Jervois Base Metal Project
Groundwater Monitoring and Management Plan

version 4.0

December 2021

PREPARED FOR KGL RESOURCES
BY CLOUDGMS

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Document review

Version	Date	Details	Approved By
Revision v4.0	02/12/2021	Include Table E-2 summarising responsibilities and accountabilities for implementation of GMMP	AK
Revision v4.0	02/12/2021	Adjust Table 6.1 to replace RN019957 with RN019958 from PB list.	AK
Revision v4.0	02/12/2021	Adjust Figure 6.1 to include RN018078.	AK
Revision v4.0	02/12/2021	Include reference to licence to extract groundwater in Table E-1, Section 1.3.2, 4.1.1, 6.2.2 & 6.3.3.	AK
Revision v4.0	02/12/2021	Include desktop bore suitability assessment in section 4.2.3.	AK
Revision v4.0	02/12/2021	Replace reference to DENR with DEPWS and DPIR with DITT.	AK
Revision v4.0	02/12/2021	Include section 8.4 responsibilities and accountabilities for implementation of GMMP.	AK

Groundwater monitoring and management plan summary

The groundwater monitoring and management plan is summarised below in Table E-1.

Table E-1 Groundwater management plan summary

Groundwater Monitoring and Management Plan Summary	
Environmental Value	• Primary industries (stock drinking water); and • Mining / industrial water use
Environmental Protection Objective	• Groundwater will be managed to minimise the risk of impacts to the beneficial uses of groundwater resources and groundwater dependent environment.
Performance Indicator/Criteria	• Development of a Class 2 numerical groundwater flow model to ensure suitable confidence in mine impact forecasts. • Groundwater drawdown 20% greater than the trigger values forecast by the numerical groundwater flow model. • Groundwater quality greater than the p80 trigger values determined from the available baseline values for the Fracture Rock and Georgina Carbonate aquifer systems.
Management Actions	• Make-good measures at receptors to ensure water availability. For example, deepening bores / off-take from process water supply pipeline. • Pump and treat seepage from beneath the TSFs using interception bores for subsequent re-use in the process plant.
Monitoring	• Monitor groundwater levels. • Monitor groundwater quality. • Quantify, record and report monthly the volume of water extracted from groundwater resources as per licence to take groundwater GEOR10338.
Reporting	• Annual groundwater management procedure review. • Annual reporting on any groundwater related incidents.

Activities and responsibilities for implementation of the GMMP are summarised below in Table E-2.

Table E-2 Activities and Responsibilities for Implementation of the GMMP.

Activity	Personnel Responsible
Groundwater monitoring and database management	KGL Environmental Officer / site personnel
Monitoring program review and optimisation and maintenance	KGL Environmental Officer / CloudGMS
Groundwater impact prediction, verification and review	KGL Environmental Officer / CloudGMS
Annual Groundwater Management Plan review	KGL Environmental Officer / CloudGMS
Groundwater Management Plan updates	KGL Environmental Officer / CloudGMS
Groundwater model review and improvement/update	KGL Environmental Officer / CloudGMS

An overview of the groundwater monitoring and management plan comprising monitoring, trigger levels and mitigation measures for the risks identified in the Supplement to the draft EIS is presented below in Table E-3. Details are provided in the sections that follow.

Table E-3 Groundwater Management and Monitoring Plan Overview

Impact / Source	Pathway	Receptor	Probability / Risk	Monitoring	Triggers	Mitigation
Water table drawdown from process water supply borefield pumping over the lifetime of mine followed by almost complete recovery post closure.	Georgina Basin Carbonate Aquifer regional groundwater flow to the east	Other groundwater users via: community bores, stock bores and domestic supply bores Riparian vegetation along large creeks	Low / Low Modelling predicts drawdown up to 3 m at other users. However, groundwater availability will not be reduced. Modelled localised impact along drainage slightly greater than criteria adopted by DEPWS. Species that may be affected are common throughout the study area.	Monitoring of water levels and quality at a network of observation bores. Monitoring of volumes and water quality pumped. Monitor vegetation (Vegetation Management Plan)	Drawdown at observation bores exceeds drawdown predicted by modelling by >20% (section 7.1).	Implement groundwater impact investigation (section 7.7) Re-calibration of model and re-assessment of predicted drawdown at receptors. Make-good measures at receptors to ensure water availability. For example, deepening bores / off-take from process water supply pipeline. Increased water efficiency to be studied and implemented if practicable. Modified pumping regimes. Implement Biodiversity Management Plan and voluntary biodiversity offset strategy Implement Mine Rehabilitation and Closure Plan
Water table drawdown and depressurisation from mine dewatering and recovery of groundwater below initial levels post closure.	Fractured Rock groundwater system, throughflow to the southeast	Other groundwater users via: community bores, stock bores, and domestic supply bores Riparian vegetation along large creeks	Low / Low Modelling predicts drawdown of less than 2 m at other users. Water table initially >15 metres below ground and greater than the criteria adopted by DEPWS. Minimal drawdown of perched groundwater in alluvial sediments along drainage supporting riparian vegetation.	Monitor vegetation (Vegetation Management Plan) Monitoring of water levels and quality at a network of observation bores. Monitoring of volumes and	Drawdown at observation bores exceeds drawdown predicted by modelling by >20% (section 7.1).	Implement groundwater impact investigation (section 7.7) Re-calibration of model and re-assessment of predicted drawdown at receptors. Make-good measures at receptors to ensure water availability. For example, deepening bores / off-take from process water supply pipeline. Implement Mine Rehabilitation and Closure Plan

Impact / Source	Pathway	Receptor	Probability / Risk	Monitoring	Triggers	Mitigation
				water quality pumped.		
Pit-lake water quality impact on areas beyond the immediate mining area post closure.	Fractured Rock groundwater system, density-driven flow to the southeast	Other groundwater users via: community bores, stock bores, and domestic supply bores	Low / Low	Monitoring of water levels and quality at a network of observation bores.	Groundwater gradient not towards pit-lake following closure.	Implement Mine Rehabilitation and Closure Plan Ensure pit-lake forms with adequate gradient to maintain groundwater sink. Scenario assessments with groundwater model verified against 2-3 years of operational data to confirm optimum closure plan.
Waste rock dumps (WRD) water quality impact on areas beyond the immediate mining area	Fractured Rock groundwater system, discharging to the southeast	Other groundwater users via: community bores, stock bores, and domestic supply bores	Low / Low Water table is at approximately 20-30m depth, surface expression of seepage very unlikely. WRD leachate quality is identified as being NAF. Seepage only occurs under high intensity rainfall events. There is no expected impact, and dilution down gradient would effectively mitigate potential impacts. Seepage ultimately captured by pit-lake sinks located down gradient of WRDs. The distance to down gradient receptors exceeds 20km.	Monitoring down gradient of WRDs for groundwater levels and quality.	Groundwater levels rise above levels predicted by modelling by >20% (section 7.1). Water quality changes lowering the beneficial use category of the groundwater source from p80 baseline values for Fracture Rock (section 7.2).	Groundwater impact investigation of seepage on receptors. LoM seepage management if required, for instance pump and treat, or pump and re-use. Ensure pit-lake forms with adequate gradient to maintain groundwater sink post-closure.

Impact / Source	Pathway	Receptor	Probability / Risk	Monitoring	Triggers	Mitigation
Tailings leachate seepage from tailings storage facility (TSF) water quality impact on areas beyond the immediate mining area	Fractured Rock groundwater system, discharging to the southeast away from	Other groundwater users via: stock bores,	Moderate / Low Water table is at approximately 20-30m depth, surface expression of seepage very unlikely. TSF leachate quality is identified as being similar to the process water supply during operations although ultimately PAF. Underdrainage implemented to intercept seepage from TSF. Seepage ultimately captured by pit-lake sinks located down gradient of TSF. Groundwater flow is away from community and domestic supply bores. There is no expected impact, and dilution down gradient would effectively mitigate potential impacts. The distance to closest down gradient receptors exceeds 8km.	Monitoring down gradient of TSF for groundwater levels and quality.	Groundwater levels rise above levels predicted by modelling by >20% (section 7.1). Water quality changes lowering the beneficial use category of the groundwater source from p80 baseline values for Fracture Rock (section 7.2).	Groundwater impact investigation of seepage on receptors. LoM seepage management if required, for instance pump and treat, or pump and re-use. Ensure pit-lake forms with adequate gradient to maintain groundwater sink post-closure.
Groundwater contamination from spills at the mine site and along the process water supply pipeline corridor	Vertical Seepage via unsaturated zone, then lateral migration in aquifer.	Other Groundwater users: Stock Community Pastoral Stations	Low / Low Risk managed by appropriate transport and storage of hazardous materials	Detailed reporting of all spills and clean- up	Event based	Spills will be managed in accordance with the Environmental Management Plan (EM Plan) and the Emergency Response Management Plan (ERMP) including the Environmental Incident Investigation Procedure.

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Abbreviations and acronyms

DEPWS	Department of Environment, Planning and Water Security (formerly DENR)
DITT	Department of Industry, Tourism and Trade (formerly DPIR)
EPA	Environmental Protection Agency
GIS	geographical information system
GL	gigalitre (10^9 litres)
kL	kilolitre (10^3 litres)
km	kilometre
km^2	square kilometre

L/s	litres per second
m^2/d	metres squared per day
m^2/d	metres squared per day
m^3	cubic metre
m^3/d	cubic metres per day
m^3/s	cubic metres per second
ML	megalitre (10^6 litres)
ML/a	megalitre per year
mAHD	metres above Australian Height Datum
mbgl	metres below ground level
mm	millimetre
mm/d	millimetre per day
SRTM	Shuttle Radar Topographic Mission
T	Transmissivity (metres squared per day)

1 Introduction

1.1 Background

This Groundwater Monitoring and Management Plan (GMMP) has been prepared to address the issues associated with the predicted impacts on groundwater at and surrounding the site from the proposed Jervois Base Metal Mine (Jervois Project). It sets out the groundwater monitoring program for the Jervois Project site and the associated groundwater impact triggers that will invoke further assessment and groundwater impact management.

The GMMP will be administered as a supporting document to the revised Mine Management Plan.

1.2 Purpose and scope

This report is a GMMP for the Jervois Project. This GMMP supports an overarching Water Management Plan.

The draft GMMP examines and addresses all issues relevant to the impacts to groundwater resources through use by the Jervois Project, and to limit the quantity of groundwater that is contaminated.

The actual and potential risks of environmental harm to the receiving groundwaters posed by mining activities have been identified and management actions that will effectively minimise these risks are presented.

Specific outcomes of the GMMP include:

- Not reducing the water availability to other users from mining activities; and
- Not adversely affect groundwater quality due to mining activities by reducing the environmental values.

The draft GMMP will be updated in accordance with future Mining Management Plans (MMPs) as required for relevance and consistency with future approvals and operations.

The GMMP includes:

- a framework identifying the location, timing, methods and parameters for the collection of further groundwater information;
- a program to monitor groundwater levels at nearby stock and community bores;
- robust groundwater level baseline data capturing seasonal changes over at least 12 months at all proposed groundwater abstraction monitoring bores, including borefield and nearby stock and community bores;

The GMMP:

- seeks to actively and continuously improve the knowledge of aquifers and groundwater levels and quality that may be affected by the proposal and incorporates these into the groundwater flow model that is used for groundwater impact assessments;
- was developed in consultation with relevant stakeholders, including other groundwater users;
- was independently peer reviewed by a suitably qualified independent professional;
- was developed and implemented to the satisfaction of the relevant regulator;
- will be reviewed at least annually; and
- reports all water monitoring data with an assessment of the impacts on groundwater hydrology in an annual Water Management Report.

It is the intention of this report that it satisfies the relevant regulator and that it shall be implemented at site as the Jervois Project develops.

Water will be managed at the Jervois Project in accordance with ANZECC / ARMCANZ (2013). Management of groundwater and will be aligned with the 5 guiding principles:

- **Protection of specified environmental value:** The current and future land use of the area is considered to be pastoral (cattle). Application of stock water ANZECC values will be used as groundwater trigger values.
- **Polluter pays principle:** The site will be constructed, operated and rehabilitated in accordance with the Mining Management Act (MM Act). The MM Act requires the Proponent to report to the Department of Mines and Energy (DME) environmental data to assess and understand potential impacts from the Jervois Project. In accordance with the MM Act, a security bond will be provided as part of the initial grant and maintaining Mine Authorisation. The security bond reinforces the polluter pays principle whereby the bond will be returned to the Proponent following successful rehabilitation or utilised by DME to complete rehabilitation (if the Proponent is not able to due to unforeseen circumstances).
- **Intergenerational equity:** Currently the predominate use for groundwater in the immediate vicinity of the Jervois Project mine site and processing site is for pastoral use (i.e. stock drinking water). The development of the Jervois Project will be undertaken with consideration of current and potential future generations of pastoralists.
- **Precautionary principle:** In-lieu of a long record of observational data, groundwater flow modelling has been undertaken to assess the potential impact of the Jervois Project on surrounding groundwater resources. In accordance with the risk-based approach and implications of the polluter pays principle, the GMMP will be implemented under a precautionary principle, that is 'where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation' (ANZECC / ARMCANZ, 2013).
- **Ecologically sustainable development:** The Jervois Project will be managed in accordance with the above principles to promote ecologically sustainable development.

1.3 Regulation

The primary tool for managing and protecting the Northern Territory's water resources is the Water Act, administered by the Department of Environment, Planning and Water Security (DEPWS), which provides for the investigation, allocation, use, control, protection, management and administration of water resources.

Previously extraction and dewatering activities were governed under the Mining Management Act (MM Act), administered by the Department of Industry, Tourism and Trade (DITT).

The Water Legislation Amendment Bill 2018 recently passed the Legislative Assembly on 28 November 2018. The amended Water Act commenced on 31 December 2018.

These changes mean that the amended Water Act applies to water use by mining activities and that a range of licence and permitting requirements will be required. The term 'water use' encompasses the following:

- Interfering with a waterway (e.g. diversions, dams, weirs etc.);
- Taking water from a waterway for other than stock and/or domestic purposes;
- Taking groundwater for other than stock and/or domestic purposes;
- Doing bore work (e.g. drilling, deepening, decommissioning, etc. water bores); and
- Recharging an aquifer.

Taking water for domestic use (drinking and household use) by a mining activity from a waterway or a bore on site will not require the grant of a water extraction licence under the Water Act.

These changes will also mean that:

- Water bore work for a mining activity must be undertaken by, or under the supervision of, a driller granted the relevant licence under the Water Act;
- Water bore work undertaken for a mining activity in a Water Control District will require a permit granted under the Water Act; and
- Taking water from a waterway or from a bore (including for dewatering) by a mining activity, for other than stock and/or domestic use, will require a licence granted under the Water Act.

The key requirements of the Water Act that will be applicable to the Jervois Project include:

- Water extraction licence for bores extracting groundwater.

A water licence is usually granted for 10 years, but longer term licences can be approved in special circumstances.

1.3.1 Water Allocation Plans

The Jervois Project mine site is not located within or near any Water Control District (WCD).

1.3.2 Water Extraction Licences

A water extraction licence is required when extracting surface water or groundwater in a Water Control District or when extracting groundwater more than 15 L/s outside of a Water Control District. The predicted Jervois Project water demand exceeds 15 L/s and thus a water extraction licence would be required for the process water supply borefield.

A licence to take groundwater (GEOR10338) has been granted by the DEPWS. The licence is for a maximum annual volume of 1595.4 ML commencing 01/05/2021 and expiring 30/05/2031.

1.4 Report structure

The Groundwater Monitoring and Management Plan is structured as follows:

Section 2: describes the existing environment, principal aquifers of interest around the Jervois Project site and the local use of groundwater.

Section 3: describes the environmental values and beneficial uses of groundwater in the area surrounding the Jervois Project.

Section 4: describe the groundwater use in the groundwater systems surrounding the Jervois Project.

Section 5: describes the predicted impacts on groundwater from the Jervois Project operations.

Section 6: describes the groundwater monitoring program for the Jervois Project site including monitoring locations, monitoring frequency, and the parameters to be recorded/analysed.

Section 7: sets out the groundwater trigger action response plan (TARP) identifying the impact triggers and protocols for investigating, and if required, mitigating the impacts on groundwater from the Jervois Project operations.

Section 8: describes the process of continual review and improvement of the GMMP to ensure it continues to meet its objectives.

2 Existing Environment

2.1 Hydrogeological setting

The hydrogeological setting is described in detail in the Jervois Project EIS, and related Groundwater Impact Assessment (CloudGMS, 2018a) and Supplement to the Groundwater Impact Assessment. This Groundwater Monitoring and Management Plan (GMMP) should be read in conjunction with those documents.

The Jervois Project mine site hosts orebodies that extend below the water table, in a Fractured Rock groundwater system which is very low yielding with water generally suitable for pastoral and industrial use only.

The Jervois Project process water supply is extracted from the regionally extensive Georgina Basin Carbonate aquifer via a planned borefield comprising at least 6 bores located about 20 km north of the mine site. Water in the Georgina Basin Carbonate aquifer at the borefield site is potable.

Regionally the groundwater system recharges via direct infiltration particularly where fractured rock aquifers are exposed, and through infiltration along creeks. Groundwater seeps to the highly transmissive Georgina Basin Carbonate aquifer and moves through the basin toward the east for eventual discharge many hundreds of kilometres from the Jervois Project site.

2.2 Principal groundwater systems at the Jervois Project site

The hydrogeology within 40 km of the Jervois Project mine is described by Ride (2016, 1971) and CloudGMS (2018). The hydrogeology of the study area can be separated into two distinct groundwater systems:

- the Fractured Rock aquifer system of the Arunta Region typified by fractured and weathered metasediments with minor groundwater resources; and
- the Georgina Basin Carbonate Aquifer system typified by karstic and fractured sedimentary rocks which host regionally extensive groundwater resources.

The Fractured Rock aquifer system of the Arunta Region and the Georgina Basin Carbonate Aquifer locations relative to the Jervois Project mine site and process water supply borefield are presented below in Figure 4-2.

2.2.1 Hydrogeology of the Fractured Rock aquifer system

Numerous local minor aquifers occur within the granites, pegmatites and other basement formations of the Arunta Region. Groundwater yield and storage within these aquifers relies on fractures and jointing, they typically form poor to marginal aquifers that are only suitable for stock and minor domestic supply. Previous investigations in similar rocks beyond the mine site indicate yields ranging between 0.5 and 2.5 L/s.

The groundwater system in the mine area is within the fractured and weathered rocks of the Bonya Metamorphics. Metamorphic rocks such as schist and gneiss have low permeabilities and generally contain small amounts of groundwater which is commonly brackish to saline. Information on the hydrogeology of the fresh rocks at greater depths is limited.

A recent groundwater investigation (CloudGMS, 2018) recorded typical flows of about 0.01 L/s, with several sites recording no flow. One site, located on an interpreted fault, yielded 6 L/s and was pump tested. Higher yielding areas are related to localised zones of more intense local fracturing and jointing (CloudGMS, 2019a).

2.2.2 Hydrogeology of the Georgina Basin Carbonate Aquifer system

Groundwater resources capable of meeting the water demand for the process water supply (45 L/s) have been located within the southern Georgina Basin in the regionally extensive fractured and karstic rocks of the Arrinthrunga Formation and Arthur Creek Formation. The Georgina Basin Carbonate Aquifer is part of the regionally extensive Georgina Basin that underlies approximately one quarter of the Northern Territory and extends beneath the northwest of Queensland (CloudGMS, 2018a; CloudGMS, 2019b).

The Georgina Basin represents a large regional scale groundwater resource of ~1,320,000 GL, assuming a specific yield of 0.04, a saturated accessible thickness of 100m and an area of ~330,000 km^2.

2.3 Existing groundwater conditions

Recent investigations have sited bores in the Georgina Carbonate aquifer system, to the north of the Jervois Project mine site (CloudGMS, 2018b; Groundwater Enterprises, 2019). These bores have typically yielded ~10 L/s.

Baseline groundwater monitoring was undertaken as part of the Jervois Project EIS (CloudGMS, 2018a). The methodology undertaken for the assessment of groundwater resources included:

- the review of geological, hydrogeological and groundwater quality data collected for the Jervois Project;
- the review of other background data available on local hydrogeology and groundwater use;
- the installation of 2 test production and 14 monitoring bores to characterise the local hydrogeology in the Fractured Rock aquifer system around the Jervois Project mine site;
- the installation of 5 production bores, 2 test production and 11 monitoring bores to characterise the local hydrogeology in the Georgina Carbonate aquifer system around the Jervois Project process water supply;
- the undertaking of aquifer pumping tests to determine aquifer parameters; and
- the formulation of a hydrogeological conceptual model to serve as the basis for a numerical model.

The detail of the baseline groundwater assessment is presented within the Jervois Project EIS and SEIS (CloudGMS, 2018a and CloudGMS 2019b).

Baselines have been defined for monitoring bores associated with the groundwater monitoring program for existing operations at the Jervois Project. Long term monitoring of bores for the expanded groundwater monitoring program which covers the Jervois Project will be undertaken to establish bore-specific groundwater level and quality baselines.

2.3.1 Groundwater levels

Groundwater levels have been obtained for investigation, monitoring and production bores drilled during the groundwater assessments conducted in 2018 (CloudGMS, 2018b; CloudGMS, 2019a; Groundwater Enterprises, 2019). The groundwater levels in the vicinity of the Jervois Project mine site are presented below in Table 2-1. The groundwater levels in the vicinity of the Jervois Project process water supply are presented below in Table 2-2.

2.3.2 Groundwater quality

Representative groundwater quality sampling for the Fractured Rock and Georgina Basin Carbonate Aquifer groundwater systems as determined from the recent groundwater investigations (CloudGMS, 2018a; CloudGMS, 2018b; Groundwater Enterprises, 2019) are presented below in Table 2-3.

Table 2-1 Groundwater levels Jervois Project mine site

Reg No	Bore_ID	Elevation	Stick-up	RL_TOC	Standing Water Level (mBGL)	RWL	Comment
RN019800	J1	362.2	0.5	362.65	18.82	343.83	Monitoring
RN019801	J4	348.5	0.5	348.88	12.58	336.30	Monitoring
RN019802	J6	347.8	0.5	348.21	15.03	333.18	Monitoring
RN019796	J7	345.8	0.5	346.33	16.38	329.95	Test production
RN019821	J8	347.3	0.6	347.81	17.22	330.59	Test production
RN019820	J10	347.0	0.7	347.57	Not Static	-	Monitoring
RN019813	J11	363.3	0.4	363.68	28.54	335.14	Monitoring
RN019815	J13	364.6	0.8	365.26	31.00	334.26	Monitoring
RN019818	J15	359.8	0.7	360.4	23.58	336.82	Monitoring
RN019797	J16	348.2	0.5	348.6	15.14	333.46	Monitoring
RN019799	J18	354.0	0.5	354.39	22.40	331.99	Monitoring
RN019814	J19	362.1	0.5	362.46	31.48	330.98	Monitoring
RN019798	J21	352.8	0.5	353.25	25.54	327.71	Monitoring
RN019817	J22	370.1	0.7	370.72	Dry	-	Monitoring
RN019819	J23	360.7	0.6	361.2	27.76	333.44	Monitoring
RN019816	J24	362.0	0.8	362.76	29.45	333.31	Monitoring
RN010121		347.0	0.3	347.3	14.18	333.12	
RN006910		343.1	0.7	343.84	20.45	323.39	Windmill
RN007598		342.0	1.0	343.03	Not accessible	-	Camp Bore
RN010323		345.2	0	345.21	14.52	330.69	Shaft Bore
RN012917		338.0	0	338.03	17.04	320.99	Solar Bore

Table 2-2 Groundwater levels Jervois Project process water supply

Reg No	Bore ID	Elevation	Stick-up	RL TOC	Standing Water Level (mBGL)	RWL	Bore
RN019782	LCP1	TBA	0.5		14.21		Test Production
RN019774	LC1	TBA	0.4		11.82		Monitoring
RN019776	LC3	TBA	0.5		11.31		Monitoring
RN019775	LC4	TBA	0.4		20.3		Monitoring
RN019793	LC5	TBA	0.5		14.46		Monitoring
RN019781	LC6	TBA	0.5		21.27		Monitoring
RN019794	LCP2	TBA	0.7		12.04		Test Production
RN019778	LC9	TBA	0.5		9.58		Monitoring
RN019779	LC14	TBA	0.4				Monitoring
RN019780	LC15	TBA	0.5		12.34		Monitoring
RN019950	LC21	TBA			12.63		Production
RN019951	LC22	TBA			-		Abandoned
RN019949	LC23	TBA			-		Abandoned
RN019948	LC24	TBA			35.47		Monitoring
RN019957	LC25	TBA			-		Abandoned
RN019952	LC26	TBA			14.47		Production
RN019953	LC27	TBA			20.64		Production
RN019954	LC28	TBA			17.28		Production
RN019955	LC31	TBA			12.62		Monitoring
RN019956	LC32	TBA			14.2		Monitoring
RN019958	LC33	TBA			12.75		Production

Table 2-3 Jervois mine site and Lucy Creek borefield groundwater in situ (field) data and laboratory results

Analyte	Units	Limit of reporting	J7	J8	Camp Bore	LCP1	LCP2	LC21	LC26	LC27	LC28	LC33	p80 mine	p80 borefield
Date								4/6/19	15/6/19	14/6/19	31/5/19	18/6/19		
FIELD DATA														
Electrical Conductivity	uS/cm	-	1810	3290	3760	688	2660	4500	580	651	1900	1370	**3572**	**2508**
pH	pH unit	-	6.96	7.07		6.96	7.07	6.87	7.38	7.1	7.26	7.01	**7.0**	**7.2**
Temperature	° C	-	28.3	29.3		28.3	29.3	27.7	28.7	27.4	27.3	27.4	**29.1**	**28.6**
LABORATORY PHYSICAL PARAMETERS														
Electrical Conductivity	uS/cm	1	1810	3290	3760	657	2650	6480	553	443	497	1870	**3572**	**2494**
Total Dissolved Solids	mg/L	10	1020	2000	2080	394	1570	4210	359	288	323	1220	**2048**	**1500**
Total Hardness	mg/L	1	494	595	915	324	612	1770	272	218	133	511	**787**	**592**
Total Alkalinity	mg/L	1	451	797	718	338	464	395	283	220	112	543	**765**	**450**
LABORATORY TOTAL METALS														
Aluminium	mg/L	0.01	<0.01	0.01	<0.01	<0.01	0.05						**0.01**	**0.05**
Arsenic	mg/L	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**
Boron	mg/L	0.05	0.37	0.83	0.78	0.05	0.68	0.62	<0.05	<0.05	0.15	0.41	**0.81**	**0.63**
Barium	mg/L	0.001	0.016	<0.001	0.002	0.275	0.029	0.007	0.063	0.026	0.007	0.052	**0.013**	**0.061**
Beryllium	mg/L	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**
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**<0.0001**	**<0.0001**
Cobalt	mg/L	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**
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.003**	**0.004**
Copper	mg/L	0.001	0.003	0.003	<0.001	<0.001	<0.001	<0.001	0.006	0.001	0.002	<0.001	**<0.001**	**<0.001**
Iron	mg/L	0.05	0.41	0.21	<0.05	<0.05	0.18							
Mercury	mg/L	0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		**0.18**
Manganese	mg/L	0.001	0.316	0.026	0.002	<0.001	0.002	0.007	0.002	0.011	0.003	0.005	**0.0001**	**<0.0001**
Nickel	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.002	<0.001	**0.2**	**0.007**
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		

Analyte	Units	Limit of reporting	J7	J8	Camp Bore	LCP1	LCP2	LC21	LC26	LC27	LC28	LC33	p80 mine	p80 borefield
Selenium	mg/L	0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**<0.001**	**0.0028**
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.002	<0.01	<0.01	<0.01	0.01	**<0.001**	**<0.001**
Uranium	mg/L	0.001	0.013	0.021	0.025	0.004	0.006						**0.01**	**<0.01**
Zinc	mg/L	0.005	0.009	<0.005	<0.005	<0.005	<0.005	0.012	0.012	0.008	0.023	0.006	**<0.01**	**0.0084**
LABORATORY DISSOLVED MAJOR ANIONS													**0.023**	**0.006**
SO4 as Sulfate	mg/L	1	259	388	414	11	341	1640	9	8	48	149	**0.009**	**0.014**
Chloride	mg/L	1	179	387	584	14	436	1200	11	12	59	279		
LABORATORY DISSOLVED MAJOR CATIONS													**404**	**303**
Calcium	mg/L	1	76	80	129	77	80	294	53	46	32	86	**505**	**405**
Magnesium	mg/L	1	74	96	144	32	100	252	34	25	13	72		
Sodium	mg/L	1	157	429	374	18	273	841	24	18	59	229	**109**	**85**
Potassium	mg/L	1	5	6	7	3	12	31	2	1	1	5	**125**	**94**

Note: The 80th percentile (p80) value for the mine site (J7, J8 & Camp Bore) and process water supply (LCP1, LCP2, LC21, LC26, LC27, LC28 & LC33) are derived using the percentile statistical function in excel. It is limited by the current number of samples available for the two groundwater systems.

3 Environment Values and Beneficial Uses of Groundwater

3.1 Environmental values

There are no identified groundwater dependant ecosystems (GDEs) within 60 km of the proposed Jervois Project. The depth of the water table in proximity to the Jervois Project is generally too deep to support terrestrial groundwater dependent ecosystems. Riparian vegetation shown to be reliant on shallow groundwater may potentially access the regional groundwater at times, however, it is more likely that this vegetation is reliant on the water available in the alluvial sediments associated with the larger creeks, hence the very limited extent of vegetation beyond the river channels. The riparian vegetation along the sections of river channel that overlie the areas impacted by lowering of the regional groundwater are unlikely to be adversely affected as these areas are replenished by surface flows.

A desktop review of stygofauna (subterranean fauna GDEs) and a survey of bores installed during the process water supply borefield investigation was undertaken. This study encountered 1 count of a commonly found taxa and it was concluded that stygofauna are unlikely to be a factor for this Jervois Project due to the limited impact on a commonly found very extensive possible habitat and the groundwater quality being only potentially suitable on the basis of total dissolved solids (frc environmental, 2019).

3.2 Beneficial uses

There are no beneficial uses as declared under the Water Act, or sites of conservation significance in the vicinity of the Jervois Project. However, in the absence of groundwater quality data beneficial uses have been identified using the ANZECC & ARMCANZ (2000) guideline to provide targets for the groundwater trigger values. The beneficial use of groundwater at the Jervois Project mine site is summarized in Table 3-1. Groundwater at the mine site is suitable for pastoral use and the Jervois Project process water supply borefield site is suitable for potable and pastoral uses.

Table 3-1 Groundwater beneficial uses

Site	Aquifer	Groundwater Beneficial Use	Water Quality constraints
Mine	Fractured Rock	Pastoral / Industrial	TDS > 1000 mg/L, Fluoride and Iron exceeds drinking water guidelines
Process borefield	Georgina Basin Carbonate	Potable / Pastoral	Salinity sometimes exceeds aesthetic drinking water guidelines

Groundwater is currently used for:

- stock watering with the nearest stock bore located 15 km from the proposed process water supply borefield,
- community water supply with the nearest bores at Orrtipa-Thurra (Bonya) community 18km from the mine site and 30 km from the proposed process water supply borefield, and
- pastoral stations potable water supplies with the nearest bore at Lucy Creek Station, approximately 15 km from the proposed Jervois Project process water supply borefield.

4 Groundwater Use at the Jervois Project

4.1 Current and future groundwater use at the Jervois Project

The Jervois Project comprises three open pit mines, three underground mines, three waste rock dumps and a 2 cell tailings storage facility. The process water supply comprises a borefield pumping up to 1.6 GL/year. About 1.6 million tonnes of ore will be processed per annum to produce about 250,000 tonnes of contained copper during the life of the Jervois Project. Ore production will decrease in the final year of the Jervois Project as ore reserves are depleted.

The main operational water supply for the Jervois Project is from a borefield to the north of the mine site, augmented by recycling of groundwater that seeps into the underground mining operations. Mine inflows / seepages will be pumped to a collection sump at the portal of each mine before being pumped back to the underground dewatering dam or the process water dam. Groundwater that seeps into the underground mining operations is expected to be of good quality (suitable for use to supply raw water demands in the process plant).

4.1.1 External process water supply borefield

Due to the poor groundwater yields from rocks at the mine site, a borefield will be established external to the mine site area to provide process water to the mine site. A borefield capable of producing up to 2000 ML/year for 10 years was installed in 2019. Bores were completed into the Georgina Basin Carbonate Aquifer at a site 20 km to the north of the mine site (Groundwater Enterprises, 2019).

A licence to take groundwater (GEOR10338) has been granted by the Department of Environment, Planning and Water Security. The licence is for a maximum annual volume of 1595.4 ML commencing 01/05/2021 and expiring 30/05/2031.

4.1.2 Potable water and wastewater treatment

A potable water treatment plant will be located at the Jervois Project to supply potable demands to the workforce (WRM, 2018). Wastewater from the accommodation camp and offices will be treated by a septic system, with disposal of treated effluent to ground in the vicinity of the camp (WRM, 2018).

4.1.3 Underground dewatering dam

Underground water dewatering surge pond will be located adjacent the PWD with water transferred to the Process Water Dam via gravity or to the Process Plant Water tank via pumping, as need be. Flexibility is needed for water from underground as it is generally of high quality and should be generally stored separately to ensure it does not unnecessarily mix with mine affected and sediment laden water that is stored in the process water dam. A water & oil separator will be included in the circuit to account for potential hydrocarbon presence in the recovered underground water.

The underground dewatering dam will likely commence as standalone tank(s) and is likely to become a standalone turkeys nest (i.e. has no catchment except for the dam itself) and has a storage capacity of around 10 ML. Underground derived water will overflow into the Process Water Dam (WRM, 2018).

4.1.4 Site water balances

WRM developed a concept site water balance as part of the Jervois Project EIS (WRM, 2018) which is presented below in Figure 4-1. The site water balance will be reviewed annually to assess the historical performance of the water management systems as well as forecast performance over the following two years.

Groundwater Use at the Jervois Project

The annual updates of the projected water balance for the Jervois Project will be incorporated into the Groundwater Monitoring and Management Plan, including detailed estimates for the various phases of the Jervois Project and specifying the source and quantity of the water to be used.

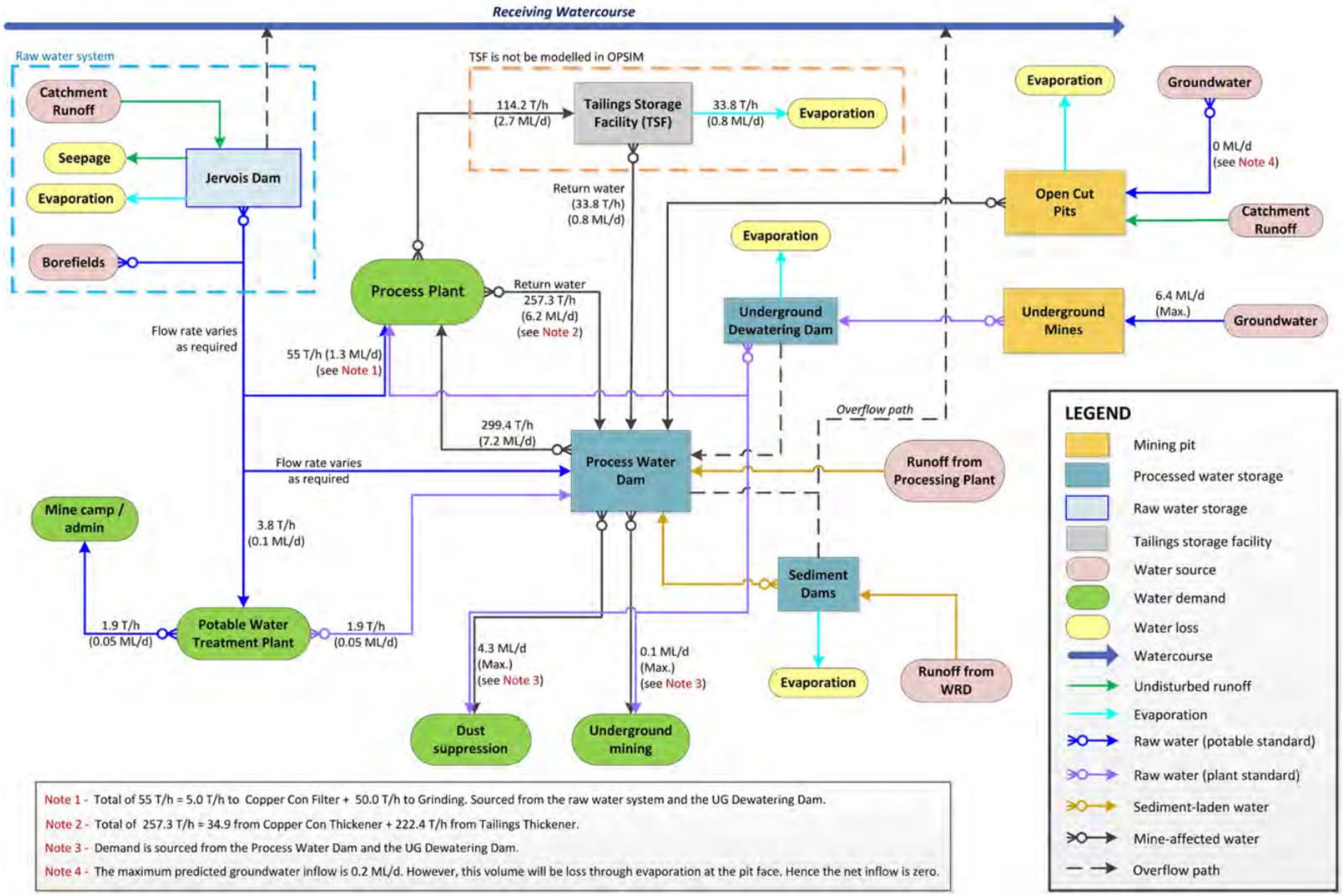

Figure 4-1 Mine site water management system schematic showing water balance components.

4.2 Groundwater use external to the Jervois Project

4.2.1 Community and outstation water supply bores

Groundwater is the source of water supply at Orrtipa Thurra community to the southwest of the mine site and Maperte outstation to the northeast of the mine site. Inspection of the bores at the Maperte outstation indicate that this outstation has not been utilised for some time.

The details of the production bores at Orrtipa Thurra community and Maperte outstation are presented below in Table 4-1 and their locations are presented in Figure 4-2.

Table 4-1 Details of bores used for community and outstation water supplies.

Site ID	Location	Completion Depth (mBGL)	Screen Interval (mBGL)	SWL (mBGL)	Available Drawdown (m)
RN016189	Orrtipa-Thurra	29.2	17 - 29.2	11.1	5.9
RN018072	Orrtipa-Thurra	36.5	29 - 33	13.6	15.4
RN018073	Orrtipa-Thurra	30.5	25.2 - 27.2	13.2	12.0
RN016283	Maperte Outstation	48.8	31 - 37	25.0	6.0

4.2.2 Pastoral bores

The details of the stock and domestic bores on Jervois Station and Lucy Creek Station are presented below in Table 4-2. The locations of the stock watering bores and the domestic water supply bores within 25 km of the Jervois Project mine site and process water supply and the aquifer types are presented below in Figure 4-2.

Table 4-2 Details of bores used for stock and domestic water supplies.

Bore Id	Property (Use)	Completion Depth (mBGL)	Screen Interval (mBGL)	SWL (mBGL)	Available Drawdown (m)
RN000580	Jervois (Stock)	41.2	-	21	<20.2
RN002874	Jervois (Stock)	44.8	-	33.8	<11.0
RN002880	Jervois (Stock)	34.4	28.9 - 34.4	19.5	9.4
RN006901	Jervois (Stock)	48.8	-	-	-
RN010311	Jervois (Stock)	132.6	-	21.97	<110.6
RN012917	Jervois (Stock)	61.8	46.8 - 61.8	15	31.8
RN013675	Jervois (Stock)	52	40 - 52	32.7	7.3
RN013677	Jervois (Stock)	52	40 - 52	11	29.0
RN013678	Jervois (Stock)	41	29 - 41	17	12.0
RN014242	Jervois (Stock)	31	-	9	<22.0
RN015978	Jervois (Stock)	52	46 - 52	26	20.0
RN018077	Jervois (Stock)	29.2	38 - 44	18.5	19.5
RN018078	Jervois (Stock)	48.8	31 - 37	15.6	15.4
RN011107	Lucy Creek (Homestead)	27.6	-	7.2	<20.5
RN011495	Lucy Creek (Homestead)	18.6	-	7.6	<11.0
RN013689	Lucy Creek (Homestead)	14.8	8.8 - 14.8	6.68	2.1

Bore Id	Property (Use)	Completion Depth (mBGL)	Screen Interval (mBGL)	SWL (mBGL)	Available Drawdown (m)
RN000626	Lucy Creek (Stock)	52.4	-	18.3	<34.1
RN001864	Lucy Creek (Stock)	137.2	-	34.7	<102.5
RN001870	Lucy Creek (Stock)	137.2	-	36.6	<100.6
RN002275	Lucy Creek (Stock)	111.3	-	-	-
RN004779	Lucy Creek (Stock)	81.7	-	-	-
RN010314	Lucy Creek (Stock)	274.3	-	-	-
RN011101	Lucy Creek (Stock)	88.5	-	15.25	<73.3
RN011102	Lucy Creek (Stock)	28	-	20.74	<7.3
RN011103	Lucy Creek (Stock)	32.3	-	-	-
RN011104	Lucy Creek (Stock)	131	-	-	-
RN012037	Lucy Creek (Stock)	137	-	44	<93.0
RN012038	Lucy Creek (Stock)	46	40 - 46	28	12.0
RN012989	Lucy Creek (Stock)	34	28 - 34	19	9.0
RN012993	Lucy Creek (Stock)	18	12 - 18	6.36	5.6
RN013274	Lucy Creek (Stock)	49	43 - 49	14	29.0
RN013275	Lucy Creek (Stock)	64	58 - 64	22	36.0
RN013381	Lucy Creek (Stock)	34	25 - 31	16	9.0
RN013558	Lucy Creek (Stock)	95	89 - 95	23	66.0
RN013577	Lucy Creek (Stock)	56	50 - 56	18	32.0
RN013578	Lucy Creek (Stock)	96	84 - 90	54	30.0

During 2017 an audit of stock watering bores on Jervois Station and Lucy Creek Station was conducted by Ride Consulting (summarised in Table 4-2).

- 11 stock watering bores were located on Jervois Station and the headworks surveyed, water samples taken and standing water levels measured (2 bores).
- 20 stock watering bores have been identified on Lucy Creek Station within 25 km of the Project process water supply and 9 of these were located, headworks surveyed, water samples taken and standing water levels measured (2 Bores).

4.2.3 Pastoral bore condition survey

A condition survey of local groundwater users based on the bores listed in Table 4-1 and Table 4-2 will be completed to establish baseline conditions prior to commencing construction at the Jervois Project. The survey will be conducted subject to bore access to undertake the following measurements:

- Location (GPS);
- Description of infrastructure;
- Standing water level (metres below top of casing or other reference point);
- Total depth of bore (metres below reference point);
- Typical pump setting (if available);
- Field EC;
- Field pH; and
- Field Temp.

Previous surveys have been limited by the access to bores due to the presence of pumping equipment, further collection of baseline data will require liaising with property owners and potentially pump removal from some bores.

A desktop bore suitability assessment has been completed (CloudGMS, 2021). The assessment identified that seven existing bores (RN002874, RN010121, RN010311, RN011107, RN012993, RN013677 and RN016283) could be accessed to obtain the information identified above. These bores have been included in Table 6-2 , however, following the initial round of field measurements, the program to monitor water levels at any suitable 3rd party bores identified will be formally included in the GMMP to enhance the monitoring network installed by KGL. These bores will be used to detect whether levels are within the range of predicted drawdown.

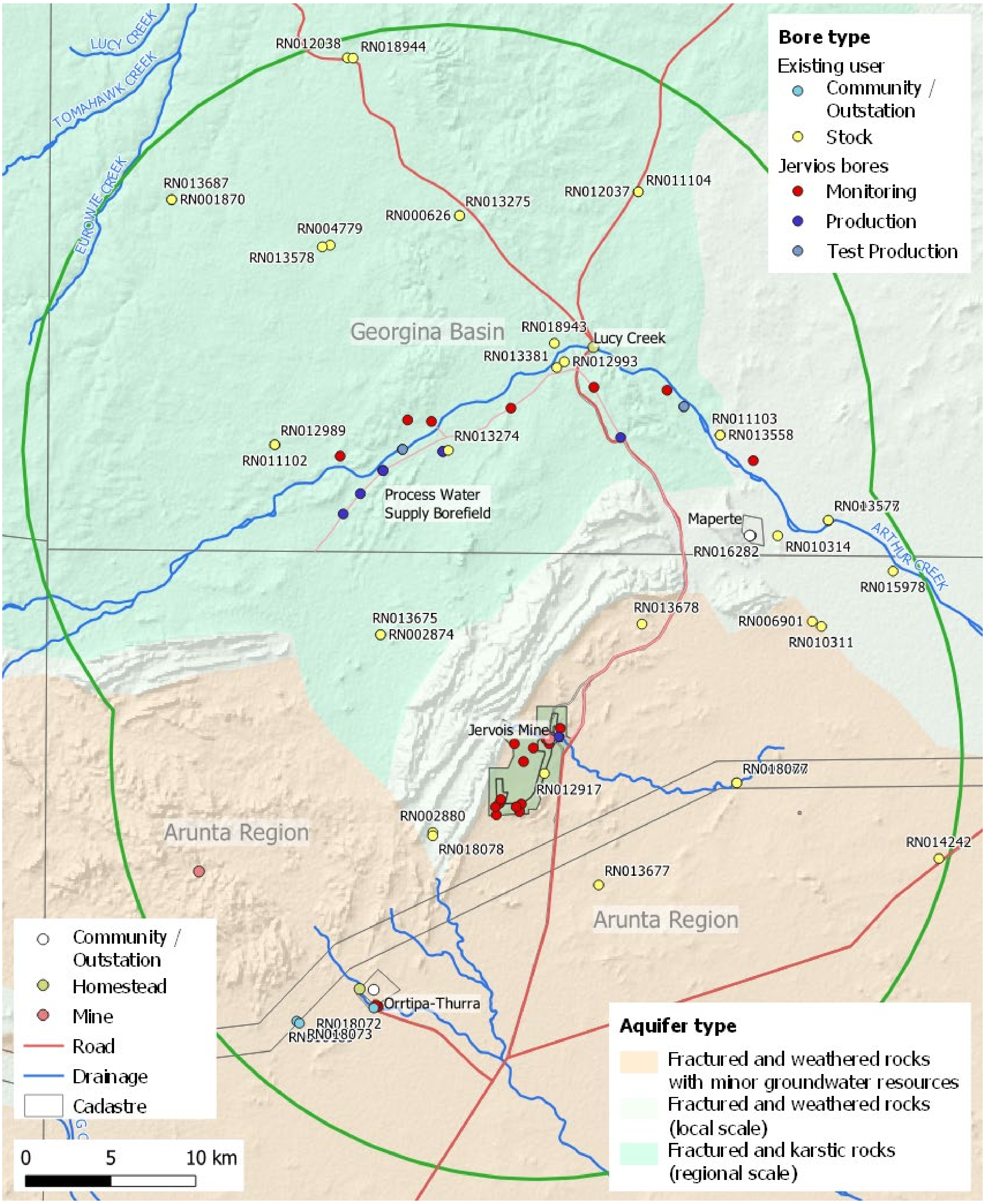

Figure 4-2 Locations of existing users within 25km of the Jervois Project mine site and the process water supply borefield.

5 Predicted Impacts on Groundwater Resources

5.1 Introduction

Groundwater levels in the Cambrian Limestone aquifer to the north of the Jervois Project site will be affected by dewatering associated with pumping from the mine process water supply (CloudGMS, 2019b). The predicted extent of the drawdown due to the process water supply is presented below in Figure 5-1.

As excavation of the Jervois Project active mine pits proceeds below the water table, groundwater will seep into the pits. Dewatering of the Bonya Schist host rock will result in the lowering of groundwater levels in the aquifer in the immediate vicinity of the Jervois Project site.

The Life of Mine (LOM) is expected to be 10 years and mining is planned to advance according to the schedule provided below:

- Reward open-pit operational from year 1 to 5
- Reward underground operational from year 5 to 10
- Reward South open-pit operational from year 6 to 7
- Rockface operational from year 1 to 5
- Bellbird open-pit operational from year 4 to 6
- Bellbird underground operational from year 7 to 10
- Process water supply operational from year 1 to 10 (45 L/s)
- Waste rock dumps operational from year 1 to 8
- Tailings storage facility (TSF) operational from year 1 to 10

It is currently assumed that the mine closure involves leaving the pit voids open and backfilling the underground voids with appropriate fill material with properties consistent with the host rock.

Following cessation of mining under these conditions, groundwater will continue to seep into the rehabilitated / backfilled final underground mine voids and groundwater levels will recover slowly and stabilise within about 100 years (CloudGMS, 2019b).

Following cessation of mining under these conditions, groundwater will continue to seep into the rehabilitated final pit voids, driven by evaporative discharge from the pit-lakes that will form in the voids. A steady state equilibrium will be reached where the pit-lake levels recover to an equilibrium where evaporation from the pit-lakes balances groundwater inflow, at a level below that of the pre-mining water table.

The Jervois Project SEIS (CloudGMS, 2019b) included the development and calibration of a transient groundwater flow model to predict groundwater drawdown in the surrounding aquifers over the life of the Jervois Project and following closure. The model and its predictions were updated as part of the SEIS (CloudGMS, 2019b). The Jervois Project Life of Mine is projected to be 10 years and is incorporated within the model by using mining zones which are activated according to the mining schedule and de-activated as they are decommissioned.

Impacts on groundwater levels will vary spatially over time as the mined area migrates across the Jervois Project site. The model predicts the greatest impacts on groundwater levels surrounding the Jervois Project will occur at the end of mining. This corresponds to the Life of Mine Plan when the deepest areas of working will result in the greatest drawdown.

Full details of the model, model calibration, predicted impacts on groundwater over the life of the Jervois Project are presented in the updated SEIS modelling report (CloudGMS, 2019b).

Following mine closure pit-lakes may form where open cut mining operations extend below groundwater level and then fill at cessation of mining and associated dewatering operations by groundwater and surface water influx. The pit-lake is expected to function as an evaporative “sink” whereby pit lake water evaporation rates exceed influx rates. The groundwater model (CloudGMS 2019b) predicted that post-mining pit lakes would develop with almost stable water levels by about 200 years post-mining at 10-40 metres below the initial water table at the sites, reducing to 10-30 metres by 1000 years post-mining, thus forming long term groundwater sinks or terminal pit lakes. As discussed in detail in section 5.3.6 below, management of local surface and groundwaters contaminated by acid and metalliferous drainage (AMD) through capture by an evaporative terminal pit lake arguably provides a best-case scenario for protection of regional water resources required by typical mine closure time scales of hundreds to thousands of years (McCullough, et al., 2012).

A summary of the predicted groundwater impacts are detailed below in Table 5-1 and the predicted impacts for LoM and post-closure stages of mine development are discussed in the following sections.

Table 5-1 Potential groundwater impacts

Groundwater Impact	LoM	Post-Closure
Water table drawdown from process water supply borefield pumping	X	
Water table drawdown from dewatering of mine features (pits and underground mines)	X	X
Groundwater contamination from waste rock dump leachate seepage	X	X
Groundwater contamination from tailings leachate seepage (LoM and Post-Closure)	X	X
Groundwater contamination from spills at the mine site	X	
Groundwater contamination from density driven flow beneath pit-lakes		X

5.2 Predicted life of mine (LoM) impacts

5.2.1 Water table drawdown from process water supply borefield

Groundwater modelling was undertaken to predict the impacts of groundwater pumping on receptors. Note that the groundwater use implemented in the groundwater modelling was assumed at the upper estimated required rate of 2 GL/yr.

The results from the drawdown analysis suggest that, for the 10 years scheduled life of mine, it is probable that:

- a maximum drawdown of 2 – 3 metres can be expected at the closest pastoral bores (RN011102 & RN013274); and
- drawdown of less than 1 metre will be observed at the Lucy Creek homestead bore (RN013689), which has an available drawdown of 11 metres based on a total depth (TD) of 15 mBGL and standing water level (SWL) 4 mBGL at 29/07/1983.

Drawdowns predicted in the Cambrian Limestone aquifer are not considered to be significant in terms of affecting the yield or access to groundwater in existing bores abstracting from the Cambrian Limestone aquifer. Importantly, current investigations demonstrate that the existing third party utilisation of groundwater sourced from the Cambrian Limestone aquifer should not be impacted by the Jervois Project.

This level of drawdown is not expected to reduce the availability of water at these bores since the pumping level in the bores is greater than 1.0 m below the water table Table 4-2.

Drawdown at the end of mining is predicted to extend less than 40 km from the borefield to the 0.5m drawdown contour. For reference the predicted drawdown contours at the end of mining (EoM) are presented below in Figure 5-1.

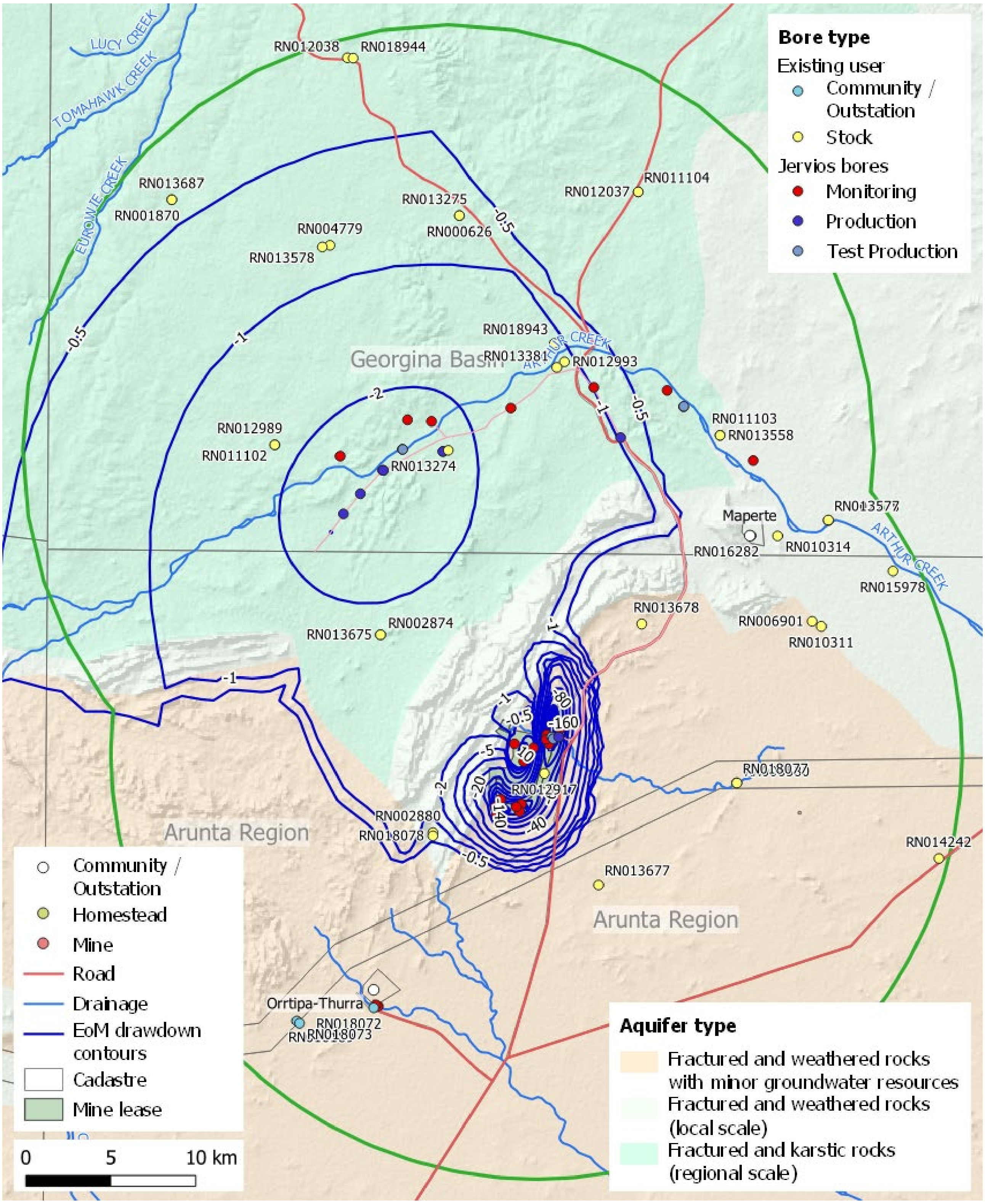

Figure 5-1 End of mine (EoM) groundwater drawdown contours.

There are no mapped Groundwater Dependant Ecosystems identified within the zone of drawdown. Riparian vegetation may be accessing the regional groundwater, however, it is more likely that this vegetation is reliant on the water available in the alluvial sediments associated with the larger creeks, as evidenced by the very limited extent of vegetation beyond the river channels. The riparian vegetation along the sections of river channel that overlie the areas impacted by lowering of the regional groundwater are unlikely to be adversely affected as

- the surface flows would not be interrupted by the Jervois Project.
- the depth to water table and ephemeral flow conditions indicates that these are losing streams, with the rate of leakage governed by the height of water in the creek when flow events occur, and any increased depth to water table due to mining would not induce any additional leakage from the creek.

5.2.2 Water table drawdown from dewatering during mining

Groundwater modelling was undertaken to predict the impacts on receptors due to mine dewatering via the Fractured Rock groundwater system.

The results from the drawdown analysis suggest that, for the 10 years scheduled life of mine, it is probable that a maximum drawdown of 0.5 – 1.0 metres can be expected at a distance of less than 3 km from the tenement boundary.

Groundwater levels at RN012917 are expected to decline below the available drawdown of the bore at the end of mining, however, groundwater levels are expected to recover to within 30 metres of the initial levels.

5.2.3 Leachate seepage from waste rock dumps (WRDs)

WRD leachate quality is identified as being predominantly non-acid forming (NAF). Seepage only occurs under high intensity rainfall events and dilution effects are expected as the seepage mixes with the ambient groundwater as it migrates down gradient.

The fate of leachate downgradient of the waste rock dumps (WRDs) has been forecast using the flow field calculated by the numerical groundwater modelling and random walk particle tracking. The WRDs downgradient seepage is expected to be slow due to the low permeability of the Fractured Rock groundwater system and ultimately any WRD seepage is expected to be captured by the local groundwater sinks formed at the Bellbird, Reward and Reward South pit-lake.

There are no receptors within this distance, and the beneficial use of the water will be unchanged.

5.2.4 Leachate seepage from tailings storage facility (TSF)

TSF leachate quality is identified as being similar to the process water supply during operations, although potentially acid forming (PAF) post mining. Underdrainage is designed to intercept seepage, with dilution effects influencing the seepage quality due to mixing with the ambient groundwater as it migrates down gradient.

The fate of leachate downgradient of the TSF has been forecast using the flow field calculated by the numerical groundwater modelling and random walk particle tracking (CloudGMS, 2019b). The TSF downgradient seepage is expected to be slow due to the low permeability of the Fractured Rock groundwater system and ultimately any TSF leachate is expected to be captured by the local groundwater sink form at the Reward and Reward South pit-lakes.

There are no receptors within this distance, and the beneficial use of the water will be unchanged.

5.2.5 Leachate seepage from landfill facility

A landfill will be constructed at the Project site adjacent the solar array as shown in Figure 1 below, for the disposal of general and non-hazardous solid waste. The landfill will be used for wastes including:

- Inert materials including concrete and timber;
- General waste including putrescibles;
- Non-recyclable plastics and glass; and
- Other benign solid waste.

When the landfill has reached its design capacity, it will be covered with a compacted low permeability soil layer to promote water shedding and reduce infiltration and potential for leaching.

Any landfill downgradient seepage is expected to be slow due to the low permeability of the Fractured Rock groundwater system and ultimately any landfill leachate is expected to be captured by the local groundwater sink formed at the Reward and Reward South pit-lakes.

There are no receptors within this distance, and the beneficial use of the water will be unchanged.

This Waste Management Plan (WMP) has been developed to provide a framework for waste management on the Project to manage potential environmental risks associated with non-mineral waste generation.

5.2.6 Groundwater contamination from spills at the mine site

Groundwater contamination might occur through spills of hazardous material at the mine site or during transport. The risk will be managed through appropriate storage and transport of hazardous materials.

Accidental spills or will be managed in accordance with the Environmental Management Plan (EM Plan), Emergency Response Management Plan (ERMP) including the Environmental Incident Investigation Procedure.

5.3 Predicted post-closure impacts

5.3.1 Water table recovery from process water supply borefield

Groundwater levels are forecast to almost recover to pre-mining levels after about 10 – 20 years post closure.

5.3.2 Post-closure water table recovery from pit-lake formation

Groundwater modelling was undertaken to predict the impacts on receptors due post-closure pit-lake formation within the Fractured Rock groundwater system (CloudGMS, 2019b).

Groundwater levels at RN012917 are expected to decline below the available drawdown of the bore at the end of mining, however, groundwater levels are expected to recover to within 30 metres of the initial levels.

The model predictions show that, 1000 year after the commencement of mining (990 years post closure), the extent of the 0.5 metre drawdown is less than 30 km from the mine and drawdown impacts of about 2 metres are observed at the closest pastoral bore (RN018078) and at the Orrtipa Thurra community water supply (18 km). The predictions show that the majority of this effect is manifest within about 200 years post-closure.

5.3.3 Post-closure leachate seepage from waste rock dumps

WRD leachate quality is identified as being predominantly non-acid forming (NAF). Seepage only occurs under high intensity rainfall events and dilution effects are expected as the seepage mixes with the ambient groundwater as it migrates down gradient.

The fate of leachate downgradient of the waste rock dumps (WRDs) has been forecast using the flow field calculated by the numerical groundwater modelling and random walk particle tracking. The WRDs downgradient seepage is expected to be slow due to the low permeability of the Fractured Rock groundwater system and ultimately any WRD seepage is expected to be captured by the local groundwater sinks formed at the Bellbird, Reward and Reward South pit-lake.

There are no receptors within this distance, and the beneficial use of the water will be unchanged.

5.3.4 Post-closure leachate seepage from tailings storage facility

The fate of leachate downgradient of the TSF has been forecast using the flow field calculated by the numerical groundwater modelling and random walk particle tracking. The TSF downgradient seepage is expected to be slow due to the low permeability of the Fractured Rock groundwater system and ultimately any TSF leachate is expected to be captured by the local groundwater sink form at the Reward and Reward South pit-lakes.

There are no receptors within this distance, and the beneficial use of the water will be unchanged.

5.3.5 Post-closure leachate seepage from landfill facility

The fate of leachate downgradient of the landfill is expected to be slow due to the low permeability of the Fractured Rock groundwater system and ultimately any landfill leachate is expected to be captured by the local groundwater sink form at the Reward and Reward South pit-lakes.

At the completion of the Project the landfill pits will be covered with a compacted low permeability soil layer to promote water shedding and reduce infiltration and potential for leaching.

There are no receptors within this distance, and the beneficial use of the water will be unchanged.

5.3.6 Post closure management pit-lakes inflows / outflows

A major outcome of the groundwater monitoring and management plan and subsequent mine closure plan is to ensure that any groundwater contamination will be confined to the immediate mining area and will not impact on the environmental values of the surrounding groundwater resources.

Johnson and Wright (2003) identified that open pits with no or partial backfill are likely to be groundwater sink pit-lakes when evaporation exceeds the rate of water inflows (rainfall, surface water runoff and groundwater). In this situation the groundwater levels recover slowly to a level lower than that of the pre-mining water table and the final voids act as groundwater sinks with flow towards the pit lake. Continued evaporation with no outflow leads to progressive salinity increase with the formation of brine / hypersaline conditions, and either to salt crystallisation in the pit or potentially reflux brine. In the most extreme case for salinities approaching a maximum TDS of about 31% w/v (310g/L) the density is around 1.26 g/cm^3 and above this concentration the solution is considered saturated and salt precipitates (Hamann, et al., 2015). Most hard-rock mines in the arid portions of the NT will form groundwater sinks, and some cases salt crystallisation may occur to greater or lesser degrees.

Under groundwater sink conditions the hydraulic gradient induces flow towards the pit-lake, capturing leakage from the surface features (ie TSF and WRDs) and preventing the migration of contaminants from the pit. However, if this ambient hydraulic gradient is insufficient there is the potential (as the pit lake increases in salinity) for density-driven flow processes to occur ('brine reflux'), although this typically takes many decades or centuries to occur (if at all). The process is due to the development of higher density water in the pit-lakes that exert a slight downward force at the base of the pit, proportional to the head of water in the pit lake and the density of the water. This downward force can drive a dense saline brine out of the base of the pit, but it will be opposed by the ambient groundwater gradients related to the "sink" nature of the pits. The increase in density may be sufficient to result in density-driven flow, as the hydraulic gradient towards the pits results in upward groundwater fluxes that can be much greater than the theoretical downward flux due to density changes. Over time, there may be a localised zone beneath the base of the pit where a saline mixing zone would occur and stabilise over time.

Where there is the potential for elevated salinities, leachable compounds and / or acid and metalliferous drainage (AMD), the capture of any plume by a terminal pit lake arguably provides a best-case scenario for protection of regional water resources in terms of typical mine closure time scales of hundreds to thousands of years (McCullough, et al., 2012).

Fully or partially backfilled pit may sometimes lead to poorer regional closure outcomes than retaining a pit-lake of some form, especially in arid and semi-arid regions (McCullough, et al., 2012). Fully backfilling or partial backfilling to above pre-mining groundwater levels of the pits is more likely to result in through-flow system and would therefore be likely to introduce poor quality outcomes into the groundwater system.

Future modelling programs should investigate the various closure options to confirm the most suitable closure plan from a water management viewpoint. Such scenarios should be run with the updated model that has been verified against about 2-3 years of operational data, and in close consultation with mine planners on viable options for final landforms and TSF/WRD management.

Groundwater modelling closure scenarios to date (CloudGMS, 2018a; CloudGMS, 2019b) were completed assuming mine closure with no backfilling of the open cut pit final voids. The low groundwater inflows coupled with high evaporation rates resulted in pit-lakes forming with water levels considerably lower (10 – 30 m) than that of the pre-mining water table. The hydraulic gradient towards the pits results in upward groundwater fluxes much greater than the theoretical downward flux resulting from head increases due to density changes.

To meet the objective that any groundwater contamination will be confined to the immediate mining area and will not impact on surrounding groundwater resources the final mine closure plan will require a monitoring programme that demonstrates that the groundwater inflows and gradients are sufficient to capture water sourced from the TSF and WRDs and to prevent migration of saline water from the bottom of the pits (ie to verify the model).

To ensure that the groundwater gradient is towards the pits, monitoring of groundwater pressure using vibrating wire piezometers (VWPs) will be employed. The VWPs will be installed at sites to be determined and will extend beneath each of the pits.

The post-closure monitoring programme and trigger values for both water levels and water quality, including the pit lake water levels and water quality, will be informed from information gathered as part of the life of mine groundwater monitoring and management plan and through groundwater modelling.

Any impacts diff substantially from those predicted, will initiate an agreed management and/or mitigation response. An agreed time frame needs to be set to confirm that the predicted impacts of the mine final void on the groundwater system, and that any anticipated environmental impacts are developing within the predicted pattern.

6 Groundwater Monitoring Program

6.1 Overview

In addition to collecting site rainfall, meteorological data and surface water data (WRM, 2018), Jervois Project will operate a groundwater monitoring network and data collection program in the mine site area and in the process water supply borefield area.

The groundwater monitoring network has been designed to monitor:

- drawdown in proximity to the process water supply borefield;
- drawdown between the process water supply borefield and third-party bores;
- drawdown in proximity to the mine excavations (pits and underground workings);
- drawdown between the mine excavations (pits and underground workings) and third party bores;
- dewatering volumes and water quality from the pits and underground excavations and the post-closure pit lake levels and water quality;
- groundwater adjacent to the TSF to assess mounding and groundwater quality changes due to any seepage;
- third-party bores (where suitable).
- a sufficient number of bores that are located at an appropriate distance from potential sources of impact from mining activities and provide the following:
    - representative groundwater samples from the fractured rock groundwater system at the mine site prior to any mining activities;
    - the quality of groundwater down gradient of potential sources of contamination including groundwater passing the relevant bores.

The objective of water quality monitoring is to establish a groundwater quality condition benchmark for use in subsequent monitoring, to identify and understand the processes that may degrade the groundwater quality in the groundwater systems.

Drilling to install the monitoring bores around the mine site was undertaken in September – October 2018 (CloudGMS, 2019a), and the results of this work and ongoing monitoring will inform the final design of the mine site monitoring network.

The current groundwater monitoring network was:

- installed by a person(s) possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring program design to be able to competently make recommendations about these matters;
- constructed in accordance with methods prescribed in the latest edition of "Minimum Construction Requirements for Water Bores in Australia" (National Uniform Drillers Licencing Committee, 2012) by an appropriately qualified driller; and
- additional observation bores will be installed if the measured drawdown exceeds predicted drawdown in the existing monitoring bores by more than 20%.

Groundwater monitoring will be undertaken by appropriately trained personnel and groundwater level measurements, sample collection, storage and transportation will be undertaken in accordance with procedures conforming to the current industry standard: AS/NZS 5667.1, .11 1998.

Data collected from the groundwater monitoring program will:

- be collated into a database that will be made available to the administering authority on request;
- be collated into annual reviews of groundwater monitoring;

- be used in the continued development and refinement of groundwater impact assessment criteria and investigation triggers;
- be used to verify the groundwater flow modelling, in addition to assessing the impact of mining activities on water quality in the receiving waters.
- enable verification and refinement of the groundwater modelling predictions presented in the Jervois Project SEIS (CloudGMS 2019b).

Data collected from landholder bores, wells, and waterholes will be used in conjunction with the groundwater impact investigation procedure to determine if contingency measures are required.

6.2 Groundwater monitoring network description

The Jervois Project groundwater monitoring network is separated into two areas:

- process water supply borefield
- mine site

The locations of these areas relative to the other users in the vicinity of the Jervois Project were presented above in Figure 4-2.

6.2.1 Process water supply borefield groundwater monitoring sites

Groundwater monitoring bores installed to measure the impact of pumping from the Jervois Project process water supply borefield are presented below in Figure 6-1 and detailed in Table 6-1. The monitoring network was installed in 2018 (CloudGMS, 2018b) and comprises 7 observation bores: 2 bores are located adjacent to the production bores and 5 bores are located away from the borefield with 1 of these bores adjacent to the closest of the third party pastoral bores.

The observation bores are located at a distance from pumping bores to assess drawdown without being overly impacted by intermittent low rate pumping from the pastoral bore. The bore extraction rate / volumes from the pastoral bores will be estimated on an annual basis to assist with the interpretation of potential variations in water levels.

The 25 km buffer represents the predicted extent of 0.5 metres of drawdown at the end of mining. It is expected the confidence level of the model forecasts will increase over time as the model is updated to reflect the observed effects on groundwater obtained from the monitoring program.

Additional observation bores will be installed beyond the current predicted zone of drawdown if measured drawdown exceeds predicted drawdown by more than 20%. Additional monitoring bore locations will be chosen based on groundwater flow model drawdown predictions and presence of aquifers and receptors of interest.

6.2.2 Process water supply groundwater extraction volumes

Groundwater extraction volumes will be recorded at each of the production bores comprising the Jervois Project process water supply borefield detailed in Table 6-1 in accordance with the licence to extract groundwater (GEOR10338). The production bore locations are presented in Figure 6-1 and labelled with bold text.

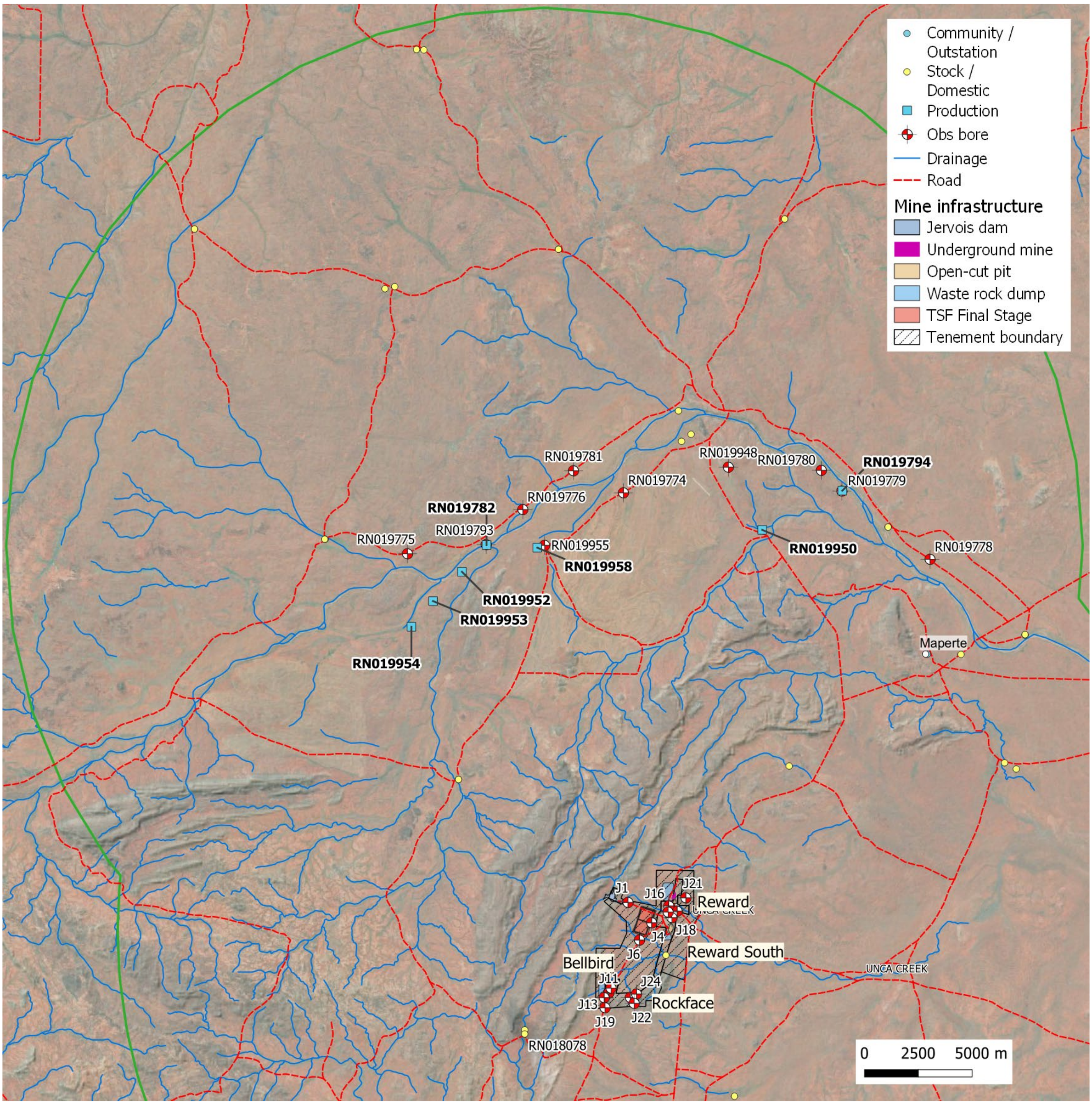

Figure 6-1 Locations of observation bores around the process water supply borefield (bold labels).

6.2.3 Mine site groundwater monitoring sites

The locations of the current groundwater levels and water quality monitoring sites around the Jervois Project mine site are presented below in Figure 6-2. Monitoring details are presented below in

Table 6-3.

Dewatering impacts

Groundwater monitoring sites to measure the impact of Jervois Project mining activities are detailed in

Table 6-3. The monitoring network comprises 25 observation bores: 24 bores are located within the mine tenement (

Table 6-3) and 1 bore is located adjacent to the closest third party pastoral bores (Table 6-2).

Bores J7 and J11 are located within the footprint of the Reward and Bellbird pits respectively and are likely to be destroyed due to mining activities. To provide continuity of groundwater levels response beneath the pits and to provide post-closure monitoring of the pit-lake evolution, vibrating wire piezometers (VWPs) will be installed to replace these bores.

Waste rock dumps (WRDs)

Groundwater monitoring sites to measure the impact of possible WRDs seepage are detailed in

Table 6-3 and their locations are presented in Figure 6-2. Two bores are currently located down-gradient of the WRDs.

Tailings storage facility (TSF)

Groundwater monitoring sites to measure the impact of tailings seepage are detailed in

Table 6-3 and their locations are presented in Figure 6-2. One bore is located upgradient of the TSF, two bores are located down-gradient and adjacent to the TSF. Three bores are located to the east between the TSF and Reward pit. An additional 3 sites are proposed adjacent to the TSF (Table 6-4); two are located downgradient of the TSF (J26 & J27) and one is located between Unca creek and the TSF (J25).

Landfill pits

The proposed groundwater monitoring site to measure the impact of landfill seepage is detailed in Table 6-4 and the location is presented in Figure 6-2. Additional bores will be installed to monitor the future landfill pits if leachate is identified in the groundwater.

6.2.4 Pit and underground workings groundwater extraction volumes

Groundwater seepage to the pits is expected to be very minor (CloudGMS, 2019b), however, any groundwater pumped from the active mine pits (Bellbird, Reward and Reward South) via in-pit sumps will be recorded to inform the updating of the groundwater flow model.

Groundwater seepage to the underground workings (Bellbird, Reward and Rockface) is expected to peak at about 2000 ML/yr (CloudGMS, 2019b). The volume of groundwater pumped from each of the underground workings will be recorded for the duration of the Jervois Project to inform the updating of the groundwater flow model.

The locations of the pits and underground workings are also presented for reference in Figure 6-2.

6.2.5 Post closure monitoring sites

It is currently assumed that the mine closure plan involves leaving the pit voids open and backfilling the underground voids with appropriate fill material.

To understand the evolution of the groundwater system following closure of the mine under these conditions the following monitoring will continue at the Jervois Project:

- groundwater levels / pressures in suitable bores and at the vibrating wire piezometers (VWPs) located beneath Reward and Bellbird pits (eg replacements for J7 and J11) and adjacent to the underground mines.
- water level and quality in the pit lakes

Monitoring will be conducted and used to verify / update the model against about 2 – 3 years of operational data and then run scenarios to investigate the various closure options to confirm the most suitable closure plan from a water management viewpoint. Such scenarios should be run in close consultation with mine planners on viable options for final landforms and TSF/WRD management.

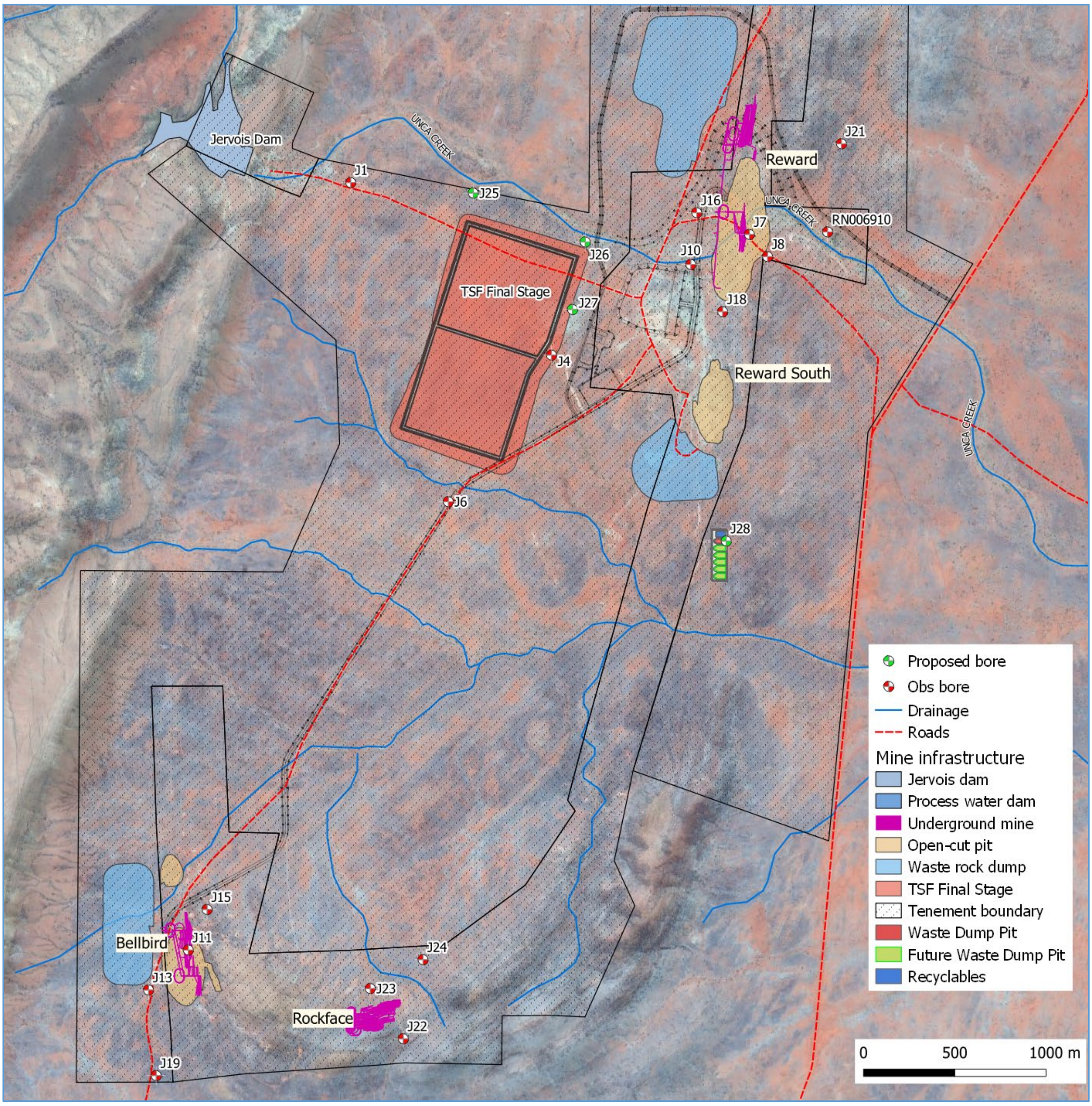

Figure 6-2 Locations of current and proposed observation bores around the Jervois mine site.

Table 6-1 Process water supply groundwater monitoring locations

Site name	Easting	Northing	Purpose	Measurement Interval	Monitoring Water Quality Analysis	Volume Pumped
Groundwater levels / quality						
RN019776 (Mon)	623311	7513279	Borefield Performance	Monthly	None	N/A
RN019793 (Mon)	621599	7511640	Borefield Performance	Monthly	None	N/A
RN019955 (Mon)	624320	7511619	Borefield Performance	Monthly	None	N/A
Production Bores Volumes						
RN019782 (Prod)	621622	7511636	Borefield Performance	Monthly	Monthly	Weekly
RN019950 (Standby)	634423	7512336	Borefield Performance	Monthly	Monthly	Weekly
RN019952 (Prod)	620478	7510390	Borefield Performance	Monthly	Monthly	Weekly
RN019953 (Prod)	619135	7509029	Borefield Performance	Monthly	Monthly	Weekly
RN019954 (Prod)	618131	7507838	Borefield Performance	Monthly	Monthly	Weekly
RN019958 (Prod)	623977	7511510	Borefield Performance	Monthly	Monthly	Weekly

Table 6-2 Third party groundwater monitoring locations

Site name	Easting	Northing	Purpose	Water Level Measurement	Monitoring Water Quality Analysis	Volume Pumped
RN019774	627979	7514063	Third Party Process Water Supply Impact Assessment	Monthly	None	N/A
RN019775	617946	7511234	Third Party Process Water Supply Impact Assessment	Monthly	None	N/A
RN019781	621907	7513363	Third Party Process Water Supply Impact Assessment	Monthly	None	N/A
RN019948	632857	7515290	Third Party Process Water Supply Impact Assessment	Monthly	None	N/A
RN019955	623994	7511520	Third Party Process Water Supply Impact Assessment	Monthly	None	N/A
RN018078 (200m offset)	623390	7488922	Third Party Mine Dewatering Impact Assessment	Monthly	None	N/A

Table 6-3 Mine site groundwater monitoring locations

Site name	Easting	Northing	Purpose	Water Level Measurement	Monitoring Water Quality Analysis	Volume Pumped
Groundwater levels / quality						
J1	628190	7495025	Tailings mounding and seepage assessment	Monthly	Monthly	N/A
J4	629290	7494080	Tailings mounding and seepage assessment	Monthly	Monthly	N/A
J6	628725	7493277	Tailings mounding and seepage assessment	Monthly	Monthly	N/A
J7^	630375	7494741	Reward pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J8	630474	7494620	Reward pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J10	630056	7494574	Reward pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J11^	627300	7490821	Bellbird pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J13	627082	7490602	Bellbird pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J15	627403	7491043	Bellbird pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J16	630086	7494860	Reward pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J18	630228	7494318	Reward pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J19	627124	7490133	Bellbird pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J21	630879	7495238	Reward pit and underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J22	628478	7490335	Rockface underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J23	628297	7490610	Rockface underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
J24	628586	7490768	Rockface underground mine excavation dewatering drawdown	Monthly	Yearly	N/A
RN006910	630803	7494755	Reward pit and underground mine dewatering drawdown Unca Ck	Monthly	Monthly	N/A
Groundwater volumes						
Bellbird pit			Bellbird pit and underground mine excavation dewatering drawdown	N/A	Quarterly	Weekly
Bellbird underground			Bellbird pit and underground mine excavation dewatering drawdown	N/A	Quarterly	Weekly
Reward pit			Reward pit and underground mine excavation dewatering drawdown	N/A	Quarterly	Weekly
Reward underground			Reward pit and underground mine excavation dewatering drawdown	N/A	Quarterly	Weekly
Reward South pit			Reward South pit and underground mine excavation dewatering drawdown	N/A	Quarterly	Weekly
Rockface underground			Rockface underground mine excavation dewatering drawdown	N/A	Quarterly	Weekly
Post-closure						
Pit-lake levels / quality			Pit lake development model verification	6 monthly	Annually	N/A
Underground mine levels			Underground mine groundwater recovery (VWPs) for model verification	6 monthly	Annually	N/A

Note J7 and J11 will be replaced by vibrating wire piezometers (VWPs)

Table 6-4 Proposed mine site groundwater monitoring locations adjacent to the TSF and landfill

Site name	Easting	Northing	Purpose	Water Level Measurement	Monitoring Water Quality Analysis	Volume Pumped
Groundwater levels / quality						
J25	628861	7494968	Tailings mounding and seepage assessment	Monthly	Monthly	N/A
J26	629475	7494700	Tailings mounding and seepage assessment	Monthly	Monthly	N/A
J27	629405	7494330	Tailings mounding and seepage assessment	Monthly	Monthly	N/A
J28	630248	7493062	Landfill groundwater levels and seepage assessment	Monthly	Monthly	N/A

6.3 Monitoring suite and frequency

Water levels and water quality samples will be taken by local environmental monitoring staff with appropriate training.

Groundwater level measurements, sample collection, storage and transportation will be undertaken in accordance with procedures conforming to the current industry standard: AS/NZS 5667.1, .11 1998. Groundwater sample analysis will be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA).

Field measurement of water quality parameters will be undertaken using appropriate field equipment that is maintained and calibrated in accordance with the manufacturer's recommendations.

The monitoring requirements for the mine site and process water supply are described in the following sections.

Table 6-5 Groundwater monitoring analyte suite

Field	Standard cations / anions	Metals	
Dissolved oxygen	Bicarbonate	Aluminium	Mercury
Electrical Conductivity	Calcium	Antimony	Molybdenum
pH	Carbonate	Arsenic	Nickel
Redox	Chloride	Barium	Nitrate as N
Turbidity	Fluoride	Beryllium	Phosphorous
	Magnesium	Boron	Selenium
	Manganese	Bromide	Silicate
	Potassium	Cadmium	Silver
	Sodium	Chromium	Strontium
	Sulphate	Cobalt	Tin
	Total Alkalinity as CaCO3	Copper	Uranium
		Iron	Vanadium
		Lead	Zinc

6.3.1 Process water supply groundwater level monitoring

Groundwater levels at the Jervois Project process water supply monitoring sites are described in Table 6-1 and presented in Figure 6-2. Groundwater levels will be recorded at least monthly and analysis of the data reported annually.

6.3.2 Process water supply groundwater quality monitoring

Water quality will be monitored quarterly at actively pumping bores. A full suite of analytes as per Table 6-5 will be analysed for all samples. The monitoring suite and frequency will be reviewed and optimised following two years data collection.

Sample collection, storage and transportation will be undertaken in accordance with procedures conforming to the current industry standard: AS/NZS 5667.1, .11 1998. Groundwater sample analysis will be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA).

Field measurement of water quality parameters will be undertaken using appropriate field equipment that is maintained and calibrated in accordance with the manufacturer's recommendations.

6.3.3 Process water supply groundwater extraction volumes

Volumes of groundwater pumped from the Jervois Project process water supply production bores will be recorded monthly for the duration of the life of mine in accordance with the licence to extract groundwater (GEOR10338).

All production bores will have water meters that comply with the National Framework for Non-urban Water Metering Policy (https://www.agriculture.gov.au/water/policy/nwi/nonurban-water-metering-framework) and the Department of Environment, Planning and Water Security (DEPWS) 'Non-urban water metering code of practice for water extraction'.

The monthly groundwater extraction volumes will be recorded in the groundwater hydrology database and the monthly water meter readings will be submitted to the DEPWS either online www.nt.gov.au/water or by email to: water.regulation@nt.gov.au.

https://nt.gov.au/environment/water/water-licences/water-meter-reading-form

6.3.4 Mine site groundwater level monitoring

Groundwater levels at the monitoring sites are described in

Table 6-3 and presented in Figure 6-2. Groundwater levels will be recorded at monthly intervals and analysis of the data reported annually.

6.3.5 Groundwater extraction volumes from open-pits and underground workings

A groundwater extraction licence is not required for extraction of water from an active mine pit via an in-pit sump, and groundwater seepage to the pits is expected to be very minor (CloudGMS, 2019b), however, any groundwater pumped from the active mine pits via in-pit sumps will be recorded at monthly intervals for the duration of the Jervois Project to inform the updating of the groundwater flow model.

Groundwater seepage to the underground workings is expected to peak at about 2000 ML/yr (CloudGMS, 2019b) all groundwater pumped from the underground workings via sumps will be recorded monthly for the duration of the Jervois Project.

The underground mining activities will be greater than three metres deep and the water will be used for operational use and mine dewatering and is subject to the DEPWS 'Non-urban water metering code of practice for water extraction'.

All sump pumps will have water meters that comply with the National Framework for Non-urban Water Metering Policy (https://www.agriculture.gov.au/water/policy/nwi/nonurban-water-metering-framework) and the DEPWS 'Non-urban water metering code of practice for water extraction'.

The monthly groundwater extraction volumes from the separate mine features will be recorded in the groundwater hydrology database and the monthly water meter readings will be submitted to the DEPWS either online www.nt.gov.au/water or by email to: water.regulation@nt.gov.au.

https://nt.gov.au/environment/water/water-licences/water-meter-reading-form

6.3.6 Mine site groundwater quality monitoring

Groundwater quality will be monitored monthly from the pits and underground workings as specified in

Table 6-3. A total of 8 bores around the TSF and landfill sites will be monitored for water quality; 4 current (

Table 6-3) and an additional 4 bores (Table 6-4) to be installed within the first year of construction phase, once the mine plan is finalised.

The monitoring bores will be sampled at monthly intervals as specified in

Table 6-3 and Table 6-4. A full suite of analytes as per Table 6-5 will be analysed for all samples. The monitoring suite, frequency and triggers will be optimised following the first year of data collection (minimum 12 data points as per ANZECC & ARMCANZ (2000) guidelines) and confirmed following 2 years of data collection (24 data points).

These 8 bores have been chosen for regular water quality sampling as the other sites are adjacent to features that are unlikely to have sufficient moisture content to generate recharge to the groundwater system and are not down gradient of features that do have this potential.

Water quality will be monitored monthly at pumping bores. A full suite of analytes as per Table 6-5 will be analysed for all water quality samples. The monitoring suite and frequency will be reviewed and optimised following the first year of data collection (minimum 12 data points as per ANZECC & ARMCANZ (2000) guidelines) and confirmed following 2 years of data collection (24 data points).

If conditions at the mine site change within the two year timeframe, the frequency of water quality monitoring at the existing sites will be reviewed and / or additional groundwater quality monitoring sites installed.

Sample collection, storage and transportation will be undertaken in accordance with procedures conforming to the current industry standard: AS/NZS 5667.1, .11 1998. Groundwater sample analysis will be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA).

Field measurement of water quality parameters will be undertaken using appropriate field equipment that is maintained and calibrated in accordance with the manufacturer's recommendations.

6.4 Monitoring database

The data gathered from the groundwater monitoring program will be collated into a comprehensive and robust groundwater hydrology database, this database will include:

- a GIS site plan showing sample locations;
- all data collected during each monitoring round including;
  - groundwater levels
  - groundwater quality
  - groundwater extraction volumes from pits and underground workings
- tabulated results of the monitoring compared with applicable background/trigger levels;
- a record of chain of custody of the samples from sampling through to analysis;
- laboratory analysis certificates;
- groundwater monitoring program reports,
- identification of sampling personnel, and
- a description of the sampling procedures, methods and calculations used.

6.4.1 Implementation schedule

Observation bores at the mine site and the process water supply were installed during September - October 2018. Monitoring of these bores will commence post Covid-19 restrictions, to provide an ongoing baseline data set.

Any remaining observation bores will be installed at the beginning of the construction phase or as required. This will enable collection of one year of pre-mining baseline data.

Additional observation bores will be installed beyond the current predicted zone of drawdown if measured drawdown exceeds predicted drawdown by more than 20%. The timing of these bores will be dependent on the annual review of monitoring results.

Additional bores will also be installed to monitor the future landfill pits if leachate is identified in the groundwater associated with the current pit.

6.4.2 Monitoring program review and optimisation and maintenance

The monitoring suite and frequency will be reviewed and optimised following two years data collection and every two years thereafter.

If the stated purpose of the monitoring is not met then additional bores will be installed.

Over the lifespan of the Jervois Project (approximately 10 years of working) and the post closure monitoring period, it is likely that groundwater monitoring bores will become unserviceable and need to be replaced (eg J7 and J11 are located within the footprint of the Reward and Bellbird pits and will likely be disturbed/destroyed by mining). KGL will proactively maintain the groundwater monitoring network, replacing bores as necessary, and use the regular review of monitoring data to inform the location of additional monitoring bores, as required.

6.4.3 Monitoring bore installation guidelines

Bores will be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licencing Committee, 2012).

The nominal bore design comprises:

- 100mmDN Class18 UPVC Bore casing with slotted production zone.
- Bores will be drilled to approximately 30m below the first water yielding interval. The bore casing will be slotted against water producing intervals.
- The screen annulus will be gravel packed, and the casing annulus grout sealed to prevent surface water ingress.
- A steel lockable cover will be installed to protect the PVC from damage and to secure logging equipment.
- All monitoring and production bores are surveyed to a common datum (mAHD) to ±0.1m vertical accuracy to allow for accurate characterisation of groundwater flow directions.
- All bores will be registered with DEPWS and allocated an RN number.

6.5 Groundwater impact prediction, verification and review

The groundwater model that was used to inform the impacts assessment was based on a number of inputs and assumptions, some of which were directly measured, some of which were interpreted, and some were the result of model calibration. There is a moderate level of confidence in the magnitude of the water quantity effects caused by the Jervois Project, but a high level of confidence in the relative effects (ie drawdown due to mining activities). These relative effects become less in the latter phases of mining. Therefore, the approach to address uncertainty in these later phases of mining is through monitoring in the early phases of mining, and refinement and re-calibration of the model to provide an accurate predictive tool for the later phases of mining.

KGL is committed to the development of a Class 2 groundwater flow model. The development of the groundwater flow model will be undertaken in accordance with the Australian Groundwater Modelling Guidelines (Barnett, et al., 2012).

To ensure that this objective is attained, data collected through the groundwater monitoring program during the life of the Jervois Project, will be used to update and refine this model and its predictions to reflect the actual activities undertaken on site (e.g. process water supply extraction volumes, mine development and sump locations) and the results of regular groundwater monitoring.

The Jervois Project groundwater flow model has been independently reviewed, and the annual review and / or update of it in the future may be reduced depending on the stage of the mine development, changes in the depth of working, and the availability and results of new monitoring data. For example, at the conclusion of the installation program for any additional monitoring bores for the Jervois Project, the data collected from the monitoring program will be used to immediately refine the model and produce a revised impact assessment. Similarly, the onset of pumping from the process water supply borefield and the dewatering activities will be accompanied by monitoring that will be used to verify and/or refine the groundwater model and may give rise to further prediction and/or uncertainty scenarios.

The results of any groundwater model verification and refinement, or the justification that this action is not necessary, will be documented, and as required, presented to the NT EPA and/or DEPWS (regulatory authority under the Water Act 2018).

7 Trigger Action Response Plan (TARP)

Predictions of drawdown using the calibrated groundwater flow model will be a leading indicator of groundwater related impacts due to mining activities and monitoring of groundwater levels at the receptors sites will be used to confirm impacts and verify the model.

If impacts are greater than predicted by more than 20% for groundwater levels or water quality is greater than the p80 water quality objectives, the following contingency measures will be implemented

- Impact assessment – the revised magnitude of the impact will be assessed for the full Jervois Project duration from mining to mine closure and aquifer recovery.
- Make-good measures will be assessed and implemented if required, for instance deepening of existing users bores to ensure ongoing water availability.
- Additional water recycling methods will be explored, for example enhanced water recovery from tailings.
- Alternative water sources will be explored, for instance extending / relocating the borefield further from receptors into deeper parts of the Georgina Basin might be considered – though this is likely to be cost prohibitive.

The triggers used are discussed in the following sections.

7.1 Groundwater level triggers

7.1.1 Process water supply monitoring sites

The trigger values for the monitoring sites in the Jervois Project process water supply area for EOY1, EOY2, EOY4 EOY6 and EOY8 have been determined by increasing the final predicted drawdown by 20%.

The predicted and trigger values for the monitoring sites around the process water supply borefield are presented below in Table 7-1.

Table 7-1 Process water supply predicted and trigger groundwater drawdowns (metres).

Site Id	EOY 1		EOY 2		EOY 4		EOY 6		EOY 8	
	Pred	Trigger	Pred	Trigger	Pred	Trigger	Pred	Trigger	Pred	Trigger
RN019774	2.0	**2.4**	2.0	**2.4**	2.0	**2.4**	2.0	**2.4**	2.0	**2.4**
RN019775	2.5	**3**	2.5	**3**	2.5	**3**	2.5	**3**	2.5	**3**
RN019776	7.0	**8.4**	7.0	**8.4**	7.0	**8.4**	7.0	**8.4**	7.0	**8.4**
RN019781	2.0	**2.4**	2.0	**2.4**	2.0	**2.4**	2.0	**2.4**	2.0	**2.4**
RN019793	6.5	**7.8**	6.5	**7.8**	6.5	**7.8**	6.5	**7.8**	6.5	**7.8**
RN019948	1.0	**1.2**	1.0	**1.2**	1.0	**1.2**	1.0	**1.2**	1.0	**1.2**
RN019955	2.5	**3**	2.5	**3**	2.5	**3**	2.5	**3**	2.5	**3**
RN019956	7.0	**8.4**	7.0	**8.4**	7.0	**8.4**	7.0	**8.4**	7.0	**8.4**

7.1.2 Mine site monitoring sites

The trigger values for the monitoring sites in the Jervois Project mine site area for EOY1, EOY2, EOY4 EOY6 and EOY8 have been determined from the predicted drawdown by 20%.

The predicted and trigger values for the sites around the mine site and the TSF are presented below in Table 7-2 and Table 7-3 respectively.

Table 7-2 Mine site predicted and trigger groundwater drawdowns (metres).

Site Id	EOY 1		EOY 2		EOY 4		EOY 6		EOY 8	
	Pred	Trigger	Pred	Trigger	Pred	Trigger	Pred	Trigger	Pred	Trigger
J7	0	**0**	25	**30**	75	**90**	147	**176**	211	**253**
J8	0	**0**	14	**16**	37	**44**	110	**132**	156	**187**
J10	0	**0**	16	**19**	42	**50**	110	**132**	124	**149**
J11	18	**22**	55	**66**	84	**101**	87	**104**	163	**196**
J13	5	**5**	17	**21**	38	**45**	47	**57**	93	**112**
J15	25	**30**	76	**92**	105	**126**	110	**132**	119	**143**
J16	0	**0**	3	**4**	21	**25**	96	**115**	104	**124**
J18	0	**0**	16	**19**	42	**50**	110	**132**	124	**149**
J19	2	**3**	10	**12**	26	**31**	36	**43**	59	**71**
J21	0	**0**	2	**3**	14	**17**	62	**74**	102	**123**
J22	65	**78**	145	**174**	232	**279**	206	**247**	154	**184**
J23	65	**78**	145	**174**	232	**279**	206	**247**	154	**184**
J24	42	**50**	94	**112**	147	**176**	164	**196**	144	**172**
RN006910	0	**0**	3	**4**	17	**20**	63	**76**	103	**124**

Note J7 and J11 are within the footprint of Reward and Bellbird pits and will be replaced by suitable vibrating wire piezometers (VWPs).

Table 7-3 Tailings storage facility predicted and trigger increase in groundwater levels (metres).

Site Id	EOY 1		EOY 2		EOY 4		EOY 6		EOY 8	
	Pred	Trigger	Pred	Trigger	Pred	Trigger	Pred	Trigger	Pred	Trigger
J1	<1	**<1**	<1	**<1**	<1	**<1**	<1	**<1**	<1	**<1**
J4	-3	**-3**	-4	**-5**	-5	**-6**	-6	**-7**	-4	**-5**
J6	< -1	**< -1**	-1	**-1**	-2	**-2**	-2	**-3**	-2	**-2**

Note: negative values indicate an increase in the groundwater level compared to the initial groundwater level.

7.2 Water quality trigger values for reduced beneficial use

Water quality objectives (WQOs) for groundwater are consistent with the values presented in the surface water management plan (WRM, 2018). Where WQOs for a given analyte are not provided in the surface water WQOs the water quality guidelines for the beneficial use primary industries including livestock drinking water (ANZECC & ARMCANZ, 2000) were adopted. Table 7-4 presents the adopted groundwater WQOs and compares the adopted WQOs against the 80th percentile (using the percentile Excel function) observed water quality for the Fractured Rock (J7, J8 & Camp Bore) and Carbonate Aquifer (LCP1, LCP2, LC21, LC26, LC27, LC28 & LC33) groundwater systems presented in Table 2-3.

ANZECC & ARMCANZ (2000) recommends that wherever possible site-specific data be used to define trigger values for physical and chemical factors which can adversely impact the environment, rather than using ANZECC guideline values.

The adopted WQO limits will be revised once a suitable number of water quality samples are available from the background groundwater monitoring sites at the mine site (J7, J8, Camp Bore, J13, J25, J26, J27 and J28) and at the Jervois Project water supply borefield (LCP1, LCP2, LC21, LC26, LC27, LC28 & LC33) to develop site specific WQOs.

Table 7-4 Water quality objectives for groundwater impacted by the Jervois Project.

Analyte	WRM Limit (mg/L)	Livestock Limit (mg/L)	Fractured Rock p80 (mg/L)	Carbonate Aquifer p80 (mg/L)	Comment
Calcium	-	1000	**109.4**	**84.8**	
Magnesium	2000	2000	**124.8**	**94.4**	Drinking water containing magnesium at concentrations up to 2000 mg/L has been found to have no adverse effects on cattle.
Nitrate	0.7	1500	**Not Determined**	**Not Determined**	Nitrate concentrations less than 400 mg/L in livestock drinking water should not be harmful to animal health. Water containing more than 1500 mg/L nitrate is likely to be toxic to animals and should be avoided.
Nitrite		30	**Not Determined**	**Not Determined**	Concentrations of nitrite exceeding 30 mg/L may be hazardous to animal health.
Sulphate	1000	2000	**403.6**	**302.6**	No adverse effects are expected if the concentration of sulfate in drinking water does not exceed 1000 mg/L.
TDS	4000	4000	**2048**	**1500**	Loss of production and a decline in animal condition and health would be expected at values greater than 5000 mg/L.
pH	6.0 – 8.5	9	**7.1**	**7.2**	
Aluminium	0.055	5	**0.01**	**0.05**	
Arsenic	0.024	5	**<0.001**	**0.001**	May be tolerated if not provided as a food additive and natural levels in the diet are low
Beryllium	-	-	**<0.001**	**<0.001**	not determined
Boron	-	5	**0.81**	**0.632**	
Cadmium	0.0002	0.01	**<0.0001**	**<0.0001**	
Chromium	-	1	**<0.001**	**<0.001**	
Cobalt	-	1	**<0.001**	**<0.001**	
Copper	0.0014	1	**0.003**	**0.0044**	
Fluoride	-	2	**Not Determined**	**Not Determined**	
Iron	0.3-	-	**0**	**0.18**	not sufficiently toxic
Lead	0.0034	0.1	**<0.001**	**<0.001**	
Manganese	1900	-	**0.2**	**0.007**	not sufficiently toxic
Mercury	0.0006	0.002	**0.0001**	**<0.0001**	
Molybdenum	-	0.15	**0**	**0**	
Nickel	0.011	1	**<0.001**	**0.0028**	
Selenium	-	0.02	**0.01**	**<0.01**	
Uranium	-	0.2	**0.0234**	**0.0056**	
Vanadium	-	-	**<0.01**	**0.0084**	not determined
Zinc	0.008	20	**0.009**	**0.0142**	

7.3 Water table drawdown from process water supply borefield pumping

Water table drawdown from the process water supply borefield pumping will be measured at observation bores as described above in section 6.2.1.

If a trigger or trend is identified in a data set based on the predicted range of drawdown increased by 20% as presented in Table 7-1, or a landholder complaint received (refer to section 7.9), the first step will be to verify the data if it appears anomalous. A re-measure will be conducted where appropriate.

Where monitoring results indicate that a groundwater level has breached the reporting trigger, the Groundwater Impact Investigation Procedure (section 7.7) will be implemented.

If the Groundwater Impact Investigation deems that triggers have been 'activated' as a result of mining activities, contingency measures discussed in section 7.8 will be implemented.

7.4 Water table drawdown from mine dewatering.

Water table drawdown associated with groundwater inflows to the pit and underground workings be measured at observation bores as described above in section 6.2.3.

If a trigger or trend is identified in a data set based on the predicted range of drawdown increased by 20% as presented in Table 7-2, or a landholder complaint received (refer to section 7.9), the first step will be to verify the data if it appears anomalous. A re-measure will be conducted where appropriate.

Where monitoring results indicate that a groundwater level has breached the reporting trigger, the Groundwater Impact Investigation Procedure (section 7.7) will be implemented.

If the Groundwater Impact Investigation deems that triggers have been 'activated' as a result of mining activities, contingency measures discussed in section 7.8 will be implemented.

7.5 Waste rock dump leachate seepage

Waste rock is anticipated to be deposited to the WRDs dry, however, seepage may result during significant rainfall events. It is unlikely that these events will result in groundwater level rises, although deterioration of water quality may occur. Groundwater quality downgradient of waste rock dumps will be monitored at the current observation bores to detect for the impacts of seepage if it occurs.

Trigger Levels comprise:

- Water level rise greater than predicted by more than 20% as presented in Table 7-3.
- Water quality changes lowering the beneficial use category of the groundwater source for Fractured Rock p80 as identified in Table 7-4.

Mitigation measures will be implemented in line with the Groundwater Impact Investigation Procedure (section 7.7) as follows:

Stage 1 if the measured groundwater level at observation bores exceeds the trigger value based on the predicted range of groundwater increased by 20% as presented in Table 7-3.

If a trigger or trend is identified in a data set the first step will be to verify the data if it appears anomalous. A re-measure will be conducted where appropriate.

Where monitoring results indicate that a groundwater level has breached the reporting trigger, the following steps will be implemented.

Stage 2 Assess the impact of water table rise. Water level rise can impact the environment if:

- water levels rise to the root zones of plants, nominally higher than 15m below ground surface where the current groundwater table lies; or

- water tables rise to within 2 metres of the ground surface and cause soil waterlogging and/or salinisation.

Assess the impact of water quality decline. The current beneficial use of groundwater beneath the mine is livestock watering use. The impact of tailings leachate seepage if detected should be assessed to determine if the beneficial use category of groundwater will change.

Stage 3 If seepage from the WRDs causes unacceptable impacts (change in beneficial use) then design and implement additional seepage management measures:

- Pump and treat seepage from beneath the WRDs using interception bores for subsequent re-use in the process plant.

7.6 Tailings storage facility leachate seepage

Groundwater levels and water quality downgradient of tailing storage will be monitored at 5 observation bores to detect for the impacts of seepage if it occurs.

Trigger Levels comprise:

- Water level rise greater than predicted by more than 20% as presented in Table 7-3.
- Water quality changes lowering the beneficial use category of the groundwater source for Fractured Rock p80 as identified in Table 7-4.

Mitigation measures will be implemented in line with the Groundwater Impact Investigation Procedure (section 7.7) as follows:

Stage 1 if the measured groundwater level at observation bores exceeds the trigger value based on the predicted range of groundwater increased by 20% as presented in Table 7-3.

If a trigger or trend is identified in a data set the first step will be to verify the data if it appears anomalous. A re-measure will be conducted where appropriate.

Where monitoring results indicate that a groundwater level has breached the reporting trigger, the following steps will be implemented.

Stage 2 Assess the impact of water table rise. Water level rise beyond the TSF footprint can impact the environment if water levels rise to the root zones of plants, nominally higher than 15m below ground surface where the current groundwater table lies. Or if water tables rise to within 2 metres of the ground surface and cause soil waterlogging and/or salinization.

Stage 3 Assess the impact of water quality decline. The current beneficial use of groundwater beneath the mine is pastoral use. The impact of tailings leachate seepage if detected should be assessed to determine if the beneficial use category of groundwater will change.

Stage 4 If tailing seepage causes unacceptable impacts (water table rise to near surface beyond the TSF footprint or change in beneficial use) then design and implement seepage management measures:

- Pump and treat seepage from beneath the TSFs using interception bores for subsequent re-use in the process plant.

It is possible that groundwater impacts (water level drawdown and reduced groundwater availability to other users) exceeds the magnitude predicted in the impact assessment.

7.7 Groundwater impact investigation procedure

The groundwater impact investigation procedure will be implemented in response to an exceedence of a relevant trigger (groundwater quality or groundwater level) or a legitimate complaint from a landholder (groundwater related). The relevant data set will be reviewed by an appropriately qualified environmental specialist who will determine if further investigation is necessary. The groundwater impact investigation procedure will follow the following framework.

- If a trigger or trend is identified in a data set, or a landholder complaint received, the first step will be to verify the data if it appears anomalous. A resample/re-test/re-measure will be conducted where appropriate.
- Where monitoring results indicate that a groundwater level has breached the reporting trigger, the administering authority will be notified within 30 days of completion of monitoring.
- In relation to groundwater quality triggers, if the groundwater contaminant trigger levels defined in Table 7-4 are exceeded then an investigation into the potential for environmental harm will be completed and sent to the administering authority within 3 months of receiving the analysis results.
- Once the validity of the breach in groundwater level triggers or a landholder complaint has been verified, a preliminary assessment will be undertaken by an appropriately qualified specialist involving the evaluation of the monitoring results/complaint in conjunction with mining activities being undertaken at the time, baseline groundwater monitoring results, groundwater data for surrounding locations, local use of groundwater, the prevailing and preceding meteorological conditions, and other factors affecting the local hydrogeological regime.
- A recalibrated model will be delivered within 3 months of the trigger value being exceeded.
- The preliminary investigation may deem that further additional investigation and monitoring is required to determine the cause of the 'activation' of the trigger and whether or not it is directly related to mining activities.
- If the investigations deem that triggers have been 'activated' as a result of mining activities, contingency measures may need to be implemented.
- Additional monitoring may be implemented to measure the effectiveness of contingency measures (i.e. if deemed necessary).
- In the event that trigger levels or impact assessment criteria continue to be exceeded, further investigations may be undertaken (i.e. a process of continual improvement or adjustment of the relevant triggers if warranted).
- Where additional management strategies are required in response to environmental performance, the existing numerical model model (as updated, refined and/or verified with latest monitoring data) will be used to test the effectiveness of mitigation measures prior to implementation to improve the outcomes of the proposed measures.
- The results of any breaches of trigger levels and investigations will be documented for reporting and audit purposes.
- If a definite case of material or serious environmental harm or the potential for material or serious environmental harm is clearly established by a groundwater investigation into an exceedance of a relevant trigger (groundwater quality or groundwater level) or a legitimate complaint, KGL will ensure the DITT, EPA and DEPWS are notified.

7.8 Mitigation measures for existing groundwater users

In the event that a formal groundwater investigation conclusively identifies that the Jervois Project mining operations have adversely impacted a neighbouring groundwater user (affected groundwater user), KGL will attempt in 'good faith' to negotiate suitable mitigation measures in a timely manner to rectify the identified groundwater problem. KGL may involve an appropriately qualified environmental specialist to assist with development of the mitigation measures. The development of suitable mitigation measures will be based on the outcomes of an appropriate scientific investigation.

The groundwater impact assessment studies indicated that no private water supply bore is expected to be adversely impacted by the Jervois Project. Should any private landholder notify KGL of a loss of yield or deterioration in water quality in a groundwater supply bore on their land, KGL will review the monitoring data to determine if there is a possibility that the impact is due to the mining activities or the process water supply.

If the performance measure is exceeded such that there is a more than negligible impact on water levels in any groundwater supply bore on privately-owned land as a result of the Jervois Project, KGL will investigate appropriate remedial measures which may include bore-reconditioning or provision of an alternative water supply, in the event that as a result of dewatering or depressurisation groundwater levels are lowered at a privately-owned supply bore or well by an amount that exceeds the predicted impacts, and that leads to a continued loss or reduction of supply to the local groundwater user.

Additional monitoring (e.g. increase in monitoring frequency or additional sampling) may also be undertaken in conjunction with the above.

The exact nature of remedial measures will be determined in consultation with the affected landholder. Equivalent water supply will be provided (at least on an interim basis) as soon as practicable after the loss being identified.

Possible mitigation measures that may be applied by KGL include:

- the refurbishment of an existing groundwater bore;
- the installation of a new groundwater bore;
- the establishment of an alternative water supply arrangement; and/or
- the use of another mutually agreed form of mitigation.

KGL will ensure as a minimum that the proposed mitigation measures are acceptable to the affected groundwater user, and if acceptable, will enter into a legal agreement for the installation of the proposed mitigation measures at KGL's expense. KGL will also ensure the proposed mitigation measures are commensurate with the identified groundwater loss.

KGL may be required to install interim mitigation measures until the permanent mitigation measures have been developed and installed. As required, KGL will seek agreement with the affected groundwater user and pay all reasonable cost for the use of any interim mitigation measures.

If agreement cannot be reached with the affected groundwater user in relation to the proposed mitigation measures, KGL will facilitate some form of legal disputes resolution for the matter.

KGL will ensure the administering authority is fully advised about the details and progress of these types of groundwater matters.

KGL is committed to rectifying all groundwater problems that are legitimately attributed to the Jervois Project mining operations through proper scientific evaluation, in an appropriate timeframe, using accepted and practical mitigation measures, and to the satisfaction of the affected groundwater user.

If an alternative water supply source is to be provided, it will be the responsibility of KGL to obtain a licence and pay for this source, in consultation with relevant landowner(s). The nature of the source will depend on the location of the affected landholder and the availability of nearby sources.

If an alternative long-term water supply source is unable to be provided, KGL may provide alternative compensation in consultation with the relevant landholder(s).

7.9 Groundwater complaints management process

Complaints will be addressed in accordance with the Complaint Investigation procedures provided in the Social Impact Management Plan. Groundwater complaints that are believed to be attributed to the operation of Jervois Project should be immediately reported to KGL. Groundwater complaints may be reported verbally by telephone or in writing using e-mail (info@kglresources.com.au) or letter (KGL Resources Pty Ltd, Level 7, 167 Eagle Street, Brisbane, QLD, AUSTRALIA 4000).

The general details of the groundwater complaint need to be provided at the time of reporting the complaint to KGL. KGL will make all reasonable efforts to ensure the reported groundwater complaint is managed in a timely and appropriate manner. KGL's Environmental Officer is responsible for environmental complaints management for the Jervois Project.

KGL will record the details of the groundwater complaint in the Jervois Project complaint database (register) and review this information. As required, KGL will re-contact the complainant about the groundwater complaint to obtain all the necessary details to decide the next course of action. Depending on the severity of the groundwater complaint, KGL as a courtesy may also advise the DEPWS about the matter.

KGL's investigation of the groundwater complaint is designed to establish the legitimacy of the complaint, and if legitimate, whether the Jervois Project is directly or indirectly responsible for the complaint. If current evidence or further scientific investigation establishes KGL is responsible for the groundwater complaint, KGL will advise the complainant, the DEPWS and follow the mitigation strategy outlined in Section 7.8 of this Plan. If current evidence or further scientific investigation establishes KGL is not responsible for the groundwater complaint, KGL will advise the complainant in a timely manner, and depending on circumstances, the DEPWS.

At the cessation of the complaint investigation process, KGL will record all the relevant details about the groundwater complaint in the Jervois Project complaint database (register), including all management actions undertaken, the final outcomes of the complaint investigation process, the details of any required follow-up or on-going management actions, and whether the complaint is 'closed off' to the satisfaction of the complainant. KGL maintains the Jervois Project complaint database for issue analysis, regulatory and audit purposes.

Importantly, KGL is committed to working with its near neighbours to resolve genuine issues as they arise in relation to the operation of the Jervois Project.

8 Groundwater Monitoring and Management Plan Review and Improvement

8.1 Annual Groundwater Management Plan Review

KGL will conduct an annual review of the environmental performance of the Jervois Project. The annual review will address the performance of the GMMP and will:

- be conducted by a person possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring analysis;
- include a comprehensive review of the monitoring results and complaints records for the Jervois Project over the year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria,
  - monitoring results of previous years, and
  - relevance to the Jervois Project approvals;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify trends and distinguish between natural fluctuations and possible mining induced changes over the life of the Jervois Project;
- identify any discrepancies between the predicted and actual impacts of the Jervois Project, and analyse the potential cause of any significant discrepancies (verify the model);
- describe mitigation measures that have or are being implemented to address breaches of any groundwater impact triggers; and
- review the condition and extent of the groundwater monitoring network in the context of meeting its objectives.

A summary of the annual review will be provided in the Annual Report for the Jervois Project.

8.2 Groundwater Management Plan Update

As required, KGL may update or revise the GMMP based on the outcomes of the annual review process. The NT EPA and DEPWS will be consulted in relation to any significant changes to the GMMP and as necessary will be re-issued any new versions of the document.

8.3 Groundwater model review and improvement / update

KGL is committed to the development of a Class 2 groundwater flow model (NT EPA recommendation 5).. The development of a Class 2 groundwater flow model will be undertaken in accordance with the Australian Groundwater Modelling Guidelines (Barnett, et al., 2012). This will be achieved through the ongoing collection of data and updating specific aspects of the groundwater model as detailed below.

The current groundwater flow model is classified as a having a Class 1 confidence classification with some Class 2 components. and it has been independently reviewed and endorsed as Class 1-2. The GMMP program is designed to generate the data required to support the development of a Class 2 groundwater flow model in accordance with the Australian Groundwater Modelling Guidelines (Barnett, et al., 2012).

8.3.1 Framework for achieving a class 2 groundwater flow model

The aspects of the model that need to be addressed to achieve a Class 2 confidence category are:

- project scale pumping volumes from the process water supply borefield;
- project scale pit / underground seepage fluxes;
- Transient calibration performance (model match to monitoring) and forecast scenarios;

- Forecast scenarios with a time frame less than 3 times the available calibration dataset; and
- Magnitude of stresses used in the calibration consistent with those used in the forecast scenarios.

Future improvements to the numerical groundwater flow model will be undertaken as and when new data become available, including when there is a divergence of the observed groundwater system response from the predicted response. Groundwater monitoring data including groundwater abstraction (sump pumping rates) and groundwater level observations, as well as pit and underground working inflow monitoring data will be used to verify the groundwater model predictions.

Volumes pumped from the Jervois Project process water supply borefield and mine dewatering rates will be used to define hydraulic stress for the model. Water level drawdown measured at the monitoring bores will be used to provide a calibration data set. Aquifer parameters applied in the model will be adjusted such that the model drawdown matches the measured drawdown.

New data may prompt a revision and update of the conceptual hydrogeological model prior to updating and recalibrating the numerical model and re-running of predictive scenarios. This will be important in the early stages of mining (2 – 3 years) to guide mine water management requirements, review predicted impacts and guide water licensing requirements. The Water Management Plan may also need to be updated depending on any changes to the conceptualisation and model predictions.

8.3.2 Timeframe for achieving a class 2 groundwater flow model

The time frame required to collect data suitable to meet the criteria for a Class 2 groundwater flow model is approximately 2 – 3 years, which is the minimum duration for the calibration dataset required to provide a 10 years forecast at the target confidence level.

The recalibrated model will be run to predict drawdown impacts on other users. If these impacts will reduce water availability to other users, then subsequent mitigation will be implemented. A recalibrated model will be delivered within one year of the trigger value being exceeded.

Mine closure plan scenarios will be investigated with the updated model that has been verified against 2-3 years of operational data, and in close consultation with mine planners on viable options for final landforms and TSF/WRD management, to confirm the most suitable closure plan from a water management viewpoint.

As mining progresses, a need for further model updates will be assessed every year based on evaluation of groundwater monitoring data and findings of impact verification. As identified above, it is expected the confidence level of model predictions will increase over time as the model is updated to reflect the observed effects on groundwater obtained from the monitoring program.

8.4 Responsibilities and Accountabilities for Implementation and Updating of the Groundwater Monitoring and Management Plan

The responsibilities and accountabilities for the implementation of activities associated with groundwater monitoring and management plan are detailed below in Table 8-1.

Table 8-1 Groundwater monitoring and management plan activities and responsibility / accountability

Activity	Personnel Responsible
Groundwater monitoring and database management	KGL Environmental Officer / site personnel
Monitoring program review and optimisation and maintenance	KGL Environmental Officer / CloudGMS
Groundwater impact prediction, verification and review	KGL Environmental Officer / CloudGMS
Annual Groundwater Management Plan review	KGL Environmental Officer / CloudGMS
Groundwater Management Plan updates	KGL Environmental Officer / CloudGMS
Groundwater model review and improvement/update	KGL Environmental Officer / CloudGMS

9 References

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10 Document history and version control

Version	Date released	Approved by	Brief description
0.1	21/09/2018	AK	Draft
1.0	02/10/2018	AK	Comments from NT (Nitro Solutions)
2.0	04/07/2019	AK	Updated for EIS supplement
2.1	09/07/2019	AK	Comments from PR (KGL)
3.0	27/03/2020	AK	Comments from EPA and HM
3.1	03/04/2020	AK	Comments from KGL and HM
3.2	07/08/2020	AK	Comments from EPA
3.3	13/08/2020	AK	Comments from MS (KGL)
3.5	22/06/2021	AK	Comments from RD (KGL)
4.0	02/12/2021	AK	Comments from RD & MS (KGL)

Water Meter Reading Form

Water Meter Reading

(https://nt.gov.au/__data/assets/pdf_file/0020/202349/water-meter-reading-form.pdf)

To: Water Resources Division From:

Fax: Fax:

Phone: Phone

Date:

Email water.regulation@nt.gov.au

Darwin:	Fax: 8999 3666	Phone: 8999 3690
Katherine:	Fax: 8973 8894	Phone: 8973 8834
Alice Springs	Fax: 8951 9268	Phone: 8951 9215

Water Licence Details

As a condition on all water extraction licences in the Northern Territory, licensees are required to submit monthly water meter readings to the Department unless otherwise stated on your licence.

Licence Number:

Date	Registered Bore Number	Meter Name/Model/Serial No.	Meter Reading

1. Has the meter been replaced? Yes / No (please circle)
2. Has the meter been maintained? Yes / No (please circle)
3. Was meter un-operable? No / Yes No. of days _______

Other comments: