Water Management Plan for Jervois Mine

KGL Resources Pty Ltd

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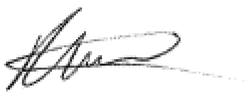

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Document Review Table

Version	Date	Details	Approved By
Revision C3	09/09/2020	Section 3.4 updated to reference ANZECC (2018) guidelines	R. Cullen
		Section 3.4 and Table 3.1 updated to include additional parameters	R. Cullen
		New last paragraph included in Section 3.4 to clarify site specific trigger values	R. Cullen
		New sections 3.5, 7.4 and 7.5.2 added to include sediment monitoring	R. Cullen
		Section 4.4.3.2 updated to clarify use of water for dust suppression	R. Cullen
		Section 4.6.3 updated to include requirement for WDL	R. Cullen
		Section 7.3, Table 7.2 and Figure 7.1 updated to include additional sampling locations and descriptions	R. Cullen
		Section 8.2 updated to address additional TARPs	R. Cullen

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1 Introduction

1.1 PURPOSE AND SCOPE

This report, prepared by WRM Water and Environment, presents the Water Management Plan (WMP) for the Jervois Mine project. The WMP will be supplemented by a Groundwater Management Plan. The WMP is closely aligned with the Erosion and Sediment Control Plan (ESCP). The Biodiversity Management Plan provides detail on how potential impacts to riparian vegetation will managed and monitored.

The WMP examines and addresses all issues relevant to the importation, generation, use, and management of water at the Project, in order to limit the quantity of surface water that is contaminated and minimise the likelihood of uncontrolled releases by and from the Project.

The actual and potential risks of environmental harm to the receiving waters posed by mining activities have been identified and management actions that will effectively minimise these risks are presented. This WMP primarily addresses activities within the Project Exploration Licence as works associated with the borefield and pipeline will not impact natural surface water flows. Erosion management in this area is addressed in the ESCP which centres around works on the pipeline being completed prior to the wet season.

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

Figure 1.1 shows the location of Jervois Mine. The layout of the Jervois Mine and local drainage features is shown in Figure 1.2. Mining operations will be split between three operational areas referred to as the Reward, Bellbird and Rockface (refer to Figure 1.2). Mining at Reward and Bellbird is both open cut and underground, whilst Rockface is underground only.

1.2 REPORT STRUCTURE

This draft WMP has been structured as follows:

- Section 2 describes the regional and local surface water catchment and drainage characteristics in and around the Project;
- Section 3 describes the environmental values and beneficial uses for the receiving surface water environments (receiving waters);
- Section 3.5 presents the surface water quality classes and the water management objectives, principles and measures for the Project and the proposed surface water management measures;
- Section 5 describes the site water balances undertaken for the Project;
- Section 6 presents the flood risk and management measures at the Project;
- Section 7 provides an overview of the surface water monitoring program at the Project;
- Section 8 provides a summary of the emergency and contingency planning information related to water management at the Project;
- Section 9 presents the life-of-mine considerations for the surface water management measures at the Project;
- Section 10 summarises the planned surface water mitigation measures during operations and closure; and
- Section 11 gives a list of references.

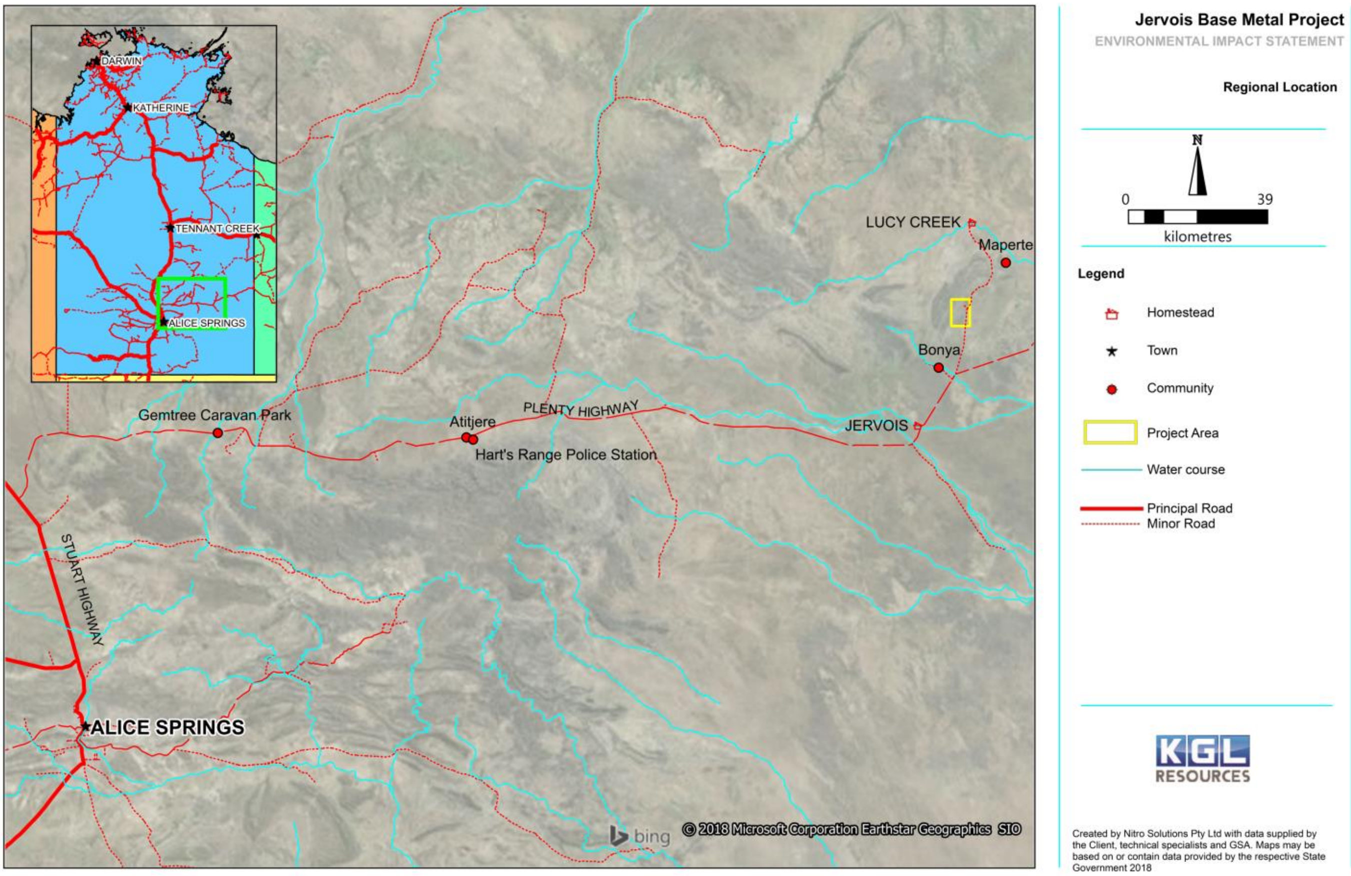

Figure 1.1 – Project locality plan

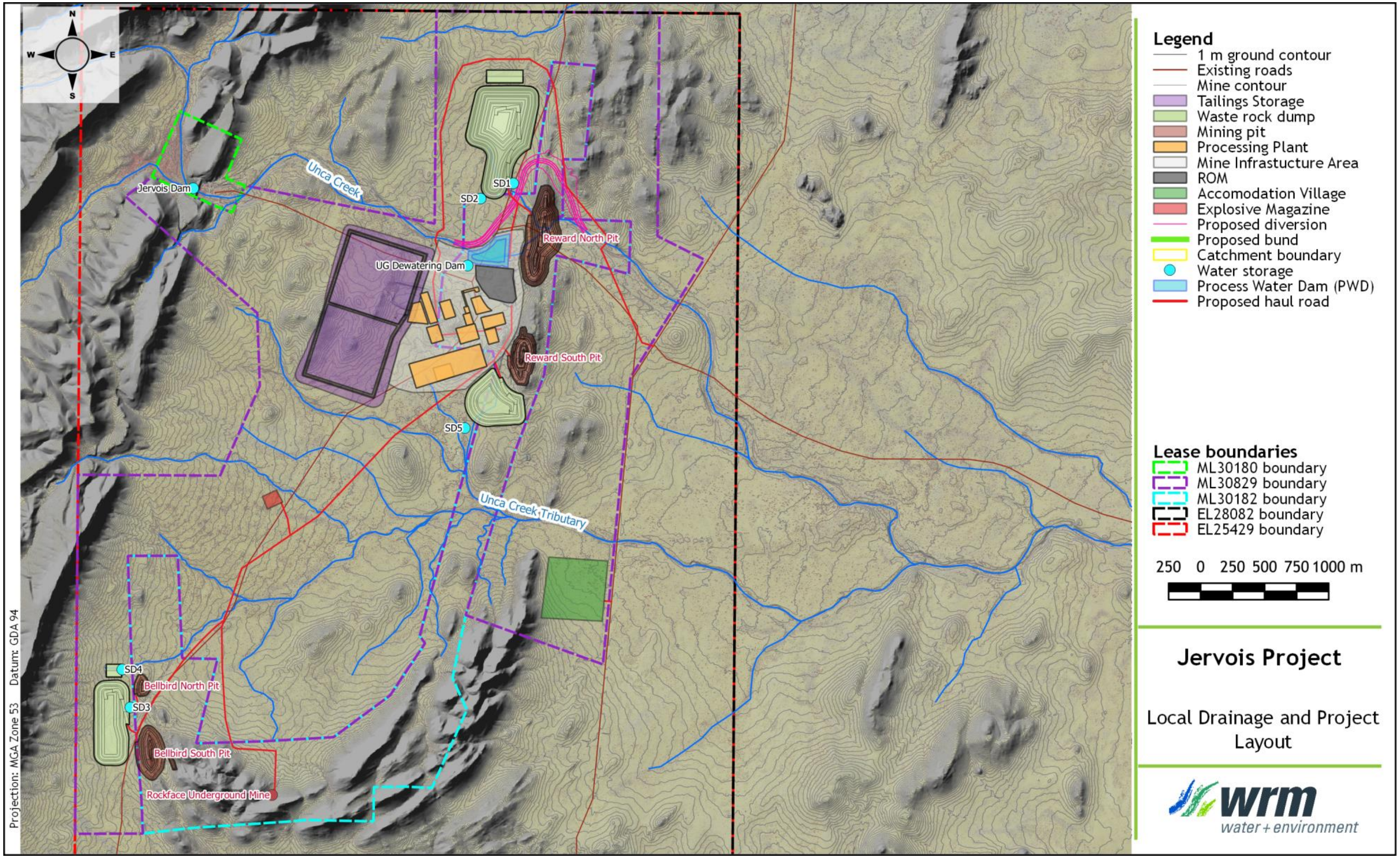

Figure 1.2 – Jervois project layout and local drainage characteristics

2 Existing environment

2.1 REGIONAL DRAINAGE CHARACTERISTICS

The Project is located in the upper catchment of the Hay River basin. The Hay River originates in the Dulcie Ranges and flows in a southeasterly direction towards the Simpson Desert. The Plenty River drains roughly parallel to the Hay River. Flows from the Hay and Plenty rivers would appear to converge at the southern edge of the Simpson Desert before eventually feeding into Lake Eyre. The total catchment area of the Hay River basin upstream of Lake Eyre (including the Plenty River catchment) is approximately 100,000 km^2.

Figure 2.1 shows the drainage network of the Hay River catchment and its major tributaries, including the Plenty River, the Marshall River and Arthur Creek. The Hay River catchment is bounded by the Georgina River catchment to the north and northeast, and by the Todd and Finke rivers catchments to the west.

The catchment is sparsely populated with isolated communities. Land use is typically rural throughout the catchment, with some evidence of historical mining activities in small areas, particularly within the Project area.

The Project is located adjacent to Unca Creek, a tributary of Arthur Creek in the upper headwaters of the Hay River catchment. Arthur Creek and the Marshall River converge into the Hay River approximately 60 km southeast of the Project.

2.2 LOCAL DRAINAGE CHARACTERISTICS

Figure 2.2 shows the local drainage network in the vicinity of the Project. The Project area is incised by a number of ephemeral drainage features that generally flow only during runoff-producing rainfall events.

The only watercourse of note in the vicinity of Jervois project is Unca Creek. Unca Creek originates about nine kilometres upstream of the Project and joins Arthur Creek approximately 45 km southeast of the Project. Unca Creek has a catchment area of 21.8 km^2 upstream of upstream of the Project area, with 17.1 km^2 (78%) of this catchment being captured in Jervois Dam within the Project area. Downstream of Jervois Dam, the Unca Creek channel runs in an easterly direction through the northern portion of the Project area before turning southeast and crossing Lucy Creek Access Road.

A tributary of Unca Creek runs east through the southern portion of the Project area before joining the main creek channel approximately 1.5 km east of Lucy Creek Access Road. The southern Unca Creek tributary has a catchment area of 21.9 km^2 upstream of the Unca Creek confluence.

The Unca Creek catchment upstream of Jervois Dam is steep and rocky, with poorly defined, sandy drainage features located along valley floors. Downstream of Jervois Dam, the catchment becomes flat and open, with wide expanses of sandy flats and spinifex grass, with scattered vegetation along the creek and drainage feature channels.

The Unca Creek channel downstream of Jervois Dam is generally about 10 m wide and less than 1m deep, with a sandy bed that would become mobile during flood events. Loose rock is evident in the bed of the Unca Creek channel at locations where depths and flow velocities increase (i.e. at constrictions or bends in the channel).

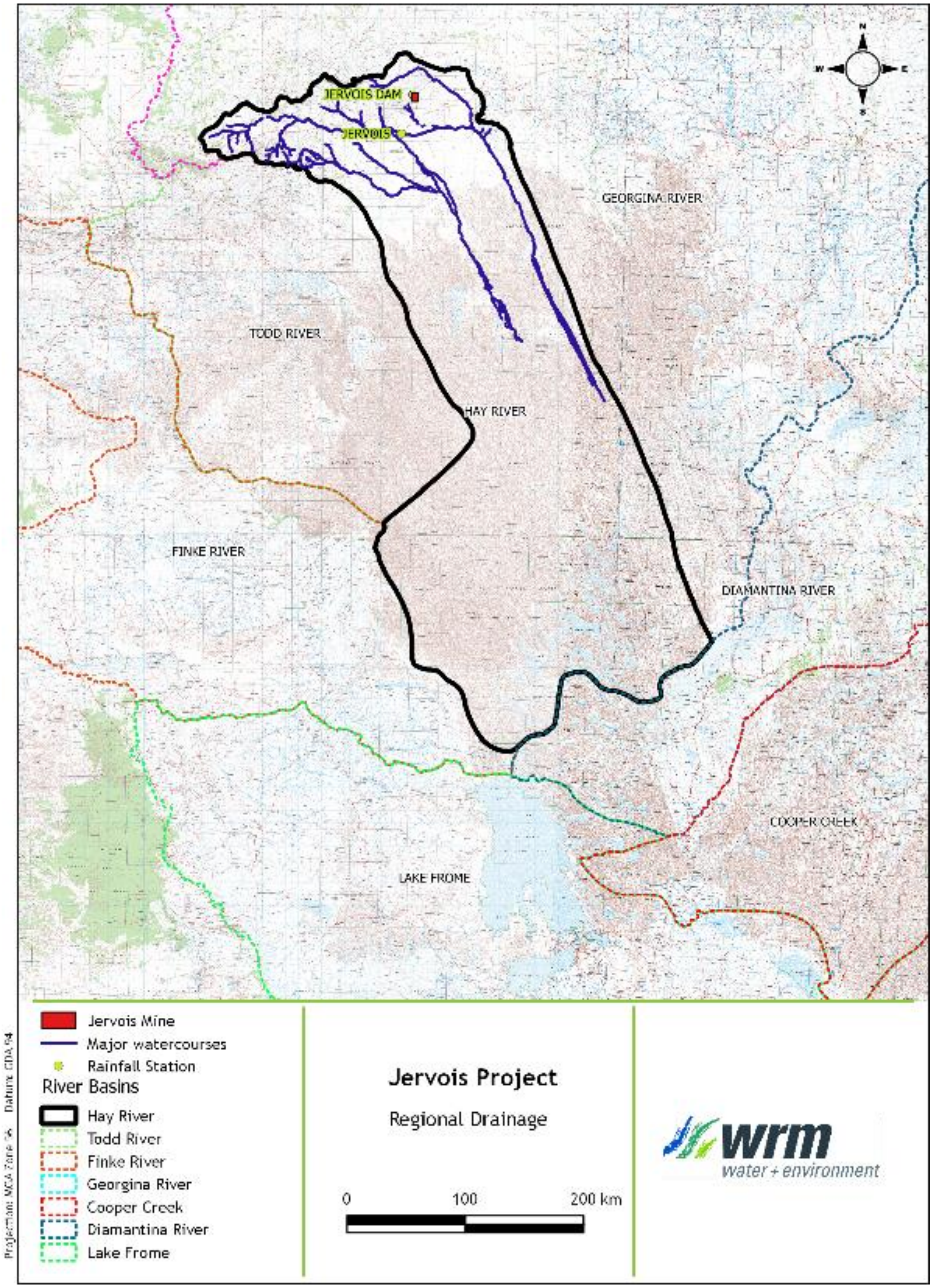

Figure 2.1 – Hay River basin drainage network

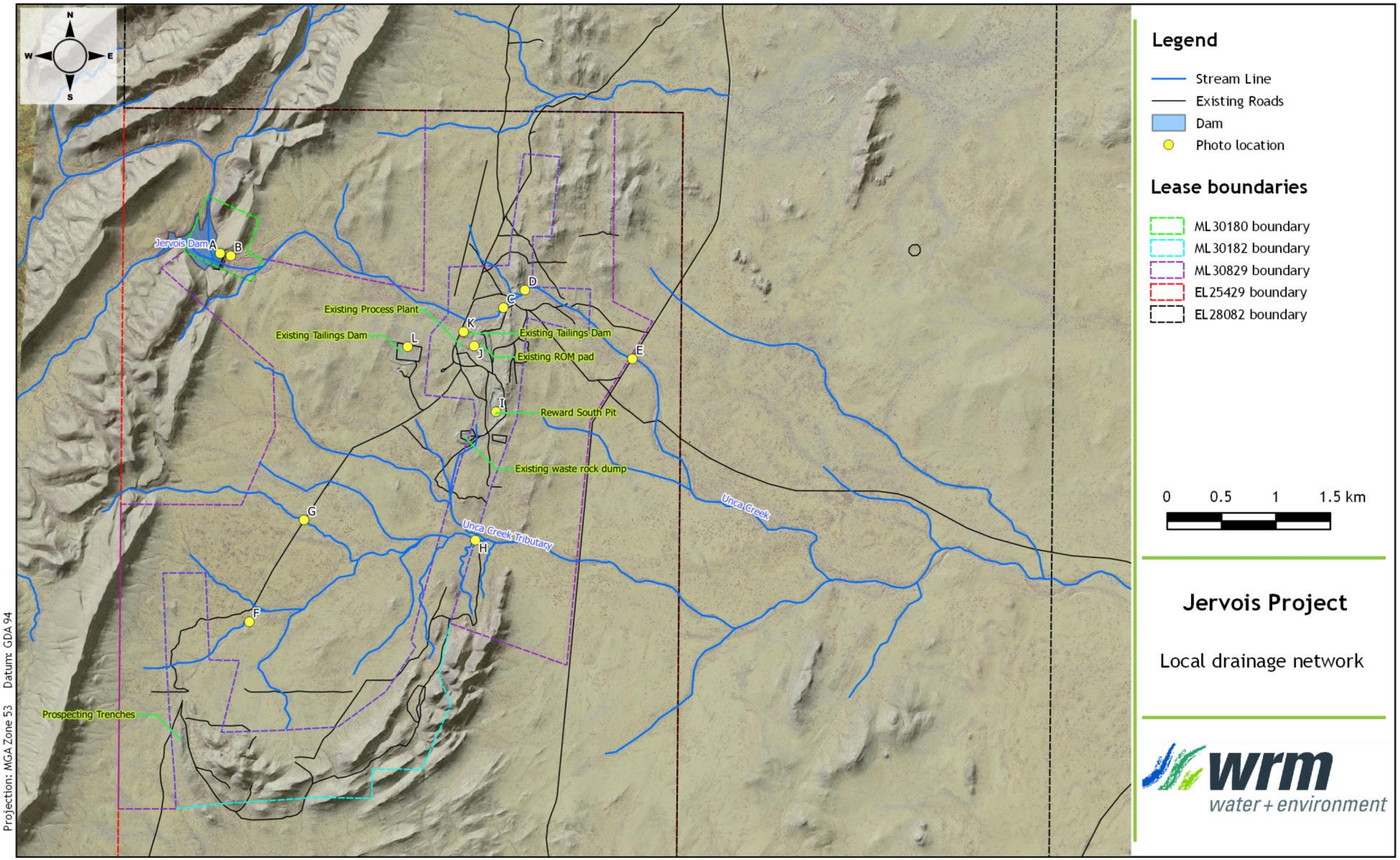

Figure 2.2 – Local drainage network in the vicinity of Jervois Project

2.3 CLIMATIC CONDITIONS – RAINFALL AND EVAPORATION

The climate of the Jervois area is arid, with rainfalls predominantly occurring in summer between October and March. Summers are hot with average maxima in the high thirties reducing to low twenties at night, and winters are mild with daily maxima in the mid-twenties and cooling to around 5°C at night. Temperatures of over 45°C in December and January and as low as -5°C in July have been recorded at the Bureau of Meteorology's (BoM's) Jervois Station (Station No. 15602) (MBS, 2013).

2.3.1 Rainfall

Available rainfall data has been assessed for the Jervois Station (Station No. 15602), which is located about 35 km southwest of the Jervois Project area adjacent to the Marshall River and the Jervois Dam gauge (Gauge No. R0070009), which is at Jervois Dam within the Project area.

Long term daily rainfall data recorded at the Jervois Station (Station No. 15602) was obtained from the Queensland Government DSITIA Patch Point data service. The Patch Point data provides a continuous daily data set between January 1889 and December 2017 (129 years). The Patch Point data contains recorded climate data at the Jervois Station for when data is available, with missing values derived by interpolation of recorded climate data between regional stations.

Recorded daily rainfall data at the Jervois Dam gauge (Gauge No. R0070009) were obtained from the Northern Territory (NT) Government water portal for the period between October 1977 and December 2010 (33 full years between 1978 to 2017). This gauge is closest to the Project area, however, the data includes some periods (up to several months) where data is not available.

Table 2.1 compares long-term monthly rainfall averages for the Patch Point and Jervois Dam data for the common period (1978 to 2017) and for the entire 129-year patch point period. Figure 2.3 compares the annual distribution of average monthly rainfall for the Patch Point and Jervois Dam data.

Table 2.1 and Figure 2.3 show that the differences in average monthly rainfalls between the long-term (129-year) Patch Point data and the Jervois Dam (34-year) data are between 5% and 22% for the wetter months (November to April), and between 13% and 68% for the drier months (May to October). However, the Patch Point data correlates well with the Jervois Dam data during the period of available data at Jervois Dam (1977 to 2010). For the purpose of this assessment, the long-term (129-year) Patch Point data was adopted for characterising existing climatic conditions.

The average monthly rainfalls at the Project area exhibit distinct wet (October to March) and dry (April to September) seasons during the year, with a dry season low of 5.2 mm in August to a wet season high of 44.3 mm in February. The wet season average monthly rainfalls (13.2 mm to 44 mm) are up to eight times higher than the equivalent dry season monthly rainfalls (5.2 mm to 13.3 mm). The Patch Point average annual rainfall over the period from 1889 to 2017 is approximately 227 mm.

2.3.2 Evaporation

Long term daily Morton's Lake evaporation data was also obtained from DSITIA's Patch Point data service for the period between 1889 and 2017 (at the Jervois Station). Table 2.1 shows the long-term monthly averages of Morton's lake evaporation for the Patch Point data. Figure 2.3 compares the annual distribution of average monthly Morton's lake evaporation for the available rainfall data.

The Patch Point average annual Morton's lake evaporation at the Jervois Station is estimated to be approximately 1,900 mm, which is approximately 8.4 times the average annual rainfall. The evaporation rate is high throughout the year, with the highest evaporation rates occurring in the months between October and March. Evaporation is generally much higher than rainfall in all months of the year.

Table 2.1 - Long-term Patch Point average monthly rainfall and evaporation

Month	Patch Point average monthly Mlake evaporation (mm) (1889 - 2017)	Average monthly rainfall (mm)		
		Patch Point rainfall (1889 - 2017)	Patch Point rainfall (1978 - 2010)	Jervois Dam rainfall (1978 - 2010)
Jan	225.7	37.0	48.5	47.0
Feb	191.6	44.3	55.3	47.2
Mar	182.2	25.7	27.8	27.1
Apr	136.9	12.8	18.7	15.6
May	101.1	13.3	18.9	17.0
Jun	80.7	9.4	11.3	6.5
Jul	90.7	9.7	15.9	16.6
Aug	119.6	5.2	4.7	3.1
Sep	151.9	6.5	9.6	9.6
Oct	189.8	13.2	17.1	15.1
Nov	205.2	18.1	22.8	23.1
Dec	224.2	31.9	37.5	36.5
Average annual	***1899.7***	***227.2***	***288.2***	***264.5***

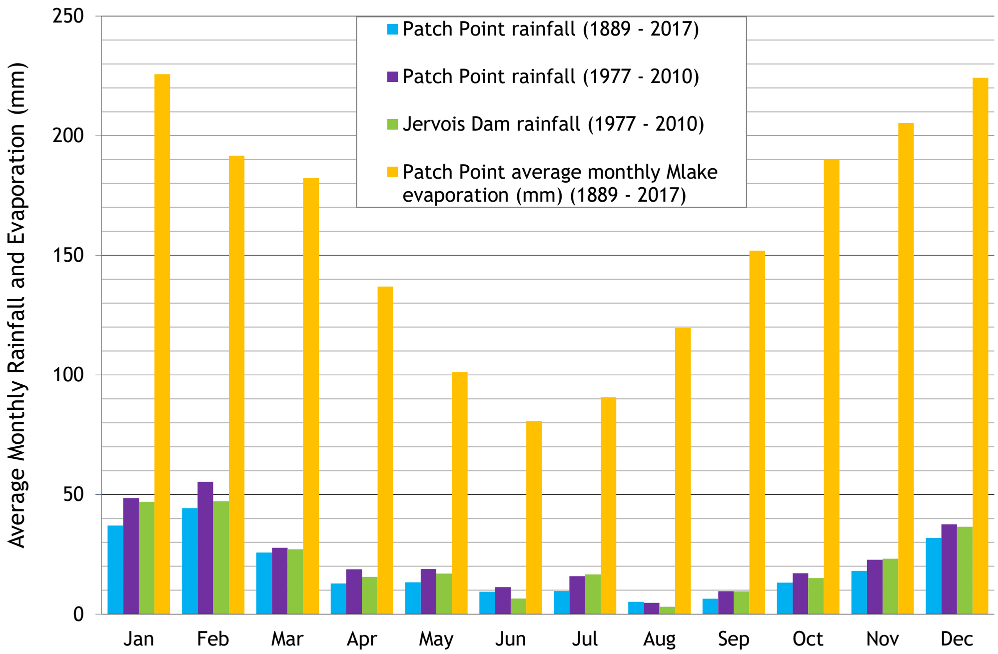

Figure 2.3 - Distribution of Patch Point average monthly rainfall and evaporation

2.4 SURFACE WATER QUALITY

Water quality samples at the Project are collected by a network of remote sampling stations located in the waterways throughout the site. The network collects water quality samples from the watercourses automatically when water levels in the watercourses are sufficient to reach the sampling stations. The sampling network was installed in 2015, and has collected samples from all significant rainfall events since then.

Figure 7.1 shows the locations of surface water quality monitoring sites across the Project area. In summary, water quality at the Project area is characterised as follows:

- Across the Project area, pH is slightly acidic, while salinities (ECs) are low.
- Water stored in Jervois Dam has low turbidity as well as low concentrations of TSS, TDS and metals. This was expected as the catchment upstream of the dam is located outside of the mineralised region of the Project area. Water quality immediately downstream of Jervois Dam (monitoring sites JSW02 and JSW06) is consistent with the observed water quality in the dam.
- In the undisturbed areas along the Unca Creek Tributary (monitoring sites JSW04, JSW05, JSW07 and JSW08), turbidity is relatively high, while concentrations of TSS and metals are also relatively high. The catchment upstream of these monitoring sites is located within in the mineralised region of the Project area. This likely resulted in the elevated metal concentrations observed here despite the absence of mining disturbance in the contributing catchment.
- Downstream of the Project area (monitoring sites JSW01, JSW09 and JSW10), contaminant concentrations are consistent with those observed in the undisturbed areas along the Unca Creek Tributary. Runoff from the mineralised zone within the Project area reports to these monitoring sites. It is possible that runoff from existing mining disturbance in the catchment of Unca Creek and its tributary may have also contributed to the elevated contaminant concentrations observed here.

3 Environmental values and beneficial uses

3.1 ENVIRONMENTAL VALUES

Environmental values (EVs) are the qualities of waterways to be protected from activities in the catchment. Protecting environmental values aims to maintain healthy aquatic ecosystems and waterways that are safe and suitable for community use. Environmental values reflect the ecological, social and economic values and uses of the waterway (such as stock water, cultural uses, maintaining biodiversity, fishing and agriculture).

The processes to identify EVs and determine water quality objectives (WQOs) are based on the National Water Quality Management Strategy: Implementation Guidelines (NWQMS, 1998). They are further outlined in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000).

There are no currently prescribed EVs for the Project Area. Therefore, based on the NWQMS (1998) and ANZECC & ARMCANZ (2000) guidelines, the following EVs are proposed for the Project:

- aquatic ecosystems;
- primary industries including stock drinking water, irrigation and general water uses;
- recreation and aesthetics; and
- cultural and spiritual values.

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 Project.

3.3 MIXING ZONES

Mixing zones are specifically defined areas where the water quality may be below that required to protect environmental values and beneficial uses.

There are no mixing zones currently in place at the Project site.

3.4 SURFACE WATER SITE SPECIFIC TRIGGER VALUES

Based on the ANZECC (2018) guideline, the condition of the watercourses in the vicinity of the Project is considered as *Condition 2: slightly to moderately disturbed ecosystem*. The ANZECC (2018) guideline does not provide updated trigger values for the EVs described above, and instead refers to trigger values defined in the ANZECC & ARMCANZ (2000) guideline. The ANZECC & ARMCANZ (2000) trigger values have been adopted.

Table 3.1 shows the adopted water quality objectives (WQOs) for the receiving waters downstream of the Project. It is anticipated that these WQOs will be applied to any waste discharge licence issued for the Project site.

The ANZECC & ARMCANZ (2000) WQOs for aquatic ecosystems are considered to be the most conservative of the EVs listed above and have therefore been adopted as the surface water WQOs for most parameters. Where no aquatic ecosystem WQO value is available for a certain parameter, a WQO has been sourced from alternative EVs (as listed in Section 3.1). WQOs for pH, electrical conductivity (EC), turbidity, dissolved oxygen (DO), sulphate and iron were sourced from ANZECC & ARMCANZ (2000) guidelines for either livestock drinking water or recreation.

The following is of note with regards to the adopted WQOs:

- The WQOs in Table 3.1 were obtained from the ANZECC & ARMCANZ (2000) guideline for aquatic ecosystems based on 95% of species level of protection, except for pH, EC, turbidity, DO, sulphate, nitrate and iron.
- The ANZECC & ARMCANZ (2000) recommended pH level for general water uses is between 6 and 8.5 for groundwater and between 6 and 9 for surface water. The recommended pH limit of between 6 and 8.5 is adopted for the Project.
- The adopted WQO limits for EC and sulphate are based on the ANZECC & ARMCANZ (2000) guidelines for livestock drinking water.
- In absence of more site-specific guidelines, the adopted turbidity limit is based on the ANZECC & ARMCANZ (2000) guidelines for upland and lowland rivers in south central Australia: low rainfall area.
- In absence of more site-specific guidelines for arid regions, the adopted DO (%) limit is based on the ANZECC & ARMCANZ (2000) guidelines for freshwater lakes and reservoirs in south central Australia: low rainfall area. No data is available in the guideline for upland rivers, which would have been more representative of the Project area.
- The WQO limit for iron is based on the ANZECC & ARMCANZ (2000) guidelines for recreational purposes.

The adopted WQO limits will be revised once a suitable number of water quality samples are available from the background surface water monitoring stations at the Project (JSW04, JSW05, JSW02 and JDW06) to develop site specific WQOs. The current available background water quality sampling data is not suitable for deriving site specific WQOs as no filtered metalloid concentrations have been measures (only total metal concentrations are available).

There are no WQOs available for total suspended solids (TSS) for any of the identified EVs. Background TSS concentrations are very high in both Unca Creek and Unca Creek Tributary. The sampled TSS concentrations in Unca Creek are significantly less than those for Unca Creek Tributary, which reflects the differences in catchment type. The maximum sampled TSS concentration in Unca Creek has been conservatively adopted as the WQO. It is likely that parameters other than TSS will determine the suitability of water for release at the Project.

The adopted WQOs (generally derived from ANZECC & ARMCANZ (2000)) are conservative and are considered suitable for use until such time as sufficient site data (12 samples) is available to develop site specific trigger values (which will occur at some point within the mine operations).

Table 3.1 – Adopted surface water quality objectives (WQOs) for the Project

Parameter	Abbreviation	Units	Adopted WQO value [a]
Non-metallic indicators			
pH	pH	pH units	6.0 - 8.5 [b]
Electrical conductivity	EC	µS/cm	5,970 [c]
Total dissolved solids	TDS	mg/L	4,000 [c]
Total suspended solids	TSS	mg/L	218 [i]
Turbidity	Turbidity	NTU	50 [d]
Dissolved oxygen	DO	% saturation	90 [e]
Sulphate	SO_4	mg/L	1,000 [f]
Nitrate	NO_3	mg/L	0.7
Total Hardness[j]	$CaCO^3$	mg/L	350
Total petroleum hydrocarbons[k]	(C6-C9)	µg/L	10
Total petroleum hydrocarbons[k]	(C10-C36)	µg/L	10
Metals and metalloids (filtered, unless otherwise stated)			
Aluminium	Al	µg/L	55
Arsenic	As	µg/L	24
Boron	B	µg/L	370
Cadmium	Cd	µg/L	0.2
Chromium	Cr	µg/L	3.3
Cobalt	Co	µg/L	2.8
Copper	Cu	µg/L	1.4
Iron	Fe	µg/L	300 [g]
Lead	Pb	µg/L	3.4
Magnesium	Mg	mg/L	2,000 [h]
Manganese	Mn	µg/L	1,900
Mercury	Hg	µg/L	0.6
Molybdenum	Mo	µg/L	34
Nickel	Ni	µg/L	11
Selenium	Se	µg/L	5
Silver	Ag	µg/L	0.05
Uranium	U	µg/L	0.5
Vanadium	V	µg/L	6
Zinc	Zn	µg/L	8

[a] – Obtained from Table 3.4.1 in ANZECC & ARMCANZ (2000) based on 95% species level of protection, unless otherwise stated.

[b] – Section 4.2.10.1 in ANZECC & ARMCANZ (2000) for general water uses.

[c] – Table 4.3.1 in ANZECC & ARMCANZ (2000), adopted the lower limit for beef cattle and horses.

[d] – Table 3.3.9 in ANZECC & ARMCANZ (2000) for upland & lowland rivers.

[e] – Table 3.3.8 in ANZECC & ARMCANZ (2000) for lowland rivers and freshwater lakes and reservoirs.

[f] – Section 4.3.3.4 in ANZECC & ARMCANZ (2000) for livestock drinking water.

[g] – Table 5.2.3 in ANZECC & ARMCANZ (2000) for recreational purposes.

[h] – Section 4.3.3.2 in ANZECC & ARMCANZ (2000) for livestock drinking water.

[i] – No WQO values for TSS available, maximum sample TSS concentration from Unca Creek nominated

[j] – ANZECC & ARMCANZ (2000) limit for pipe fouling

[k] - ANZECC & ARMCANZ (2000) limit for benzene

3.5 SEDIMENT QUALITY OBJECTIVES

Sediment guidelines/trigger values are summarised below in Table 3.2 in order to outline appropriate receiving environment targets for the sediment monitoring outlined in this WMP.

Table 3.2 – Sediment Quality Objectives for the project (ANZECC, 2018)

Quality Characteristic	Units	Sediment Quality Objective	
		ANZECC 2018 default guideline value (DGV)	ANZECC ARMCANZ guideline value – high (GV-high)
Antimony	mg/kg	2	25
Arsenic	mg/kg	20	70
Cadmium	mg/kg	1.5	10
Chromium	mg/kg	80	370
Copper	mg/kg	65	270
Lead	mg/kg	50	220
Mercury	mg/kg	0.15	1
Nickel	mg/kg	21	52
Silver	mg/kg	1	4.0
Zinc	mg/kg	200	410

The toxicant concentrations measured from the <2 mm sediment fraction of a sediment sample should be compared with the sediment DGVs.

The GV-high represents the median value of the effects ranking. As such, GV-high could be considered as more likely to be associated with biological effects than the DGV but the extent of that impact is not necessarily known. The GV-high value is provided as an indicator of potential high-level toxicity problems, not as a guideline value to ensure protection of ecosystems.

In the absence of reliable site specific trigger values, the ANZECC (2018) DGVs have been adopted for sediment comparisons.

4 Surface water management

4.1 GENERAL

The key objectives of the Project's water management system are:

- To protect environmental values of the receiving waters downstream of the Project during the operational period and post-closure;
- To ensure no impact to the environmental values of the area as a result of Project activities;
- To ensure no deterioration in water quality in accordance with beneficial use values;
- To achieve the water quality objectives provided in Table 3.1.and
- To ensure that the Project has sufficient water available for operations during dry times.

The water management system proposed for the Project has been designed to achieve these objectives, as discussed in the following sub-sections.

The proposed water management system (WMS) layout for the Project is shown Figure 4.1 for the Reward operations and Figure 4.2 for the Bellbird operations. A schematised plan for the WMS configuration is shown in Figure 4.3.

4.2 SURFACE WATER TYPES

For surface water management purposes, the surface water that is generated and/or managed at the Project is divided into five classes based on water quality:

- **Undisturbed runoff**: runoff from catchments unaffected by mining;
- **Raw water (potable standard)**: raw water suitable for use in supplying the potable water treatment plant. Raw water (potable) standard will not have been in contact with any areas disturbed by mining, or any ore bodies. Raw water (potable standard) is typically sourced from Jervois Dam or the external borefield. Note that water sourced from both Jervois Dam and the external borefield would require some level of treatment prior to human consumption.
- **Raw water (plant standard):** water suitable for use in the raw water streams of the process plant and for dust suppression on parts of the project where runoff is captured by the mine water management system. Raw water (plant standard) will have suitably low levels of TSS to prevent clogging of machinery nozzles but may have elevated levels of metalloids, salinity (EC), and sulphates. Raw water (plant standard) is typically sourced from groundwater dewatered from the underground mining operations.
- **Sediment laden water:** sediment laden runoff from waste rock dumps. Sediment laden water is suitable for use as make-up process water in the plant, and for dust suppression.
- **Mine affected water:** runoff from areas where chemicals, contaminants or oxidised ore may be present. Includes runoff that collects from the process plant, ROM and product stockpiling areas, open cut mining pits and tailings storage facilities. Suitable for use as make up process water in the plant and for dust suppression on parts of the project where runoff is captured by the mine water management system.

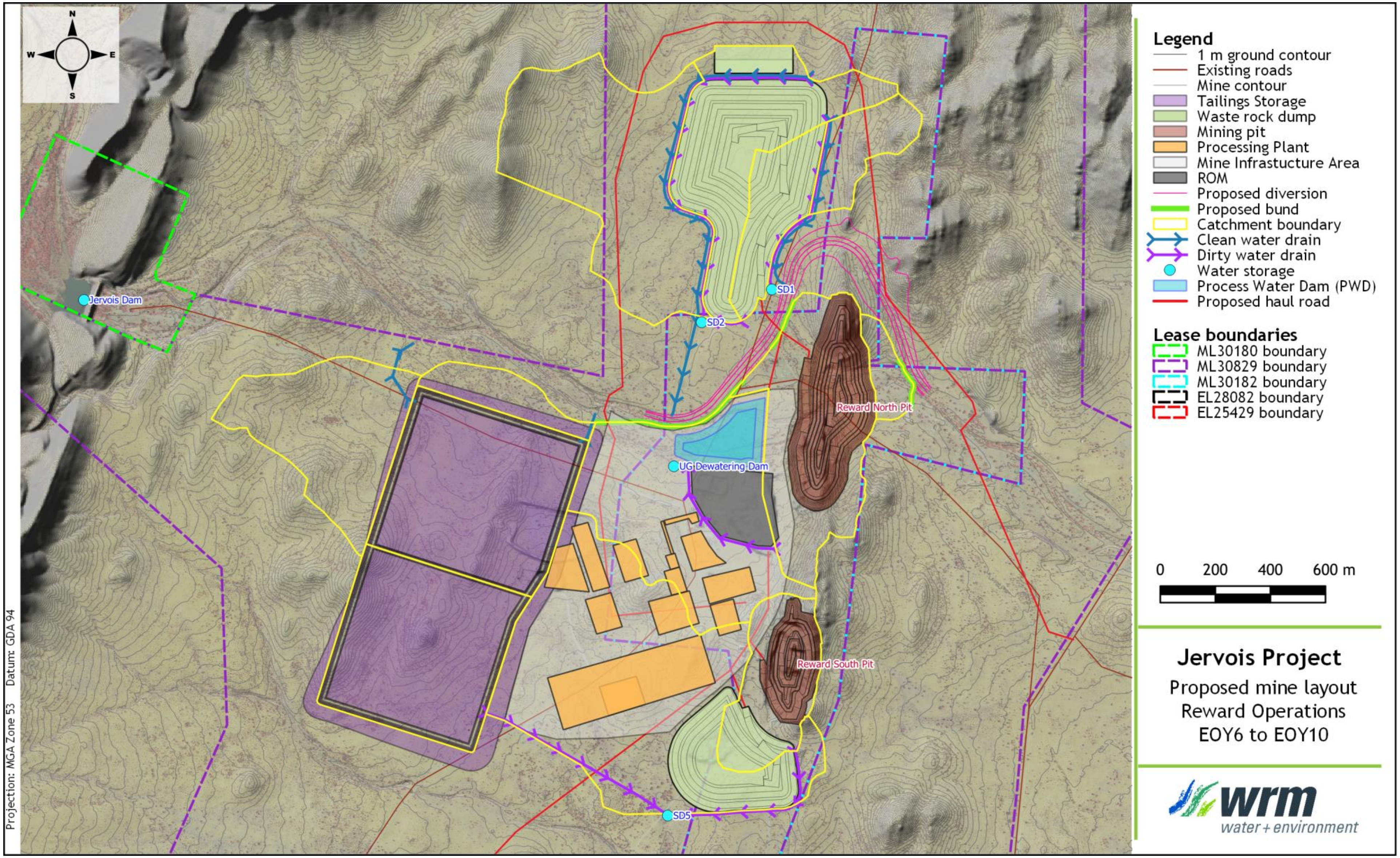

Figure 4.1 - Proposed water management system (WMS) lay out for the Reward mining operations

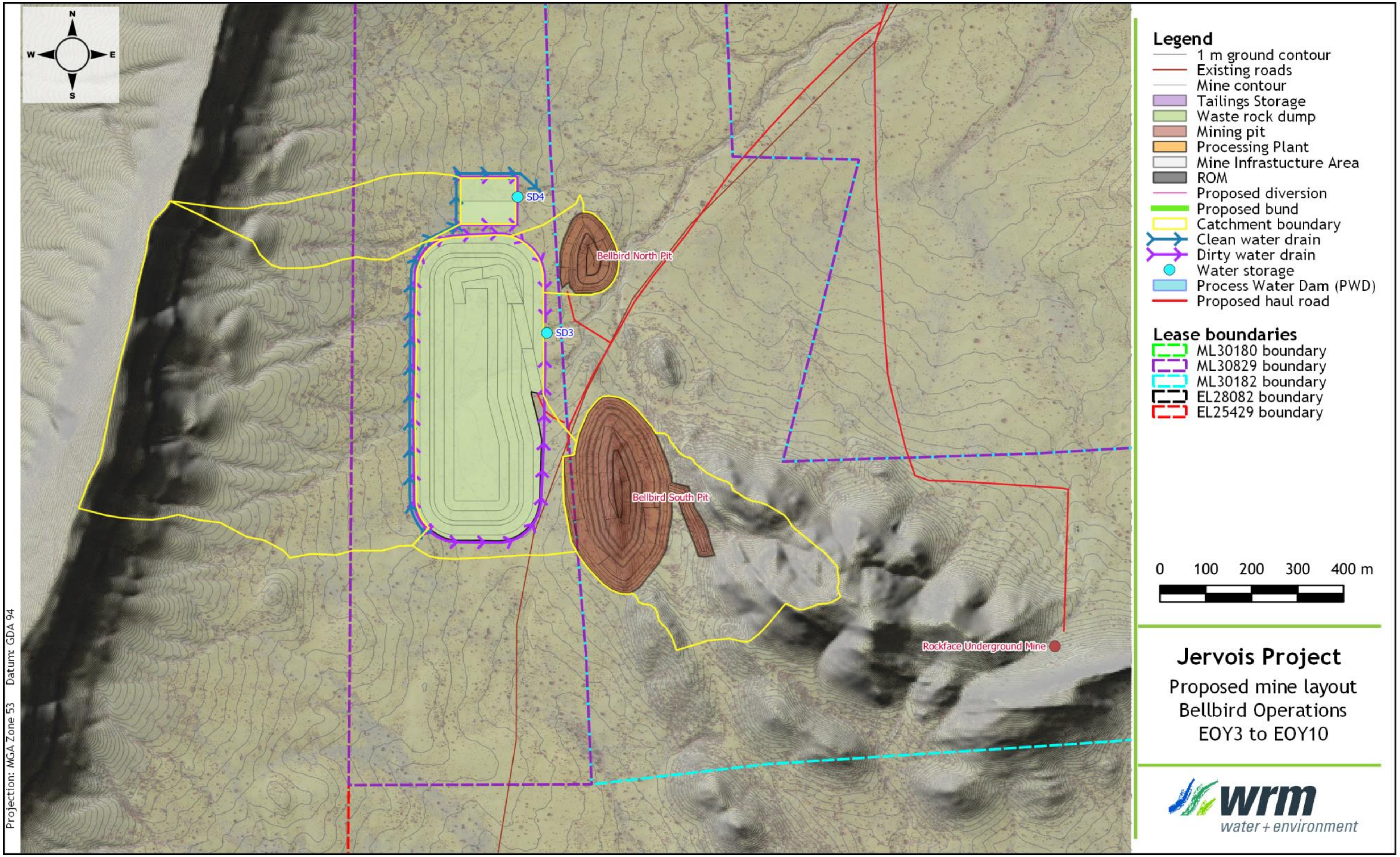

Figure 4.2 - Proposed water management system (WMS) layout for the Bellbird and Rockface mining operations

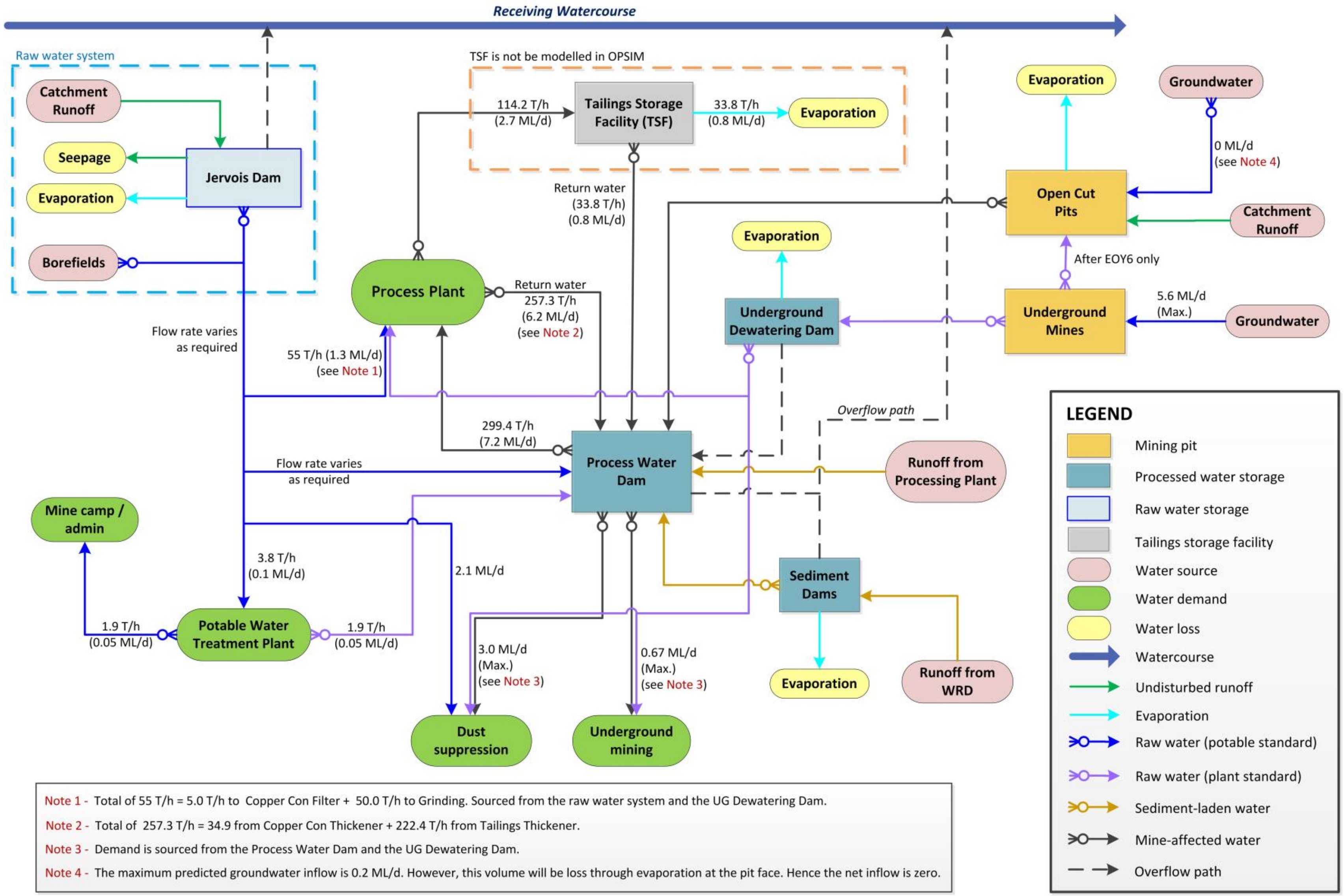

Figure 4.3 – Water management system schematic

4.3 KEY WATER MANAGEMENT OBJECTIVES

The adopted principles for management of water on the site are summarised as follows:

- Existing surface water drainage patterns will be maintained where practical to do so;
- Water from different sources will be managed separately:
  - Undisturbed runoff will be diverted around disturbed areas where practical;
  - Mine affected water collected in-open cut pits, and in the process water dam will be managed using temporary in-pit sumps and re-used within the water management system;
  - Sediment-laden runoff from the proposed waste rock dumps will be captured in dedicated sediment dams and re-used within the water management system;
  - Raw water (plant standard) dewatered from the open cut pits and underground mines will be reused within the water management system.
- Water will be selected for use based on water quality considerations;
- Water collected on site as part of mining operations will be used preferentially in order to reduce demand on external water sources. Water for mine operating purposes (excluding supplying potable water) will be sourced preferentially as follows:
  - Mine affected water;
  - Raw water (plant standard), dewatered from the underground mines;
  - Sediment laden water;
  - Raw water (potable standard), sourced from Jervois Dam; and
  - Raw water (potable standard) sourced from the external borefield.

4.4 WATER MANAGEMENT AT THE MINE

4.4.1 General

To achieve the water management objectives and strategies listed Section 4.3, mine water is managed based on quality using the mine water quality classification system. The classification of mine water in each storage is affected by the water source (e.g., catchment, land use interactions, etc), water use and interactions with other waters on site.

The quality of water stored in each mine water storage will be sampled regularly as part of the mine's proposed water quality monitoring program to identify trends in water quality over time, inform mine water management decisions and comply with the WDL.

4.4.2 Sources of water

Water captured and stored in the site water management system would comprise a mixture of runoff water from various catchment land use types and groundwater from seepage into the underground mines. Full details of the water quality of water in the water management system will not be known until the project is operational.

The water quality characterisation described in the following sections has been used (in conjunction with the site water balance model) for the purposes of assessing the potential risks for the receiving waters.

Undisturbed Areas – surface runoff from undisturbed areas is likely to be of a similar quality to those samples monitoring stations JSW04, JSW05, JSW07 and JSW08. The data from these monitoring locations is detailed in Section 3.9 of this report. Runoff from undisturbed areas will be diverted around disturbance areas and released to the environment.

Water Storage Surfaces – direct rainfall onto water surfaces will have negligible dissolved salt/metal concentrations.

Runoff from ROM and product stockpiles (mine affected water) – runoff from the ROM and product stockpiles will likely have been in contact with exposed ore. It is likely this runoff would contain sediment and elevated levels of metals.

Runoff from process plant area (mine affected water) – runoff from the process plant area will likely have been in contact with ore, and may contain sediment, chemicals and oil and grease. Suitable at source controls will be implemented within the process plant area to contain oil and grease and chemicals:

- Appropriate bunding of all chemical stores; and
- Hydrocarbon capture and oil and grease separators.

Runoff from pit areas (mine affected water) - water collecting on the floor of the pits is likely to surface runoff that has been in contact with exposed ore. It is likely this runoff would contain sediment, elevated levels of metals and potentially oil and grease.

Groundwater seepage to underground mines (raw water plant standard) – Groundwater seepage into the underground mine will likely have been in contact with ore, and may contain elevated levels of metals.

Waste rock dumps (sediment laden water) –Due to the proposed capping of the waste rock dumps with NAF material, runoff from the dumps is likely to be of relatively similar quality to baseline surface water quality at the project site, however seepage from the dumps is likely to be of poorer quality (EGI, 2019). It is anticipated that runoff from the waste rock dumps may be suitable for release to the environment (following a period of monitoring).

4.4.3 Site water demands

Based on the water mass balance process flow diagram for the Project (Sedgman, 2018) the predicted water demand rate to the Potable Water Treatment Plant is 3.8 T/h (0.1 ML/d or 36.5 ML/year). Based on a plant yield of 50%, 1.9 T/h (0.05 ML/d) of treated water from the Potable Water Treatment Plant will be used to supply potable water uses at the mine camp and the administration area. The remaining 1.9 T/h (0.05 ML/d) waste stream from the potable water treatment plant will be pumped to the process plant to supply non-potable uses.

4.4.3.1 Process plant demands

The Sedgman (2018) water mass balance shows the Process Plant is projected to require a constant water demand rate of 86.1 T/h (2.05 ML/d) over the life of the Project, which includes:

- 55 T/h (1.3 ML/d or 475 ML/year) of raw water (plant standard); and
- 31 T/h (0.75 ML/d or 274 ML/year) of process water (mine affected water or sediment laden water).

The above water demand rate has accounted for all internal recycling of processed water within the process plant and tailing storage facility. If insufficient mine affected or sediment laden water is available to supply the process water demand to the plant, raw water will be used to supply the plant demand.

4.4.3.2 Dust suppression

Dust suppression demand rates were calculated based on the predicted surface area (waste rock dump, open cut pits, haul roads and access roads) to be wetted, and the average daily evaporation rate for during dry days. The following methodology was adopted:

- For mining pit and waste rock dumps, dust suppression demand was calculated assuming that 50% of the total area require dust suppression. Dust suppression is not required when the open cut pit or waste rock dump is no longer in operation.
- For haul roads and access roads, dust suppression demand was calculated based on a total road length of 13.9 km and road width of 30 m as per the proposed haul road layout supplied by KGL. The total road surface area requiring dust suppression will remain the same over the life of the Project.
- Based on the 130-year Patch Point data, there is an average of 354 dry days per year, and an average daily evaporation rate of 5.6 mm during these dry days. The daily dust suppression rate for each mine stage was calculated by multiplying the average daily evaporation rate (5.6 mm) and the surface area requiring dust suppression.

Dust suppression demand will be supplied by both raw water (potable standard) from Jervois Dam and the borefields, as well as sources of lower water quality (via the Process Water Dam), such as harvested surface runoff and groundwater dewatered from the underground mine.

To minimise the potential for impacts to surface water quality in receiving watercourses, it is proposed to only use water from the process water dam (with lower quality) for dust suppression on areas that are captured by the water management system. These areas include the waste rock dumps, open cut pits, mine infrastructure area and some haul roads.

Dust suppression for areas that drain off-site (not captured by the water management system) will preferentially be supplied from water collected in sediment dams, or alternately be supplied from raw water (potable standard) sources (i.e. Jervois Dam and the borefields). Water from the process water dam will not be used for dust suppression on areas that drain off-site.

It should be noted that should ongoing monitoring indicate that the quality of water stored in the Process Water Dam is comparable to the water quality observed in the sediment dams, then water from the process water dam could be used for dust suppression on areas of the project that are not captured by the water management system.

Table 4.1 summarises the predicted dust suppression demand for the areas captured in the WMS as well as for areas that drain off-site over the various stages of the project.

Table 4.1 - Dust suppression demand

Project year	Total area requiring dust suppression (ha)			Total area captured in WMS (ha)	Total area draining off-site (ha)	Dust suppression demand			
						For areas captured in WMS		For areas draining off-site	
	Mining Pit	Waste Rock dump	Haul Roads			(kL/d)	(ML/yr)	(kL/d)	(ML/yr)
Start year 1 to EOY3	16.6	36.7	46.9	35.0	38.5	1,902	694	2,094	764
EOY3 to EOY4	26.8	55.3	46.9	49.4	38.5	2,685	980	2,094	764
EOY4 to EOY5	26.8	55.3	46.9	49.4	38.5	2,685	980	2,094	764
EOY5 to EOY6	33.9	61.3	46.9	56.0	38.5	3,041	1,110	2,094	764
EOY6 to EOY7	33.9	45.9	46.9	48.3	38.5	2,624	958	2,094	764
EOY7 to EOY10	33.9	23.0	46.9	36.8	38.5	2,000	730	2,094	764

4.4.3.3 Underground mining equipment demands

A maximum nominal underground mining demand rate of 100 kL/d was adopted when all three underground mines (Rockface, Bellbird and Reward) are operating. That is, the adopted underground mine demand is 33.3 kL/d for each operating underground mine. Table 4.2 shows the adopted underground mine demand rates over the Project life. It is assumed that underground mining equipment demands can be supplied from raw water (plant standard), mine affected water and sediment laden water if necessary. If insufficient water is available from the above sources, raw water (potable standard) will be used.

Table 4.2 - Underground mining demand

Project year	Reward operations	Bellbird operations	Rockface operations	Underground mine demand (kL/d)	Underground mine demand (ML/yr)
Start year 1 to EOY3	open cut only	none	underground only	33.3	12.2
EOY3 to EOY4	open cut only	open cut only	underground only	33.3	12.2
EOY4 to EOY5	open cut + underground	open cut only	underground only	66.7	24.3
EOY5 to EOY6	open cut + underground	open cut only	none	33.3	12.2
EOY6 to EOY7	open cut + underground	underground only	none	66.7	24.3
EOY7 to EOY10	underground only	underground only	none	66.7	24.3

4.4.4 Groundwater inflows

4.4.4.1 Open cut mining pit dewatering

Runoff and any groundwater seepage (mine affected water) collecting in the Reward and Bellbird open cut pits will be collected in sumps before being pumped out to the process water dam.

CloudGMS (2019) provided estimates of the groundwater seepage rates for the Reward and Bellbird open cut pits. Evaporation from the pit surfaces will exceed the maximum predicted seepage rates to both pits, and hence net volume of groundwater that will need to be dewatered from the open cut pits is predicted to be zero.

4.4.4.2 Underground mine dewatering

Figure 4.4 shows the CloudGMS (2019) predicted groundwater inflow rates to each of the underground mines at the Project. Groundwater that seeps into the underground mining operations will be pumped to a collection sump at the portal of each mine before being pumped back to the underground dewatering dam for re-use. The following is of note:

- Until the end of year 4, the only groundwater inflows are into the Rockface underground mine, which peaks at approximately 1,413 ML/year (3.9 ML/day) in year 2 of operations;
- Underground mining at Reward commences in year 5, and groundwater inflows to the Reward underground peak in year 6 at approximately 1,556 ML/year (4.3 ML/day);
- Underground mining commences at Bellbird in year 8, and groundwater inflows to the Bellbird underground peak in year 8 at approximately 919 ML/year (2.5 ML/day);

- The total groundwater inflow to the underground mines peaks in year 8 at 2,039 ML/year (5.6 ML/day); and
- Underground mining at Rockface is complete at EOY5, and it is not proposed to continue to dewater the Rockface underground mine beyond that point in time.

When open cut mining ceases at the Bellbird North Pit after EOY6 and at the Reward South Pit after EOY7, groundwater inflows in excess of the WMS capacity will also be pumped to the Bellbird North and the Reward South Pits. Excess groundwater collected in the Bellbird North and Reward South pits will be pumped back into the underground mines once underground operations cease.

Groundwater associated with the ore body is brackish (1,000 to 2,000 mg/L TDS), has a neutral pH, and elevated sulphates, total iron and manganese (CloudGMS, 2019). For the purposes of the EIS it has been assumed that dewatering from underground operations is likely to be of much poorer quality than natural groundwater due to oxidation effects (Pers comm. EGI, 2019). However, the dewatered groundwater is likely to be suitable for use to supply raw water demands in the process plant, and dust suppression for areas that drain to the mine water management system.

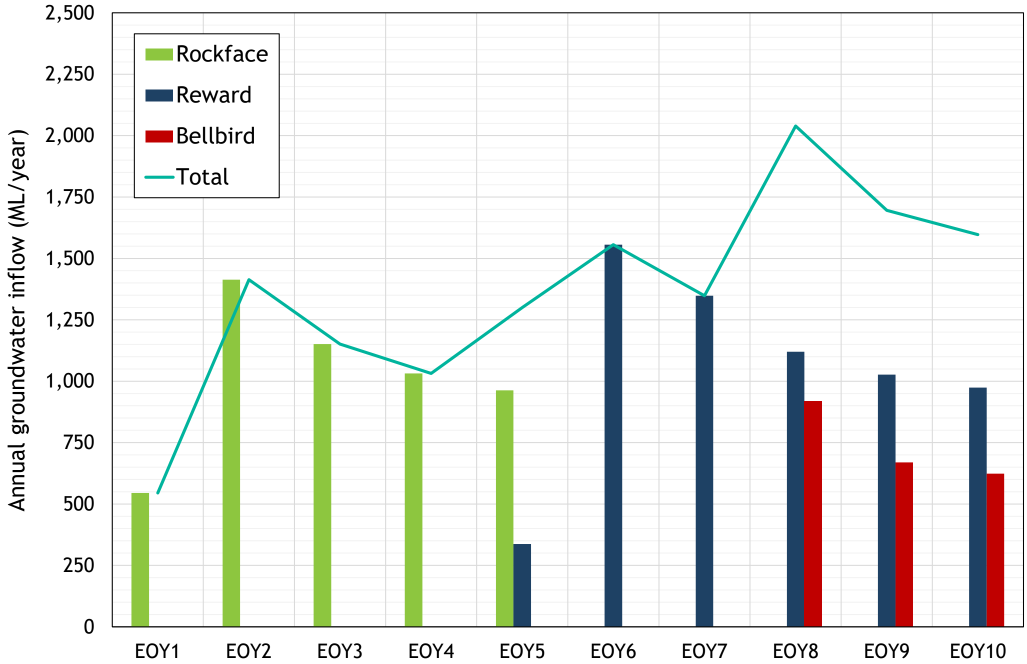

Figure 4.4 - Predicted groundwater inflows to underground mines

4.4.4.3 Sensitivity of predicted groundwater inflows

CloudGMS (2019) indicates that the predicted groundwater inflows to the open cut pits and underground mines are particularly sensitive to the adopted hydraulic conductivity in the groundwater model.

CloudGMS (2019) states that groundwater inflows are forecast to decrease by a factor of about 40% due to a decrease in hydraulic conductivity, and conversely groundwater inflows are forecast to increase by a factor of about 40% due to an increase in hydraulic conductivity.

4.4.5 Waste rock dump runoff and sediment dams

Due to the proposed capping of the waste rock dumps with NAF material, runoff from the dumps is likely to be of relatively similar quality to baseline surface water quality at the project site, however seepage from the dumps is likely to be of poorer quality (EGI, 2019). It is anticipated that runoff from the waste rock dumps may be suitable for release to the environment (following a period of monitoring). Nevertheless, a cautionary approach has been adopted to the management of runoff from the waste rock dumps:

- Runoff and seepage collecting in the waste rock dump sediment dams will be pumped back to the mine water management system;
- It is possible that the sediment dams would overflow when the design rainfall (10% AEP 24-hour storm) is exceeded. Any overflows from the sediment dams would occur during periods where there will be significant flows in the receiving watercourses, and runoff from the dumps during these events is likely to comply with the trigger values proposed in Table 3.1.
- Seepage from the dumps following rainfall events will be captured and pumped back to the mine water management system. Dump seepage is most likely to contain contaminants that would exceed the adopted trigger values in the trigger values proposed in Table 3.1.
- Surface runoff and seepage from waste rock dumps that collects in the sediment dams would be monitored for water quality parameters including, but not limited to pH, EC, major anions (sulphate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids;
- The sediment dam monitoring would be used to validate the anticipated quality of water runoff reporting to sediment dams. Initially, the sediment dam monitoring would occur on an event basis to demonstrate the water quality of stored waters is consistent with the relevant operating parameters to allow releases from sediment dams to occur if required.

4.4.6 Managed releases and waste discharge licence

No managed releases of mine affected water or dewatered groundwater are predicted to be required from the project. It is not currently proposed to acquire A WDL for the Project.

4.5 WATER MANAGEMENT INFRASTRUCTURE

4.5.1 Surface water storages

Table 4.3 lists the proposed surface water storages for the Project, including the catchment area draining to each storage, the proposed storage volume and the type of water held in each storage.

Table 4.3 - Surface water storages

Storage name	Catchment area (ha)	Full supply Volume (ML)	Water type
Underground dewatering dam	NA	10.0	Raw water (plant standard)
Process water dam	43.2	203.6	Mine affected water
Sediment dam SD1	11.2	5.5	Sediment laden water
Sediment dam SD2	30.1	14.8	Sediment laden water
Sediment dam SD3	20.5	10.1	Sediment laden water
Sediment dam SD4	1.2	0.6	Sediment laden water
Sediment dam SD5	70.0	34.4	Sediment laden water
Jervois dam	1,710	945.0	Raw water (potable standard)

4.5.1.1 Underground dewatering dam

An underground dewatering dam will be constructed adjacent to the process plant and process water dam. The underground dewatering dam will receive pumped dewatering flows from the underground mining operations at Reward, Bellbird and Rockface. This water is considered to be raw water (plant standard), and hence requires its own storage to ensure it does not mix with mine affected and sediment laden water that is stored in the process water dam.

The underground dewatering dam is a turkey nest storage (i.e. has no catchment except for the dam itself) and has a storage capacity of 10 ML. The underground dewatering dam overflows into the adjacent process water dam.

4.5.1.2 Process water dam

A process water dam will be constructed between the Process Plant and the Tailings dam. The process water dam receives inflows from the following sources:

- Catchment runoff from a 43.6 ha mine affected water catchment that includes the process plant and ROM and product stockpiles, as well as the existing ROM pad and tailing storage dam;
- Pumped transfers of sediment laden water from the waste rock dump sediment dams;
- Pumped transfers of mine affected water from the open cut mining pits; and
- Overflows of raw water (plant standard) from the underground dewatering dam;

The process water dam will have a capacity of approximately 204 ML and will have emergency spillway to the adjacent Unca Creek diversion channel.

4.5.1.3 Waste rock dump and MIA sediment dams

Five sediment dams are proposed to capture runoff from waste rock dumps, including three sediment dams for the Reward waste rock dump (SD1, SD2 and SD5) and two sediment dams for the Bellbird waste rock dump (SD3 and SD4). Sediment dams SD1 and SD2 both overflow into the Unca Creek diversion drain. Sediment Dams SD3, SD4 and SD5 overflow into the Unca Creek tributary.

Note that Sediment Dam SD5 will capture runoff from the southern portion of the Mine Infrastructure Area for the entire Project life. Sediment Dam SD5 will also capture runoff from the proposed waste rock dump adjacent to the Reward South Pit from the end of year 6 to the end of the mine life.

Sediment dams have been sized to capture all runoff from the waste rock dumps for a 10% AEP 24-hour rainfall event. Runoff and seepage collected in the waste rock dump sediment dams will be pumped back to the process water dam or may be released to the environment if runoff is of suitable quality (i.e. water stored in the sediment dams complies with the adopted WQO values in Table 3.1).

The ESCP provides detail on temporary and permanent erosion and sediment control structures which will be installed across the site.

4.5.1.4 Jervois Dam Repair

It is proposed to repair (and improve) Jervois Dam as part of the project. The repair will involve construction of an improved dam wall and spillway. The improved dam wall (373 mAHD) will limit leakage and improve dam safety during extreme events. The upgraded spillway will have capacity to pass the peak 0.1% (1 in 1,000) AEP discharge from the dam catchment without the wall becoming overtopped.

The spillway level will be raised to 370.0 mAHD to provide additional storage volume. The storage volume below the spillway will be increased to approximately 945 ML. The new spillway level will ensure that the sacred site located upstream of the dam will not be inundated by standing water. Figure 4.5 shows the stage-storage relationship for the repaired Jervois Dam.

The repaired Jervois Dam will be used as a source of raw water (potable standard) and will have a permanent pump and pipeline to the process plant and potable water treatment plant.

The timing of the repairs to the dam will be determined by a number of factors, including the need for additional raw water in the first 4 years of operations.

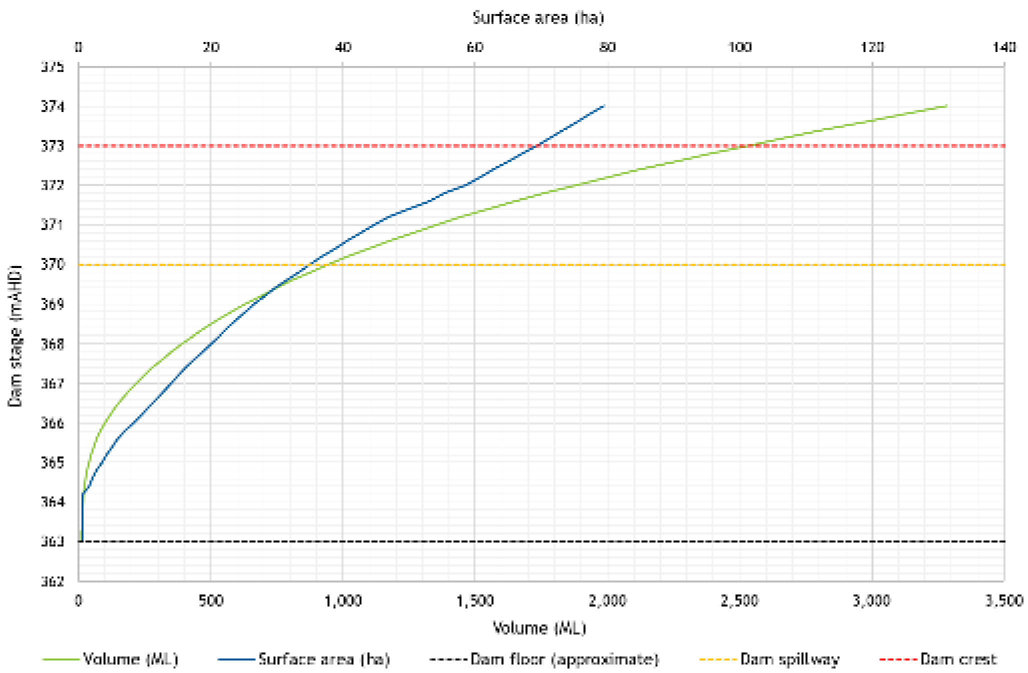

Figure 4.5 - Repaired Jervois Dam stage-storage relationship

4.5.2 Clean and dirty water diversion drains

Proposed clean water drains will be constructed to divert undisturbed runoff around disturbed areas. Key catchments to be diverted include undisturbed catchments upstream of and adjacent to the proposed Tailings Storage Facilities and upstream of the Reward and Bellbird waste rock dumps.

Proposed dirty water drains will capture and convey sediment laden runoff from waste rock dumps to the waste rock dump sediment dams.

Both clean and dirty water drains will be sized to convey all runoff from events up to and including 1 % AEP.

4.5.3 Tailings storage facility

The proposed tailings storage facility will be located at the site of the existing tailings dam to the west of the process plant and to the south of Unca Creek.

The design and operation of the tailings storage facility will be undertaken by others. The tailing storage facility will be designed to have sufficient storage capacity to contain all runoff from the tailings storage area.

The tailing storage facility will include a decant system to return water to the process plant.

4.5.4 External borefields

A borefield will be established external to the Project area to provide raw water (potable standard). CloudGMS (2019) proposes a borefield capable of producing up to 2,000 ML/year for 10 years. Bores will be completed into the Georgina Basin Carbonate Aquifer at a site 10km to the north of the mine site.

4.5.5 Haul and access road crossings

All haul and access road crossings of drainage features and waterways will be low level causeway crossings. No culverts are proposed for any crossings.

4.5.6 Potable water and wastewater treatment

A potable water treatment plant will be located at the Project to supply potable demands to the workforce. Wastewater from the accommodation camp and offices will be treated by systems and a waste treatment plant for the accommodation village.

4.5.7 Rockface workshop

The workshop area at Rockface will drain to a hydrocarbon separator and oil and grease trap. Chemical and fuel stores will be bunded to contain any spills.

4.5.8 Explosives magazine

The explosives magazine will be covered and bunded to contain any spills or releases of chemicals.

4.6 MINE SITE DISCHARGES

4.6.1 Waste rock dump sediment dams

Due to the proposed capping of the waste rock dumps with NAF material, runoff from the dumps is likely to be of relatively similar quality to baseline surface water quality at the project site, however seepage from the dumps is likely to be of poorer quality (EGI, 2019). Nevertheless, a cautionary approach has been adopted to the management of runoff from the waste rock dumps:

- Runoff and seepage collecting in the waste rock dump sediment dams will be pumped back to the mine water management system.
- The sediment dams will overflow when the design rainfall (10% AEP 24-hour storm) is exceeded. The WRM (2019a) site water balance model indicates that there is a 10% chance that the sediment dams would overflow in any given year of mine operations. Any overflows from the sediment dams would occur during periods where there will be significant flows in the receiving watercourses, and runoff from the dumps during these events is likely to comply with the trigger values proposed in Table 3.1.
- Seepage from the dumps following rainfall events will be captured and pumped back to the mine water management system. Dump seepage is most likely to contain contaminants that would exceed the adopted trigger values in the trigger values proposed in Table 3.1.
- Surface runoff and seepage from waste rock dumps that collects in the sediment dams will be monitored as part of the surface water monitoring program. The sediment dam monitoring would be used to validate the anticipated quality of water runoff reporting to sediment dams.

It is anticipated that runoff from the waste rock dumps may be suitable for release to the environment (following a period of monitoring), however It is not proposed to make controlled releases of water from the sediment dams. If, after a period of monitoring, the water quality in the sediment dams can be shown to comply with the water quality trigger limits in Table 3.1, then controlled releases of sediment laden water may occur.

4.6.2 Process water dams

The WRM (2019a) site water balance model predicts that no overflows (uncontrolled releases) would occur from the Process water Dam over the life of the project.

It is not proposed to make controlled releases of mine affected water from the Process Water Dam.

Water quality in the process water dam will be monitored as part of the surface water monitoring program.

4.6.3 Controlled discharges and need for a WDL

It is not proposed to make controlled releases of mine affected water from the project site. However, there may be periodic uncontrolled releases of water from sediment dams if the design rainfall for these structures is exceeded. It is expected that releases of water from sediment dams following design rainfall exceedance would comply with the water quality trigger limits in Table 3.1.

An application for a waste discharge licence will be made to ensure any releases of water from sediment dams are undertaken under an approved WDL.

5 Site water balance

5.1 OVERVIEW

A concept site water balance has been undertaken as part of the Jervois Project EIS supplement (WRM, 2019a). 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. The annual site water balance assessment is undertaken to determine:

- The ability to meet water supply requirements for mine water demands;
- The risk of uncontrolled releases (spillway overflows) from on-site water storages;
- The risk of inundation o the open cut pits and underground mines, and the ability to dewater them within an acceptable time frame;
- The likely behaviour of the various on-site storages during the coming two years;
- The frequency and volume of any managed releases;
- Information for storage and pumping infrastructure requirements and trigger action response plan (TARP) trigger levels for each year; and
- Recommendations for additional monitoring and investigations to improve the accuracy of future water balances.

5.2 ASSESSMENT OF FUTURE PERFORMANCE

5.2.1 OPSIM model development

The WRM (2019a) study uses the computer-based operational simulation model (OPSIM) to assess the behaviour of the mine water balance under varying rainfall and catchment conditions throughout the development of the Project. The OPSIM model dynamically simulates the operation of the proposed water management system (WMS) and keeps complete account of all site water volumes on a daily time step.

The OPSIM model is configured to simulate the operations of all major components of the water management system (WMS). The simulated inflows and outflows included in the model are given in Table 5.1.

Table 5.1 - Simulated Inflows and Outflows to Mine Water Management System

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	Process Plant demand
Groundwater inflow to open cut pits	Dust suppression demand
Groundwater inflow to underground mines	Underground mining water demand
Raw water supply	Mine camp and infrastructure area demand

The OPSIM model uses a 10-year ‘forecast’ period. To assess the effects of varying climatic conditions, the forecast model will be run for 118 realisations (with each realisation corresponding to the 10 year mine life), using 129 years of simulated climatic and streamflow data available from January 1889 to December 2017. A different rainfall input sequence is applied to each realisation. The first realisation adopts climatic data from 1889 to 1898, the second from 1890 to 1899 and so on through the 129 years of simulated climatic data. A percentile analysis of the resultant realisations can then be undertaken at user-defined confidence intervals to assess the behaviour of the various storages over extended dry and wet periods, reflecting the full range of climatic conditions experienced in the last 129 years.

5.2.2 Forecast water balances

The WRM (2019a) water balance model will be annually refined and validated against observed site data, before being used to undertake a 2-year forecast simulation to predict the likely performance of the water management systems for a large range of possible climatic conditions. Key water balance results include:

- The behaviour of the various on-site storages;
- The risk of overflows from various on-site storages;
- The ability to dewater the open cut pits and underground mines within acceptable time frames;
- The frequency and volume of any managed water releases; and
- The overall site water balance.

Sensitivity analyses will also be undertaken to assess the impact of alternative assumptions (e.g., additional water storage, pumping configurations, higher rainfall, etc.) of the water management system on the forecast water balance and the water management system behaviour.

The water balance model is also used to inform TARP operating levels at the Mine, particularly for the process water dam.

5.3 SUMMARY OF RESULTS

5.3.1 Process water dam

The PWD does not empty over the simulation period due to the supply of water from Jervois Dam and the groundwater bore fields, maintaining the minimum operating storage level in the dam (9.5 ML).

There is a 1% chance that the volume in the PWD will exceed the maximum operating storage level (95 ML).

The maximum predicted volume in the PWD based on all simulated realisations is 194 ML, which is 9 ML less than the full supply level (203 ML).

5.3.2 Open cut pits and underground mines

There is a relatively low risk of accumulating significant volumes of water in the open cut pits and the underground mines over the life of the Project.

During the operating phase of the open cut pits:

- There is a 10% chance of accumulating more than 8.5 ML in the Reward Pit, 1.5 ML in Bellbird South Pit and 0 ML in the Bellbird North Pit.
- There is a 1% chance of accumulating up to 85 ML in the Reward Pit, 42 ML in the Bellbird South Pit and 9 ML in the Bellbird North Pit.

In the Rockface Underground Mine, there is less than 1% chance of accumulating more than 3 ML of water during the operating phase of the mine (from EOY0 to EOY7). Water accumulates after EOY7 when mining ceases and the underground mine is no longer dewatered.

In the Reward Underground Mine, there is a 10% chance of accumulating more than 4 ML of water over the life of the Project. There is also a 1% chance of accumulating up to 150 ML between EOY5 and EOY7.

In the Bellbird Underground Mine, there is a 10% chance of accumulating more than 2 ML of water over the life of the Project. There is also a 1% chance of accumulating up to 190 ML between EOY6 and EOY8.

In the existing Marshall Reward pit, there is less than 1% chance of the full supply storage level (30 ML) being exceeded.

5.3.3 Uncontrolled releases (overflows)

No uncontrolled releases of mine affected water are predicted to occur from the process water dam in any year of Project life.

Uncontrolled releases of sediment laden water from the waste rock sediment dams have the potential to occur in all years of the Project life:

- Throughout the Project life, there is a 10% chance of minor uncontrolled releases (less than 11.5 ML in any year) of sediment laden water from the waste rock dump sediment dams.
- There is a 1% chance of between 80 ML and 309 ML of uncontrolled releases throughout the Project life.

5.4 REVIEW OF SITE WATER BALANCE MODEL

Following operations at the project commencing, the site water balance model will be calibrated against observed site data, and used to developed updated forecast model results.

The maximum period between review and recalibration of the site water balance model will be 12 months.

6 Jervois flood management measures

6.1 GENERAL

The flood risk at the Jervois Project has been investigated by a flood study undertaken as part of the EIS (WRM, 2019a). The WRM (2018a) Jervois flood model simulates flood behaviour of the watercourses and drainage features in the vicinity of the Project. Details on the hydrologic and hydrologic and hydraulic model development, validation and results are provided in WRM (2019a).

The proposed Jervois mine infrastructure is generally located outside of the 1% (1 in 100) AEP flood extent, with the exception of the proposed Reward pit and underground mine. The Unca Creek diversion channel will be constructed to divert floodwater in Unca Creek to the north, around the Reward Pit.

6.2 UNCA CREEK DIVERSION CHANNEL

The proposed diversion will ensure that the Reward Pit is protected from flows from the upstream catchment (including overflows from Jervois Dam) for events up to and including 0.1% AEP (1,000 year ARI) during the operational phase of the mine. Full details of the Unca Cree Diversion are available in the Unca Creek Diversion at Jervois Mine Design Report (WRM, 2020)

6.3 FLOOD MITIGATION MEASURES

6.3.1 Jervois Dam repair

It is proposed to repair (and improve) Jervois Dam as part of the project. The repair will involve construction of an improved dam wall and spillway. The improved dam wall (373 mAHD) will limit leakage and improve dam safety during extreme events. The upgraded spillway will have capacity to pass the peak 0.1% (1 in 1,000) AEP discharge from the dam catchment without the wall becoming overtopped.

The spillway level will be raised to 370.0 mAHD to provide additional storage volume. The storage volume below the spillway will be increased to approximately 945 ML. The new spillway level will ensure that the sacred site located upstream of the dam will not be inundated by standing water.

6.3.2 Unca Creek Diversion Bunds

There are three proposed bunds along the Unca Creek Diversion are required to prevent water overflowing from the diversion channel into the existing creek channels (and then into the Reward pit) The bunds will be formed as wide, self-sustaining structures, and will have a crest level equivalent to the predicted 0.1% (1 in 1000) AEP peak flood levels in the Unca Creek diversion plus 0.3 m freeboard.

Bund crest levels along the most upstream bund range from 350.7 mAHD near the TSF to 348.3 mAHD at the Process Water Dam. Bund crest levels along the middle bund (western side of Reward pit) range from 347.8 mAHD to 347.2 mAHD. Bund crest levels along the downstream bund (eastern side of Reward pit) range from 344.3 mAHD to 344.0 mAHD.

6.3.3 Process Water Dam Spillway and embankment level

The Process Water Dam is located between the process plant and the tailings storage facility. The process water dam has been located such that it is outside of the Unca Creek 0.1% AEP event flood extent.

6.3.4 Erosion management

Excessive velocities are not predicted in the Unca Creek diversion channel, and therefore excessive erosion (beyond what naturally occurs in streams at the Project) is unlikely to occur. Nevertheless, the diversion channel will be inspected following flow events to identify any locations where erosion is occurring and identify remediation works.

The ESCP examines potential erosion risks and provides strategies for the management and mitigation of erosion and sediment transport. The ESCP provides detail on temporary and permanent erosion and sediment control structures which will be installed across the site.

6.3.5 Inundation of waste rock dumps and toe of TSF

Modelling has shown that the proposed waste rock dumps and TSF are not inundated during a 1 % (1 in 100) AEP flood event. Hence it unlikely that floodwater would interact with these structures and cause damage.

7 Surface water and sediment monitoring

7.1 OVERVIEW

In addition to collecting site rainfall and meteorological data, Jervois Mine will operate a surface water monitoring network and data collection program within and in the vicinity of the mine site to collect:

- Background surface water (undisturbed) quality data along natural streams upstream and downstream of the mine site, and through the mine site;
- Surface water storage (storage) quantity and quality data in the water storages at the mine site; and
- Receiving environment surface water (receiving) quality data along streams downstream of disturbance areas at the mine site.

The monitoring program has the following objectives:

- Be capable of detecting changes in receiving environment water and alluvial sediment quality and potential impacts associated with the project;
- Be capable of establishing baseline water and alluvial sediment quality and distinguishing between historic and Proposal related mining impacts; and
- Establish comprehensive and robust surface water quality datasets using event based monitoring records.

Figure 7.1 shows the locations of the proposed water quality monitoring points. Data from the water monitoring stations will be used to inform mine site water use and water inventories, validate hydrologic, hydraulic and water balance modelling, in addition to assessing the impact of mining activities on water quality in the receiving waters. The adopted water quality trigger levels for the project are given in Table 3.1.

No controlled releases of mine affected water are proposed as part of the mine water management system, and therefore the monitoring samples will not be relied upon to determine if the quality of water held in site storages is suitable for release.

7.2 SURFACE WATER STORAGES

The proposed storages at the Project (process water dam, Jervois Dam, underground dewatering dam and waste rock sediment dams) will be monitored at least quarterly (and daily during or following significant runoff events). The proposed suite of monitoring parameters and recommended monitoring frequency is given in Table 7.1. A significant runoff event is one where the water level in any dam rises by greater than 0.3 m.

Table 7.1 – Surface water storage monitoring parameters and frequencies

Parameter	Frequency
Water level / storage volume	Monthly / following rainfall
Non-metallic indicators	
pH (in-situ and lab)	Quarterly / minimum of one sample during significant runoff events
Electrical conductivity (in-situ and lab)	
Total dissolved solids	
Total hardness	
Total Petroleum Hydrocarbons (TPH C6-C9, C10-C36)	
Total Recoverable Hydrocarbons (TRH C6-C9, C10-C16)	
Turbidity (in-situ and lab)	
Dissolved oxygen	
Sulphate	
Nitrate	
Metals and metalloids (total and filtered)	
Aluminium	Quarterly / minimum of one sample during significant runoff events
Arsenic	
Boron	
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	
Lead	
Magnesium	
Manganese	
Mercury	
Molybdenum	
Nickel	
Selenium	
Silver	
Uranium	
Vanadium	
Zinc	
Chemicals used on site	
Sodium di-isobutyl dithiophosphinate	Quarterly / minimum of one sample during significant runoff events
Sodium di-isobutyl-dithiophosphate	
Calcium hydroxide	
Glycol ether	

7.3 BACKGROUND SITES, DISTURBED AND IMPACTED AREAS AND RECEIVING WATERS

Monitoring of water quality at background sites, disturbed and impacted areas and receiving waters will continue to take place following runoff events at the monitoring locations specified in Table 7.2. The background and receiving water monitoring parameters will be as per those specified for surface water storages in Table 7.1.

Three new monitoring locations are proposed (in addition to the existing monitoring locations:

- JW11 is a new background monitoring location upstream of Jervois Dam. The water quality from JSW11 will give a good indication of the water quality generated from an upgradient undisturbed catchment. Existing monitoring location JSW05 will give good representation of an undisturbed low land site.
- JSW12 is a new receiving water monitoring location in a drainage feature downstream the Reward South WRD, processing plant and TSF. JSW12 will allow clear identification of potential impacts due to these structures.
- JSW13 is a new receiving water monitoring location in the Unca Creek diversion drain downstream of the Reward South WRD, processing plant and TSF. JSW12 will allow clear identification of potential impacts due to these structures.

It is not proposed to undertake monitoring at additional up-gradient and lowland reference sampling locations in neighbouring streams outside of immediate project area. As outlined above the water quality from JSW11 give a good indication of the water quality generated from an upgradient undisturbed catchment and existing monitoring location JSW05 will give good representation of an undisturbed low land site.

It is noted that JSW07 will be located sufficiently upstream of the proposed haul road to ensure the haul road does not 'mask' the impacts from the Bellbird WRD and pit. The proposed monitoring for site water storages will also provide significant supporting data when assessing results from receiving water monitoring locations.

Table 7.2 – Background and receiving water monitoring locations

Location	Background / receiving water / disturbed	Comments
Jervois Dam	Background	Unca Creek at Jervois Dam. No mining disturbance in catchment. May become disturbed by Jervois Dam construction works.
JSW01	Receiving water	Downstream boundary of Project on Unca Creek tributary. Includes Bellbird and Rockface mining disturbance area.
JSW02	Background	Unca Creek upstream of diversion. No mining disturbance in catchment. May become disturbed by Jervois Dam construction works.
JSW04	Background	Drainage feature in catchment of Unca Creek tributary. No mining disturbance in catchment. May become impacted by TSF water quality.
JSW05	Background	Drainage feature in catchment of Unca Creek tributary. No mining disturbance in catchment.
JSW06	Background	Unca Creek downstream of Jervois Dam. May become disturbed by Jervois Dam construction works.
JSW07	Receiving water	Drainage feature in catchment of Unca Creek tributary. Includes Bellbird mining disturbance area.

Location	Background / receiving water / disturbed	Comments
JSW09	Receiving water	Downstream of Project at confluence of Unca Creek and Unca Creek tributary. Includes all mining disturbance area.
JSW10	Receiving water	Downstream boundary of Project on Unca Creek. Includes Reward mining disturbance area.
JSW11	Background	Unca Creek upstream of Jervois Dam.
JSW12	Receiving water	Drainage feature in in catchment of Unca Creek tributary. Downstream of Reward South WRD, processing plant and TSF.
JSW13	Receiving water	Unca Creek diversion downstream of processing plant, TSF and Reward North WRD

7.4 SEDIMENT SAMPLING

Table 7.3 summarises the sediment monitoring schedule. Sediment monitoring will be implemented twice a year within the wet season (if more than one flow event per wet season). As sediment sampling requires muddy or silty substrates, where these conditions are not present at the monitoring point, a suitable site as close as possible to the monitoring point will be sampled.

Table 7.3 - Sediment sampling schedule

Monitoring Location	Sampling schedule	Toxicants for sampling
JSW01 – JSW13	Early and late wet season	Al, Sb, Se, As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Ag, Zn, N, F and SO_4.

7.5 SAMPLING PROCEDURES

7.5.1 Surface water sampling

All samples will be collected in accordance with recognised Australian Standards and guidelines (such as AS/NZS 5667, ANZECC & ARMCANZ).

All samples will be analysed at a laboratory with current NATA accreditation or equivalent, for the analytes tested.

Due to the remote nature of the project site, samples will be delivered to Alice Springs via vehicle, and then flown to Darwin for analysis (there is no NATA accredited laboratory in Alice Springs).

A handheld probe may be used to derive basic sampling data before the results of the lab analysis are available. In particular pH, EC and turbidity should be sampled in the field using a calibrated handheld probe.

7.5.2 Sediment sampling

The proposed sediment sampling methodology is summarised in Table 7.4.

Table 7.4 – Sediment sampling methodology

Characteristic	Methods summary	Methods reference
Sieving to 2mm preferably (typical laboratory sieving performed at 75µm).	Sampling sites should be selected at locales where muddy or silty substrates exist; sediment monitoring will not be necessary where no silty or muddy substrate exists (i.e. monitoring of sand is not performed). Hand collection methods, (such as using a small spade). Composite sediment sample collected, then broken into three single samples of equal volumes. Van veen Grab Sampler used where water depth and/or macrophyte cover prevent hand collection.	ANZECC & ARMCANZ (2000); AS/NZS 5667.12:1999

7.6 REVIEW OF THE MONITORING PROGRAM

The surface water monitoring program will:

- Be reviewed by a suitably qualified person to ensure the program is meeting its objectives;
- Be updated at least annually; and
- Provide data to be reported in a Water Management Report within 6 months of construction commencing and on an agreed reporting period thereafter.

The corrective actions to be implemented should the annual review identify any noncompliances with this WMP include (but are not limited to):

- Modification of management strategies in response to new and updated information; and
- Review of this WMP, the Groundwater Management Plan and the Erosion and Sediment Control Plan.

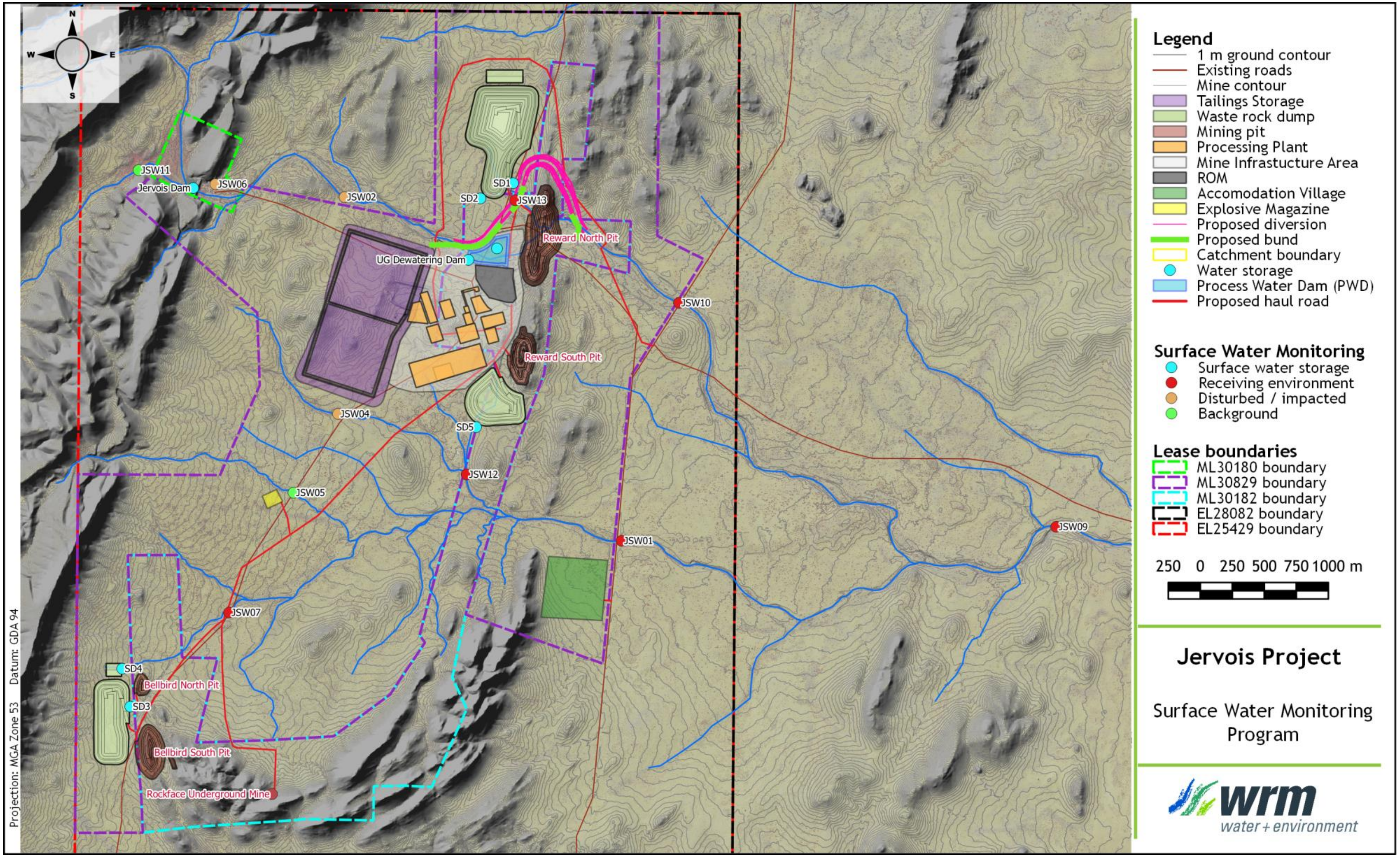

Figure 7.1 - Surface water monitoring program

8 Emergency and contingency planning

8.1 GENERAL

Emergency responses to specific incidents will be carried out as per the Environmental Emergency Management Plan for the mine. With respect to water management, the Environmental Emergency Management Plan is implemented for a range of potential emergency scenarios:

- Spillage or release of hazardous substances during operation and transportation;
- Inadequate design, failure of TSF;
- Structural failure of the process water storage facility; and
- Insufficient capacity of the process water storage facility.

Water storages at the Mine are operated in accordance with the Trigger Action Response Plan (TARP) for each structure.

8.2 EMERGENCY PLAN DOCUMENTS

Standalone TARP documents will be developed for the surface water storages at the mine prior to operations commencing. The general principles of the TARPs for each storage (based on the outcomes of the EIS water balance modelling) are outlined below.

8.2.1 Waste rock dump sediment dams TARP

Runoff and seepage that collects in the waste rock sediment dams will be sampled in accordance with the surface water monitoring program, and pumped back to the Process Water Dam for reuse in the mine water management system.

Waste rock sediment dams will be dewatered to the process water dam as soon as is practical following runoff events to ensure that maximum capture volume is available in the dams.

If the design criteria (10 year 24-hour rainfall) of the waste rock dump sediment dams is exceeded, an uncontrolled release of runoff may occur. If this occurs the following actions should be taken:

- Sample the quality of water overflowing from the waste rock sediment dams;
- Sample water quality at the relevant upstream background water quality site; and
- Sample water quality at the relevant downstream receiving water quality site.

8.2.2 Process water dam TARP

Water balance modelling has been used to define the maximum operating level for the Process Water Dam, such that sufficient storage remains available in the dam to contain all runoff from the contributing catchment and prevent uncontrolled releases of mine affected water.

The maximum operating level for the Process Water Dam is 142.5ML. The following actions should be taken when the dam reaches this level:

- Stop dewatering from the open cut pits to the Process Water Dam:
    - Allow the pit sumps to fill;

    - If additional storage is required, dewater active mining pits to the Reward South pit void.
- Stop dewatering from the underground mines to the Process Water Dam:
    - Allow the underground mine sumps to fill;
    - If additional storage is required, dewater active underground mines to the Reward South pit void.

8.2.3 Jervois Dam TARP

A TARP will be developed for Jervois Dam. It will set out the action to be taken when water levels in the dam exceed the spillway level, and also a low level alarm, when pumping out from the dam ceases.

8.2.4 TSF TARP

The TSF TARP will be developed by others, and will provide information on critical operating levels and necessary actions.

9 Life-of-Mine water management

9.1 OVERVIEW

The Jervois mine is planned to operate over a 12 to 15 year mine life. The modelling undertaken as part of the EIS (WRM, 2019a) has demonstrated that the potential impact of the planned mining operations on surface flows and water quality in the receiving waters downstream of the project will be insignificant.

The mine will have an observational and adaptive approach through the life of operations that will monitor the actual performance of the site systems to enable on-going adjustments, as necessary, to manage and mitigate site risks.

9.2 SURFACE WATER MANAGEMENT STRATEGY

9.2.1 Operations

The proposed surface water management system and water management infrastructure outlined in Section 5 will be implemented during mine operations. It is envisaged that the proposed infrastructure will be adequate to manage surface water during the full life of mine operations.

9.2.2 Post mine closure

The waste rock sediment dams and process water dam would remain in place post mine closure.

9.3 WATER BALANCE

Almost all of the direct rainfall and surface runoff inflows to the Mine water management system are generated during the wet season between November and April. During the dry season between May and October, the majority of inflows to the water management system are generated from groundwater sources.

Water balance modelling undertaken for the EIS (WRM, 2019a) indicate that, with the planned water management measures in place, the planned water management system will be robust and will have adequate storage capacity to manage surface water runoff generated within the Mine site for a wide range of possible climatic conditions, including extended wet and dry periods.

9.4 MITIGATION OF POTENTIAL FLOOD IMPACTS

The Jervois Dam repair and Unca Creek diversion and bunds are proposed to mitigate the potential impact of flooding on planned mine infrastructure. The additional measures include:

- During the operational period:
  - Repair and upgrade to Jervois Dam (increase dam embankment height to 373 mAHD, and increase spillway to 370 mAHD);
  - Construct Unca Creek diversion to protect Reward open cut pit; and
  - Construct Unca Creek diversion bunds to prevent 0.1% AEP (1 in 1000) floodwater from overflowing into the Process Water Dam and Reward Pit.
- During the post-closure period:
  - Increase the height of the Unca Creek diversion and Process Water Dam bunds to ensure that the Reward Pit final void is protected from floodwater for the Probable Maximum Flood (PMF) event.

- The final landform hydraulic modelling has demonstrated that the final voids will be protected from flooding from Unca Creek and its tributaries for all events up to and including the PMF.

The flood modelling results indicate that the mine will not have any significant impact on flooding downstream, for both the operational and post-closure scenarios.

9.5 MITIGATION OF POTENTIAL WATERWAYS IMPACTS

9.5.1 Streamflow

The proposed upgrade to Jervois Dam will potentially result in changes to the existing conditions streamflow regime in Unca Creek. The upgraded dam will require a greater volume of catchment runoff to fill the dam before the spillway is activated and flow leaves the dam. Further, the dam will be relied upon as a source of raw water, particularly during the first four years of operations (before groundwater inflows to the underground increase). Therefore, the volume of water stored in the dam will be drawn down after a runoff event more rapidly than under existing conditions.

Overall, the proposed upgrade to the dam will potentially reduce the magnitude and number of overflows from the dam, particularly in the first four years of mine life.

It should be noted that the existing dam has already altered the streamflow regime of Unca Creek significantly. Further, the dam is situated in an arid catchment, where it would not be unusual for the dam not to overflow for several years. Water balance modelling indicates that the existing dam on average only overflows in every fourth year. The upgraded dam is predicted to overflow on average every 11 years under the year 1 scenario, and every 9 years under the post-mine closure scenario.

Therefore, the proposed dam upgrades will alter the streamflow regime in Unca Creek downstream of the dam, with reduced frequency of spill events, but increased maximum spill rates. The change in streamflow regime will have a significant affect along the reach of Unca Creek within the Project, up until the Unca Creek tributary confluence which doubles the Unca Creek catchment. The impacts downstream of this point will be insignificant.

No mitigation measures are proposed as the potential impacts of the upgraded dam on Unca Creek streamflow are insignificant.

9.5.2 Water quality

The Project has the potential to impact on water quality in Unca Creek and its tributaries due to controlled and uncontrolled releases of water.

The water balance model has been used to investigate the predicted frequency and volume of uncontrolled releases (spills) of water from the process water dam and waste rock dump sediment dams.

The results of the water balance model show that no uncontrolled releases are predicted from the process water dam in any of the water balance model simulations. Therefore, the Project will not release any mine affected water or dewatered groundwater to the environment.

The water balance model indicates that there is approximately a 10% chance of uncontrolled releases of water from the waste rock sediment dams in the first four years of Project life.

Due to the proposed capping of the waste rock dumps with NAF material, runoff from the dumps is likely to be of relatively similar quality to baseline surface water quality at the project site, however seepage from the dumps is likely to be of poorer quality (EGI, 2019). It is anticipated that runoff from the waste rock dumps may be suitable for release to the environment (following a period of monitoring).

Therefore, it is considered that the predicted uncontrolled releases from the waste rock sediment dam are unlikely to have any impact of significance on water quality in Unca

Creek, as they will occur when there is likely to be some flow in the receiving watercourses, and the uncontrolled releases are likely to be of similar quality to background water quality.

The following key points are of note with regards to the predicted uncontrolled releases from the waste rock sediment dams:

- The sediment dams are designed to allow TSS and associated metalloids to drop out of suspension and therefore any overflowing water would likely achieve the WQOs.
- Runoff and seepage collecting in the waste rock dump sediment dams will be pumped back to the mine water management system;
- The sediment dams will overflow when the design rainfall (10% AEP 24-hour storm) is exceeded. Any overflows from the sediment dams would occur during periods where there will be significant flows in the receiving watercourses, and runoff from the dumps during these events is likely to comply with the trigger values proposed in Table 3.1.
- Seepage from the dumps following rainfall events will be captured and pumped back to the mine water management system. Dump seepage is most likely to contain contaminants that would exceed the adopted trigger values in the trigger values proposed in Table 3.1.
- The material placed in the waste rock dumps and the proposed dump construction methods will ensure that runoff from the dumps is generally of similar quality to background runoff from undisturbed catchments within the project site, and will not contain acid rock drainage or significantly elevated concentrations of metalloids (beyond background values).

Therefore, it is considered that the predicted uncontrolled releases from the waste rock sediment dam are unlikely to have any impact of significance on water quality in Unca Creek, as they will occur when there is likely to be some flow in the receiving watercourses, and the uncontrolled releases are likely to be of similar quality to background water quality.

10 Summary

Modelling undertaken in EIS (WRM, 2019a) demonstrates that the Jervois mining operations, with the planned surface water management system, infrastructure and mitigation measures in place, would have very limited potential for significant impacts on surface flows and water quality in the receiving waters downstream of the Project.

Water will be managed in accordance with following principles:

- Existing surface water drainage patterns will be maintained where practical to do so;
- Water from different sources will be managed separately:
  - Undisturbed runoff will be diverted around disturbed areas where practical;
  - Mine affected water collected in-open cut pits, and in the process water dam will be managed using temporary in-pit sumps and re-used within the water management system;
  - Sediment-laden runoff from the proposed waste rock dumps will be captured in dedicated sediment dams and re-used within the water management system;
  - Raw water (plant standard) dewatered from the open cut pits and underground mines will be reused within the water management system.
- Water will be selected for use based on water quality considerations;
- Water collected on site as part of mining operations will be used preferentially in order to reduce demand on external water sources. Water for mine operating purposes (excluding supplying potable water) will be sourced preferentially as follows:
  - Mine affected water;
  - Raw water (plant standard), dewatered from the underground mines;
  - Sediment laden water;
  - Raw water (potable standard), sourced from Jervois Dam; and
  - Raw water (potable standard) sourced from the external borefield.

Without the proposed water management system and infrastructure, the project has potential to impact on surface water at and downstream of the site. Table 10.1 summarises the planned surface water management measures to mitigate the potential surface water impacts.

With appropriate management measures in place, such as the planned measures outlined in Table 10.1, the potential impact of the planned operations on surface flows and water quality in receiving waters downstream of the project is likely to be insignificant.

Annual audits will be conducted to monitor the level of compliance with the strategies provided in this WMP. These audits will include a review of performance against the objectives and targets. The corrective actions to be implemented should there be any noncompliance with this WMP will include (but are not limited to):

- Modification of management strategies in response to new and updated information;
- Review of this WMP, the Groundwater Management Plan and the Erosion and Sediment Control Plan.

Table 10.1 – Summary of potential surface water impacts and planned mitigation measures

Potential surface water impact	Planned mitigation measures

Inundation of mining pits and mine infrastructure	• During the operational period:
	  ○ Repair and upgrade to Jervois Dam (increase dam embankment height to 373 mAHD, and increase spillway to 370 mAHD);
	  ○ Construct Unca Creek diversion to protect Reward open cut pit;
	  ○ Construct Unca Creek diversion bunds to prevent 0.1% AEP (1 in 1000) floodwater from overflowing into Reward Pit; and
	  ○ Monitoring of the Jervois Dam spillway works for compliance with ANCOLD Guidelines.
	• During the post-closure period:
	  ○ Increase the height of the Unca Creek diversion and Process Water Dam bunds to ensure that the Reward Pit final void is protected from floodwater for the Probable Maximum Flood (PMF) event.

Changes to streamflow in Unca Creek due upgraded Jervois Dam	• Impact of upgraded dam on stream flow will be insignificant downstream of the Project as Unca Creek catchment increases. • No mitigation measure required. • During post-closure Dam Spillway could be lowered to mimic existing conditions.
Deterioration of water quality in Unca Creek and receiving environment	• Ensure appropriate erosion and sediment control at the mine site. • Construct and manage Process Water Dam to ensure that there are no controlled or uncontrolled releases of mine affected water or dewatered groundwater from the Project. • Ensure material placed in the waste rock dumps and the proposed dump construction methods are appropriate to ensure that runoff from the dumps is generally of similar quality to background runoff from undisturbed catchments within the project site, and will not contain acid rock drainage or significantly elevated concentrations of metalloids (beyond background values). • Construct waste rock dump sediment dams to capture runoff and seepage from dumps. • Sample water quality from runoff draining to waste rock dump sediment dams. • Pump runoff and seepage captured in the waste rock dump sediment dams back to the process water dam for reuse. • Make controlled releases of water from waste rock dump sediment dams only if water is of suitable quality.

Potential surface water impact	Planned mitigation measures
	• Riparian vegetation health monitoring in accordance with the Biodiversity Management Plan; • Monitoring of the Unca Creek diversion in accordance with the program provided in the Unca Creek Diversion Design Report (WRM Water and Environment, 2020);

11 References

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