Decision Document

Environmental Protection Act 1986, Part V

Proponent: Northern Minerals Limited

Licence: L9009/2016/1

Registered office:	Level 1, 675 Murray Street WEST PERTH WA 6005
ACN:	119 966 353
Premises address:	Browns Range Rare Earths Project Mining Tenement M80/627 STURT CREEK WA 6770
Issue date:	Wednesday, 11 July 2018
Commencement date:	Wednesday, 11 July 2018
Expiry date:	Monday, 10 July 2034

Decision

Based on the assessment detailed in this document the Department of Water and Environmental Regulation (DWER), has decided to issue a licence. DWER considers that in reaching this decision, it has taken into account all relevant considerations.

Decision Document prepared by:	Haley Brunel/Sonya Poor Licensing Officer
Decision Document authorised by:	Alana Kidd Delegated Officer

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1 Purpose of this Document

This decision document explains how DWER has assessed and determined the application and provides a record of DWER's decision-making process and how relevant factors have been taken into account. Stakeholders should note that this document is limited to DWER's assessment and decision making under Part V of the *Environmental Protection Act 1986.* Other approvals may be required for the proposal, and it is the proponent's responsibility to ensure they have all relevant approvals for their Premises.

2 Administrative summary

Administrative details		
Application type	Works Approval ☐ New Licence ☒ Licence amendment ☐ Works Approval amendment ☐	
Activities that cause the premises to become prescribed premises	**Category number(s)**	**Assessed design capacity**
	5	80,000 tonnes per annual period
	89	499 tonnes per annual period
Application verified Application fee paid	Date: 3 November 2016 Date: 10 November 2016	
Works Approval has been complied with Compliance Certificate received	Yes☒ No☐ N/A☐ Yes☒ No☐ N/A☐	
Commercial-in-confidence claim	Yes☒ No☐	
Commercial-in-confidence claim outcome	Accepted	
Is the proposal a Major Resource Project?	Yes☐ No☒	

Was the proposal referred to the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986*?	Yes☒ No☐	Referral decision No: Managed under Part V☐ Assessed under Part IV☒
Is the proposal subject to Ministerial Conditions?	Yes☒ No☐	Ministerial statement No: 986 EPA Report No: 1523
Does the proposal involve a discharge of waste into a designated area (as defined in section 57 of the *Environmental Protection Act 1986*)?	Yes☐ No☒ Regulatory Services (Water) consulted Yes ☒ No ☐	
Is the Premises within an Environmental Protection Policy (EPP) Area Yes☐ No☒ If Yes include details of which EPP(s) here.		
Is the Premises subject to any EPP requirements? Yes☐ No☒ If Yes, include details here, eg Site is subject to SO_2 requirements of Kwinana EPP.		

3 Executive summary of proposal and assessment

Northern Minerals Limited (Licensee) operates the Browns Range Rare Earths Project (Premises) located on Mining Tenement M80/627, approximately 160 kilometres (km) south-east of Halls Creek in the Kimberley region of Western Australia (Figure 1). The Premises is adjacent to the Western Australian/Northern Territory border and targets heavy rare earth dominant xenotime mineralisation.

Figure 1: Regional location of the Premises

In 2015, the Licensee decided to adopt a staged approach to the implementation of the project. The first stage is the three year pilot trial involving open cut mining and mineral processing to produce approximately 49,000 kilograms (kg) of dysprosium per year in approximately 590,000 kg of Total

Rare Earth Oxide (TREO). The TREO is transported from the Premises in shipping containers using public roads to either Darwin or the Port of Wyndham for export. It is the Licensee's objective to proceed with the full scale mining and processing facility once the pilot trial is complete (Northern Minerals, 2017b). The Licensee is required to consult and obtain necessary approvals from DWER prior to full scale mining as this has not been assessed. This Licence relates solely to the operation of the first stage of the project, being the pilot plant trial.

The Delegated Officer determined that the pilot plant triggered category 5 (processing or beneficiation of metallic or non-metallic ore) under Schedule 1 of the *Environmental Protection Regulations 1987* (EP Regulations). Construction of the pilot plant was approved by the former Department of Environment Regulation on 13 March 2017 under Works Approval W6007/2016/1. The Licensee submitted compliance documentation for the construction of the pilot plant on 11 April 2018 and a commissioning report on 11 June 2018.

The Premises was assessed by the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act). Ministerial approval for the Premises was issued via Ministerial Statement (MS) 986 on 20 October 2014.

The pilot plant is sized to about 10% of the full scale plant capacity assessed by the EPA under Part IV of the Act. The pilot plant stage is scheduled to last three years with the treatment of ore occurring for approximately 10 months each year depending on the wet season. Operations may cease or be reduced during the wet season (December to March) due to the potential for road access to be restricted, which limits the ability to bring in consumables and reagents. If weather conditions permit, operations may continue throughout the summer months. It is possible that the pilot plant will operate for longer than three years if there are extended wet seasons that limit operations; or if it takes longer than expected to ramp the plant up to the design capacity (80,000 tonnes per annum (tpa)).

On 24 September 2015, Works Approval W5837/2015/1 was issued to the Licensee for the construction of a category 64 landfill and category 85 sewage facility, for full scale operations. The Licensee has advised that the quantity of septic waste generated during the pilot plant trial will not trigger the threshold levels specified for sewage facilities under Schedule 1 and 2 of the EP Regulations.

Registration R2457/2017/1 was issued to the Licensee on 23 October 2017 for a category 89 putrescible landfill at the Premises, with a design capacity of 499 tonnes per year. The category 89 landfill is now operational under this Licence. Registration R2457/2017/1 will be surrendered once this Licence is issued.

The workforce for the Premises operates on a fly-in/fly-out basis and is housed at the onsite accommodation village. The estimated peak operational workforce will be 37 people.

The Premises disturbance footprint encompasses the following key infrastructure:

- open cut mine;
- mine dewatering infrastructure;
- beneficiation processing plant (crushing, grinding, magnetic separation and flotation);
- hydrometallurgical processing plant (sulphation baking, water leaching, ion exchange, precipitation, drying and bagging);
- tailings storage facility (TSF);
- lined evaporation pond for disposal of raffinate;
- power generation (gensets); and
- hydrocarbon and chemical storage areas.

This Licence relates solely to the operation of the first stage of the project, being the pilot plant trial and putrescible landfill. A full description of the prescribed and related activities is provided in Appendix A.

Other activities

Mine dewatering is undertaken at a rate of approximately 130 cubic metres (m^3) per day, which equates to approximately 24,000 m^3 over the course of the three year trial; which is below the production capacity for category 6 as described in Schedule 1 of the EP Regulations. Water from mine dewater is utilised on site for dust suppression.

Power generation is supplied by 3 x 1.25 megawatt diesel generators. The total installed capacity on the Premises (including at the camp) is below the production capacity for category 52 as described in Schedule 1 of the EP Regulations.

The Licensee has advised that bulk storage of chemicals will not trigger category 73 as the volume stored on site during the three year trial will not exceed 1,000 m^3 in aggregate.

Location and siting

The Premises is located at the northern edge of the Tanami Desert lying within the Tanami bioregion (Tanami 1 sub-bioregion). Tanami 1 sub-bioregion consists of red desert sand plains that support mixed shrub steppes and hummock grasslands, as well as hills and ranges that support wattle scrub and hummock grasslands.

Sensitive land uses

The nearest settlement to the Premises is Kundat Djaru (Ringer Soak), approximately 34 km to the west/south-west. The Kundat Djaru community was established in the mid-1980s on land excised from the Gordon Downs pastoral station. The community is managed through the Kundat Djaru Aboriginal Corporation.

The Licensee has advised that the nearest DWER registered bore is located 24 km north-west of the Premises. The Licensee also commissioned a bores census to be undertaken. From this, six unregistered pastoral bores were identified within a nominal 30 km radius of the Premises as shown in Figure 2 (Northern Minerals, 2017a).

In identifying sensitive receptors, DWER has excluded employees, visitors or contractors of the Licensee, as protection of these parties often involves different exposure risks and prevention strategies, provided for under other State legislation.

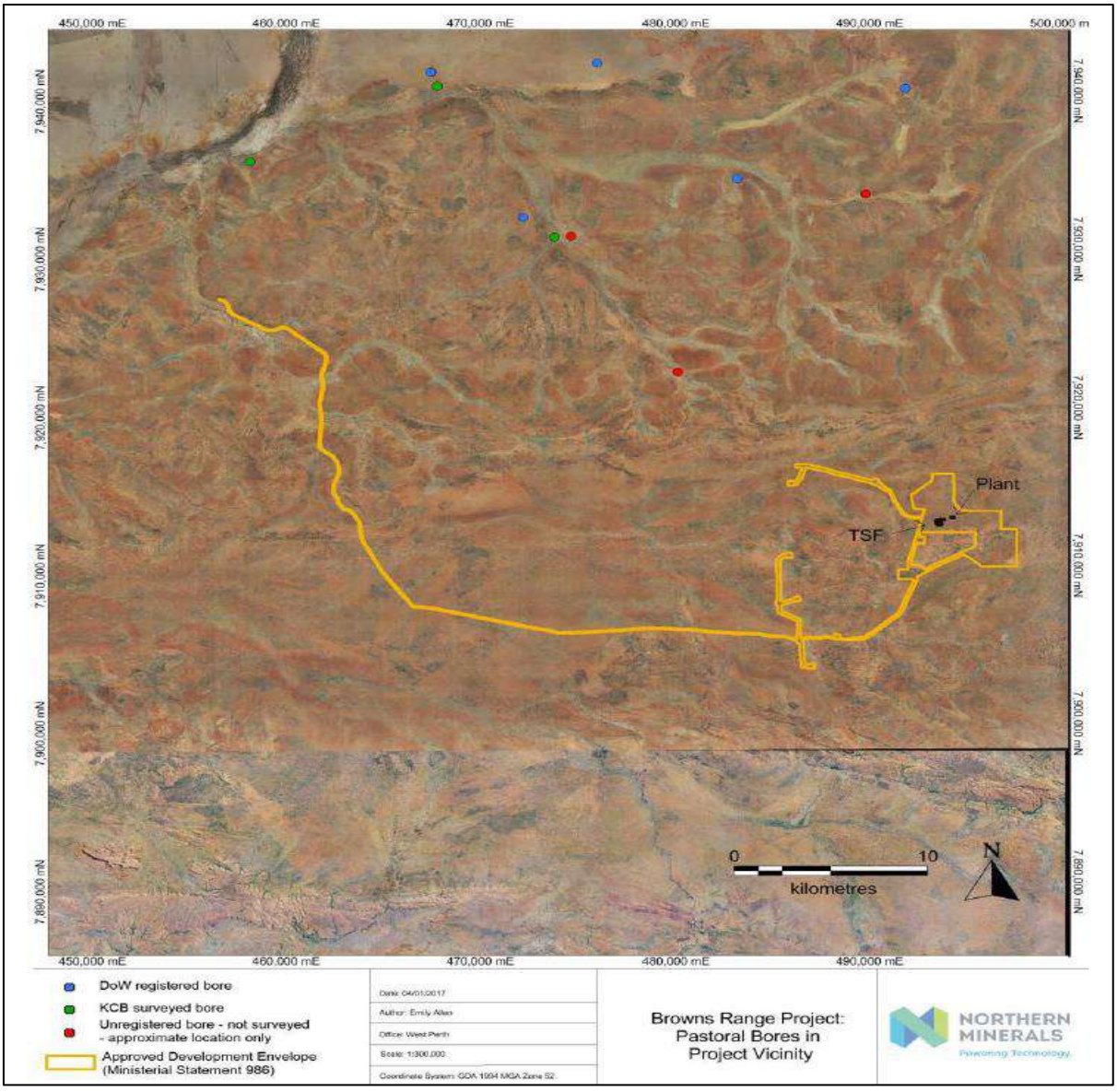

Figure 2: Pastoral bore locations

Specified ecosystems

The Premises is not located within or close to a Public Drinking Water Source Area (PDWSA) or RAMSAR wetland.

The Premises is located in a region that supports a large land and waterbird assemblage. The nearest major waterbodies that support waterbirds are Lake Gregory (200 km south/west), Lake Argyle (250 km north) and Nongra Lake (120 km north/east). Seventy-five waterbird species, including 22 international migratory species have been identified at these water bodies (Report 1523).

Vegetation and flora surveys were conducted within and outside the development envelope in May 2012 and May 2013. No Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) were recorded within the Premises. Vegetation was recorded to be in largely excellent condition. No Declared Rare Flora (DRF) has been identified within the Premises, although 21 species of conservation interest were identified, including 4 Priority-listed species, 2 species

nominated for inclusion as Priority species, 6 species with 'medium' range extensions, 6 species with 'high' range extensions, 2 species not previously recorded in Western Australia and 1 undescribed species (Northern Minerals, 2014).

The Delegated Officer notes that the Licensee amended the development envelope to avoid and minimise impacts to conservation significant flora and vegetation associations (Report 1523).

A baseline fauna study was completed in May 2012 with a subsequent targeted survey carried out in December 2013. Six vertebrate fauna habitats were identified; none being restricted to the development envelope. A total of 16 species of conservation significance were identified by the baseline survey, with 7 of these species known to occur or have occurred in the development envelope:

- Greater Bilby (*Macrotis lagotis*) – Schedule 1 (*Wildlife Conservation Act 1950* (WC Act));
- Major Mitchell's Cockatoo (*Lophochroa leadbeateri*) – Schedule 4 (WC Act);
- Spectacled Hare-wallaby (mainland subspecies) (*Lagorchestes conspicillatus leichardti*) – Priority 3 (DBCA Priority Fauna List);
- Lakeland Downs Mouse (*Leggadina lakedownensis*) – Priority 4 (DBCA Priority Fauna List);
- Bush Stone-curlew (*Burhinus grallarius*) - Priority 4 (DBCA Priority Fauna List);
- Australian Bustard (*Ardeotis australis*) - Priority 4 (DBCA Priority Fauna List); and
- Oriental Plover (*Charadrius veredus*) – Schedule 3 (WC Act).

Short range endemic invertebrate fauna surveys were conducted and the Delegated Officer notes that the Licensee amended the development envelope to also avoid impacting on habitat considered likely to contain short range endemic invertebrate fauna species.

Topography

Topography at the Premises is generally subdued, with an average gradient of about 1%. The Gardiner Sandstone forms the most prominent topographic features in the area, comprising low ridges and undulating terrain. Rocky outcrops of Browns Range Metamorphics are also present, rising approximately 25-30 metres (m) above the surrounding land (Knight Piesold, 2016).

Groundwater and hydrology

The Premises lies within the Sturt Creek catchment, which flows to the southwest, ultimately discharging into Lake Gregory, approximately 220 km downstream of the Premises. Lake Gregory is recognised as a wetland of national importance under criteria 1, 2, 3, 4 and 6 of the *A Directory of Important Wetlands in Australia*.

The main water course of Sturt Creek is located approximately 45 km west/northwest of the Premises and is classified as an ephemeral system. Sturt Creek is classified by DWER as a 'wild river' (a river that is undammed and lies in a largely unmodified catchment with intact biological and hydrological processes).

Groundwater in the area is fresh to slightly brackish, with a near-neutral pH and very low concentrations of dissolved metals. The natural groundwater table is approximately 14 m below ground level (mbgl) (Knight Piesold, 2016).

The Licensee has installed five pairs of shallow and deep monitoring bores in accordance with W6007/2016/1 around the TSF (MB01S/D; MB02S/D and MB03/S) and evaporation pond (MB04S/D and MB05/S) as shown in Figure 3.

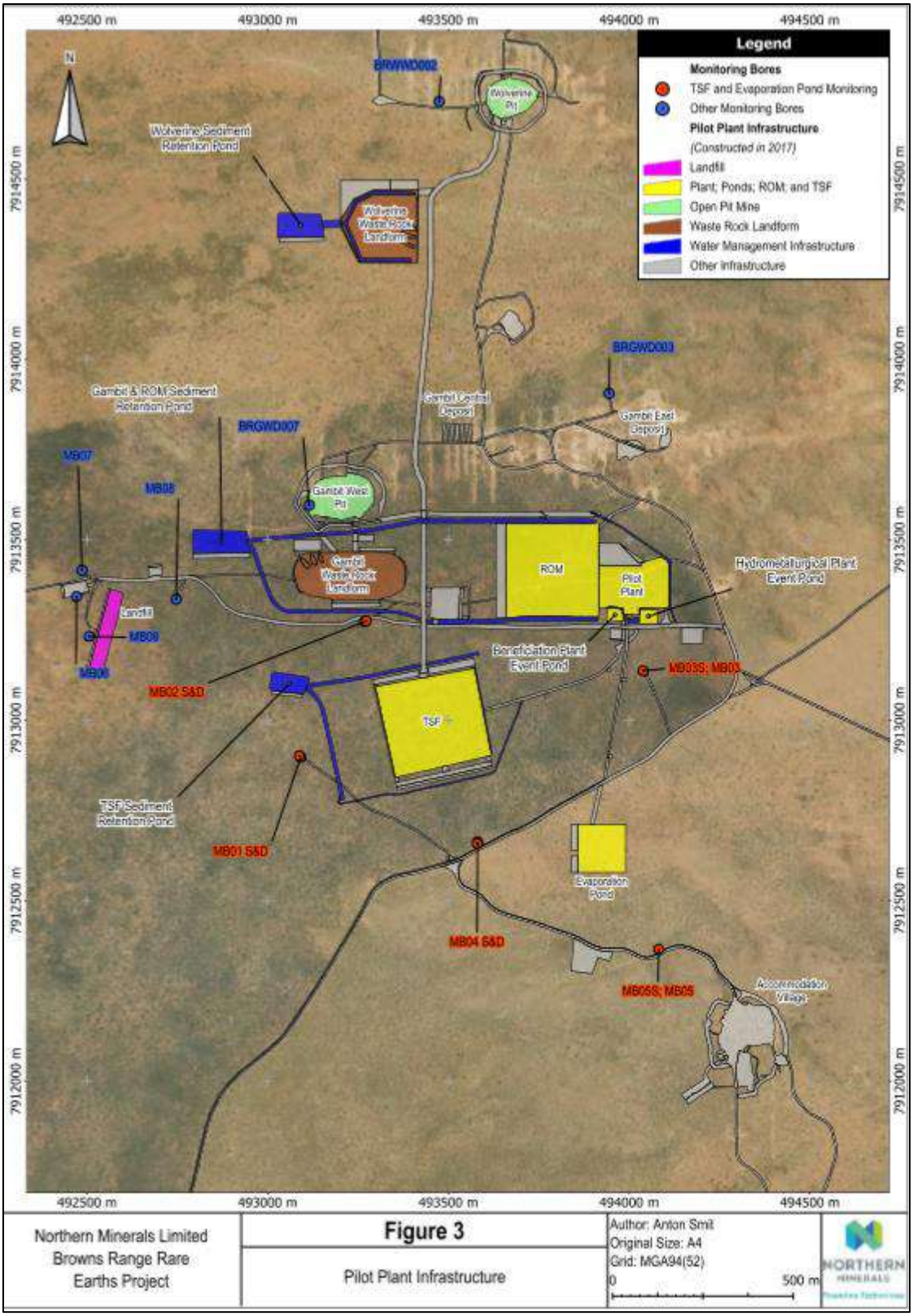

Figure 3: Infrastructure layout and monitoring bore locations

The standing water levels (SWLs) for the TSF and evaporation pond monitoring bores are provided in Table 1 (W6007 Commissioning Report). *W6007 Commissioning Report* states the following:

- *"Rapid changes in SWL in shallow monitoring bores are driven by rainfall recharge and are expected to continue to be observed, with greater variation occurring after heavier wet seasons.*
- *SWLs in shallow monitoring bores when the bores are not dry are significantly higher than in the corresponding deep bore indicating that there is separation between shallow and deep aquifers or that the shallow bores are drilled into perched aquifers that form during the wet season.*
- *Water levels in deep monitoring bores were more constant since measurements began. Around the TSF MB01D shows a declining trend, MB02D little to no change; and MB03 a rising trend. Around the evaporation pond, some variation has been recorded in MB04D and MB05, however this is considered likely to be due to the slow rates of recovery of the bores after airlifting".*

Table 1: SWL in TSF and evaporation pond monitoring bores (mbgl)

Date	MB01S	MB01D	MB02S	MB02D	MB03S	MB03	MB04S	MB04D	MB05S	MB05
18/05/2017	-	-	-	-	4.8	-	-	-	dry	-
25/06/2017	-	-	8.58	15.42	5.02	17.43	dry	16.93	dry	22.15
26/06/2017	9.82	9.96	-	-	-	-	-	-	-	-
20/07/2017	9.82	10.18	9.13	15.41	-	17.4	dry	16.89	11.16	22.2
25/07/2017	-	-	-	-	5.12	-	-	-	-	-
08/08/2017	-	-	-	-	-	-	-	13.77	-	-
11/08/2017	-	-	-	-	5.94	17.38	dry	16.91	11.17	22.22
12/08/2017	-	-	-	-	-	-	dry	21.11	dry	22.51
28/10/2017	dry	11.01	9.88	15.31	10.47	17.34	dry	17.07	dry	27.19
15/11/2017	dry	11.13	10.07	15.33	dry	17.41	dry	19.17	dry	27.22
01/12/2017	dry	11.24	10.07	15.32	dry	17.39	dry	22.95	dry	23.32
11/12/2017	dry	12.44	10.08	15.37	dry	17.43	dry	25.38	dry	25.9
10/02/2018	dry	-	10.09	15.37	5.94	17.51	dry	17.57	dry	27.15
15/02/2018	-	11.54	-	-	-	-	-	-	-	-
02/03/2018	-	-	-	-	-	-	dry	17.32	dry	22.15
03/03/2018	dry	11.44	10.10	15.36	10.49	17.5	-	-	-	-
28/04/2018	dry	11.67	10.10	15.45	dry	17.61	dry	17.8	dry	22.25
Highest	**9.82**	**9.96**	**8.58**	**15.31**	**4.8**	**17.34**	**dry**	**13.77**	**11.16**	**22.15**
Lowest	**dry**	**12.44**	**10.1**	**15.45**	**dry**	**17.61**	**dry**	**25.38**	**dry**	**27.22**
Range	**>0.18**	**2.48**	**1.52**	**0.14**	**>5.7**	**0.27**	**N/A**	**11.61**	**>0.84**	**5.07**

Water quality sampling was undertaken in December 2017 and April 2018. A summary of the water quality results is provided in Table 2. *W6007 Commissioning Report* made the following general observations about baseline groundwater quality in deep monitoring bores at the TSF and evaporation pond:

- Groundwater is fresh to slightly brackish with Total Dissolved Solids (TDS) varying from <500 mg/L in MB02D and MB03 to over 1,000 mg/L in MB01.
- *"Groundwater is circum-neutral to slightly alkaline with all alkalinity present as bicarbonate.*
- *Chloride and bicarbonate are the dominant anions and the sulphate to chloride ratio in groundwater is low (≤0.25).*
- *Groundwater contains trace amounts of dissolved metals that are within drinking water and stockwater guidelines (where available), except for manganese which exceeds drinking water guidelines.*
- *Water quality in shallow monitoring bores is likely to be from rainfall recharge and have a similar or slightly lower TDS than water in deep bores and similar sulphate to chloride ratios".*

Table 2: Baseline water quality summary

Analyte		Units	TSF Bores			Evaporation Pond Bores		Guideline Value		
			MB01D	MB02D	MB03	MB04D	MB05	ADWG – Health[1]	ADWG – Aesthetic[1]	Stock[2]
Field Readings	pH	-	7.09 - 7.95	7.03 - 8.02	7.06 - 8.08	7.1 - 7.37	6.97 - 7.06		6.5-8.5	
	EC	µS/cm	1,707 – 1,838	706 - 706	723 - 735	1,244 – 1,312	1,078 – 1,117			
	Temperature	°C	33.3 - 34.9	33.1 - 35.1	32.5 - 34.6	33.1 - 34.9	33.9 - 35.3			
	Redox Potential	mV	-70.8 to -21.4	-75 to -18.3	-78.6 to -20.1	-35.7 to -21.4	-17.7 to -14.9			
General	pH	-	7.66 - 8.26	7.61 - 8.28	7.56 - 8.17	7.74 - 7.93	7.48 - 7.84		6.5-8.5	
	Electrical Conductivity	µS/cm	1,720 – 1,860	680 - 692	690 - 725	1,190 – 1,380	994 – 1,110			
	Total Dissolved Solids	mg/L	1,120 – 1,210	442 - 450	448 - 471	774 - 897	646 - 722		600 - 1200	4000
	Total Hardness as CaCO3	mg/L	264 - 269	125 - 126	108 - 112	144 - 161	130 - 136		200	
Alkalinity	Hydroxide Alkalinity as CaCO3	mg/L	<1	<1	<1	<1	<1			
	Carbonate Alkalinity as CaCO3	mg/L	<1	<1	<1	<1	<1			
	Bicarbonate Alkalinity as CaCO3	mg/L	307 - 482	224 - 232	208 - 215	392 - 394	275 - 349			
	Total Alkalinity as CaCO3	mg/L	307 - 482	224 - 232	208 - 215	392 - 394	275 - 349			
Anions	Sulphate as SO4 - Turbidimetric	mg/L	1 - 79	16 - 16	8 - 12	2 - 2	9 - 30	c	250	
	Chloride	mg/L	321 - 372	63 - 81	85 - 112	165 - 191	150 - 184	c	250	
	Fluoride	mg/L	0.7 - 0.8	0.4 - 0.5	0.6 - 0.7	0.4 - 0.4	0.8 - 0.8	1.5		2
	SO_4:Cl ratio	-	0.003 - 0.25	0.2 - 0.25	0.07 - 0.14	0.01 - 0.01	0.06 - 0.16			
Cations	Calcium	mg/L	30 - 37	17 - 19	15 - 17	15 - 15	15 - 16			
	Magnesium	mg/L	43 - 46	19 - 20	16 - 18	26 - 30	22 - 24			
	Sodium	mg/L	192 - 197	85 - 88	89 - 90	164 - 176	151 - 154		180	
	Potassium	mg/L	70 - 72	27 - 28	25 - 28	54 - 57	21 - 22			
Ionic Balance	Total Anions	meq/L	16.8 - 20.1	6.58 - 7.25	6.8 - 7.62	12.6 - 13.3	11.3 - 11.4			
	Total Cations	meq/L	15.7 - 16.87	6.91 - 7.03	6.68 - 6.86	11.4 - 12.3	9.71 - 9.98			
	Ionic Balance	%	3.5 - 8.87	1.56 - 2.39	0.42 - 6.62	0.95 - 7.54	6.58 - 7.59			
Dissolved Metals	Aluminium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	c	0.2	5
	Antimony	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.003		
	Arsenic	mg/L	0.003 - 0.005	0.002 - 0.003	0.001 - 0.002	0.005 - 0.008	0.005 - 0.005	0.01		0.5
	Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Barium	mg/L	0.593 - 0.647	0.335 - 0.344	0.537 - 0.96	0.449 - 0.494	0.303 - 0.328	2		
	Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.002		0.01
	Cerium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.05		1
	Cobalt	mg/L	<0.001	<0.001	<0.001	0.002 - 0.003	<0.001			1

Analyte		Units	TSF Bores			Evaporation Pond Bores		Guideline Value		
			MB01D	MB02D	MB03	MB04D	MB05	ADWG – Health[1]	ADWG – Aesthetic[1]	Stock[2]
	Copper	mg/L	<0.001	<0.001 - 0.007	<0.001	<0.001	<0.001	2	1	0.4
	Dysprosium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Erbium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Europium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Gadolinium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Holmium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Lanthanum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.01		0.1
	Lutetium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Manganese	mg/L	0.517 - 0.918	1.44 - 1.51	0.422 - 0.435	0.101 - 0.136	0.849 - 1.04	0.5	0.1	
	Molybdenum	mg/L	0.004 - 0.004	0.001 - 0.002	0.002 - 0.004	0.004 - 0.004	0.002 - 0.003		0.05	0.15
	Neodymium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Nickel	mg/L	<0.001 - 0.003	<0.001 - 0.009	<0.001 - 0.002	0.013 - 0.024	0.002 - 0.004	0.02		1
	Praseodymium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Samarium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.1		
	Terbium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Thorium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Thulium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Tin	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Uranium	mg/L	<0.001	<0.001	<0.001 - 0.001	<0.001	<0.001	0.017		0.2
	Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01			
	Ytterbium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Yttrium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
	Zinc	mg/L	<0.005	<0.005	<0.005	<0.005 - 0.01	<0.005	c	3	20
	Boron	mg/L	0.75 - 0.93	0.41 - 0.5	0.43 - 0.55	0.58 - 0.74	0.41 - 0.47	4		5
	Iron	mg/L	<0.05 - 0.52	0.1 - 1.24	<0.05 - 0.73	0.96 - 3.11	1.59 - 2.32	c	0.3	
	Mercury	µg/L	<0.005	0.0065 - 0.01	0.006 - 0.0065	<0.005	<0.005	1		2
	Selenium	µg/L	<0.2	<0.2	<0.2 - 0.6	<0.2	<0.2	10		20
Nutrients	Ammonia as N	mg/L	0.43 - 18.8	0.02 - 0.26	0.03 - 0.56	0.23 - 0.5	0.2 - 0.27	c	0.5	
	Nitrite as N	mg/L	<0.01	<0.01 - 0.08	<0.01	<0.01	<0.01	3		
	Nitrate as N	mg/L	<0.01 - 0.01	<0.01 - 0.02	0.02 - 1.3	<0.01 - 0.01	<0.01 - 0.01	50		
	Nitrite + Nitrate as N	mg/L	<0.01 - 0.01	<0.01 - 0.1	0.02 - 1.3	<0.01 - 0.01	<0.01 - 0.01			
	Total Kjeldahl Nitrogen as N	mg/L	0.7 - 20.9	<0.5 - 0.2	0.3 - 0.8	0.9 - 1.1	0.6 - 0.8			

Analyte		Units	TSF Bores			Evaporation Pond Bores		Guideline Value		
			MB01D	MB02D	MB03	MB04D	MB05	ADWG – Health[1]	ADWG – Aesthetic[1]	Stock[2]
	Total Nitrogen as N	mg/L	0.7 - 20.9	<0.5 - 0.3	0.8 - 1.6	0.9 - 1.1	0.6 - 0.8			
	Inorganic Nitrogen as N	mg/L	0.44 - 18.8	0.12 - 0.26	0.58 - 1.33	0.24 - 0.5	0.21 - 0.27			
	Total Phosphorus as P	mg/L	0.06 - 0.78	0.13 - 0.34	0.09 - 2.79	0.09 - 0.14	0.06 - 0.07			
	Reactive Phosphorus as P	mg/L	<0.01 - 0.02	<0.01	<0.01	<0.01 - 0.02	<0.01			

Analysis required under Works Approval
Exceeds Drinking Water Aesthetic Guideline
Exceeds Drinking Water Health Guideline

1 Australian Drinking Water Guidelines 2011
2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality Volume 1: The guidelines (ANZECC 2000)

Meteorology
The region experiences an arid subtropical climate within a monsoonal influence. Most of the rainfall occurs during the relatively short wet season between November and March, associated with tropical monsoonal activity and cyclonic activity. Average rainfall is approximately 410 millimetres (mm) and annual average evaporation is approximately 3,000 mm (Knight Piesold, 2016).

Clearing
The clearing of native vegetation is approved under MS 986.

Other approvals
*Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act*)*
The Browns Range Rare Earths Project (full scale) was referred to the Commonwealth Department of the Environment due to the potential presence of species listed as Threatened and/or Migratory under the EPBC Act. On 14 August 2014, the Department of Environment determined that the Project was not a Controlled Action and did not require further assessment.

Part IV of the Act
MS 986 for the Browns Range Rare Earths Project was issued 20 October 2014. The EPA identified rehabilitation and closure, inland waters environmental quality, flora and vegetation and terrestrial fauna as key environmental factors. These factors were evaluated by the EPA in Report 1523. The outcome of the EPA's assessment and recommendation to the Minister was the inclusion of condition 6 in MS 986 relating to the development of a fauna management plan (which was approved by the EPA on 3 April 2017) to reduce impacts to conservation significant fauna during construction and operation of the proposal.

The Delegated Officer has not considered potential impacts to terrestrial vertebrate fauna in the risk assessment for the pilot plant so as to avoid duplication with Part IV of the EP Act.

Rights in Water and Irrigation Act 1914 (RIWI Act)
Pursuant to section 5C of the RIWI Act, the Licensee has been issued GWL177452(5) authorising the abstraction of 292,160 kilolitres (kL) of groundwater for the purposes of mine dewatering; mineral exploration activities; earthworks and construction; mineral ore processing and other mining purposes; and potable water supply.

Mining Act 1978
The Mining Proposal for the pilot plant trial was approved on 5 May 2017 (Reg ID: 64609).

Radiation Management
Mineralisation at the Premises also hosts low levels of uranium and thorium. A Radiation Management Plan (RM/234-181589) has been developed for exploration activities associated with the Premises to address the requirements of the *Mines Safety Inspection Regulations 1995*, the *Radiation Safety Act 1975* and Regulations, the requirements of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) *Code of Practice and Safety Guide on Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA, 2005) The former Department of Mines and Petroleum (DMP) approved the implementation of the plan on 19 May 2015.

The Delegated Officer understands radiation management in relation to the pilot plant was considered in the assessment of the Browns Range Project Management Plan, approved by the Resources Safety Division of DMP on 31 August 2016.

The *Radiation Management Plan* was updated prior to mining and construction and was approved on 1 May 2017.

Radiological Council of Western Australia

The Licensee has registered the Project with the Radiological Council of Western Australian, as premises in which radioactive substances are to be used, stored or manufactured (registration number RS 73/2012 22222). Conditions of this registration include the development of a radiation management plan, and the appointment of a Radiation Safety Officer.

Local Government

The Licensee have sought relevant approvals from the Local Government authority and Department of Health for the operation of a septic system to dispose of septic waste from the ablutions on site.

DWER's assessment and decision making with respect to emissions and discharges associated with the operation of the pilot plant trial and putrescible landfill at the Premises is detailed in section 4 of this document.

4 Decision table

All applications are assessed in line with the EP Act, EP Regulations and *Guidance Statements: Decision Making and Risk Assessments*. Where other references have been used in making the decision they are detailed in the Decision Document.

DECISION TABLE			
Licence section	**Condition number**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
Interpretation	Conditions 1.1.1 – 1.1.4.	Definitions for terms used in the Licence are specified under condition 1.1.1 and 1.1.2. Conditions 1.1.3 and 1.1.4 refers to references made to Australian or other standards and codes of practice meaning the relevant parts and version of that standard, guideline or code of practice.	General provisions of the EP Act.
General conditions	Condition 1.2.1.	The Delegated Officer has applied condition 1.2.1 relating to the immediate recovery or removal of spills of wastewater, process liquors, tailings, hydrocarbons or processing chemicals outside of engineered containment systems (refer to stormwater management in Appendix B). A range of chemicals including sodium silicate, caustic soda (sodium hydroxide), flocculant, sulphuric acid, sodium carbonate, quick lime, ferric sulphate, magnesium oxide and ion exchange resin will be used in the beneficiation and hydrometallurgical processes.	Northern Minerals, 2016. Knight Piesold, 2016. Golder Associates, 2015a.
Premises operation	Conditions 1.3.1 - 1.3.8.	DWER's assessment and decision making for the operation of the TSF, evaporation pond and putrescible landfill is detailed in Appendix B.	General provisions of the EP Act. Golder Associates, 2015a.
Emissions general	N/A.	The Delegated Officer notes that there will be no specified emission points on the Licence, therefore general emissions conditions have not been applied to the Licence.	General provisions of the EP Act.
Point source emissions to air including monitoring	N/A.	Point source air emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO) and particulates are expected from the burning of diesel fuel at the power station. Emissions of SO_x, NO_x, CO, radon, thoron and particulates will occur during ore processing.	National Environment Protection (Ambient Air Quality) Measure. General provisions of the EP Act.

DECISION TABLE			
Licence section	**Condition number**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
		The Delegated Officer acknowledges that radionuclides in airborne dust is regulated by the Department of Mines, Industry Regulation and Safety under the requirements of the *Radiation Management Plan*. The Delegated Officer has noted that the Licensee will be undertaking quarterly monitoring of radon and thoron in air, in accordance with the *Radiation Management Plan*, which also addresses the management of radionuclides in airborne dust. The *Radiation Management Plan* has been developed to address the requirements of the *Mines Safety Inspection Regulations 1995*, the relevant parts of the *WA Radiation Safety Act* and Regulations and the requirements of *ARPANSA, 2005.* Air emissions modelling for particulates (total suspended particles (TSP), PM_{10} and $PM_{2.5}$) for the full scale hydrometallurgical plant has been undertaken to assess potential worst case air quality impacts. The modelling demonstrates that the ambient air criteria are met at the site's accommodation village which is located a few kilometres from the sources of air emissions. As previously noted, the accommodation village is not considered a sensitive receptor by DWER. The Delegated Officer also notes that the modelling was undertaken for the full scale operations, which is considerably larger than the pilot plant subject to this Licence. It can be reasonably assumed that the ambient air quality for the pilot plant, which will be operating at a tenth of the capacity of full operations, will meet the air quality criteria at sensitive receptors. The Delegated Officer notes there are no sensitive receptors within 30 km of the Premises. This distance is considered to be a sufficient separation distance for point source air emissions generated at the Premises, as such a detailed risk assessment has not been undertaken.	Northern Minerals, 2016. Radiation Management Plan. *Guidance Statement*: *Environmental Siting*. ARPANSA, 2005.

DECISION TABLE			
Licence section	**Condition number**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
Point source emissions to surface water including monitoring	N/A.	There will be no point source emissions to surface water during operation of the Premises. No specified conditions relating to point source emissions to surface water are required for the Licence.	General provisions of the EP Act. *Environmental Protection (Unauthorised Discharges) Regulations 2004.*
Point source emissions to groundwater including monitoring	N/A.	There will be no point source emissions to groundwater during operation of the Premises. No specified conditions relating to point source emissions to groundwater are required for the Licence.	General provisions of the EP Act. *Environmental Protection (Unauthorised Discharges) Regulations 2004.*
Emissions to land including monitoring	N/A.	There will be no emissions to land during operation of the Premises. No specified conditions relating to emissions to land are required for the Licence.	General provisions of the EP Act. *Environmental Protection (Unauthorised Discharges) Regulations 2004.*
Fugitive emissions	N/A.	**Operation – Fugitive Dust** The Delegated Officer notes there are no sensitive receptors within 30 km of the Premises. The nearest settlement to the Premises is Kundat Djaru (Ringer Soak), approximately 34 km to the west/southwest. This distance is considered to be a sufficient separation distance for fugitive dust emissions generated at the Premises. <u>Emission description</u> *Emission:* Dust emissions from the handling, storage and processing of ore. Vehicle movements and dust lift off from cleared areas.	General provisions of the EP Act. Radiation Management Plan. ARPANSA, 2005.

DECISION TABLE			
Licence section	**Condition number**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
		Impact: Impacts to vegetation health from dust deposition, impacts to human health from inhalation. *Controls:* There are no human receptors within 30 km of the Premises. The Licensee has advised the following measures are implemented to manage dust: • Water trucks and a sprinkler system are used to suppress dust emissions from stockpiles; • A dust suppression system using raw water and compressed air (to provide suppression mist) is located at the ROM hopper loading point, jaw feed and discharge, grizzly screen undersize discharge as well as the mill re-load hopper discharge; • Sensors are installed to ensure the suppression system only activates during loading and crushing; • Dryers have dedicated baghouses complete with cyclones; and • Water trucks are used to water the haul roads and access roads. The Delegated Officer notes that the management of radionuclides in dust has been addressed in the *Radiation Management Plan*, which has been developed to address the requirements of the *Mines Safety Inspection Regulations 1995*, the relevant parts of the *WA Radiation Safety Act* and Regulations and the requirements of *ARPANSA, 2005*. The Delegated Officer understands radiation management in relation to the pilot plant was considered in the assessment of the *Radiation Management Plan*. <u>Risk Assessment</u> *Consequence*: Fugitive dust will have minimal onsite impacts. Even in areas most impacted by dust it is likely that the natural dust tolerance of vegetation at the Premises will prevent widespread vegetation impacts. Therefore, the consequence is slight.	

DECISION TABLE			
Licence section	**Condition number**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
		Likelihood: Based on the Licensee's controls in place to manage dust (as described above), adverse impacts to vegetation health from fugitive dust emissions will not occur in most circumstances. Therefore, the likelihood of the consequence is unlikely. *Risk Rating:* Comparison of the consequence and likelihood ratings described above with the Risk Rating Matrix (Table 3) determines the overall rating of risk for dust emissions to be **low**. <u>Regulatory Controls</u> Fugitive dust emissions are considered a low risk given the location of the Premises (nearest sensitive human receptor over 30 km away) and there are no PEC, TEC or DRF within the Premises. Fugitive dust emissions can be sufficiently regulated under section 49 of the EP Act. The regulation of radionuclides in airborne dust and potential impacts to onsite personnel is regulated under the *Mines Safety and Inspection Regulations 1995*. <u>Residual Risk</u> *Consequence:* Slight *Likelihood:* Unlikely *Risk rating:* Low	
Odour	N/A.	Minor odour emissions may be generated from the operation of the landfill. The Delegated Officer notes the nearest settlement to the Premises is Kundat Djaru (Ringer Soak), approximately 34 km to the west/southwest. The Delegated Officer considers the separation distance sufficient and no specified conditions relating to odour emissions are required for the Licence.	General provisions of the EP Act.

DECISION TABLE			
Licence section	**Condition number**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
Noise	N/A.	During operation, noise is generated from the operation of mobile equipment (haul trucks, water trucks and dozers), power generation facilities and ore handling and processing facilities. The Delegated Officer notes the nearest settlement to the Premises is Kundat Djaru (Ringer Soak), approximately 34 km to the west/southwest. A detailed risk assessment of noise emissions has not been undertaken as there are no sensitive receptors at risk of being impacted by noise emissions from the Premises. The Delegated Officer notes that the *Environmental Protection (Noise) Regulations 1997* applies for the operation of the Premises.	General provisions of the EP Act. *Environmental Protection (Noise) Regulations 1997.*
Monitoring general	Conditions 2.1.1 - 2.1.4.	The Delegated Officer has included general monitoring requirements under conditions 2.1.1, 2.1.2, 2.1.3 and 2.1.4. Condition 2.1.1 will ensure that samples are appropriately collected and preserved and testing is carried out by a NATA accredited laboratory. Condition 2.1.2 specifies the requirements relating to the frequency of monitoring. Conditions 2.1.3 and 2.1.4 require the calibration of monitoring equipment in accordance with the manufacturer's specifications, or where these cannot be reasonably met, the implementation of an alternative method.	Australian Standard AS/NZS 5667.1. Australian Standard AS/NZS 5667.11.
Monitoring of inputs and outputs	Condition 2.2.1.	The Delegated Officer has included condition 2.2.1 which requires the Licensee to monitor the waste inputs at the landfill to ensure the efficient operation of the landfill and to ensure that the landfill is operating in accordance with the design capacity.	N/A.
Process monitoring	Condition 2.3.1.	The Delegated Officer has included condition 2.3.1 which requires the cumulative monthly volume of tailings deposited into the TSF and raffinate discharged to the evaporation pond to be monitored.	N/A.
Ambient quality monitoring	Condition 2.4.1.	Following the risk assessment (refer to Appendix B) for potential seepage from the TSF, evaporation pond and the operation of the putrescible landfill, the Delegated Officer has determined that the risk is acceptable, subject to	Australian Standard AS/NZS 5667.1.

DECISION TABLE			
Licence section	**Condition number**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
		appropriate operational regulatory controls. The Delegated Officer has applied condition 2.4.1 to the Licence which specifies the ambient groundwater monitoring requirements for the TSF, evaporation pond and putrescible landfill.	Australian Standard AS/NZS 5667.11. Northern Minerals, 2017c.
Meteorological monitoring	N/A.	Conditions relating to the monitoring of meteorological conditions at the Premises are not required to be applied to the Licence.	N/A.
Improvements	N/A.	The Delegated Officer will not be applying any improvement conditions to the operating Licence.	N/A.
Information	Conditions 3.1.1, 3.1.2, and 3.1.3. Conditions 3.2.1 and 3.2.2. Condition 3.3.1.	The Delegated Officer has applied conditions 3.1.1, 3.1.2 and 3.1.3 to ensure that records associated with the Licence are appropriately managed, a complaints management system is implemented and an Annual Audit Compliance Report is submitted to the CEO within 90 days of the Anniversary date. Condition 3.2.1 has been applied to the Licence to require the submission of an Annual Environmental Report for the Premises. The report will contain the information collected from the monitoring conducted under the Licence. DWER will review this information to identify any emerging trends that could signify groundwater impacts from the putrescible landfill, TSF and raffinate seepage. Condition 3.2.2 requires the Licensee to assess the information contained within the report against previous monitoring results. Condition 3.3.1 has been applied to the Licence. This relates to notification requirements for breaches of Licence limits and to ensure that where the requirements for calibration cannot be practicably met as described in condition 2.1.4, that a report is provided to the CEO.	N/A.
Licence Duration	N/A.	Mining tenement M80/627 expires 16 June 2035. In accordance with the *Guidance Statement*: *Licence Duration*, the Delegated Officer has issued the operating licence for a period of 16 years (not exceeding the tenure expiry date).	*Guidance Statement: Licence Duration*.

5 Advertisement and consultation table

Date	Event	Comments received/Notes	How comments were taken into consideration
17 November 2016	Application referred to interested parties: • Former Department of Water; • Department of Mines Industry Regulation and Safety (DMIRS) (former DMP) and • Radiological Council of Western Australia	**Department of Water comments:** Comments regarding potential impacts from drawdown and additional monitoring requirements to determine interconnection between the Browns Range Metamorphic and impacts to the hydrology of Banana Springs. **DMIRS** Advice that the Mining Proposal and Mine Closure Plan for the pilot plant were approved by the former DMP on 28 November 2016. Radiation management in relation to the pilot plant was considered in the assessment of the Browns Range Project Management Plan, approved by the Resources Safety Division of the former DMP on 31 August 2016.	Comments noted. Drawdown impacts will be regulated under the Groundwater Operating Strategy, implemented under the Licensee's section 5C of the RIWI Act groundwater licence. Comments noted.
21 November 2016	Application advertised in the West Australian (or other relevant newspaper)	No comments received.	N/A.
21 November 2016	Application referred to Shire of Halls Creek	No comments received.	N/A.
5 July 2018	Licensee sent a copy of draft instruments	The Licensee provided comments on 9 July 2018 (Northern Minerals, 2018b).	Refer to Appendix C.

6 Risk Assessment

Note: This matrix is taken from the Guidance Statement Risk Assessments

Table 6: Emissions Risk Matrix

Likelihood	Consequence				
	Slight	Minor	Moderate	Major	Severe
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Medium	Medium	Medium	High
Rare	Low	Low	Medium	Medium	High

Appendix A

Primary activities
The pilot plant includes both a beneficiation and hydrometallurgical process. The primary purpose of the beneficiation plant is to remove gangue (mainly silica) materials and increase the rare earth concentration prior to treatment in the hydrometallurgical plant. The beneficiation plant processes up to 60,000 tpa of ore at 1.19% TREO grade to produce approximately 3,200 tpa of mineral concentration at 20% TREO. This mineral concentrate is further processed at the hydrometallurgical plant.

The trial mine has a production period of about six months to provide the ore stockpile for the pilot processing plant and also material for construction of the TSF. The general site layout is shown in Figure 4.

Beneficiation plant
Run of Mine (ROM) ore is transported to the ROM pad where it is stockpiled and blended to the desired grade. Ore stored at the ROM is placed on a compacted engineered base. A front end loader is used to reclaim the ore from the stockpile and transfer it to the ROM bin.

The beneficiation plant comprises of:

- A primary crushing unit;
- Semi-autogenous grinding (SAG) mill to reduce the particle size of the ore to 80% passing 63 micrometres (µm);
- Two stage wet high gradient magnetic separation process to produce magnetic concentrate rich in xenotime, and a non-magnetic stream containing largely silica and mica which is rejected as tailings;
- Flotation circuit to produce a 20% TREO mineral concentrate; and
- Thickening of the residue stream from the magnetic separation and flotation circuits, prior to combining with hydrometallurgical tailings for disposal in the TSF.

Flotation reagents (fatty acid), sodium silicate, caustic soda (sodium hydroxide) and flocculant is used in the beneficiation process.

Figure 4: Site layout

Hydrometallurgical plant

The hydrometallurgical plant further processes the 20% TREO mineral concentrate to extract rare earths and remove contaminants such as iron, phosphate and aluminium; and small amounts of thorium and uranium.

The hydrometallurgical plant process is described below:

- Mineral concentrate produced at the beneficiation plant is reclaimed from bunkers with a bobcat, fed into a live bottom bin and screw conveyed into a dryer;
- The dry concentrate is then fed into an acid mixer to be mixed with 98% H_2SO_4 and then to the kiln (the "sulphation bake" step). The sulphation bake is undertaken at a nominal 275 degrees Celsius, which cracks the xenotime mineral to allow the rare earths to be readily leached in water;
- Following the water leach step, the leach residue is washed, filtered and separated from the pregnant leach solution (PLS);
- The PLS undergoes a series of purification steps where the pH of the solution is steadily increased with lime and magnesia to reject impurities such as phosphate, iron, aluminium, thorium and uranium;
- The solid purification residue is separated from the PLS by thickening and filtering, and the PLS is passed through an ion exchange column to remove any residual uranium. The purification residue is repulped and mixed with the repulped water leach residue before being combined with the beneficiation tailings and pumped to the TSF; and
- Following purification and ion exchange, the PLS is contacted with sodium carbonate to precipitate the rare earths. The mixed rare earth carbonate is thickened, filtered, washed and dried before being bagged for export.

An estimated 1,200 tpa of mixed rare earth carbonate product containing around 52% TREO will be produced.

Sulphuric acid, sodium carbonate, quick lime, ferric sulphate, magnesium oxide, ion exchange resin, caustic soda (sodium hydroxide) and flocculant is used in the hydrometallurgical process.

Surplus raffinate water produced at the hydrometallurgical plant is discharged to a high density polyethylene (HDPE) lined evaporation pond for disposal.

Rare earth concentrate product is put into 1 tonne bulk bags for transport off site. There is sufficient space in the hardstand container yard to provide for two months' storage of product.

Ore processing waste generation and storage

The main wastes resulting from the beneficiation and hydrometallurgical processing are:

- Solid, non-magnetic particulate residue from the magnetic separator, consisting mainly of silica and mica;
- Rejected gangue materials from the beneficiation plant flotation circuit;
- Water leach residues generated following the sulphation bake process;
- Purification residues generated following the purification process;
- Acidic wastewater from the hydrometallurgical plant;
- Precipitates from the neutralisation of acid wastewater; and
- Off gases from the waste gas scrubber.

Northern Minerals, 2016 (Attachment 3A) states *"The hydrometallurgical waste streams that undergo neutralisation include the sulphation bake waste gas scrubber bleed, precipitation barren solution, ion exchange waste solutions, purification effluent and potable water plant effluent. The solid precipitates generated from the neutralisation step are combined with the purification and water leach residues from the hydrometallurgical plant. This combined waste stream will be co-mingled with the*

beneficiation tails (comprising flotation tailings and WHGMS circuit tailings). The co-mingled beneficiation and hydrometallurgical tailings will be pumped to the TSF".

TSF

Waste and residue streams from the beneficiation and hydrometallurgical processes are combined prior to being sent to the above ground TSF for disposal and storage.

Loss of containment of tailings streams in the processing plant is minimised through the incorporation of the following controls:

- High level detectors in the mixing tank, which is linked to a supervisory control and data acquisition (SCADA) control system;
- Automatic, variable speed pumps to maintain flow of material from the mixing tank to the TSF;
- Tailings pipework equipped with density and pressure detectors (also linked to the SCADA control system) to alert plant operators to blockages or loss of containment; and
- Concrete bunding to contain any spillages from the mixing tank or associated pipework.

As some components of the hydrometallurgical tailings are classified as radioactive material they are managed under the *Radiation Management Plan*. The combined beneficiation and hydrometallurgical tailings is classified as non-radioactive. Over the course of the three year trial, approximately 198,000 tonnes of combined tailings will be produced and disposed of in the TSF. The characteristics of the tailings from each process is summarised Table 3 below.

Table 3: Tailings characteristics

Source	Rate of deposition (tonnes/hour)	Characteristics
Beneficiation plant (90% of tailings mass)		
WHGMS circuit	10	Crushed and milled ore, no chemical processes
Flotation circuit		Crushed and milled ore, trace amounts of flotation reagents
Hydrometallurgical plant (10% of tailings)		
Leach residue	1	Traces of sulphuric acid, some uranium and thorium and other elements
Purification residue		Contains iron, aluminium, thorium hydroxides and some uranium
Ion exchange (IX) residue		Contains low level uranium and thorium
Waste water treatment plant residue		Gypsum and remaining metals as hydroxides
Total	11	

The TSF comprises of a single cell paddock storage, constructed as a multi-zoned earth and rockfill dam. It is an integrated waste landform, using non-reactive waste rock from the Gambit open pits to construct the main embankment. Embankment raises will be undertaken using a downstream construction method. The first stage has been constructed to RL 449.6 m using mine waste and/or local borrow, providing for 12 months storage capacity. It is anticipated that in Year 2 of the trial the embankment will be raised to the final elevation of RL 453.0 m, corresponding to a maximum embankment height of approximately 6 m.

Tailings is deposited into the facility by sub-aerial deposition methods, via spigots spaced at approximately 28 m intervals along the embankments.

The TSF is lined with a 1.5 mm thick HDPE geomembrane, underlain by a seepage collection system and a prepared, low permeability earthen base. The permeability of the HDPE geomembrane is in general not greater than 10^{-11} m/s (Pilot Plant Construction Compliance Report). Figure 5 shows the typical TSF embankment cross section.

A single decant tower is used to pump supernatant water from the TSF back to the processing plant for reuse.

The Licensee has implemented an underdrainage system beneath the TSF to reduce seepage and an upstream toe drain to lower the potential phreatic surface adjacent to the embankment. The upstream toe drains and underdrainage system drain by gravity to a collection sump located at the north-west corner of the TSF. Water recovered from the underdrainage and toe drain system is pumped directly to the decant tower, from where it is conveyed to the process plant for reuse (Knight Piesold, 2016). The underdrainage system is shown in more detail below (Figure 6).

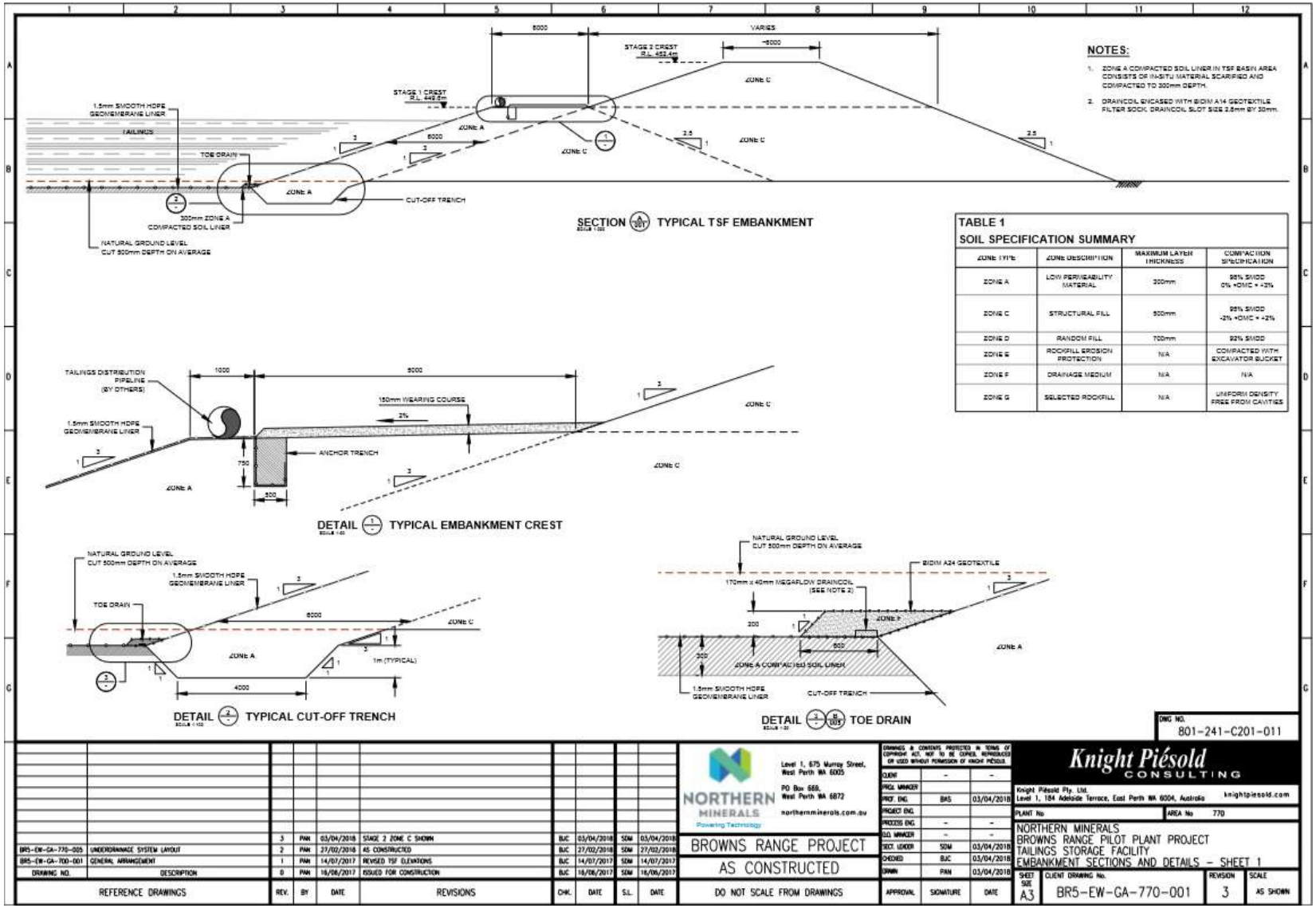

Figure 5: TSF embankment cross section

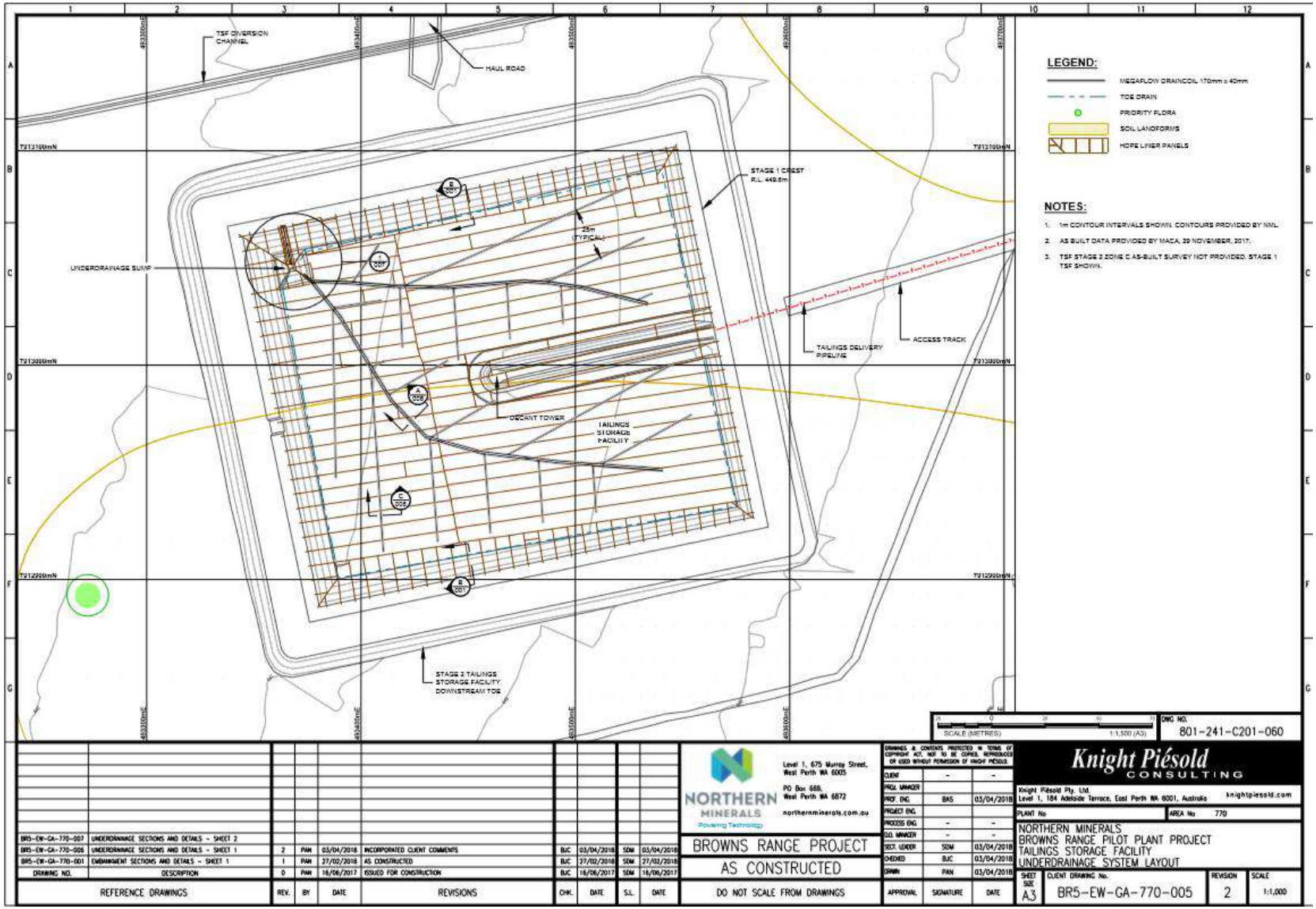

Figure 6: TSF underdrainage system and sump

Evaporation pond

The Licensee has constructed a 1.5 mm HDPE (permeability not more than 1 x 10^{-11} m/s) lined evaporation pond facility, with a compacted soil liner (300 mm thickness beneath the HDPE liner) (Knight Piesold, 2016), designed to evaporate surplus raffinate (liquid containing impurities from the wastewater treatment plant) water produced at the hydrometallurgical plant. The embankment of the evaporation pond has been formed by constructing embankments to a height of 2.5 m, with a crest width of 4 m. The evaporation pond will have a top area of 0.85 hectares (ha) and an overall footprint of 1.52 ha.

Wastewater is discharged at a rate of approximately 3 m^3 per hour (approximately 18,000 m^3 per year) and the maximum operating water depth under average climatic conditions is approximately 1.9 m. The embankment has been designed for average conditions plus an allowance of 300 mm depth below the spillway invert to store runoff from a 1 in 100 year, 72 hour storm event, or the height to store a 1 in 100 wet year annual sequence to determine the spillway invert level. Based on the maximum operating level for average climatic conditions, at most times the pond will have storage capacity available to contain all direct incident rainfall without the need for removing accumulated salts / sediments or de-sludging.

The raffinate contains approximately 48,429.68 mg/L of dissolved solids; with more than 97% comprising of sodium sulphate, potassium sulphate and magnesium sulphate. Other minor constituents are listed in Table 4 below.

Table 4: Typical raffinate composition

Constituent	mg/L	% of solids	Constituent	mg/L	% of solids
Na2SO4	45717.89	94.40%	Ce2(SO4)3	3.67	0.01%
K2SO4	828.05	1.71%	Sr(SO4)	2.73	0.01%
MgSO4	737.51	1.52%	Nd2(SO4)3	2.61	0.01%
Al2S3O	335.36	0.69%	Sm2(SO4)4	2.23	0.00%
Na2SiO3	184.56	0.38%	Ho2(SO4)3	1.97	0.00%
Floc	144.31	0.30%	CuSO4	1.41	0.00%
MnSO4	116.91	0.24%	La2(SO4)3	1.37	0.00%
Y2(SO4)3	73.53	0.15%	Tb2(SO4)3	1.26	0.00%
NaOH	62.84	0.13%	Zr(SO4)2	0.94	0.00%
NaCl	49.37	0.10%	Tm2(SO4)3	0.81	0.00%
CoSO4	48.2	0.10%	K2SO3	0.72	0.00%
NiSO4	28.03	0.06%	Lu2(SO4)3	0.6	0.00%
Fe2SO4	24	0.05%	Pr2(SO4)3	0.5	0.00%
Na3 PO4	20.43	0.04%	Eu2(SO4)3	0.39	0.00%
Na2SO3	9.52	0.02%	UO2SO	0.25	0.00%
Dy2(SO4)3	9.18	0.02%	Ti(SO4)2	0.23	0.00%
H2SiF6	8.28	0.02%	Sb2(SO4)	0.14	0.00%
MgCl2	7.57	0.02%	CaSO4	0.12	0.00%
Gd2(SO4)3	5.54	0.01%	ThS208	0.11	0.00%
Er2(SO4)3	5.46	0.01%	ZnSO4	0.1	0.00%
KHCO3	4.65	0.01%	PbSO4	0.01	0.00%
Mg(HCO3)	4.27	0.01%	BaSO4	0	0.00%
Yb2(SO4)3	4.22	0.01%	Sn(SO4)2	0	0.00%

Naturally occurring uranium and thorium

The Licensee appointed JRHC Enterprises Pty Ltd to develop a radiation technical report for the Browns Range Rare Earths Project. The primary guidance for radioactive materials is provided in national standards by the ARPANSA. *ARPANSA, 2005* guidance notes that material containing naturally occurring radionuclides in secular equilibrium, with head-of-chain uranium or thorium activity

concentrations less than 1 Becquerel per gram (Bq/g) would generally be considered inherently safe and therefore exempt from regulation. 1Bq/g equates to 81 parts per million (ppm) uranium or 245 ppm thorium, and also applies to the combined activity if both decay chains are present (JRHC Enterprises, 2014).

In Western Australia the primary legislation relating to radiation management is the *Radiation Safety Act 1975* and subsidiary legislation. Radiation is also subject to regulation under the *Mines Safety and Inspection Act 1994*. The *Guideline on managing naturally occurring radioactive material (NORM) in mining and mineral processing* provides detailed advice on radiation protection in mines.

Testing carried out by the Australian Science and Technology Organisation (ANSTO) has found that the Browns Range ore deposits contain naturally occurring uranium and thorium as oxides, at concentrations of approximately 40 ppm and 30 ppm respectively. These concentrations are below the *ARPANSA, 2005* classification for radioactive material. Table 5 compares the radionuclide concentrations of material at Browns Range with the classification levels for radioactive material specified by *ARPANSA, 2005* and illustrates that the ore is below the classification for radioactive material.

Table 5: Uranium and Thorium concentrations compared to guideline

Material	**Uranium**		**Thorium**	
	(ppm)	(Bq/g)	(ppm)	(Bq/g)
Soils (above ore body)	1.2	0.02	11	0.05
Ore bodies (average)	40	0.05	30	0.12
Threshold of Classification as Radioactive	81	1.0	245	1.0

While ore is below the classification for radioactive material, the Licensee has advised that during the hydrometallurgical process some radionuclides are concentrated and therefore exceed the trigger for classification as 'radioactive material'. Concentrations of uranium and thorium in the hydrometallurgical tailings waste stream are expected to reach 620 ppm and 240 ppm respectively (JRHC Enterprises, 2014). The beneficiation plant tailings are not classified as radioactive.

The Delegated Officer notes that the various residue streams from the hydrometallurgical plant are combined into a single residue stream that is combined with the beneficiation tailings and directed to the TSF. Concentrations of uranium and thorium in the combined tailings are similar to the ore (approximately 40 ppm uranium and 30 ppm thorium), meaning the combined tailings material is not classified as a radioactive material (JRHC Enterprises, 2014).

Putrescible landfill

The landfill at the Premises accepts inert waste type 1, putrescible wastes (e.g. household type waste, waste from litter bins and food wastes) and inert waste type 2 (tyres and plastic pellets) in accordance with the *Landfill Waste Classifications and Waste Definitions 1996.* The landfill has been designed to meet the requirements as outlined in the *Environmental Protection (Rural Landfill) Regulations 2002*.

The Licensee has constructed the following waste disposal cells (Northern Minerals, 2017c) as shown in Figure 7:

- One 30 m long x 10 m wide x 2 m deep, unlined trench for the acceptance of putrescible and inert wastes;
- One 15 m long x 10 m wide x 1 m deep, unlined trench for the acceptance of glass and metal wastes;
- One 15 m long x 10 m wide x 1 m deep, lined trench for the acceptance of industrial wastes, such as hydrocarbon contaminated oily rags and used filters; and

- A fence has been constructed around the active trenches and a gate installed. The fence is 1.5 m above ground and 0.3 m below ground to prevent entry of livestock and feral fauna.

As the active trenches reach capacity, additional trenches will be excavated and the fence will be extended as required.

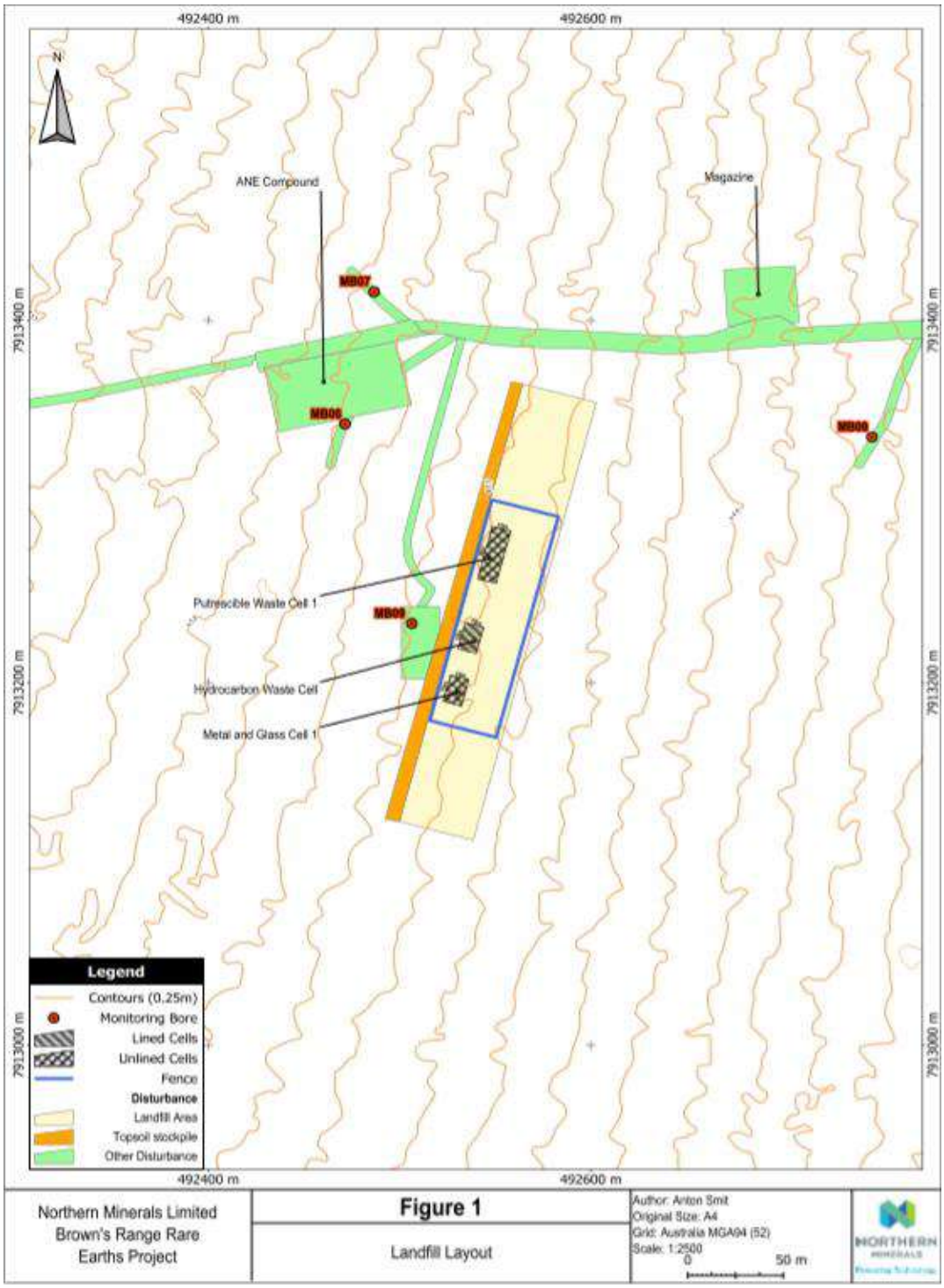

Figure 7: Landfill layout

Appendix B

Premises operation

Stormwater management – general

Emission Description

Emission: Stormwater from cleared/disturbed areas, stockpiled earthen materials and operational areas containing high sediment loads.

Stormwater contaminated by chemicals used in processing (flotation reagents (fatty acid), sodium silicate, caustic soda (sodium hydroxide), flocculent, sulphuric acid, sodium carbonate, quick lime, ferric sulphate, magnesium oxide and ion exchange resin), and hydrocarbons.

Stormwater from the hydrometallurgical plant potentially containing elevated concentrations of radionuclides.

Impact: Stormwater with high sediment loads discharging to surface drainage leading to downstream sedimentation, disrupting aquatic ecosystems through reduced primary production and/or direct impacts through the smothering of organisms and benthic habitats. Stormwater contaminated by chemicals/hydrocarbons causing soil, groundwater and surface water contamination; leading to ecosystem disruption.

The Premises lies within the Sturt Creek catchment, which flows to the southwest, ultimately discharging into Lake Gregory, approximately 220 km downstream of the site. Lake Gregory is recognised as a wetland of national importance under *A Directory of Important Wetlands in Australia*.

Controls: The Licensee commissioned Golder Associates to develop a surface water management plan for the Premises. The Licensee manages surface water in accordance with the design principles in this plan, specifically:

- Infrastructure is located above the 100 year annual recurrence interval (ARI) flood level, or appropriate protection is required;
- Runoff from undisturbed catchments upstream of the operational areas is diverted away from operational areas into existing drainage lines;
- Diversion channels and bunds around mine infrastructure, including the process plant, TSF and waste rock landforms sized to withstand an event with a probability of exceedance of 20% over the life of the mine. For a nominal 3 year trial, an exceedance probability of 20% corresponds to approximately a 1 in 15 year storm event;
- Surface water runoff from waste rock landforms, ROM pad and external faces of the TSF is directed to sediment detention ponds (Golder Associates, 2015a); and
- Earthen bund structures around the landfill to prevent stormwater from entering open trenches (KASA Consulting, 2015).

The Licensee has advised of a number of controls to manage stormwater and/or prevent stormwater contamination:

- Bunds are used to divert stormwater away from operational and chemical storage areas;
- Infrastructure located above the 100 ARI flood level;
- Quick lime, sodium carbonate, magnesium oxide and ferric sulphate is delivered to the site as dry solids in 1 tonne bulka bags; and subsequently stored in a 20 foot sea container; Flocculant and ion exchange resin is brought to site in 25 kg bags and also stored in a 20 foot sea container;

- Caustic soda, sodium silicate and fatty acid collector is delivered in 1,000 litre intermediate bulk containers (IBC) and stored in separate bunded areas;
- 3,200 tpa of sulphuric acid is delivered to site via bulk road tanker and discharged into five dedicated 21,000 litre isotainer storage tanks, located in a separate bunded area;
- Diesel is managed in accordance with Australian Standard 1940-2004. Hydrocarbon and reagent spills is managed in accordance with site procedures; and
- Operations may cease or be reduced in the wet season, during which very limited stocks of fuels and reagents will be stored onsite. Sumps and bunds are emptied prior to the wet season and the site will be manned at all times.

Stormwater in the process area and surrounding infrastructure is managed by a combination of elevated terraces, stormwater cut-off drains and drainage channels. Clean water external to the processing areas is diverted to natural drainage lines.

Stormwater within the plant area is collected on raised terraces through an interconnected network of drainage channels that gravity flow into HDPE lined event ponds, designed to contain a 1 in 20 year return period, 24 hour rainfall event. Water in the event ponds is evaporated or reused in the processing circuit. The beneficiation and hydrometallurgical event ponds will be emptied to 0.5 m of water in each pond prior to plant shut down at the onset of the wet season. The Licensee has stated that "*below a certain depth the pump will start to suck air, and potentially the liner. If there is a cyclone, we would also prefer to have some water in the ponds to weigh down the liner to prevent it from blowing away*" (Northern Minerals, 2018a). Allowing 0.5 m of water in each pond will leave 2.2 m of freeboard in the beneficiation pond and 2.5 m of freeboard in the hydrometallurgical pond, which is well below the 1.1 m freeboard required to contain a 1 in 20 year return period, 24 hour rainfall event.

Spillage within the beneficiation plant is controlled within the bunded area of each process building. Bunds are equipped with pumps to return spillage back into the HDPE lined event-ponds.

The hydrometallurgical plant consists of a number of processing units each fitted with an integral spill tray, sump and spillage sump for spillage containment and the prevention of cross-contamination between adjacent process facilities. The individual spill trays and sumps overflow into the dedicated HDPE lined event-pond. The main pipe rack connecting individual components of the hydrometallurgical plant are located above the concrete lined central drain that connects the units to the event-pond.

Surface runoff or through flow at the ROM pad, the Wolverine waste dump and the external TSF embankments is captured in detention ponds to remove sediment. Detention ponds are designed to contain a 1 in 20 year rainfall event. Leachability testing carried out on representative samples of waste rock and ore has generally found that trace element concentrations in samples subjected to leaching by water are low and none of the leachable concentrations exceeded the *ANZECC, 2000* water quality guideline values for water used for watering livestock.

The closest ephemeral drainage line is 2 km from the Premises and there are no permanent water bodies within the Premises. The main water course of Sturt Creek is located approximately 45 km west/northwest of the Premises and is also classified as an ephemeral system. Groundwater is located approximately 14 mbgl. Groundwater in the area is fresh to slightly brackish, with a near-neutral pH and very low concentrations of dissolved metals.

Risk Assessment

Consequence: Based on the distance to the nearest ephemeral creek and Sturt Creek (approximately 2 km and 45 km away respectively), depth to groundwater (14 mbgl) and the potential

stormwater contaminants, stormwater runoff will have low-level onsite impacts and minimal offsite impacts. Therefore, the consequence is minor.
Likelihood: Based on the Licensee's controls (diversion channels/bunds, sediment detention ponds, individual bunding of processing units, processing spillage containment in HDPE event-ponds, infrastructure above the 100 ARI flood level, appropriate chemical/diesel storage) adverse impacts to the environment from stormwater runoff will not occur in most circumstances.

With respect to stormwater from the hydrometallurgical plant, the Delegated Officer considers the proposed Licensee's controls (spill trays, concreted lined central drain and the lined event-ponds etc.) are appropriate to prevent stormwater containing radionuclides from discharging to the environment. Therefore, the likelihood of the consequence is unlikely.

Risk Rating: Comparison of the consequence and likelihood ratings described above with the Risk Rating Matrix (Table 6) determines the overall rating of risk for stormwater runoff during operation to be **medium**.

Regulatory Controls
The Delegated Officer has determined that the risk associated with stormwater runoff is acceptable, subject to appropriate operational regulatory controls.

The Delegated Officer has included general condition 1.2.1 requiring the immediate recovery or removal of spills outside of containment areas. This will minimise the risk of contaminated stormwater discharging to the environment.

The Delegated Officer has also included condition 1.3.4 to specify infrastructure requirements for the event-ponds; and condition 1.3.5 has been applied to the Licence to require the event-ponds to be emptied to maximum level of 0.5 m at the commencement of the wet season. These requirements are consistent with the Licensee's controls considered by the Delegated Officer in the risk assessment for stormwater discharge.

Residual Risk
Consequence: Minor
Likelihood: Unlikely
Risk Rating: Medium

TSF – abnormal operation (seepage)
Emission Description
Emission: Seepage of tailings leachate in event of liner breach.

Impact: Groundwater contamination, impacts to ecosystems receiving groundwater in the area. Deterioration of water quality impacting on stock health.

Controls: The TSF has been constructed with a compacted soil base and a HDPE geomembrane liner on the base and embankments to achieve a permeability of 1 x10^{-9} m/s. The soil base comprises primarily of in-situ soils, scarified and re-compacted through the TSF basin to form a 300 mm thick soil subgrade. The 1.5 mm smooth HDPE geomembrane liner is expected to achieve overfall seepage performance of less than 4 kL per ha per day (Knight Piesold, 2016).

An underdrainage collection system, designed to reduce the phreatic surface on the tailings basin has been constructed. This drainage system minimises seepage, and increases the density of tailings to maximise storage potential. The underdrainage system has been constructed above the HDPE liner and consists of two drainage networks, branch drains and finger drains. The finger drains are spaced at approximately 25 m and connect to the branch drains. The branch drains feed directly into the

underdrainage collection sump located at the upstream toe of the embankment. The branch and finger drains are corrugated, perforated tubing surrounding by sand and wrapped in geotextile which has been continuously seamed or heat welded (Knight Piesold, 2016).

A toe drain has been constructed along the upstream toe of the embankment to increase the stability of the embankment by providing drainage at the embankment. It also acts as an underdrainage collection pipe.

The underdrainage collection sump collects seepage from the toe drains and underdrainage system (finger and branch drains). It comprises an excavated sump, filled with clean gravel wrapped in geotextile, located on top of the HDPE geomembrane liner against the upstream toe of the embankment. A pump is used to direct water from the collection sump to the decant tower, from where it is sent to the process plant wastewater treatment plant. The treated water from the wastewater treatment plant is sent to the beneficiation plant water tank for reuse through the plant (Northern Minerals, 2017a).

Deposition occurs from multiple spigots and deposition locations are moved progressively along the line to control the location of the supernatant pond. After initial establishment of the tailings beaches, a suitable cycle time has been determined to ensure even deposition of tailings around the facility, thereby maintaining the supernatant pond at the decant tower and maintaining the formation of tailings beaches. Sub-aerial tailings deposition allows for maximum amount of water removal through the formation of a large beach for drying and draining (Knight Piesold, 2016).

Groundwater is located approximately 14 mbgl at the location of the TSF. The nearest ephemeral creek is located approximately 2 km from the TSF and Sturt Creek is located approximately 45 km from the Premises.

During the hydrometallurgical process some radionuclides concentrate exceed the trigger for classification as ‘radioactive material’, with concentrations of uranium and thorium in the hydrometallurgical tailings waste stream expected to reach 620 ppm and 240 ppm respectively (JRHC Enterprises, 2014).

The hydrometallurgical plant produce tailings with low level radiation levels. Beneficiation tailings are not classified as radioactive. The Licensee has advised that the overall activity of the co-mingled tailings does not exceed an overall average radioactivity concentration of 1 Bq/g, the level at which materials are considered to warrant some form of radiological assessment and control (ARPANSA, 2005).

The Delegated Officer notes that the various residue streams from the hydrometallurgical plant are combined into a single residue stream that is then combined with the beneficiation tailings and directed to the TSF. Concentrations of uranium and thorium in the combined tailings is similar to the ore (approximately 40 ppm uranium and 30 ppm thorium), meaning the combined tailings material is not classified as a radioactive material (JRHC Enterprises, 2014).

Leachability testing carried out on representative samples of waste rock and ore has generally found that trace element concentrations in samples subjected to leaching by water are low and none of the leachable concentrations exceeded the *ANZECC, 2000* water quality guideline values for water used for watering livestock. Ecotoxicological testing was carried out on the tailings materials to evaluate the risk of environmental hazard associated with loss of containment, for example from a pipeline or embankment cell failure. Results from this assessment demonstrated that the highest concentrations of tailings constituents generated in acute aquatic toxicity tests did not exceed the selected aquatic toxicity benchmarks (Golder Associates, 2015b), which for the purposes of this assessment were the *ANZECC, 2000* 95% species protection trigger values for freshwater. This means that the tailings are “not classifiable as an environmentally hazardous substance”.

The Delegated Officer notes that waste rock samples from the area were subjected to chemical analysis to compare their chemical composition to the Global Abundance Index (GAI) for elements in the earth's crust. Samples were also subjected to static testing to determine the risk of acid drainage being produced, and to short-term leaching tests with deionised water to determine the risk of potentially toxic chemical constituents being leached into groundwater.

Testing of representative samples of waste rock found that only boron and possibly selenium are present in the waste rock at concentrations exceeding a GAI value of 3, which is commonly taken to represent significant enrichment (compared to average crustal abundances). The static testing suggested that although total sulfur levels in rocks at the site were generally very low, the acid neutralising capacity of the rocks was also low. Consequently, some samples were shown to be potentially acid forming. Additionally, although many samples were considered to be "non-acid forming" they plotted very close to the boundary between "acid forming" and non-acid forming" on a NAG pH versus NAPP plot (SRK Consulting, 2013). The Delegated Officer notes that there is a significant degree of uncertainty about how these materials will behave after a prolonged period of weathering. Further, longer term kinetic testing is required to determine the leaching characteristics of waste rocks after the materials have been subjected to a prolonged period of weathering.

Data from the geochemical testing indicate that mercury, thallium and gadolinium have the potential to reach levels that that may adversely affect the suitability of groundwater for livestock (and wildlife) water supply if leachate from waste rock and tailings were to percolate to groundwater.

With respect to longer term kinetic testing, the Delegated Officer notes that in *Report 1523*, the EPA provided advice to DMP that further geochemical testing will need to be undertaken at the site, including longer term kinetic humidifier tests, for example, 48 month tests. These tests will determine what the long-term leachate will likely contain and will be particularly useful for modelling post-closure scenarios for the pit lakes and waste landform (Report 1523). The Licensee has advised DWER that longer term kinetic testing will commence once bulk samples are obtained at the commencement of mining (Northern Minerals, 2016).

The Licensee has installed monitoring bores upstream and downstream of the TSF to identify if seepage from the TSF is occurring. Monitoring bores comprise one shallow bore (5-10 m of the near surface horizon) to detect any seepage from the TSF within the surface sediment and a deep bore to monitor any changes in the chemical composition of the groundwater. Each borehole has been cased and screened over an interval set in the field during installation and sealed back to surface with low permeability grout. Monitoring boreholes were constructed prior to commissioning of the TSF to accumulate background data specific to the storage location.

Tailings return water is expected to be approximately 4,000 mg/L TDS with sodium and calcium as the dominant cations and sulphate the dominant anion. Any seepage from the TSF will be evident as rising TDS levels (particularly of sodium and sulphate) and a high sulphate to chloride ratio in groundwater monitoring bores (W6007 Commissioning Report).

Monthly monitoring of groundwater levels is undertaken, while groundwater chemistry (major component analysis – pH, total dissolved solids, major cations and anions, aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, mercury, nickel, thorium, tin, uranium, vanadium and zinc) is undertaken six monthly.

The Licensee undertakes daily inspections of the drainage blanket outflow, tailings and water levels, size and location of decant pond, outflow from decant, tailings quantity discharged and tailings density, including during the wet season.

Risk Assessment

Consequence: Based on the distance to the nearest ephemeral creek and Sturt Creek (approximately 2 km and 45 km away respectively), depth to groundwater (14 mbgl), and the

extended timeframe that the TSF will be in existence, potential seepage from the TSF could have mid-level onsite impacts and low level offsite impacts at a local scale with minimal off-site impacts at a wider scale. Therefore, the consequence is moderate.

Likelihood: Based on the Licensee's controls (compacted soil base, HDPE liner, underdrainage system, decant tower for removal of supernatant water, daily inspections, groundwater monitoring) adverse impacts to the environment from TSF seepage will not occur in most circumstances. Therefore, the likelihood of the consequence is unlikely.

Risk Rating: Comparison of the consequence and likelihood ratings described above with the Risk Rating Matrix (Table 6) determines the overall rating of risk for TSF seepage during operation to be **medium**.

Regulatory Controls
The Delegated Officer has determined that the risk associated with potential seepage from the TSF is acceptable, subject to appropriate operational regulatory controls. Condition 1.3.4 has been applied to the Licence to specify liner permeability requirements for the TSF, consistent with the Licensee's controls, considered by the Delegated Officer in the risk assessment for TSF seepage.

Ambient groundwater monitoring requirements, consistent with the monitoring proposed by the Licensee, has been applied to the Licence through the application of condition 2.4.1 to determine if seepage is impacting on groundwater used for stock watering. The following analyses will be undertaken:

- Field parameters (monthly): groundwater levels, pH, electrical conductivity, redox potential;
- Total acidity, total alkalinity monthly in-field; and six monthly via external laboratory testing;
- Major ions (6 monthly, or immediately should field parameters be detected to have increased from established levels): sodium, potassium, calcium, magnesium, chloride, sulfate and bicarbonate; and
- Metals (6 monthly, or immediately should field parameters be detected to have increased from established levels): aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, manganese, molybdenum, nickel, lead, thorium, tin, uranium, vanadium, zinc, mercury, selenium, thallium and gadolinium.

Residual Risk
Consequence: Moderate
Likelihood: Unlikely
Risk Rating: Medium

TSF – emergency situation (overtopping/embankment failure)
Emission Description
Emission: Overtopping of TSF, embankment failure resulting in discharge of tailings material and supernatant water into the environment.

Impact: Groundwater contamination, impacts to ecosystems receiving groundwater in the area. Deterioration of water quality impacting on stock health. Surface discharge to drainage lines, impacts to aquatic ecosystems and biota. Impacts to vegetation.

Controls: The Licensee maintains a 300 mm freeboard on the TSF. The TSF has been designed to contain storm events during operation up to and including an annual exceedance probability (AEP) of 1:100, on top of the predicted maximum pond level under average climatic conditions. In the event that the storage capacity during operation of the facility is exceeded, water will be discharged via an engineered spillway. The emergency spillway is designed to convey runoff from a 1:100,000 AEP

critical duration storm, assuming that the decant pond level is at the spillway invert level at commencement of the storm event (Knight Piesold, 2016).

The TSF has been designed in accordance with the Australian National Committee on Large Dams (ANCOLD) guidelines and geotechnical stability analysis of the proposed design demonstrate that an acceptable factor of safety for both static and dynamic loading.

As previously described, ecotoxicological testing was carried out on the tailings materials to evaluate the risk of environmental hazard associated with loss of containment. The outcome of this assessment was tailings at the Premises are "not classifiable as an environmentally hazardous substance".

Groundwater is located approximately 14 mbgl at the location of the TSF. The nearest ephemeral creek is located approximately 2 km from the TSF and Sturt Creek is located approximately 45 km from the Premises.

The Licensee undertakes daily checks of available freeboard; and weekly checks of the toe drains and embankments for evidence of erosion, slippage or cracks.

Risk Assessment
Consequence: Based on the distance to the nearest ephemeral creek and Sturt Creek (approximately 2 km and 45 km away respectively) and depth to groundwater (14 mbgl), overtopping of the TSF or embankment failure would have mid-level onsite impacts and low level offsite impacts at a local scale. Therefore, the consequence is moderate.

Likelihood: Based on the Licensee's controls (TSF spillway, frequent freeboard and embankment inspections, and adequate facility design) adverse impacts to the environment from overtopping/rupture of TSF embankment could occur at some time. Therefore, the likelihood of the consequence is possible.

Risk Rating: Comparison of the consequence and likelihood ratings described above with the Risk Rating Matrix (Table 6) determines the overall rating of risk for overtopping or embankment failure of the TSF during operation to be **medium**.

Regulatory Controls
The Delegated Officer has determined that the risk associated with an embankment breach/overtopping of the TSF is acceptable, subject to appropriate operational regulatory control. The infrastructure requirements specified in condition 1.3.4 of the Licence include the requirement to maintain a 300 mm top of spillway freeboard on the TSF. Condition 1.3.7 specifies that daily inspections of the TSF freeboard be undertaken.

Residual Risk
Consequence: Moderate
Likelihood: Unlikely
Risk Rating: Medium

TSF – emergency situation (pipeline rupture)
Emission Description
Emission: Rupture of tailings and decant water pipelines resulting in discharge of tailings material and supernatant water into the environment.

Impact: Groundwater contamination, impacts to ecosystems receiving groundwater in the area. Deterioration of water quality impacting on stock health. Surface discharge to drainage lines, impacts to aquatic ecosystems and biota.

Controls: Tailings delivery and decant return pipelines are contained within an earthen bunded trench between the process plant and TSF. Pipelines are equipped with an automatic pressure drop cut-out and daily inspections of pipelines are undertaken.

The specifications for the tailings and return water pipelines are as follows:

- Tailings pipeline - 63 mm HDPE pipe (SDR11 PE100 PN16 – nominal working pressure of 1.6 megapascal (MPa)); and
- Return water pipeline - 40 mm HDPE pipe (SDR11 PE80 PN12.5).

The pipelines have been installed in accordance with the relevant provisions of Australian/New Zealand Standard *AS/NZS 2033:2008 Installation of polyethylene pipe systems*.

As previously described, ecotoxicological testing was carried out on the tailings materials to evaluate the risk of environmental hazard associated with loss of containment. The outcome of this assessment was tailings at the Premises are “not classifiable as an environmentally hazardous substance”.

Groundwater is located approximately 14 mbgl at the location of the TSF. The nearest ephemeral creek is located approximately 2 km from the TSF and Sturt Creek is located approximately 45 km from the Premises.

Risk Assessment

Consequence: Based on the distance to the nearest ephemeral creek and Sturt Creek (approximately 2 km and 45 km away respectively) and depth to groundwater (14 mbgl), discharges of tailings and/or return water in the event of a pipeline rupture will have low level onsite impacts and minimal offsite impacts. Therefore, the consequence is minor.

Likelihood: Based on the Licensee’s controls (pipeline bunding, automatic cut-out and daily inspections) adverse impacts to the environment from tailings/return water discharged in the event of a pipeline rupture could occur at some time. Therefore, the likelihood of the consequence is possible.

Risk Rating: Comparison of the consequence and likelihood ratings described above with the Risk Rating Matrix (Table 6) determines the overall rating of risk for TSF and return water pipeline ruptures during operation to be **medium**.

Regulatory Controls

The Delegated Officer has determined that the risk associated with tailings and/or return water discharged as a result of a pipeline rupture is acceptable, subject to appropriate operational regulatory control. Regulatory controls have been imposed through conditions 1.3.6 and 1.3.7 which require appropriate controls on tailings pipelines and daily visual inspections to identify any leaks or ruptures.

Residual Risk

Consequence: Minor
Likelihood: Possible
Risk Rating: Medium

Evaporation pond – abnormal operation (seepage)

Emission Description

Emission: Seepage of raffinate in event of liner breach.

Impact: Groundwater contamination, impacts to ecosystems receiving groundwater in the area. Deterioration of water quality impacting on stock health.

Controls: The pond has been constructed with a compacted soil base and lined with a 1.5 mm thick HDPE geomembrane liner, which has a designed hydraulic conductivity of 1 $x10^{-9}$ m/s (Knight Piesold, 2016).

The typical concentration of thorium in raffinate is 0.06 mg/L. The typical concentration of uranium in raffinate is 0.16 mg/L, which compares with the *ANZECC, 2000* livestock drinking water guideline for uranium of 0.2 mg/L. There is no comparable published value for thorium for livestock drinking water (Northern Minerals, 2017a).

Groundwater is located approximately 14 mbgl at the location of the evaporation pond. The nearest ephemeral creek is located approximately 2 km from the evaporation pond and Sturt Creek is located approximately 45 km from the Premises.

The Licensee has installed two monitoring bores, one upstream and one downstream of the evaporation pond. Each monitoring location comprises of one shallow bore (5-10 m of the near surface horizon) to detect any seepage from the evaporation pond within the surface sediment and a deep bore to monitor any changes in the chemical composition of the groundwater. Each borehole is cased and screened over an interval set in the field during installation and sealed back to surface with low permeability grout. Monitoring boreholes were constructed prior to commissioning of the evaporation pond to accumulate background data specific to the storage location.

Raffinate is expected to be approximately 50,000 mg/L TDS with sodium the dominant cation and sulphate the dominant anion. Any seepage from the evaporation pond will be evident as rising TDS levels (particularly of sodium and sulphate) and a high sulphate to chloride ratio in groundwater monitoring bores (W6007 Commissioning Report).

The Licensee conducts monthly monitoring of groundwater levels, pH and total dissolved solids, while groundwater chemistry (major component analysis – major cations and anions, aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, manganese, molybdenum, nickel, lead, thorium, tin, uranium, vanadium and zinc) is undertaken six monthly.

Embankments are inspected daily for evidence of seepage.

Risk Assessment

Consequence: Based on the distance to the nearest ephemeral creek and Sturt Creek (approximately 2 km and 45 km away respectively) and depth to groundwater (14 mbgl), rafffinate seepage will have mid-level onsite impacts, low-level on-site impacts at a local scale and minimal offsite impacts at a wider scale. Therefore, the consequence is moderate.

Likelihood: Based on the Licensee's control (compacted soil base and HDPE liner) adverse impacts to the environment from evaporation pond seepage could occur at some time. Therefore, the likelihood of the consequence is possible.

Risk Rating: Comparison of the consequence and likelihood ratings described above with the Risk Rating Matrix (Table 6) determines the overall rating of risk for seepage from the evaporation pond during operation to be **medium**.

Regulatory Controls
The Delegated Officer has determined that the risk associated with seepage from the evaporation pond is acceptable, subject to appropriate operational regulatory controls. Condition 1.3.4 specifies the evaporation pond liner permeability, consistent with the Licensee's controls assessed by the Delegated Officer.

Condition 2.4.1 also includes ambient groundwater monitoring requirements from two bores at the evaporation pond to identify potential impacts to groundwater from raffinate seepage.

Residual Risk
Consequence: Moderate
Likelihood: Possible
Risk Rating: Medium

Evaporation pond - emergency situation (overtopping, loss of containment)
Emission Description
Emission: Overtopping of evaporation pond, embankment failure or pipeline rupture resulting in discharge of raffinate into the environment. The area is prone to significant rainfall.

Impact: Groundwater contamination, impacts to ecosystems receiving groundwater in the area. Deterioration of water quality impacting on stock health. Surface discharge to drainage lines, impacts to aquatic ecosystems and biota.

Controls: The embankment of the evaporation pond has been designed for average conditions plus an allowance of 300 mm depth below the spillway to store runoff from a 1 in 100 year 72 hour storm event.

The evaporation pond is operated to maximise the area of water and thus evaporation losses. The average operating depth of the pond is 1.9 m.

Raffinate pipelines are contained within an earthen bunded trench between the process plant and evaporation pond. Pipelines are equipped with an automatic pressure drop cut-out. Pipeline specifications are 40 mm HDPE pipe (SDR11, PE100 PN10).

Groundwater is located approximately 14 mbgl at the location of the evaporation pond. The nearest ephemeral creek is located approximately 2 km from the evaporation pond and Sturt Creek is located approximately 45 km from the Premises.

Daily checks of pipelines, available freeboard and discharge volumes are undertaken.

The Mining Proposal for the pilot plant trial was approved by DMP on 5 May 2017 (Reg ID: 64609). The evaporation pond design would have been assessed as part of the review of the Mining Proposal.

Risk Assessment
Consequence: Based on the distance to the nearest ephemeral creek and Sturt Creek (approximately 2 km and 45 km away respectively), depth to groundwater (14 mbgl) and quality of the raffinate liquid, unplanned discharges due to overtopping or loss of containment will have low level onsite impacts and minimal offsite impacts. Therefore, the consequence is minor.

Likelihood: Based on the Licensee's controls (300 mm pond operating freeboard, evaporation losses maximised through appropriate operating depth, daily inspections of pipelines and operating freeboard (including during the wet season), pipeline cut outs, emergency spillway) adverse impacts

to the environment from raffinate discharging due to overtopping or loss of containment could occur at some time. Therefore, the likelihood of the consequence is possible.

Risk Rating: Comparison of the consequence and likelihood ratings described above with the Risk Rating Matrix (Table 6) determines the overall rating of risk for evaporation pond overtopping or loss of containment during operation to be **medium**.

Regulatory Controls
The Delegated Officer has determined that the risk associated with the evaporation pond overtopping or losing containment is acceptable, subject to appropriate operational regulatory control. Condition 1.3.4 specifies that a 300 mm freeboard needs to be maintained on the evaporation pond. Condition 1.3.6 requires appropriate controls on the evaporation pond delivery pipelines. Condition 1.3.7 requires daily visual inspections of the pipelines and evaporation pond freeboard.

Residual Risk
Consequence: Minor
Likelihood: Possible
Risk Rating: Medium

Putrescible landfill – operation
Emission Description
Emission: Potential leachate generation containing excess organic nutrients and metals and windblown waste from the putrescible landfill.

Impact: Contamination of the surrounding environment including soil and groundwater causing potential death of vegetation and fauna. Impacts to ecosystems receiving groundwater discharge from the addition of nutrients and heavy metals.

Controls: The landfill is located:

- More than 500 m from any accommodation blocks;
- More than 100 m from any surface waters;
- Landfill base at least 3 m above the water table; and
- Outside of the 1-in-100 year floodplain.

A lined trench has been established for industrial wastes such as used oil filters and oily rags where these are unable to be recycled. Hazardous waste are removed from the Premises by a licensed contractor for treatment or disposal in an approved facility in accordance with the requirements of the *Environmental Protection Controlled Waste Regulations 2004*.

Fencing has been installed around active sections of the landfill to prevent windblown litter and access by feral animals or livestock to the landfill. Waste that is washed or blown from the tipping area of the landfill is returned to the tipping area at least once a month and waste is covered at least fortnightly. Active trenches are typically 2 m in vertical height and 30 m in length and a fire break around the perimeter of the landfill site has been established.

Tyres will be placed in the landfill cells at least 100 mm apart and covered with at least 500 mm of soil when disposed of. Plastic pallets will be placed in the landfill and covered with clean fill as per the putrescible waste requirements.

W5837/2015/1 required the Licensee to install monitoring bores around the perimeter of the landfill to establish groundwater conditions. The Licensee installed four bores MB06, MB07 and MB09 (down-gradient) and MB08 (up-gradient) at the landfill. Northern Minerals, 2017c stated that baseline groundwater monitoring detected recoverable hydrocarbons in all monitoring bores, which are

believed to have come from the drilling mud and the PVC primer used to construct the monitoring bores.

The Licensee committed to conducting quarterly monitoring of groundwater levels, while pH, electrical conductivity, total dissolved solids, biochemical oxygen demand, total recoverable hydrocarbons, chloride, fluoride, potassium sulfate, total nitrogen, nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen, total phosphorus, phosphate and dissolved metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc) is undertaken six monthly (Northern Minerals, 2017c).

Risk Assessment
Consequence: Based on the distance to the nearest ephemeral creek and Sturt Creek (approximately 2 km and 45 km away respectively) and depth to groundwater (14 mbgl) environmental impacts from the putrescible landfill may result in low level onsite impacts and minimal offsite impacts. Therefore, the consequence is minor.

Likelihood: Based on the Licensee's controls listed above and waste acceptance criteria, adverse impacts to the environment from landfill seepage will not occur in most circumstances. Therefore, the likelihood of the consequence is unlikely.

Risk Rating: Comparison of the consequence and likelihood ratings described above with the Risk Rating Matrix (Table 6) determines the overall rating of risk for landfill seepage during operation to be **medium**.

Regulatory Controls
The Delegated Officer has determined that the risk associated with the operation of the putrescible landfill is acceptable, subject to appropriate operational regulatory control.

Conditions 1.3.2 and 1.3.3 specify the waste acceptance criteria, waste management requirements and cover requirements for the putrescible landfill consistent with the Licensee's controls, considered by the Delegated Officer in the risk assessment for the putrescible landfill.

Requirements for the landfilling of tyres are set out in Part 6 of the *EP Regulations*.

Condition 2.4.1 also includes ambient groundwater monitoring requirements from the four bores at the landfill to identify potential impacts to groundwater from landfill seepage. The requirement for, or specifications of, condition 2.4.1 will be reviewed by DWER once there is sufficient data from previous years' for a comparison to be made.

Residual Risk
Consequence: Minor
Likelihood: Unlikely
Risk Rating: Medium

Process limits
The Delegated Officer has included condition 1.3.8 for the process limit for category 5. This is consistent with the design capacity assessed under this Licence and ensures that the Licensee does not exceed the approved design capacity for category 5.

Appendix C

Licensee comments on draft Licence and Decision Document, dated 9 July 2018 (Northern Minerals, 2018b) and DWER's response.

Condition	Summary of Licensee comments	DWER response
Response to DWER queries		
Decision Document page 31 – Monitoring and contingencies for removal of sludges and sediments from the evaporation pond.	Evaporation Pond freeboard will be monitored daily under the environmental licence. We do not expect to have to remove any precipitates or sediments from the pond during the life of the project. If we do need to remove material from the pond, then it will be disposed of in the tailings dam, which is also a lined facility.	DWER notes the Licensee's response and commitments.
Decision Document page 32 – Verification of the Uranium and Thorium content of ore and tailings.	The Uranium and Thorium content of the ore was verified as the orebody was mined. For every 10 tonnes of ore processed, we produce about 11 tonnes of tailings solids (the increase is due to the addition of chemicals in the process), so it is unlikely that Uranium and Thorium will be concentrated. There is provision to undertake periodic waste characterisation samples of the tailings stream and Uranium and Thorium are included in this.	
Decision Document page 35 – Provisions for sampling of stormwater as it flows into the event pond to ensure that any discharges under worst case conditions are not contaminated.	We do not plan to sample water flowing into the event ponds as flows into the event ponds are not representative of the water already in the ponds. This could result in spurious conclusions if the ponds discharge into the environment (e.g. a sample of clean stormwater flowing into a contaminated pond that then discharged would lead to the false conclusion that there was no environmental impact). If there is a discharge, then we will sample the water that has been discharged when we assess the impacts	

Condition	Summary of Licensee comments	DWER response
	and there is provision for this.	
Decision Document page 39 – Contingencies in the event of groundwater contamination	We agree that monitoring is not a control but serves to check that controls (clay and HDPE liners) are working effectively. If monitoring does detect seepage, then this will be investigated. The outcome will depend on the investigation and could be simple such as identifying sample contamination; repairs to the liner or increasing the %solids in the tailings, or more involved such as installing recovery bores or a seepage recovery trench. Currently none of the groundwater in the project area is used for stock watering, however the area is on a pastoral lease and this is a possible future use.	
Licence L9009/2016/1 and Decision Document		
Page 1	The Licensee has requested that the suburb for the Premises be changed from Sturt Creek to Halls Creek	According to Geocortex Viewer the locality of M80/627 is Sturt Creek, so this has been retained.
Other Activities Licence page 4 Decision Document page 5	The Licensee has stated that "*1,673 kL of water was pumped out of Wolverine pit during mining for the pilot plant stage and none out of Gambit West pit. All mine dewater was reused for dust suppression. Should additional ore be mined for the pilot plant; dewatering volumes are likely to be below the prescribed premises threshold for Category 6 as described in Schedule 1 of the EP Regulations*". This updated information on mine dewatering at the Premises, which could be used to update this section.	DWER notes the Licensee's comments. The section on mine dewatering at the Premises has been retained as it states the rate expected over the three year trial i.e. "*Mine dewatering is undertaken at a rate of approximately 130 cubic metres (m^3) per day, which equates to approximately 24,000 m^3 over the course of the three year trial*; *below the production capacity for category 6 as described in Schedule 1 of the EP Regulations. Water from mine dewater is utilised on site for dust suppression".*
	The Licensee has stated that "*Power is supplied by 3, 1.25 MW diesel generators. Total installed capacity on the premises (including at the camp) is still less than the Category 52 threshold of 10 MW for diesel generators*". The Licensee requests this section be updated to reflect	The Licence and Decision Document have been updated to include the words in bold and remove the strikethrough words: Power generation is supplied by ~~a 1.5~~ **3 x 1.25** megawatt **diesel** generator**s**. **The total installed**

Condition	Summary of Licensee comments	DWER response
	the above.	**capacity on the Premises (including at the camp) is** below the production capacity for category 52 as described in Schedule 1 of the EP Regulations.
Decision Document only		
Other Approvals page 13	The Licensee states "*An amended groundwater licence (GWL177452(5)) has been issued to NML. The allocation was not changed in the amendment, but mineral exploration activities have been included as a purpose"*.	This section has been updated to read – "Pursuant to section 5C of the RIWI Act, the Licensee has been issued GWL177452(5) authorising the abstraction of 292,160 kilolitres (kL) of groundwater for the purposes of mine dewatering; mineral exploration activities; earthworks and construction; mineral ore processing and other mining purposes; and potable water supply".
	The Licensee states that the Decision Document refers to the Radiation Management Plan (RMP) that was approved for exploration. The RMP was updated prior to mining and construction to cover these activities and was approved 1 May 2017.	The following text has been added under the Radiation Management heading: "The *Radiation Management Plan* was updated prior to mining and construction and was approved on 1 May 2017".
Licence only		
Table 1.3.1	The Licensee has requested that Inert Waste Type 2 be included in Table 1.3.1, as the Registration application included Inert Waste Type 2 (50 tyres and 5 tonnes of plastic pellets per annum). The Licensee has stated "*Tyres will be placed in the landfill cells at least 100 mm apart and covered with at least 500 mm of soil when disposed of. Plastic pallets will be placed in the landfill and covered with clean fill as per putrescible waste requirements*".	Inert Waste Type 2 (tyres and plastic pellets) have been included under waste type in Table 1.3.1. Under requirements for tyres[1] and plastic pellets the following have been included: • No more than 50 tyres and 5 tonnes of plastic pellets shall be disposed of by landfilling. • Batches must be separated from each other by at least 100 mm of soil. Note 1: Requirements for landfilling tyres are set out in Part 6 of the *Environmental Protection Regulations 1987*.
	The Licensee has stated that "According to Regulation 5 of the *Rural Landfill Regulations 2002* - the occupier of the landfill site must ensure that the tipping area of the site is not greater than 2 metres above ground level in height". The Licensee has requested that this condition be	This requirement has been updated to include the words in bold and remove the strikethrough words: **The tipping area of the Landfill** ~~active landfill area~~ ~~is managed such that at no time does landfilling result in an exposed face~~ shall not **be greater than** ~~exceeding~~ 2 m **above ground level** in ~~vertical~~ height.

Condition	Summary of Licensee comments	DWER response
	updated to conform to the *Rural Landfill Regulations 2002*.	
	The Licensee has stated that the requirement to repair a fence within 24-hours is not reasonable for an operation of our size and manpower. The Licensee has requested that this be changed so that the repair is undertaken within 14 days.	This requirement has been updated to "within 14 days".
Table 1.3.2	The Licensee has stated that Regulation 3 of the *Rural Landfill Regulations 2002* requires putrescible waste to be covered monthly, where less than 500 tpa is being disposed of. However, we committed to fortnightly covering in the registration application. The Licensee has requested that this requirement be changed to stipulate fortnightly covering of putrescible wastes.	Timescale requirements for putrescible waste has been changed to fortnightly. Inert Waste Type 2 (plastic pellets) have also been included under this cover requirement. Cover requirements for Inert Waste Type 2 (tyres) has been added with a depth requirement of 500 mm and timescale of "by the end of the working day in which the waste was deposited'.
Table 2.4.1	The Licensee has requested that a 'note' be added to Table 2.4.1 to allow Total Alkalinity and Total Acidity monthly analyses to be undertaken in the site laboratory. This is due to the remoteness of the site and difficulty in transporting samples to Perth. The Licensee has stated that they "*have a fully equipped laboratory on site supervised by a qualified chemist with experience in NATA-accredited analytical laboratories and methods*. *Total Acidity and Total Alkalinity are measured by titration which is a simple method easily performed on site*". The Licensee has also requested that Total Acidity and Total Alkalinity be added to the 6-monthly sampling schedule so that the monthly in-house analyses are periodically verified against external laboratory testing.	Table 2.4.1 has been updated as per Licensee's request.

References

	Document title	In text ref	Availability
1	A Directory of Important Wetlands in Australia, Third Edition, Environment Australia, 2001	A Directory of Important Wetlands in Australia	accessed at http://www.environment.gov.au
2	Browns Range Event Ponds – L9009, received from Anton Smit (Northern Minerals Limited), dated 13 April 2018	Northern Minerals, 2018a	DWER records (A1659764)
3	Browns Range Project Pilot Plant – Tailings Storage Facility and Evaporation Pond Permitting Design Report (PE801-00241/05) Rev 2, prepared by Knight Piesold Pty Limited for Northern Minerals Limited, June 2016	Knight Piesold, 2016	DWER records (A1185511)
4	Browns Range Project – Surface Water Management Plan (1413059-007-R-Rev0), prepared by Golder Associates for Northern Minerals Limited, March 2015	Golder Associates, 2015a	DWER records (A1185522)
5	Browns Range Rare Earth Element (REE) Project – Geochemical Data Review, prepared by SRK Consulting for Northern Minerals Limited, 11 June 2013	SRK Consulting, 2013	DWER records (A1185528)
6	Browns Range Rare Earths Pilot Plant W6007/2016/1 Construction Compliance Report (BR5-EN-RA-100-006), Northern Minerals Limited, 11 April 2018	Pilot Plant Construction Compliance Report	DWER records (A1651904 and A1651910)
7	Browns Range Rare Earths Pilot Plant W6007/2016/1 Commissioning Report (BR5-EN-RA-100-007), Northern Minerals Limited, 9 June 2018	W6007 Commissioning Report	DWER records (A1688871)
8	Browns Range Rare Earths Project – Assessment on Proponent Information – Environmental Review, Northern Minerals Limited, EPA Assessment No: 1973, June 2014	Northern Minerals, 2014	accessed at http://www.epa.wa.gov.au
9	Browns Range Rare Earths Project – Radiation Technical Report, prepared by JRHC	JRHC Enterprises, 2014	DWER records (A1185520)

	Document title	In text ref	Availability
	Enterprises Pty Ltd for Northern Minerals Limited, June 2014		
10	Browns Range Rare Earths Project – Works Approval Application Supporting Documentation: Wastewater Treatment Plant and Landfill (Report 2014-130), prepared by KASA Consulting for Northern Minerals Limited, April 2015	KASA Consulting, 2015	DWER records (A895157)
11	Code of Practice & Safety Guide. Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing, Radiation Protection Series No. 9, Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), August 2005	ARPANSA, 2005	accessed at http://www.arpansa.gov.au
12	Guidance Statement: Decision Making, Department of Environment Regulation, February 2017	*Guidance Statement: Decision Making*	accessed at www.dwer.wa.gov.au
13	Guidance Statement: Environmental Siting, Department of Environment Regulation, November 2016	*Guidance Statement: Environmental Siting*	
14	Guidance Statement: Licence duration, Department of Environment Regulation, August 2016	*Guidance Statement: Licence duration*	
15	Guidance Statement: Setting Conditions, Department of Environment Regulation, October 2015	*Guidance Statement: Setting Conditions*	
16	Guidance Statement: Risk Assessments, Department of Environment Regulation, February 2017	*Guidance Statement: Risk Assessments*	
17	Guideline: Annual Audit Compliance Reports, Department of Environment Regulation, August 2016	*Guideline: Annual Audit Compliance Reports*	
18	Guideline, Managing naturally occurring radioactive material (NORM) in mining and minerals processing, Department of Mines and Petroleum, 2014	Guideline on managing naturally occurring radioactive material (NORM) in mining and minerals processing	accessed at http://www.dmp.wa.gov.au
19	Landfill Construction Report (BR5-EN-RA-100-0003),	Northern Minerals, 2017c	DWER records (A1533249)

	Document title	In text ref	Availability
	Northern Minerals Limited, October 2017		
20	Landfill Monitoring Plan (BR5-EN-RA-100-0002), Northern Minerals Limited, 2 October 2017		
21	Landfill Waste Classifications and Waste Definitions 1996 (As amended 2009, Department of Environment and Conservation	Landfill Waste Classifications and Waste Definitions 1996	accessed at www.dwer.wa.gov.au
22	Letter correspondence, 'Additional information: W6007/2016/1 – Browns Range pilot trial project (your reference CEO2811/16)', Robin Jones, Northern Minerals Limited, dated 16 January 2017	Northern Minerals 2017a	DWER records (A1358374)
23	Letter correspondence, 'Further information: W6007/2016/1 – Browns Range pilot plant trial project (your reference CEO2811/16)', Robin Jones, Northern Minerals Limited, dated 7 February 2017	Northern Minerals, 2017b	DWER records (A1373016)
24	Letter correspondence, 'Northern Minerals application for works approval and Part V licence – pilot plant project', Robin Jones, Northern Minerals Limited, dated 25 October 2016	Northern Minerals, 2016	DWER records (A1185341 and A1185488)
25	L9009 – NML response to draft conditions and decision document, Robin Jones, Northern Minerals Limited, dated 9 July 2018	Northern Minerals, 2018b	DWER records (A1701545)
26	Ministerial Statement 986	MS 986	accessed at http://www.epa.wa.gov.au
27	National Water Quality Management Strategy, Paper No. 4, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, October 2000	ANZECC, 2000	accessed at http://www.agriculture.gov.au
28	Northern Minerals – Environmental Hazard Advice for Tailings (147613013-003-R-Rev0), prepared by Golder	Golder Associates, 2015b	DWER records (A1185517)

	Document title	In text ref	Availability
	Associates for Northern Minerals Limited, 27 March 2015		
29	Priority Ecological Communities for Western Australia version 27, Species and Communities Branch, Department of Biodiversity, Conservation and Attractions, 30 June 2017	DBCA, 2017a	accessed at https://www.dpaw.wa.gov.au
30	Radiation Management Plan – Browns Range Pilot Plant (BR5-HS-PN-100-001 Rev 2), Northern Minerals Limited, 6 March 2017	Radiation Management Plan	DWER records (A1412436)
31	Report and recommendations of the Environmental Protection Authority, Browns Range Rare Earths Project – Northern Minerals Limited, Report 1523, August 2014	Report 1523	accessed at www.epa.wa.gov.au
32	Threatened and Priority Fauna List, Department of Biodiversity, Conservation and Attractions	DBCA Priority Fauna List	accessed at https://www.dpaw.wa.gov.au