were only detectable in the Mono 2 and / or the NPUG_out sites. These sites have the highest TSS and presumably the highest flow rates as they are composites of all other inputs, so it is not surprising they have the widest range of metal concentrations. The low concentrations of aluminium, iron, copper and cobalt are consistent with the pH of the waters, with these metals being present as hydroxides or carbonate flocs under these conditions. The dissolved iron present in the samples is likely present as Fe^{2+}, and will oxidise and precipitate during storage in South Lens. The maximum dissolved zinc concentration at NPUG_out was 866 µg/l, but the median concentration at the site was 41 µg/l (n=29). The overall low concentration of dissolved metals is consistent with the low acidity levels recorded for the samples.Table 2

Table 2. Summary of dissolved metal results from NPUG monitoring. Table shows the number of samples where the result is less than the limit of laboratory reporting (LoR), and the maximum value of the samples that were above the LoR. Green infill indicates that all samples were below the LoR. The LoRs are listed below each parameter in the first column. Multiple LoRs are due to varying analytical techniques. All LoR and max values in µg/l concentrations shown in italics for clarity. Mercury was only determined on samples collected from NPUG_out.

Parameter LoR (µg/l)	Range	BSD2 RHWall n=8	BSD2 Face n=7	BSD to Sump n=5	Whitlam Fault n=2	SD RH Wall n=8	Mono 2 n=8	SP1 DD n=2	NPUG out n=29
Al dis	n<LoR						6		23
LoR<8, 20	max						*38*		*577*
As dis	n<LoR	5	6				6	1	
LoR<1, 20	max	*4*	*1*				*1*	*1*	

Parameter LoR (μg/l)	Range	BSD2 RHWall n=8	BSD2 Face n=7	BSD to Sump n=5	Whitlam Fault n=2	SD RH Wall n=8	Mono 2 n=8	SP1 DD n=2	NPUG out n=29
Co dis	n<LoR						6		
LoR<0.5, 3	max						*5.5*		
Cr dis	n<LoR								27
LoR<1, 2	max								*60*
Cu dis	n<LoR		6				6		28
LoR<1, 2	max		*1*				*1*		*9*
Fe dis	n<LoR	2	1	4	0	1	3		11
LoR<20	max	*139*	*93*	*22*	*154*	*2440*	*346*		*1470*
Hg dis	n<LoR	NA	NA	NA	NA	NA	NA	NA	
LoR<0.05	max								
Mn dis	n<LoR	0	0	1	0	0	2	0	10
LoR<5	max	*18*	*13*	*7*	*14*	*59*	*101*	*48*	*126*
Mo dis	n<LoR	1	1	3			5		25
LoR< 0.5, 5	max	*7.6*	*6.2*	*5*			*5*		*19*
Ni dis	n<LoR						6		
LoR<0.5, 10	max						*10.4*		
Pb dis	n<LoR								
LoR<0.5 10	max								
Se dis	n<LoR								
LoR<2, 30	max								
Zn dis	n<LoR	0	4	0		0	1	0	2
LoR=<2	max	*36*	*2*	*40*		*8*	*34*	*8*	*866*

3.4 Synthesis of water quality results

The composition of seepage inputs to the underground workings varies, as demonstrated in Figure 3-7 for sulphate. The SD RH Wall site has the lowest pH and highest sulphate and dissolved iron concentrations of any of the measured inputs. The water entering the Bulk Sample Drive at BD2 RH Wall and BD2 Face are similar to each other, and to the quality of water at the Mono 2 and Mono 1 (NPUG_out) sampling sites. This could be the result of the majority of water being derived from the Bulk Sample Drive, or that water quality entering the underground along the decline being similar to the Bulk Sample Drive inflow. Flow rates at each of the sites would be required to discern between these possibilities. TSS increases as the flow progresses through the underground towards the portal, with the variable input likely related to the number of truck movements and drilling activity.

Overall, the water discharged from the underground into South Lens has pH>7.5, elevated alkalinity, low acidity, low dissolved metals, moderate sulphate and high TSS. The alkalinity in the underground water would assist in the neutralisation of acid drainage entering South Lens, and the surface area associated with the TSS would provide surface area for precipitation, and promote settlement. The low dissolved metal concentrations would not significantly alter the alkali demand within the pit.

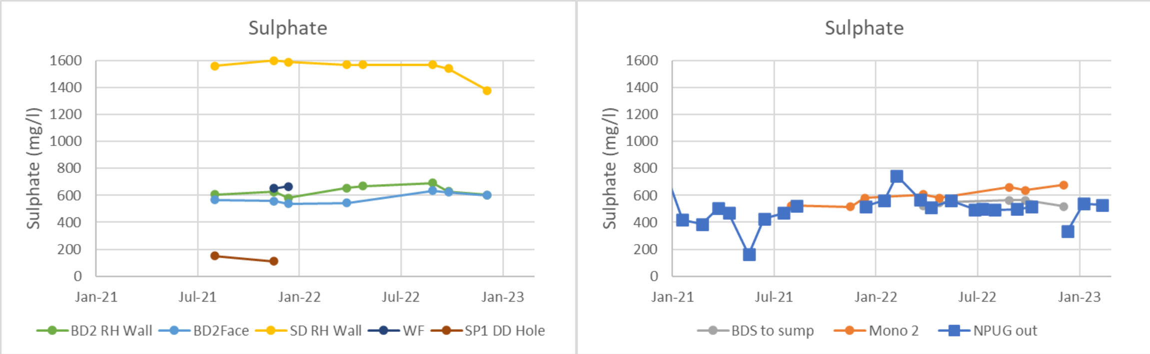


Figure 3-7. (left) sulphate concentration in seepage entering the underground and (right) concentration of sulphate in the flows reporting to sumps and pumps.

4 Recommendations

The following are recommended for future monitoring in the underground workings:

- Flow rates should be collected at each of the sampling locations to allow fluxes to be calculated. Based on this evaluation, some of the input seeps could be eliminated if their overall inputs was minor;
- Monitoring should be completed at a similar frequency at each of the sites. If sites only flow infrequently, this should be noted in the results;
- Monitoring results from underground should be compared to the water quality of the surface input from North Pit to South Lens (when available) to determine whether there are any differences in water quality between the surface and underground.

Waste Rock Management Plan (Grange Resources, 2021)

Appendix C

pitt&sherry

EMS-04 Waste Rock Management Plan

Table of Contents

Document Control

Version	Date	Description	Author	Approved
Draft 1	Feb 2014	EMS-04 Waste Rock Management Procedure	OSH & ESR Team	
Draft 1 Review - Tony Ferguson, Daniel Lester, Stephen Kent and Karen Ashley				
Draft 2	May 2019	EMS-04 Waste Rock Management Plan	HSE, Geology and Planning Team	
Draft 2 Review – Tony Ferguson and Nicholas Van Der Hout				
Draft 3	June 2020	EMS-04 Waste Rock Management Plan	HSE, Geology, Planning Team	
Draft 3 Review – Lisa Georgiou, Tony Ferguson, Roger Hill				
Draft 3	July 2020	EMS-04 Waste Rock Management Plan	HSE, Geology	Nov 2020

1 INTRODUCTION

1.1 Purpose

To define the required plan for the management of waste rock to prevent environmental impacts, promote beneficial post-mining land uses and reduce post mining closure and rehabilitation liability.

1.2 Scope

This plan applies to the design, construction, operational and closure phases of Grange Operations and addresses waste rock management.

1.3 Summary

Grange commits to employing Best Practice Environmental Management (BPEM) in the identification, storage and monitoring of waste rock. At Savage River Grange's Waste Rock Management Plan commits to:

- Identify waste types during all stages of exploration and extraction and in particular any Potential Acid Forming (PAF) waste rock
- Waste rock will be disposed of in current approved dumps or as approved by the EPA Director and/or the EPA Board.
- Dumps will be designed to be geotechnically stable
- PAF waste rock will be encapsulated with a cover (currently 2-m of track or Truck compacted clay at the completion of active dumping to prevent oxidation and reduce the formation of Acid and Metalliferous Drainage (AMD)
- This encapsulation will be protected from erosion with a protective cover of Non-Acid Forming waste rock to a minimum of 5 metres. A-type encapsulation also contributes to oxygen ingress reduction
- Dumps will be allowed to naturally revegetate once completed and closed subject to protection of encapsulation to prevent oxygen ingress.
- Performance monitoring of the Waste Rock Management Plan will be conducted with an aim of continual correction and improvement
- Grange will seek to improve legacy issues at the site through approved Savage River Rehabilitation Projects (SRRP) in conjunction with normal operations

1.4 RESPONSIBILITIES

Director / General Manager Operations	➢ Ensure adequate resources are provided to effectively manage waste rock in compliance with licence conditions and requirements of this plan and associated management plans.
Senior Management	➢ Ensure all statutory requirements for waste rock management are carried out and complied with.
Mine Manager	➢ Ensure adequate resources are provided to effectively manage waste rock in compliance with licence conditions and requirements of this procedure and associated management plans. ➢ Ensure waste rock management responsibilities are communicated to all relevant staff and supervisors. ➢ Ensure all surveillance and inspection programs are followed. ➢ Ensure systems are in place to manage waste rock tracking and dumping. ➢ Ensure compliant waste rock storage facilities.
Mine Superintendent	➢ Implement the weekly mine plan in relation to the waste rock management plan ➢ Monitor the waste rock dump for stability on a shift basis. ➢ Ensure the correct waste types are being placed in the designated dumps according to the weekly plan.
Mine Supervisors/Leading Hands	➢ Ensure excavator operators have appropriate mining plans and are familiar with waste rock management requirements. ➢ Communicate required waste rock management programs to operational staff during pre-start meetings. ➢ Ensure all waste rock dumping procedures are adhered to as per the technical specifications of the Waste Rock Management Plan.
Geotechnical Department	➢ Providing and assessing the design parameters for the geotechnical stability of the waste dumps ➢ Inspecting, monitoring, assessing, and reporting on the geotechnical stability of the waste dumps ➢ Conducting regular inspections (risk based) of all active waste dumps.
Health Safety and Environment Team	➢ Develop and manage Environmental Management Plans (EMPs) relating to pit and waste dump proposals ➢ Provide the design parameters relating to environmental requirements and mine closure; for example, prevention of sulphide oxidation, erosion protection, landforms, etc. ➢ Monitoring and reporting to the Environmental Protection Authority (EPA) against the requirements for relevant Environmental Protection Notice (EPN) and/or Environmental Management Plan (EMP). ➢ Ensure licence conditions are maintained and advise operational personnel of any changes required to Waste Management Plans. ➢ Analyse and report waste rock management data and report on performance statistics.

	➢ Provide awareness information to relevant personnel on waste rock management ➢ Carry out required monitoring, water sampling and testing as per licence conditions ➢ Facilitate the investigation of waste rock management and acid and metalliferous drainage incidents and ensure appropriate reports are disseminated and where required facilitate the reporting to external regulators.
The Geology Department	➢ Carry out waste rock classification as per the Waste Rock Management Plan ➢ Undertake required training for waste rock management. ➢ Developing and updating the resource and waste rock block model for planning purposes ➢ The field assessment, characterisation and sampling of waste rock types. These characterisations shall be reported to operations on a daily basis with frequent checks during the excavation process. ➢ Frequently check waste rock dumps to ensure that the correct waste type is being placed in a dump. ➢ Ensuring that training for all pit personnel includes waste rock management instruction; including understanding of waste rock types and appropriate disposal requirements.
Employees	Comply with, record and monitor waste rock digging and dumping requirements.

1.5 Legislative Requirements

The Environment Protection Authority (EPA) is Tasmania's principal environmental regulator. The EPA administers the Environmental Management and Pollution Control Act 1994 (EMPCA) which is the principal environmental legislation that impacts on Grange Resources Savage River Operations. The EPA imposes conditions attached to the planning permit issued by the planning authority. These conditions are issued in the form of an Environment Protection Notice (EPN) or Permit Conditions Environmental (PCE) and set the environmental conditions for the operation.

Waste rock storage facilities in use are designed, constructed, decommissioned and rehabilitated according to Grange’s Environmental Management Plan (EMP) as approved by the EPA who details operating requirements through the EPN or PCE. Requirements of the sites EPN's, PCE’s are incorporated into the EMS-04 Waste Rock Management Plan which details technical specifications, waste rock requirements and standards.

The EMS-04 Waste Rock Management Plan is designed to meet the requirements of Savage River environmental approvals and detail compliance with waste rock requirements that in summary include:

- Notification of incidents;
- Requirements to review EMP each 3 years;
- Implementation of an Environmental Management System that meets the requirements of the ISO 14000 series;
- Requirement for catch drains for run off waters containing sediment or discolouration to be delivered to settling dams and treated to BPEM prior to discharge to natural drainage lines;
- Requirements for storm water diversion and treatment;
- The undertaking of a monitoring and reporting regime as outlined in the EMP;
- Disposal of mine wastes to be undertaken in accordance with the EMP;
- Representative samples of waste rock types should be subjected to long-term (at least 6 months) column leach tests and ABA accounting and characterised to each waste type according to the ABA results, with requirement to report the results to the Director as required;
- Identification and segregation of potentially acid forming and non-acid forming waste rocks types;
- The development and implementation of a Waste Rock Management Plan, with a copy submitted to the Director as required.

2 WASTE ROCK TYPES

2.1 General Requirements

Waste rock disposal facilities in use are approved by the EPA and are described in the current approved Environment Management Plan (EMP) and the current Environmental Rehabilitation Plan (ERP).

2.2 Waste Rock Classification

Waste types at Savage River are classified into four main geochemical groups as shown in Table 1.

Table 1 Savage River Waste Rock Classification

Waste Type	Material Lithology	Material Character	Flow Through Suitability	Net Acid Producing Potential (NAPP)	Presence of Sulphides	Acid Forming
A	Fresh Chlorite, Carbonate, Calcite Schist, Magnesite or dolomite.	Hard weather resistant & durable	Yes	<-30 kgH_2SO_4 Alkalinity ≥ Max Acidity	No or Minimal Visible Pyrite	NAF
	Weathered Magnesite, Dolomite or Chlorite - Carbonate Schist.	Soft liable to break down by weathering or compaction	No	<-30 kgH_2SO_4 Alkalinity ≥ Max Acidity	No or Minimal Visible Pyrite	NAF
	Metamorphosed gabbro, dolerite and basalt.	Hard weather resistant & durable	Yes	<-30 kgH_2SO_4 Alkalinity ≥ Max Acidity	No or Minimal Visible Pyrite	NAF
B	Western stratigraphic units. with albite / chlorite / muscovite.	Friable, weak rock units	No	Neutral ANC = MPA	Some Visible Pyrite – sufficient capacity for self-neutralisation	Neutral
C	Schist, low sulphide serpentinite and clay.	Soft liable to breakdown by weathering or compaction	No			NAF
D	Chlorite – sulphide schists, sulphide intrusives, serpentinite, talc schist, mixed waste rock and unidentified materials.		No	>+30kg H_2SO_4 ANC < MPA	Significant Visible Pyrite	PAF

2.3 Management of A-Type Waste

A-Type waste is intended to contain the hard, durable, non–acid forming rocks. Type A waste rocks are dominantly magnesite or calcite chlorite schist rocks with an ANC ≥ 30 kg H_2SO_4/tonne and with low or no visible sulphides. A-type is used for rock armouring completed dump complexes. It is also used to build haul roads and flow-throughs.

2.4 Management of B-Type Waste

Type B-Type waste compacts to a low level of permeability when consistently run over by loaded haul truck movements. B-type waste is segregated and generally dumped with D type waste.

2.5 Management of C-Type Waste

C-Type waste is characterised as non-acid forming clay and silt material. C-Type is segregated from other waste types and stockpiled on site for use in D-type dump encapsulation. Compacted C-type waste prevents water and oxygen ingress and is used for encapsulating D-type waste to prevent oxidation.

In general C-Type waste is free dug and therefore should be subject to inspection and testing to ensure it is not PAF.

2.6 Management of D-Type Waste

D-Type waste is Reactive PAF Rock or rock of unknown classification requiring encapsulation to prevent oxidation.

2.7 Management of Waste Initially Classified as Uncertain

During the current laboratory classification of waste rock through NAG testing samples may be classified as uncertain (UC). Further testing may allow these samples to be reclassified to another waste class. If this is not possible within the time frame of sampling to diging then these samples must be treated as D-Type waste.

2.8 Management of Unclassified Waste

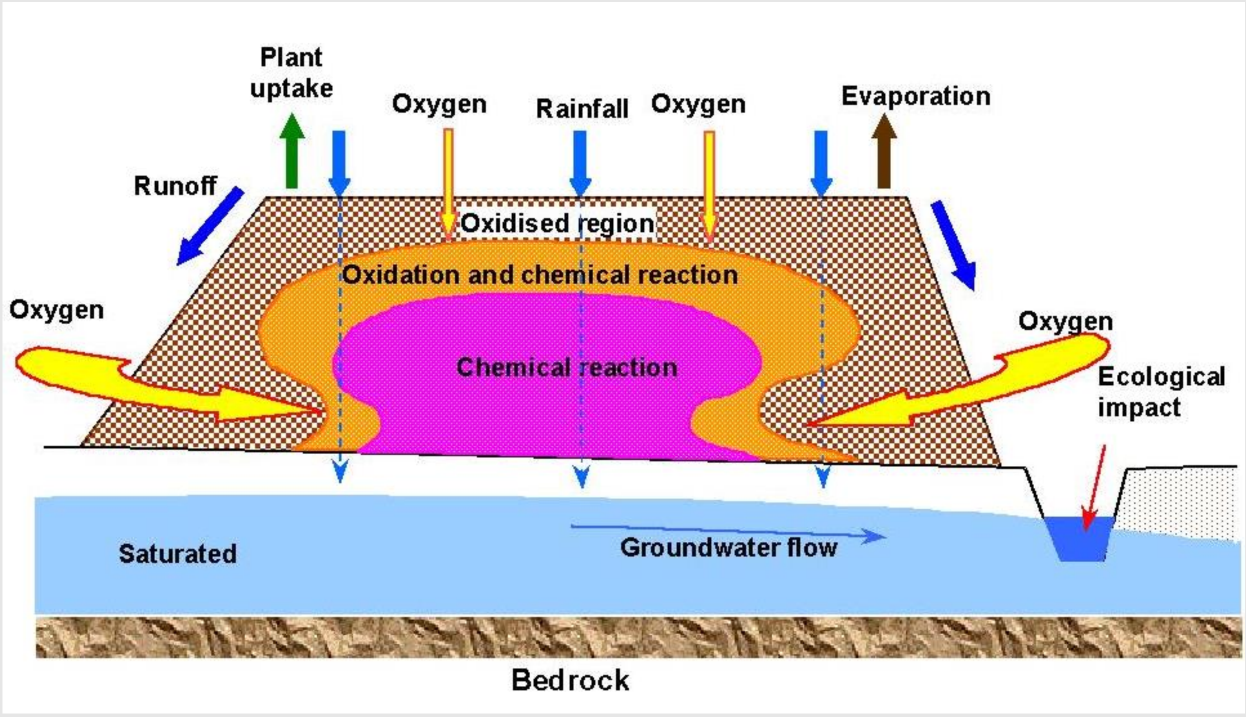
Waste rock that cannot be classified through normal sampling and classification procedures should be classified as D-Type waste. This can occur when mining through legacy waste dumps.

3 WASTE ROCK DUMP DESIGNS

3.1 Acid and Metalliferous Drainage

Acid and Metalliferous Drainage (AMD) occurs when PAF material and specifically sulphides are left exposed to oxygen. The oxidation of sulphide minerals in the rock results in products that are characterised by low pH (acidic), and high metal concentrations. The chemical processes that take place in a waste dump are depicted in Error! Reference source not found..

Figure 1 Pictorial Diagram of Oxygen and Water Transport into a Waste Dump

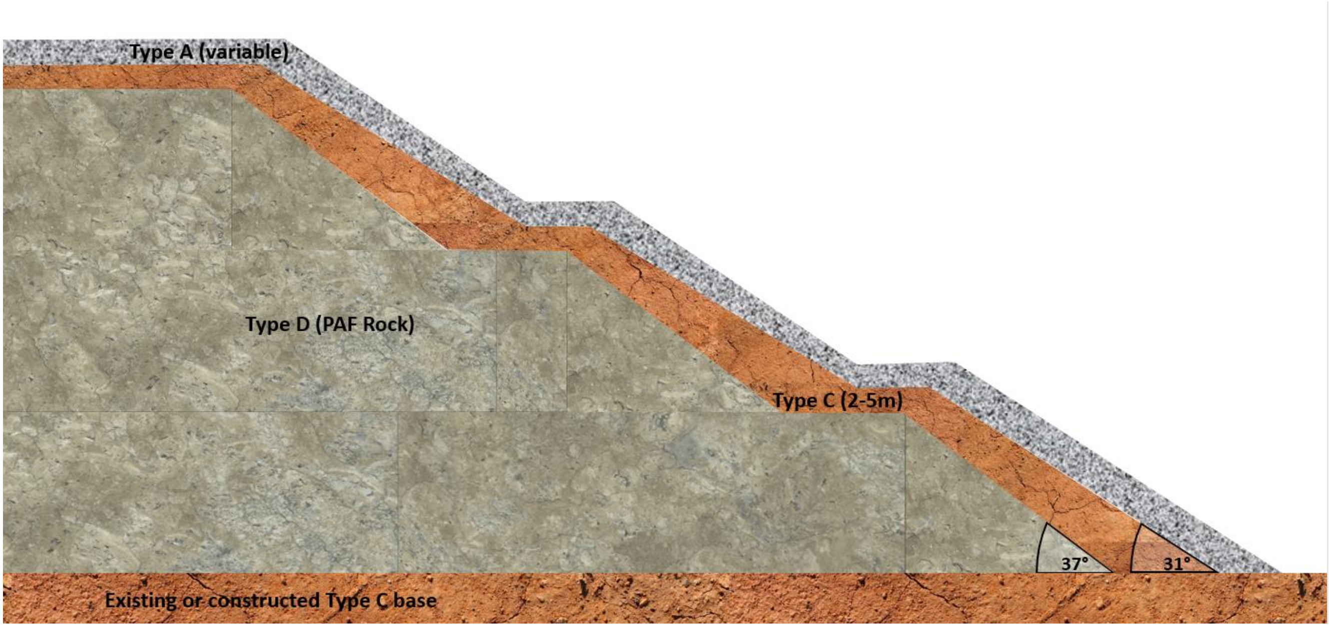


3.2 Waste Rock Dump Encapsulation

All dumps containing D-Type waste (PAF waste) shall be sealed through the use of C-Type encapsulation to minimise oxygen diffusion through the barrier and maintain the percentage reduction of the Acid Sulphate Generation Rate (ASGR) at greater than 95%. To achieve a 95% reduction of ASGR, D-type waste dumps are to be constructed by:

- Covering the base and top of the D-type dump with a minimum of 2m of compacted C-type “clay”. Note that track or truck rolling successive paddock dumped layers is an acceptable method of compacting the C-type where further dump layers (>15m) are to be placed above.
- Covering the sides of the D-type dump with a minimum of 2m of un-compacted C-type “clay”.

Figure 2 Pictorial representation of C-type capping of D-type cells



Note: most waste rock, when end-tipped from a truck, rills out at 37º. The clay however is much finer material and it therefore rills out at a lesser angle at around 28º-33º. This means that 2m of clay at the top will typically place about 5m of clay at the toe of the tip head.

An outer layer of A-type armouring, at least 5m thick, shall be placed over the final layer of C-type capping to prevent erosion of the C-type and provide stability to the end dumped C-type. The thickness of the armouring is dependent on the height of the overall dump and needs to be assessed by the Geotechnical Engineer for stability.

An additional layer of clay may be placed on the outer edges of the top of the A-type armouring to assist in the re-growth of vegetation. By restricting the re-vegetation media to the outside edges, the potential for tree root ingress into the oxygen excluding barrier is minimised.

Increasing temperature and oxygen within the dump indicates that sulphide oxidation is occurring and will trigger corrective action to increase alkalinity, reduce the available oxygen and increase saturation within the dump. This will be achieved by:

- decreasing the PAF layer thickness
- increasing compaction of the layers
- adding alkalinity to the PAF layers
- increasing the clay encapsulation thickness

3.3 Active Waste Dump Designs

The current waste rock dump designs are generally updated annually or as required to meet operational requirements. The current designs are contained within Life of Mine Waste Dump Plan which are developed in accordance with MHS-16 Mine Planning Procedure.

3.4 Broderick Creek Dump Complex

Waste rock from all of the pits may be disposed of in the Broderick Creek Dump Complex and associated dumps.

The Broderick Creek flow through dump has been constructed across Broderick Creek by placing blocky A type rock into the creek covering with a layer of clay and then encapsulating D type rock over the clay and against the clay lined walls of the valley.

Figure 3 Broderick Creek Indicative Cross Section

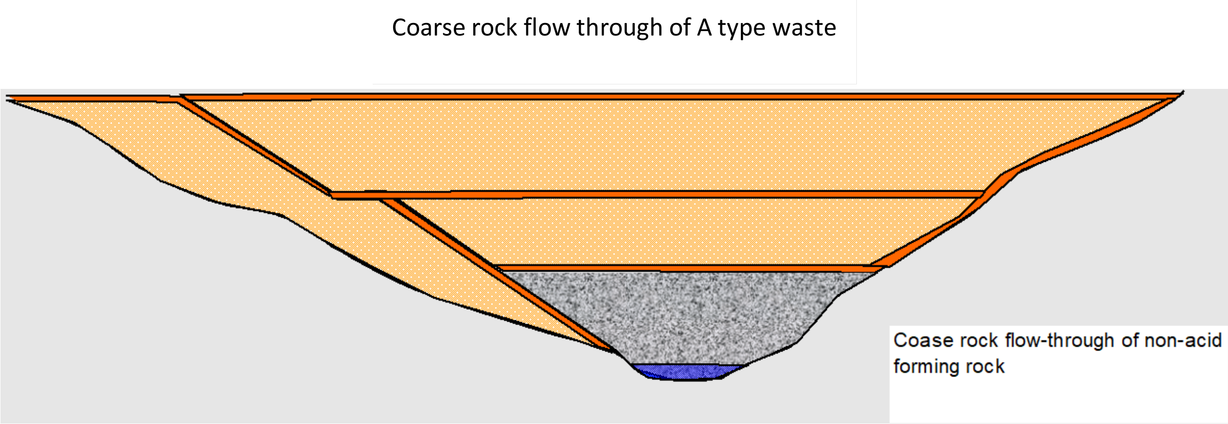
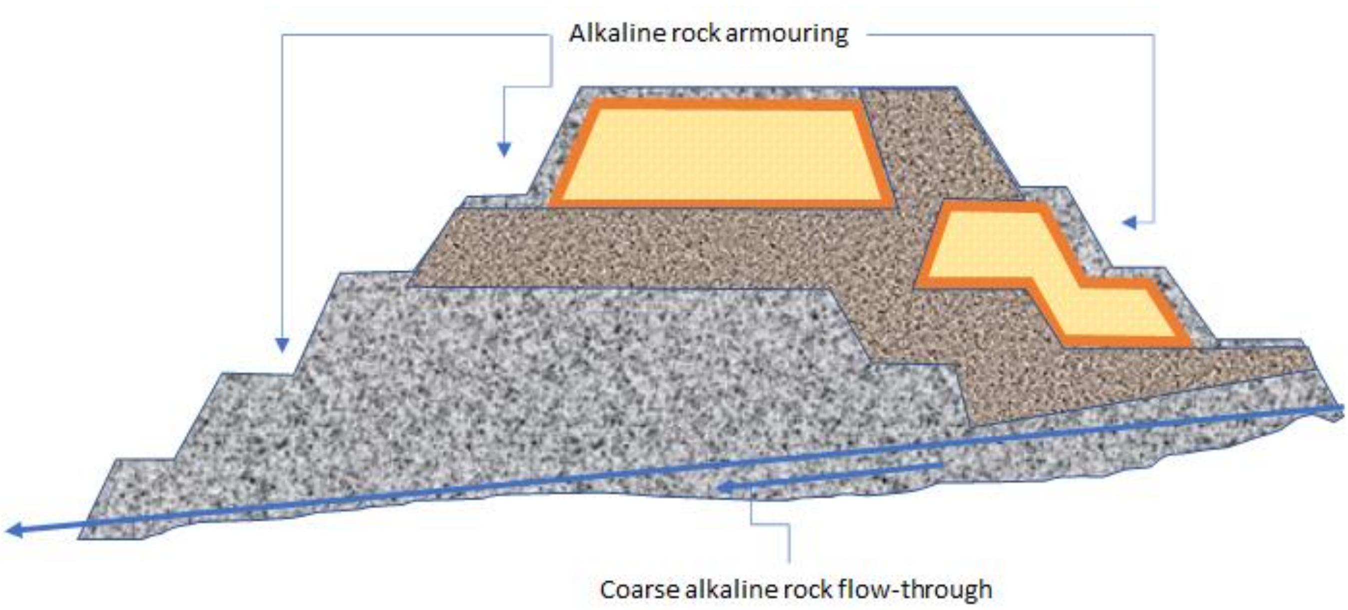


Figure 4 Broderick Creek Dump – Long Section



3.5 South Deposit Tailings Storage Facility

The South Deposit Tailings Storage Facility (SDTSF) and its associated dumps are built and managed in accordance with requirements detailed in Permit Conditions Environmental PCE8808. These conditions are specific to the

SDTSF and have resulted in a separate WRMP. The SDTSF will become the primary tailings storage facility when the MCTD is closed.

3.6 Centre Pit Waste Rock Dumps

Grange has interim approval from the EPA for the pre-stripping of the Eastern wall of Centre Pit. This interim approval allows use of the B and South Dumps for the placement of waste rock subject to the conditions within the interim approval. Grange is preparing an Environmental Impact Statement (EIS) for full approval of the Centre Pit Project.

3.7 Management of Legacy Waste Rock Materials

Under the Goldamere Agreement Act Grange is not to be held responsible for AMD associated with pre 1997 waste rock placement at Savage River. No emission limits on water quality can be set where influences of pre 1997 waste rock dumping may contribute to water quality. Through the Savage River Rehabilitation Project (SRRP) Grange may assist with the rehabilitation of pre 1997 waste rock dumps through SRRP contracts resulting in reduction of the purchase price. Grange should investigate ways to assist the SRRP with rehabilitation objectives through integration with current operational planning.

4 OPERATIONAL WASTE ROCK MANAGEMENT

4.1 Planning and Segregation Procedures

Waste rock material classification is normally defined during the drill and blast cycle, through logging of the drill cuttings at the hole collar. All blasted collars are visually assessed in the field for waste type and one sample from each discreet waste type identified in a blasted shot is sent for NAG testing to confirm the field assessment.

Where materials are free-dug, regular visual field assessment of waste type is required and in addition grab samples need to be taken frequently while free-digging is in progress and sent for NAG testing.

The logging process (drill cuttings or grab samples) records details of:

- Location
  - linked to survey collars in the case of drill cuttings or
  - direct GPS coordinates in the case of free-dig samples.
- Magnetic susceptibility (DTR)
- Rock type, mineralisation, alteration,
- Accessory minerals,
- Colour,
- Grain size'
- Results of HCL 'Fiz' test
- Paste pH and Conductivity
- NAGpH, NAG, Total S and C and ABA Accounting

Both the drill hole survey and the logged geological data are uploaded into Surpac mining software. The boundaries of the ore and different waste types are digitised into three-dimensional coordinates from the plan. Based on the logging data, the waste areas are subdivided into the different waste categories, i.e. 'A', 'B', 'C' or 'D' type. The digitised data is used for pegging on the ground to identify the boundaries of the mining blocks.

Additional information on the identified risks and controls to carry out these activities safely and in detail can be found in the relevant SOPs and Handbooks.

Table 2 Sampling and Testing Standard Operating Procedures and Handbooks

Grange Standard Operating Procedures	Document Type
Blast Hole Sampling	Procedure
NAG Sampling Procedure	Procedure
Testing Procedures as specified in AMIRA 2002 ARD Test Handbook	External Resource

4.2 Excavation and Transport Procedures

The level plan information is translated for survey and marked up on the ground for excavation. Mining plans issued to the Pit Supervisor and Excavator Operators clearly identifying the ore or waste type boundaries. Procedures are in place to ensure each step of the process is managed by the excavator calling the material type during loading and the truck operator recording the load number, material source and destination on the truck sheet for each load during the shift. Pre-shift meetings ensure that all operators are familiar with the designated dumping areas for the various material types including waste.

A pre-shift briefing is conducted at the start of each mining shift to ensure that all operators are familiar with the designated dumping areas for the differing material types.

Additional information on the identified risks and controls to carry out these activities safely and in detail can be found in the relevant SOPs.

Table 3 Operational Standard Operating Procedures

Grange Documents	Document Type
SAVMINSOP_Excavator Loading Operation	Procedure
SAVMINSOP_Haul Truck Operation	Procedure
SAVMINSOP_Dozer Operations	Procedure
SAVMINSOP_Waste Rock Dumping into Water	Procedure
SAVMINSOP_Production Study	Procedure

4.3 Waste Rock Dump Design and Construction Procedures

SOPs and JHAs and other administrative steps are in place to ensure the risk associated with waste rock dump construction activity are identified and controlled.

Table 4 Planning Standard Operating Procedures

Grange Documents	Document Type
MHS-16 Mine Planning Procedure	Procedure
MTS-Mine Planning Management Manual	Manual
MTS-Geology Management Plan Manual	Manual
MHS-04 Ground Control Management Plan	Procedure

SAVMINSOP_Waste Rock Dumping into Water	Procedure

4.4 Water Management

Water management strategies are focused on acceptable discharge water quality. EMS-06 Surface and Ground Water Management details water management requirements including:

- Requirements of the water management plan;
- Hydrology assessment and controls;
- Water quality limits;
- Water management instrumentation, locations and inspection / testing frequency.

All water management sampling, testing and monitoring is scheduled within MHS-01 Monitoring and Measurement Management Plan located on the SharePoint intranet site SEMS.

5 MONITORING

5.1 Operational Waste Rock Sampling

Sampling of waste is a vital part of the mining cycle. If the sample is not representative of the ground to be mined, all Grade Control procedures undertaken after this point cannot compensate for this error. Sampling provides the geological / geochemical data for interpreting waste types. For the drill, blast and load cycle the samples are collected from drill cones.

Cones should be cut with a pelican pick following the requirements detailed in the Blast Hole and NAG Sampling Procedure.

All drill collars are visually assessed in the field for waste type and one sample from each discreet waste type identified in a blasted shot is sent for NAG testing to confirm the field assessment.

NAG samples are bagged and identified for dispatch to NATA registered laboratories.

Where mining occurs in undrilled ground a procedure will be developed for sampling of this area. Sampling should be carried out to allow required laboratory testing.

Eg: Where materials are free-dug, daily visual field assessment of waste type is required and in addition grab samples need to be taken each day that free-digging is in progress and sent for NAG testing.

5.2 Waste Rock Laboratory Testing

A number of test procedures are used to assess the acid forming characteristics of mine waste materials. The most widely used assessment methods are the acid-base account (ABA) and the net acid generation (NAG) test. These methods are referred to as static procedures because each involves a single measurement in time.

The acid-base account involves NATA certified laboratory procedures that evaluate the balance between acid generation processes (oxidation of sulphide minerals) and acid neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases, and weathering of silicates). The values arising from the acid-base account are referred to as the maximum potential acidity (MPA) and the acid neutralising capacity (ANC), respectively. The difference between the MPA and ANC value is referred to as the net acid producing potential (NAPP).

Kinetic test procedures involve a number of measurements over time, and are used to assess a range of ARD issues including sulphide reactivity, oxidation kinetics, metal solubility and the leaching behaviour of test materials. Kinetic NAG and Leach column tests are examples of kinetic procedures.

A suggested test program may include the following stages dependent on the test materials, the information required and the speed with which the information is required:

Stage 1: Screening – samples are screened and categorised using relatively rapid and inexpensive static tests;

Stage 2: Follow up testing – to obtain more information on acid forming capacities and resolve samples with uncertain classifications. A variety of static and kinetic NAG test methods may be employed at this stage; and

Stage 3: Leach Column testing – longer term kinetic column testing to provide data reaction rates and leachate chemistry.

5.2.1 $pH_{1:2}$ and Electrical Conductivity $(EC)_{1:2}$

The $pH_{1:2}$ and electrical conductivity $(EC)_{1:2}$ of a sample is determined by equilibrating the sample in deionised water for 12 –16 hours (or overnight), at a solid to water ratio of 1:2 (w/w). This gives an indication of the inherent acidity and salinity of the waste material when initially exposed in a waste emplacement area. A modified field test can be used to quickly identify PAF material.

Paste pH generally indicates whether or not a material has already become acidic and may be used to infer the degree of weathering. Low paste pH values (pH<5) generally are indicative of stored acidity (i.e. potential for net acid generation) and net acid generating conditions. High paste pH values (i.e. pH 7 or above) indicates the presence of reactive neutralising minerals.

5.2.2 NAG pH

NAGpH samples are collected by site personal and shipped to the lab at SGS Renison Bell for testing. The NAGpH test involves the forced oxidation of the sample with hydrogen peroxide. Once the sample has fully reacted it is heated to drive off excess peroxide and returned to room temperature for pH measurement.

5.2.3 Maximum Potential Acidity (MPA)

MPA is a measure of the total acid producing potential of a material, irrespective of whether that material may also have the potential to produce alkali. MPA is determined from the analysis of total sulphur in the sample and is calculated assuming a total conversion of sulphur to sulphuric acid. MPA is reported as kg H2SO4 per tonne.

$$MPA\ (kg\ H_2SO_4/t) = (Total\ \%C) * 30.6$$

5.2.4 Acid Neutralising Potential (ANC)

ANC measures the capacity of a sample to neutralise any acid that is produced. In the ANC analysis a finely ground sample is reactive with a known amount of hydrochloric acid. The resultant solution is back titrated to pH 7.0 with sodium hydroxide to determine the amount of acid neutralised by the carbonates and other acid consuming minerals present in the original sample. ANC is reported by the laboratory as either Kg $CaCO_3$ or Kg H_2SO_4 equivalent per tonne. For calculation of NAPP Kg H_2SO_4 equivalent per tonne should be used. An estimate of ANC can be determined by calculation from the % C assuming all C is present as $CaCO_3$.

$$ANC\ (kg\ H_2SO_4/t) = (Total\ \%S) * 83.3$$

5.2.5 Net Acid Production Potential (NAPP)

NAPP gives a theoretical prediction of whether the acid production potential of a material is greater than its acid consumption capacity. The results are usually provided as either a positive or negative number. The difference between the MPA and ANC value is referred to as the net acid producing potential (NAPP). A negative NAPP indicates that ANC exceeds MPA.

NAPP = MPA - ANC

5.2.6 Net Acid Generation (NAG)

The NAG test is used in association with the NAPP to classify the acid generating potential of a sample. The NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulphide minerals contained within a sample. During the NAG test both acid generation and acid neutralisation reactions can occur simultaneously. Therefore, the end result represents a direct measurement of the net amount of acid generated by the sample. This value is commonly referred to as the NAG capacity and is expressed in the same units as NAPP, that is kg H2SO4/t.

5.3 Interpretation of Results

Results from grade control observation and laboratory analysis are entered into the Geology Database and /or the Geology Calculation Spreadsheets. The spreadsheets calculate the waste type from the analytical results and compare these with the grade control observation. Waste is classified into waste type generally on the basis of the following.

The acid forming potential of a sample is preliminarily classified on the basis of the NAGpH, Acid-base account and static NAG test results and fall into one of the following categories:

- Non Acid Forming (NAF)
- Potentially Acid Forming (PAF)
- Acid Forming (AF)
- Uncertain (UC)

Non-Acid Forming (NAF): A sample classified as NAF may, or may not, have a significant sulphur content but the availability of ANC within the sample is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulphide minerals. As such, material classified as NAF is considered unlikely to be a source of acidic drainage. A sample is usually defined as NAF when it has a negative NAPP and a final NAGpH ≥ 4.5.

Potentially Acid Forming (PAF): A sample classified as PAF always has a significant sulphur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material. This means there is a high risk that such a material, even if pH is circa neutral when freshly mined or processed, could oxidise and generate acidic drainage if exposed to atmospheric conditions. A sample is usually defined as PAF when it has a positive NAPP and a final NAGpH < 4.5.

Uncertain (UC): An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results (i.e. when the NAPP is positive and NAGpH > 4.5, or when the NAPP is negative and NAGpH < 4.5). Uncertain classifications may be moved to other waste classes by further testing procedures. If there is insufficient time for further testing within the mining cycle UC classified waste must be treated as D-Type.

Acid Forming (AF): A sample classified as AF has the same characteristics as the PAF samples however these samples also have an existing pH of less than 4.5. This indicates that acid conditions have already been developed, confirming the acid forming nature of the sample.

Figure 3 NAGpH vs NAPP

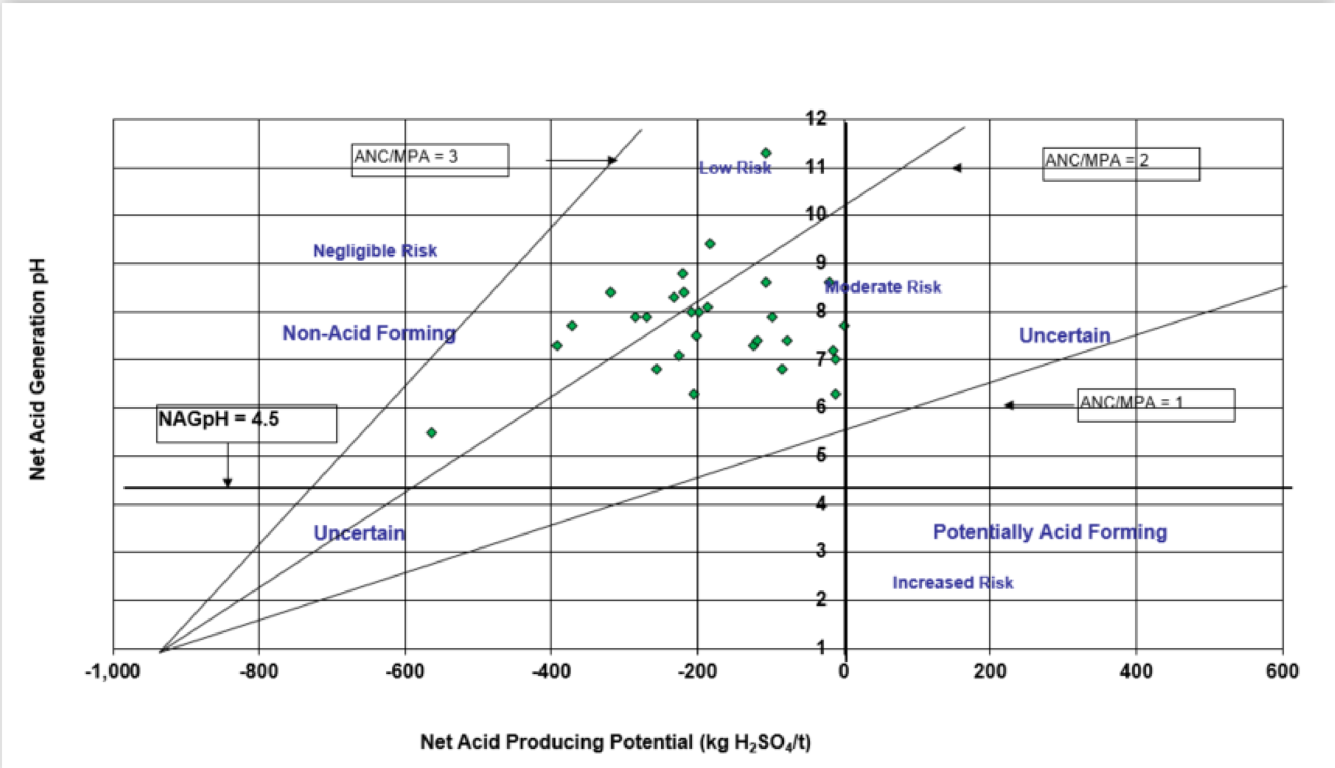
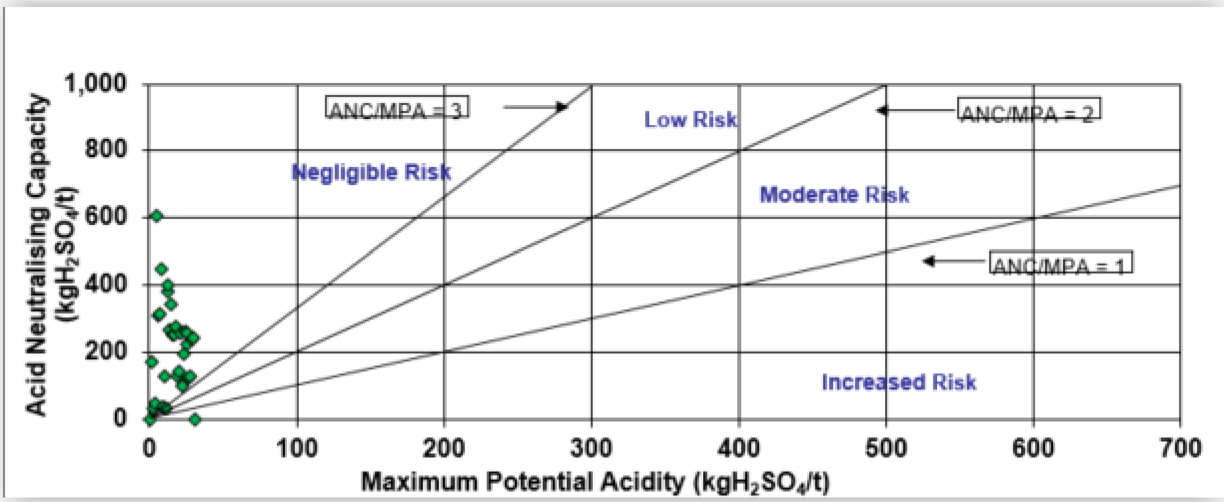


Figure 4 ANC vs MPA



5.4 Column Leachate Monitoring

Leach columns are used to develop further understanding of the waste materials drainage chemistry. Free draining leach columns simulate dump conditions to provide information on a range of issues including oxidation, metal solubility and the leaching behaviour of the test materials. Understanding reactivity of mixing waste rock types for future waste dump designs is also generated through this monitoring study.

5.5 Waste Rock Dump Construction Monitoring

Geotechnical monitoring of waste rock disposal facilities is conducted on a routine basis to detect any possible abnormal conditions such as subsidence and to verify the integrity of the run on and run off controls.

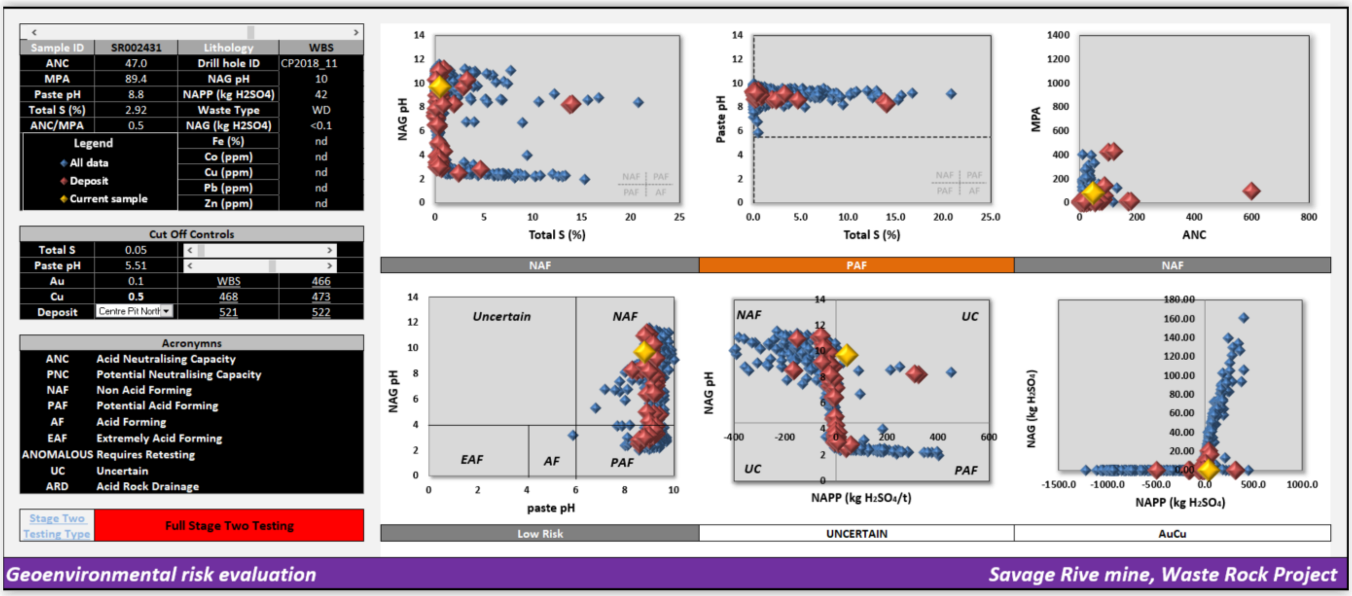
Waste rock disposal facilities are inspected on a risk based schedule, the inspection documents:

- Water ponding on top of the waste rock disposal facility;
- Seepage from the toe;
- Adverse settlement, cracking or signs of instability;

5.6 Continual Improvement

Grange continues to apply BPEM principals to the classification and management of waste rock at the Savage River operations. Recently grange has been involved in the development of a Geo-environmental Risk Evaluation Dashboard and is currently assessing the suitability of this dashboard for use in classification of waste types and auditing of performance in waste rock management at Savage River.

Figure 5 Geo-environmental Risk Evaluation Dashboard Snapshot



Further work is also to be carried out on the use of portable XRD equipment for waste classification and 'Equotip' equipment for hardness testing to further improve waste classification.

5.7 Geochemical Monitoring Frequency

Grange Resources at Savage River uses the NAGpH test for operational categorisation of waste types. The suite of Acid Based Accounting Tests (MAP, ANC, NAPP and NAG) are carried out on drill core for geological waste model construction and for initial waste categorisation and to verify, reconcile and audit waste rock classification. Testing is carried out as per Table 5.

Table 5 Testing Application and Frequency

Waste Type Testing Point	Test Type	Frequency	Parameter
During Exploration Activities			
Diamond Drill core	NAGpH MAP, ANC & NAPP NAG	Per drill campaign in waste	Several ABA samples are taken per lithological unit within an assemblage domain with no less than 30 samples per domain to establish a statistically valid preliminary classification.
During Mining Operations			
Active pit benches: A) Blast hole cone sampling Or B) Free-dig areas (grab samples)	Visual assessment NAGpH	Daily Per pit blast	Visual and field characterisation of waste type of each blast-hole Collect sample of each unique waste type in a blast or daily in the case of free dig.
	ABA Accounting	Monthly	Confirm Waste Types
Active Waste Rock Dumps	Visual assessment NAGpH	Daily Weekly	Visual inspection to check for mis-dumping Collect sample of each active dump to validate that correct material is being dumped.
	ABA Accounting	Monthly	Confirm Waste Types

6 QUALITY CONTROL AND REVIEW

6.1 Competence Awareness Training

Technical and operational staff including geologists, grade controllers, mine planners and other relevant mining personnel will be provided independent geochemical training on a regular basis and at least every five years. All relevant staff holding responsibilities for waste rock management are trained in the requirements of the EMS-04 Waste Rock Management Plan.

6.2 Review of Waste Rock Classification

Grade control classifications are assessed against laboratory NAGpH analysis to verify accuracy and waste rock segregation. NAGpH is also assessed against full geochemical test results from NATA certified laboratories.

Performance of Grade Control classification against laboratory test results will be analysed over time by the Environmental and Geology Groups and by suitably qualified external contractors. Variations between field classification and laboratory results will be addressed as soon as is practical. These will also be reported in Technical Services Group meetings. Quality control is carried out as per Table 6.

Table 6 Waste Rock Quality Control Testing and Frequency

Quality Control	Type	Frequency	Parameter
Review results of NAGpH data	Grade Control vs NAGpH	Weekly	Check Grade Control Classification vs NAGpH Classification to verify correct dumping.
Graph results of all waste rock classification data.	NAGpH vs NAG & NAPP	Monthly	Determine variance between Classifications
Review available publications	Knowledge Base	Yearly	Update on AMD Prevention current thinking and analytical methods
Attend Workshops and Conferences	Knowledge Base	As Available	Update on AMD Prevention current thinking and analytical methods
Review Waste Type availability against Planned and Required Type	Waste Types Available and Required	Yearly	Waste Volumes

6.3 Internal Review of Waste Rock Segregation

Grange will review grade control vs laboratory classification regularly along with confirmation of correct dumping by waste type. Mine planning volumes by waste type shall also be reviewed against actual dumped volumes by waste type.

6.4 Review of Waste Rock Management Plan

Operations perform an audit of the waste rock management system at intervals required by licence conditions, determined by risk or in any event no less once every two years. Reviews, assessments, and audits are conducted by competent personnel.

In addition, Grange will ensure that independent auditing of waste rock selection, segregation, management and disposal is undertaken every 2 years during mining and construction of waste rock dumps, PAF cells, flow-throughs and filter faces. Audits are detailed in Table 4.

Table 7 Audit Frequency

Audit	Type	Frequency	Parameter
Audit compliance to WRMP and EPA approved permit conditions	Internal Audit	At least every 2 years	As required by licence conditions
Audit compliance to WRMP and EPA approved permit conditions	Independent External Audit	Every 2 years	Off-site NAG testing Updating and use of the site's resource block model waste attributes Blast holes sampling, geological logging and analyses for NAG testing Development and use of day-to-day bench plans showing boundaries between different material types occurring on respective benches Demarcation of block boundaries Information dissemination at toolbox meetings Accuracy of the material tracking system Daily routine field testing at the mine face for the prediction and identification of PAF/NAF materials Conformance with the segregation and allocation of waste to both the PAF cell dump and the flow-through dump Assessing the accuracy of PAF identification on site by reviewing results obtained to date Undertaking duplicate analytical assessment for acid base accounting of a suite of

			samples to compare in-house and external results. PAF cell performance (oxygen/temperature array)

6.5 Record Keeping

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Records will be kept of the amount of waste rock by geochemical type including source and final location. Grange will maintain a haulage database of the daily source of waste rock by waste type, by quantity, noting source and eventual dump location. Records of all data generated by EMS-04 Waste Rock Management Plan will be kept as described in Table 8.

Table 8 Record Keeping

Record Type	Minimum Records	Where to Access
Waste Rock Type, Source and Destination	10 Years	Grange's Haulage Database
ABA Accounting	10 Years	Geology Department
Internal Review Grade Control classification vs NAGpH classification	2 Years	Geology Department
Internal Review of NAGpH vs NAG & NAPP	2 Years	Geology Department
Water Analysis Results	10 Years	HSE Department
Staff Competence Training	2 Years	HSE Department (Training)
Internal review of EMS-04 WRMP	10 Years	HSE Department
External Review of EMS-04 WRMP	10 Years	HSE Department

7 REPORTING

Grange reports waste rock by type, source and destination as required by relevant EPN's. to the EPA. Waste Rock type and movement details are separately reported to the EPA for the South Deposit Tailings Storage Facility and are audited when actual movements occur.

8 EXTERNAL RESOURCES

Table 9 External Resources

Document	Description	Link
Global Acid Rock Drainage Guide	The GARD Guide is a detailed international resource on AMD prediction and management. The resource has been developed by world leaders in the industry and forms the basis for assessment of proposals worldwide.	http://www.gardguide.com
Preventing Acid and Metalliferous Drainage | Leading Practice Sustainable Development Program for the Mining Industry	This resource is provided by the Australian Government as a more local resource of the prediction and management of AMD on site. Designed to be more simplistic than the GARD guide, with Australian case studies, this document forms the basis for regulators assessment within Tasmania	https://www.industry.gov.au/sites/default/files/2019-04/lpsdp-preventing-acid-and-metalliferous-drainage-handbook-english.pdf
AMIRA International | ARD Test Handbook | Project P387A Prediction & Kinetic Control of Acid Mine Drainage	The AMIRA ARD Handbook forms the basis in Australia for AMD prediction and waste characterisation. The manual also has the lab methods used by many NATA labs to undertake the tests.	http://amirainternational.com/documents/downloads/P387AProtocolBooklet.pdf
	Alternate Handbook Download	Grange File
MEND | Guidance Documents	Mine Environment Neutral Drainage (MEND) program is based in Canada and provides much of the technical guidance for AMD management throughout the world, this link provides links to all their resources throughout the mining lifecycle.	http://mend-nedem.org/guidance-documents/
Good Practice Guide for Management of Metalliferous Drainage in Tasmania	The Good Practice Guide for Management of Acid and Metalliferous Drainage (AMD) has been developed to provide guidance on how AMD is best managed on sites within Tasmania.	https://www.mrt.tas.gov.au/land_and_resource_management/management_of_acid_and_metalliferous_drainage_in_tasmania

9 DEFINITIONS

Table 10 Definitions

Term	Definition
Potentially Acid Forming (PAF)	A sample classified as PAF always has a significant sulphur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material.
Acid Forming (AF)	A sample with a significant sulphur content and a low pH indicating that oxidation has commenced.
Acid Neutralising Capacity (ANC)	The inherent acid buffering which occurs when acid formed from pyrite oxidation reacts with acid neutralising minerals contained within the sample.
Maximum Potential Acidity (MPA)	The MPA of a sample is calculated from the total sulphur content and assumes that all the sulphur measured in the sample occurs as pyrite (FeS_2) and that the pyrite reacts under oxidising conditions to generate acid.
Net Acid Generation (NAG)	The NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulphide minerals contained within a sample.
Net Acid Producing Potential (NAPP)	Represents the balance between the capacity of a sample to generate acid (MPA) and its capacity to neutralise acid (ANC).
Acid and Metalliferous Drainage (AMD)	Drainage or seepage produced by the exposure of sulphide minerals such as pyrite to atmospheric oxygen and water.
Acid Base Accounting (ABA)	The use of chemical reactions and indicators, as a tool to identify in advance any mine materials that could potentially produce ARD, being static laboratory procedures that evaluate the balance between acid generation processes and acid neutralising processes
Non Acid Forming (NAF)	A sample classified as NAF may, or may not, have a significant sulphur content but the availability of ANC within the sample is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulphide minerals
Uncertain (UC)	An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results. (i.e. when the NAPP is positive and NAGpH > 4.5, or when the NAPP is negative and NAGpH ≤4.5).

Tailings Leach Column Testing Program for the Savage River Mine (Geo-Environmental Management Pty Ltd, 2023)

Appendix D

pitt&sherry

Tailings Leach Column Testing Program for the Savage River Mine, Tasmania

Interim Report

September 2023

Prepared For:

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Prepared By:

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Table of Contents

Page

Appendix

Tables

Page

Figures

Page

1.0 Introduction

Geo-Environmental Management Pty Ltd (GEM) has been commissioned by Grange Resources (Tasmania) Pty Ltd (Grange) to carry out an environmental geochemical assessment of the future tailings from the Savage River Mine, north-west Tasmania. The assessment involves the detailed geochemical characterisation of four laboratory generated tailings from the different ore types/areas utilising a range of static and kinetic (leach column) geochemical test procedures. This interim report provides the results of the static testing and the first 6 months of leach column testing.

The objectives of this assessment are to:

- Determine the salinity, acid forming characteristics and elemental composition of the different tailings types provided.
- Evaluate the leaching behavior of the tailings, including sulfide reactivity, oxidation kinetics and metal solubility.
- Provide an interim (6 month) and final (12 month) report documenting the results and findings of the assessment, identifying any implications for environmental management of the tailings and providing recommendations for the leach column testing program.

2.0 Sample Collection and Preparation

Laboratory derived non-magnetic residues, processed from ore samples collected from the Centre Pit North (CPN), Centre Pit South (CPS), Long Plains (LP) and North Pit underground (NPUG) and representing the tailings from these ore types, were provided by ALS Geochemistry - Burnie in a dry, pulverized state for geochemical characterisation and leach column testing. Table 1 provides the detail for these samples.

Table 1: Sample details for the Savage River Mine tailings leach column program.

Location/ Ore Type	Sample ID	Sample Description	Leach Column ID
Centre Pit North	CPN	Non-magnetic residue from the CPN Ore Composite	SRT/CPN
Centre Pit South	CPS	Non-magnetic residue from the CPS Ore Composite	SRT/CPS
Long Plains	LP	Non-magnetic residue from the LP Ore Composite	SRT/LP
North Pit Underground	NPUG	Non-magnetic residue from the NPUG Ore Composite	SRT/NPUG

3.0 Geochemical Assessment Program

The geochemical test procedures used to characterise the tailings samples included static geochemical test procedures and the kinetic free-draining leach column test procedure. These test procedures are detailed below.

3.1 Static Geochemical Testing

The laboratory program for the static geochemical testing included the following tests and procedures:

- pH and electrical conductivity (EC) determination;
- total sulfur (S) assay and S forms analysis;
- Acid Neutralisation Capacity (ANC) determination;
- single addition Net Acid Generation (NAG) testing; and
- multi-element scans on solids.

The acid-base analysis (total S, S forms, ANC) and NAG tests were performed by ALS Geochemistry - Brisbane, and the multi-element scans were performed by Genalysis Laboratory Services in Perth.

3.1.1 pH and Electrical Conductivity Determination

The pH and electrical conductivity (EC) of a sample is determined by equilibrating the sample in deionised water for a minimum of 2 hours at a solid to water ratio of 1:2 (w/w). This gives an indication of the inherent acidity and salinity of the material when it is initially exposed. The general salinity ranking based on $EC_{1:2}$ is provided below:

$EC_{1:2}$ (dS/m)	Salinity
< 0.5	Non-Saline
0.5 to 1.5	Slightly Saline
1.5 to 2.5	Moderately Saline
> 2.5	Highly Saline

3.1.2 Acid Forming Characteristic Evaluation

A number of test procedures are used to assess the acid forming characteristics of mine waste materials. The most widely used assessment methods are the acid-base account (ABA) and the net acid generation (NAG) test. These methods are referred to as static procedures because each involves a single measurement in time.

Acid-Base Account

The acid-base account involves laboratory procedures that evaluate the balance between acid generation processes (oxidation of sulfide minerals) and acid neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases, and weathering of silicates). The values arising from the acid-base account are referred to as the maximum potential acidity (MPA) and the acid neutralising capacity (ANC), respectively. The difference between the MPA and ANC value is referred to as the net acid producing potential (NAPP).

The MPA is calculated using the total sulfur content of the sample. This calculation assumes that all of the sulfur measured in the sample occurs as pyrite (FeS_2) and that the pyrite reacts under oxidising conditions to generate acid according to the following reaction:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \Rightarrow Fe(OH)^3 + 2\ H_2SO_4$$

According to this reaction, the MPA of a sample containing 1 %S as pyrite would be 30.6 kilograms of H_2SO_4 per tonne of material (i.e. kg H_2SO_4/t). Hence the MPA of a sample is calculated from the total sulfur content using the following formula:

MPA (kg H_2SO_4/t) = (Total %S) x 30.6

The use of the total sulfur assay to estimate the MPA is a conservative approach because some sulfur may occur in forms other than pyrite. Sulfate-sulfur and native sulfur, for example, are non-acid generating sulfur forms. Also, some sulfur may occur as other metal sulfides (e.g. covellite, chalcocite, sphalerite, galena) that yield less acidity than pyrite when oxidised.

The acid formed from pyrite oxidation will to some extent react with acid neutralising minerals contained within the sample. This inherent acid neutralisation is quantified in terms of the acid neutralising capacity (ANC) and is determined using the Modified Sobek method. This method involves the addition of a known amount of standardised hydrochloric acid (HCl) to an accurately weighed sample, allowing the sample time to react (with heating), then back titrating the mixture with standardised sodium hydroxide (NaOH) to determine the amount of unreacted HCl. The amount of acid consumed by reaction with the sample is then calculated giving the ANC expressed in the same units as the MPA, which is kg H_2SO_4/t.

Determination of the ANC using the Modified Sobek provides an indication of the total neutralisation capacity of a material. However, in some materials not all mineral phases will be readily available to neutralise sulfide generated acidity. For these material types acid buffering characteristic curves (ABCC) can be used to determine the amount of ANC that is available to neutralise any sulfide generated acidity under more natural weathering conditions. The ABCC's are obtained by slow titration of a sample with acid while continuously monitoring pH and plotting the amount of acid added against pH. Careful evaluation of the plot provides an indication of the portion of ANC within a sample that is readily available for acid neutralisation.

The net acid producing potential (NAPP) is a theoretical calculation commonly used to indicate if a material has the potential to produce acid. It represents the balance between the capacity of a sample to generate acid (MPA) and its capacity to neutralise acid (ANC). The NAPP is also expressed in units of kg H_2SO_4/t and is calculated as follows:

NAPP = MPA - ANC

If the MPA is less than the ANC then the NAPP is negative, which indicates that the sample may have sufficient ANC to prevent acid generation. Conversely, if the MPA exceeds the ANC then the NAPP is positive, which indicates that the material may be acid generating.

The ANC/MPA ratio is used as a means of assessing the risk of acid generation from mine waste materials. A positive NAPP is equivalent to an ANC/MPA ratio less than 1, and a negative NAPP is equivalent to an ANC/MPA ratio greater than 1. Generally, an ANC/MPA ratio of 3 or more signifies that there is a high probability that the material is not acid generating.

Figure 1 is an acid-base account plot which is commonly used to provide a graphical representation of the distribution of sulfur and ANC in a sample set. This figure shows a plotted line where the NAPP=0 (i.e. ANC = MPA or ANC/MPA=1). Samples that plot to the lower-right of this line have a positive NAPP and samples that plot to the upper right of it have a negative NAPP. This figure also shows the plotted lines corresponding to ANC/MPA ratios of 2 and 3.

Net Acid Generation (NAG) Test

The NAG test is used in association with the NAPP to classify the acid generating potential of a sample. The NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulfide minerals contained within a sample. During the NAG test both acid generation and acid neutralisation reactions can occur simultaneously. Therefore, the end result represents a direct measurement of the net amount of acid generated by the sample. This value is commonly referred to as the NAG capacity and is expressed in the same units as the NAPP, that is kg H_2SO_4/t.

The standard NAG test involves the addition of 250 millilitres (mL) of 15% hydrogen peroxide to 2.5 grams (g) of sample. The peroxide is allowed to react with the sample overnight and the following day the sample is gently heated to accelerate the oxidation of any remaining sulfides, then vigorously boiled for several minutes to decompose residual peroxide. When cool, the pH and acidity of the NAG liquor are measured. The acidity of the liquor is then used to estimate the net amount of acidity produced per unit weight of sample.

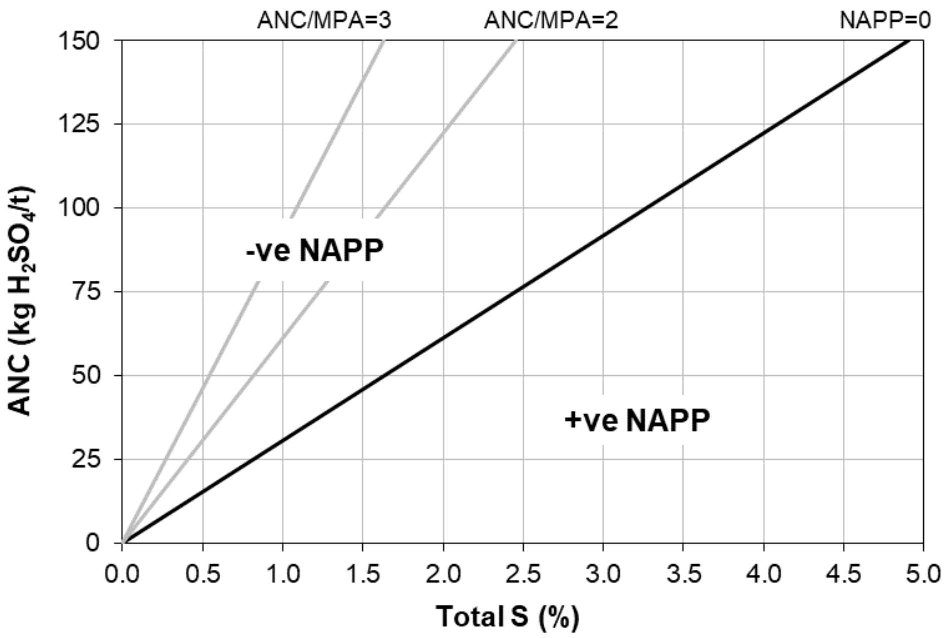

Figure 1: Typical acid-base account plot.

3.1.3 Geochemical Classification

The acid forming potential of a sample is classified on the basis of the acid-base account and NAG test results into one of the following categories:

- Barren
- Non-Acid Forming (NAF)
- Potentially Acid Forming (PAF)
- Acid Forming (AF)
- Uncertain (UC)

Barren

A sample classified as barren essentially has no acid generating capacity and no acid buffering capacity. This category is most likely to apply to highly weathered materials. In essence, it represents an 'inert' material with respect to acid generation. The criteria used to classify a sample as barren may vary between sites, but it generally applies to materials with a total sulfur content ≤ 0.1 %S and an ANC ≤ 5 kg H_2SO_4/t.

Non-Acid Forming (NAF)

A sample classified as NAF may or may not have a significant sulfur content but the availability of ANC within the sample is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulfide minerals. As such, material classified as NAF is considered unlikely to be a source of acidic drainage. A sample is usually defined as NAF when it has a negative NAPP and a final NAGpH ≥ 4.5.

Potentially Acid Forming (PAF)

A sample classified as PAF always has a significant sulfur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material. This means there is a high risk that such a material, even if pH circum-neutral when freshly mined or processed, could oxidise and generate acidic drainage if exposed to atmospheric conditions. A sample is usually defined as PAF when it has a positive NAPP and a final NAGpH < 4.5.

Acid Forming (AF)

A sample classified as AF has the same characteristics as the PAF samples however these samples also have an existing pH of less than 4.5. This indicates that acid conditions have already been developed, confirming the acid forming nature of the sample.

Uncertain (UC)

An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results (i.e. when the NAPP is positive and NAGpH > 4.5, or when the NAPP is negative and NAGpH ≤ 4.5).

Figure 2 is a geochemical classification plot where the NAPP values are plotted against the NAGpH values. Marked on this plot are the quadrates containing the NAF, PAF and UC classifications.

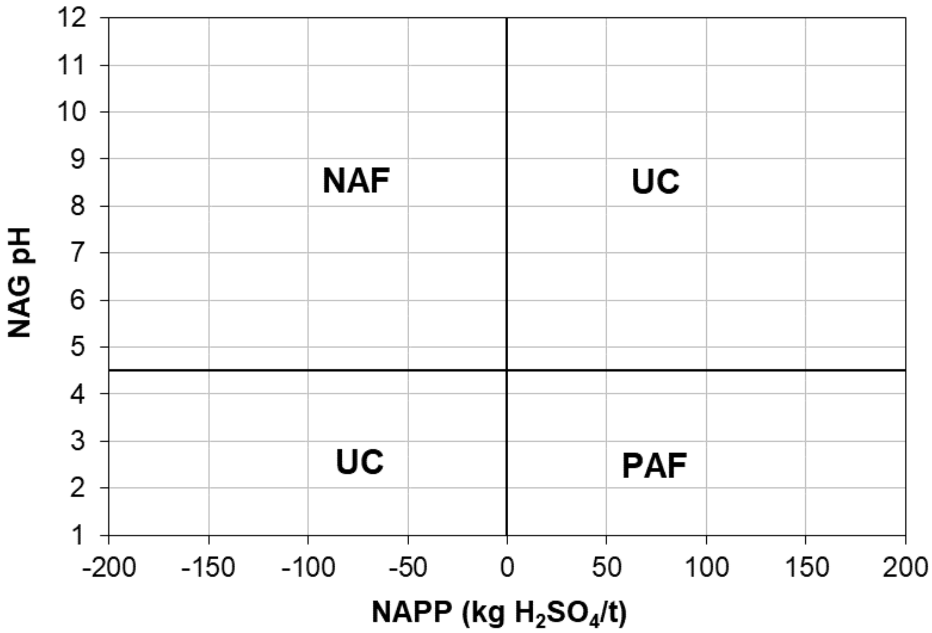

Figure 2: Typical geochemical classification plot.

3.1.4 Multi-Element Analysis

Multi-element scans are primarily carried out on solid samples to identify any elements that are present at concentrations that may be of environmental concern with respect to water quality and revegetation. The assay results from the solid samples are compared to the average crustal abundance for each element to provide a measure of the extent of element enrichment. The extent of enrichment is reported as the Geochemical Abundance Index (GAI). However, identified element enrichment does not necessarily mean that an element will be a concern for revegetation, water quality, or public health and this technique is used to identify any significant element enrichments that warrant further examination.

3.2 Kinetic Leach Column Testing

Leach column tests are used to compliment mine waste geochemical investigations and provide information on a range of issues including sulfide reactivity, oxidation kinetics and the leaching behaviour of the test materials. The test period required for the leach columns varies depending on material characteristics and the investigation requirements, the results are usually reviewed on a 6 or 12 monthly basis.

Free draining leach columns are used to achieve optimum oxidation conditions. Figure 3 provides a schematic of the free draining column configuration. The standard free draining column has an approximate diameter of 175 millimetres (mm) and height of 100 mm, giving it a capacity of approximately 2.5 litres (L). The columns typically hold 2.0 to 2.5 kg of sample. The leach column operation is designed to achieve a weekly wet-dry cycle and a monthly leaching cycle. The sample is wetted by applying deionised water to the surface of the sample once a week and heat lamps are used daily to ensure drying of the sample. The leachates, which are allowed to free drain from the base of the column, are typically collected monthly, depending on the material characteristics and analytical requirements.

A free draining leach column was set-up for each of the four provided tailings samples and the columns have now been in operation for a 6 month (24 week) period. The leachates were collected weekly for the first two collections (Weeks 1 and 2), fortnightly for the next two collections (Weeks 4 and 8) and 4-weekly for the remainder of the period (Week 12 to 24). The volume, pH and EC are measured at the time of collection and the leachates are filtered (<0.45 μm) and a split is preserved (HCl) prior to being sent to Genalysis Laboratories in Perth for alkalinity determination and elemental analysis. Collections 1, 2 and 4 were submitted for a multi-element suite and the latter Collections were submitted for a selected element suite, as listed below:

Multi-Element Suite:	Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Se, Si, Sn, Th, U, V, Zn
Selected Element Suite:	Ag, As, Ba, Ca, Cd, Co, Cu, Mg, Mn, Mo, Na, Ni, S, Sb, Se, Zn

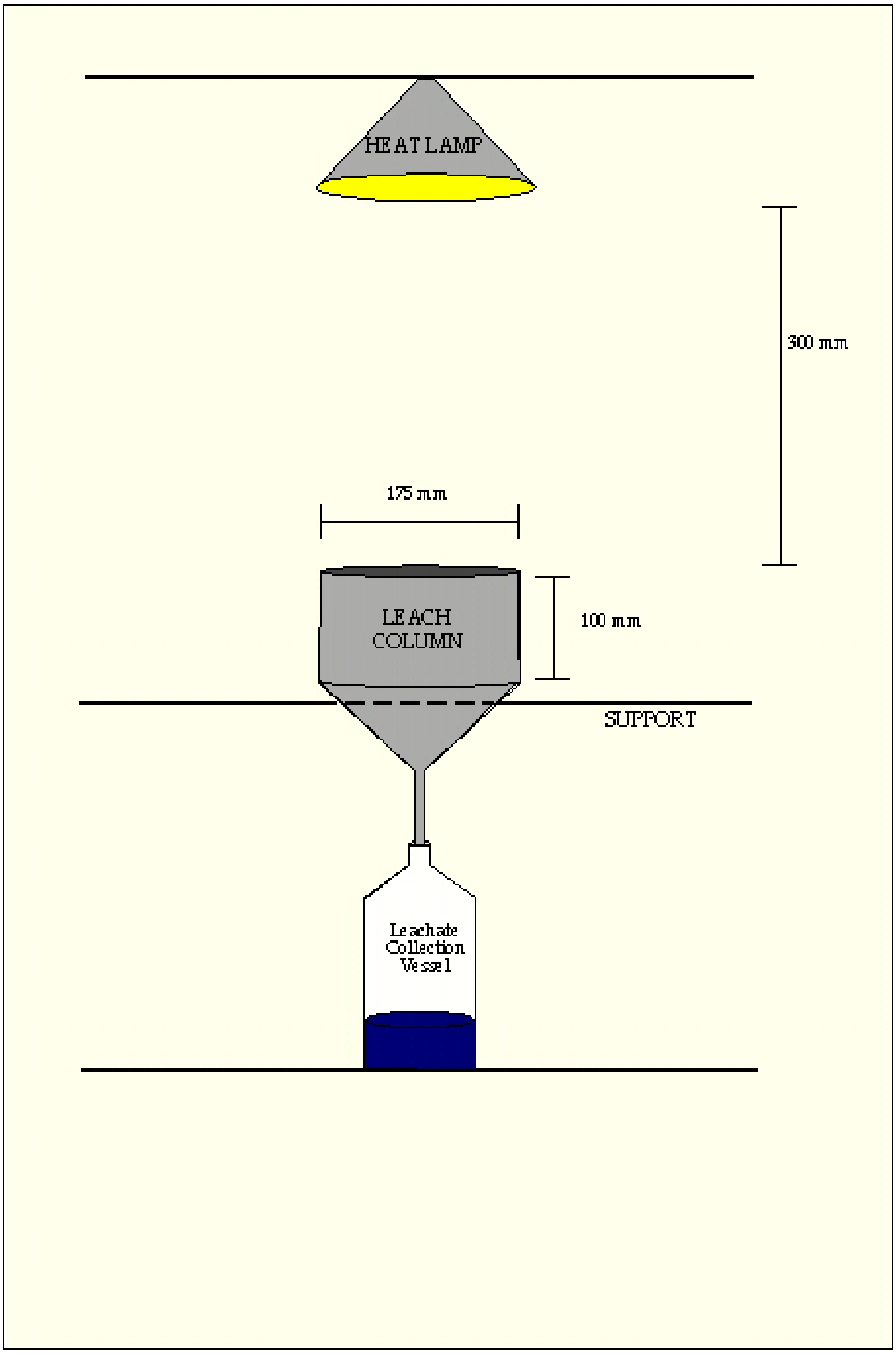

Figure 3: Schematic of the free-draining leach column test set-up.

4.0 Tailings Geochemistry

The static geochemical test results for the tailings samples, including the acid forming characteristics and multi-element composition, are provided below, and the kinetic leach column test results are provided in Appendix A.

4.1 Acid Forming Characteristics

The acid forming characteristics of the tailings samples, including the acid-base analysis, NAG test results and geochemical classification, are provided in Table 2. The acid-base account plot for these samples, where the sulfide-S contents are plotted against the ANC values, is provided in Figure 4. The sulfide S content of the Long Plains (LP) sample is relatively low at 1.51 %S and is moderate for the North Pit Underground NPUG sample at 4.48 %S, compared to the high sulfide S contents for the Centre Pit samples (CPN and CPS) at 7.28 and 11.4 %S, respectively. The ANC values are relatively consistent ranging from a low of 58 kg H_2SO_4/t for the LP sample to a high of 118 kg H_2SO_4/t for the NPUG sample. The ANC of the CPS sample is 69 kg H_2SO_4/t and of the CPN sample is 74 kg H_2SO_4/t.

Table 2: Acid forming characteristics of the Savage River Mine tailings samples.

Location/ Ore Type	Sample ID	ACID-BASE ANALYSIS							NAG TEST			Geochem Class.
		Total %S	Sulfide %S	MPA	ANC	NAPP (tot S)	NAPP (sulfide S)	ANC/ MPA	NAGpH	$NAG_{4.5}$	$NAG_{7.0}$	
Centre Pit North	CPN	8.68	7.28	266	74	192	149	0.3	2.1	110	122	PAF
Centre Pit South	CPS	13.8	11.4	422	69	353	280	0.2	2.2	95	114	PAF
Long Plains	LP	1.79	1.51	55	58	-3	-11	1.1	8.9	0	0	NAF
North Pit Underground	NPUG	6.09	4.48	186	118	68	19	0.6	8.2	0	0	UC(NAF)

KEY		Geochemical Classification Key
MPA = Maximum Potential Acidity (kg H_2SO_4/t)	NAGpH = pH of Net Acid Generation liquor	NAF = Non-Acid Forming
ANC = Acid Neutralising Capacity (kg H_2SO_4/t)	$NAG_{4.5}$ = NAG capacity to pH 4.5 (kg H_2SO_4/t)	PAF = Potentially Acid Forming
NAPP = Net Acid Producing Potential (kg H_2SO_4/t)	$NAG_{7.0}$ = NAG capacity to pH 7.0 (kg H_2SO_4/t)	UC = Uncertain (expected class.)

The acid-base account for these samples indicate that the LP sample is NAPP negative, with a NAPP value of minus 11 kg H_2SO_4/t, the NPUG sample is NAPP positive, with a NAPP value of 19 kg H_2SO_4/t, and the CPN and CPS samples are strongly NAPP positive, with NAPP values of 149 and 280 kg H_2SO_4/t, respectively.

Figure 5 presents the geochemical classification plot for these samples, where the NAPP values are plotted against the NAGpH. This plot shows that the LP sample, with a NAGpH value of 8.9, is classified as NAF and that the CPN and CPS samples, with NAGpH values of 2.1 and 2.2, are classified as PAF. With a NAPP value of 19 kg H_2SO_4/t and a NAGpH of 8.2, the NPUG sample has an uncertain classification.

The lower NAG capacity of these samples compared the NAPP value, is likely due to the presence of lower reactivity, crystalline sulfides, and therefore it is expected that the NPUG material will be NAF. However, further leach column testing will be required to confirm that this material is NAF.

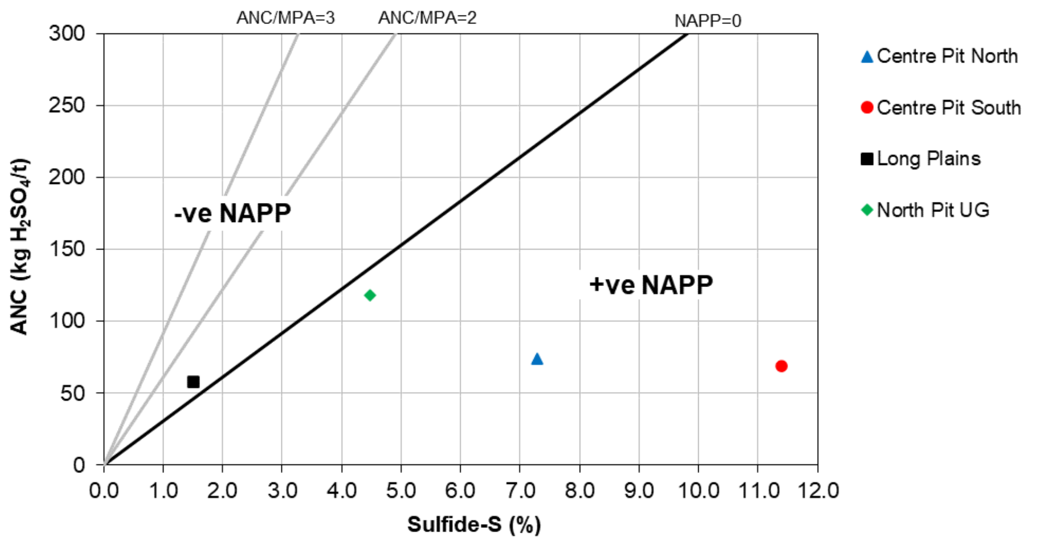

Figure 4: Acid-base account plot for the Savage River Mine tailings samples.

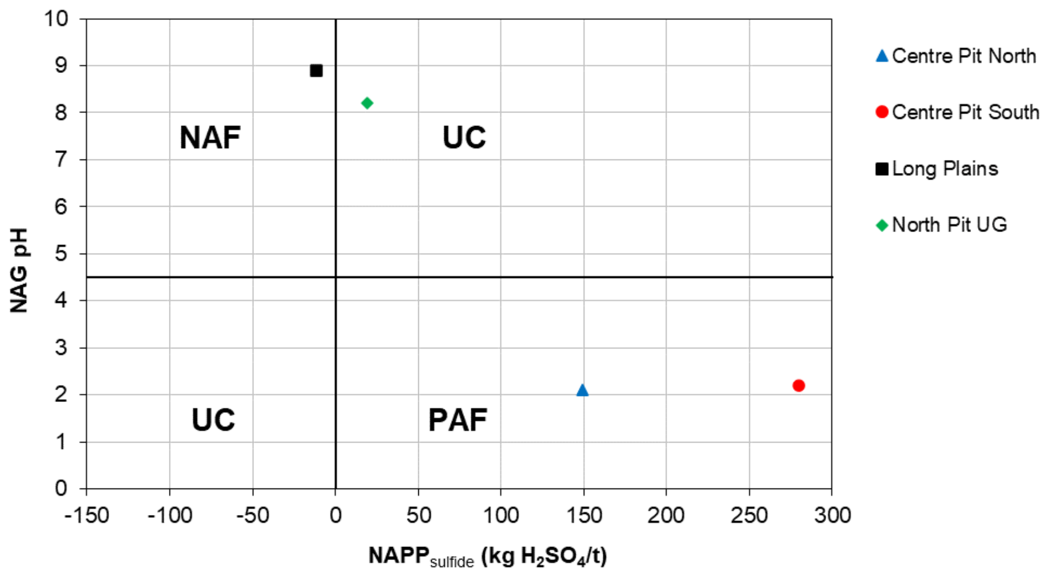

Figure 5: Geochemical classification plot for the Savage River Mine tailings samples.

4.2 Metal Enrichment

The results from multi-element scans performed on the tailings samples and the geochemical abundances indices for these samples are provided in Table 3. These results indicate that boron (B), cobalt (Co), copper (Cu) and selenium (Se) are significantly enriched in two or more of these samples.

4.3 Leaching Behaviour

The interim leach column test results after 24 weeks of leaching are provided in Appendix A (Table A1 to A 4) and selected plots showing the trend in leachate pH, and SO_4, Co, Cu, Mo and Se concentration are provided in Figures 6 to 11, respectively.

Based on the static geochemical testing, the CPN and CPS tailings samples are classified as PAF, the LP tailings samples are classified as NAF, and although the NPUG tailings sample have an uncertain geochemical classification, this material is expected to be NAF. After 24 weeks of leaching the pH of leachates from CPN, LP and NPUG has been maintained above 7.0, whereas the pH of leachates from CPS decreased to a low of 4.9 (Figure 6). The SO_4 and dissolved metal concentrations, including Co, Cu and Se concentrations have increased in response to the decreasing pH (Figures 7, 8, 9 and 11). Differing from this trend, the dissolved Mo concentrations have decreased with the decreasing pH trend (Figure 10).

Table 3: Multi-element composition and geochemical abundance indices for the Savage River Mine tailings samples.

Element	Unit	Detect. Limit	Element Concentration				*Average Crustal Abundance	Geochemical Abundance Indices (GAI)			
			CPN	CPS	LP	NPUG		CPN	CPS	LP	NPUG
Ag	mg/kg	0.05	0.15	0.16	0.09	0.18	0.07	1	1	-	1
Al	%	0.005%	1.499%	2.485%	4.590%	0.885%	8.2%	-	-	-	-
As	mg/kg	0.5	4.6	5.2	2.4	7.8	1.5	1	1	-	2
B	mg/kg	50	50	89	201	96	10	2	**3**	**4**	**3**
Ba	mg/kg	0.1	8.2	2.9	23	9.8	500	-	-	-	-
Be	mg/kg	0.05	0.11	0.14	0.39	0.08	2.6	-	-	-	-
Ca	%	0.005%	3.143%	3.548%	5.515%	2.851%	4.0%	-	-	-	-
Cd	mg/kg	0.02	0.14	0.03	0.18	0.64	0.11	-	-	-	2
Co	mg/kg	0.1	424.6	588.1	128.9	337.9	20	**4**	**4**	2	**3**
Cr	mg/kg	5	9	24	46	6	100	-	-	-	-
Cu	mg/kg	1	1326	1823	245	329	50	**4**	**5**	2	2
Fe	%	0.01%	11.89%	15.63%	9.17%	7.20%	4.1%	1	1	1	-
Hg	mg/kg	0.001	0.004	0.015	0.004	0.027	0.05	-	-	-	-
K	%	0.002%	0.029%	0.018%	0.100%	0.005%	2.1%	-	-	-	-
Mg	%	0.002%	13.646%	11.156%	11.220%	18.508%	2.3%	2	2	2	2
Mn	mg/kg	1	1296	822	1338	1040	950	-	-	-	-
Mo	mg/kg	0.1	0.5	1	0.3	0.3	1.5	-	-	-	-
Na	%	0.002%	0.269%	0.156%	0.579%	0.031%	2.3%	-	-	-	-
Ni	mg/kg	1	431	609	207	213	80	2	2	1	1
P	mg/kg	50	5671	5915	2088	1202	1000	2	2	-	-
Pb	mg/kg	0.5	6.5	12.4	37.4	18.3	14	-	-	1	-
Sb	mg/kg	0.05	0.18	0.21	0.25	0.46	0.2	-	-	-	1
Se	mg/kg	0.01	3.81	4.86	0.65	2.08	0.05	**6**	**6**	**3**	**5**
Si	%	0.1%	17.0%	14.1%	19.6%	15.7%	27.7%	-	-	-	-
Sn	mg/kg	0.1	1.8	4.3	2.2	4.1	2.2	-	-	-	-
Th	mg/kg	0.01	2.83	4.01	1.36	0.86	12	-	-	-	-
U	mg/kg	0.01	0.39	0.41	0.57	0.2	2.4	-	-	-	-
V	mg/kg	1	284	391	440	630	160	-	1	1	1
Zn	mg/kg	1	631	444	203	289	75	2	2	1	1

< element at or below analytical detection limit.

*Bowen H.J.M.(1979) Environmental Chemistry of the Elements.

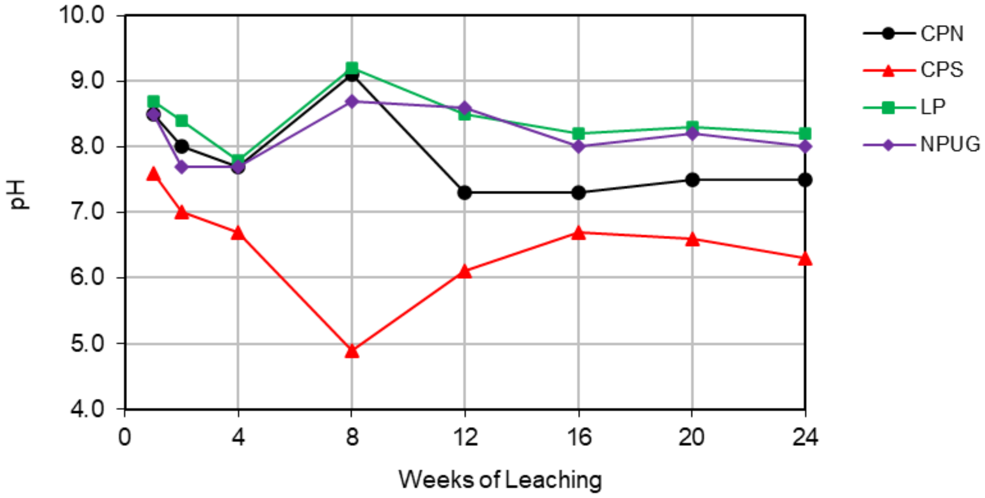

Figure 6: pH trend in tailings column leachates.

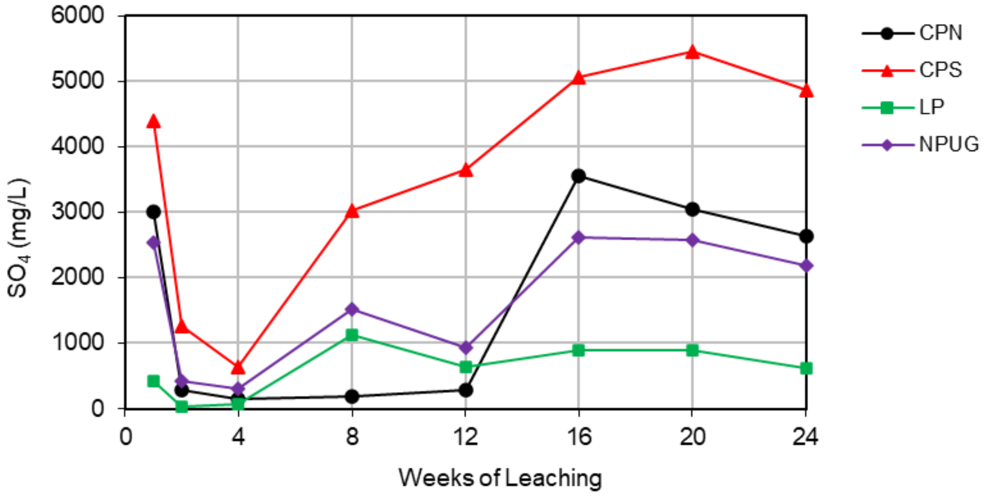

Figure 7: Sulfate concentration trend in tailings column leachates.

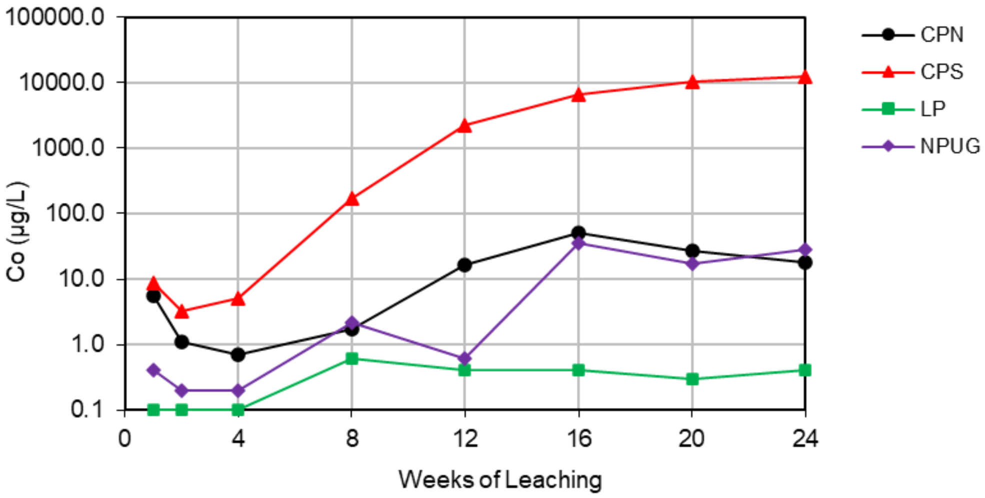

Figure 8: Cobalt concentration trend in tailings column leachates.

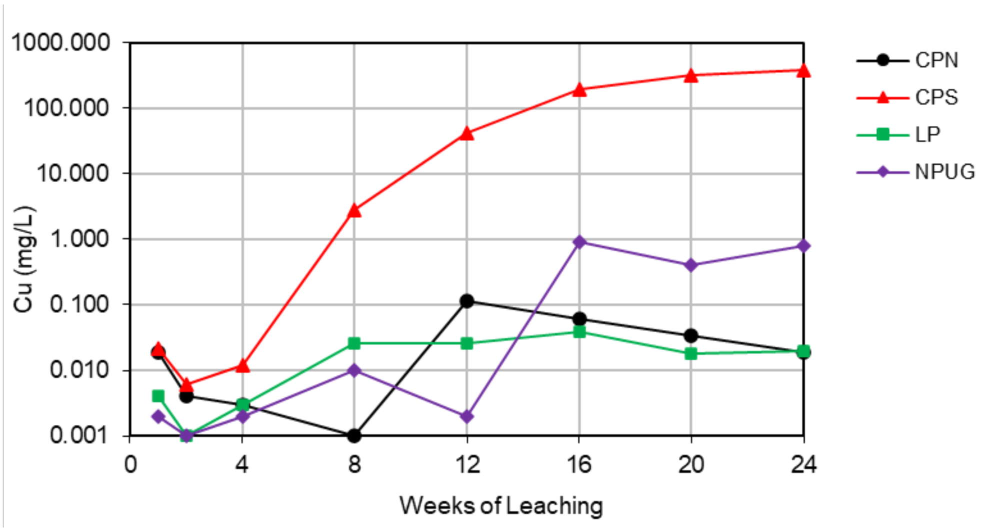

Figure 9: Copper concentration trend in tailings column leachates.

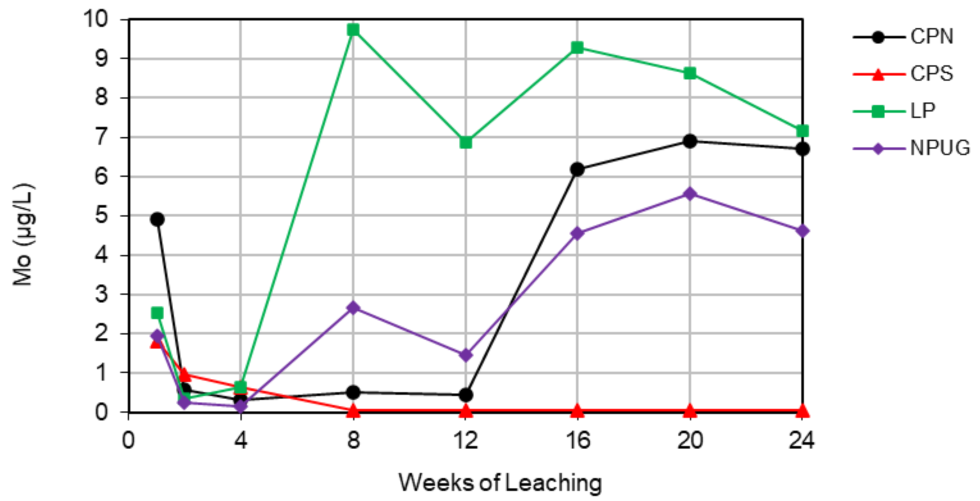

Figure 10: Molybdenum concentration trend in tailings column leachates.

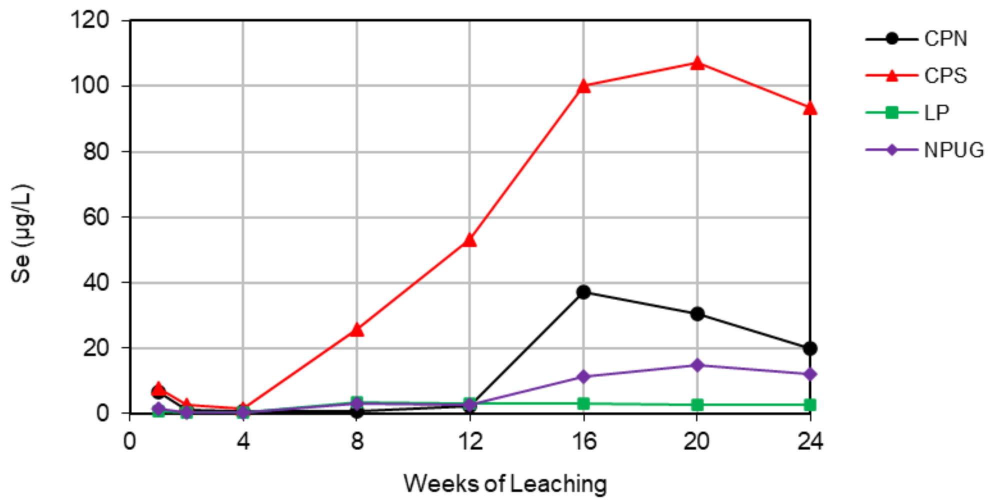

Figure 11: Selenium concentration trend in tailings column leachates.

5.0 Conclusions and Recommendations

The static geochemical test results indicate that the CPN and CPS tailings are expected to be PAF, and LP and NPUG tailings are expected to be NAF, and these materials are typically expected to be enriched with B, Co, Cu and Se. The results from the leach column program to-date are consistent with the static geochemical test results and it is recommended that each of the columns is continued for the additional proposed 6 months, with a total leaching period of 48 weeks, at which time the results will be evaluated a final report submitted. The final report will recommend if any of these leach columns should be extended for a further period in order to provide the information required for the environmental approvals and management of these materials.

Appendix A

Leach Column Test Results

Table A1: Chemical composition of leachates from the Savage River Mine Centre Pit North (CPN) tailings sample.

Table A2: Chemical composition of leachates from the Savage River Mine Centre Pit South (CPS) tailings sample.

Table A3: Chemical composition of leachates from the Savage River Mine Long Plain (LP) tailings sample.

Table A4: Chemical composition of leachates from the Savage River Mine North Pit Underground (NPUG) tailings sample.

Table A1: Savage River Centre Pit North (CPN) tailings leach column results.

Parameters	Units	Detect. Limit	Measured Parameters in Leachates							
Collection Number (Week)			**1**	**2**	**4**	**8**	**12**	**16**	**20**	**24**
Volume	ml	1	348	313	453	639	574	259	402	430
pH		0.1	8.5	8.0	7.7	9.1	7.3	7.3	7.5	7.5
EC	dS/m	0.001	3.540	0.535	0.330	0.407	0.577	5.066	4.466	3.479
Alkalinity	mg/l	5	27	22	10	20	6	26	28	33
SO_4	mg/l	0.3	2996.8	283.5	143.9	178.3	290.4	3557.2	3042.8	2639.8
Major Elements										
Al	mg/l	0.01	<0.01	<0.01	<0.01					
B	mg/l	0.01	<0.01	<0.01	<0.01					
Ca	mg/l	0.01	495.72	54.63	33.73	43.31	38.58	360.78	330.60	353.01
Cr	mg/l	0.01	<0.01	<0.01	<0.01					
Cu	mg/l	0.001	0.019	0.004	0.003	<0.001	0.114	0.060	0.034	0.019
Fe	mg/l	0.01	<0.01	<0.01	<0.01					
K	mg/l	0.1	16.1	3.1	1.5					
Mg	mg/l	0.01	371.39	34.68	17.6	23.37	50.33	667.96	564.52	444.02
Mn	mg/l	0.001	0.064	0.013	0.007	0.019	0.074	0.246	0.132	0.105
Na	mg/l	0.1	23.7	2.7	1.4	1.5	2.6	27.2	20.4	15.1
Ni	mg/l	0.001	0.012	0.002	<0.001	0.002	0.016	0.032	0.016	0.012
P	mg/l	0.05	<0.05	<0.05	<0.05					
Si	mg/l	0.05	12.75	3.59	2.46					
V	mg/l	0.01	<0.01	<0.01	<0.01					
Zn	mg/l	0.01	0.04	0.02	0.01	0.02	0.14	0.28	0.16	0.08
Minor Elements										
Ag	µg/l	0.01	0.07	0.03	0.01	0.03	0.07	0.10	0.04	0.03
As	µg/l	0.1	1.1	0.2	0.2	0.3	0.3	0.6	0.6	0.3
Ba	µg/l	0.05	16.41	7.33	4.62	4.66	4.52	17.26	8.90	7.16
Be	µg/l	0.1	<0.1	<0.1	<0.1					
Cd	µg/l	0.02	0.1	0.04	<0.02	<0.02	0.05	0.16	0.14	0.05
Co	µg/l	0.1	5.6	1.1	0.7	1.7	16.6	50.4	27.4	18.2
Hg	µg/l	0.1	<0.1	<0.1	<0.1					
Mo	µg/l	0.05	4.93	0.56	0.33	0.52	0.45	6.18	6.90	6.70
Pb	µg/l	0.5	<0.5	<0.5	<0.5					
Sb	µg/l	0.01	0.25	<0.01	<0.01	0.02	0.02	0.08	0.08	0.09
Se	µg/l	0.5	6.8	1.1	0.6	0.9	2.3	37.0	30.6	19.8
Sn	µg/l	0.1	<0.1	<0.1	<0.1					
Th	µg/l	0.005	<0.005	<0.005	<0.005					
U	µg/l	0.005	0.391	0.029	0.016					
Calculated Results										
SO_4 Release Rate (mg/kg/wk)			521	44	16	14	21	115	153	142
Intrisic Oxidation Rate (kg/kg/sec)			5.0E-10	4.3E-11	1.6E-11	1.4E-11	2.0E-11	1.1E-10	1.5E-10	1.4E-10
CO_3/SO_4 molar ratio			0.89	0.95	1.05	1.10	1.00	0.99	0.99	0.99

Table A2: Savage River Centre Pit South (CPS) tailings leach column results.

Parameters	Units	Detect. Limit	Measured Parameters in Leachates							
Collection Number (Week)			**1**	**2**	**4**	**8**	**12**	**16**	**20**	**24**
Volume	ml	1	291	306	251	481	384	402	460	563
pH		0.1	7.6	7.0	6.7	4.9	6.1	6.7	6.6	6.3
EC	dS/m	0.001	3.764	1.539	1.035	3.692	5.048	6.512	6.840	6.264
Alkalinity	mg/l	5	<5	<5	<5	<5	<5	<5	<5	<5
SO_4	mg/l	0.3	4392.6	1267.7	637.5	3018.7	3659.8	5056.8	5452.2	4857.8
Major Elements										
Al	mg/l	0.01	<0.01	<0.01	<0.01					
B	mg/l	0.01	<0.01	<0.01	<0.01					
Ca	mg/l	0.01	437.27	178.22	126.53	315.12	303.54	235.14	216.50	240.88
Cr	mg/l	0.01	<0.01	<0.01	<0.01					
Cu	mg/l	0.001	0.022	0.006	0.012	2.799	42.426	190.110	317.102	377.276
Fe	mg/l	0.01	<0.01	<0.01	<0.01					
K	mg/l	0.1	9.7	4.4	3.8					
Mg	mg/l	0.01	434.62	130.25	73.15	535.91	710.70	1000.66	1020.26	812.9
Mn	mg/l	0.001	0.081	0.038	0.044	0.777	3.066	7.142	10.050	10.256
Na	mg/l	0.1	17.4	5.6	3.1	14	8.6	4.0	1.6	0.8
Ni	mg/l	0.001	0.024	0.011	0.015	0.325	2.688	7.722	13.132	15.610
P	mg/l	0.05	<0.05	<0.05	<0.05					
Si	mg/l	0.05	4.64	3.35	3.13					
V	mg/l	0.01	<0.01	<0.01	<0.01					
Zn	mg/l	0.01	0.06	0.03	0.04	1.92	25.56	68.40	104.92	115.72
Minor Elements										
Ag	µg/l	0.01	0.15	0.13	0.06	0.05	0.04	0.04	0.06	0.06
As	µg/l	0.1	0.9	0.1	0.4	0.9	0.8	0.6	0.4	0.6
Ba	µg/l	0.05	8.66	3.58	3.7	6.74	7.60	4.86	4.78	2.82
Be	µg/l	0.1	<0.1	<0.1	<0.1					
Cd	µg/l	0.02	0.07	0.06	0.05	0.26	2.10	4.96	8.34	9.52
Co	µg/l	0.1	8.6	3.2	5.1	172.2	2228.4	6643.0	10567.4	12246.6
Hg	µg/l	0.1	0.1	<0.1	<0.1					
Mo	µg/l	0.05	1.83	0.97	0.65	<0.05	<0.05	<0.05	<0.05	<0.05
Pb	µg/l	0.5	<0.5	<0.5	<0.5					
Sb	µg/l	0.01	0.23	0.05	0.01	0.05	<0.01	0.10	0.04	0.04
Se	µg/l	0.5	7.6	2.5	1.5	25.8	53.0	100.0	107.4	93.6
Sn	µg/l	0.1	<0.1	<0.1	<0.1					
Th	µg/l	0.005	<0.005	<0.005	<0.005					
U	µg/l	0.005	0.043	0.014	<0.005					
Calculated Results										
SO_4 Release Rate (mg/kg/wk)			639	194	40	181	176	254	314	342
Intrisic Oxidation Rate (kg/kg/sec)			6.2E-10	1.9E-10	3.9E-11	1.7E-10	1.7E-10	2.4E-10	3.0E-10	3.3E-10
CO_3/SO_4 molar ratio			0.63	0.74	0.93	0.95	0.97	0.89	0.84	0.78

Table A3: Savage River Long Plains (LP) tailings leach column results.

Parameters	Units	Detect. Limit	Measured Parameters in Leachates							
Collection Number (Week)			**1**	**2**	**4**	**8**	**12**	**16**	**20**	**24**
Volume	ml	1	260	252	145	327	306	373	350	409
pH		0.1	8.7	8.4	7.8	9.2	8.5	8.2	8.3	8.2
EC	dS/m	0.001	0.821	0.172	0.280	1.842	1.197	1.529	1.543	1.174
Alkalinity	mg/l	5	42	39	43	39	49	45	62	60
SO_4	mg/l	0.3	425	39.1	70	1116.9	634.4	892.3	884.7	616.5
Major Elements										
Al	mg/l	0.01	<0.01	0.01	<0.01					
B	mg/l	0.01	<0.01	0.01	<0.01					
Ca	mg/l	0.01	82	19.68	28.51	224.63	132.24	183.83	180.7	123.37
Cr	mg/l	0.01	<0.01	<0.01	<0.01					
Cu	mg/l	0.001	0.004	<0.001	0.003	0.026	0.026	0.038	0.018	0.02
Fe	mg/l	0.01	<0.01	0.02	0.02					
K	mg/l	0.1	15.5	4.1	4.2					
Mg	mg/l	0.01	52.15	7.05	10.46	137	82.84	113.21	117.94	86.59
Mn	mg/l	0.001	0.045	0.005	0.009	0.079	0.048	0.052	0.068	0.05
Na	mg/l	0.1	15.9	1.8	2	26	14.4	17.6	15.5	10.4
Ni	mg/l	0.001	0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
P	mg/l	0.05	<0.05	<0.05	<0.05					
Si	mg/l	0.05	5.61	3.39	3.36					
V	mg/l	0.01	<0.01	<0.01	<0.01					
Zn	mg/l	0.01	0.01	0.03	0.02	0.02	0.02	0.02	0.02	0.01
Minor Elements										
Ag	µg/l	0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.02	0.04	<0.01
As	µg/l	0.1	0.4	0.2	0.3	0.5	0.4	0.4	0.5	0.3
Ba	µg/l	0.05	15.33	11.52	18.99	89.23	41.69	59.62	41.73	24.64
Be	µg/l	0.1	<0.1	<0.1	<0.1					
Cd	µg/l	0.02	<0.02	<0.02	<0.02	0.02	0.05	0.05	0.04	<0.02
Co	µg/l	0.1	0.1	<0.1	<0.1	0.6	0.4	0.4	0.3	0.4
Hg	µg/l	0.1	<0.1	<0.1	<0.1					
Mo	µg/l	0.05	2.54	0.35	0.64	9.73	6.88	9.29	8.63	7.16
Pb	µg/l	0.5	<0.5	<0.5	<0.5					
Sb	µg/l	0.01	0.31	0.12	0.13	0.39	0.24	0.24	0.23	0.16
Se	µg/l	0.5	0.9	<0.5	<0.5	3.4	3.1	3.0	2.7	2.6
Sn	µg/l	0.1	<0.1	<0.1	<0.1					
Th	µg/l	0.005	<0.005	<0.005	<0.005					
U	µg/l	0.005	0.144	0.009	0.029					
Calculated Results										
SO_4 Release Rate (mg/kg/wk)			55	5	3	46	24	42	39	32
Intrisic Oxidation Rate (kg/kg/sec)			5.3E-11	4.7E-12	2.4E-12	4.4E-11	2.3E-11	4.0E-11	3.7E-11	3.0E-11
CO_3/SO_4 molar ratio			0.95	1.92	1.57	0.97	1.02	1.00	1.02	1.04

Table A4: Savage River North Pit Underground (NPUG) tailings leach column results.

Parameters	**Units**	**Detect. Limit**	**Measured Parameters in Leachates**							
Collection Number (Week)			**1**	**2**	**4**	**8**	**12**	**16**	**20**	**24**
Volume	ml	1	322	256	393	421	379	300	348	342
pH		0.1	8.5	7.7	7.7	8.7	8.6	8.0	8.2	8.0
EC	dS/m	0.001	3.071	0.793	0.645	2.239	1.550	3.346	3.386	2.976
Alkalinity	mg/l	5	19	18	19	50	32	42	52	47
SO_4	mg/l	0.3	2527.7	427.9	306.1	1527.3	929.4	2622.9	2566.9	2186.7
Major Elements										
Al	mg/l	0.01	<0.01	<0.01	<0.01					
B	mg/l	0.01	0.18	0.03	0.02					
Ca	mg/l	0.01	591.26	143.46	118.88	341.95	242.48	392.33	357.49	376.32
Cr	mg/l	0.01	<0.01	<0.01	<0.01					
Cu	mg/l	0.001	0.002	<0.001	0.002	0.010	0.002	0.914	0.399	0.786
Fe	mg/l	0.01	<0.01	<0.01	0.01					
K	mg/l	0.1	3.7	0.6	0.4					
Mg	mg/l	0.01	215.65	24.11	13.28	185.71	99.84	412.07	444.76	326.67
Mn	mg/l	0.001	0.007	0.006	0.007	0.092	0.026	0.100	0.069	0.068
Na	mg/l	0.1	7.6	0.9	0.4	3.7	1.8	5.8	6.2	4.0
Ni	mg/l	0.001	0.003	<0.001	<0.001	0.002	<0.001	0.043	0.026	0.043
P	mg/l	0.05	<0.05	<0.05	<0.05					
Si	mg/l	0.05	5.23	1.94	1.99					
V	mg/l	0.01	<0.01	<0.01	<0.01					
Zn	mg/l	0.01	0.01	0.02	0.01	0.02	0.01	0.36	0.15	0.27
Minor Elements										
Ag	µg/l	0.01	0.11	0.05	<0.01	0.05	<0.01	0.04	<0.01	<0.01
As	µg/l	0.1	0.7	<0.1	0.2	0.6	0.4	0.3	0.4	0.3
Ba	µg/l	0.05	20.03	15.43	15.22	18.19	13.47	21.16	13.00	17.44
Be	µg/l	0.1	<0.1	<0.1	<0.1					
Cd	µg/l	0.02	0.08	0.02	0.03	0.1	0.06	0.15	0.10	0.10
Co	µg/l	0.1	0.4	0.2	0.2	2.2	0.6	35.0	16.9	28.8
Hg	µg/l	0.1	0.2	<0.1	<0.1					
Mo	µg/l	0.05	1.94	0.25	0.15	2.66	1.47	4.54	5.56	4.62
Pb	µg/l	0.5	<0.5	<0.5	<0.5					
Sb	µg/l	0.01	1.47	0.12	0.23	0.65	0.37	0.69	0.56	0.55
Se	µg/l	0.5	1.7	<0.5	<0.5	3.2	2.5	11.4	14.7	12.2
Sn	µg/l	0.1	<0.1	<0.1	<0.1					
Th	µg/l	0.005	<0.005	<0.005	<0.005					
U	µg/l	0.005	0.071	0.012	0.009					
Calculated Results										
SO_4 Release Rate (mg/kg/wk)			407	55	30	80	44	98	112	93
Intrisic Oxidation Rate (kg/kg/sec)			3.9E-10	5.3E-11	2.9E-11	7.7E-11	4.2E-11	9.5E-11	1.1E-10	9.0E-11
CO_3/SO_4 molar ratio			0.90	1.03	1.10	1.02	1.05	0.98	1.02	1.00

Kinetic Trials, Savage River Mine, Tasmania, Final Report for Grange Resources (The University of Queensland, 2022)

Appendix E

pitt&sherry

Sustainable Minerals Institute

Kinetic trials, Savage River mine, Tasmania

Final Report for Grange Resources

Reporting Date: 31/05/2022

The project information contained in this report is confidential and must be handled in accordance with the Agreement between the parties.

Ranked in the world's top 50[1], The University of Queensland (UQ) is one of Australia's leading research and teaching institutions. UQ strives for excellence through the creation, preservation, transfer and application of knowledge. For more than a century, we have educated and worked with outstanding people to deliver knowledge leadership for a better world.

The Sustainable Minerals Institute (SMI) is a world-leading research[2] institute committed to developing knowledge-based solutions to the sustainability challenges of the global resource industry, and to training the next generation of industry and community leaders.

The Institute is transdisciplinary, and our work is independent, impartial and rigorous. Our research integrates the expertise of production, environmental and social science specialists to deliver responsible resource development.

Demand for minerals and the secure supply of resources worldwide is increasing. At SMI we are training the people and developing transformative approaches and technologies to ensure sustainability for the future.

SMI is made up of six research centres and a Centre of Excellence based in Chile. We have a strong track record across all areas of mining - in exploration, mining, mineral processing, workplace health and safety, mine rehabilitation, water and energy, social responsibility, and resource governance.

Our core business is deeply rooted in the minerals industry and our researchers have experience working across the sector to support industry, governments, communities and civil society through analysis and thought leadership.

We offer future focused professional development and customise courses to suit industry trends or company needs. We supervise Higher Degree by Research students and are proud that many of our alumni are now in influential roles in resource companies, non-government and government organisations around the world.

The project management methodology to be used for this research project is SMI's Project Management Framework. This is a lifecycle based approach which provides internal controls to ensure that deliverables are delivered to time, cost and quality specifications. Delivery is managed in accordance to agreed milestones, risks are managed and issues resolved promptly, status is reported internally as well as to the funding sponsor regularly. SMI prides itself on not just delivering technically excellent products that meet your specification, but also delivering this in line with international best practice project management, based on the Project Management Body of Knowledge.

W.H.Bryan Mining & Geology Research Centre

The W.H.Bryan Mining & Geology Research Centre has a reputation for practical innovation and leadership in geology applied to the entire mining value chain. With a diverse range of geoscientific and related expertise, the Centre is focused on delivering industrial research solutions for active and future mines. It does this by developing new and improved methods for mineral discovery, total deposit knowledge and predictive understanding of ore bodies.

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[1] QS World University Rankings and the Performance Ranking of Scientific Papers for World Universities (2019)

[2] The University of Queensland is ranked third in the world for mining and mineral engineering, 2018 Shanghai Rankings by subject

Contents

Glossary

ANC:	*acid neutralising capacity (kg H_2SO_4/t)*
AF:	*acid forming*
NAF:	*non-acid forming*
UC:	*uncertain*
MPA:	*maximum potential acidity (kg H_2SO_4/t)*
NAPP:	*net acid producing potential (kg H_2SO_4/t)*
NAG:	*net acid generation (kg H_2SO_4/t) (NB. NAG pH is a separate measurement)*

1. Introduction

1.1 Project background

Grange Resources are the largest iron-ore producer in Tasmania located 100 km southwest of Burnie (where its main office is located) in Tasmania's northwest (Figure 1a). With a life-of-mine currently until 2034, Grange Resources plan to increase annual iron ore pellet production to 2.7 Mt per annum. The mine comprises three principal open cut pits- North, Centre and South (Figure 1b) where magnetite lenses are oriented N-S over a 4 km strike.

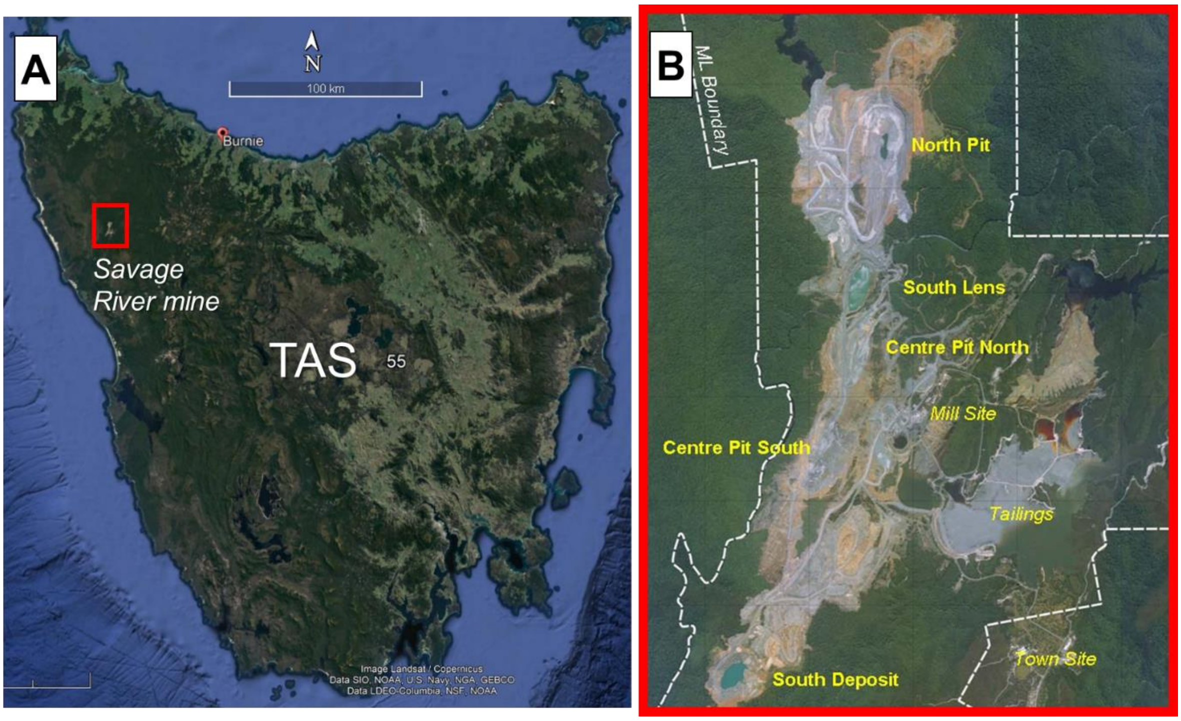

Figure 1. *A) Location of Savage River mine, Tasmania; B) Savage River mine 3 principle open cut and tailings dams (OTD and MCTD).*

To sustain increased production, new opportunities to extend operations are being evaluated. In this project, North Pit is the focus where Grange Resources are considering further development. As part of their Environment Impact Statement in the current prefeasibility study on Block Caving in North Pit, Grange Resources are seeking to define what the metal concentrations in water pumped from sumps at the bottom of the cave to surface will be (i.e., meteoric and ground water passing through magnetite and sulphide-rich materials).

1.2 Project aims and objectives

The scope of work includes three components:

1) Set-up and maintain AMIRA Column leach cells (5) for block cave materials from North Pit. The pH and EC of these columns will be recorded weekly and monthly leachates (i.e., metals, sulphate) will be collected and analysed by solution ICPMS methods.

2) Collection of mineralogical data (XRD and MLA) pre- mid- and post column testing to provide a snapshot of the mineralogy assisting with the interpretation of the leachate chemistry data.

3) Interpret the leachate column data and compare the kinetic data results with static testing results (collected separately by an external laboratory as organised independently by Grange Resources) on the feed materials.

Specifically, the following will be addressed:

- Comparison of water chemistry results against Australian guideline values to understand the AMD risk and future leachate quality assisting with future water management.
- Identify if there are intermediate mineral reaction products being formed during the mining process which are enhancing, or limiting, sulphide oxidation in PAF materials impacting on the water chemistry.

Limitations: Outcomes and recommendations of this project are dependent on the time frame of the kinetic trials (i.e., based on the observation of laboratory weathering for ~12 months).

It was agreed that on completion Grange Resources will be provided with a final report describing the total metal concentration within water that will follow through the cave column and to better understand if the water being pumped to surface will need to be treated before it is discharged into South Lens.

***Table 1**: Details of the SMI project team.*

Name/ Organisation	Expertise	Role in project
A/Prof. Anita Parbhakar-Fox *Principal Research Fellow* *BRC-SMI, UQ*	Environmental Geochemistry/ Waste Characterisation	Project manager
Dr Laura Jackson *Research Fellow* *BRC-SMI, UQ*	Environmental Geochemistry/ Waste Characterisation	Set up and maintenance of the columns
Dr Nathan Fox *Senior Research Fellow* *BRC-SMI, UQ*	Geology/ Geometallurgy	Maintenance of the columns

1.3 Provided data

To meet the objectives of the project the following terms and data to be provided to UQ were agreed upon:

- Material (25L x 5 crushed samples to -4 mm from North Pit) from within a designed Block Cave Column, mainly the mineralised envelope (UQ MSDS sheets to accompany sample entry to the campus)
- Geochemical data collected on the North Pit waste materials
- Geological logs and access to the North Pit geological data base
- Static ABA data collected on similar North Pit materials
- Regular communication with Emily McPhee and Tony Ferguson

Despite this list, no additional data was provided to the project team (geochemical data, logs, static data) that corresponds to the origin of these tested samples. A review of North Pit data and a geoenvironmental review was provided to Tony Ferguson in June 2020 and information from this report will not be presented in this report. However, information from it may be referred to assist with data interpretation.

2. Materials and methods

2.1 Column setup

Following discussions with Emily McPhee in late 2020, 5 x 25L buckets of coarse materials (- 4 mm) were sent to UQ and arrived in early 2021. Given the materials safety data sheets reported the presence of asbestiform minerals a new standard operating procedure had to be introduced at the UQ geoenvironmental testing laboratory with the risks around exposure to asbestiform minerals well managed. Once risk assessment approval had been gained from the OHS Manager at the Sustainable Minerals Institute and indeed, the Institute Director, the columns were set up in March 2021. As agreed with Grange Resources, the samples had to be sent to UQ already portioned to go into the Buchner Funnels. A 5-step sample preparation methodology was then followed:

- **Step 1:** Weighed 2kg sample of 6.7mm rock chips into zip lock bag (Figure 2a)
- **Step 2:** Cover rock chip sample with deionised water (Figure 2a)
- **Step 3:** Placed sample in a second zip lock bag
- **Step 4**: Place doubled zip lock bags into RC green sample bag (*these steps were then repeated for the 1 kg sample required for mineral analysis)*
- **Step 5**: Bagged samples placed in 20 litre bucket (Figure 2a)
- **Step 6:** Buckets sealed and taped.

On arrival at SMI-UQ the samples were carefully placed into each column (with clean Buchner funnel's and a new wooden stand made to the AMIRA P387A Handbook specification (Figure 3).

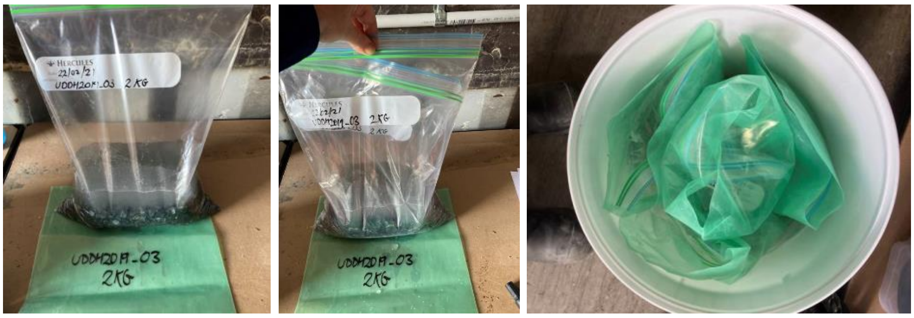

Figure 2. *Sample preparation undertaken by Grange Resources.*

Figure 3. *Setup of the kinetic leach cells at the UQ geoenvironmental laboratory.*

2.2 Bulk mineralogy

2.2.1 Sample preparation

Sub-samples were accurately weighed and specimens prepared for X-ray diffraction analysis by the addition of a corundum (Al_2O_3) internal standard at 20 wt. %. The specimens were micronised in a McCrone mill using zirconia beads and ethanol, then dried in an oven overnight at 40 °C. The resultant homogenous powders were back-pressed into sample holders.

A small portion of the crushed samples were dispersed in water. After sonication (5 min) and settling for 5 min, the fine fraction (nominally < 5 μm in suspension) was transferred via pipette to a low background plate and allowed to settle and dry (these samples have the label N in this report). This preparation is used to concentrate the fine (clay dominant) fraction and aids identification of the clays present. This means ratios of the clays and other phases present in this extract may vary from the bulk sample: the fine fraction result is qualitative. The air-dried slides were further treated in an ethylene glycol atmosphere (60 °C) for several hours, then immediately re-examined.

2.2.2 Sample analysis

Step scanned X-ray diffraction patterns were collected for an hour per sample using a Bruker D8 Advance powder diffractometer and cobalt Kα radiation operating in Bragg-Brentano geometry. The collected data was analysed using JADE (V2010, Materials Data Inc.), EVA (V5, Bruker) and X'Pert Highscore Plus (V4, PANalytical) with various reference databases (PDF4+, AMCSD, COD) for phase identification. Rietveld refinement was performed using TOPAS (V6, Bruker). The known addition of corundum facilitates reporting of absolute phase abundances for the modelled phases. The sum of the absolute abundances is subtracted from 100 wt. % to obtain a residual (called non-diffracting/unidentified, also known as "amorphous"). The residual represents the unexplained portion of the pattern: it may be non-diffracting content but will also contain unidentified phases and the error from poorly modelled phases. It is the least accurate measure as its error is the sum of the errors of the modelled phases. The estimated uncertainties in the reported phase abundances are 20 wt.% relative or better for every modelled phase. Due to propagation of errors the uncertainty in the amorphous (non-diffracting/unidentified) content is higher at approximately 30 wt. % relative. The detection limit using the described method is approximately 0.5 – 1 wt. % depending on the phase in question and sample matrix. In general, clay phases (e.g., kaolinite) have higher detection limits and more uncertainty than non-clay phases (e.g., quartz).

Powder X-ray diffraction is bulk phase analysis, it is not bulk chemical analysis or trace phase analysis. Phase abundances may be mis-estimated if an incorrect chemical formula is assigned to a phase. Therefore, the closest matches in the reference phase identification databases were used in the Rietveld refinement model, but other members of the identified mineral groups may be present.

2.3 Insitu mineralogy

Automated mineralogy tools such as the mineral liberation analyser (MLA), Quantitative Evaluation of Minerals by SCANning electron microscopy (QEMSCAN) and the Tescan TIMA uniquely combine back scattered electron (BSE) image analysis, X-ray mineral identification and advanced imaging and pattern recognition analysis to produce classified mineralogy outputs (Parbhakar-Fox and Lottermoser, 2015). Primary applications of these technologies have been to collect modal mineralogy data through point counting methods, and to characterise target mineral phases in terms of their size, shape, liberation characteristics and mineral associations. It was in this context that these samples were studied with a focus on sulfides and iron oxides, as potentially, these were the most likely Co-bearing phases. The 10 most Cu-Co endowed samples were studied.

Given UQ's concerns with asbestiform minerals potentially being present, the mounts were prepared at the AST Laboratory in Perth, WA. One sample per column was prepared only. When set in resin, they were considered 'low-risk'. The selected samples (n=5) were analysed at the Sustainable Minerals Institute, University of Queensland JKMRC MLA lab. Prior to analyses the samples were carbon coated. GXMAPing was used to differential between pyrite and iron oxide. This method employs X-ray mapping to the phases that cannot be segmented by BSE grey levels alone and the employs the faster area X-ray analysis for phases that are readily segmented. The operator selects the grains for mapping through a BSE trigger or a specific X-ray standard trigger. Fig. 8 illustrates the advantages of the selective mapping of GXMAP over traditional X-ray mapping for the example of a particle containing pentlandite, chalcopyrite and quartz. A BSE trigger set at a grey level below that of pentlandite and chalcopyrite ensures that all grains of interest are mapped, saving. A site-specific mineral reference library was developed for these samples.

2.4 Water chemistry

The methodology for the free draining kinetic leach cells followed the AMIRA P387A Handbook (Smart et al., 2002). The pH and EC of the leachates were monitored weekly, and the leachate was collected every month and sent to ALS Global for measurement of the chemistry (Method Codes: EA015, EA025, ED037P, ED038, ED041G, ED093F, EG020F, EN055).

3. Results

3.1 Column feed mineralogy

The bulk mineralogy of the feed material is summarised in Table 2. All columns are dominated by magnetite (average: 34 wt. %), amphibole (average: 11.5 wt. %) and chlorite (average: 11 wt. %) though a high content of amorphous material was identified in all columns (average: 15.6 wt. %). The carbonate abundance was relatively low with average calcite (identified in 3 columns only) measured at 1.3 wt. % and lesser dolomite (average: 0.5 wt. %). Pyrite was identified in all columns with an average of 1.5 wt. % reported. No chalcopyrite was identified by XRD. Based on these data, the columns would be predicted as acid forming.

***Table 2**: Bulk mineralogy of column feed materials by XRD.*

	Column 1	Column 2	Column 3	Column 4	Column 5
Quartz			0.2		
Ilmenite	2.2		2.7		
Magnetite	47.9	28.9	49.9	22.2	22.3
Pyrite	2.3	1.4	1.1	1.6	1.3
Calcite		1.6		0.5	1.8
Dolomite	0.8		0.6	0.2	0.5
Anhydrite				1.3	
Gypsum				1.6	
Amphibole	8.6	12.5	2.3	16.4	18.0
Plagioclase	6.1	4.9	2.7	15.2	10.4

K-Feldspar	1.9	2.0	1.6	1.7	3.0
Serpentine	8.0	8.0	10.1	4.4	6.6
Kaolinite	2.3	2.1	2.8	1.8	1.3
Chlorite / clinochlore	8.3	14.8	6.3	12.3	12.4
Illite/mica	1.0	1.8	0.7	4.4	3.8
Talc	0.4	3.2	1.0	2.5	1.5
Amorphous	10.3	18.6	18.1	13.8	17.2

3.2 Insitu mineralogy

The insitu mineralogy is indicative only as only 1 sample per column was studied. of the feed material is summarised in Table 3 and Figures 4 to 6. The major minerals (Figure 4) were dominated by magnetite (termed FeOxide) continues to dominate (range: 16 to 42 wt. %) followed by amphibole/pyroxene (range: 7 to 38 wt. %), and chlorite (9 to 37 wt. %). Epidote was identified in Column 3 only (6 wt. %) and pyrite was highly variable (< 1 wt. % in Column 3, 23 wt. % in Column 1). The minor minerals were dominated by dolomite in column 1 (6 wt. %) whilst ilmenite and talc were identified in most columns (Figure 5). The trace minerals (Figure 6) were dominated by calcite and titanite. Overall, with the exception of column 3, these materials would be expected to be acid forming as the abundance of pyrite far exceeds the neutraliser content. Considering this, pyrite mineral parameters were investigated further. The pyrite particle size in Column 3 and 4 is notably finer than the others (*p80* of < 400 µm; Figure 7 and Table 4).

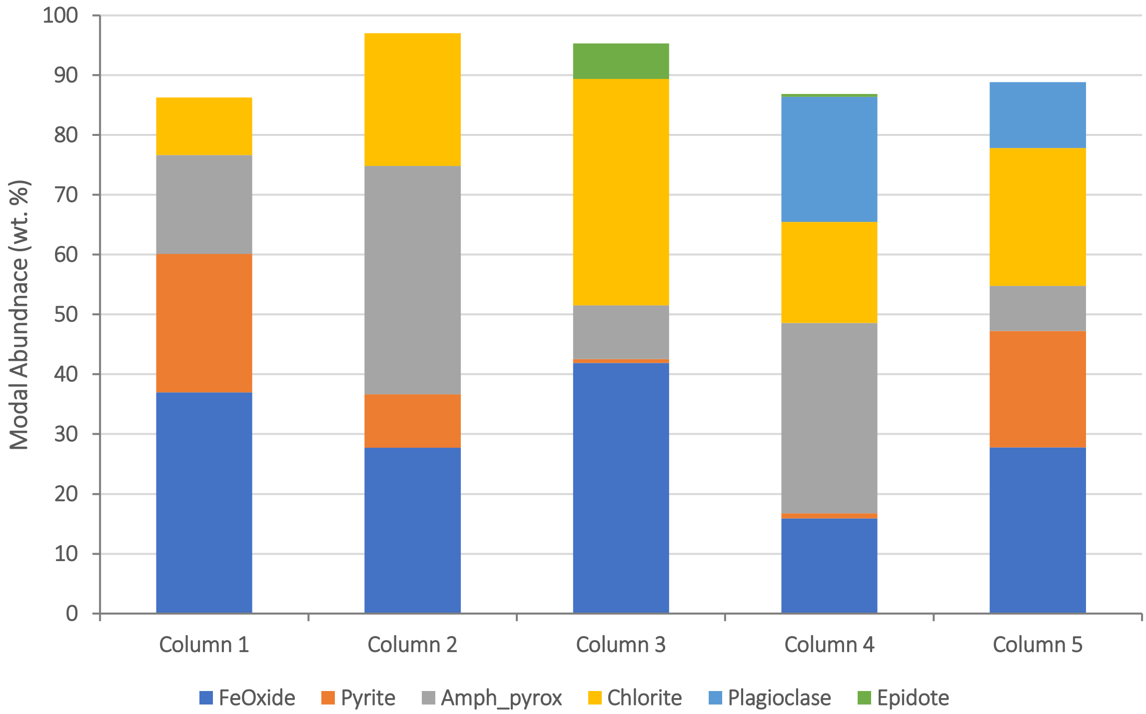

Figure 4. *Major minerals - Column Feed (wt. %) determined by MLA.*

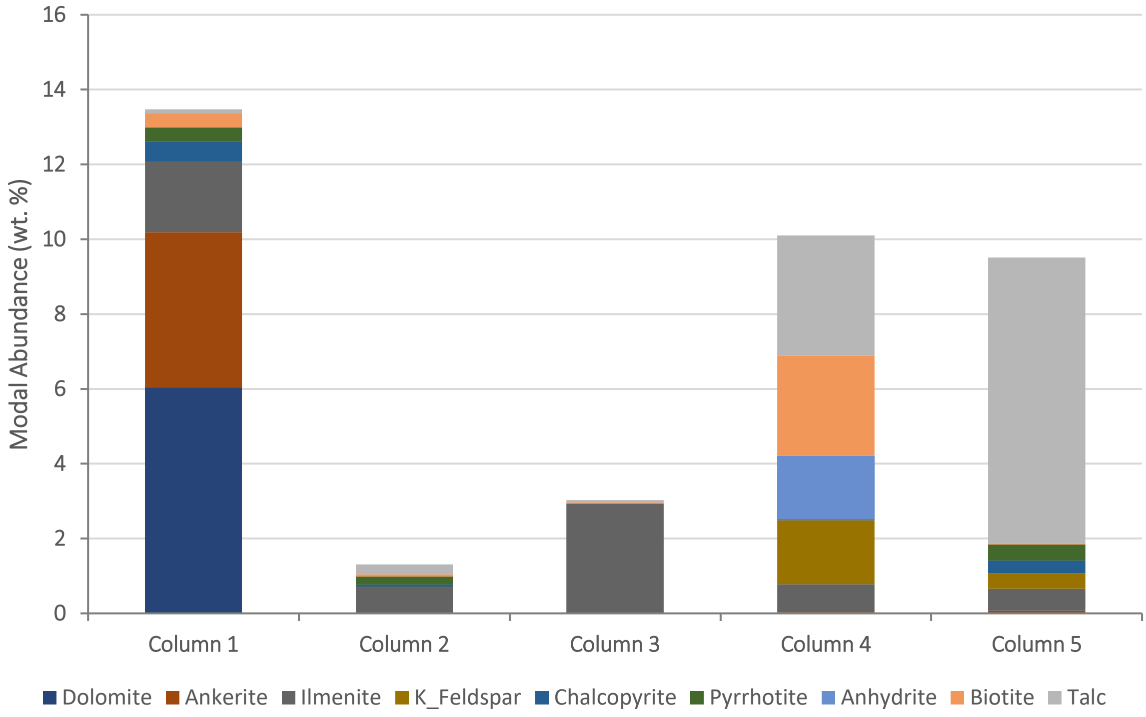

Figure 5. *Minor minerals - Column Feed (wt. %) determined by MLA.*

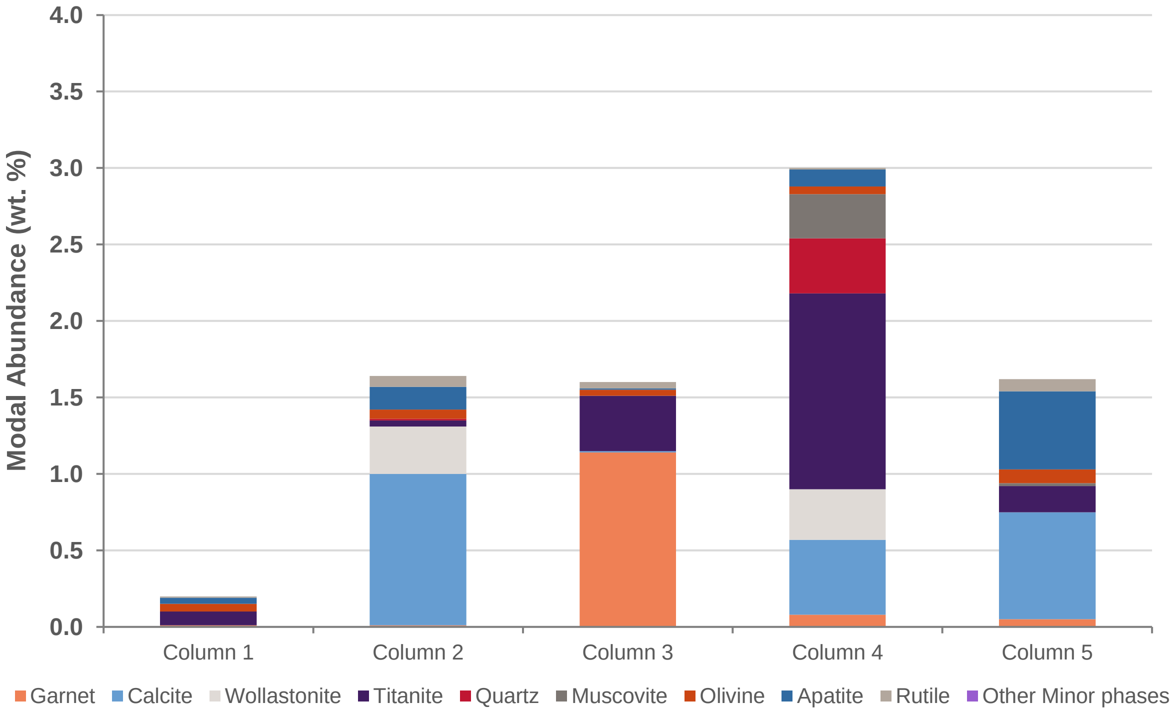

Figure 6. *Trace minerals - Column Feed (wt. %) determined by MLA.*

***Table 3**: Bulk mineralogy of column feed materials by MLA.*

	Column 1	Column 2	Column 3	Column 4	Column 5
FeOxide	36.98	27.73	41.88	15.92	27.79
Pyrite	23.17	8.93	0.67	0.87	19.47
Amph_pyrox	16.51	38.16	8.97	31.77	7.52
Chlorite	9.63	22.21	37.88	16.93	23.05
Plagioclase	0.00	0.00	0.00	20.89	11.00
Epidote	0.00	0.00	5.93	0.48	0.00
Dolomite	6.03	0.00	0.00	0.00	0.00
Ankerite	4.16	0.02	0.00	0.03	0.07
Ilmenite	1.89	0.70	2.93	0.75	0.59
K_Feldspar	0.00	0.00	0.00	1.71	0.42
Chalcopyrite	0.53	0.05	0.00	0.01	0.33
Pyrrhotite	0.38	0.21	0.00	0.01	0.43
Anhydrite	0.00	0.00	0.00	1.70	0.00
Biotite	0.37	0.06	0.04	2.68	0.02
Talc	0.11	0.27	0.06	3.21	7.65
Garnet	0.01	0.01	1.14	0.08	0.05
Calcite	0.00	0.99	0.01	0.49	0.70
Wollastonite	0.00	0.31	0.00	0.33	0.00
Titanite	0.09	0.04	0.36	1.28	0.17
Quartz	0.00	0.01	0.00	0.36	0.00
Muscovite	0.00	0.00	0.00	0.29	0.02
Olivine	0.05	0.06	0.04	0.05	0.09
Apatite	0.04	0.15	0.01	0.11	0.51
Rutile	0.01	0.07	0.04	0.01	0.08
Other Minor phases	0.00	0.00	0.03	0.04	0.03

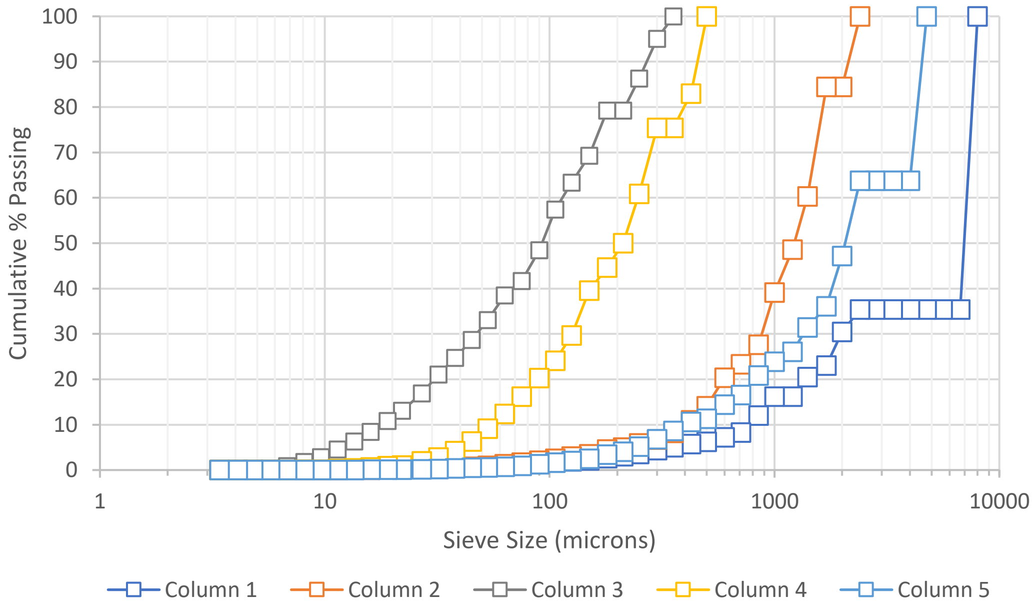

***Figure 7.** Pyrite mineral particle size distribution.*

Table 4: Pyrite particle size distribution.

	P80_microns	P70_microns	P60_microns	P50_Microns
Column 1	7,597	7,396	7,195	6,994
Column 2	1,645	1,521	1,397	1,272
Column 3	216	162	108	53
Column 4	397	305	213	120
Column 5	4,336	4,129	3,921	3,714

Pyrite mineral associations are shown in Figure 8 and Figure 9. In Column 1, only 2.29 % of pyrite is considered 'free surface' (broadly liberated). Where locked, it associates with magnetite (25%), amphibole (25%) and chlorite (22%). This is similar for Column 2 where 7.1 % is considered free surface so more reactive. Approximately 40.3 % of pyrite associated with amphibole/pyroxene; and 5.5 % with calcite. In Columns 3 and 4, with the smaller *p80,* pyrite has lowest free surface (due to armouring by mineral associations – Column 3 – 91 % of pyrite is associated with chlorite). In Column 4, 18.3 % of pyrite is associated with chlorite (46.9 % of fine-grained pyrite is associated with plagioclase). In Column 5 approximately 2.25% of pyrite is classified as free surface (like Column 1). Here the dominant associations are with biotite (unlike all other columns) and with other sulfides (pyrrhotite, chalcopyrite) and only minor calcite (Figure 8). This suggests material in this column could be more reactive due to galvanic interactions between sulphides (Parbhakar-Fox and Lottermoser, 2015).

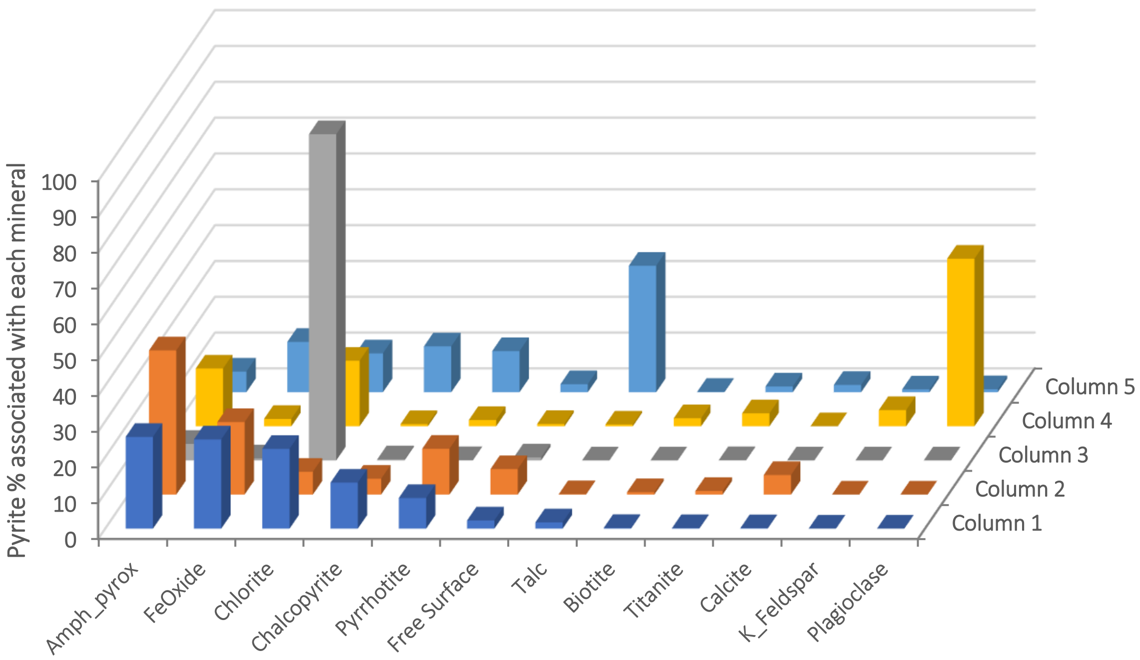

***Figure 8.** Pyrite mineral associations measured by MLA (n=5).*

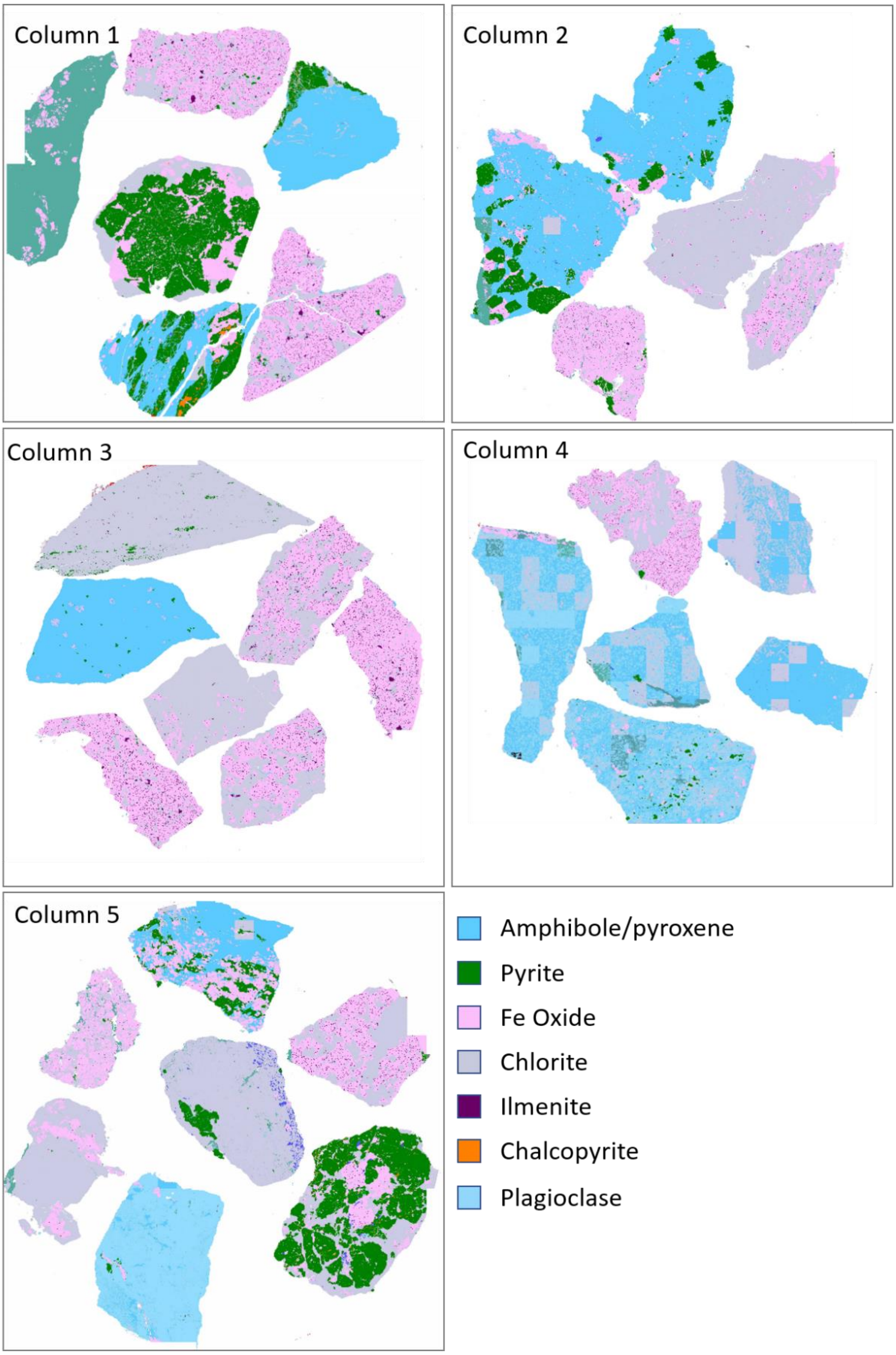

Figure 9. *Classified mineralogy map of the MLA mapped grains from each column, with major minerals only shown.*

3.3 Water quality parameters

The results up to week 46 are shown in the following graphs (noting gaps due to Brisbane floods and COVID-19 shutdowns). The pH range for the columns was circumneutral (Column 1- avg: pH 6.31; Column 2- pH 6.47; column 3- pH 6.48; column 4: pH 6.46; column 5: pH 6.72). In the 46-week period, the pH appears reasonably stable until week 20; between weeks 20 and 34 it appears to drop and then increase, and then towards the end of the experiment, pH values appear similar to those in the first 10 weeks (Figure 10). EC values for all but Column 4 appear to be similar (Figure 11) and are < 350 µs/cm. Alkalinity values for Column 1 is the highest but decreases over time to 10 mg/L (Figure 12). Acidity is measured between 2-7 mg/L for all columns except 2 which showed two significant fluctuations (week 16 and 26) twice during the 46 weeks (Figure 13). Chloride values were low (< 1 mg/L) except for in the final water measurement (Figure 14). However, it is suspected that potentially this may be erroneous (i.e., longer residence time in the lab before measurement at ALS, and potentially the bottle may not have been pre-acidified sufficiently). Sulphate decreases over the 46 weeks (Figure 15), with Column 4 reporting the highest values. Integrating these observations with the insitu mineralogy shows that the locked nature of pyrite (with magnetite, amphibole/pyroxene) is significant at retarding AMD formation, which based on the bulk mineralogy, could be expected longer term.

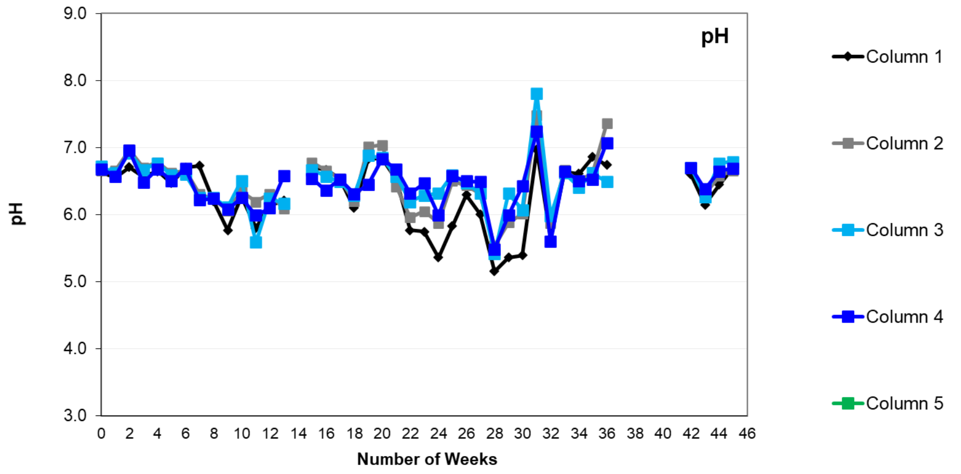

Figure 10. *Leachate pH measured for 46 weeks.*

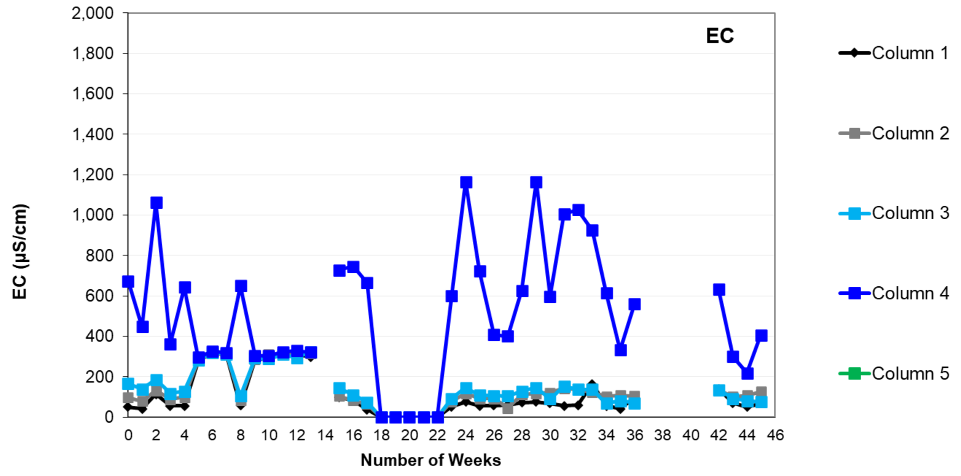

Figure 11. *Leachate EC measured for 46 weeks.*

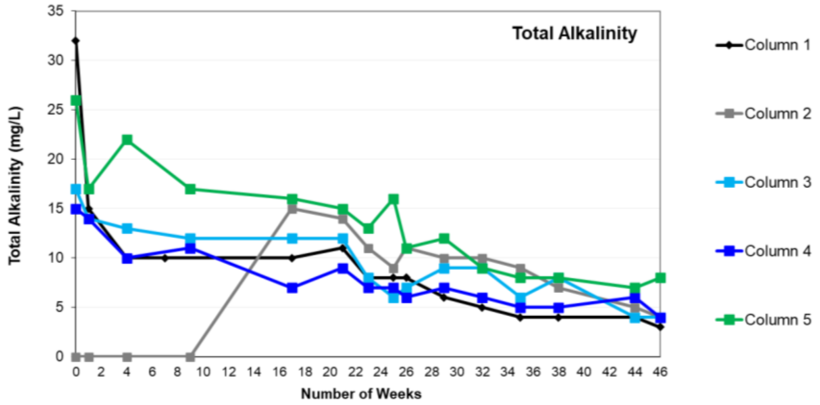

Figure 12. *Total alkalinity measured in leachate for 46 weeks.*

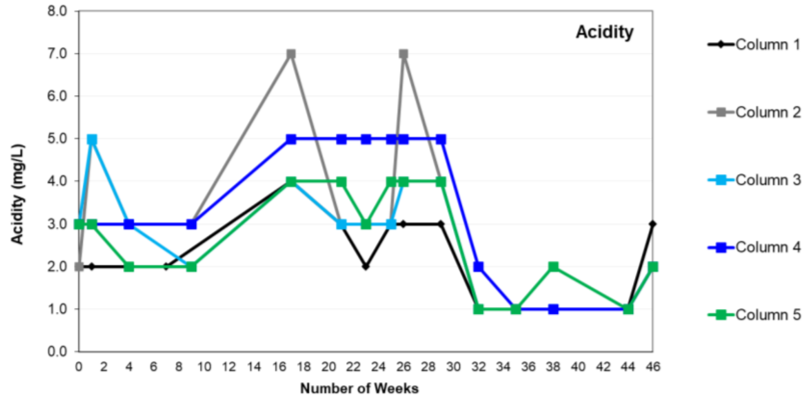

Figure 13. *Total acidity measured in leachate for 46 weeks.*

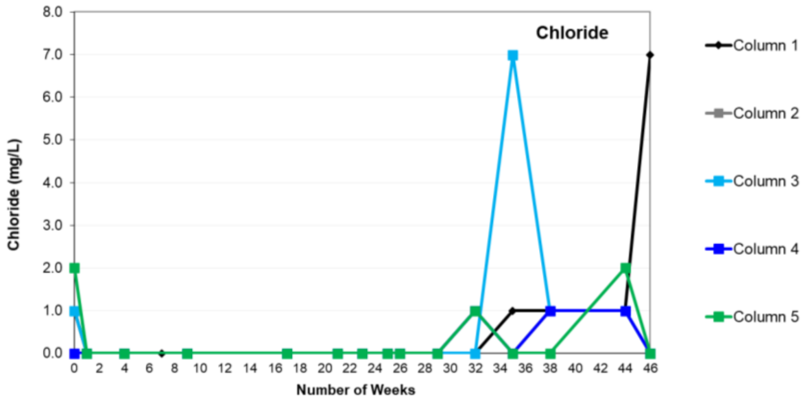

Figure 14. *Chloride measured in leachate for 46 weeks.*

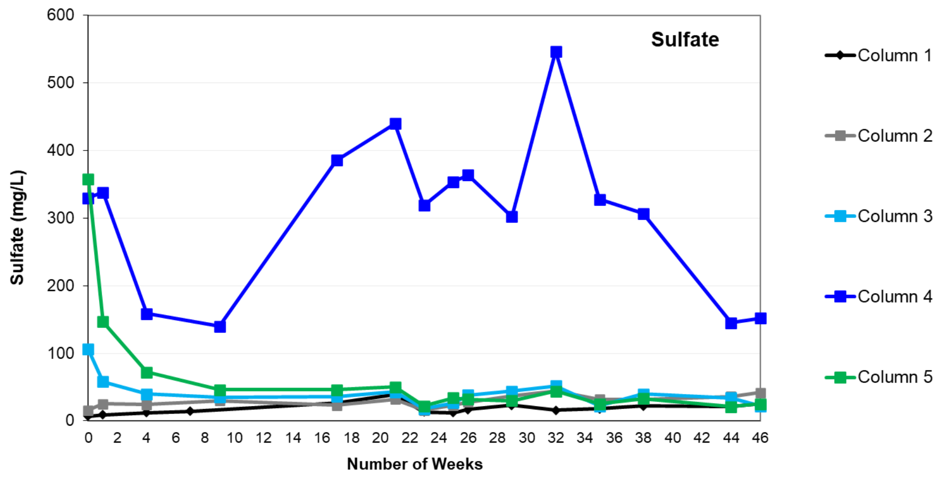

Figure 15. *Sulfate measured in leachate for 46 weeks.*

3.4 Metals

ANZECC (2000) 80% water quality protection guidelines and Livestock Drinking Water Levels (Irrigation Levels used for Fe and Mn) were used to screen these data. For Column 1, Ba, Cr, Fe, Mn, Mo and Ni are below guidelines (Table 5). Copper, Zn and Ni all reported 2, 4 and 1 elevated values relative to ANZECC (2000) freshwater 90% protection levels and livestock drinking water values (Table 5).

Table 5*: Column 1: Metals screened against ANZECC (2000) guidelines.*

Trace metals/ metalloids (mg/L)	LoR	95 % Protection	90 % Protection	80 % Protection	Livestock drinking water	0	1	4	7	17	21	23	25	26	29	32	35	38	44	46
Ba	0.001	---	---	---	---	0.012	0.01	0.007	0.006	0.007	0.01	0.004	0.01	0.01	0.009	0.007	0.005	0.007	0.004	0.009
Co	0.001	*0.0014*	*0.0014*	*0.0014*	---											0.001	0.001	0.002	<0.001	
Cr	0.001	*0.0033*	*0.0033*	*0.0033*	*1*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Cu	0.001	*0.0014*	*0.0018*	*0.0025*	*0.4*	<0.001	<0.001	0.004	0.002	0.005	0.004	0.003	<0.001	0.001	0.004	0.004	0.004	0.012	0.006	0.004
Fe	0.05	---	---	---	*1*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.39
Mn	0.001	*1.9*	*2.5*	*3.6*	---	0.016	0.008	0.004	0.004	0.004	0.007	0.003	0.003	0.011	1.03	0.038	0.02	0.118	0.081	0.005
Mo	0.001	*0.034*	*0.034*	*0.034*	*0.034*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni	0.001	*0.011*	*0.013*	*0.017*	*1*	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pb	0.001	*0.0094*	*0.0056*	*0.0034*	*0.01*	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	<0.001	<0.001	0.004	0.003	<0.001
Zn	0.005	*0.008*	*0.015*	*0.031*	*20*	0.018	0.069	0.019	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	0.107	0.017	0.01	0.058	0.058	<0.005

In Column 2, Ba, Cr, Fe, Mn, Mo, Ni and Pb are below guidelines (Table 6). Copper increased in leachate and from week 17 onwards, was above ANZECC (2000) 80% and 90% protection values until the end of the experiment. One elevated Zn measurement was reported (week 1- i.e., first-flush).

Table 6*: Column 2: Metals screened against ANZECC (2000) guidelines.*

Trace metals/ metalloids (mg/L)	LoR	95 % Protection	90 % Protection	80 % Protection	Livestock drinking water	0	1	4	7	17	21	23	25	26	29	32	35	38	44	46
Ba	0.001	---	---	---	---	0.004	0.007	0.003	0.003	0.002	0.003	0.002	0.009	0.005	0.004	0.006	0.004	0.003	0.004	0.005
Co	0.001	*0.0014*	*0.0014*	*0.0014*	---											0.003	0.003	0.004	0.002	
Cr	0.001	*0.0033*	*0.0033*	*0.0033*	*1*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu	0.001	*0.0014*	*0.0018*	*0.0025*	*0.4*	<0.001	0.002	<0.001	0.001	0.002	0.002	0.006	0.005	0.004	0.005	0.008	0.008	0.013	0.005	0.008
Fe	0.05	---	---	---	*1*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07

Mn	0.001	*1.9*	*2.5*	*3.6*	---	0.002	0.004	0.007	0.008	0.004	0.005	0.004	0.006	0.01	0.015	0.025	0.019	0.02	0.023	0.007
Mo	0.001	*0.034*	*0.034*	*0.034*	*0.034*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni	0.001	*0.011*	*0.013*	*0.017*	*1*	<0.001	0.004	0.003	0.003	<0.001	0.001	0.002	0.004	0.002	0.004	0.004	0.005	0.006	0.004	0.006
Pb	0.001	*0.0094*	*0.0056*	*0.0034*	*0.01*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	0.005	*0.008*	*0.015*	*0.031*	*20*	0.01	0.011	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	0.008	0.009	0.014	0.006

In Column 3, Ba, Cr, Fe, Mn, Mo and Ni are below guidelines (Table 7). As with Column 2, Cu increased in leachate from week 17 onwards and was above ANZECC (2000) 80% and 90% protection values until the end of the experiment. One elevated Pb measurement was reported (week 0- i.e., rinse water rather than leachate) whilst Zn remained below guidelines from week 4 until week 29 to the end.

***Table 7**: Column 3: Metals screened against ANZECC (2000) guidelines.*

Trace metals/ metalloids (mg/L)	LoR	95 % Protection	90 % Protection	80 % Protection	Livestock drinking water	0	1	4	7	17	21	23	25	26	29	32	35	38	44	46
Ba	0.001	---	---	---	---	0.014	0.043	0.009	0.006	0.004	0.004	0.002	0.01	0.004	0.005	0.006	0.003	0.004	0.003	0.002
Co	0.001	*0.0014*	*0.0014*	*0.0014*	---											0.005	0.004	0.006	0.005	
Cr	0.001	*0.0033*	*0.0033*	*0.0033*	*1*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu	0.001	*0.0014*	*0.0018*	*0.0025*	*0.4*	<0.001	<0.001	<0.001	<0.001	0.003	0.006	0.003	0.002	0.004	0.008	0.01	0.009	0.016	0.01	0.005
Fe	0.05	---	---	---	*1*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	0.001	*1.9*	*2.5*	*3.6*	---	0.007	0.002	0.004	0.004	0.003	0.004	0.003	0.004	0.008	0.008	0.018	0.019	0.01	0.011	0.002
Mo	0.001	*0.034*	*0.034*	*0.034*	*0.034*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni	0.001	*0.011*	*0.013*	*0.017*	*1*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pb	0.001	*0.0094*	*0.0056*	*0.0034*	*0.01*	0.011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.002	<0.001
Zn	0.005	*0.008*	*0.015*	*0.031*	*20*	0.027	0.007	0.014	<0.005	<0.005	0.005	<0.005	<0.005	0.007	0.011	0.01	0.013	0.012	0.017	0.009

In Column 4, Ba, Cr, Fe, Mn, Mo, Ni and Pb are below ANZECC(2000) guidelines (Table 8). Copper again is elevated from week 17 onwards (above ANZECC, 2000). Nickel, Pb and Zn show occasional exceedances.

***Table 8**: Column 4: Metals screened against ANZECC (2000) guidelines.*

Trace metals/ metalloids (mg/L)	LoR	95 % Protection	90 % Protection	80 % Protection	Livestock drinking water	0	1	4	7	17	21	23	25	26	29	32	35	38	44	46
Ba	0.001	---	---	---	---	0.011	0.016	0.004	0.009	0.011	0.016	0.011	0.013	0.015	0.013	0.015	0.012	0.011	0.008	0.014
Co	0.001	*0.0014*	*0.0014*	*0.0014*	---											0.007	0.005	0.004	0.003	
Cr	0.001	*0.0033*	*0.0033*	*0.0033*	*1*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Cu	0.001	*0.0014*	*0.0018*	*0.0025*	*0.4*	<0.001	<0.001	0.012	<0.001	0.006	0.006	0.002	0.003	0.002	0.003	0.007	0.006	0.006	0.004	0.004
Fe	0.05	---	---	---	*1*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.93
Mn	0.001	*1.9*	*2.5*	*3.6*		0.011	0.009	0.008	0.019	0.021	0.036	0.02	0.022	0.024	0.029	0.048	0.026	0.021	0.022	0.014
Mo	0.001	*0.034*	*0.034*	*0.034*	*0.034*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni	0.001	*0.011*	*0.013*	*0.017*	*1*	<0.001	<0.001	0.002	<0.001	<0.001	0.003	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	<0.001
Pb	0.001	*0.0094*	*0.0056*	*0.0034*	*0.01*	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.001
Zn	0.005	*0.008*	*0.015*	*0.031*	*20*	0.009	0.01	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	0.006	0.017

In Column 5, all metals shown are below ANZECC (2000) guidelines except Cu (Table 9). However, in comparison to Columns 2-4, only 4 exceedances are reported after week 17.

Table 9: Column 5: Metals screened against ANZECC (2000) guidelines.

Trace metals/ metalloids (mg/L)	LoR	95 % Protection	90 % Protection	80 % Protection	Livestock drinking water	0	1	4	7	17	21	23	25	26	29	32	35	38	44	46
Ba	0.001	---	---	---	---	0.011	0.013	0.011	0.007	0.007	0.008	0.004	0.013	0.012	0.006	0.01	0.005	0.007	0.004	0.005
Co	0.001	0.0014	0.0014	0.0014	---											<0.001	<0.001	0.001	<0.001	
Cr	0.001	0.0033	0.0033	0.0033	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu	0.001	0.0014	0.0018	0.0025	0.4	<0.001	<0.001	<0.001	<0.001	0.003	0.002	0.001	<0.001	0.002	0.001	0.003	0.002	0.003	0.002	0.003
Fe	0.05	---	---	---	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	0.001	1.9	2.5	3.6		0.015	0.007	0.012	0.008	0.008	0.015	0.008	0.01	0.011	0.01	0.022	0.018	0.012	0.011	0.010
Mo	0.001	0.034	0.034	0.034	0.034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni	0.001	0.011	0.013	0.017	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pb	0.001	0.0094	0.0056	0.0034	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	0.005	0.008	0.015	0.031	20	<0.005	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005

Summary graphs for major elements are the metals presented in Tables 5-9 are shown in Figures 16-27.

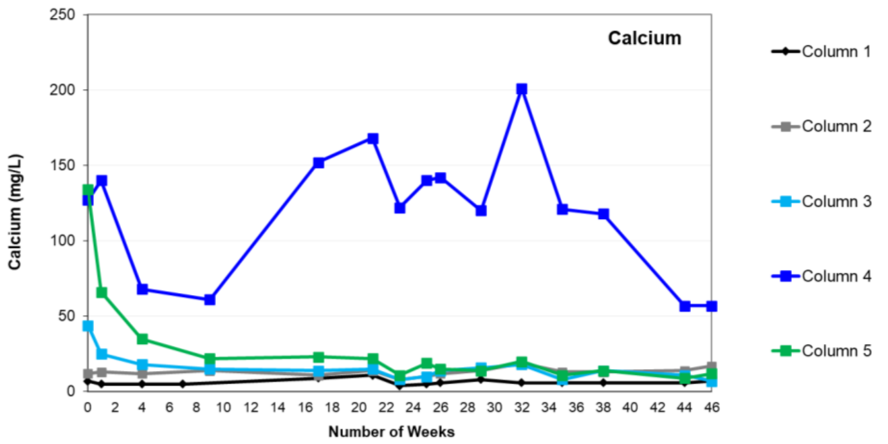

***Figure 16.** Calcium measured in leachate for 46 weeks.*

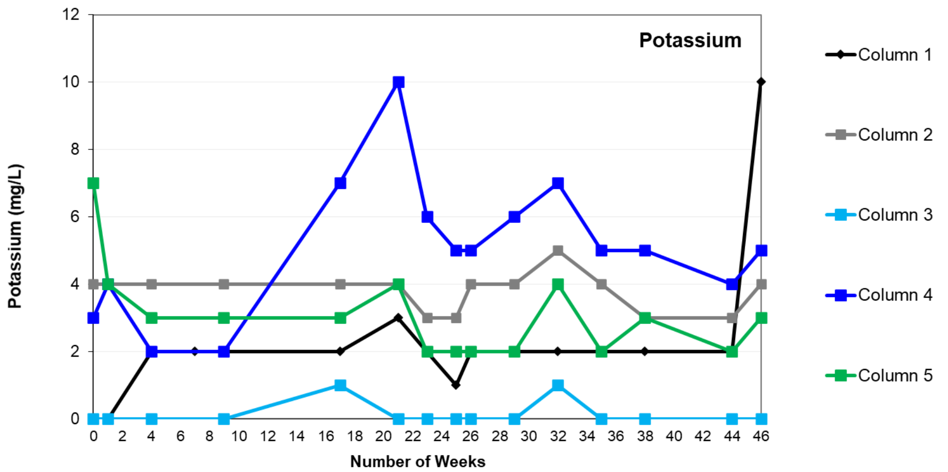

Figure 17. Potassium measured in leachate for 46 weeks.

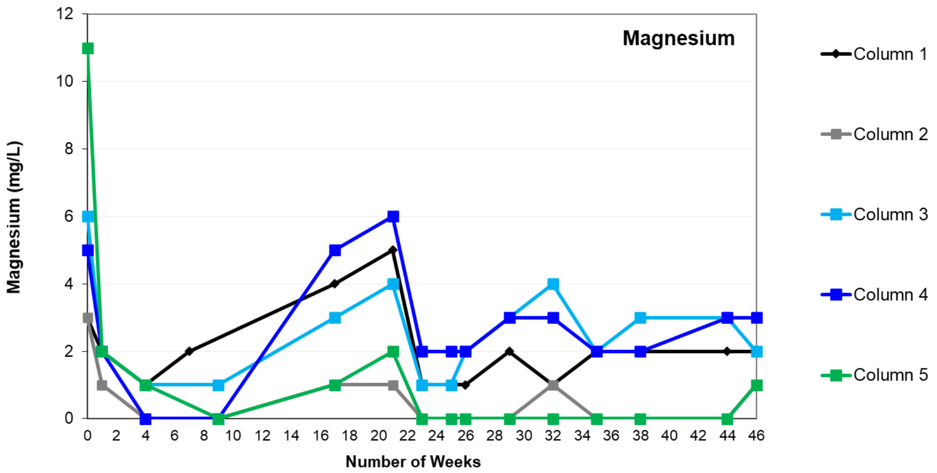

Figure 18. *Magnesium measured in leachate for 46 weeks.*

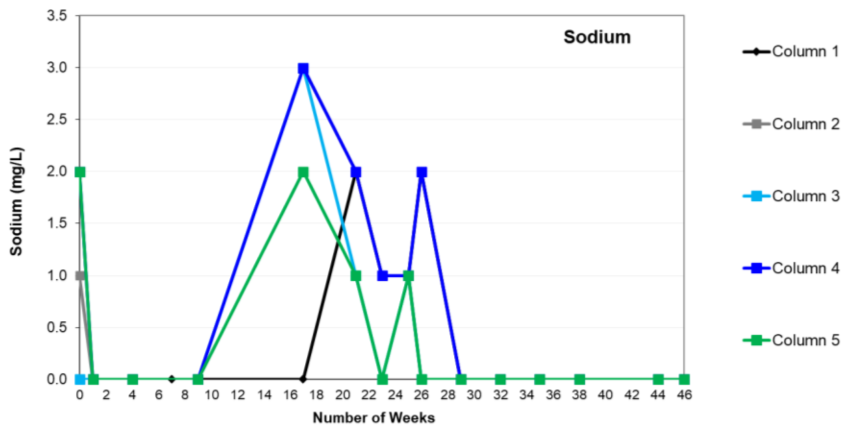

Figure 19. *Sodium measured in leachate for 46 weeks.*

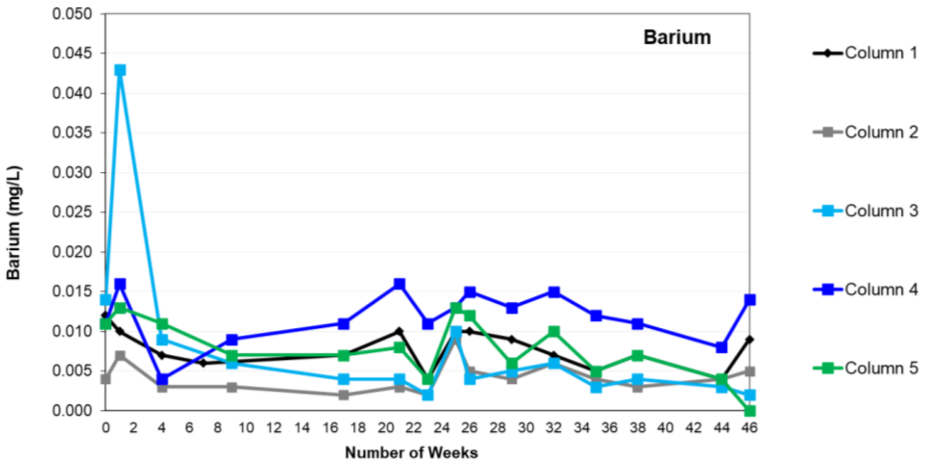

Figure 20. *Barium measured in leachate for 46 weeks.*

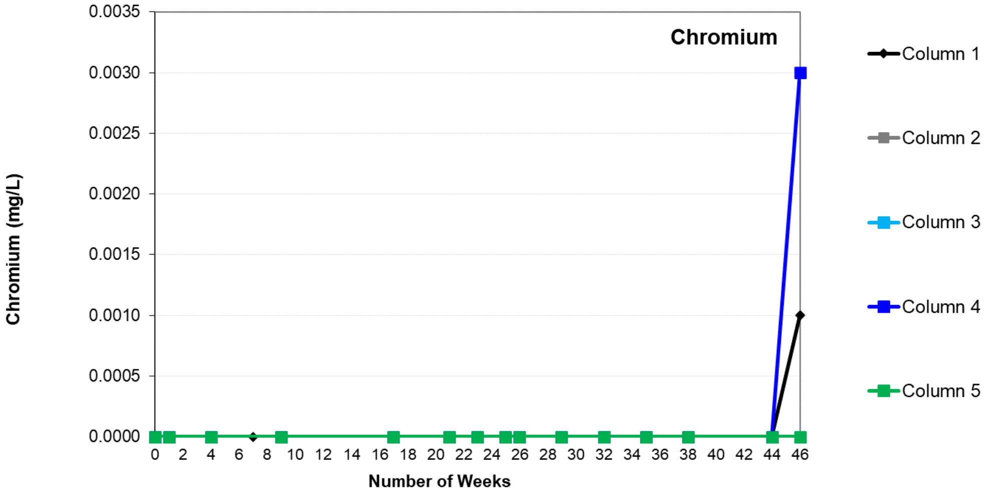

Figure 21. *Chromium measured in leachate for 46 weeks.*

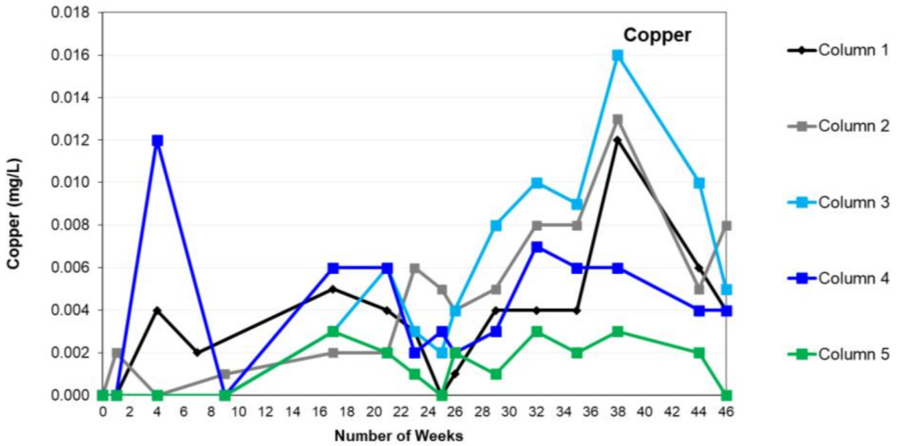

Figure 22. *Copper measured in leachate for 46 weeks.*

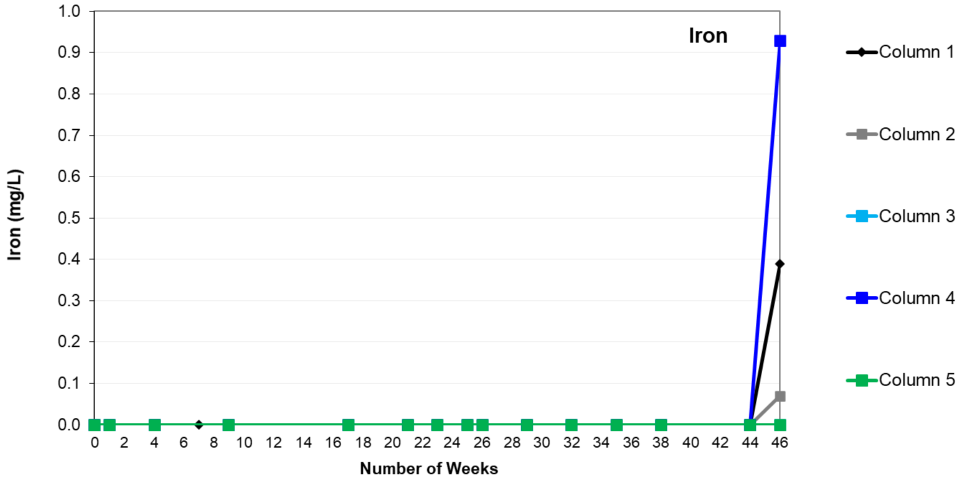

Figure 23. *Iron measured in leachate for 46 weeks.*

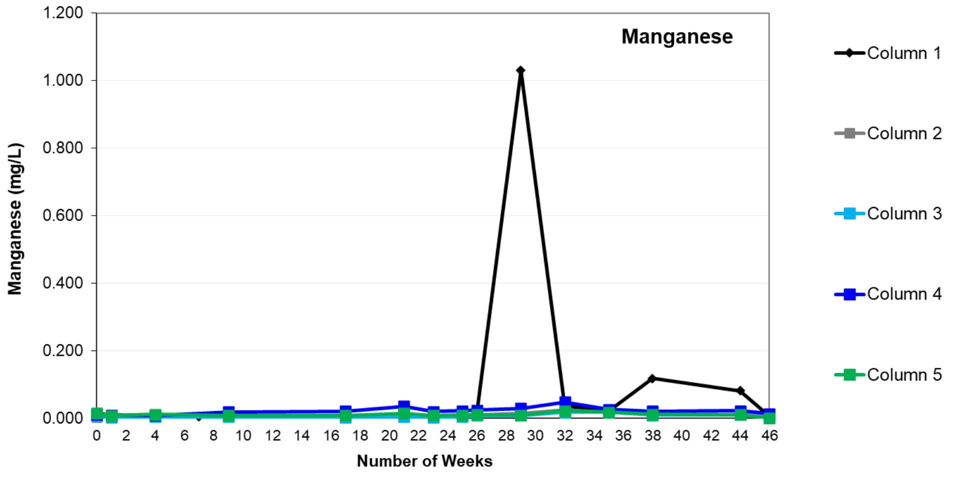

Figure 24. *Manganese measured in leachate for 46 weeks.*

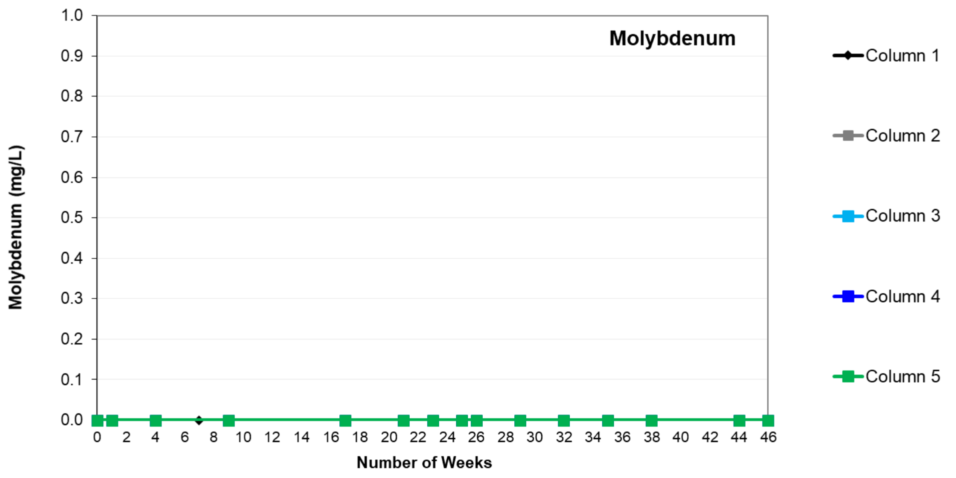

Figure 25. *Molybdenum measured in leachate for 46 weeks.*

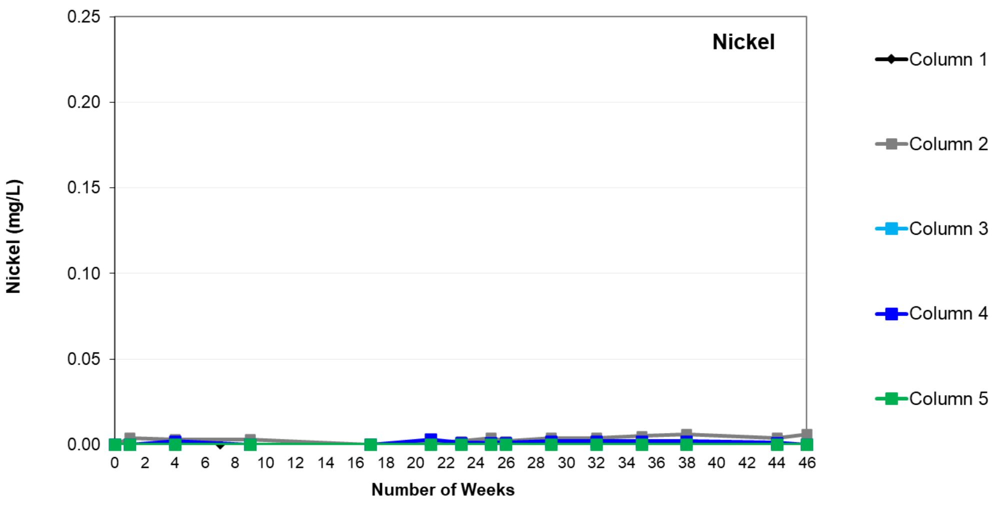

Figure 26. *Nickel measured in leachate for 46 weeks.*

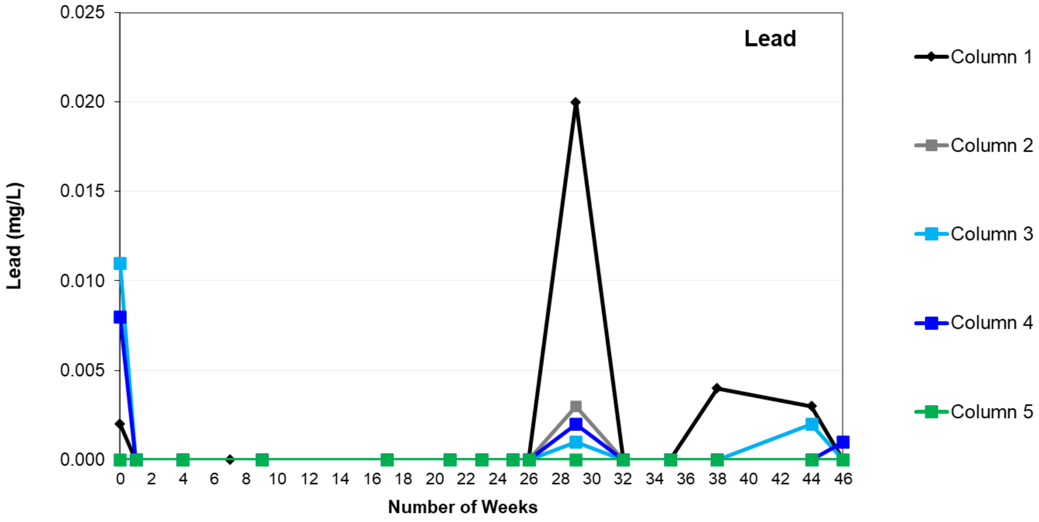

Figure 27. *Lead measured in leachate for 46 weeks.*

3.5 Post-column feed mineralogical observations

At the end of the testing, the columns were dismantled, and a representative bulk sample was prepared for XRD analysis to enable a comparison to the pre-tested materials. There are limitations in undertaking this data comparison, as based on one sample, absolute comparisons cannot be made, however, this section will focus on examining the acid forming and acid consuming minerals.

The bulk mineralogy of the feed material is summarised in Table 10. All columns remain dominated by magnetite (average: 33 wt. %), amphibole (average: 11.3 wt. %) and chlorite (average: 10.9 wt. %) though a high content of amorphous material remained all columns (average: 14.7 wt. %). The carbonate abundance was relatively low with average calcite (identified in 3 columns only) measured at 1.14 wt. % and lesser dolomite (average: 0.46 wt. %). Given the small decrease in dolomite this may indicate it has been consumed in the experiment. Pyrite was identified in all columns with an average of 1.6 wt. % reported- suggesting broadly no bulk change in comparison to Table 2. Graphs comparing the mineralogy of each column are shown in Figures 28 to 32. Some visual oxidation of particles was noticed at the end of the experiment and likely represents where pyrite is in contact with chlorite (e.g., Figure 33). Sulphates have not precipitated as reaction products, however, examination of the post-column feed by SEM would have confirmed if pyrite, or other sulfides, have reacted under the experimental conditions on a micro-scale.

Table 10: *Bulk mineralogy of column feed materials by XRD at the end of the experiment.*

	Column 1	Column 2	Column 3	Column 4	Column 5
Savage River					
Quartz		0.5			
Ilmenite	2		2.5		
Magnetite	49.1	22	47.7	20.2	26
Pyrite	1.9	1.6	1.1	1.9	1.9
Calcite	0.9	1.5	0.9	0.6	1.8
Dolomite	1.3	0.1	0.5	0.1	0.3
Anhydrite				0.9	

Gypsum				1.5	
Amphibole	7.8	13.8	2.2	16.1	16.7
Plagioclase	6.4	5.6	1.9	15.7	9.1
K-Feldspar	1.1	2.4	1.6	1.4	3.1
Serpentine	12.6	8.5	9.4	3.6	7.5
Kaolinite	2.8	3.3	4	1.6	1.8
Chlorite / clinochlore	9.3	16.9	5.3	10.8	12.2
Illite/mica	1.5	1.1	2.2	5.4	2.7
Talc	0.9	5	0.5	2	2.3
Amorphous	2.4	17.9	20.3	18.1	14.8

Based on the mineral textures observed, it is evident that the pyrite is well encapsulated, and this is the primary control on AMD generation. Currently, the encapsulation is keeping the pH circumneutral (average pH values ranging from pH 6.31 to pH 6.72), not the presence of carbonates, which were notably low in these materials. Copper is regarded to be the main contaminant of potential concern, likely from chalcopyrite, which is a trace mineral only observed by MLA. Modelling of these data geochemically to predict how long for, has not been undertaken, however, there is sufficient mineralogical data to facilitate this.

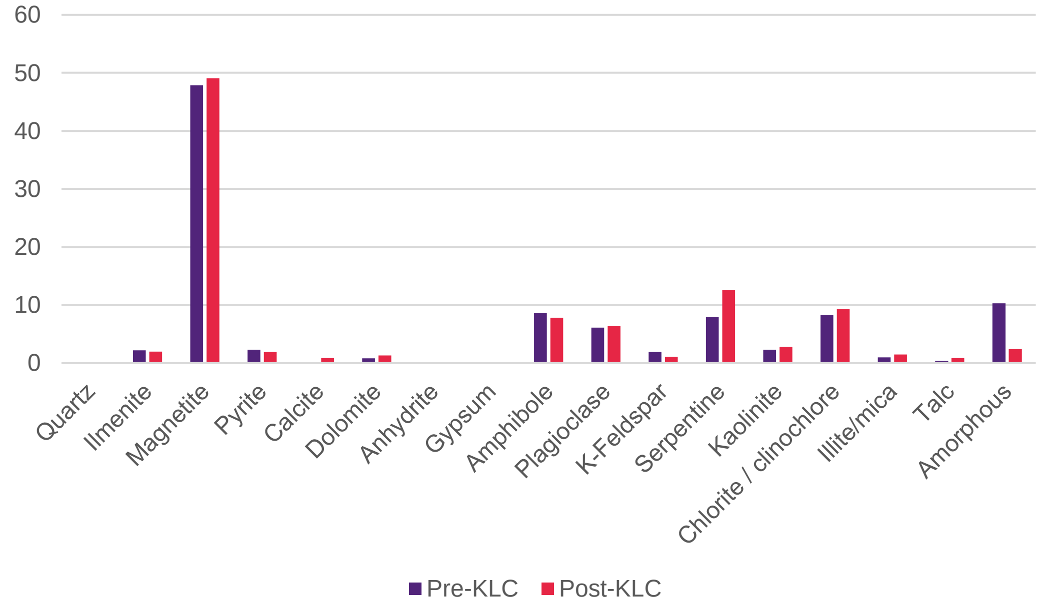

Figure 28. *Column 1- comparison of pre- and post-kinetic trial mineralogy (by XRD).*

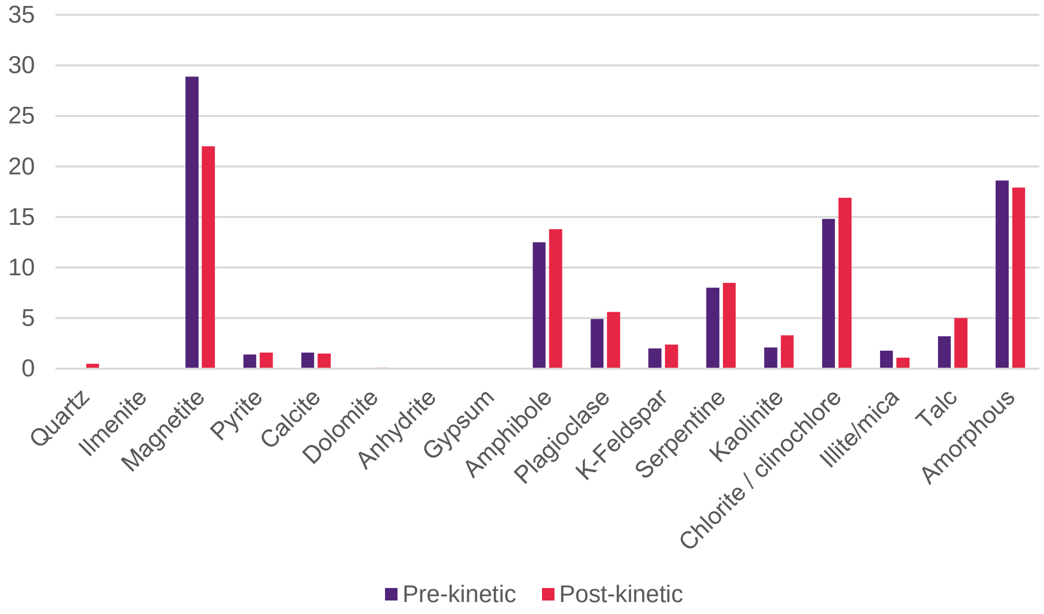

Figure 29. *Column 2- comparison of pre- and post-kinetic trial mineralogy (by XRD).*

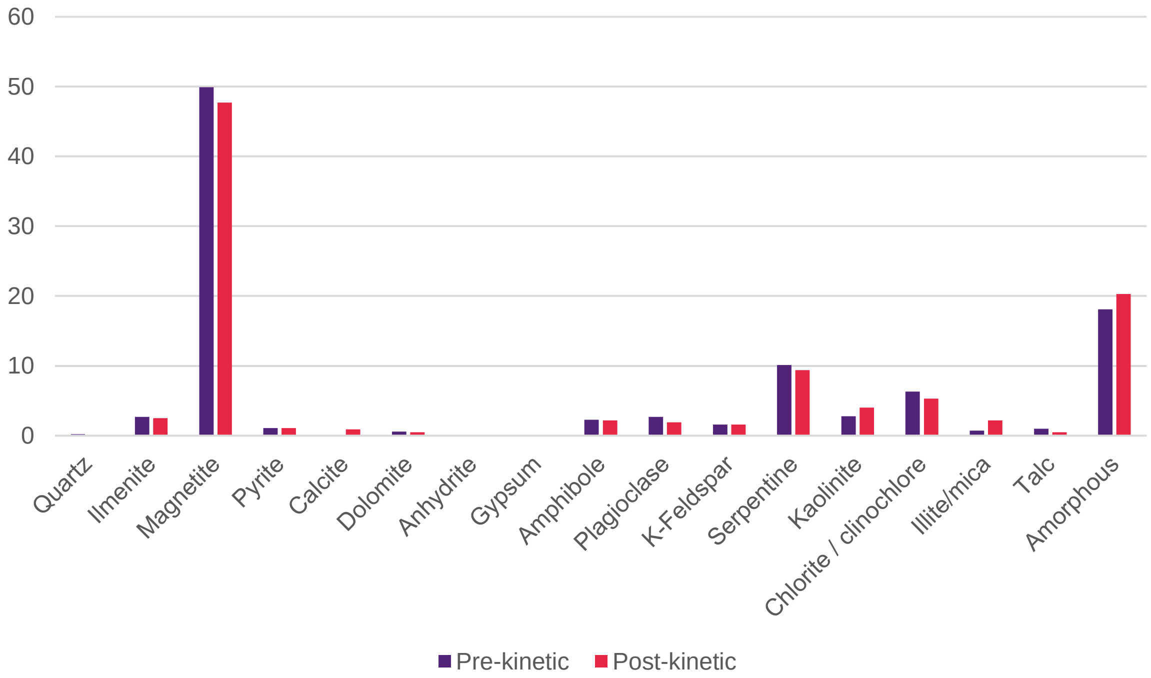

Figure 30. *Column 3- comparison of pre- and post-kinetic trial mineralogy (by XRD).*

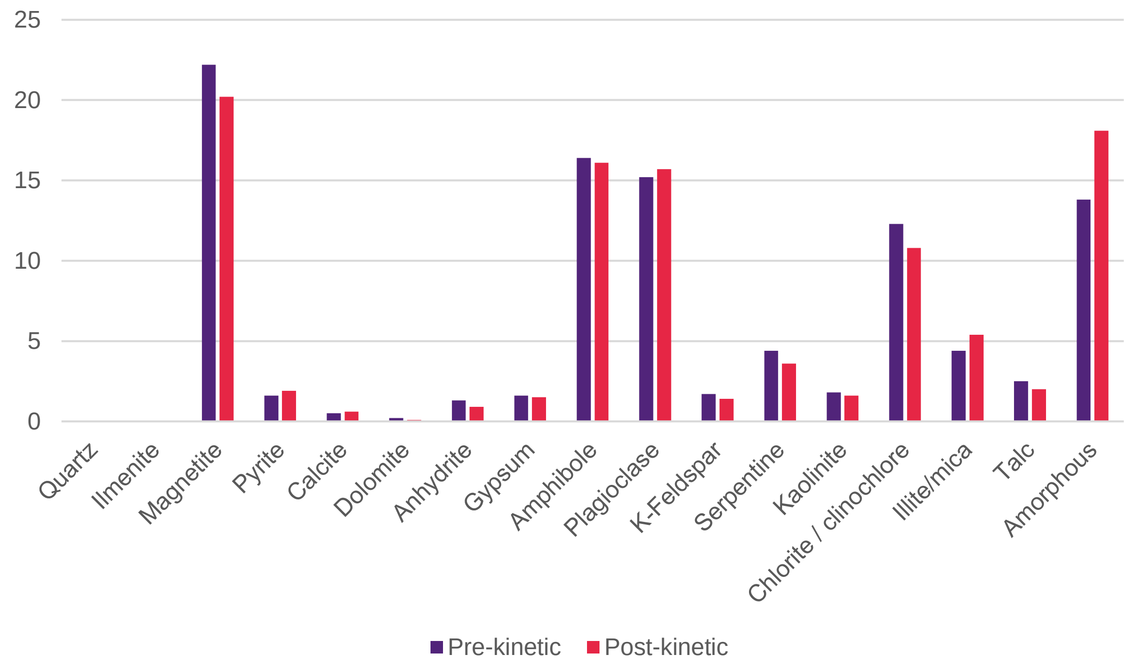

Figure 31. *Column 4- comparison of pre- and post-kinetic trial mineralogy (by XRD).*

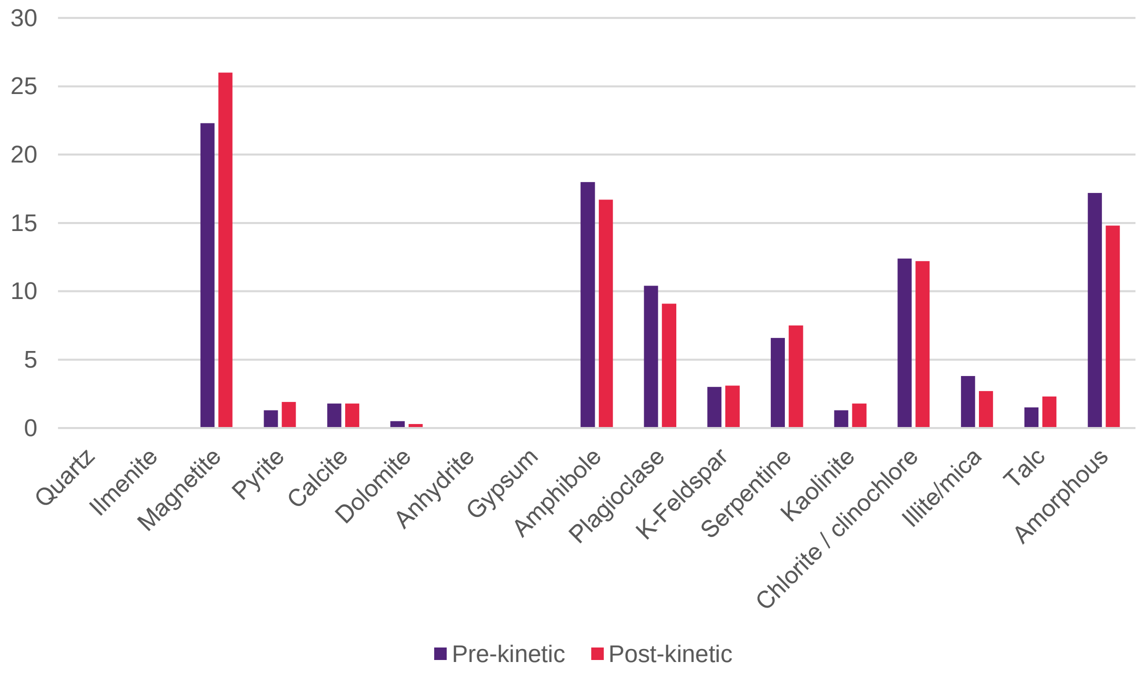

Figure 32. *Column 5- comparison of pre- and post-kinetic trial mineralogy (by XRD).*

Figure 33. *Example of visual oxidation- Column 2 post kinetic trial.*

3.5.1 Acid base accounting observations

Static testing on kinetic trial column feed material shows the patterns of metal release seen in the columns is likely to continue longer than the trial period (Table 11). Total sulfur values of Columns 1, 2, 4 and 5 decrease over the test period. Remaining total sulfur is present in sulfide minerals as defined by bulk and detailed mineralogy (Sections 3.1 and 3.2). All columns show a decrease in NAPP over the test period as well as a decrease in ANC.

Table 11. *Acid Base accounting results for pre- and post-column feed material*

	Column ABA: Post-trial					Column ABA: Pre-trial				
	1	2	3	4	5	1	2	3	4	5
Net Acid Production Potential (kg H2SO4/t)	-8.5	-8.9	-26.8	15.8	-13	-8.7	-27.8	-20.2	5.1	-25.3
NAG pH	8	8.5	8.7	3	10.3	7.8	9.5	7.8	4	10.4
ANC as H2SO4 (kg H2SO4/t)	43.4	45.9	45.8	42.6	48.5	52.2	56.6	40.1	43.9	51.6
Sulfur - Total as S (LECO) %	1.14	1.21	0.62	1.91	1.16	1.42	0.94	0.65	1.6	0.86

4. Summary

Grange Resources commissioned the SMI to set-up and maintain AMIRA Column leach cells (5) for block cave materials from North Pit. The pH and EC of these columns were recorded weekly and monthly leachates (i.e., metals, sulphate) were collected and analysed by solution ICPMS methods. Due to COVID-19 and flooding events, some measurement weeks were not attended to, further, a different solution ICPMS instrument had to be used at ALS and not UQ (due to an instrument failure). Considering this, the agreed sampling budget had to managed appropriately. This report describes the total metal concentration within water that will follow through the cave column to help understand if the water being pumped to surface will need to be treated before it is discharged into South Lens.

- The pH values over the 46 weeks are circumneutral ranging from pH 6-7.
- Pyrite is present in greater abundance than carbonates, however, insitu mineralogical data collected demonstrates that it is well encapsulated and associated with magnetite, amphibole, pyroxene and chlorite. Other sulfides (pyrrhotite, chalcopyrite) are trace minerals only.
- In all column materials, Cu appears to be the main potential contaminant of concern with values, from week 17 onwards, for many columns, measured above ANZECC (2000) 80% water quality protection guidelines.
- Occasional exceedances above ANZECC (2000) 80% water quality protection guidelines and Livestock Drinking Water Levels for Ni, Pb and Zn were measured, but were not consistent and may indicate that disseminated pyrite (in contact with chlorite) is liberating and commencing oxidation with these metals mobilising into the leachate.
- No obvious intermediate reaction products were observed in mineralogical studies. Instead, these data could be used as input feeds into modelling software (e.g., MIN3PRO) to determine the microscale mineralogical changes occurring which may manifest on a larger scale in the leachate water chemistry.
- Examination of the mineral chemistry of the sulfides may better inform future waste management options (i.e., confirm Cu hosts and indeed, pyrite chemistry as it may report to tailings/ WRDs).

5. References

ANZECC & ARMCANZ (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, 2000, ANZECC (Australian and New Zealand Environment Conservation Council) and ARMCANZ (Agriculture and Resource Management Council of Australia and New Zealand). Livestock Drinking Water Levels (Irrigation Levels used for Fe and Mn).

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Smart, R., Skinner, W.M., Levay, G., Gerson. A.R., Thomas, J.E., Sobieraj, H., Schumann, R., Weisener, C.G., Weber, P.A., Miller, S.D., Stewart, W.A. 2002. ARD test handbook: Project P387, A prediction and kinetic control of acid mine drainage, Melbourne, Australia, AMIRA, International Ltd.

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pitt&sherry

Savage River Mine: North Pit Underground Operations

Environmental Impact Assessment

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Savage River Mines

Traffic Impact Statement

Prepared for

Grange Resources Tasmania

Client representative

Carl Ptolemy

Date

9 October 2023

Rev01

Table of Contents

List of figures

List of tables

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Reviewed by — Rebekah Ramm	RRamm	**Date —** 9 October 2023
Authorised by — Tonia Robinson	[signature]	**Date —** 9 October 2023

Revision History

Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
00	Traffic Impact Assessment	LA	RR	TR	04/10/2023
01	Traffic Impact Assessments (minor amendments)	LA	RR	TR	09/10/2023

1. Introduction

1.1 Project Background

Grange Resources (Tasmania) Pty Ltd (Grange) operates the Savage River iron ore (magnetite) mine 100 km southwest of Burnie, located in northwest Tasmania. The mine commenced operations in 1967, extracting magnetite from a series of open pits. The mine includes several pits, working deposits, water treatment body, tailings dam and storage, rock dump and process facilities. Magnetite concentrate is pumped via an 85 km pipeline to a pelletising plant at Port Latta, west of Burnie for processing and transport to international and Australian markets via bulk cargo vessel.

Grange is proposing to commence underground mining below the Savage River Mine's North Pit. The NPUG will proceed as a Sub Level Cave (SLC) Transition mine prior to, or possibly at the same time as, Block Cave (BC) mining.

Following consultation with the Department of State Growth (State Growth), State Growth have advised that to support the Development Application (DA) for the underground mining, a Traffic Impact Statement (TIS) outlining the key items related to an increase in use of the existing access is required.

1.2 Traffic Impact Assessment Scope

Grange have engaged pitt&sherry to undertake a TIS outlining the key items related to an increase in use of the existing access.

This report has been prepared with reference to the State Growth Publication *Traffic Impact Assessment (TIA) Guidelines* and the *Tasmanian Planning Scheme* – Waratah-Wynyard (the Planning Scheme).

2. Existing Conditions

2.1 Site Location

The Savage River mine (the site) is located along Corinna Road/ Waratah Road, north of the Savage River campsite. Corinna is located approximately 20 km east of the site while Waratah is located approximately 25 km west.

Under the Planning Scheme, the site has a land zoning of Environmental Management (zone number 23). Surrounding land uses includes Rural (20) to the west and Environmental Management to the north, south and east.

Figure 1 shows the site in the local context.

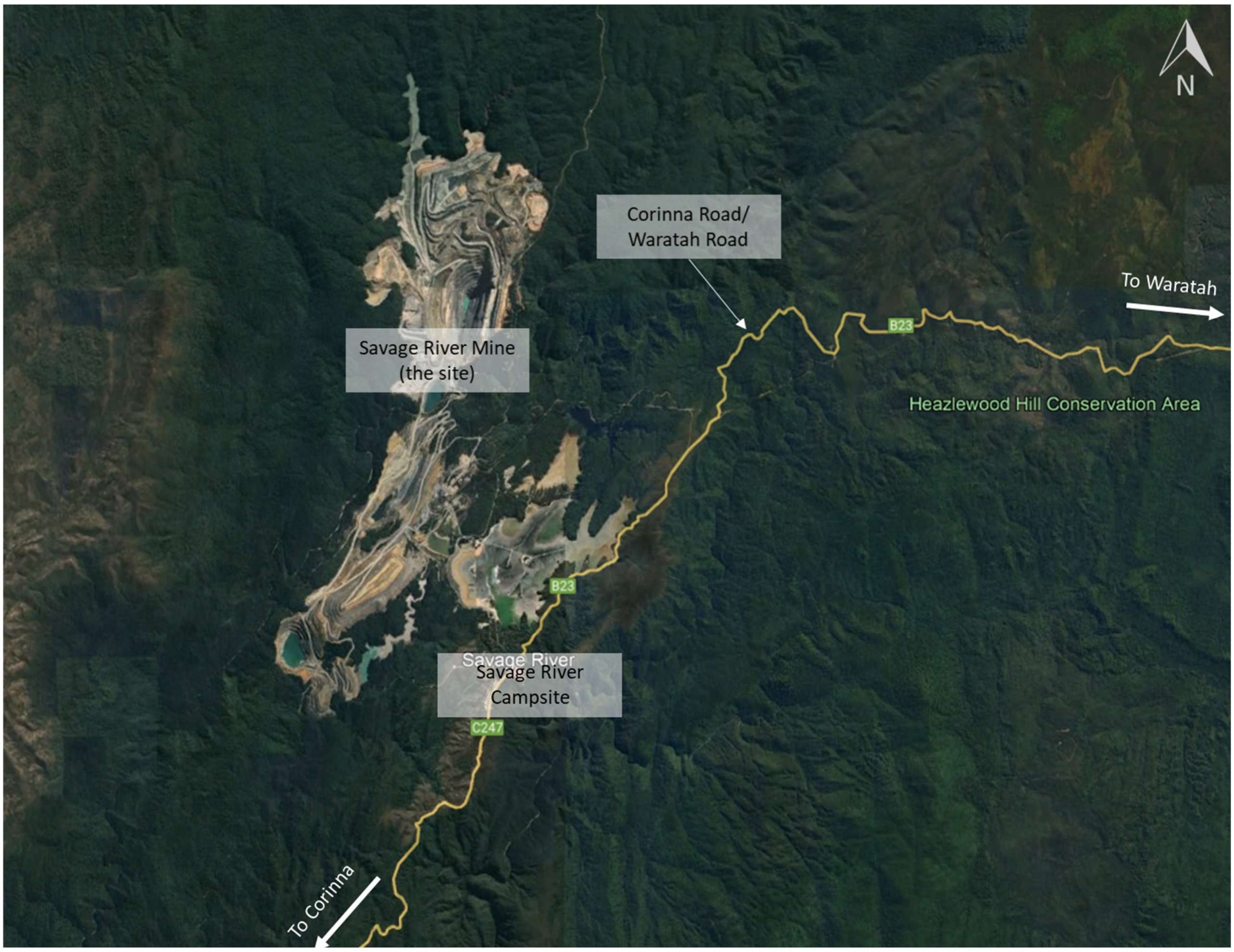

Figure 1: Site location (Basemap source: Google Earth)

2.2 Site Operation

The site and the Savage River campsite have been designed and constructed to support the mining operations.

The site currently accommodates the tailing storage facility, site offices, associated parking and access roads connecting the various components within the site.

The campsite accommodates the ancillary facilities including but not limited to accommodation, additional site offices, cafeteria and associated parking.

The site operates 24 hours a day, 7 days a week. The existing workforce averages up to 150 employees and contractors at any one time on site and up to 100 employees and contractors at any one time in the camp facilities.

All site staff work on rotational shifts with varying work patterns, including 7/7, 4/4, 8/6 and 5/2 (note that the X/Y represents the work schedule where the X signifies days on-site and the Y indicates the consecutive days off). On working days, site staff reside in the campsite. On non-working days, site staff return to their homes.

Additional Grange Staff and approved contractors (including but not limited to deliveries, waste disposal, cleaning, camp related activities) also access the site as required each day using private vehicles. This results in approximately 350 personnel attending the site in an average 24-hour period.

While staff generally drive to the campsite using their own vehicles, Grange also provide a coach from Burnie on major shift changes. Travel between the site and the campsite generally occurs using transfer buses.

The site is not open to the public and is only accessible to Grange staff and approved contractors. Access is restricted by boom gates and swipe access.

The site receives a range of deliveries each day, including but not limited to, fuel, food, materials and waste disposal. Deliveries are equivalent to approximately 2 semi-trailers a day and 4 rigid trucks a day. Additional wide load semi-trailers also access the site to deliver mining truck parts, cranes, drills and other equipment as required.

Apart from the vehicles listed above, no other vehicle routinely access the site.

2.3 Site Access and Circulation Roads

The site has a single access (shown in Figure 2) onto Waratah Road that is used by all vehicles accessing the mine. This access has a separate entry and exit with a width of 15 m and 19 m respectively. The entry and exit are separated by a 2 m wide splitter island that is offset from the intersection by 5 m.

There are currently four accesses available to the camp site listed in descending order from the northernmost entry as follows:

- Access 1 – Entry into camp site
- Access 2 – Exit from camp site
- Access 3 – Alternate access to accommodation; and
- Access 4 – Alternate access to accommodation.

The access to the site and camp site are shown below in Figure 3.

Within the site, vehicles travel along marked circulation roads. All circulation roads are a minimum 10 m wide with additional widening provided to support the turn paths of larger vehicles as required.

Figure 2: Site access

Figure 3: Access (Basemap source: Google Earth)

2.4 Surrounding Road Network

2.4.1 Corinna Road/ Waratah Road

Corinna Road/ Waratah Road (shown in Figure 4 and Figure 5) is a State Growth owned two-way road that operates between Waratah and Corinna. To the north of the campsite, the road is named Waratah Road while to the south of the campsite, the road is named Corinna Road.

The road is classified as a Category 5 – Other Road under State Growth's State Road Hierarchy and is configured with a single lane in each direction.

Waratah Road is generally subject to a posted speed limit of 100 km/h while Corinna Road is generally subject to a posted speed limit of 80 km/h. In the vicinity of the site and the campsite, the road is subject to a posted speed limit of 60 km/h.


Figure 4: Waratah Road - facing south


Figure 5: Waratah Road - facing north

2.5 Surrounding Intersections

There are no major intersections located in the vicinity of the site.

2.6 Road Network Operation

2.6.1 Traffic Volumes

Traffic data collected in 2021 by counter A1617120 located along Waratah Road is accessible from the State Growth Traffic Data website. A summary of the available traffic data is presented below in Table 1.

Table 1: Existing traffic volumes

Peak Hour	Traffic Volumes
AM Peak Hour (7:00am – 8:00am)	48 vehicles per hour
PM Peak Hour (3:00pm – 4:00pm)	47 vehicles per hour

2.6.2 Existing Operation

pitt&sherry staff undertook a site visit on Wednesday 13 September 2023. Based on observations made during the site visit, the site access and Corinna Road/ Waratah Road operated well during the identified AM and PM peak hours with minimal queues and delays experienced by all vehicles.

2.7 Road Safety

State Growth have provided crash history for the most recent 5-year period in the vicinity of the site.

The available data shows that there have been no recorded crashes in the vicinity of the site in the most recent 5-year period.

3. Development Proposal

3.1 Overview

Grange is proposing to commence underground mining below the Savage River Mine's North Pit. The North Pit Underground Mine (NPUG) will proceed as a Sub Level Cave (SLC) Transition mine prior to, or possibly at the same time as, Block Cave (BC) mining.

3.2 Operating Hours and Staffing

As part of the proposed change to commence underground mining, there will be approximately 33 additional staff on site.

There will be no change in the operating hours and the site will continue to be not open to the public and will only be accessible to Grange staff and approved contractors.

3.3 Vehicular Access and Circulation

As part of the proposed change, there will be no change to the existing vehicle accesses or circulation roads on site.

3.4 Deliveries

In order to commence underground mining, a number of equipment deliveries will be made to site.

It is anticipated that up to 18 deliveries will be made a year using 19 m semi-trailers (approximately 13 semi-trailers and 5 wide load semi-trailers).

4. Traffic Impact Assessment

4.1 Traffic Generation

Due to the unique nature of this development, there are no traffic generation rates specified in the *Roads and Maritime Services (RMS) Guide to Traffic Generating Developments* or the *ITE Trip Generation Manual*. As such, the traffic generation has been calculated based on the expected operation of the proposed change.

Using the operational information provided by Grange, the traffic generation of the proposed change has been determined as follows:

- There will be approximately 33 additional staff vehicles generated by the site (assuming all staff drive personal vehicles and do not utilise the coach from Burnie). These vehicles will be generated at shift change (i.e. when staff are coming/ departing the camp site) and will generally occur outside of the AM and PM peak hours; and
- There will be 19 new semi-trailer trucks generated by the site. These trucks will be generated sporadically.

Based on the above, the worst-case traffic generation is expected to result in 66 light vehicle movements and 38 semi-trailer movements during the AM and PM peak hours (conservatively assuming all staff and trucks arrive during the AM peak hour and depart during the PM peak hour and very conservatively assuming that a years' worth of semi-trailer movements occur on a single day, which is highly unlikely).

4.2 Traffic Impact

As discussed, there are currently 48 vehicles recorded during the AM peak hour and 47 vehicles recorded during the PM peak hour along Waratah Road. With the additional traffic generated by the proposed change, the worst-case traffic volumes along Waratah Road are anticipated to be 100 vehicles during the AM peak hour and 101 vehicles during the PM peak hour.

Although the capacity of roads are generally determined by the capacity of downstream and upstream intersections, the RMS Guide does provide guidance metrics on LOS for mid-block locations on urban roads with interrupted flow conditions. Table 2 shows the criteria that the RMS Guide adopts in assessing the LOS. It is generally accepted that LOS C or better is an acceptable level of mid-block operation.

Table 2: Mid-block LOS (data source: RMS Guide, 2002)

Level of Service		**Peak hour traffic flow (vehicle per hour per lane)**	
		From	**To**
A	Free flow – drivers are virtually unaffected by other drivers in the traffic stream	0	200
B	Reasonably unimpeded flow – drivers have reasonable freedom to manoeuvre and select their desired speed	200	380
C	Stable flow – drivers are restricted to some extent in their freedom to manoeuvre and select their desired speed	380	600
D	Approaching unstable flow – drivers are severely restricted in their freedom to manoeuvre and select their desired speed	600	900

Level of Service		Peak hour traffic flow (vehicle per hour per lane)	
		From	To
E	Unstable flow – traffic volumes at or close to capacity, drivers have virtually no freedom to manoeuvre or select their desired speed	900	1,400
F	Forced flow – traffic volumes over capacity with flow breakdown, queuing and delays	Greater than 1,400	

Based on the above capacity ranges, the LOS for Waratah Road is anticipated to remain at free flow conditions (i.e. LOS A).

4.3 Wide Load Semi-Trailers

As discussed, approximately 5 wide load semi-trailers are anticipated to access the site for delivery of equipment.

The wide-load semi-trailers are currently accommodated along the road network surrounding the site and are not anticipated to impact the safety and/or operation of the surrounding road network. It is noted that all wide load semi-trailers are escorted by pilot vehicles with radio contact as per requirements set out int the permits issued by the National Heavy Vehicle Register.

4.4 Sight Distance Assessment

The Safe Intersection Sight Distance (SISD) to the accesses along Waratah Road has been assessed in accordance with the *Austroads Guide to Road Design – Part 4A: Unsignalised and Signalised Intersections* (Austroads Guide Part 4A). The SISD was also measured in accordance with the Austroads Guide Part 4A.

As all recorded sight distances are in excess of 125 m and the Austroads Guide requires a sight distance of 123 m (with a desirable reaction time of 2.5s), the available sight distances at the accesses meet the sight distance requirements of the Austroads Guide Part 4A.

4.5 Site Layout Assessment

Clause 5.1 of the *Australian Standard AS/NZS2890.2:2018 Off-street Commercial vehicle facilities* (AS 2890.2) states that "*Swept paths shall be used to check that the paths of vehicles travelling in the forward direction when negotiating access driveways and circulations roadways, can be accommodated within the proposed roadway".*

As the existing accesses and circulation roads are used by vehicles up to wide-load 19 m semi trailers with no issues noted or reported on site, and no changes proposed to the existing accesses, circulation roads or vehicle sizes accessing the site, trucks are expected to continue to navigate these accesses and circulation roads safely and efficiently.

5. Planning Scheme Assessment

The proposed change to commence underground mining has been assessed against the use standards of C3.0 Road and Railway Assets Code of the Planning Scheme as presented below.

5.1 C3.0 Roads and Railway Assets Code

5.1.1 Use Standards

Table 3: Road and Railway Assets Code - Use Standards

C3.5.1 Traffic generation at a vehicle crossing, level crossing or new junction	
Objective: To minimise any adverse effects on the safety and efficiency of the road or rail network from vehicular traffic generated from the site at an existing or new vehicle crossing or level crossing or new junction.	
Acceptable Solution	**Comment**
A1.1 For a category 1 road or a limited access road, vehicular traffic to and from the site will not require: a) A new junction b) A new vehicle crossing; or c) A new level crossing. **A1.2** For a road, excluding a category 1 road or a limited access road, written consent for a new junction, vehicle crossing, or level crossing to serve the use and development has been issued by the road authority. **A1.3** For the rail network, written consent for a new private level crossing to serve the use and development has been issued by the rail authority. **A1.4** Vehicular traffic to and from the site, using an existing vehicle crossing or private level crossing, will not increase by more than: a) The amounts in Table C3.1; or b) Allowed by a licence issued under Part IVA of the Roads and Jetties Act 1935 in respect to a limited access road. **A1.5** Vehicular traffic must be able to enter and leave a major road in a forward direction.	**Complies with Acceptable Solution A1.1, A1.2, A1.3 and A1.5 and satisfies Performance Criteria P1 in place of A1.4** The proposed change complies with Acceptable Solutions as follows: A1.1 Corinna Road/ Waratah Road in the vicinity of the site is not a Category 1 or limited access road. A1.2 No new junctions are proposed as part of the proposed change. A1.3 There is no rail network in the vicinity of the site. A1.5 All vehicular traffic can enter and leave the site in a forward direction. As the proposed change is unable to comply with Acceptable Solution A1.4, it has been assessed again Performance Criteria P1 as demonstrated below. a) As discussed within this report, the traffic increase from the proposed development is not anticipated to result in a detrimental impact to the safety or function of the road network b) The proposed development is expected to generate vehicle types which are currently catered for on the road network c) All roads in the vicinity of the site have spare capacity to accommodate the expected traffic generation of the proposed development

Performance Criteria P1

Vehicular traffic to and from the site must minimise any adverse effects on the safety of a junction, vehicle crossing or level crossing or safety or efficiency of the road or rail network, having regard to:

a) Any increase in traffic caused by the use;

b) The nature of the traffic generated by the use;

c) The nature of the road

d) The speed limit and traffic flow of the road

e) Any alternative access to a road

f) The need for the use

g) Any traffic impact assessment; and

h) Any advice received from the rail or road authority.

d) It was observed during the site visit that traffic flows well along the surrounding road network

e) There are no alternative accesses to the road

f) The proposed development will allow the site to commence underground mining

g) This Traffic Impact Statement has been prepared for the proposed change and identifies that the proposed change is not expected to have any negative impact on the safety and operation of the road network; and

h) The Department of State Growth own and maintain the local road network in the vicinity of the site. State Growth have provided written advise that a Traffic Impact Statement addressing the impact of the proposed change on the surrounding road network be undertaken. This Traffic Impact Statement has been prepared for the proposed change and identifies that the proposed change is not expected to have any negative impact on the safety and operation of the road network

6. Conclusion

Grange operates the Savage River iron ore (magnetite) mine 100 km southwest of Burnie and are proposing to commence underground mining at below the Savage River Mine's North Pit. To support the Development Application (DA) for the underground mining, a Traffic Impact Statement (TIS) has been undertaken. The key findings presented within this report may be outlined as follows:

- The LOS for Waratah Road is anticipated to remain at free flow conditions (i.e. LOS A) with the proposed change
- The proposed development is expected to generate vehicle types which are currently catered for in the road network
- Trucks are expected to continue to navigate the accesses and circulation roads safely and efficiently; and
- The available sight distances at the accesses meet the sight distance requirements of the Austroads Guide Part 4A.

Important information about your report

In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints. The Report may only be used and relied on by the Client for the purpose set out in the Report. Any use which a third party makes of this document, or any reliance on or decisions to be made based on it, is the responsibility of the Client or such third parties.

The services undertaken by pitt&sherry in connection with preparing the Report were limited to those specifically detailed in the report and are subject to the restrictions, limitations and exclusions set out in the Report. The Report's accuracy is limited to the time period and circumstances existing at the time the Report was prepared. The opinions, conclusions and any recommendations in the Report are based on conditions encountered and information reviewed at the date of preparation of the Report. pitt&sherry has no responsibility or obligation to update the Report to account for events or changes occurring after the date that the report was prepared. If such events or changes occurred after the date that the report was prepared render the Report inaccurate, in whole or in part, pitt&sherry accepts no responsibility, and disclaims any liability whatsoever for any injury, loss or damage suffered by anyone arising from or in connection with their use of, reliance upon, or decisions or actions based on the Report, in whole or in part, for whatever purpose.

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Savage River Mines – Traffic Impact Statement

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