HASTINGS
Technology Metals Limited

APPENDIX 4-4

Water Management Plan

YANGIBANA RARE EARTHS PROJECT

WATER MANAGEMENT PLAN

DOCUMENT NO. YGB-

REVISION HISTORY

Revision	Date	Issued for	Prepared By	Reviewed By	Approved By
A	23/06/18	Issued for review	Lara Jefferson	Kathy McDougall	Stefan Wolmarans COO

CHANGE HISTORY

Revision	Date	Change Description	Updated by
A	Insert	First Draft for stakeholder review Rev A	Lara Jefferson Environmental Manager
00	Insert		

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- The potable demand will be met by the fractured rock aquifer or the palaeochannel aquifer, which will be treated via Reverse Osmosis (RO) package plants to meet potable demands.
- The process water for the Project will be sourced from a combination of mine dewatering, fractured rock bores and the SipHon Well Borefield.
- Dust suppression demand will be met by the dewatering discharge, supplemented if required, by the fractured rock and SipHon Well Borefield.
- Decant water from the TSF will be re-used within the process plant.
- A water balance model for the Project has been developed as part of the Stage II hydrogeological investigation (GRM 2018). The water balance will be used as part of ongoing assessments into the performance of the borefields to assist in Hastings sustainable management of the Project, and to help avoid unacceptable impacts upon the groundwater and surface water environments.

  The following storage receptors are expected to be used on site:

- Three tailings storage facilities:
  - TSF1 will store tailings from the rougher circuit of the beneficiation process, comprising 91% of the total tailings mass produced by the process plant. The TSF will comprise 1 cell and constructed to a maximum perimeter embankment height of 6 m, with a downstream perimeter embankment raising, and lined with a proof compacted basal clayey sand layer. Encapsulation will comprise nominal capillary break / erosion protection with growth medium (soil and rock armour). The discharge method will be single point, central thickened discharge.
  - TSF2 will store tailings from the cleaner circuit of the beneficiation process, comprising 5% of the total tailings mass produced by the process plant. The TSF will comprise 1 cell and constructed to a maximum perimeter embankment height of 6 m, with a downstream perimeter embankment raising, and lined with a HDPE / other liner and compacted clay sand. Encapsulation will comprise HDPE and compacted clay liner with growth medium (soil and rock armour). The discharge method will be perimeter spigots.
  - TSF3 will store tailings from the hydrometallurgical circuit, comprising 4% of the total tailings mass produced by the process plant. The TSF will comprise 1 cell and be constructed to a maximum perimeter embankment height of 6 m, with a downstream perimeter embankment raising, and lined with a HDPE / other liner and compacted clay sand. Encapsulation will comprise HDPE and compacted clay liner with growth medium (soil and rock armour). The discharge method will be perimeter spigots.
  - There will be water storage ponds, for the temporary storage of dewatering discharge prior to use, for dust suppression and mineral processing. The storage ponds will be lined with a HDPE / other liner.

Title of proposal	Yangibana Rare Earths Project
Proponent name	Hastings Technology Metals Limited
EPA assessment number	2115
Purpose	The purpose of this WMP is to meet the requirements of the Environmental Scoping Document (work program # 11): *Provide a Water management plan to address significant residual impacts to surface water and groundwater resources. The following should be addressed in the plan:* • *Monitoring program - to monitor impacts to surface water and groundwater resources.* • *Management program - develop adaptive management actions to be triggered should monitoring shows a detrimental impact as a result of implementing the proposal.* • *Management of offset (if applicable).*
Key Environmental Factor	Hydrological Processes and Inland Waters Environmental Quality
Objective	*To protect surface and groundwater resources so that biological diversity and ecological integrity are maintained.*
EMP Provision Outcomes	No decline in potential GDE vegetation condition beyond natural variability. No impact to calcrete aquifers of the Gifford Creek PEC. No decline in water levels or water quality of pastoral bores as a result of Hastings activities. No impacts to flora and vegetation as a result of altered surface water flow patterns. No decline in surface water quality within the Fraser Creek catchment. No exceedance in trigger levels for dust deposition. No seepage from TSFs beyond TSF and RWP footprint. No seepage of contaminants into groundwater. No release of evaporation pond water into surrounding environment. No evidence of failure of TSF embankment. No reduction in Fraser Bore (pastoral bore within Fraser Creek catchment) water levels beyond natural variation. No exceedances in water quality thresholds as a result of proposal activities.

- Corporate Endorsement
- I hereby certify that to the best of my knowledge, the EMP provisions within this Flora and Vegetation Environmental Management Plan are true and correct and address the requirements of the Environmental Scoping Document for the Yangibana Rare Earths Project (Assessment number 2115).
- [Signature of duly authorised proponent representative]
- Name: Signed:
- Designation: Date:
-

1. CONTEXT, SCOPE AND RATIONALE

1.1 PROPOSAL

Hastings Technology Metals Limited (Hastings) is developing the Yangibana Rare Earths Project (the Project), which is located approximately 150 km north east of Gascoyne Junction, in the Upper Gascoyne region of Western Australia (Figure 1-1).

The Project's tenement package covers approximately 650 km^2 and hosts extensive rare-earths-bearing ferrocarbonatite / ironstone veins containing neodymium, praseodymium and dysprosium predominantly within the mineral monazite. The elements are of interest to the rare earths magnet market, and the advancing technologies in electric vehicles, wind turbines, robotics and digital services.

Hastings has undertaken a Definitive Feasibility Study (DFS) on the basis of developing two pits; Fraser's and Bald Hill (Figure 1-2), with other pits following to the south and north-west of the plant site. The project will include on-site processing, a FIFO / DIDO mine camp and an airstrip.

The pits will be developed using conventional open cut methods to depths of 120 m below ground level at Fraser's and 95 m below ground level at Bald Hill. The pits extend well below the ambient groundwater level and will require pit dewatering to maintain dry mining conditions.

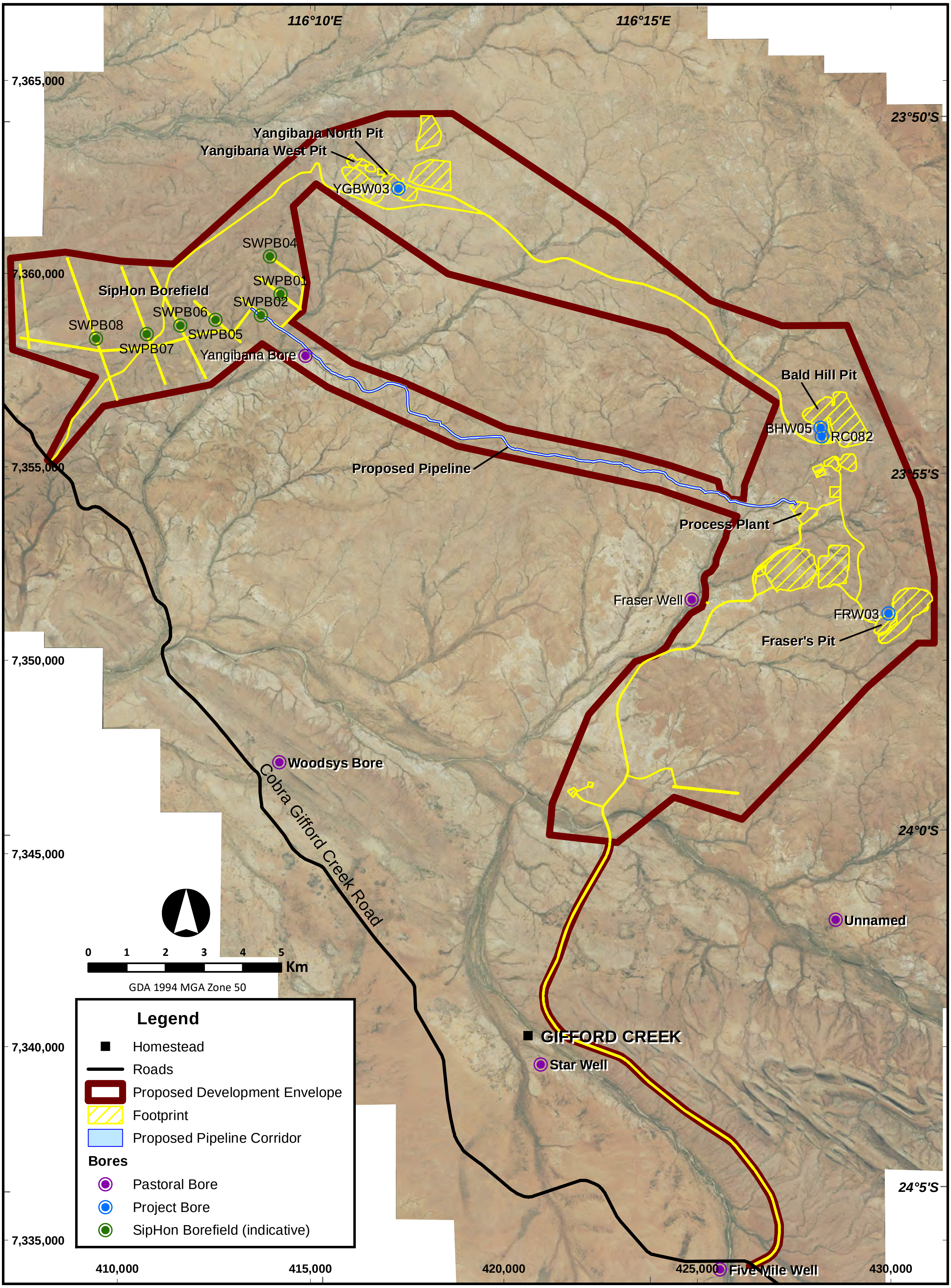
On-site processing will produce a Mixed Rare Earth Carbonate (MREC), via a crushing, grinding, flotation and hydrometallurgy circuit. Tailings will be managed in three tailings storage facilities (TSFs). The plant has a proposed annual throughput of 1 Mtpa, producing approximately 12,000 to 13,000 tpa of MREC concentrate. The Project's proposed Life of Mine (LoM) is ten years.

The Project has an estimated water demand of up to 2.5 GL/annum (79.3 L/sec), for the purposes of mineral processing, dust suppression and camp / potable water supply (via reverse osmosis treatment). The Project water demand will be met by a combination of mine dewatering, fractured rock aquifer bores, supplemented by a remote palaeochannel aquifer borefield (the SipHon Well Borefield).

The Project water scheme is presented schematically in Figure 1-2, and summarised below:

- Dewatering of the open cut pits, via a combination of sump pumping and dewatering bores, will be required to maintain dry conditions during mining. The groundwater is fresh to brackish and will be used for dust suppression and mineral processing.
- Additional fractured rock water supply bores will supplement the dewatering discharge. The groundwater quality is fresh to brackish.
- The SipHon Well Borefield, located west of the plant (Figure x), is installed into a paleotributary of the larger Lyons River palaeodrainage system. The borefield provides fresh to brackish quality groundwater and will provide additional make-up water to supplement the dewatering supply.
- There will be no requirement to discharge excess groundwater to the environment.

- A decant water pond occurs downstream and at the base of TSF1 for the storage of decant returns from the TSF and surface water from the plant area following high rainfall events. The process ponds will be lined with a HDPE / other liner.
- A process water pond (or tank) located within the process plant footprint area will be used to store process water that is re-circulated between the processing circuits.
- An evaporation pond will be used to store waste water from the hydrometallurgical circuit.



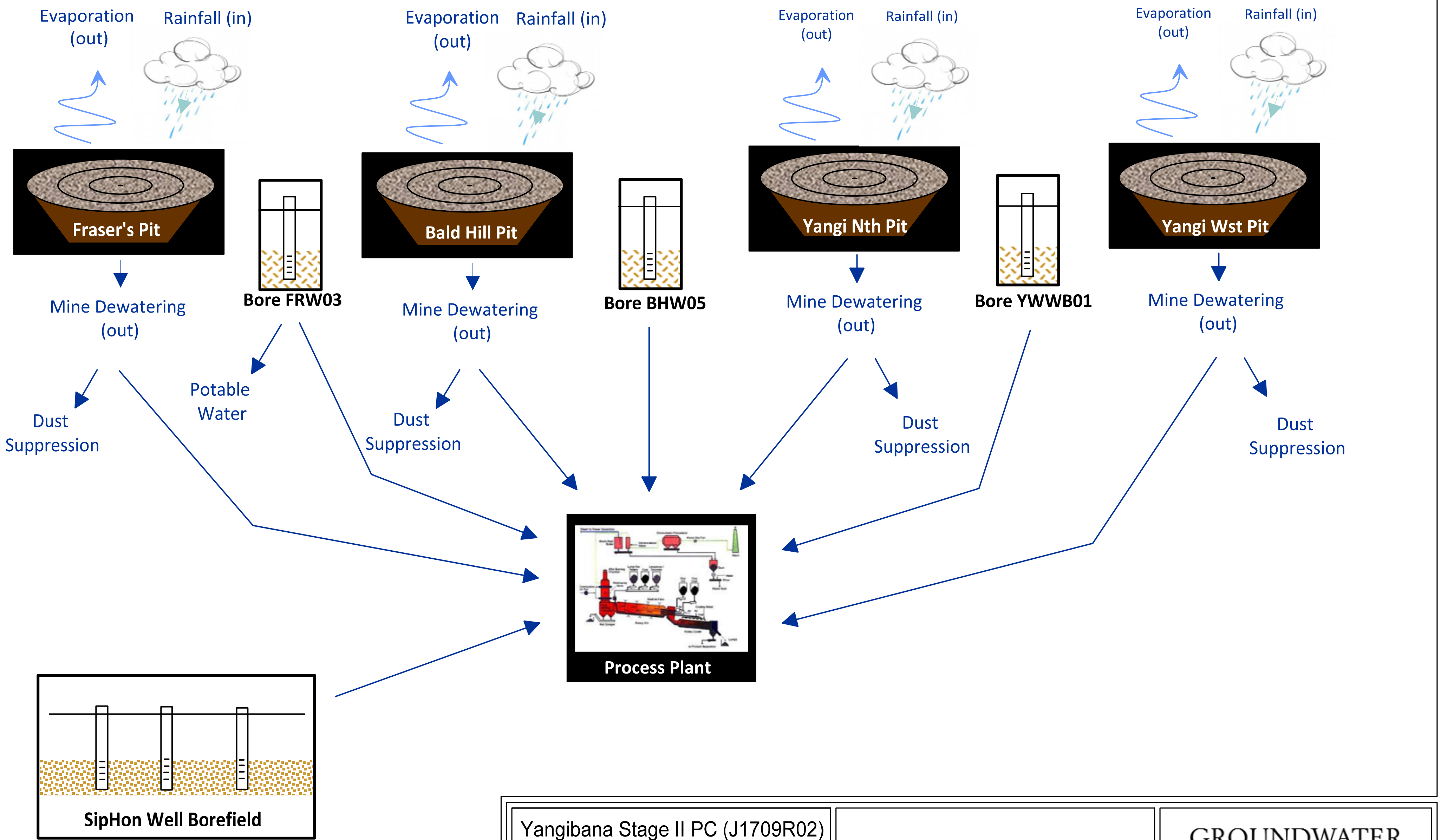
HASTINGS Technology Metals Limited

YANGIBANA RARE EARTHS PROJECT

PER_F1-1_Water_Project_Layout.mxd
25 June 2018

Project Layout

Figure 1-1



Yangibana Stage II PC (J1709R02)			Water scheme	GROUNDWATER RESOURCE MANAGEMENT
Hastings Technology Metals Ltd				
KM	May 18	FIGURE 1-2		

FILE://J1709YangibanaDFS/figures/surfer/palaeochannel/water balance conceptual.srf

1.2 KEY ENVIRONMENTAL FACTOR

This WMP specifically addresses the following key environmental factors:

- Hydrological processes.
- Inland waters environmental quality.
- Flora and vegetation.
- Subterranean fauna.

1.2.1 PROPOSED ACTIVITIES

Key activities that have the potential to affect key environmental factors include:

- Abstraction of groundwater.
- Construction works resulting in the alteration of surface water flows through the development envelope.
- Use and storage of operational liquids such as processing reagents, chemicals, process liquor, and hydrocarbons.
- Generating dust with elevated radiation levels through mining, handling and transporting ore (as radiation levels associated within the ore body are higher in comparison to nearby locations – Naturally Occurring Radioactive Materials (NORM)).
- Construction of three permanent TSF, two of which contain elevated radiation levels from NORMs.

1.2.2 SITE SPECIFIC ENVIRONMENTAL VALUE

1.2.2.1 Other groundwater users

A search of the DWER Water Information Reporting (WIR) database identified 15 registered bores within 20 km of the Project tenements. The closest bores to the proposed pits are Yangibana Bore and Fraser Well, located 2 km south of the SipHon Well Borefield and 5 km west of Fraser's deposits, respectively. The bores are listed as being of unknown type and status. However, it is believed the bores are operational livestock bores.

Groundwater modelling (GRM 2017 and 2018) has indicated that at the end of mining the predicted 5 m drawdown contour extends up to 2 km from the perimeters of the proposed pits, whilst drawdown in the shallow groundwater environment at the SipHon Well Borefield is less than 6 m. The groundwater drawdown contours indicate that other groundwater users in the area are not expected to be impacted by dewatering activities.

1.2.2.2 Groundwater dependent ecosystems

Ecoscape (2015) completed a flora and vegetation assessment of the broad Project area, including the proposed development envelope. The assessment reported the presence of one vegetation type, which represents a GDE (presence of *Eucalyptus camaldulensis*), and three other vegetation types representing potential GDEs (presence of *Eucalyptus victrix*). General GDE vegetation types are located outside the proposed disturbance footprint, except where linear infrastructure crosses the Lyons River, Fraser Creek and Yangibana Creek.

One vegetation type, namely AcEt is characterised as a potential GDE due to the presence of *Eucalyptus vitrix* (Ecoscape 2015). This vegetation type occurs in the vicinity of the SipHon Well Borefield and the immediate surrounds. However, Ecoscape (2017) also reports that this vegetation type is primarily dominated by *Acacia cyperophylla*, which is not a groundwater dependant species. Furthermore, *Eucalyptus victrix* was only occasionally observed as scattered or isolated individuals and more commonly was absent. Ecoscape (2017) concludes that groundwater drawdown is unlikely to impact this vegetation type.

1.2.2.3 Subterranean fauna

Hastings have completed subterranean fauna studies in the Project area (Ecoscape 2016; Bennelongia 2018) and within the broader area, as part of the DFS process.

A Department of Biodiversity Conservation and Attractions (DBCA) listed Priority Ecological Community (PEC) occurs within the study area, and the development envelope occurs within the northern portion of this PEC. The PEC is listed as:

> Priority 1 (P1) Gifford Creek, Mangaroon, Wanna calcrete groundwater assemblage type on Lyons palaeodrainage on Gifford Creek, Lyons and Wanna Stations.

The DBCA refer to the PEC as the “Gifford Creek Calcrete PEC”, which comprises unique assemblages of invertebrates (stygofauna) that have been identified in the groundwater calcretes.

Ecoscape (2016) collected 236 stygofauna specimens from four families representing 10 discrete species. In addition, a total of 1400 specimens from 79 discrete species of stygofauna were recorded by Bennelongia (2018) from the Project and surrounding region during surveys conducted in 2016-2018. Reference sites yielded 1301 specimens from 79 species, while impact areas yielded 99 specimens from 6 species. The total number of stygofauna species known from the broader Gifford Creek PEC study area is at least 81 (Bennelongia 2018). At least 50 species are new to science and are probably restricted to the Gifford Creek Calcrete PEC. Considering other extensively surveyed calcrete aquifers in Western Australia, the Gifford Creek Calcrete PEC is among the most diverse in terms of known species richness (Bennelongia 2018).

Note that the Gifford Creek calcrete aquifer has not been targeted as a potential groundwater supply, because of the environmental values associated with the aquifer.

1.2.2.4 Water quality

Baseline groundwater quality data has been collected from the following areas:

- The proposed pit areas.
- The fractured rock water supply bores.
- The SipHon Well Borefield.

- Neighbouring pastoral bores.
- Surface water pools (Fraser Creek Pool and Lyons River Pool)

The water quality data indicates the pH is neutral to slightly alkaline, and the salinity is fresh to slightly brackish.

1.3 CONDITION REQUIREMENTS

This WMP meets the requirements of the Environmental Scoping Document (EPA, April 2017) for the Yangibana Rare Earths Project (EPA Assessment Number 2115):

> 63. Provide a description of monitoring, management, closure and rehabilitation arrangements and attach a management plan.

This document provides the preliminary Water Management Plan for the Project. The closure and rehabilitation aspects have been excluded from this report and are considered in the Mine Closure Plan.

1.4 RATIONALE AND APPROACH

Results of baseline surveys and a number of assumptions and uncertainties inform the management approach for meeting the environmental objective of this WMP. The identified management actions, management targets, monitoring, reporting, and review and revision of management actions are aligned with the overall management approach.

1.4.1 Baseline Surveys

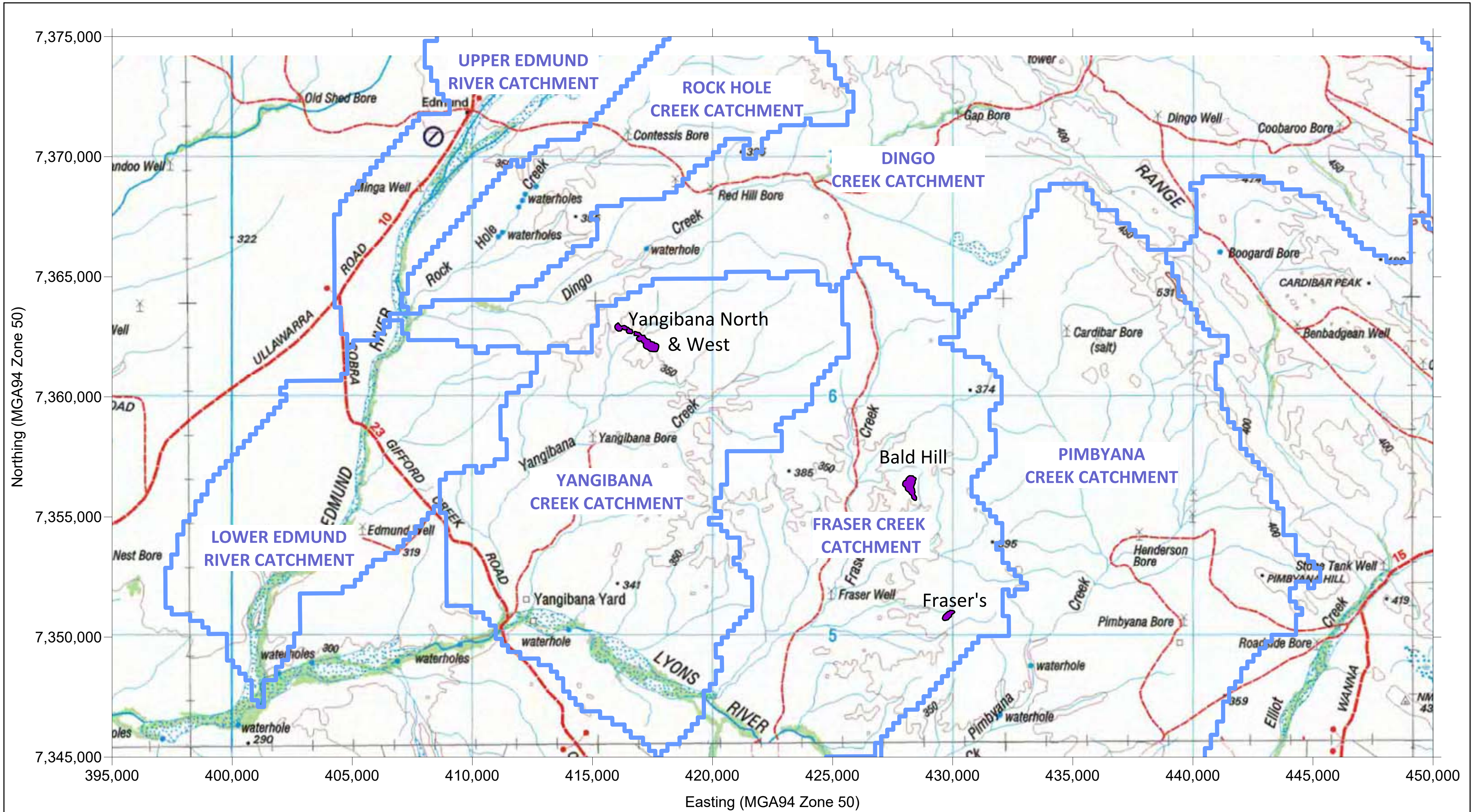
The following studies have informed this section:

- Flora and Vegetation Report (Ecoscape 2015)
- GDE Memo (Ecoscape 2017)
- Subterranean Fauna Reports (Ecoscape 2016; Bennelongia 2018)
- Soils Assessment Report (Landloch 2016)
- Conceptual Hydrogeological Assessment (Global Groundwater 2016)
- Hydrogeological Assessments (GRM 2017 and 2018)
- Surface Water Assessment Report (JDA 2016)
- Geotechnical Assessment (ATC Williams 2017)

1.4.1.1 Topography

The topography in the Project area is influenced by the Lyons River to the south, and a small range of hills to the north of Fraser's and Bald Hills. The remainder of the area is characterised by subdued topography, with rounded granitic hills and open flat areas, cross cut by small dendritic drainages.

The Project is situated within the Lyons River catchment. The Lyons River is located about 10 km south of the Project and flows westward, ultimately discharging to the Gascoyne River. Several smaller sub-catchments to the main Lyons River Catchment influence surface drainage within portions of the Project tenements, including Fraser Creek Catchment, Yangibana Creek Catchment and the Edmund River Catchment. Surface drainage within the Project area typically flows to the south, discharging to the westerly draining Lyons River (Figure 1-3). The creeks and rivers in the region are typically ephemeral, only flowing following significant rainfall events.



LEGEND

Proposed Pits

Surface Water Catchments

Yangibana Stage II PC (J1709R02)		
Hastings Technology Metals Ltd		
KM	May 18	FIGURE 1-3

SURFACE WATER CATCHMENTS

GROUNDWATER RESOURCE MANAGEMENT

FILE://J1709_Yangibana/figures/surfer/palaeochannel/surface water catchments.srf

1.4.1.2 Climate

The Gascoyne region is semi-arid to arid, characterised by cool day time temperatures in winter, and hot day time temperatures in summer. Rainfall is typically bi-modal, whereby intense summer rainfall can result from the passage of tropical cyclones from the north west, whilst winter rainfall is typically less intense, and associated with cold winter fronts from the south west.

The nearest registered Bureau of Meteorological (BoM) weather station is Wanna homestead (station number 7028), located approximately 12 km south of the Project. The station has a 98% complete data set for the 63 year period between 1 Jan 1946 to 31 October 2009. Minimum, maximum and mean monthly rainfall data is provided in Table 1. The data from Wanna homestead indicates that the average annual rainfall is around 240 mm, with the highest rainfall occurring from January to March, closely followed by May and June.

Evaporation data is recorded at Paraburdoo (station number 7178), located 160 km north east of the Project, and Learmonth Airport (station number 5007), 290 km north west of the Project. The data from Paraburdoo and Learmonth has been scaled, based upon distance, to develop an estimate of average monthly evaporation for Yangibana (Table 1-1).

The evaporation data indicates that the pan evaporation exceeds mean monthly rainfall in all months of the year, with the total annual evaporation well over an order of magnitude higher than the annual rainfall.

Table 1-1: Long term average rainfall and evaporation data

Month	Wanna (BoM station 7028)			Yangibana Project
	Minimum Monthly Rainfall (mm)	Maximum Monthly Rainfall(mm)	Mean Monthly Rainfall (mm)	Mean Monthly Pan Evaporation (mm)
January	0	155.0	32.5	411
February	0	219.4	59.0	365
March	0	258.2	32.3	335
April	0	110.0	18.1	272
May	0	148.5	25.3	187
June	0	170.0	32.0	137
July	0	106.2	18.9	147
August	0	104.1	10.1	191
September	0	28.9	2.7	261
October	0	43.5	3.0	346
November	0	24.1	3.3	396
December	0	49.0	7.7	427
Annual Total			240.2	3,475

1.4.1.3 Hydrogeology

The Project is located within the Bangemall / Capricorn Groundwater subarea of the Gascoyne Groundwater area.

The hydrogeology of the area is characterised by a south westerly draining system, coincident with the Lyons River surface water catchment. Groundwater occurrences in the region are associated with recent alluvium, palaeochannel sands, calcrete and fractured bedrock.

The recent alluvium is discontinuous within the Project area, typically occupying low lying areas in creeks and drainage channels. Alluvium is generally absent or less than a few metres thick across the remainder of the Project area. In locations where the recent alluvium is sufficiently thick to extend below the water table (i.e. in the larger creeks), permeability can be modest, depending upon the composition of the alluvium, as evidenced by several stock watering bores installed into this lithological unit. It is likely this unit could fluctuate between saturated and unsaturated seasonally, in response to streamflow.

The palaeochannel sediments in the area are associated with the Lyons palaeodrainage system, a previously unexplored palaeodrainage system which lies to the south and west of the Project area. The SipHon Well Borefield is situated in a palaeotributary to the larger Lyons River system, which flows to the south west, and is incised into metasediments and granites of the Proterozoic Durlacher Supersuite. The palaeochannel comprises a basal sand aquifer, which is up to 40 m thick, 150 m deep and approximately 1 km wide. The sand aquifer is typically fine to medium grained with some coarser sands and gravels in higher energy environments (i.e. on the outer bend of meanders). The sand aquifer is recharged by fractured rock aquifers and to a lesser extent by overlying sediments. The palaeochannel sand aquifer within the study area is overlain by up to 100 m of clay, which acts as an aquitard. A thin veneer of unsaturated colluvium, laterite and till overlies the clay sequence. The shallow palaeochannel groundwater environment is not considered an aquifer. The groundwater quality in the SipHon Well Borefield is fresh to slightly brackish, which is lower than typical palaeodrainage systems in Australia.

Surface calcrete is known to occur adjacent to the major drainages (Lyons and Edmund Rivers) and may extend over large areas beneath the alluvial cover. The surface calcrete is known to extend to depths of up to 30 m and permeability in this unit is likely to be modest to high. There is likely to be hydraulic connection between the calcrete, the alluvium, and the underlying fractured bedrock. Groundwater quality within the calcrete is typically fresh.

Groundwater occurrences within the basement rocks occur as fractured bedrock aquifers, whereby permeability in the natural rock is enhanced by fracturing, dissolution and chemical weathering. Away from the fractures, permeability in the bedrock is typically low. In the Project area the extensive ironstone dykes form a discontinuous fractured rock aquifer, when enhanced by cross cutting water bearing structures. These cross-cutting structures were targeted for the Project's dewatering bores. The groundwater quality within the fractured rock aquifers is fresh to brackish.

Groundwater is recharged by direct rainfall infiltration or by stream flow during episodic rainfall events. Recharge is expected to be highest following streamflow events, in locations where the alluvium or calcrete overlies fractured basement. Groundwater recharge by direct infiltration of rainfall is likely to be minor.

1.4.2 Key Assumptions and Uncertainties

It is assumed that the surveys and assessments conducted to date have accurately recorded the conditions of the groundwater environment and all conservation significant species, vegetation types and habitat values in the Proposal development envelope and over a regional area.

The assumptions made in the hydrogeological assessment and groundwater modelling is considered conservative. However, there remain several areas of uncertainty, including:

- The assessment and model inputs are based on information collected during the field investigations and may not reflect the average conditions of the groundwater environment.

- Groundwater modelling in fractured rock systems has inherent limitations because numerical codes are designed for porous media and using bulk hydraulic properties to simulate fracture flow is problematic.

- Fractured rock aquifers have limited storage and bore yields and dewatering rates may diminish with time. Alternatively, higher than anticipated inflows to the pits may occur upon interception of water bearing structures which weren't identified during drilling.

- The Lyons River palaeodrainage system was previously un-explored, and whilst comparisons can be made with similar palaeodrainage systems across Australia (specifically the well-studied Yilgarn system), there remains a knowledge gap of the physical extent of the broader system. The hydrogeological studies have maintained a conservative approach and impacts are likely overstated.

1.4.3 Management Approach

Hastings has adopted a risk-based management approach. The risk management process is based on the approach set out in the *Leading Practice Sustainable Development Program for the Mining Industry - Risk Assessment and Management* (Department of Resources, Energy and Tourism (DRET) 2008).

The risk assessment identifies risk pathways (unwanted event and the associated environmental receptor / factor), which may cause material impact to key environmental factors specified by the DMP (2016) and the EPA (2016). It also identifies the level of uncertainty associated with a risk pathway, which are:

- Low certainty: Risk rating is based on subjective opinion or relevant past experience.

  Limitations in baseline data/information, which results in general conclusions and/or further work is required.

- Moderate certainty: Risk rating is based on similar conditions being observed previously.

  Baseline data/information has some gaps or minor further work required.

- High certainty: Risk rating is based on testing, modelling or experiments.

  Baseline data/information is complete and analysis appropriate for level of data.

In order to focus management efforts, the risk assessment has been used to determine:

- Inherent risk of identified risk pathways;

- Mitigation of risk (using the hierarchy of controls); and

- Assessment of residual risk.

When mitigating inherent risk, treatment measures have been evaluated using the hierarchy of controls, as recommended by DMP (2016):

- Where reasonably practicable, eliminate the risk;
- Reduce the risk by substituting a different activity which poses a lower risk;
- Control the risk with engineered solutions (including physical barriers); and
- Mitigate the risk using administrative controls.

Hastings will demonstrate, throughout all phases of the Project, regular review of the risk assessment by relevant personnel and key stakeholders, progressive implementation of priority treatment measures, and on-going evaluation of performance. An adaptive management approach will be implemented, where performance objectives are not met by mitigation measures or due to change management, as a component of the continual improvement of this WMP.

1.4.4 Rationale for Choice of Management Target/s

Management targets are based on:

- Survey outcomes (local and regional) including:
- presence of GDE or potential GDEs;
- groundwater drawdown impact to the environment or other groundwater users; and
- water quality impacts (groundwater or surface water) to the environment or other groundwater users.
- Proposal activities (as per section 1.2.2)
- Consideration of inherent risk severity from a risk assessment.
- Consideration of level of uncertainty.
- Industry best-practice.

1.5 LEGAL REQUIREMENTS

This WMP is developed to ensure compliance with relevant laws and regulations as well as, meeting licence conditions of the:

- Ministerial Statement under Part IV of the *Environmental Protection Act 1986*;
- Works approvals and operating licences under Part V of the *Environmental Protection Act 1986*;
- Commitments within the Mining Proposal as approved under the *Mining Act 1950*; and

- Conditions of a 5C licence under the Rights in Water and Irrigation Act 1914.

Relevant laws and regulations include:

- *Country Areas Water Supply Act 1947* (WA)
- *Environmental Protection Act 1986* (WA)
- *Environment Protection and Biodiversity Conservation Act 2000* (C'th)
- *Rights in Water and Irrigation Act 1914* (WA)
- *Radiation Safety Act 1975* (WA)
- *Mining Act 1978* (WA)
- *Mining Regulations 1981* (WA)
- *Waterways Conservation Act 1976* (WA)
- *Waterways Conservation Regulations 1981* (WA)

Relevant guidelines include:

- ANZECC and ARMCANZ (2000) Australian and New Zealand guidelines for fresh and marine water quality;
- DFAT (2016) Water Stewardship - Leading Practice Sustainable Development Program for the Mining Industry;
- DMP and EPA (2015) Guidelines for Preparing Preliminary Mine Closure Plans;
- DWER (2009a) Hydrogeological reporting associated with a groundwater well licence;
- DWER (2009b) Water quality monitoring program design: A guideline for field sampling for surface water quality monitoring programs;
- DWER (2011) Use of operating strategies in the water licensing process;
- DWER (2013a) Western Australian Water in Mining Guideline;
- DWER (2013b) Use of mine dewatering surplus;
- DoH (2013) System compliance and routine reporting requirements for small community water providers;
- EPA (2016a) Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans.
- EPA (2016b) Environmental Factor Guideline: Hydrological processes;
- EPA (2016c) Environmental Factor Guideline: Inland waters environmental quality;
- Johnson and Wright (2003) Mine void water resource issues in Western Australia, Hydrogeological Record Series HG9;
- NHMRC and ARMCANZ (1996). Australian drinking water guidelines; and
- WRC (2000) Water Protection Guidelines No. 11 Mining and Mineral Processing: Mine dewatering.

A groundwater licence has been issued for the project, GWL183285(2) for an annual entitlement of 280,000 kL per annum from the Combined-Fractured Rock West – Fractured Rock groundwater resource. The licence was acquired to meet the construction demand and a subsequent amendment has been submitted (in April 2018; awaiting approval) to increase the allocation to 820,000 kL per annum. The allocation increase is expected to cover mine dewatering and abstraction from the fractured rock aquifer bores for the first three to five years of operation.

An additional licence application will be submitted to cover abstraction from the SipHon Well Borefield palaeochannel aquifer.

Prior to commencement, the Project will require the following:

i. DWER water abstraction licenses to take water from pit dewatering activities for dust suppression, and processing. Separate licenses are required to draw from the fractured rock and palaeochannel groundwater resources.
ii. DWER works approvals and operating licenses for pit dewatering, processing and TSFs.
iii. Formal advice must be submitted to the Water Unit of the Department of Health (DoH) of self-managed water abstraction, for reticulation, distribution and consumption:
    - Drinking Water Quality Management Plan including:
        i. Monitoring as per ‘Small Community Sampling Grid’.
        ii. Reporting in accordance with ‘Systems Compliance and Routine Reporting Requirements for Mine sites and Exploration Camps’.
iv. Approval of a Mining Proposal and Mine Closure Plan by the Department of Mines, Industry Regulation and Safety.

2. EMP PROVISIONS

2.1 OBJECTIVE

The environmental objective for each key environmental factor is as follows:

Hydrological processes

To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.

Inland waters environmental quality

To maintain the quality of groundwater and surface water so that environmental values are protected.

Flora and vegetation

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Subterranean fauna:

To protect subterranean fauna so that biological diversity and ecological integrity are maintained.

2.2 MANAGEMENT ACTIONS AND TARGETS

Management-based provisions, identified through risk assessment, will be implemented to achieve the environmental objective (Section 3.1) for each environmental factor (Table 1). These management actions focus the greatest management effort on proposal activities that have the highest likelihood of causing environmental impact or where the consequence of an impact is severe and likely to be irreversible (an inherent risk rating of high and above). The level of certainty is based on the availability of information and studies to inform the risk assessment (and does not imply probability/likelihood of the event occurring). These management actions were specifically developed to meet the environmental objective for water and will be implemented by Hastings for the Yangibana Rare Earths Project.

Table 3-1: Management-based provisions

EPA factor and objective Hydrological processes: Inland waters environmental quality: Flora and vegetation: Subterranean fauna:
Outcome(s)
Risks and impacts *Risk 1:* Pit dewatering results in groundwater drawdown Inherent risk severity: Moderate Level of certainty: Moderate Impacts: Decline in groundwater availability to existing users, GDE's or stygofauna *Risk 2:* Water abstraction from SipHon Well Borefield results in groundwater level drawdown Inherent risk severity: Moderate Level of certainty: Moderate Impacts: Decline in groundwater availability to existing users, GDE's or stygofauna *Risk 3:* Site establishment results in erosion and sedimentation Inherent risk severity: Moderate Level of certainty: High Impacts: Erosion of soils and landforms, and resultant sedimentation of waterways, leading to degradation of surface water quality. *Risk 4:* Site establishment and presence of linear infrastructure results in altered surface water flows Inherent risk severity: High Level of certainty: Moderate Impacts: • Shadow effects resulting in loss of flora and vegetation • Consolidation of water resulting in water inundation impacts to flora and vegetation • Road crossings of the River impede or divert natural flow and/or increase channel flow velocity.

Risk 5: Operation of crushers, SAG mill and conveyors results in generation of dust
Inherent risk severity: Moderate
Level of certainty: Moderate
Impacts: Dust deposition in the broader Fraser Creek catchment area, and within Fraser Creek and Lyons River, results in degradation of surface water quality.

Risk 6: Failure of TSF 2, 3 or evaporation pond liner results in seepage
Inherent risk severity: High
Level of certainty: Moderate
Impacts: Seepage containing elevated metals, radionuclides and salts results in localised contamination of PEC habitat

Risk 7: Over-topping of evaporation pond results in release of process liquor
Inherent risk severity: High
Level of certainty: High
Impacts: Process liquor containing elevated metals, radionuclides and salts enters ephemeral waterways draining to Fraser Creek.

Risk 8: Failure of a TSF embankment results in exposure and release of tailings and leachate
Inherent risk severity: High
Level of certainty: High
Impacts: Potential contamination of ephemeral waterways from elevated sediment load, metals, radionuclides and salts. Potential downstream impacts to Fraser Creek.

Risk 9: Presence of WRL and TSFs reduces groundwater recharge
Inherent risk severity: Moderate
Level of certainty: Moderate
Impacts: Modification of aquifer recharge mechanisms beneath WRD / TSF results in local lowering of the water table impacting on other groundwater users

Risk 10: Uncontrolled release, leak, spill or discharge of hydrocarbons, reagents, or waste water (from the waste water treatment plant)
Inherent risk severity: Low
Level of certainty: High
Impacts: Residual soil impacts leading to groundwater contamination.

Management actions	Management targets	Monitoring	Reporting
Risk 1 and 2 Mitigation Borefield management strategy (section 3.2.2) Pit dewatering management strategy (section 3.2.4) Trigger levels for groundwater quality: • Exceedances of >25% beyond natural	No decline in potential GDE vegetation condition beyond natural variability. No impact to calcrete aquifers of the Gifford Creek PEC.	Monitoring of the condition of potential GDEs. Monitoring water abstraction as per the Groundwater Monitoring Work Instruction. Monitoring water quality as per the Groundwater	Annual groundwater monitoring report to DWER. Annual review to include a comparison of the monitoring data to the model simulated data to enable ongoing assessment of future drawdown impacts. Incidence records and investigation of

variability on 3 consecutive samples • Exceedances of ANZECC guidelines for fresh and marine water quality (2000) for livestock and Australian NHMRC and ARMCANZ (1996) Australian Drinking Water Guidelines for drinking water quality for elements that are not exceeded naturally. Borefield designed to include a contingency water source supply. Implement an adaptive management program. Measure monitoring data against groundwater model simulation and re-calibrate groundwater model as required, to increase certainty in simulated drawdown. Develop and implement the Environmental Specification for Contractors detailing Hastings environmental policy, minimum standards, and licence conditions.	No impact on water levels or water quality of pastoral bores beyond natural variation as a result of Hastings activities.	Monitoring Work Instruction. Monitoring water level and water quality of the nearest downstream calcrete aquifer. Monitoring water levels and water quality of pastoral bores in the same aquifer and/or within 2km of SipHon Well Borefield (i.e. Yangibana Bore).	decline in GDE vegetation condition beyond natural variability (summarised in the AER).
Risk 3 and 4 Mitigation Surface water management strategy (section 3.2.1) Linear infrastructure will incorporate engineering structures (e.g. culverts, drains) identified during detailed engineering design phase to ensure natural surface water flows are maintained. Where pipelines cross drainage channels, they will	No impacts to flora and vegetation as a result of altered surface water flow patterns.	Visual inspection of linear infrastructure following flood events. Sedimentation monitoring upstream and downstream of the Lyons River crossing. Annual spring monitoring of vegetation condition upstream and downstream of linear infrastructure in areas where sheet flow occurs:	The AER will include a summary of the monitoring outcomes.

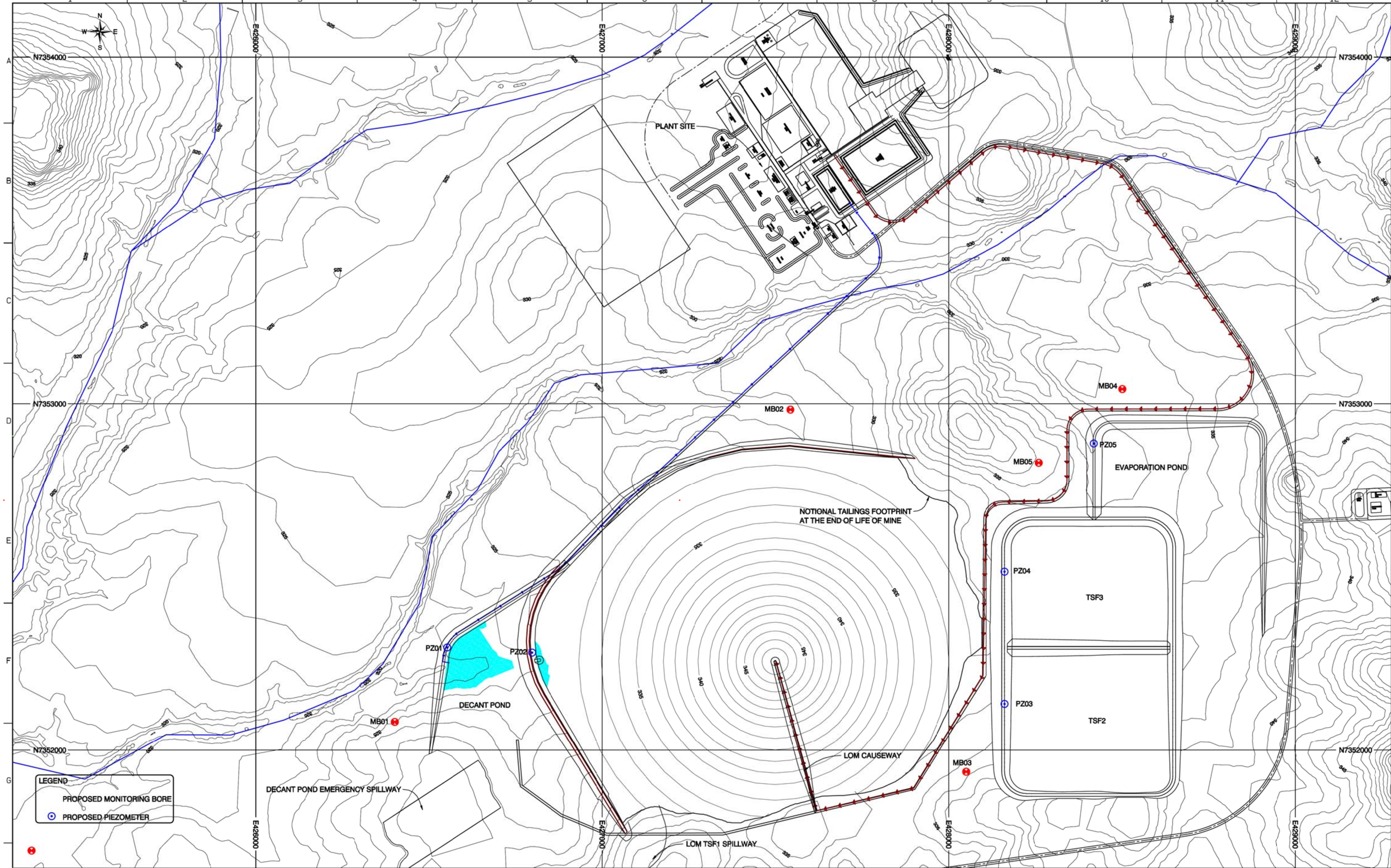
be either buried or raised above drainage channels. Where the access road crosses the Lyon's river, a floodway at ground level will be designed to ensure water flow is not impeded. Roads / infrastructure will be located in elevated areas of the catchment where possible. Soil stockpiles will be located outside of low-lying areas.		• Access road - south of Lyons River • Access road – north of Lyons River • Water pipeline	
Risk 5 Mitigation Radiation Waste Management Plan detailing dust mitigation measures. Detailed engineering design to include dust mitigation measures. Identification of trigger levels for dust deposition.	No decline in surface water quality within the Fraser Creek catchment. No exceedance in trigger levels for dust deposition.	Surface water quality sampling will be conducted opportunistically following significant rainfall events or on a quarterly basis as per the Surface Water Monitoring Work Instruction. Dust deposition monitoring in accordance with monitoring requirements of RWMP. Monitoring of effectiveness in dust mitigation measures identified in detailed engineering design of process plant against dust deposition trigger levels.	AER to summarise monitoring results in RWMP; dust deposition and surface water quality monitoring.
Risk 6 Mitigation Tailings storage facilities management strategy (section 3.2.5)	No seepage from TSFs beyond TSF and RWP footprint.	A network of monitoring bores will be established down gradient from the TSFs (Figure 3-1), sampled and	AER to summarise monitoring outcomes.

Construction of fit-for-purpose impermeable liner and audited to ensure it is constructed in accordance with the design criteria. Evaporation Pond Operations Manual detailing inspections of toe of embankment for evidence of seepage. Installation of groundwater recovery systems (bores, trenches etc.), or installation of low permeability barriers (grout curtain). Trigger levels as per 95% protection in Guidelines for fresh and marine water quality (ANZECC 2000) for chemicals that do not exceed these trigger levels naturally in the local environment.	No seepage of contaminants into groundwater.	analysed for heavy metals including radionuclides, on a quarterly basis, as per the Environmental Radiation Monitoring Work Instruction.	
Risk 7 Mitigation Tailings storage facilities management strategy (section 3.2.5) Water balance and optimal water depth to maximise evaporative losses, to incorporate in the engineering design of an adequate freeboard. Evaporation Pond Operations Manual, detailing operational inspections of freeboard and management of water	No release of evaporation pond water into surrounding environment	Verification that evaporation pond has been designed in accordance with detailed engineering design. Annual audit of evaporation pond performance by independent expert.	Summary of monitoring in AER

level with pending high rainfall. Trigger levels as per 95% protection in Guidelines for fresh and marine water quality (ANZECC 2000) for chemicals that do not exceed these trigger levels naturally in the local environment.			
Risk 8 Mitigation Tailings storage facilities management strategy (section 3.2.5) Selection of relevant design standards based on ANCOLD risk category and IAEA Safety Standards; The TSF Construction Management Plan with quality assurance procedures will be developed and implemented to ensure that the TSF construction meets design specifications and tolerances. An independent competent person will be engaged to certify that the construction of the TSF meets design specifications and tolerances. During operations supernatant will be pumped to the evaporation pond pending high rainfall events.	No evidence of failure of TSF embankment	Annual TSF audit by independent Geotechnical Engineer. TSF3 Operations Manual, detailing: • Operational inspections (every 12 hours) of embankments, freeboard, pipes • Embankment piezometers to monitor phreatic levels within embankment • Survey pins to monitor movement	TSF audit report (as per criteria described in the Radiation Waste Management Plan) following construction and annually will be appended to the AER.

Trigger levels as per 95% protection (Appendix A) in Guidelines for fresh and marine water quality (ANZECC 2000) for chemicals that do not exceed these trigger levels naturally in the local environment.			
Risk 9 Mitigation Augment water supplies for third party groundwater users if impacts to water level from infrastructure are proven.	No reduction in Fraser Bore (pastoral bore within Fraser Creek catchment) water levels beyond natural variation	Water level monitoring (Groundwater Monitoring Work Instruction) of nearest pastoral bore downstream from TSFs as shown in Figure 1-2.	Monitoring results summarised in AER
Risk 10 Mitigation Surface water management strategy (section 3.2.1) Potable and waste water management strategy (section 3.2.3) All chemicals will be stored in accordance with Australian Standards as detailed in the Land Management Plan. Materials with elevated levels of radionuclides shall be managed in accordance with the Radiation Waste Management Plan. Trigger levels as per 95% protection (Appendix A) in Guidelines for fresh and marine water quality (ANZECC 2000) for	No exceedances in water quality thresholds as a result of proposal activities.	Groundwater and surface water quality monitoring as per the Groundwater Monitoring Work Instructions and the Surface Water Monitoring Work Instruction.	Annual groundwater monitoring report to DWER, Water Division.

chemicals that do not exceed these trigger levels naturally in the local environment.			



No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
0	DFS ISSUE	24/11/2017	BM	JL	KDS
A	DRAFT ISSUE	12/05/2017	BM	JL	-

SCALE: 1:10,000	
JOB No.	112391.12
DATE	11/10/2017
DESIGN	BM
DRAWN	BM
CHECKED	JL
APPROVED	KDS

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HASTINGS TECHNOLOGY METALS LIMITED
YANGIBANA RARE EARTH PROJECT

Figure 3-1

TAILINGS STORAGE FACILITY
FEASIBILITY STUDY
MONITORING LAYOUT

112391.12_011

CLIENT No.
CAD REF.
REV. No. A | SHT SIZE A3
SHEET 1 OF 1

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Surface water management strategy

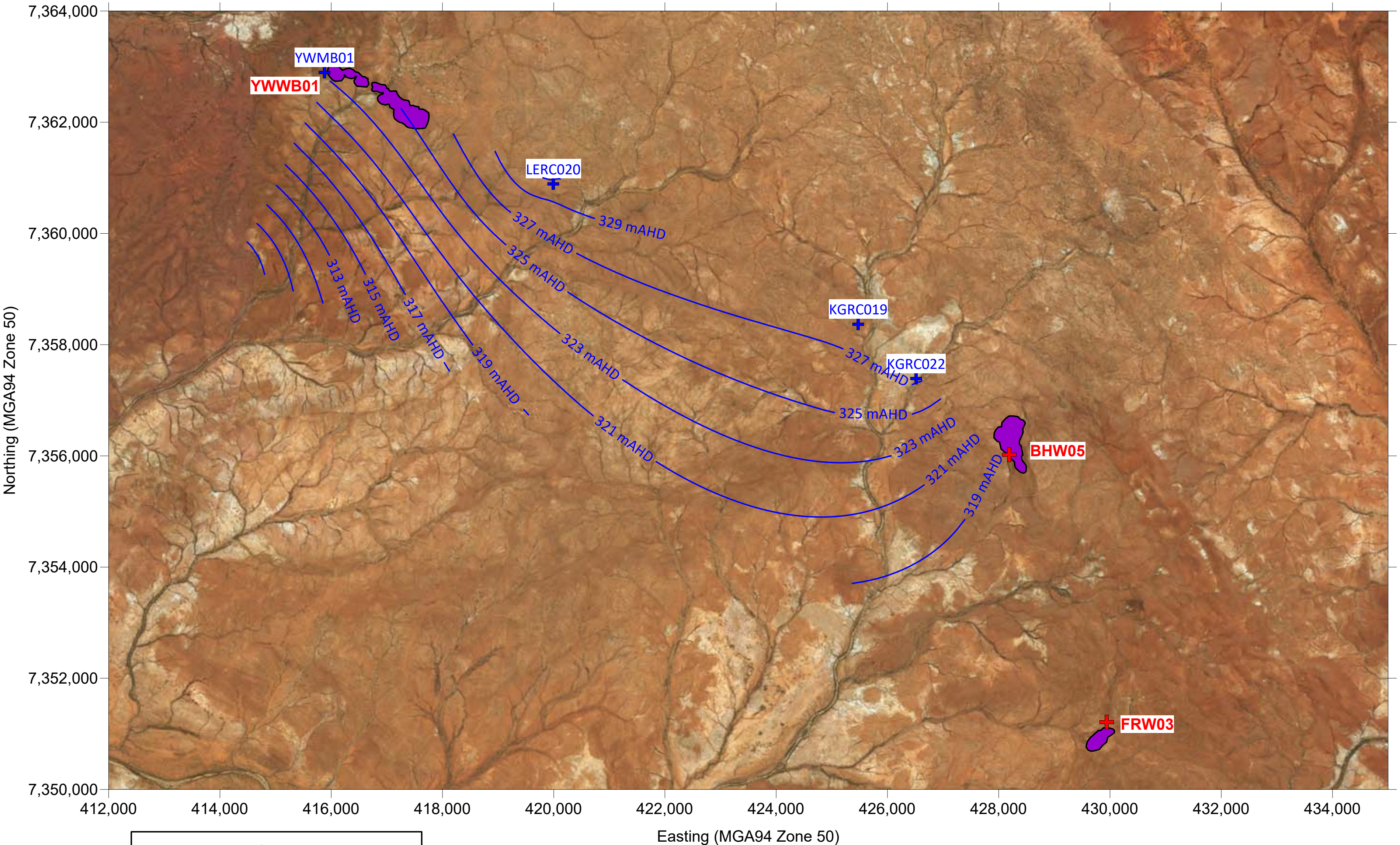
The following management actions will be implemented to address the potential surface water impacts:

- A series of diversion drains will be installed to direct storm water around workshops, plant areas, hydrocarbon storages and other disturbed areas, discharging to the natural drainages.
- Infrastructure within the diversion drains, including the ROM and plant will be internally draining, discharging to sumps and then to a process pond for use within the plant.
- Oily water separators and sediment traps will be installed to manage runoff from contaminated and disturbed areas.
- Hydrocarbons and other chemicals will be stored in bunded facilities, which will comply with Australian Standards and licence conditions.
- An on-site bioremediation facility will be established and maintained, to treat hydrocarbon contaminated soil as per the Land Management Plan and managed in accordance with the Bioremediation Facility Work Instruction.
- Monitoring and inspection schedules, contingency and reporting requirements have been developed to manage surface water upon commencement of the Project, and are discussed in the following sections.

Fractured rock aquifer bores management strategy

The following management actions will be implemented to address the groundwater abstraction:

- Bore details and maximum pumping rate for each bore is provided in Table 3.2 below.
- Each bore shall be equipped with a submersible pump, dip tube, flow meter and control box.
- A network of five monitoring bores has been installed (KGRC019, KGRC022, LERC020, YWMB01, HYRC02 and HYRC03) have been installed to provide regional water level information in the fractured rock aquifer. The monitoring bore locations are shown in Figure 3-2.
- Monitoring and inspection schedules, contingency and reporting requirements are discussed in the following sections.



LEGEND

- Groundwater Contours
- Completed Production Bores
- Completed Monitoring Bores

Yangibana Stage II FR (J1709R01)	
Hastings Technology Metals Ltd	
KM	Mar 18	FIGURE 3-2

FRACTURED ROCK PRODUCTION AND MONITORING BORES

GROUNDWATER RESOURCE MANAGEMENT

FILE://J1709_Yangibana/figures/surfer/fractured rock/prod and monitor bores.srf

Table 3-2: Fractured rock aquifer bore schedule

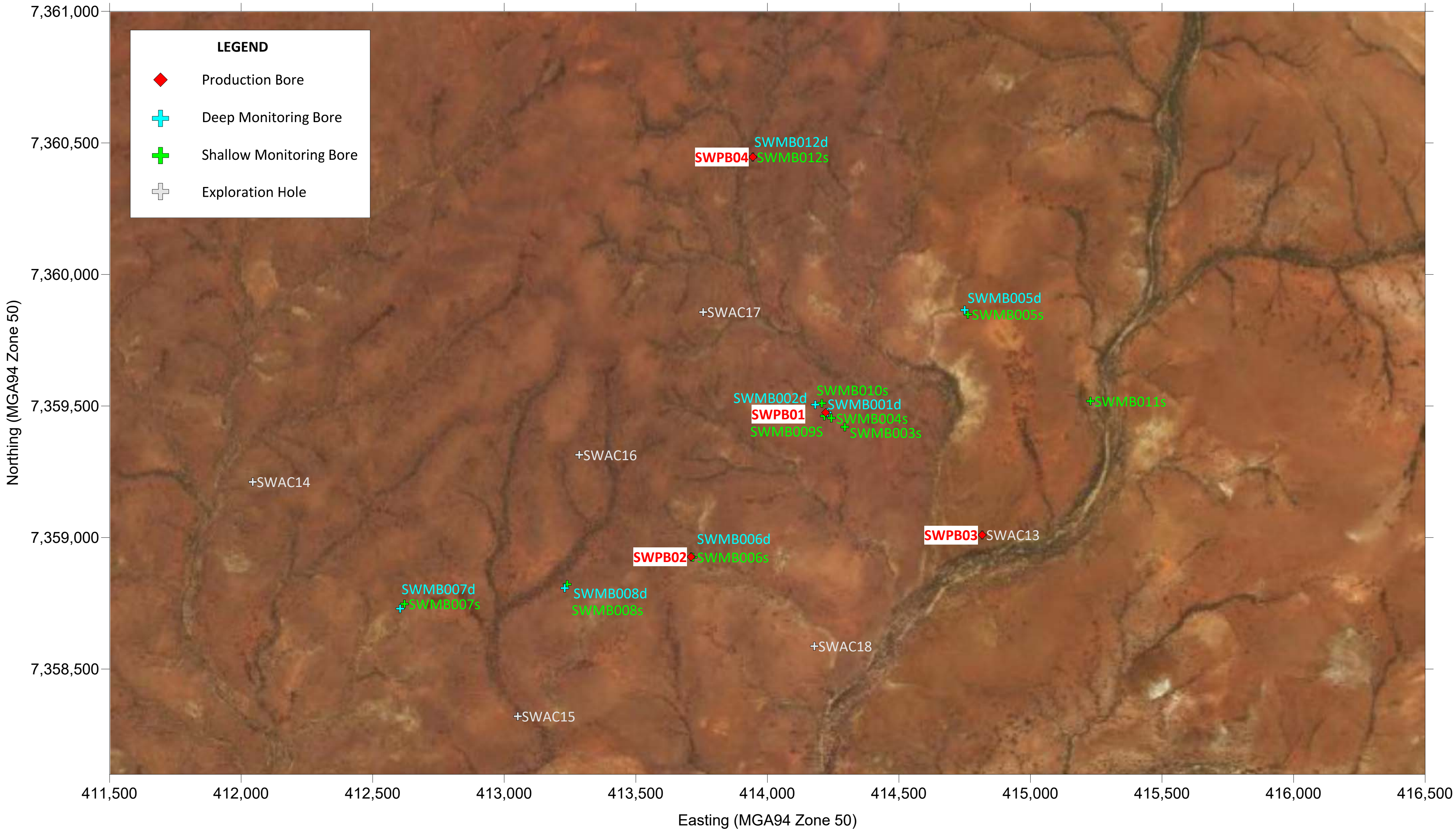
Parameter	Units	Production Bores		
		FRW03	BHW05	YWWB01
Exploration Drill Hole		FRW01	BHW04	YWRC075
Collar Location MGA Zn 50	(mE)	429,940	428,194	415,887
	(mN)	7,351,210	7,356,015	7,362,891
RL	(mAHD)	350.97	345.45	336.4
Depth Drilled/Reamed	(mbgl)	110	106	126
Surface Casing Depth	(mbgl)	3.2	4	2
Cased Depth	(mbgl)	95.2	104	126
Casing Type		155 mm Class 9 uPVC	155 mm Class 9 uPVC	155 mm Class 9 uPVC
Slotted Interval	(mbgl)	71.2 to 95.2	80 to 104	96 to 126
Slot Type		1 mm	1 mm	1 mm
Gravel Pack Grade	mm	3.2 to 6.4	3.2 to 6.4	3.2 to 6.4
Gravel Pack Interval	(mbgl)	+0.1 to 95.5	+0.1 to 104	5 to 126
Annual Bentonite Seal	(mbgl)	0.1 to +0.1	0.1 to +0.1	3 to 5
Stick-up	(magl)	0.1	0.1	0.2
SWL	(mbtoc)	33.8	26.5	13.14
SWL Date		4 Nov 2016	14 Nov 2016	11 Dec 2017
Peak Pumping Rate	L/s	7	10	2
Long-Term Operational Rate	L/s	6	8	1-2

SipHon Well Borefield management strategy

The following management actions will be implemented to address the groundwater abstraction:

- The Borefield will likely comprise seven production bores, at a spacing of approximately 1 km, with a sustainable duty rate of approximately 8 to 10 L/s per bore. Currently three bores have been installed. Bore details and maximum pumping rates for each bore are provided in Table 3.3 below.
- Groundwater abstraction from the SipHon Well Borefield will be distributed across the bores to manage impacts on the groundwater environment. A maximum permissible total allocation from the borefield, as well as recommended sustainable pumping rates for each bore, are provided in the Groundwater Operating Strategy.
- Each bore shall be equipped with a submersible pump, dip tube, flow meter, water level instrument and control box.
- Borefield details and pumping rates will be tabulated as per the Groundwater Operating Strategy.

- A network of monitoring bores has been installed to enable the drawdown impacts to be measured. Currently there are seven deep and ten shallow monitoring bores installed. Additional shallow and deep monitoring bore will be installed at each new production bore location for the four remaining bores, as well as two additional calcrete monitoring bores. The existing monitoring bore locations are shown in Figure 3-3, along with the proposed locations for the remaining bores.
- Monitoring and inspection schedules, contingency and reporting requirements are discussed in the following sections.



Yangibana Stage II PC (J1709R02)		
Hastings Technology Metals Ltd		
KM	May 18	**Figure 3-3**

SIPHON WELL BOREFIELD LAYOUT

GROUNDWATER RESOURCE MANAGEMENT

FILE://J1709_Yangibana/figures/surfer/palaeochannel/borefield layout.srf

Table 3-3: SipHon Well Borefield bore schedule

Parameter	Units	Production Bores			
		SWPB01	SWPB02	SWPB03	SWPB04
Collar Location MGA Zn 50	(mE)	414,222	414,750	414,817	413,945
	(mN)	7,359,475	7,359,865	7,359,010	7,360,446
RL Ground Level	(mAHD)	322.73	321.5	318.1	327.3
RL Top of Casing	(mAHD)	323.17	-	-	-
Depth Drilled	(mbgl)	150	110	77	132
Cased Depth	(mbgl)	150	110	72	124
Blank Casing Type		203 mm ID mild steel	200 mm Cl 18 uPVC	200 mm Cl 18 uPVC	200 mm Cl 18 uPVC
Screen Type		165 mm ID stainless steel screen	200 mm Cl 18 uPVC	200 mm Cl 18 uPVC	200 mm Cl 18 uPVC
Slot/Screen Aperture	(mm)	0.3	1	1	1
Slotted Interval	(mbgl)	115 to 150	90 to 110	48 to 72	94 to 124
Gravel Pack Grade	mm	Nil	+1.6 – 3.2	+1.6 – 3.2	+1.6 – 3.2
Gravel Pack Interval		Nil	70 to 110	27 to 77	82 to 124
Pressure Grout Interval		0 to 114	0 to 70	0 to 27	0 to 82
Stick-up	(magl)	0.44	-	-	-
SWL	(mbtoc)	17.64	17.05	-	20.76
	(mAHD)	305.53	-	-	-
SWL Date		14 Apr 18	4 Mar 18	-	12 Apr 18
Airlift after Development	L/s	10	14	2	14

Potable and waste water management strategy

The following management actions will be implemented to manage potable water usage for the Project:

- Potable water will initially be sourced from fractured rock aquifer bore FRW03. However, this bore was chosen due to proximity for the construction phase of the Project, and other fractured rock or palaeochannel bores may be used for potable water feed. All bores on site are suitable for potable water (with RO treatment).
- Potable water will be treated via an on-site RO treatment plant located either at the camp and/or at the process plant.
- The potable water will be further treated with a chlorinator or in-line UV treatment system.
- Waste potable water will be blended with treated water from the waste water treatment plant, before treatment in the waste water treatment plant, before being discharged to an

irrigation area. The irrigation area will be located on flat ground, bunded to prevent runoff and will be rested following periods of high rainfall to promote evaporation.

- Water usage within the camp will be monitored regularly to determine the relative water efficiency in the village, and allow the assessment of ongoing water minimisation strategies implemented during the life of the Project.
- Install water-wise fittings in the accommodation village to reduce potable water consumption and implement a water savings awareness program in the village.
- Monitoring and inspection schedules, and contingency and reporting requirements will be developed to manage the potable water supply as per the Drinking Water Quality Management Plan.

Pit dewatering management strategy

Dewatering of the proposed pits will be best achieved using sump pumping, supplemented by dewatering bores as required. The inflow rates to the pits were estimated using analytical techniques (Thiem equation for unconfined flow) and are provided in Table 3-4 below.

It is important to note that the estimates do not allow for surface water runoff following high rainfall events, which can increase dewatering rates significantly.

Sump pumping will require ongoing management during the operational life of the pits. Sumps should be strategically located at low points along the pit floor. All sump pumps will require flow meters to measure abstraction volume.

The requirement for dewatering bores will be assessed on a pit by pit basis. The existing bores, FRW03 and BW05, will aid dewatering to some extent. However they were constructed primarily for testing purposes (i.e. using uPVC casing) and are unlikely to remain operational once mining of the respective pits commences.

Any additional dewatering bores should be constructed into the target aquifer; the ironstone dyke cross cut by supplemental fracturing, on the down-dip side of the pit. Future dewatering bores will be installed at least 6 months prior to mining to achieve sufficient drawdown. The bores should be constructed using 6” schedule 40 steel casing (7.1 mm wall thickness). The steel casing should be slotted across the main aquifer zone with the bore annulus gravel packed to just below the surface. The annulus will need to be sealed at the surface, with cement grout, to prevent surface water ingress.

All dewatering discharge will be transferred to a water storage pond. The discharge will be used predominantly for dust suppression at the respective pit, with additional water transferred to the process plant.

At the predicted dewatering rates there shall be no requirement to discharge mine water to the surrounding environment.

Monitoring and inspection schedules, contingency and reporting requirements have been developed to manage dewatering upon commencement of the Project, and are discussed in the following sections.

Table 3-4: Dewatering Estimates

Quarter	Dewatering Estimates (L/s)				
	Fraser's	Bald Hill	Yangibana North	Yangibana West	Total
9	2.9	-	-	-	2.9
10	3.0	-	-	-	3.0
11	3.2	15.8	-	-	19.0
12	3.6	13.3	-	-	16.9
13	6.8	13.0	-	-	19.8
14	8.3	15.2	-	-	23.4
15	10.2	15.7	-	-	25.9
16	8.0	16.0	-	-	24.0
17	7.9	16.2	-	-	24.1
18	-	16.3	-	-	16.3
19	-	16.5	-	-	16.5
20	-	17.0	7.5	-	24.4
21	-	24.6	7.5	-	32.0
22	-	25.0	7.5	-	32.5
23	-	28.4	7.5	-	35.9
24	-	28.1	19.6	7.1	54.8
25	-	26.2	19.6	7.1	52.9
26	-	22.7	19.6	7.1	49.4
27	-	22.6	19.6	7.1	49.3
28	-	-	21.1	15.7	36.8
29	-	-	21.1	15.7	36.8
30	-	-	21.1	15.7	36.8
31	-	-	21.1	15.7	36.8
32	-	-	20.8	16.7	37.5
33	-	-	20.8	16.7	37.5
34	-	-	20.8	16.7	37.5
35	-	-	20.8	16.7	37.5

Tailings storage facility management strategy

The tailings storage facilities will be managed as follows:

- The TSFs will be constructed in accordance with the proposed design.
- TSF3 will be constructed with underdrain detection between the compacted clay and HDPE liners, and a sump.
- The storage ponds will be constructed with sufficient contingency for high rainfall events.
- A series of monitoring bores will be installed down hydraulic gradient from the TSFs to measure groundwater level and water quality as shown in Figure 3-1.
- Monitoring and inspection schedules, contingency and reporting requirements have been developed to manage the storage receptors upon commencement of the Project and are discussed in the following sections.
- Trigger limits for the TSF monitoring bores have been identified to assist in early detection of seepage impacts (as described in the following section).

2.3 MONITORING

Surface water

Maintenance of the diversion drains, surface water infrastructure and water supply pipelines will be the responsibility of the Mine Services team. Maintenance schedules will comprise regular inspections (weekly or immediately following heavy rainfall events) to identify leaks or maintenance required.

Surface water monitoring is the responsibility of the Environmental Officer. Surface water quality testing will be conducted following the first heavy rainfall event of the season (locations to be determined) for the following parameters:

- Physico-chemical parameters – pH, EC, TDS, total hardness, TSS and total alkalinity.
- Major ions – sodium, potassium, calcium, magnesium, chloride, sulphate, bicarbonate, carbonate, nitrate.
- Minor ions/metals – silica, aluminium, iron and manganese.
- Additional analytes – silver, barium, bismuth, cadmium, cobalt, chromium, copper, lithium, molybdenum, nickel, lead, strontium, thorium, titanium, uranium, vanadium, yttrium, zinc.

Fractured Rock Aquifer bores

Maintenance of the borefield and pipeline is the responsibility of the Mine Services team. Maintenance schedules shall be in accordance with manufacturers specifications and the borefield and pipeline shall be inspected at least weekly to identify leaks and initiate repairs.

Groundwater monitoring of the fractured rock aquifer bores is the responsibility of the Environmental Officer. The monitoring program for the fractured rock aquifer bores is summarised in Table 3.5 below.

Table 3-5: Fractured rock aquifer bores monitoring program

Location	Monitoring	Frequency
Production bores (FRW03, BHW05, YWWB01)	Water level	Monthly
	Pumping volume	Monthly
	Field EC and pH	Quarterly
	Laboratory determined groundwater chemistry (Yangibana water quality suite*)	Annually

Notes: * parameters: pH, EC, TDS, total hardness, and total alkalinity, sodium, potassium, calcium, magnesium, chloride, sulphate, bicarbonate, carbonate, nitrate, silica, aluminium, iron, manganese, silver, barium, bismuth, cadmium, cobalt, chromium, copper, lithium, molybdenum, nickel, lead, strontium, thorium, titanium, uranium, vanadium, yttrium, zinc.

SipHon Well Borefield

Maintenance of the borefield and pipeline is the responsibility of the Mine Services team. Maintenance schedules shall be in accordance with manufacturers specifications and the borefield and pipeline shall be inspected at least weekly to identify leaks and initiate repairs.

Groundwater monitoring of the SipHon Well Borefield is the responsibility of the Environmental Officer. The monitoring program for SipHon Well Borefield is summarised in Table 3.5 below. Monitoring will commence at least 12 months prior to commissioning to provide background data on natural seasonal fluctuation.

Table 3-6: SipHon Well Borefield monitoring program

Location	Monitoring	Frequency
Production bores (SWPB01, SWPB02, SWPB04, SWPB05^, SWPB06^, SWPB07^, SWPB08^)	Water level	Monthly
	Pumping volume	Monthly
	Field EC and pH	Quarterly
	Laboratory determined groundwater chemistry (Yangibana water quality suite*)	Annually
Shallow monitoring bores (SWMB03s, SWMP04s, SWMB05s, SWMB06s, SWMB07s, SWMB08s, SWMB09s, SWMB10s, SWMB11s, SWMB12s, plus 4 additional shallow bores^)	Water level	Monthly
Deep monitoring bores (SWMB01d, SWMB02d, SWMB05d, SWMB06d, SWMB07d, SWMB08d, SWMB12d, plus 4 additional shallow bores^)	Water level	Monthly
Calcrete monitoring bores (SWMB01c^, SWMB02c^)	Water level	Monthly

Notes: ^ = bore yet to be installed, * = parameters: pH, EC, TDS, total hardness, and total alkalinity, sodium, potassium, calcium, magnesium, chloride, sulphate, bicarbonate, carbonate, nitrate, silica, aluminium, iron, manganese, silver, barium, bismuth, cadmium, cobalt, chromium, copper, lithium, molybdenum, nickel, lead, strontium, thorium, titanium, uranium, vanadium, yttrium, zinc.

Potable and waste water

The RO and waste water treatment plant will be inspected at least weekly and maintained as per manufacturer specifications. The irrigation areas will be inspected daily to prevent contamination to the surrounding environment. Inspections will be the responsibility of the Mine Services team.

Quarterly maintenance inspection reports will be submitted to the Department of Health as required under the Regulations.

The proposed water monitoring programme is summarised in Table 4 below.

Table 3-7: Potable water monitoring program

Location	Monitoring	Frequency
Potable supply	Water usage	Weekly
Potable supply	Laboratory determined potable water chemistry (parameters include: pH, TDS (calculated), chloride, sulphate, nitrate as NO_3, nickel, faecal streptococci and E. Coli)	Monthly
Waste water discharge	Laboratory determined water chemistry (parameters include: total nitrogen, biochemical oxygen demand, TDS, TSS total phosphorus, E. Coli)	Fortnightly

Pit dewatering

Sump pumps, pipelines and transfer stations will be inspected at least weekly and maintained as per manufacturer specifications. Inspections will be the responsibility of the Mine Services team.

Groundwater monitoring of the pit dewatering is the responsibility of the Environmental Officer. The dewatering monitoring program is summarised in Table 3.5 below.

Table 3-8: Mine dewatering monitoring program

Location	Monitoring	Frequency
In-Pit Sumps	Pumping volume	Monthly
	Field EC and pH	Quarterly
	Laboratory determined groundwater chemistry (Yangibana water quality suite*)	Annually
Dewatering bores (if required)	Water level	Monthly
	Pumping volume	Monthly
	Field EC and pH	Quarterly
	Laboratory determined groundwater chemistry (Yangibana water quality suite*)	Annually
Local monitoring bores (KGRC019, KGRC022, LERC020, YWMB01, HYRC02, HYRC03)	Water level	Monthly
Regional livestock bores (Edmund HST, Minga Well, Edmund Well, Yangibana Bore, Woodsys Bore, Frasers Well, Contessis Bore, Red Hill 2)	Water Level	Quarterly
	Laboratory determined groundwater chemistry (Yangibana water quality suite*)	Annually

Notes: * parameters: pH, EC, TDS, total hardness, and total alkalinity, sodium, potassium, calcium, magnesium, chloride, sulphate, bicarbonate, carbonate, nitrate, silica, aluminium, iron, manganese, silver, barium, bismuth, cadmium, cobalt, chromium, copper, lithium, molybdenum, nickel, lead, strontium, thorium, titanium, uranium, vanadium, yttrium, zinc.

Tailing storage facilities and associated water storage

Pipelines and storage receptors will be inspected daily to monitor the integrity of the TSFs and ponds, and identify any potential pipeline leaks. Inspections will be the responsibility of the Mine Services team.

Groundwater monitoring of the TSF monitoring bores is the responsibility of the Environmental Officer. The proposed monitoring program is summarised in Table 3.6 below.

Table 3-9: Storage receptor monitoring program

Location	Monitoring	Frequency
Decant Returns	Volume	Monthly
TSF monitoring bores	Water Level	Monthly
TSF monitoring bores	Laboratory determined groundwater chemistry (Yangibana water quality suite*)	Quarterly (Mar, Jun, Sep, Dec)

Notes: * parameters: pH, EC, TDS, total hardness, and total alkalinity, sodium, potassium, calcium, magnesium, chloride, sulphate, bicarbonate, carbonate, nitrate, silica, aluminium, iron, manganese, silver, barium, bismuth, cadmium, cobalt, chromium, copper, lithium, molybdenum, nickel, lead, strontium, thorium, titanium, uranium, vanadium, yttrium, zinc.

2.4 TRIGGER LEVELS FOR GROUNDWATER QUALITY

Trigger levels for groundwater quality have been proposed for the Project, for all monitoring locations (including dewatering discharge, production bores, TSF monitoring bores and the regional stock water bores). The proposed trigger values have been set as follows:

- Exceedances of >25% beyond natural variability on 3 consecutive samples.
- Exceedances of ANZECC guidelines for fresh and marine water quality (2000) for livestock and Australian NHMRC and ARMCANZ (1996) Australian Drinking Water Guidelines for drinking water quality for elements that are not exceeded naturally.

Compliance to the trigger values will be assessed by the Environmental Officer immediately upon receipt of laboratory results.

Where a management target is not met the Environmental Officer will notify the Hastings Registered Mine Manager and initiate an internal assessment of the exceedance. An additional sample will be collected from the sampling point and re-submitted for analysis. If the exceedance is repeated in the follow up sample, then Hastings will further evaluate the cause. The evaluation may include seeking advice from specialist consultants and may include notification to the DWER or DoH.

12.5 REPORTING

2.4.1 Annual Reporting

Annual environmental reports (AERs) will detail environmental management and monitoring activities during the previous 12 months, compliance to the trigger values and compliance with the respective licence conditions, and the Water Management Plan. The AER will also provide an assessment of compliance to the water quality trigger values provided in Table 3-1. The AERs shall be delivered to the DWER within the specified time frame stipulated in the licence conditions. The reports shall include results of all groundwater and surface water monitoring, groundwater abstraction, during the monitoring period, and a discussion of compliance with the respective licence conditions, the Flora and Vegetation Environmental Management Plan and the Water Management Plan.

Annual groundwater monitoring reports will detail groundwater management and monitoring activities, as well as an assessment of aquifer performance and impacts on the groundwater environment. The reports will provide an assessment of measured drawdown compared to model simulated drawdown for the SipHon Well Borefield and surrounding groundwater environment. The reports shall also include a discussion of compliance with the licence conditions, the Water Management Plan and the Operating Strategy. The annual reports shall be delivered to the DWER within three months of the end of the water year (which will be stipulated in the licenses). The report shall include a review of the adopted contingency measures and any recommendations to amend the licence, Operating Strategy or Water Management Plan.

2.4.2 Reporting on Exceedance of the Management Target

The CEO of the OEPA will be notified within seven days of an identification of a trigger level exceedance that trends outside the range of natural variation.

3. ADAPTIVE MANAGEMENT AND REVIEW OF THE EMP

3.1 APPROACH

Hastings will implement adaptive management to learn from the implementation of mitigation measures, monitoring and evaluation against management target/s, to more effectively meet the environmental objective. The following approach will be followed:

- Monitoring data will be evaluated and compared to baseline and reference site data on an annual basis (or more frequently in some instances) in a process of adaptive management to verify whether or not responses to the impact are the same or similar to predictions;
- Monitoring data will be compared to model simulated drawdown for the SipHon Well Borefield and surrounding groundwater environment as a component of the annual review process to verify whether or not responses to the impact are the same or similar to predictions;
- Address evaluation of assumptions and uncertainties listed in section 1.4.2;
- Annual review of the risk assessment and revision of risk-based priorities on the basis of monitoring program information, incidences, verification of modelling outcomes and new information;
- Increased understanding of the ecological regime, best practice, new technologies;
- Revision through consideration of incidents and associated investigations, or when management actions are not as effective as predicted or as result of change management (e.g. construction versus operations phases);
- External changes during the life of the proposal (e.g. changes to the sensitivity of the key environmental factor, implementation of other activities in the area, etc.); and
- Annual review of this WMP as a component of the continual improvement process within the Environmental Management System.

3.2 REVIEW

Review requirements for the Project comprise:

- Revising the preliminary WMP once the final SipHon Well Borefield configuration has been installed.
- Revising the WMP once project licenses have been approved by the respective regulators. The review shall be undertaken prior to commencement of mining, and shall ensure compliance with all licence conditions.
- Annual reviews of the WMP, and Operating Strategy. The reviews shall include updating components of the water management system (i.e. monitoring locations and draw points), and addressing recommendations made during the annual reports. Changes to the licence and / or key documents will require submission of an addendum application to the relevant government agency.

3.3 EARLY RESPONSE INDICATORS, CRITERIA AND ACTIONS

Early response indicators are described for the following risks:

Risk 2: Groundwater drawdown

While the inherent risk severity is considered to be moderate, the level of certainty is also considered to be low due to a lack of understanding as to whether or not the potential GDE's are dependent on groundwater. The level of certainty regarding water drawdown is considered 'High' with respect to having modelled the water drawdown. Hastings has, therefore taken a conservative approach and identified early response indicators for this potential risk.

Environmental outcome

No impact to Groundwater Dependent Ecosystems outside the mine development envelope.

Early response indicator

Decline in GDE species health condition

Rationale for the choice of the early response indicator

If potential GDE's are solely reliant on groundwater levels then a drop-in water levels may result in a decline in their health condition (e.g. loss of leaves, yellowing of leaves, death of individuals).

Early response criterion

Visual inspection of potential GDEs, including photographic records, identifies the following evidence of a decline in the health condition:

- Obvious loss of leaves,
- yellowing of leaves, and/or
- death of individuals.

Early response actions

1. Investigate whether this is comparable with GDE condition at control sites.
2. Determine if the water drawdown trigger has been exceeded. If not, consider revising trigger level.
3. Reduce or stop water abstraction at this location.
4. Consult with external stakeholders (GDE-specialist consultants, regulators, consultants) of next steps.
5. Report findings.
6. Continue to monitor GDE vegetation. Monitoring frequency may increase.

3.3 REVISION OF MANAGEMENT ACTIONS

Where the management target/s is not met or exceeded, Hastings will review and revise the risk assessment, review and revise management actions and identify additional management actions where necessary. The following are examples of revised and additional management actions for each of the risks listed in Table 3-1:

1. Risk 1 - Pit dewatering results in groundwater drawdown
    a. Revised management action 1: Initiate an internal assessment of the exceedance to identify cause
    b. Revised management action 2: Rectify the cause e.g. potential re-injection in downstream groundwater
    c. Additional management action 1: Increased monitoring, if required and in consultation with stakeholders
2. Risk 2 - Water abstraction from SipHon Well Borefield results in groundwater level drawdown
    a. Revised management action 1: Revise trigger levels for groundwater levels
    b. Revised management action 2: Re-calibrate groundwater model and re-assess the revised impacts
    c. Additional management action 1: Reduce water abstraction across the bore field by identifying other water source areas.
3. Risk 3 - Site establishment results in erosion and sedimentation
    a. Revised management action 1: Identify cause
    b. Revised management action 2: Rectify the cause
    c. Additional management action 1: Monitor revised management action
4. Risk 4 - Site establishment and presence of linear infrastructure results in altered surface water flows
    a. Revised management action 1: Develop mitigation measures to remove obstruction

   b. Revised management action 2: Engineering of additional floodways to ensure sheet flow is not obstructed
   c. Additional management action 1: Realignment of linear infrastructure
5. Risk 5 - Operation of crushers, SAG mill and conveyors results in generation of dust
   a. Revised management action 1: Identify cause of dust generation
   b. Revised management action 2: Additional water sprays
   c. Additional management action 1: Covers or sheds over stockpiles
6. Risk 6: Failure of TSF 2, 3 or evaporation pond liner results in seepage
   a. Revised management action 1: Identify cause of seepage
   b. Revised management action 2: Rectify cause via engineered solutions
   c. Additional management action 1: Concrete channel to prevent lateral seepage
7. Risk 7: Over-topping of evaporation pond results in release of process liquor
   a. Revised management action 1: Transfer some liquids to TSF 3
   b. Revised management action 2: Increase embankment height
   c. Additional management action 1: Construction of another evaporation pond (subject to Approvals)
8. Risk 8: Failure of a TSF embankment results in exposure and release of tailings and leachate
   a. Revised management action 1: Reinforced embankment subject to engineering design, and closure considerations
   b. Revised management action 2: Secondary bunding to prevent dispersal
   c. Additional management action 1: Revised daily TSF inspection procedure to include failure cause visual indicators.
9. Risk 9: Presence of WRL and TSFs reduces groundwater recharge
   a. Revised management action 1: Diversion drains around landforms
   b. Revised management action 2: Release of water to local catchment (subject to Approvals and consultation with key stakeholders, consideration of environmental impacts)
   c. Additional management action 1: Re-injection of water to shallow aquifer
10. Risk 10: Uncontrolled release, leak, spill or discharge of hydrocarbons, reagents, or waste water (from the waste water treatment plant)
   a. Revised management action 1: Identify cause of release
   b. Revised management action 2: Additional containment, corrective actions, spill response
   c. Additional management action 1: Training and awareness

4. STAKEHOLDER CONSULTATION

Consistent with the EPA's expectations for this Water MP to align with the principles of EIA, Hastings consulted with key stakeholders while developing this Water MP. Table 4-1 provides a summary of consultation that occurred. The comments raised during consultations with stakeholders were considered in the development of the Water MP. The following sections present stakeholders' comments and Hastings responses to those comments.

Table 4-1: Stakeholders consulted, comments and responses

Organisation(s)	Comments	Hastings Response to Comments/Concerns
Environmental Protection Authority: Response to relevant section of the Environmental Review Document.	Requirement in the ESD for the Management Plan to be included as a component of the revised version of the Environmental Review Document.	Production of this WMP.
Department of Water and Environmental Regulation (DWER) Water Division	On-going discussions and updates regarding water source options and surface water.	No further action required.
Department of Water and Environmental Regulation (DWER) Environmental Regulation	On-going discussions regarding TSF design and waste characterisation studies	Leach testing requirements to be addressed.
Department of Mines, Industry Regulation and Safety (DMIRS)	On-going discussions regarding TSF design and closure	On-going discussions.
Pastoralist	A general discussion of infrastructure layout and areas of high pastoral values.	Infrastructure layout takes account of pastoral values.
Traditional Owners (TOs)	Lyons River and Fraser Creek have heritage values associated with them. A 150m exclusion buffer occurs on either side of the River and Creek.	Consultation with TO's required for any activities within the 150m exclusion buffer (i.e. monitoring, weed eradication). Hastings will ensure this is noted in work instructions relevant to this WMP.

5. REFERENCES

EPA (2018). *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans.* Published April 2018.

Department of Resources, Energy and Tourism (2008). *Leading Practice Sustainable Development Program for the Mining Industry - Risk Assessment and Management*. Commonwealth of Australia, May 2008.