HASTINGS
Technology Metals Limited

APPENDIX 2-2

Ecotoxicity Assessment

HASTINGS
Technology Metals Limited

Yangibana Rare Earths Project

TECHNICAL NOTE

Ecotoxicity Assessment

Document	Technical Note: Ecotoxicity Assessment		**Division**	ENV	**Status**	Draft	**Issued**	
Number			**Author**	LJ	**Review Date**	Robin Zhang 23/10/17	**Version**	0

Contents

1. Introduction

1.1 Yangibana Rare Earths Project

Hastings Technology Metals Limited (Hastings) is proposing to develop the Yangibana Rare Earths Project (the Proposal), located approximately 270 km east-northeast of Carnarvon, in the Upper Gascoyne region of Western Australia (WA).

Rare earth elements (REE) will be mined from four deposits. During mining the REE ore will be taken to the ROM pad in preparation for processing, whereas waste rock will be deposited in a waste rock landform, alongside each respective pit. A processing plant, consisting of a beneficiation process and a hydrometallurgical process, will produce a REE concentrate product. Tailings will be disposed in three tailings storage facilities (TSFs). Support infrastructure will include, but is not limited to, power, water, accommodation facilities, airstrip and linear infrastructure.

1.2 Ecotoxicity assessments

It is widely known that chemical contaminants have the potential to harm the environment. Ecotoxicity assessments are conducted to identify whether or not potential chemical contaminants, generated by human activities, pose a risk of harm to a sensitive receptor (e.g. migratory birds). There are two stages to the process:

STAGE 1: Determining if a sensitive receptor is at risk of impact by a chemical stressor.

A risk cannot occur unless a stressor (source), pathway and receptor interact at the same place and same time:

1. Source of a chemical stressor
2. Exposure pathways
3. Sensitive receptors

This technical report considers the three elements of the stage 1 process using information gathered to-date.

STAGE 2: Determine the concentration (or dose) of a chemical stressor at which toxicity is observed in a sensitive receptor. These are usually laboratory based assessments, which measure the effects of increasing concentrations of a chemical on environmental receptors. However, there is now a lot of available information that provide Environmental Impact Limits: Concentrations of chemicals that are considered lethal to environmental receptors.

1.3 Purpose

To consider work completed to-date in the context of ecotoxicity, and whether or not it poses a potential risk to fauna.

2. Potential sources of contamination

The following reports inform this section:

- Trajectory and Graham Campbell and Associates (2016) Waste Rock Characterisation
- Trajectory and Graham Campbell and Associates (2017) Tailings Characterisation
- Global Groundwater (2016) Conceptual hydrogeology
- GRM (2016) Hydrogeological investigation
- ANSTO (2017a) Pilot plant waste neutralisation and characterisation

2.1 Background

2.1.1 Geology

The Yangibana rare earths mineralisation is associated with rocks of the Gifford Creek Ferrocarbonatite Complex (GCFC). The GCFC is a high-level, carbonatite-associated igneous intrusive suite that includes localities such as the Yangibana ironstones and ferrocarbonatites, the Spider Hill ring intrusion, and the Bald Hill intrusions. It is characterised by ferrocarbonatite dykes, veins and sills and surrounded by fenitised (due to wallrock metasomatism) country rocks, which are generally southeast to east-southeast trending. They consist of dolomite, ankerite and siderite with accessory minerals that include magnetite, and the REE-bearing mineral phosphate monazite [usually $(Ce,La,Nd)PO_4$].

Sinuous ironstone veins and pods (mainly magnetite, hematite and goethite) are spatially associated with (but likely post-date) the ferrocarbonatite intrusions. They are north-northeast to east-southeast trending, surrounded by narrow haloes of fenitic alteration and are locally anomalously radioactive. The ore contains elevated naturally occurring uranium and thorium at reported average concentrations of 27ppm and 450ppm respectively.

2.1.2 Hydrology

The Project area is located within the Gascoyne River catchment. The catchment area of the Lyons River to this crossing location is approximately 11,000 km^2 (JDA 2016). The catchment extends approximately 200 km east from the Study Area.

The Lyons River, a tributary of the Gascoyne River, is associated with the southern portion of the broader Project area, and flows in a general northwestern direction. The Lyons River is considered to be ephemeral, i.e. only flows after rainfall. Semi-permanent waterholes occur within the Lyons River in the general vicinity of the Project area.

Several tributaries of the Lyons River traverse the Project area, namely Yangibana and Fraser creeks. There are also several drainage channels within the Project area. The TSFs do not intersect the Lyons River nor the creeks.

A detailed hydraulic model was developed for Fraser, Yangibana and Gifford Creeks, as well as the Lyons River to assess flood conditions that are likely to impact on the proposed mine infrastructure (JDA 2016). This model used rainfall on grid for the creek catchments, and includes flow in the Lyons River based on the larger Lyons River hydrological model. The detailed model allows for accurate delineation of flood extent, depth, flow rates and velocities, which will be used to inform mine design.

2.1.3 Conceptual hydrogeology

The Project area is not characterised by regional aquifers. Global Groundwater (2016) report that aquifers are likely to be present in superficial strata (where sufficiently thick and saturated) or in basement rocks where fractured (Figure 1). However, these will be isolated and effectively disconnected from each other over much of the area. Some degree of hydraulic connectivity will occur locally depending on geological structure, weathering, landscape position and aquifer geometry (Global Groundwater 2016).

Geological profiling, topography and soils assessments define the area on which TSFs will be located to be basement rocks. Basement rocks in the study area have very low permeability and could be regarded as effectively impermeable throughout much of the area (Global Groundwater 2016). However, some zones of very high permeability will occur i.e. in the vicinity of bedding plane partings and fractures from faulting, folding, intrusives and where solution cavities and channels (vugs) have developed in ironstone veins (Global Groundwater 2016). These zones of high permeability occur where the target resource will be mined.

Groundwater from intake areas will flow down hydraulic gradients, most likely in the direction of surface water flow (Global Groundwater 2016). Regional flow systems are not likely to be generated. Local flow systems will have established in response to aquifer distribution and geometry, which is highly variable.

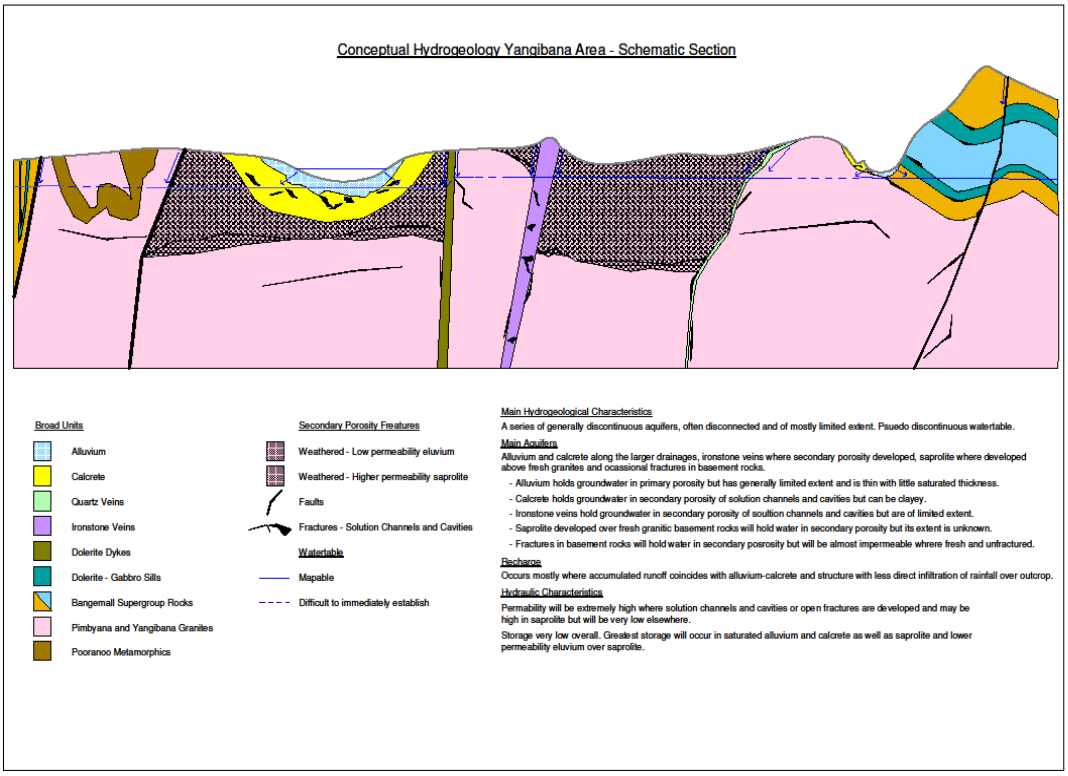


Figure 1 Conceptual Hydrogeology of the Yangibana Rare Earths Project area (Global Groundwater 2016)

2.1.4 Water quality

Pastoral stations are the only other groundwater users in the vicinity of the Proposal, with water used for domestic and stock purposes (Figure 2). The nearest pastoral bore is approximately 2 km from the Proposal. None of the existing pastoral bores are located within the fractured ironstone aquifers associated with the pit dewatering and groundwater abstraction activities of the Proposal. Water quality parameters from eight pastoral station bores were variable depending on location (Appendix A). pH ranged from 7.2 to 8.6 and salinity ranged from 600 to 2,800 mg/L TDS (as summarised in Table 1). Total dissolved thorium values were <0.001 mg/L whereas total dissolved uranium ranged from 0.004 to 0.079 mg/L.

Water quality analysis was also conducted at two ephemeral pools (LC - Pool 800US and FR – Pool) on the Lyons River, located approximately 5-10 km from the Proposed processing plant. These samples were collected at the end of the dry season (Appendix A) and thus parameters measured (as summarised in Table 1) will vary depending on time since last rainfall.

Table 1 Summary of water quality analysis

Water Quality Parameters	Water within pits	Pastoral bores	Ephemeral pools
pH range	7.8 – 8.5	7.2 – 8.6	8.1 - 9.6
Salinity range (mg/L)	920 - 1200	600 - 2800	330 - 1200
Total dissolved Th (mg/L)	<0.001	<0.001	<0.001
Total dissolved U (mg/L)	0.014 – 0.016	0.004 – 0.079	0.001 – 0.004

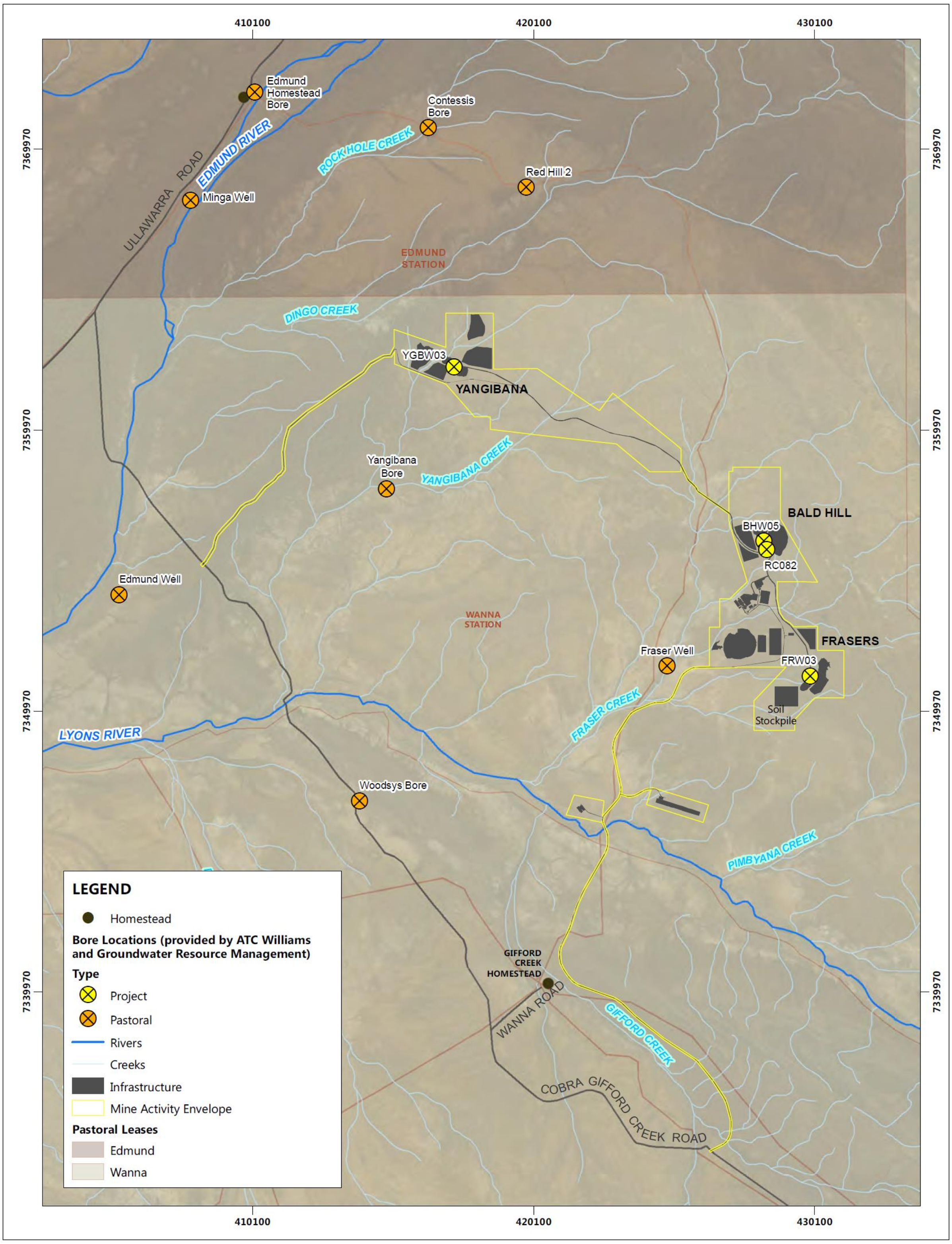


Figure 2 Project and pastoral bores

2.2 Pit voids

2.2.1 Materials characterisation

The geochemical and physical characteristics of materials from each of the four pits were so similar that the results were discussed as a whole (Trajectory and Graham Campbell and Assoc. 2016). Both regolith and bedrock samples were tested for:

- pH and salinity,
- acid formation potential,
- multi-element composition,
- water extractable solutes,
- sodicity and water dispersion.

pH and salinity

The regolith samples were either circum-neutral or alkaline with varying salinity, due to halite (NaCl) and gypsum ($CaSO_4.2H_2O$). The colluvium samples were consistently saline, and the isolated saline samples of saprolite and saprock were shallow samples (viz. within 5-6 m of ground-surface). The bedrock samples were alkaline (viz. pH-(1:2) values of 8.3-9.5) with low-to-moderate salinity.

Acid formation potential

All samples were classified as Non-Acid Forming (NAF), due to 'negligible-sulphides' (viz. Sulphide-S values less than 0.1 %; mostly less than 0.01 %).

Multi-element composition

Multi-element analysis shows both the regolith and the bedrock to be geochemically benign.

In the regolith, varying enrichment in Mo, Cu, Zn, Cd, Pb, Mn, Ag, Ba, U and Th was recorded for some samples. However, none of these enrichments were marked. As a group, the Ironstone-saprock samples stood out in terms of minor-element enrichment. The Ba content of 2.88 % in sample GCA11627 (Bald Hill) reflects mostly barite-Ba. The Mn contents of 1.17-2.29 % in the Ironstone-saprock samples indicates Mn-oxyhydroxides, consistent with the 'dark-chocolate' colour of these samples. The Fe/Mn-oxyhydroxides in the Ironstone-saprock samples account for minor-element enrichment, since these Fe/Mn-minerals are strong 'scavengers' for minor-elements in natural systems.

In the bedrock, varying enrichment in Mo, Ba, Cd, and Sn was recorded for some samples. However, none of these enrichments were marked.

Water extractable solutes

Chlorides and sulphates of Na and Ca were the major salts present in the regolith samples. Minor-element concentrations were either below, or close to, the respective detection-limits (typically 0.1-10 µg/L range). Chlorides and sulphates of Na and K were the major salts present in the bedrock samples tested.

Minor-element concentrations were either below, or close to, the respective detection-limits (typically 0.1-10 µg/L range).

The fluoride (F) concentrations ranged between 1.0-5.9 mg/L and 1.7-4.9 mg/L in the regolith and bedrock samples, respectively, and may reflect occurrences of 'trace-fluorites' (CaF_2). The Si concentrations ranged up to 14.09 mg/L in the regolith samples, which suggest occurrences of poorly-ordered siliceous phases (e.g. opaline-silica-type phases).

Sodicity and water dispersion

Colluvium, saprolite and saprock were all variously sodic. One sample was shown to be dispersive, namely a 'deep' fenitic-granite-saprock sample (viz. 75-78 m downhole).

2.2.2 Pit lake model

Fractured rock aquifers are associated with the target ore body. As a result pit dewatering will be undertaken during operations. When pit dewatering activities cease at the start of decommissioning phase of the mine, a pit lake will form in the base of each pit.

The pit lake model was developed using the generic systems modelling package GoldSim, which is ideally suited to coupled water and solute balance modelling (GRM 2017). The model was run over a 500 year period to estimate pit lake conditions after mine closure.

The final mining depth in the three planned pits lies below the ambient groundwater level. At mine closure pumping will cease and the pits will start to flood forming a pit lake. Flooding will be primarily from the inflow of groundwater, which in conjunction with sporadic inflows from rainfall and runoff, will initially exceed losses from evaporation. This regime will be maintained until the combined inflow is balanced by the combined outflow, allowing for seasonal variability.

Once the pit lake level stabilises one of two conditions are likely to develop. If the hydraulic conductivity of the groundwater systems associated with the pit lakes is sufficiently low, then a steep hydraulic gradient will be required to provide the necessary groundwater inflow to balance the evaporative loss. This will result in a depressed lake level and the development of a local groundwater sink (i.e. where the lake level lies below the groundwater level down-gradient of the pit), with no discharge of lake water to the groundwater environment.

Alternatively, if the hydraulic conductivity of the pit walls is sufficiently high then the hydraulic gradient needed to balance groundwater inflow against evaporative outflow will be low. In this instance, it is possible that the pit lake level will lie above the ambient groundwater level on the down-gradient side of the pit, thereby allowing pit lake water to discharge to the environment, forming a flow through cell.

If pit lake water is released, then there is a risk that any groundwater resources in the area could become impacted by mixing with pit water that may be contaminated.

Outcomes from modelling show:

- A rapid pit lake level rise over the initial 10 years when groundwater inflow rates far exceed evaporation rates, because of the high groundwater hydraulic gradient and the comparatively small lake area available for evaporation.
- The rate of rise reduces between 10 and 15 years after cessation of dewatering due to increased evaporation rates, because of the expanded pit lake area as the pit fills, and the reduced groundwater inflow rate in response to the lowering of the groundwater gradient towards the pit.
- The pit lake water levels equilibrate after 20 years as the falling groundwater and rainfall inflows are balanced by the evaporative losses.
- By the end of the 500 year model run, the pit lake levels have stabilised, with minor seasonal and annual variations in response to variation in rainfall and evaporation.

For the baseline condition the final predicted pit lake level ranges from 301 mAHD in Fraser's, to 311 mAHD in Bald Hill and Yangibana, which gives a residual drawdown range of 8.0 m (Fraser's), to 4.9 m (Bald Hill), to 11.5 m (Yangibana), indicating that all pits act as groundwater sinks under baseline conditions.

For the sensitivity analyses relating to wet years, the residual drawdown ranges from 2.5 m (Bald Hill) to 10.4 m (Yangibana), indicating that the pits continue to act as groundwater sinks under high rainfall conditions.

2.2.3 Water quality

During operations

Groundwater samples were collected from Fraser's, Bald Hill and Yangibana ore deposits for standard laboratory analysis to provide an indication of groundwater quality. The fractured rock aquifers will be used as a water source for the processing plant. The results, as summarised in Table 2, show:

- The groundwater is slightly alkaline, reporting a pH of 7.8 to 8.5.
- The groundwater is fresh to slightly brackish, with TDS ranging from 920 to 1,200 mg/L TDS.
- The groundwater is of sodium chloride type.

Results from the full analysis are shown in Appendix A.

Table 2 Groundwater quality analysis

Analyte	Frasers ore body (FRW03) mg/L	Bald Hill ore body (BHW05) mg/L	Yangibana ore body (YGWB03) mg/L
pH	8.5	8.0	7.8
EC (µS/cm)	2,100	1,900	1,500
TDS	1,200	1,000	920
Total alkalinity	-	-	270
Carbonate alkalinity	11	<1	<1
Bicarbonate alkalinity	280	<5	330
Chloride	380	330	250
Sulphate	160	100	89
Nitrite	<0.2	<0.05	<0.2
Nitrate	9.1	65	63
Calcium	72	81	85
Magnesium	67	51	44
Potassium	9.5	9.0	7.5
Silica, soluble	52	72	91
Silicon	-	34	43
Total hardness	460	410	390
Aluminium	<5	<5	<5
Iron	73	9	5
Manganese	<1	<1	<1
Selenium	4	7	6

Post-closure

The pit lake model also provides an estimate of TDS concentrations post-closure, based upon evaporative concentration in the pit lakes. The results indicate that after 500 years post closure the TDS in Fraser's pit increases from 1,200 mg/L to about 44,000 mg/L TDS; in Bald Hill pit, an increase from 1,000 mg/L to about 48,000 mg/L TDS; and in Yangibana pit, an increase from 920 mg/L to about 37,000 mg/L TDS.

2.3 Processing plant

2.3.1 Background

Beneficiation plant

The initial phase of processing occurs within the beneficiation plant. This consists of conventional processes to remove economic materials and increase the REE concentrations. This process includes:

- Crushing circuit;
- Grinding in SAG mill and/or ball mill;
- Flotation circuit to produce a mineral concentrate; and
- A regrind mill.

The beneficiation mineral concentrate will represent approximately 3-5% of the incoming ore mass. The remaining 95-97% comprising barren material, which will be disposed of in Tailings Storage Facilities (TSFs). The majority of water used in the beneficiation process will be recovered and reused. The beneficiation concentrate will undergo further processing in the hydrometallurgical plant.

Key reagents used in the beneficiation process include:

- Sodium hydroxide;
- Sodium silicate; and
- Fatty acid collector.

Hydrometallurgical plant

The hydrometallurgical plant will continue processing the concentrate to remove residual materials such as iron, phosphate, aluminium, uranium and thorium (and their decay products) and produce a mixed rare earth carbonate. The process includes:

- Acidification and roasting of the mineral concentrate to crack the mineral structure;
- Water leaching to bring metals into solution;
- Purification and ion exchange to remove impurities;
- Precipitation of rare earths carbonate product; and
- Neutralisation of waste streams prior to disposal in a TSF.

The key reagents required for the hydrometallurgical plant include:

- Sulphuric acid;
- Ammonium or sodium bicarbonate;
- Quick lime slaked to hydrated lime;

- Limestone;
- Magnesium oxide; and
- Sodium hydroxide (caustic soda).

The process water generated from the hydrometallurgical plant cannot be reused in the plant due to reagent solutes (i.e. sodium), and as such disposal of this water (~470,000 to 480,000 m^3/annum) to an evaporation pond will be required.

The storage of chemicals, use of chemicals and potential spillage of chemicals around the processing plant poses a potential risk of contamination to the surrounding environment.

The process flowsheet is shown in Figure 3.

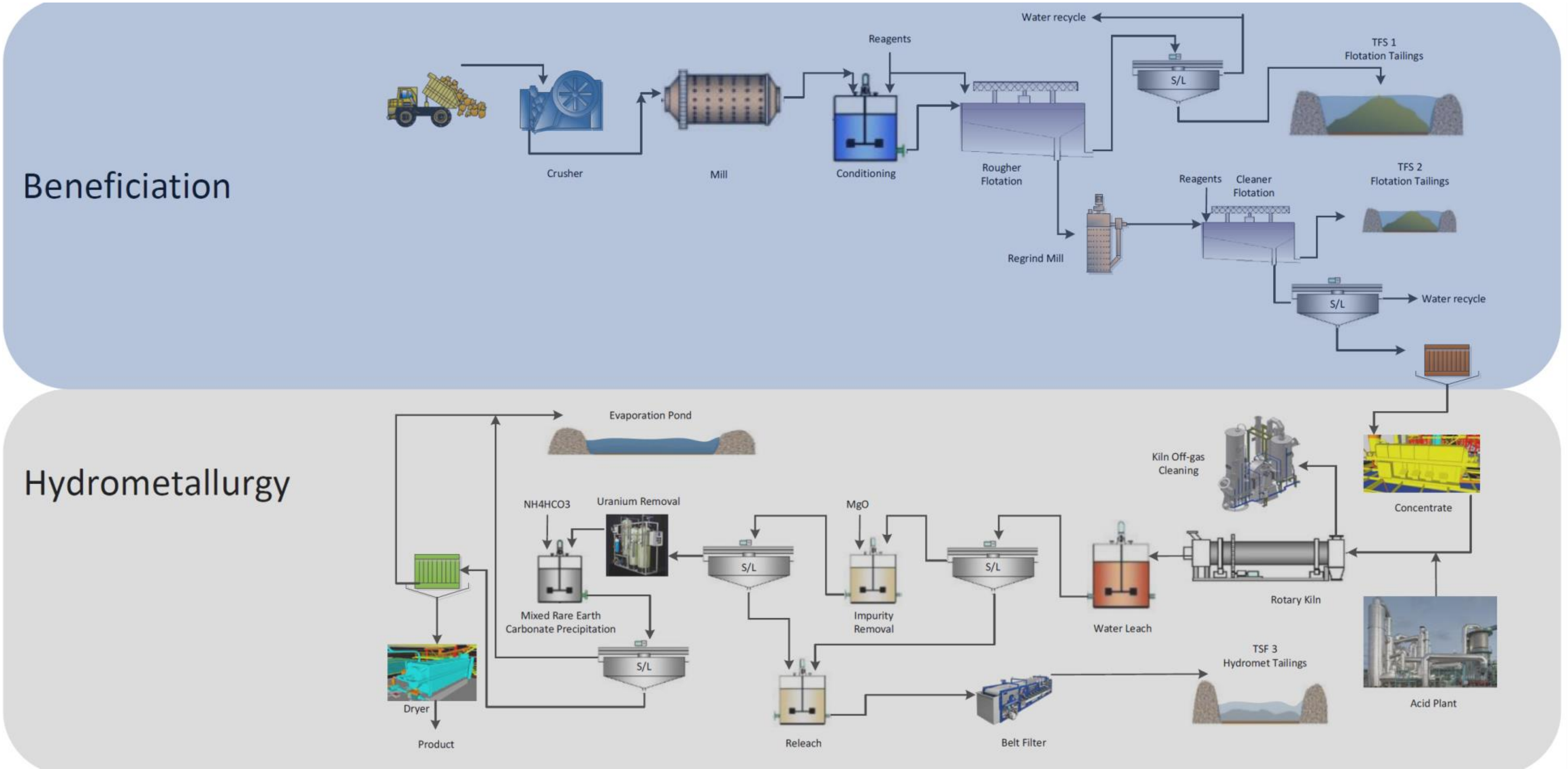


Figure 3 Process flowsheet

2.3.3 Tailings storage facility design

Taking account of the tailings characterisation studies, the TSF design criteria (Table 2) have been determined by ATC Williams to ensure the containment of elevated levels of radionuclides in the tailings materials of TSF 2 and 3.

Table 2 Summary of proposed TSF design features

Design feature	TSF1	TSF2	TSF3
Proportion of tailings	89 - 91%	3.7 – 4.7%	6%
Maximum height (m)	6 metre perimeter embankments; Tailings stack 15 metres	6 metre perimeter embankments	6 metre perimeter embankments
Area (Ha)	100 Ha	7 Ha	11 Ha
Number of cells	1	1	1
Construction	Downstream perimeter embankment raising	Downstream perimeter embankment raising	Downstream perimeter embankment raising
Discharge method	Single point Central Thickened Discharge (CTD)	Perimeter spigots	Perimeter spigots
Lining	Proof compacted basal clayey sand layer	Proof compacted basal clayey sand layer	HDPE / other and compacted clayey sand
Encapsulation	Nominal capillary break / erosion protection; growth medium (soil and rock armour)	Compacted clayey sand base; Design in accordance with IAEA safety standards to provide safe containment of NORM for periods beyond the extent of institutional control	HDPE / compacted clayey sand base; HDPE / CCL engineered capping with growth medium (soil and rock armour). Design in accordance with IAEA safety standards to provide safe containment of NORM for periods beyond the extent of institutional control
Leak detection	Downstream groundwater monitoring bores	Downstream groundwater monitoring bores	Downstream groundwater monitoring bores; Underdrain detection between compacted

Design feature	TSF1	TSF2	TSF3
			clay and HDPE liners with sump

2.3.2 Tailings characterisation

A summary of the general characteristics of the tailings pore water disposed to TSF 1, 2 and 3 are shown in Table 3 as per leach test results (ANSTO 2017b). TSF 1 is expected to be benign geochemically (NAF) with slight enrichments of metals in both the tailings solids and contact waters that were analysed, Aluminium being the most notable in terms of exceedance of trigger values for freshwater ecosystems. TSF 1 tailings are expected to have radionuclide readings (< 1Bq/g) below the probable relevant thresholds. The pH will be between 10 and 11.

TSF 2 is expected to be benign geochemically (NAF) and slight to moderate enrichments of metals in both the tailings solids and contact waters that were analysed (with Aluminium at toxic levels, as above). TSF 2 tailings will have radionuclide levels (4 Bq/g) that exceed probable relevant thresholds based on baseline studies (Radiation Professionals 2016; JRHC 2017). Radionuclides are not water soluble in these tailings (JRHC 2017).The pH will be 8.5.

TSF 3 tailings-solids are also expected to be NAF, though strongly gypsiferous (Total-S ca. 10 %), due to neutralisation of the acidic raffinate with calcite. Radionuclide levels (31 Bq/g) are in excess of expected thresholds and are not water soluble. The pH will be 6.6. At this pH, Chromium, Manganese, Nickel and Zinc are likely to occur at toxic levels to freshwater ecosystems.

Table 3 Chemical composition of TSF 1, 2 and 3 tailings pore water from leach test results (ANSTO 2017). Exceedances of trigger values (99% protection level) from the water quality guidelines (ANZECC & ARMCANZ 2000) for metal toxicants to freshwater ecosystems are shown in blue.

Element	Liquor conc. (mg/L) pH 5 acetate leachate			Liquor conc. (mg/L) pH 9.2 borate leachate		
	TSF 1	TSF 2	TSF 3	TSF 1	TSF 2	TSF 3
Ag*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	0.1	<0.1	0.2	0.2	<0.1	0.4
As*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ba	0.79	1.3	0.04	0.21	0.05	0.02
Be	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cd*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Co	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Cr	0.09	0.09	0.05	0.0	0.0	0.0
Cu*	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hg*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mn	1.7	2.3	17	<0.01	<0.01	0.51
Mo	<0.01	<0.01	0.07	0.03	0.04	0.16
Ni	0.05	0.05	3.6	<0.01	<0.01	0.10
Pb*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1
Se*	<0.1	<0.1	<0.1	<0.1	<0.1	<10
Zn	0.12	<0.01	0.10	<0.02	<0.02	0.02

*Analytical methods not sufficiently sensitive to determine concentrations at trigger value range.

Table 4 Source, disposal and general characteristics of tailings streams

Processing source	Physical processing	Chemical properties	Radionuclide concentration	Disposal
Beneficiation				
1. Rougher circuit	Crushed and milled ore, flotation	Trace flotation reagents; pH 10-11.5	<1 Bq/g (head of chain)	TSF 1
2. Cleaner circuit	Crushed and milled ore, flotation	Trace flotation reagents; U and Th; pH 10-11.5	~4 Bq/g (head of chain)	TSF 2
Hydrometallurgical	Acid Heating Water leach Neutralisation and waste removal Thickening	Trace sulphuric acid; U and Th; Iron phosphates Aluminium; Gypsum Metal hydroxides; pH 7-8	~31 Bq/g (head of chain)	TSF 3

2.3.4 Evaporation pond

The liquor in the evaporation pond is predominantly magnesium sulphate with lesser concentrations of calcium and sodium sulphate (Table 5). Radionuclide levels do not exceed the threshold limit of 1 Bq/g.

Analysis of liquor generated by pilot plant hydrometallurgy testing, which will report to the evaporation pond, indicates that there may be some metals that are at levels that exceed water quality trigger levels and may be toxic (ANZECC & MARCANZ 2000). Note that the ANSTO (2017) detection limits are not sufficiently sensitive to provide a clear concentration of many elements other than to indicate they are less than a set concentration. For example, ANSTO report Aluminium (Al) as less than 1, whereas the trigger values for an 80% and 99% level of protection (%species) is 0.150 mg/L and 0.027 mg/L, respectively. Therefore a conservative approach is maintained using the set value of 1 mg/L to make the comparison and ignoring the 'less than' when determining potentially toxic levels of an element.

Table 5 Chemical composition of evaporation pond liquor (ANSTO 2017)

Element	Conc. mg/L	Element	Conc. mg/L
Al*	<1	Na	38
As	<10	P	<1
B	<1	Pb	<1
Be	<1	S	13,004
Bi	<1	Sb	<2
Ca	521	Se	<10
Cd	<1	Si	40
Co	3	Th	<1
Cr	<1	U	<1
Cu	<2	Zn	9
F	5	pH	7.04
Mg	6,721	ORP**(mV)	172
Mn	356	SG^	1.036
Mo	<1		

Blue shading: Exceeds trigger values for fresh water in the Australian Drinking Water Guidelines (NHRMC and MARCANZ 2011)

**ORP – Oxidation/reduction potential

^SG – specific gravity

3. Exposure Pathways

The following reports inform this section:

- JDA and Associates (2016) Surface water assessment
- Global Groundwater (2016) Conceptual hydrogeology
- GRM (2016) Hydrogeological investigation
- Pacific Environment (2016) Air quality assessment
- ATC Williams (2017a) TSF geotechnical assessment
- ATC Williams (2017b) TSF design report

3.1 Surface water

The Proposal is located within the Gascoyne River catchment. Two tributaries of the Lyons River, Yangibana Creek and Fraser's Creek, occur within or in the near vicinity of the proposed development envelope. Both creeks are ephemeral and only flow following heavy rainfall events.

The Lyons River hydrological model was developed to generate flow hydrographs for a detailed hydrodynamic model of the Fraser Creek and Yangibana Creek catchments. This detailed model assessed flood conditions that are likely to impact on proposed mine infrastructure of the Project during operations and post closure. The findings have been used to determine where surface water management structures are required or inform the location of infrastructure to reduce cost of management and maintenance, and reduce the potential for environmental impacts.

During heavy rainfall events, surface water has the potential to carry potential contaminants away from their source if they are not contained.

3.1.1 Final pit void

Surface discharge from brackish-hyper-saline pit water is unlikely. Low rainfall and high evaporation rates means that there is a net evaporation. The location of the pits are at the top of the catchment and thus no rivers, creeks or drainage channels have the potential to fill the pit voids during heavy rainfall events and thus they will not overtop.

Access to the pit void for vertebrate fauna can be allowed or prevented. Apart from becoming saline with time, the pit void may initially be a water source for fauna.

3.1.2 Tailings storage facilities

All three TSFs will be exposed to heavy rainfall events. TSF 1, which is geochemically benign, will shed water. The water from TSF 1 will be collected in a water pond at the toe of the TSF and reused in the processing plant. The water pond at the toe of the facility has been designed to contain water from a 1 in 100 year ARI rainfall event.

TSF 2 and 3 are paddock style landforms, which will contain any rainfall that falls on them. The TSFs will have adequate freeboard to ensure that water from a 1 in 100 year ARI rainfall event is contained and will not overtop. At closure, these facilities will be covered with a clay layer to contain the tailings and ensure water is shed from the facility during heavy rainfall events.

3.2 Groundwater

3.2.1 Final pit void

Contamination of regional groundwater is unlikely because:

- The water level within the pits remains below the groundwater level (even after heavy rainfall events);
- high evaporation rates ensure the pit lake remains a groundwater sink;
- the pit void is surrounded by fresh granite, which ensures water is confined to the pit void i.e. no connectivity to other aquifers.

3.2.2 Tailings storage facilities

It is widely acknowledged that all TSFs seep to some degree.

TSF 1, which is geochemically benign, is a central thickened discharge facility, which means that it will shed water from its surface (as opposed to retaining water within the tailings). The water is then collected at the toe of the facility and stored in a pond, where it is then pumped back to the processing plant for reuse.

Given the presence of radionuclides in the tailings materials of TSF 2 and 3 and the evaporation pond, containment has from prefeasibility, been incorporated into the engineering design of the facilities. TSF 2 and 3 will not seep due to liner and cover systems in their design. At closure the tailings will be allowed to dry and consolidate. A clay and waste rock cover will then be placed over the TSFs to ensure that rainfall is shed and tailings are contained.

Regardless, a geotechnical assessment was conducted to determine potential for seepage. Fresh granite, which is impermeable to water (and any water soluble contaminants) occurs below the TSFs. Groundwater occurs at 40m BGL and is confined (also confirming the lack of permeability of the overlying fresh granite). Therefore vertical seepage is unlikely to occur.

Lateral seepage has also been considered. Lateral seepage often occurs where porous materials overlay a continuous impervious material such as fresh granite. It is widely acknowledged that there may be some localised variation of parameters that were not detected in the sampling regime of the geotechnical study. Therefore lateral seepage may occur and contingency measures during construction and operations need to be identified for implementation if required.

To reduce the potential for lateral seepage beneath the TSF embankment, the design allows for excavation of a cut-off trench to the upstream toe to penetrate the superficial deposits and residual soils to a nominal depth of 1.5 m or excavator refusal in highly to moderately weathered rock. The excavated trench will be backfilled with compacted clayey sand material.

3.3 Dust

Mining activities, by their very nature, cause fugitive dust emissions through the movement of vehicles on unsealed roads, blasting, mining activities including movement of ore at the ROM pad and disposal of waste rock, and crushing of ore at the processing plant. Pacific Environment (2016) conducted an air quality assessment and dust modelling. Using this information, Jim Hondros then determined the exposure levels for flora and fauna using a level 2 ERICA assessment. The outcomes from the assessments show that exposure limits from radioactive dust are not exceeded. However, mitigation will be implemented to ensure fugitive dust is as low as reasonably achievable (ALARA).

4. Sensitive Environmental Receptors

The following reports inform this section:

- Ecoscape (2015) Flora and vegetation assessment
- Ecoscape (2016) Fauna assessment
- Ecoscape (2016) Subterranean fauna assessment
- Bennelongia (2016) Subterranean fauna assessment
- EcoLogical Australia (2017) Flora and fauna assessment

4.1 Conservation Significant Fauna

4.1.1 Vertebrate Fauna

A total of 134 vertebrate fauna species, were recorded in the study area (55,625 Ha) over the two phases of assessment, which consisted of 20 species of mammal (12 species of non-volant mammals, eight species of bat), 85 species of bird, 25 species of reptile and four species of amphibian. No threatened fauna species listed under the EPBC Act were found within the study area.

One species of conservation significance was recorded in the study area:

- *Sminthopsis longicaudata* (Long-tailed Dunnart; listed as a Priority 4 species by DPaW).

The Long-tailed Dunnart, which typically occurs in rocky areas such mesas and breakaways, was found on the rocky plain habitat type.

In addition, *Falco hypoleuca* (Grey Falcon; listed as a Schedule 1 species under the WC Act and Vulnerable under the EPBC Act) was recorded 3.5 km south of the study area in near proximity to the proposed southern access road.

Two migratory bird species (listed as Schedule 5 species under the WC Act) were recorded within the study area i.e. the rainbow bee eater and the eastern great egret.

The major river habitat type harbours a variety of fauna species after the occurrence of rainfall events and has the potential to support a number of conservation significant species such as breeding sites for Grey Falcons and foraging habitat for migratory bird species.

4.1.2 Short Range Endemic (SRE) Fauna

No SRE fauna were found in the study area. Thirteen species of potential SRE fauna were recorded in the study area: Three spiders, two scorpions, three pseudoscorpions, four isopods and one tropical centipede. Minor creeklines and major rivers are the most suitable habitats for invertebrate SRE fauna due to the increased moisture and shade provided by shrubs and small trees associated with surface drainage, creeks and rivers.

4.1.3 Subterranean fauna

The project area occurs within the DPaW listed Gifford Creek Priority Ecological Community (Priority 1; PEC):

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

Habitat analysis indicated that there is no obvious link between the preferred calcrete habitats of stygofauna as found in the PEC (Figure 4) and the occurrence of subterranean fauna within the Proposal area. Geological drill logs and datasets have shown that calcrete is not present within the mineral exploration areas of the Proposal, indicating that subterranean fauna habitat is not typical of that recorded from PEC calcrete areas, although it may overlap and be representative of that on the fringes of the Gifford Creek PEC.

4.2 Conservation significant wetlands

No internationally recognised wetlands occur within the study area. In fact, no RAMSAR listed wetlands occur in the Upper Gascoyne Region of Western Australia. The nearest nationally significant wetland is Lake MacLeod, which is approximately 270km west of the proposal area.

4.3 Lyons River

The Lyons River and associated creeks are of cultural heritage significance to the Traditional Owners. In addition, groundwater dependent ecosystems (GDE; Figure 5) and ephemeral pools provide an important source of water to migratory birds and other species, which are closely associated with the ecological values of the Lyons River ecosystem.

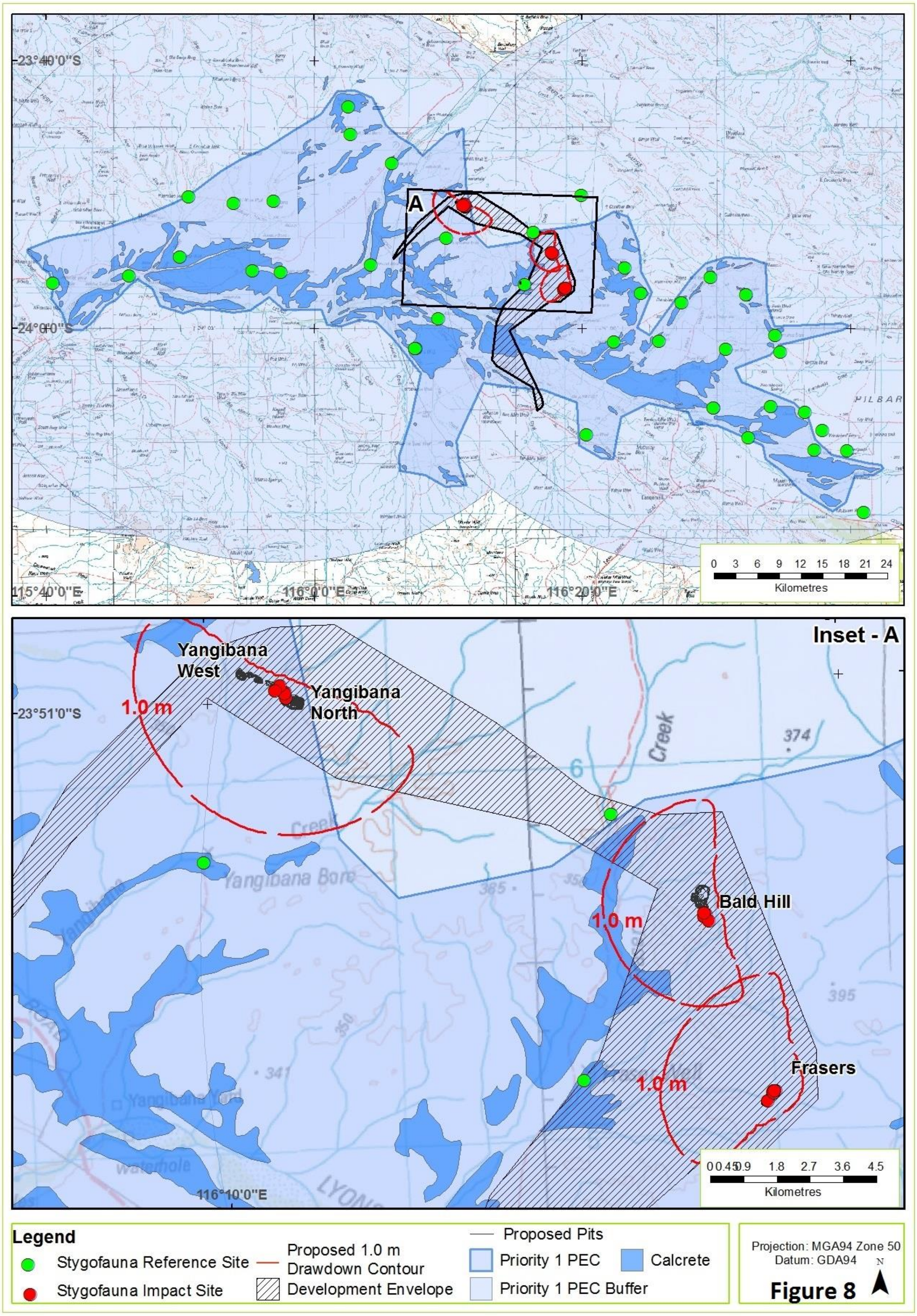


Figure 4 Gifford Creek Priority Ecological Community (PEC) habitat relative to the Frasers, Bald Hill and Yangibana pit areas.

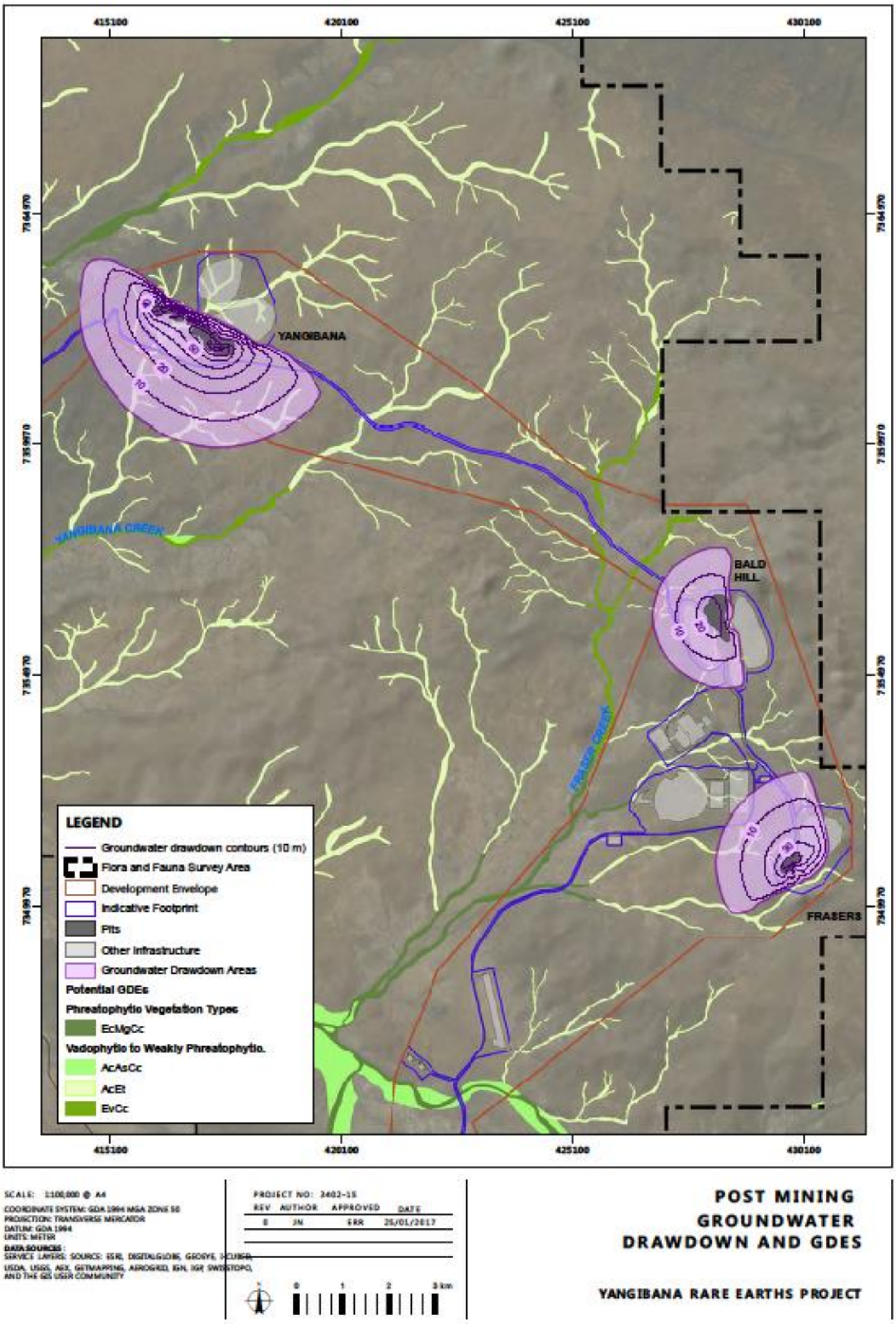


Figure 5 Potential Groundwater Dependent Ecosystems (GDEs) relative to Project mine and infrastructure areas.

5. Environmental Risk Assessment

5.1 Risk approach

The risk assessment 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 sensitive receptors. 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.

The risk assessment considers the likelihood of the event occurring and the consequence of it occurring. The risk severity is then determined using the risk and consequence matrix.

5.2 Risk pathways

Sources of contamination, exposure pathways and sensitive receptors were considered in this assessment and summarised in Table 6.

Table 6 Summary of sources of contamination, exposure pathways and sensitive receptors

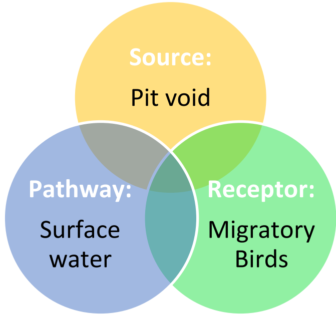
Sources of Contamination	Exposure Pathways	Sensitive Receptors
Pit void (saline)	Groundwater	Gifford Creek PEC calcrete aquifers
Processing plant (elevated radionuclides)	Surface Water	Lyons River and assoc. GDE (fauna habitat)
Tailings Storage Facilities (TSF 2 and 3 and evaporation pond with elevated radionuclides)	Dust	Migratory Birds

Where a source of contamination, exposure pathway and sensitive receptor have the potential to interact, the following potential scenarios' are identified and considered further to determine the level of risk:

- Scenario 1: Migratory birds may be attracted to saline pit void lakes.
- Scenario 2: Chemical spills around the processing plant may be carried to the Lyon's River during heavy rainfall events.
- Scenario 3: Ore or concentrate spills at the process plant may result in dust containing radionuclides.
- Scenario 4: Seepage from TSF 2 and 3.
- Scenario 5: Overtopping of TSF 2 and 3 during extreme rainfall events.
- Scenario 6: Migratory birds may be attracted to the evaporation pond.

Where a 'high' risk is identified, further consideration is then given to the ecotoxicity of the contaminant to the sensitive receptor and management actions to be implemented to mitigate the risk.

5.3 Risk assessment



Scenario 1: *Migratory birds may be attracted to saline pit void lake*

Potential impact: *Loss of migratory birds from consuming water from the pit void lake*

The following assumptions and considerations are made during this assessment:

- The pit lake water quality at closure will be brackish increasing to hyper-saline with time.
- Materials characterisation indicates the geochemical characteristics of the surrounding rock will be benign.
- The pit lake will serve as a groundwater sink and water levels will remain below the groundwater level (even after heavy rainfall events).
- There is no risk of contamination of groundwater or surface water systems.
- The exposure pathway is via the expression of water within the pit void.
- Migratory birds may be attracted to the water in the lake.

Two migratory birds, while not listed as conservation significant, have been recorded within the Project area:

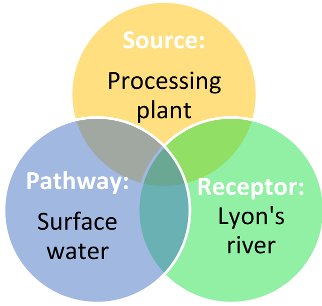
- Rainbow bee-eater
- Eastern great egret

While the birds may sample the water, they are unlikely to continue returning to the pit lake after the first visit. The increasing salinity levels will likely result in a sterile environment, with no plant or animal life residing within the pit lake. This is typical of pit lakes in the arid zone of Australia.

Therefore, it can be concluded that the risk of impact to migratory bird species is considered to be low.

Risk pathway	Likelihood	Consequence	Risk rating	Certainty
Migratory birds may be attracted to saline pit void lake	Unlikely	Minor	Low	High

Scenario 2: *Chemical spills around the processing plant may be carried to the Lyon's River during heavy rainfall events.*



Potential impacts: *Alteration or disturbance to the Lyon's River ecosystem from chemical spills*

The following assumptions and considerations are made during this assessment:

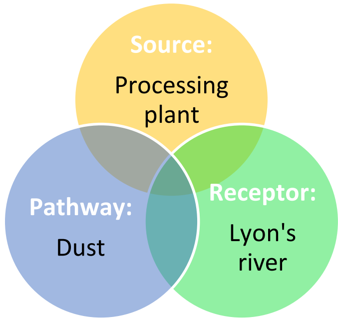
- Chemicals will be stored and used at the processing plant.
- Storage and handling of chemicals must be in accordance with relevant laws, regulations, standards and guidelines, which include but are not limited to:
    - *Dangerous Goods Safety Act 2004* (WA)
    - Dangerous Goods Safety (General) Regulations 2007 (WA)
    - Department of Mines and Petroleum 2010. Storage and handling of dangerous goods — code of practice (2nd edition): Resources Safety, Department of Mines and Petroleum, Western Australia, 111 pp.
    - Australian Standard AS 1940:2004 The storage and handling of flammable and combustible liquids
    - Australian Standard AS/NZS 3833:2007 The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers for mixed classes
    - AS/NZS 4452:1997 The storage and handling of toxic substances
- Spills are likely to be contained within facilities with secondary containment bunds.
- Spills are likely to be minor and cleaned up as per safe work instructions for spill response.
- Heavy rainfall events occur in this region from cyclonic or winter rainfall resulting in significant surface water over short periods of time.
- The process plant is located outside of the flood zone.
- The movement of surface water downstream from the process plant will congregate at the Lyon's river.
- The Lyon's river ecosystem is considered to be important fauna habitat.

Due to strict laws and regulations associated with the containment and storage of chemicals used at the processing plant, it is unlikely that there will be a spill of significant magnitude to have any impact on the Lyon's river habitat.

Therefore, it can be concluded that the risk of impact to the Lyon's River habitat is considered to be low.

Risk pathway	Likelihood	Consequence	Risk rating	Certainty
Chemical spills around the processing plant may be carried to the Lyon's River during heavy rainfall events.	Possible	Insignificant	Low	High

Scenario 3: *Ore or concentrate spills at the process plant may result in dust containing radionuclides*



Potential impact: *Alteration or disturbance to the Lyon's River ecosystem from radioactive dust*

The following assumptions and considerations are made during this assessment:

- The ore feed will be slightly radioactive (~2Bq/g) and dust may occur around the ROM pad.
- The concentration of the concentrate as it moves through the process plant will become more radioactive following the beneficiation process.
- The process is a 'wet' process and thus the concentrate will be moist or wet as it moves through the process plant.
- Dust may occur around the area of concentrate handling where the concentrate is exposed to atmosphere. A dust collector or dust control system will form a component of the detailed engineering design in the processing plant.
- Spills from conveyor belts may dry out if they are not cleaned up immediately.
- Dust containing radionuclides has the potential to settle on vegetation and be consumed by fauna.
- Dispersion modelling from generation of dust during mining taking account of mining activities, weather conditions, wind direction and velocity has been completed.
- A level 2 ERICA assessment, taking account of dust dispersion modelling, has determined that plants or animals will not be exposed to doses that exceed a threshold limit.
- Hastings is committed to application of the ALARA principle (As Low As Reasonably Achievable; reflected in the Radiation Management Plan and Radiation Waste Management Plan) despite exposure doses to humans, flora and fauna shown to be below threshold limits (JRHC 2016).

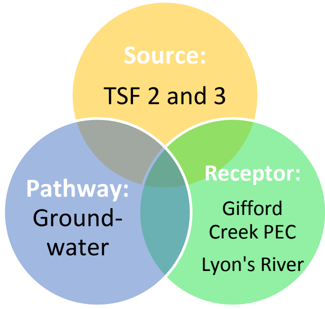
Radioactive dust has the potential to become airborne under windy conditions, and may settle on the surrounding vegetation of the Lyon's river and associated drainage system. Concentrations are likely to be low as spills will be minor and the company will implement spill response procedures (as is standard industry practice for all toxic substances).

Therefore, it can be concluded that the risk of impact to the Lyon's river habitat is considered to be low.

Risk pathway	Likelihood	Consequence	Risk rating	Certainty
Ore or concentrate spills at the process plant may result in dust containing radionuclides	Possible	Insignificant	Low	High

Scenario 4: *Seepage from TSF 2 and 3*

Potential impact: *Alteration or disturbance to the Gifford Creek PEC or Lyon's River habitat or ecosystem*



The following assumptions and considerations are made during this assessment:

- Tailings within TSF 2 and 3 contain radionuclides at ~ 4 Bq/g and 31 Bq/g, respectively.
- Radionuclides are strongly tied to the tailings solids in all TSFs and are not water soluble.
- Geotechnical studies show the granite basement below the TSFs is impermeable and thus vertical seepage will not occur.
- Lateral seepage will occur, however, it will not extend beyond the toe of the Return Water Pond (ATC Williams 2017b).
- The TSF design report includes a containment measure for any lateral seepage and involves a compacted clayey sand trench to prevent downstream lateral seepage beyond the TSF 1 embankment.
- TSF 2 will have a compacted clayey sand liner system to impound the tailings.
- TSF 3 will have a double liner system to contain the tailings reducing the likelihood of significant seepage occurring.
- There are records of elevated levels of naturally occurring radionuclides in water sampled from pastoral bores, some located in calcrete aquifers (i.e. habitat of stygofauna).

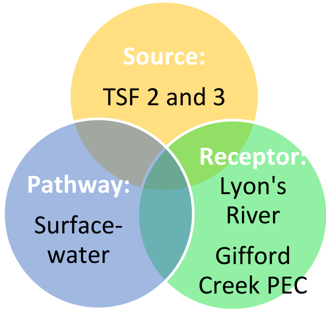
TSF 2 or 3 pore water will not contain toxic levels of radionuclides. The TSF designs ensure pore water is unlikely to seep into groundwater due to the liner systems, which are designed to contain the tailings materials. As a result tailings pore water will not enter the groundwater exposure pathway. Thus if over time pore water does contain elevated radionuclides, it is unlikely to reach sensitive environmental receptors i.e. Gifford Creek PEC calcretes or the Lyon's River.

Therefore, due to the TSF designs and assuming TSFs are constructed in accordance with design specifications, it can be concluded that the risk of impact to the Gifford Creek PEC and Lyon's river habitat as a result of tailings seepage from TSF 2 and 3 is considered to be low.

Risk pathway	Likelihood	Consequence	Risk rating	Certainty
Seepage from TSF 2 and 3	Unlikely	Minor	Low	Moderate

Scenario 5: *Overtopping of TSF 2 and 3 and evaporation pond*

Potential impact: *Alteration or disturbance to the Gifford Creek PEC or Lyon's River habitat or ecosystem*



The following assumptions and considerations are made during this assessment:

- Surface hydrology modelling has determined flow velocities and surface water depth under worst case scenario's.
- 'Worst case' rainfall events will increase the pore water stored within the TSFs.
- Landform evolution modelling has provided specifications to ensure landform stability over a 1000 year period.
- TSF 2 and 3 tailings will be of neutral pH, are not acid forming and test work has demonstrated that solution and mobilisation of dissolved metals (including radionuclides) from the tailings deposit are not expected as a result of infiltration.
- TSF 2 and 3 pore water may contain some metals at toxic levels.
- Evaporation pond waters contain heavy metals and salts at levels that may be toxic to sensitive receptors.
- TSF 2, 3 and evaporation pond design provides containment and contingency freeboard for extreme storm events (1:100 ARI, 72 hr rainfall).
- Surface water moves down gradient and flows into the nearby drainage channels, into the creeks and into the Lyon's River.
- The Lyon's River and associated creeks will recharge the calcrete aquifers of the Gifford Creek PEC.

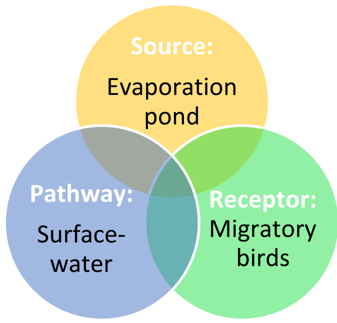
Due to 'worst case' rainfall events and hydrology modelling being incorporated into the TSF design considerations, it is unlikely that TSF 2 and 3 will overtop from extreme rainfall events. Adequate freeboard has been incorporated into the TSF design in accordance with ANCOLD and DMIRS tailings storage facility design guidelines. As a result tailings or tailings pore water will not be released into the surrounding environment as a result of extreme rainfall events.

Therefore, it can be concluded that the risk of impact to the Gifford Creek PEC and Lyon's river habitat as a result of the overtopping of tailings from TSF 2 and 3 is considered to be low.

Risk pathway	Likelihood	Consequence	Risk rating	Certainty
Overtopping of TSF 2 and 3	Unlikely	Moderate	Low	Moderate

Scenario 6: *Migratory birds may be attracted to the evaporation pond.*

Potential impact: *Loss of migratory birds from consuming water from the evaporation pond*



The following assumptions and considerations are made during this assessment:

- The evaporation pond will not contain liquor with elevated levels of radionuclides.
- A number of measured parameters exceed ANZECC & MARCANZ (2011) trigger levels for toxicity to fresh water ecosystems.
- The evaporation pond will likely be a sterile environment due to high salinity (i.e. magnesium sulphate).
- Migratory birds or other conservation significant fauna will likely be attracted to the evaporation pond as a source of water.
- Heavy metals, such as Lead, Zinc, Iron and Selenium, are commonly known to be toxic to birds.

Due to the toxic nature of the water within the evaporation pond, and that it will likely attract birds as a drinking water source, it is considered to have a high inherent risk.

Risk pathway	Likelihood	Consequence	Risk rating	Certainty
Migratory birds may be attracted to the evaporation pond	Likely	Moderate	High	High

6. Mitigation of Risk

The purpose of this section is to identify management actions that reduce the risk of ecotoxicity to acceptable levels.

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

- Inherent risks that are evaluated as having a 'extreme', 'high' or 'moderate' risk severity;
- Mitigation of risk; and
- Assessment of residual risk.

When mitigating inherent risk, treatment measures have been evaluated using the hierarchy of controls, as recommended by DMIRS (prev. 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.

Consideration of one scenario, taking account source of contamination, exposure pathway and sensitive receptors, with a high inherent risk of ecotoxicity:

Scenario 6: Migratory birds may be attracted to the evaporation pond.

Inherent risk: High

Level of certainty: High

Mitigation hierarchy:

The risk cannot be eliminated nor substituted with a different activity.

The following mitigation actions shall be implemented:

- Waste characterisation upon start of operations will verify characterisation studies conducted on pilot plant samples.
- Fencing will be constructed around the evaporation pond to deter fauna.
- Bird deterrent structures (e.g. netting, motion sensors setting off a loud noise) will be trialled to determine their effectiveness.

The effectiveness of the mitigation actions will be monitored: An inspection of the facility for evidence of bird presence and the integrity of the controls should be conducted on a weekly basis.

The management actions, monitoring and review will form a component of the *Preliminary Terrestrial Fauna Environmental Management Plan*.

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Appendix A: Groundwater quality at pastoral and project bores

Analyte (mg/L)	Minga Well	Edmund HST Bore	Contessis Bore	Edmund Well	Fraser Well	Fraser Well	Yangibana Bore	Woodsys Bore	Red Hill 2	YGBWB1 *	Bald Hill RC081 *	Windmill Bore	Bald Hill Bore	FRW03 *	BHW05 *	YGWB03 *	Australian Drinking Water Guideline
Sample Date	Jun-15	Jun-15	Jun-15	Jun-15	Jun-15	Oct-16	Jun-15	Jun-15	Jun-15	Jun-15	Jun-15	Oct-16	Oct-16	Nov-16	Dec-16	Dec-16	
Chloride	110	270	95	810	570	510	530	590	710	240	410	460	320	380	330	250	250
Sulphate	110	330	45	320	160	170	180	250	830	73	100	360	110	160	100	89	250
Nitrate	6.5	8.97	0.05	17	12	11	18	12.98	<0.01	11	21	15	17	9.1	65	63	50
Sodium	150	280	70	610	550	420	350	380	620	150	340	280	240	230	240	180	180
Potassium	-	-	-	-	-	9.1	-	-	-	-	-	15	11	9.5	9.0	7.5	-
Calcium	39	66	30	79	47	53	120	110	250	61	60	160	86	72	81	85	-
Magnesium	58	90	48	100	40	41	75	110	130	38	43	88	52	67	51	44	-
Fluoride	2.3	1.4	2.5	2.9	3	-	2.2	1.3	4	2.1	3	-	-	-	-	-	1.5
Silica	36	32	30	23	24	-	23	26	31	24	20	-	-	52	72	91	-
Iron	<0.01	0.07	<0.01	<0.01	<0.01	0.84	<0.01	<0.01	0.19	<0.01	0.26	<0.01	0.19	0.073	0.009	0.005	0.3
Aluminium	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.8	<0.1	<0.1	<0.005	<0.005	<0.005	0.2
Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	0.03
Arsenic	0.002	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	0.001	<0.001	-	-	-	0.01
Barium	0.04	0.02	0.16	0.04	0.04	-	0.03	0.03	0.07	0.23	0.08	-	-	-	-	-	2
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	4
Boron	0.5	1	0.26	1.4	0.83	-	0.55	0.8	2.1	0.36	0.61	-	-				4
Cadmium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	0.002
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	0.05
Copper	<0.01	<0.01	0.02	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	2
Cobalt	<0.01	<0.01	0.02	0.04	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	
Lead	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	0.01
Manganese	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	0.87	0.07	0.01	-	-	<0.001	<0.001	<0.001	0.5
Molybdenum	0.01	<0.01	0.01	0.01	0.02	-	<0.01	<0.01	0.01	0.03	0.02	-	-	-	-	-	0.05
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	0.02

Analyte (mg/L)	Minga Well	Edmund HST Bore	Contessis Bore	Edmund Well	Fraser Well	Fraser Well	Yangibana Bore	Woodsys Bore	Red Hill 2	YGBWB1 *	Bald Hill RC081 *	Windmill Bore	Bald Hill Bore	FRW03 *	BHW05 *	YGWB03 *	Australian Drinking Water Guideline
Sample Date	Jun-15	Jun-15	Jun-15	Jun-15	Jun-15	Oct-16	Jun-15	Jun-15	Jun-15	Jun-15	Jun-15	Oct-16	Oct-16	Nov-16	Dec-16	Dec-16	
Selenium	0.003	0.007	<0.001	0.003	0.005	0.005	0.005	0.003	<0.001	0.005	0.008	0.009	0.009	0.004	0.007	0.006	0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	0.1
Strontium	0.41	0.76	0.3	1.1	0.52	-	0.92	0.82	2.2	0.52	0.58	-	-	-	-	-	-
Thorium	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	-	-	-	-
Tin	<0.01	<0.01	0.02	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-
Titanium	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	0.02	-	-	-	-	-	-
Uranium	0.004	0.004	0.02	0.038	0.025	0.029	0.029	0.009	0.079	0.016	0.014	0.038	0.029	-	-	-	0.017
Vanadium	0.05	0.04	<0.01	0.03	<0.01	-	<0.01	0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-
Zinc	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	-	-	-	3
TDS	920	1400	600	2200	1600	1400	1600	1800	2800	870	1300	1600	980	1200	1000	920	600

Notes: Shading indicates analytes exceeding Australian Drinking Water Guidelines (NHRMC 2011)

* denotes Project related production bore / drill hole

TDS – Total Dissolved Solids