Decision Report

Application for Works Approval

Part V Division 3 of the *Environmental Protection Act 1986*

Works Approval Number	W6409/2020/1
Applicant	Pilbara Iron Company (Services) Pty Ltd
ACN	107 210 248
File Number	DER2020/000195
Premises	Greater Tom Price Iron Ore Mine Mining tenement AML70/4 sections 1-7, 10, 13, 232 – 235, 258, L47/136, L47/209, L47/210, L47/342, L47/645, AG70/3, G47/1258 and L47/668 MOUNT SHEILA WA 6751 As defined by the Premises map attached to the issued works approval
Date of Report	**26/11/2020**
Decision	Works approval granted

Alana Kidd
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Alana Kidd
MANAGER, RESOURCE INDUSTRIES
an officer delegated under section 20 of the *Environmental Protection Act 1986* (WA)

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1. Decision summary

This Decision Report documents the assessment of potential risks to the environment and public health from emissions and discharges during the construction and operation of the Premises. As a result of this assessment, Works Approval W6409/2020/1 has been granted.

2. Scope of assessment

2.1 Regulatory framework

In completing the assessment documented in this Decision Report, the department has considered and given due regard to its Regulatory Framework and relevant policy documents which are available at https://dwer.wa.gov.au/regulatory-documents.

2.2 Application summary and overview of Premises

On 22 April 2020, the applicant submitted an application for a works approval (the application) to the department under section 54 of the *Environmental Protection Act 1986* (EP Act).

The applicant is proposing to deposit waste fines produced from wet processing of ore to a new in-pit Waste Fines Storage Facility (WFSF) in the previously mined and dewatered (dewatering ceased in 2017) South East Prongs (SEP) pit at the Premises. The Premises boundary is approximately 700 m south of the township of Tom Price, while the proposed SEP WFSF is approximately 7.2 km away.

The application relates to category 5 activities under Schedule 1 of the *Environmental Protection Regulations 1987* (EP Regulations) and the assessed production capacity of 620,000 tonnes per annual period. This application will not result in any changes to the assessed design capacity for category 5 on the existing licence L4762/1972/14.

The infrastructure and equipment relating to the premises category and any associated activities which the department has considered in line with *Guidance Statement: Risk Assessments* (DER 2017) are outlined in Works Approval W6409/2020/1.

The Premises includes open cut above and below water table mining of iron ore, ore processing in central processing facilities at approximately 40 million tonnes (Mt) per annum, and associated infrastructure including the rail network which transports processed ore to port facilities located in Dampier.

The beneficiation process generates fines, which are thickened and currently deposited in Tailings Storage Facility (TSF) 2A. However, the existing TSF2A is approaching capacity and a new WFSF is required. The objective of the SEP WFSF project is to provide additional tailings storage capacity to meet the future demands of the Premises' processing facilities. Figure 1 shows the location of the existing TSF2A and the proposed SEP WFSF.

Recent mine planning estimates that up to 1.6 Mt of waste fines will be produced by the processing facilities at the Premises annually, resulting in approximately 30.65 Mt waste fines. The SEP pit has the capacity to store all waste fines produced for the life of wet processing to 2041 and beyond if production increases. The SEP pit has approximately 35 million m^3 of storage between 570 metres Reduced Level (mRL) and 715 mRL. The rate of rise will initially be rapid with the waste fines top surface rising to 590 mRL in the first year, levelling off to reach 675 mRL by the end of 2041. Out of the 30.65 Mt, TSF2A is to receive an estimated 4.05 Mt and SEP WFSF the remaining 26.6 Mt.

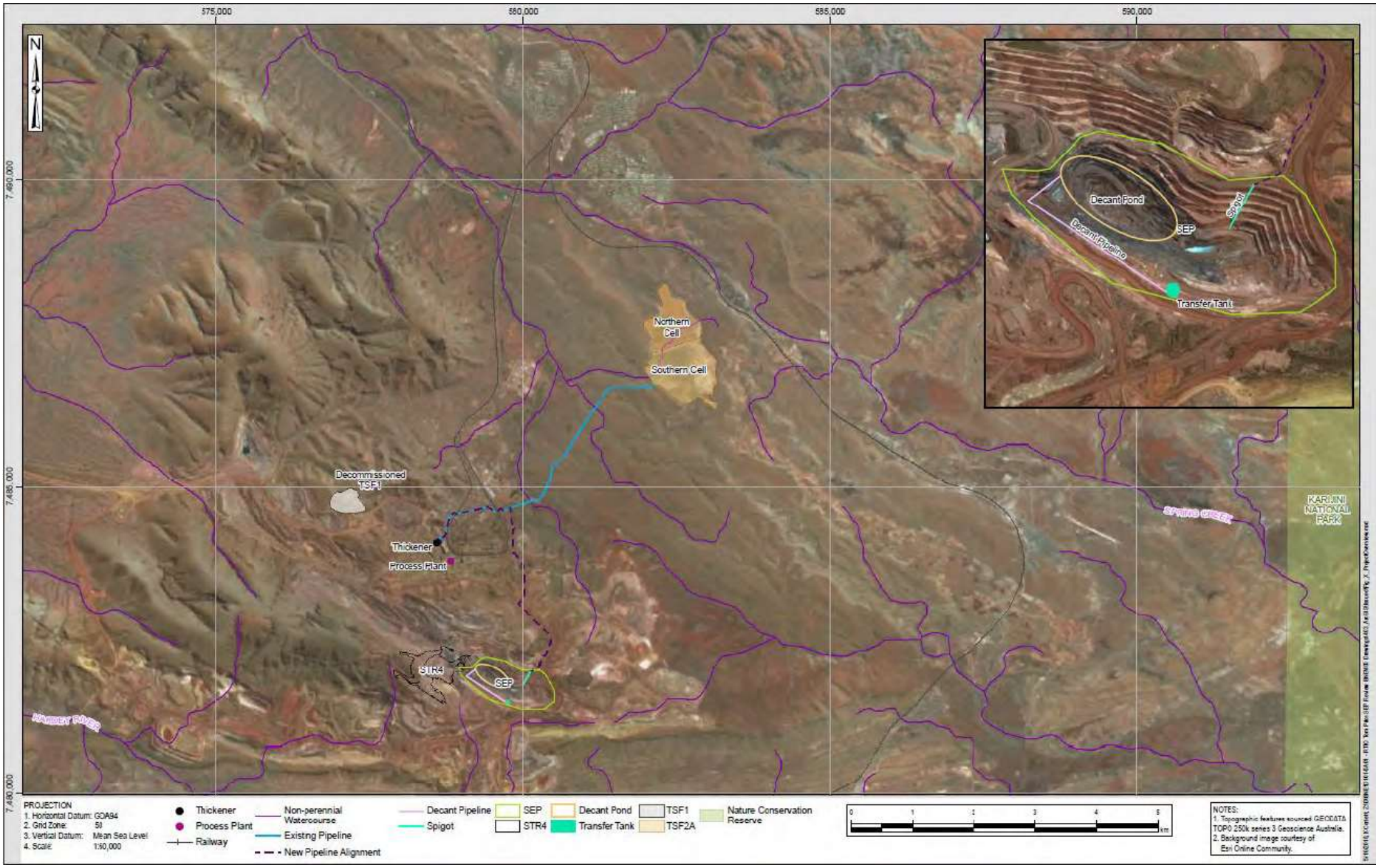

Figure 1: Location of the existing TSF2A and proposed SEP WFSF

The applicant has stated that the proposed SEP WFSF is classified as:

- a significant facility according to *ANCOLD 2012*; and
- a Category 2 facility according to *DMP 2013*.

The SEP WFSF will be totally contained within the previously mined SEP pit, no confining embankments are proposed as the remnant pit walls will form the perimeter of the storage areas.

The infrastructure and equipment required for the proposed SEP WFSF includes (Figure 2):

- Waste fines deposition system consisting of:
    - a new waste fines line;
    - a series of droppers (spigots); and
    - thickener (existing).
- Waste fines storage (SEP pit).
- Decant and treatment system consisting of:
    - new decant pump;
    - decant line;
    - buffer tank; and
    - existing Acid Water Treatment Plant (AWTP) to be refurbished so that decant liquor from the SEP can be treated and added to tailings before returning to the SEP.

The deposition of waste fines to the SEP WFSF will be via a delivery pipeline from the processing plant. There are three sets of deposition droppers (primary deposition, secondary deposition and emergency bypass). During normal operations, waste fines will be deposited from the primary set of droppers, which includes a set of three pipes used to distribute flow and located at the eastern end of the SEP pit. This will result in a beach forming where the waste fines are deposited and a pond of waste fines water developing at the western end of the pit.

The excess water will be decanted via a single pipeline and recycled back to the tailings plant via the transfer tank. From the transfer tank, decant will be pumped to the Buffer Tank, the AWTP where it is treated with hydrated lime ($Ca(OH)_2$) to a pH >7 and then transferred into the thickener where it is mixed with tailings. Flocculant is added at the thickener feedbox, using Flopam AN905 at a rate of approximately 250 kg/month.

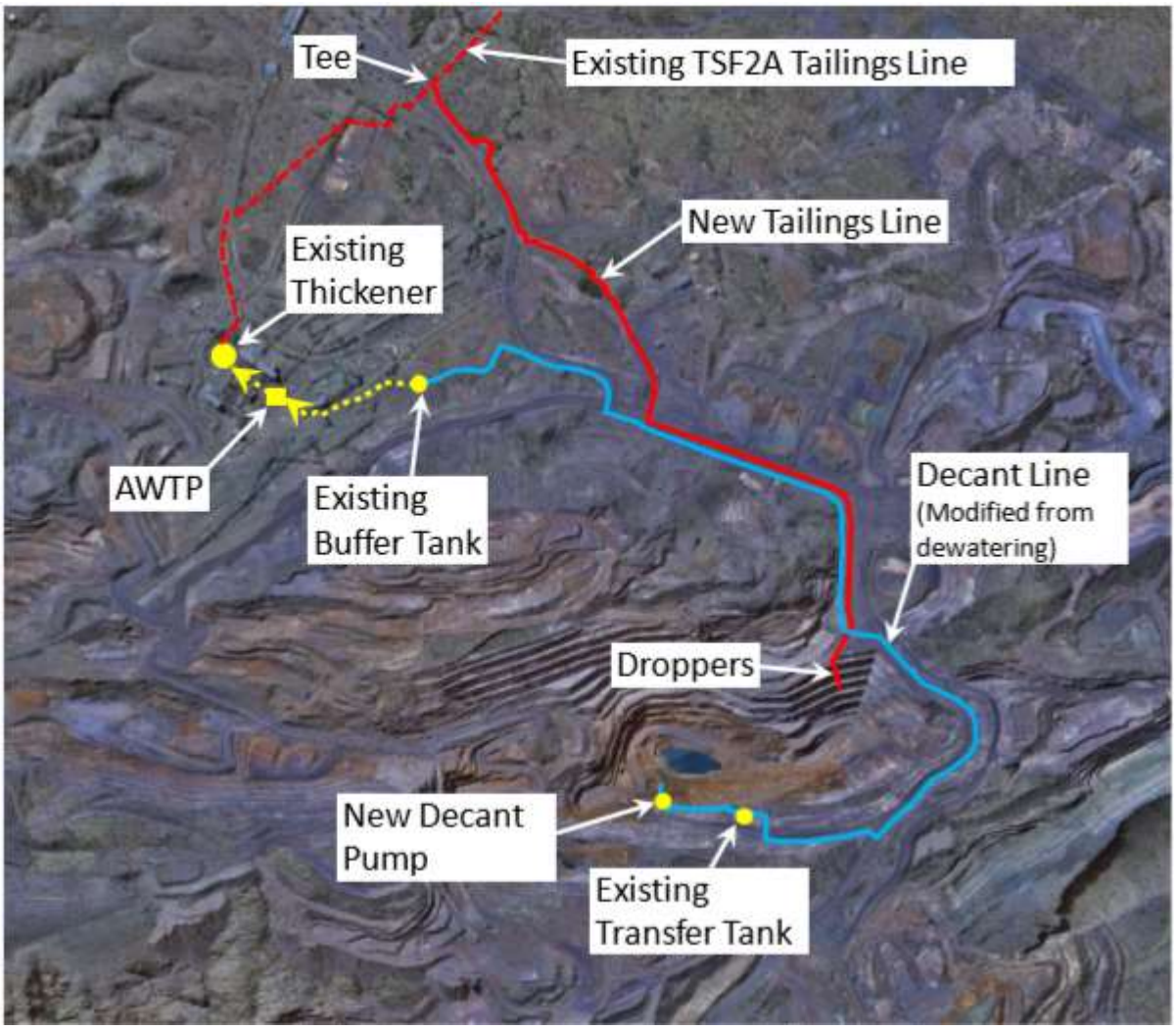

Figure 2: Layout of the proposed SEP WFSF and deposition infrastructure

3. Risk assessment

The department assesses the risks of emissions from prescribed premises and identifies the potential source, pathway and impact to receptors in accordance with the *Guidance Statement: Risk Assessments* (DER 2017).

To establish a Risk Event there must be an emission, a receptor which may be exposed to that emission through an identified actual or likely pathway, and a potential adverse effect to the receptor from exposure to that emission.

3.1 Source-pathways and receptors

3.1.1 Emissions and controls

The key emissions and associated actual or likely pathway during premises construction, commissioning and operation which have been considered in this Decision Report are detailed in Table 1 below. Table 1 also details the proposed control measures the applicant has proposed to assist in controlling these emissions, where necessary.

Table 1: Proposed applicant controls

Emission	Sources	Potential pathways	Proposed controls
Commissioning and Operation			
Acid Mine Drainage (AMD)	Runoff from exposed Potentially Acid-Forming (PAF) lithologies in the pit walls	Surface water runoff	• Filling to tailings to 670 mRL or higher to cover exposed PAF lithologies. • Operation of the AWTP to add alkalinity to decant water.
Spillage of tailings and decant return water	Tailings delivery pipeline	Direct discharge to land and infiltration to soil	• Tees off a steel section of the existing TSF2A tailings pipeline. After the tee there is a short section of steel, followed by HDPE for the remainder of the line to the SEP WFSF. • Magnetic flowmeter installed close to the end of the tailings pipeline. • Pipeline corridor bunded as required. • Sensors to halt pumping if sudden pressure drop is detected. • Suitably sized sumps in low areas along the pipeline routes to contain spillages. • Routine inspection of pipeline infrastructure to identify small or potential leaks.
	Decant return pipeline		• HDPE pipeline from the SEP WFSF to the AWTP. • Pipeline corridor bunded as required. • Suitably sized sumps in low areas along the pipeline routes to contain spillages. • New flowmeter installed on the pipe between Decant Pump Units and Transfer Station. • Existing flowmeters installed at the discharge of AWTP pumps and at the Buffer Tank. • Routine inspection of pipeline infrastructure to identify small or potential leaks.
Tailings seepage	Tailings discharge	Seepage to soil/ground adjacent to the WFSF and infiltration to groundwater	• Decant water recovered from the WFSF at a rate of 45 L/s to 60 L/s during deposition so that water level in the pit is below the groundwater rebound level for most of operations. • Operate AWTP to improve pond quality during deposition. • Filling of waste fines to 670 mRL or higher to cover exposed potentially acid-forming lithologies. • Monitoring undertaken in accordance with Table 2 and Figure 3 during and post-deposition to assess water quality, identify potential seepage, compare with baseline conditions, and compare with model

Emission	Sources	Potential pathways	Proposed controls
			predictions. Monitoring data will also enable optimisation of seepage interception bore locations if they become necessary. • Three additional infill bores will be installed in advance of environmental commissioning to enable radial monitoring. The new bores will augment the existing closer network and provide greater monitoring access during operations (RTIO 2020b). • Three further monitoring bores are planned to be installed distal to SEP by the end of year 2021 (RTIO 2020b).
Pond water Tailings material	Overtopping	Direct discharge to land and infiltration to soil	• Maintaining freeboard adequate to store a 1:100 year, 72-hour rainfall event. • Contain inflows from a 1:100 year Annual Exceedence Probability. • Decant pumping at 60 L/s or more. • Routine inspections to monitor tailings and supernatant water levels.

Table 2: Proposed monitoring of the SEP WFSF

Monitoring Location	Monitoring parameter	Target	Frequency
TBD	Decant pond level during and after waste fines deposition[1]	None specified	Monthly
TBD	Decant pond quality during and after waste fines deposition: pH (pH units)[1] Electrical Conductivity (µS/cm)[1] Alkalinity (HCO_3) (mg/L) TDS (mg/L) Nitrate as N, Nitrite as N, Reactive P (mg/L) Major Ions (mg/L): Br, Ca, Cl, Fl, K, Mg, Na and SO4 Metals / metalloids (mg/L)[2]: Ag, Al, As, B, Ba, Cd, Co, Cr, Cu, Fe, Hg (dissolved), Mn, Mo, Ni, Pb, Sb, Se, Sn, Sr, Ti, V and Zn	None specified	Quarterly
Monitoring bores located around the pit perimeter (Figure 6-4) HM18SEP0001, HM18SEP0002, MB18SEP0001, MB18SEP0002, GR17SEP0001, GR17SEP0002, GR17SEP0003.	Depth to groundwater around WFSF[1]	None specified	Six-month intervals
Monitoring Location	**Monitoring parameter**	**Target**	**Frequency**
Monitoring bores located around the pit perimeter (Figure 6-4) MB12SEP04, MB10SEP01, PZ07SEP03.	Groundwater quality around WFSF during and after waste fines deposition: pH (pH units)[1] Alkalinity (HCO_3) (mg/L) Major Ions (mg/L): Ca, Cl, Fl, K, Mg, Na and SO4 Metals / metalloids (mg/L)[2]: Al, As, Cd, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, and Zn	None specified Comparison against ANZECC (2000) Guidelines for Livestock Drinking Water, taking into consideration background water quality.	Six-month intervals

Note 1: In-field non NATA analysis

Note 2: Site specific triggers are not required given the risk rating for the facility and the absence of sensitive environmental receptors.

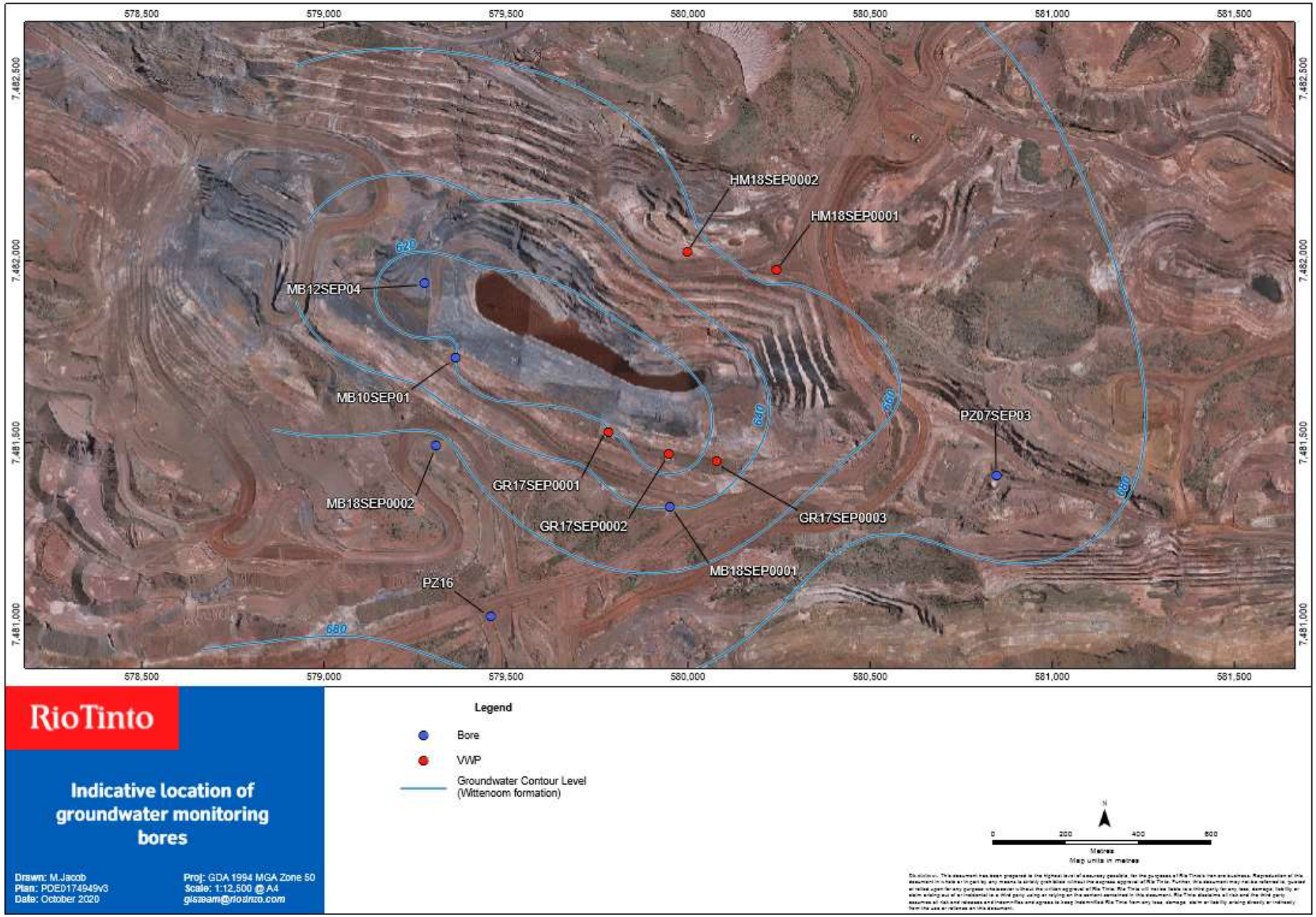

Figure 3: SEP monitoring bore locations

3.1.2 Receptors

In accordance with the *Guidance Statement: Risk Assessment* (DER 2017), the Delegated Officer has excluded employees, visitors and contractors of the applicant's from its assessment. Protection of these parties often involves different exposure risks and prevention strategies and is provided for under other state legislation.

The township of Tom Price is not considered a receptor for this application. While the township is located approximately 700 m to the north of the prescribed premises boundary, it is approximately 7.2 km north-east of the proposed SEP WFSF.

Table 3 and Figures 4, 5 and 6 provide a summary of potential environmental receptors that may be impacted as a result of activities upon or emission and discharges from the prescribed premises *(Guidance Statement: Environmental Siting* (DER 2016)).

Table 3: Environmental receptors and distance from prescribed activity

Environmental receptors	Distance from prescribed activity
Threatened and/or priority flora (Figure 4)	The nearest *Eucalyptus victrix* communities to the proposed SEP WFSF have been recorded more than 3 km from the existing pit. The nearest Priority flora records to the proposed SEP WFSF, *Indigofera ixocarpa* (P2), Sida sp. Barlee Range (P3), *Eremophila magnifica* subsp. *magnifica* (P4) and *Lepidium catapycnon* (P4) have been recorded more than 450 m from the existing pit.
Public Drinking Water Source Area (PDWSA)	The proposed SEP WFSF is located within the Priority 1, Paraburdoo Water Reserve (Figure 5). Drinking water borefields are located more than 10 km from the potential impact site (Figure 6).
Groundwater and Surface Water Areas	The proposed SEP WFSF is located within the Proclaimed Pilbara Groundwater and Surface Water Areas.

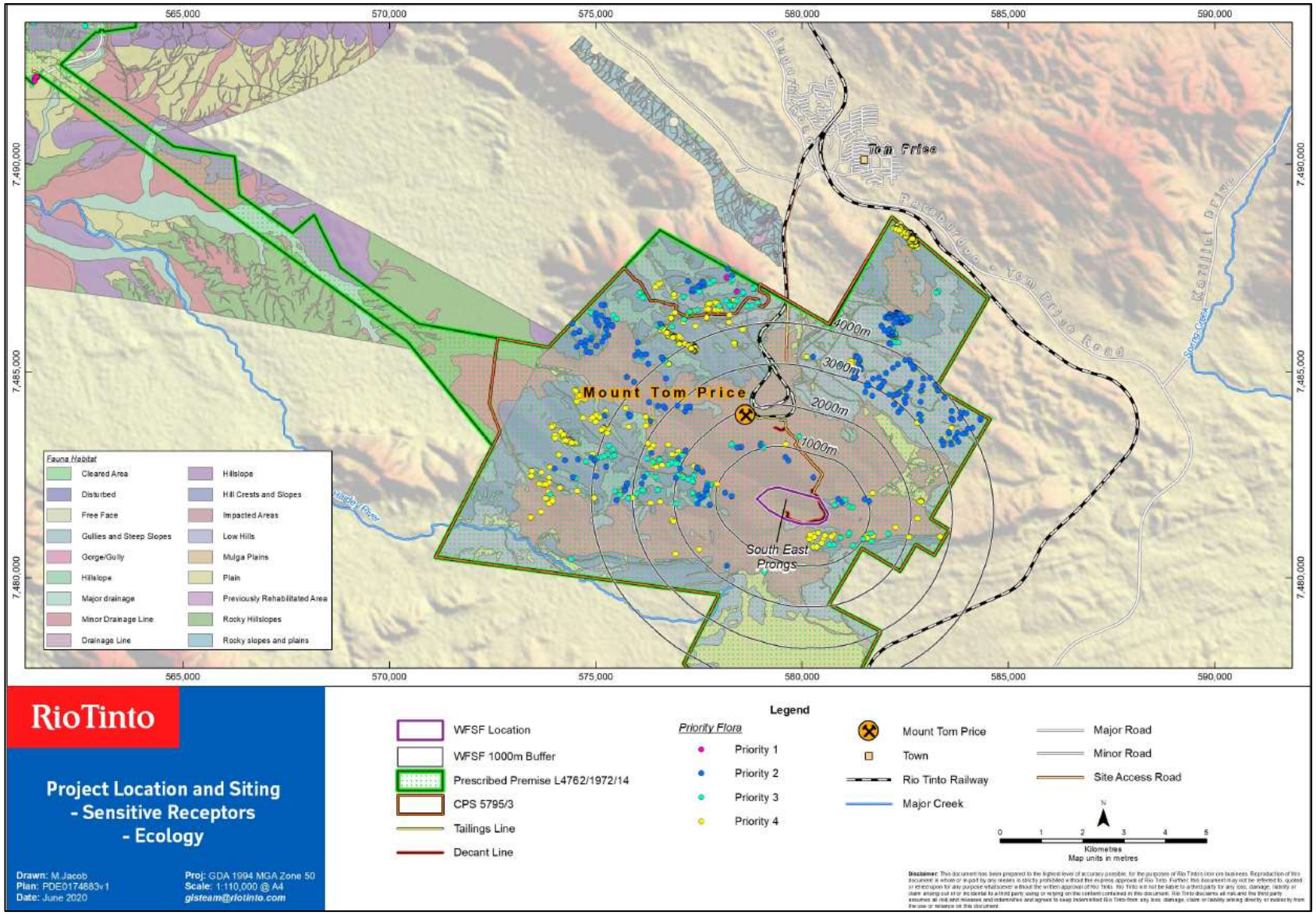

Figure 4: Distance to environmental receptors

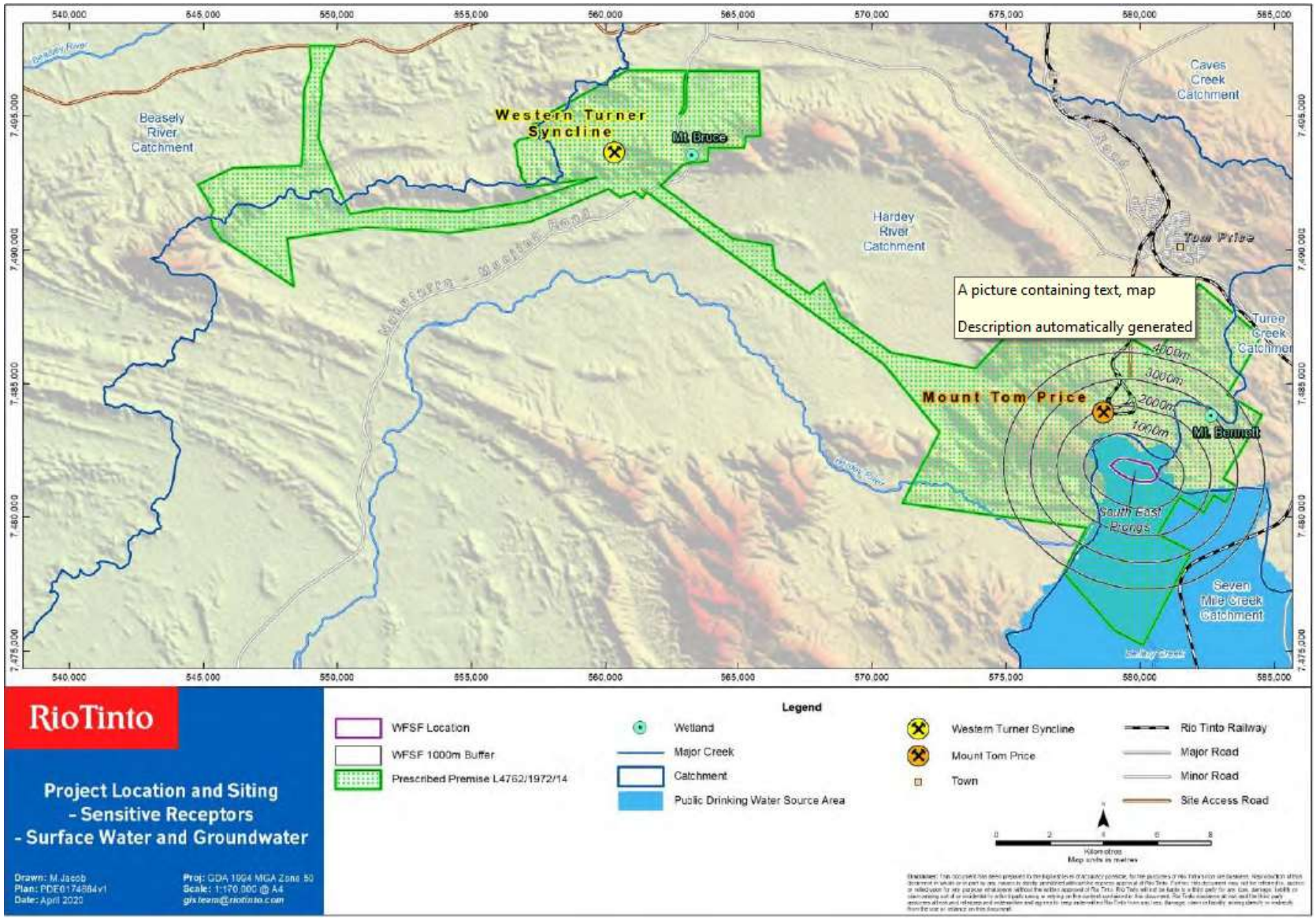

Figure 5: Location of proposed SEP WFSF and PDWSA

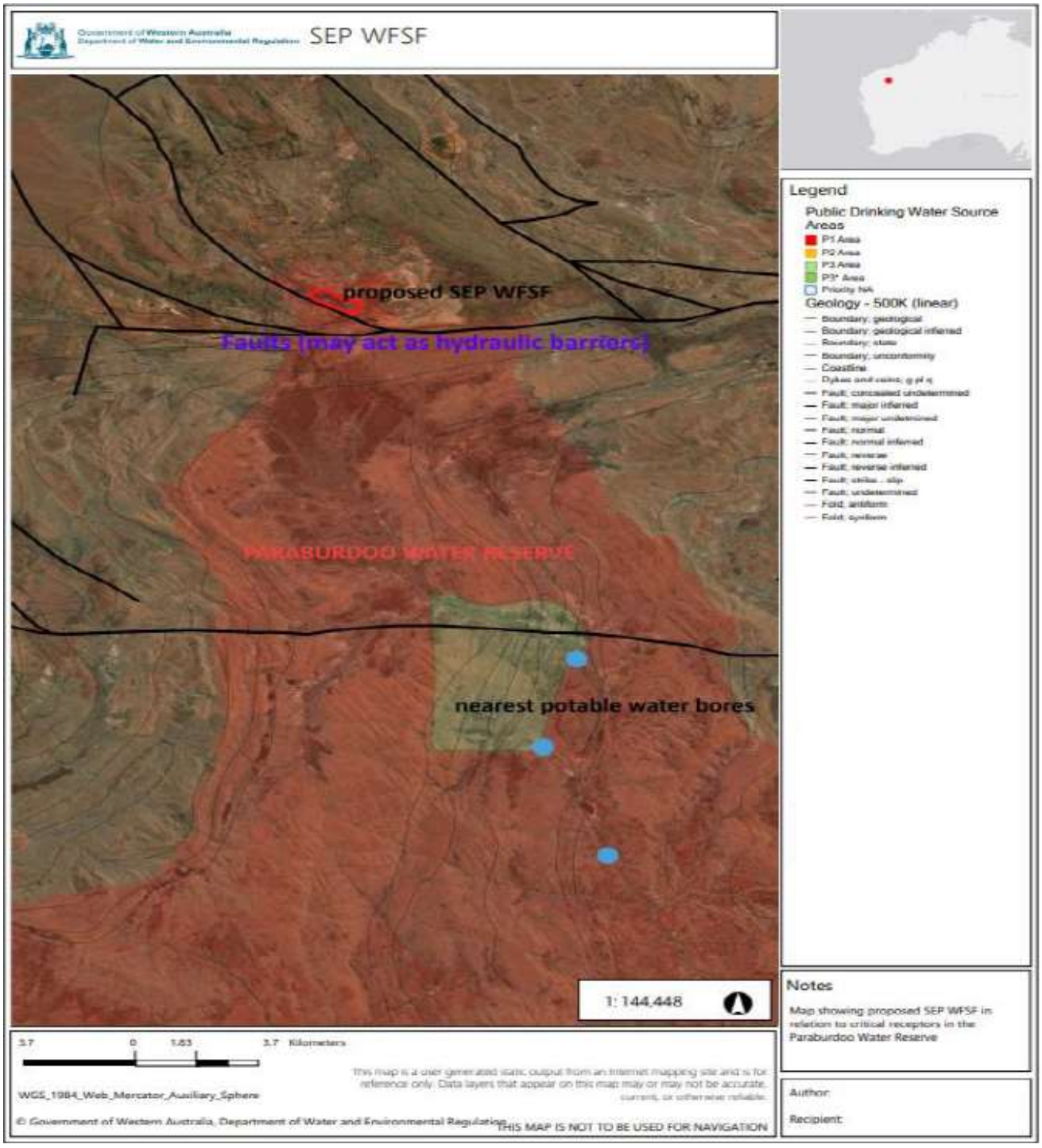

Figure 6: Distance of proposed SEP WFSF to potable water bores (indicated by the blue dots) within the Paraburdoo Water Reserve

3.2 Risk ratings

Risk ratings have been assessed in accordance with the *Guidance Statement: Risk Assessments* (DER 2017) for each identified emission source and takes into account potential source-pathway and receptor linkages as identified in Section 3.1. Where linkages are in-complete they have not been considered further in the risk assessment.

Where the applicant has proposed mitigation measures/controls (as detailed in Section 3.1), these have been considered when determining the final risk rating. Where the Delegated Officer considers the applicant's proposed controls to be critical to maintaining an acceptable level of risk, these will be incorporated into the works approval as regulatory controls.

Additional regulatory controls may be imposed where the applicant's controls are not deemed sufficient. Where this is the case the need for additional controls will be documented and justified in Table 4.

Works Approval W6409/2020/1 that accompanies this Decision Report authorises construction, commissioning and time-limited operations. The conditions in the issued Works Approval, as outlined in Table 4 have been determined in accordance with *Guidance Statement: Setting Conditions* (DER 2015).

A licence amendment is required following the time-limited operational phase authorised under the works approval to authorise emissions associated with the ongoing operation of the Premises i.e. tailings deposition activities. A risk assessment for the operational phase has been included in this Decision Report, however licence conditions will not be finalised until the department assesses the licence amendment application.

Table 4: Risk assessment of potential emissions and discharges from the Premises during commissioning, time-limited operations and operation

Risk Event					Risk rating[1] C = consequence L = likelihood	Applicant controls sufficient?	Conditions[2] of works approval/ licence	Justification for additional regulatory controls
Source/Activities	**Potential emission**	**Potential pathways and impact**	**Receptors**	**Applicant controls**				
Construction								
There are no source-pathway and receptor linkages during construction of the waste fines deposition system and the decant and treatment system for the proposed SEP WFSF.								
Commissioning and time-limited operations of the SEP WFSF								
Runoff from exposed PAF lithologies in the pit walls	AMD	Surface water runoff Leaching resulting in the contamination of groundwater by metals and other toxic inorganic constituents	Paraburdoo Water Reserve, Priority 1 PDWSA Groundwater	Refer to Section 3.1	C = Minor L = Likely **Medium Risk**	N	Condition 1 **Condition 17**	Refer to Sections 3.3 and 3.4
Tailings discharge	Tailings seepage	Seepage from the WFSF potentially contaminating the soil and impacting on the water quality of the groundwater	Paraburdoo Water Reserve, Priority 1 PDWSA Soil Groundwater	Refer to Section 3.1	C = Moderate L = Possible **Medium Risk**	N	**Condition 2** **Condition 3** **Condition 4** Condition 16	Refer to Sections 3.3 and 3.4
Tailings delivery and decant return pipelines	Spillage of tailings through leaks, pipeline ruptures or	Direct discharges to land and infiltration to soil resulting in contamination and vegetation decline	Soil Priority flora	Refer to Section 3.1	C = Minor L = Unlikely **Medium Risk**	N	Condition 1 **Condition 19**	Refer to Section 3.4

Risk Event					Risk rating[1] C = consequence L = likelihood	Applicant controls sufficient?	Conditions[2] of works approval/ licence	Justification for additional regulatory controls
Source/Activities	**Potential emission**	**Potential pathways and impact**	**Receptors**	**Applicant controls**				
	failure							
Overtopping	Pond water Tailings material	Direct discharges to land and infiltration to soil resulting in contamination and vegetation decline	Soil Priority flora	Refer to Section 3.1	C = Moderate L = Rare **Medium Risk**	N	Condition 1 **Condition 19**	Refer to Section 3.4
Operation of the SEP WFSF								
Runoff from exposed PAF lithologies in the pit walls	AMD	Surface water runoff Leaching resulting the contamination of groundwater by metals and other toxic inorganic constituents	Paraburdoo Water Reserve, Priority 1 PDWSA Groundwater	Refer to Section 3.1	C = Minor L = Likely **Medium Risk**	Y	Licence will be updated to include ambient groundwater monitoring requirements for the SEP WFSF	N/A
Tailings discharge	Tailings seepage	Seepage from the WFSF potentially contaminating the soil and impacting on the quality of groundwater	Paraburdoo Water Reserve, Priority 1 PDWSA Soil Groundwater	Refer to Section 3.1	C = Moderate L = Possible **Medium Risk**	N	Licence will be updated to include ambient groundwater monitoring and water balance requirements for the SEP WFSF	N/A

Risk Event					Risk rating[1] C = consequence L = likelihood	Applicant controls sufficient?	Conditions[2] of works approval/ licence	Justification for additional regulatory controls
Source/Activities	**Potential emission**	**Potential pathways and impact**	**Receptors**	**Applicant controls**				
Tailings delivery and decant return pipelines	Spillage of tailings through leaks, pipeline ruptures or failure	Direct discharges to land and infiltration to soil resulting in contamination	Soil Priority flora	Refer to Section 3.1	C = Minor L = Unlikely **Medium Risk**	Y	Licence will be updated to include pipeline containment and inspection requirements	N/A
Overtopping	Pond water Tailings material	Direct discharges to land and infiltration to soil resulting in contamination and vegetation decline	Soil Priority flora	Refer to Section 3.1	C = Moderate L = Rare **Medium Risk**	Y	Existing freeboard condition on licence.	N/A

Note 1: Consequence ratings, likelihood ratings and risk descriptions are detailed in the *Guidance Statement: Risk Assessments* (DER 2017).

Note 2: Proposed applicant controls are depicted by standard text. **Bold and underline text** depicts additional regulatory controls imposed by department.

3.3 Detailed risk assessment – SEP WFSF

3.3.1 Hydrogeology and geology

The Wittenoom Formation, which is the major regional aquifer, is generally present approximately 100 m behind the SEP pit walls. The doubly-plunging synclinal structure at SEP has resulted in the walls of the pit being largely within the Mount McRae Shale (MCS) aquitard (Figure 7).

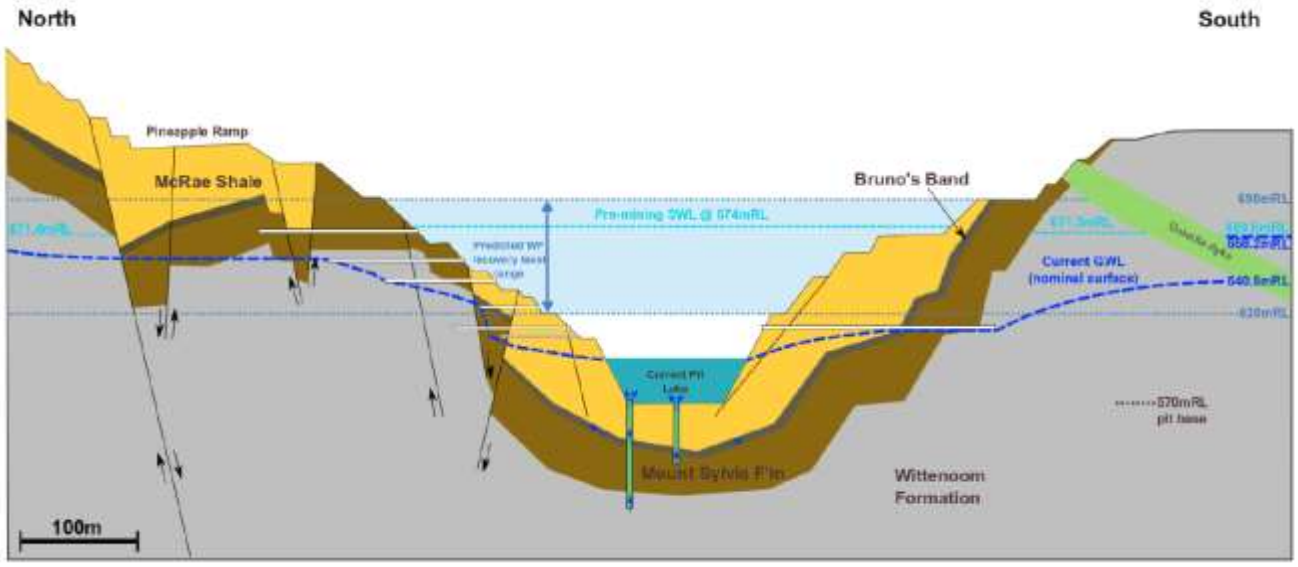

Figure 7: Hydrogeological model of the SEP pit

The SEP pit contains significant exposures of MCS. Sulfides such as pyrite (FeS_2), which can form sulfuric acid when exposed to oxygen and water. Pyrite is found in the MCS. Flushing of pyrite oxidation products from black shale also increases sulphate concentrations. Pyrite oxidation and acid generation makes runoff from the MCS significant to the pH and alkalinity balance of the water body in the SEP pit.

The MCS consists of four units: Footwall Zone (FWZ); Upper MCS with low Sulfur; Middle MCS Reactive with Sulfur over 7% in places; and Lower MCS with moderate Sulfur (over 3% in places).

Unoxidised MCS is further delineated into either “hot” (reactive) or “cold” MCS depending on the quantity of pyritic Sulfur in the material. Both pose an acid drainage risk, but the hot MCS poses an additional self-heating and spontaneous combustion risk due to higher pyrite concentrations.

Figure 8 shows the distribution of lithologies in the SEP pit, which identifies the MCS exposures as follows:

- Hot MCS – top contact defined at 14 m below FWZ and includes both Middle MCS and Lower MCS. Sulfur concentration generally greater than 0.3 weight percent (wt%) (greater than 0.7 wt% common).
- Cold MCS – this comprises all unoxidised MCS that is not oxidised MCS or hot MCS. Sulfur concentration generally less than 0.3 wt% (less than 0.1 wt% common).

The proposed deposition of waste fines into the SEP WFSF should cover a substantial portion of the MCS exposures, which could reduce the generation of AMD.

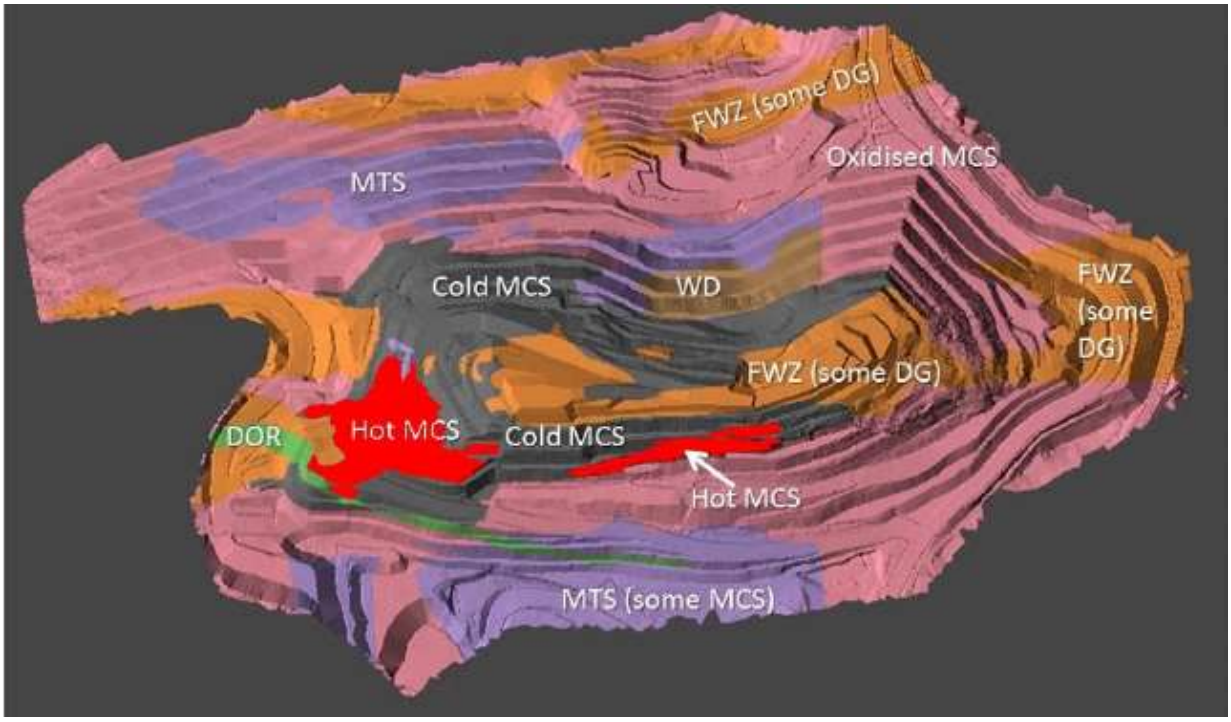

Figure 8: Lithology exposures in the SEP

The pre-mining groundwater level is 674 mRL. It was previously assumed in the application that the SEP pit would maintain a sink post-deposition, however this assumption is not valid. *RTIO 2020a* states that until the SEP pit deposition level exceeds the groundwater level of the surrounding Wittenoom Formation (690 mRL), groundwater inflows will still occur from the Wittenoom Formation into SEP. The rate of inflow will decline as the deposition height increases (i.e. as the head differential reduces). As the head differential reverses towards the latter stages of deposition, minor seepage will occur from the SEP WFSF to the surrounding Wittenoom Formation.

The results of the groundwater and water balance modelling indicate that a decant pond will form above the waste fines during deposition, with modelling pit lake water elevations of around 680 mRL predicted by the end of deposition. After waste fines deposition, the water level declines to a modelled elevation of 676 mRL. Owing to the evaporation rates exceeding rainfall in the Pilbara, excess water in the pit after waste fines deposition will eventually dry up. However, modelling suggests that rainfall will result in a small ephemeral pond forming in the SEP pit during the wet season (pond depth generally less than 1 m).

3.3.2 Seepage

Seepage flux from the SEP pit to the aquifer formations was estimated from a 2D Seep/W numerical model. Seepage modelling was conducted for combinations of:

- Rebound groundwater levels of 620 mRL and 690 mRL;
- Tailings up to 610 mRL, 650 mRL or 690 mRL, plus 2 m water; and
- Sensitivity in tailings permeability for the conservative case of 620 mRL rebound level.

The findings are summarised in Table 5, with the most conservative scenario being:

- Tailings to 690 mRL (conservative compared to forecast ~ 675 mRL);
- Rebound groundwater level of 620 mRL (conservative compared to pre-mining level of around 674 mRL); and
- Tailings permeability of $1x10^{-8}$m/s (highest of the range considered).

The conservative scenario indicated an estimated seepage rate of 3.2 L/s into the surrounding groundwater. *RTIO 2020a* has stated that it "*must be emphasised that the differential in driving head for this scenario is very conservative, and the best estimate is that the final tailings/water level will be similar to the nearby rebound water levels.*"

Table 5: Tailings seepage flux summary

SEP Pit level (mRL)	Submerged Wall area (m^2)	K: $2x10^{-9}$ m/s (0.00017 m/d) & GWL @ 620 mRL		K: $5.8 x10^{-9}$ m/s (0.0005 m/d) & GWL @ 620 mRL		K: $1x10^{-8}$ m/s (0.00086 m/d) & GWL @ 620 mRL		K: $5.8 x10^{-9}$ m/s (0.0005 m/d) & GWL @ 690 mRL	
		m3/d	Flux (l/s)	m3/d	Flux (l/s)	m3/d	Flux (l/s)	m3/d	Flux (l/s)
569.99	0	0	0.0	0	0.0	0	0.0	0	0
610	105087	0	0.0	0	0.0	0	0.0	2.0E-09	2.19E-11
650	262103	33	0.4	59	0.7	77	0.9	3.0E-09	3.16E-11
690	429792	126	1.5	214	2.5	277	3.2	4.0E-09	4.86E-11

The 2D model did not include detail on lithologies within the pit shell. The rates provided in Table 6 are indicative estimates using the seepage modelling results detailed above and apportioned by lithology unit using exposure areas calculated from Figure 8. Seepage estimates are steady state results for tailings at elevation 650 mRL (year 2032) and 690 mRL (beyond year 2042), both assuming a groundwater level of 620 mRL. Other simulations conducted used a groundwater level of 690 mRL, which results in the in-pit facility remaining a sink (RTIO 2020a).

Table 6: Seepage estimates by lithology type

		Lithology Type					
		DOR	MCS Hot	MCS Cold	FWZ	MCS Oxidised	Total Pit
Total Pit Seepage by Lithology	m3/d	0	4	32	21	2	59
(Tailings RL 650 / Groundwater RL620)	l/s	0.00	0.05	0.37	0.24	0.02	0.68
Total Pit Seepage by Lithology	m3/d	1	25	100	47	41	214
(Tailings RL 690 / Groundwater RL620)	l/s	0.01	0.29	1.16	0.55	0.47	2.48

The applicant provided the statistics of groundwater analyses from four bores screened in the Wittenoom and Bruno's Band aquifers and stated that groundwater in aquifers beyond the MCS aquitard were relatively unaffected by AMD.

There are presently no groundwater users in the immediate vicinity of the SEP pit. Potable water borefields within the Paraburdoo Water Reserve (refer to Figure 6) are over 10 km away and generally hydraulically isolated from the SEP pit by multiple east-west trending faults. The borefield is also owned and operated by the applicant (as the licensed water service provider).

3.3.3 Tailings characterisation

The application states that tests were undertaken on five samples of tailings solids and liquors from the Premises in 2013. The tests and results of the ore samples (similar to that which is currently being processed and planned for deposition to the SEP WFSF) is shown in Table 7.

Table 7: Tailings characterisation tests and results

Tailings solid	
Tests	**Results**
Sulfur forms (Total Sulfur and SO_4-S)	Total Sulfur concentration in the five samples ranged from 0.03 to 0.05% resulting in low Mean Potential Acidity (MPA) of 1-2 kg H_2SO_4/t.
Acid Neutralising Capacity (ANC) determinations	ANC range was 1 kg H_2SO_4/t or less.
Net Acid Generation (NAG) testing	NAG pH ranged from 5.3 to 6.3. These classify the tailings as barren with respect to acid generation and neutralisation, that is, no significant acid-forming potential or acid neutralising potential.
Multi-element solids assay	pH ranged from 6.8 to 7.2. Low concentrations of most metals and metalloids were observed in deionized and saline water extractions of the tailings.
Tailings liquor	
Tests	**Results**
pH and Electrical Conductivity Acidity / Alkalinity Multi-element solids assay	pH ranged from 5.9 to 6.7. Alkalinity in three liquors ranged from 17 to 26 mg/L as $CaCO_3$.

Geochemical testing was completed in 2019 from samples taken from the tailings stream downstream of the thickener (post treatment) during normal processing of the ore being delivered at that time, the results showed (RTIO 2020a):

- pH of the tailings is confirmed neutral and ~ pH 8.
- Sulphate and metal concentrations are in the same order as the 2013 results.
- Screening level acid base accounting data confirms that the tailings are low Sulfur.
- The testing shows that the tailings are negligible or no potential for acid drainage to occur.

In May 2020, tailings daily percent solids were taken. Table 8 compares the 2013 and May 2020 results.

Table 8: Comparison of 2013 and May 2020 results for tailings solids content and density

Geotechnical		
Parameter	**Results from 2013**	**Results from May 2020**
Material Description	Low-Plasticity, Clayey SILT	-
Solids Content (end of pipe)	35%	34.5% Median of 31 samples
Particle Size Distribution	Sand: 3% Silt: 72% Clay: 25%	Not available
Soil particle density	3.66 (t/m^3)	3.69 (t/m^3) Median of 8 samples
In Situ Dry Density (Nominal)	1.50 t/m^3	-

3.3.4 Decant water quality

Decant water quality may be affected by acid runoff from the pit walls. At the modelled elevation of the decant pump inlet (620 mRL), the delay until decant recovery is approximately six months.

Dosing at the AWTP is required to offset the acidity of the SEP pit water returned to the plant during tailings deposition. The proposed treatment method is as follows:

- Decant water at the SEP WFSF will be collected by pumps located at the western extent of the pit and pumped to the buffer tank (provides storage and allows particulate matter to settle).
- Water from the buffer tank will be gravity fed into two treatment tanks at the AWTP where it will be dosed (average dosing rate is 0.7 tonnes per day) with hydrated lime ($Ca(OH)_2$) resulting in a neutral pH.
- Treated water and any treatment sludge (consisting mostly of gypsum, ferrihydrite and $Al(OH)_3$) by-product will be pumped to the tailings launder at the process plant, where it will be mixed with raw tailings.
- The combined material will then be moved to the tailings thickener, where flocculant will be added to encourage the settling of tailings solids.
- The thickened underflow, containing the thickened tailings will be sent to the SEP WFSF and the remaining water recycled for use in processing around site.

Water quality modelling indicated that providing the alkalinity of tailings water at the thickener underflow is maintained at 180 mg/L as $CaCO_3$, then the quality of water in the SEP decant pond is expected to be moderately saline (TDS <2,000 mg/L) and neutral to moderately alkaline (approximately pH 8) throughout deposition.

The application states that alkaline conditions significantly reduce the solubility of metals (e.g. Zinc (Zn), Lead (Pb) and Nickel (Ni)). Therefore, the metal mass in the tailings-water system is overwhelming present in the solid phase, rather than in solution, and dissolved metal concentrations are low. However, some metals (e.g. Aluminium (Al)) and metalloids (e.g. Arsenic (As) and Selenium (Se)) are more soluble under alkaline conditions. Table 9 shows the likely pit water quality following geochemical modelling.

Table 9: Summary of modelled concentrations with increased tailings alkalinity

	Deposition			Post-deposition			Guidelines			
Units mg/L	MIN	MEDIAN	MAX	MIN	MEDIAN	MAX	Livestock	NPUG	Drinking Water	
									Health/Aesthetic	
pH	*2.53*	8.06	8.22	6.63	7.38	8.01	-	-	6.5—8.5	-
Al	0.001	2.25	**30**	0.001	0.02	1	5	0.2		0.2
Alk	0	50	78	2	10	41	-	-		
As	0.000002	0.000004	0.07	0.00001	0.0001	0.002	0.5	0.1	0.01	
B	0.18	0.25	0.40	0.43	2.15	3.70	-	40	4	
Ba	0.007	0.009	0.010	0.003	0.004	0.007	-	20		
Ca	13	85	219	181	481	540	-	-		
Cd	0.000001	0.000002	0.0008	0.00001	0.0001	0.001	0.01	0.02	0.002	
Cl(3)	50	205	335	355	609	646	-	250		250
Co	0.001	0.005	0.317	0.012	0.127	0.760	1	-		
Cr	0.0002	0.001	0.04	0.002	0.004	0.01	1	-		
Cu	0.000004	0.0001	**0.42**	0.0001	0.0001	0.0005	0.4	20	2	
F	0.06	0.07	0.41	0.12	0.48	0.79	-	15	1.5	
Fe	0.00004	0.00005	98	0.0001	0.0001	0.0007	-	0.3		0.3
K	0.001	21	38	32.94	267	493	-	-		
Mg	32	111	167	189	760	1395	-	-		
Mn	0.00000004	0.000001	0.79	0.000001	0.00004	0.002	-	5	0.5	0.1
Mo	0.0002	0.0007	0.01	0.001	0.07	0.12	0.15	0.5	0.05	
N(5)	0.000003	0.00003	0.001	0.0001	0.03	0.05	400	500	50	
Na	27	158	258	274	477	515	-	-		
Ni	0.0004	0.002	0.94	0.01	*0.05*	0.33	1	0.2	0.02	
P	0.0003	0.001	0.02	0.002	0.004	0.01	-	-		
Pb	0.00000001	0.00000004	0.003	0.0000001	0.0000003	0.000002	0.1	0.1	0.01	
S(6)	*582*	*705*	**1124**	**1278**	**4699**	**7378**	1000	1000	500	250
Sb	0.0002	0.0002	*0.02*	0.0004	*0.03*	*0.06*	-	-	0.003	
Se	0.01	0.01	*0.02*	*0.02*	**0.29**	**0.55**	0.02	0.1	0.01	
Si	2.83	3.26	5.05	5.98	133	262	-	-		
Sr	0.03	0.31	0.50	0.53	1.19	1.53	-	-		
U	0.0002	0.001	0.004	0.002	0.04	0.08	-	0.17		
Zn	0.0001	0.001	0.66	0.001	0.01	0.11	20	3	-	3
TDS	723	1300	2060	2343	7466	11157	-	-		

Notes:

(1) Livestock guideline ANZECC (2000)

(2) Non-potable use guidelines DoH (2014)

(3) Drinking water guidelines

(3) Cl was used to charge balance input solution compositions

3.4 Additional regulatory controls imposed

Conditions 2, 3 and 4:

The applicant has proposed ambient groundwater monitoring as per Table 2 and at the locations specified by Figure 3. The applicant has also reviewed its conceptualisation and now considers three additional infill bores in advance of environmental commissioning to be adequate to enable radial monitoring for emissions (RTIO 2020b). Under this works approval the three additional monitoring bores will be installed in the vicinity of the SEP WFSF.

The applicant has also stated that three further monitoring bores are planned to be installed distal to SEP by the end of year 2021 (RTIO 2020b).

Grounds: The department will adopt a precautionary approach with respect to seepage from the SEP WFSF as the proposed SEP WFSF is located within the Priority 1, Paraburdoo Water Reserve PDWSA.

Design requirements for the construction and installation of the three new monitoring bores have been included to ensure bores are installed correctly and able to detect contamination (if applicable).

Monitoring of ambient groundwater levels and quality is required to determine if the SWL is changing indicating seepage from the WFSF or water quality is deteriorating. Comparison to the *NHMRC NRMMC 2011* is required as the proposed SEP WFSF is located within the Priority 1, Paraburdoo Water Reserve PDWSA. Monitoring prior to environmental commissioning is required to ensure that baseline groundwater quality data can be collected and used as a comparison against results obtained during commissioning and operation.

Condition 17:

The works approval requires that the waste fines that will be deposited in the SEP pit are subjected to saturated column testing using methodologies such as those outlined in *Watson et. al (2016).*

Grounds: Information from carrying out the above geochemical testing could be utilised in reactive transport models to predict the potential impacts of seepage from the SEP pit on offsite receptors.

The application was referred internally with the following key points identified:

- *"The geochemical modelling that has been undertaken to predict changes in pore-water composition in the TSF is considered to be of limited value. This is because the modelling has not considered the likelihood that the reaction of tailings mineral surfaces with organic carbon will produce highly reducing conditions that could lead to the release of dissolved iron, manganese, arsenic and antimony into pore-water; and*
- *As a result of this, additional geochemical testing of mixtures of waste fines with powdered shale is recommended to provide information for groundwater monitoring of the site, and to help develop closure strategies for the facility."*

Rationale: *"The PHREEQC model does not consider the likelihood that highly anaerobic conditions will develop within pore-water in tailings materials below the water table. This would probably take place due to the microbial oxidation of organic carbon. The source of organic carbon is likely to be the carbonaceous shales that are exposed in pit wall rocks, where microbes are able to break-down highly resistant organic compounds in weathered shales into simpler,*

more soluble and bioavailable organic compounds (Matlakowska and Sklodowska, 2011; Włdacsyk et al., 2018).

The organic compounds that are produced by the biodegradation of exposed shale units could then be utilised as a food source by iron-reducing bacteria populations that would probably be present in the iron-rich tailings deposited below the water table. The partial reductive dissolution of iron oxy(hydroxide) mineral surfaces triggered by microbial action, has the potential to release high concentrations of iron, manganese, arsenic and antimony from solid materials into the tailings pore-water."

The following was recommended:

- The waste fines that will be deposited in the SEP pit are subjected to saturated column testing using methodologies such as those outlined in Watson *et. al* (2016).
- The testing is carried out on mixtures of the waste fines with various proportions of powdered MCS. This is necessary to determine the likely range of concentrations of chemical constituents of potential concern that will develop in pore water during tailings deposition.
- The column testing is undertaken for an extended period (several months) during the period of tailings deposition.

Condition 19:

An inspection regime for the following:

- Tailings delivery and decant return pipelines; and
- SEP WFSF embankment freeboard.

Grounds: Visual inspection of containment infrastructure and pipelines are required during commissioning and time limited operations. The applicant is required to keep records of visual monitoring undertaken (but is not required to report this on an annual basis instead is required to record the information in their books).

Conditions 3, 5, 11, 17 and 20:

The following reports are required to be submitted:

- Bore construction report evidencing compliance with condition 2, ensuring the correct depth is targeted and depicting the new bore locations.

- Environmental Compliance Report demonstrating that the infrastructure has been installed as committed to and as per condition 1 including a summary of the monitoring results required by condition 4.

- Environmental Commissioning Report providing a summary of the commissioning activities with timeframes, waste fines deposited, summary of monitoring results obtained and environmental performance.

- Saturated column report including an analysis of the concentrations of contaminants in the leachate and detailing the methodology used and the source of the samples.

- Time limited operations report providing timeframes, waste fines density (solid vs water content), the WFSF water balance summary, summary of monitoring results obtained and environmental performance.

Grounds: Reporting requirements are necessary for the administration of the works approval, validating ongoing acceptability of the operations and for validation against design criteria prior to operation.

4. Consultation

Table 10 provides a summary of the consultation undertaken by the department.

Table 10: Consultation

Consultation method	Comments received	Department response
Application advertised on the department's website (3/08/2018)	None received	N/A
Local Government Authority (Shire of Ashburton) advised of proposal on 10/08/2020	None received	N/A
Department of Mines, Industry Regulation and Safety (DMIRS)	DMIRS provided comment on the 27 July 2020 outlining that the following "*key points of the geotechnical assessment are:* • *No significant changes to the mined out SEP pit are required to use it as an in-pit WFSF, and no embankments are required within or outside the pit to contain waste fines.* • *Based on modelling waste fines slurry pond level the average pond level by the end of deposition is expected to be at 680 mRL, which is 43 m below the lowest crest elevation (723 mRL) of the land bridge.* • *The documentation recognises that the pond may overtop the land bridge at 723 mRL level and spill into the adjacent STR3/4 pit under a combined scenario of PMP rainfall occurs before the residual decant pond volume has been reduced and the pond level is already too high when waste fines deposition stops. The documentation states that this risk can be managed by decant water pumping at the recommended rate of 48 L/s or higher."*	The department noted the comments provided.
Applicant was provided with the draft documents on 12/10/2020	Applicant provided comments on 5/11/2020. Refer to Appendix 1.	Refer to Appendix 1.

The application was referred internally to the Department's North West Planning Advice, with implementation of the following recommended:

- "*An addition of a 1 or 2 metre layer of alkaline amendment on top of the tailings post deposition to neutralise acidity generated from potentially available sulphide minerals or water flowing off the remaining Mount McRae Shale exposures in the pit walls;*

- *The creation of passive treatment cells to strip out any contaminant metals or sulphates; and*
- *Consideration for vegetating the post deposition surface with suitable flora of a local provenance to encourage evapotranspiration."*

5. Conclusion

Based on the assessment in this Decision Report, the Delegated Officer has determined that a works approval will be granted, subject to conditions commensurate with the determined controls and necessary for administration and reporting requirements.

References

1. Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy; no. 4.
2. Australian National Committee on Large Dams (ANCOLD) 2012, *Guidelines on the Consequence Categories for Dams*.
3. Department of Environment Regulation (DER) 2016, *Guidance Statement: Environmental Siting*, Perth, Western Australia.
4. DER 2017, *Guidance Statement: Risk Assessments*, Perth, Western Australia.
5. DER 2015, *Guidance Statement: Setting Conditions*, Perth, Western Australia.
6. Department of Mines and Petroleum (DMP) 2013, *Tailings storage facilities in Western Australia – code of practice*: Resources Safety and Environment Divisions, Western Australia.
7. Matlakowska, R. and Sklodowska, A., 2011, Biodegradation of Kupferschiefer black shale organic matter (Fore-Sudetic Monocline, Poland) by indigenous microorganisms. *Chemosphere*, **83(9)**, 1255-1261.
8. National Health and Medical Research Council (NHMRC) Natural Resource Management Ministerial Council (NRMMC) 2011, *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*, Commonwealth of Australia, Canberra.
9. Rio Tinto Iron Ore (RTIO) 2020a, *Application for a Works Approval under the Environmental Protection Act 1986 – Response Version 2 to Request for Information*, 19 June 2020.
10. RTIO 2020b, *Re: [External] Applicant Notification – Application for a Works Approval W6409/2020/1 – Draft Instrument and Decision Report*, 5 November 2020.
11. Watson, A., Linklater C. and Chapman, J., 2016. *Backfilled Pits – Laboratory-Scale Tests for Assessing Impacts on Groundwater Quality*. Proceedings of the AusIMM Life-of-Mine Conference, Brisbane, 28-30 September, 2016. The paper is available from web site https://www.srk.com.hk/en/publication/au-backfilled-pits-laboratory-scale-tests-assessing-impacts-groundwater-quality.
12. Włdacsyk, A., Lirski, M., Fogtman, A., Koblowska, M., Bidziński, G. and Koblowska, M., 2018. The oxidative metabolism of fossil hydrocarbons and sulfide minerals by the lithobiontic microbial community inhabiting deep subterrestrial Kupferschiefer black shale. *Frontiers in Microbiology*, **9**, 972. The paper is available from web site https://www.frontiersin.org/articles/10.3389/fmicb.2018.00972/full?report=reader

Appendix 1: Summary of applicant's comments on risk assessment and draft conditions

Condition	Summary of applicant's comment	Department's response
Works Approval Table 2: Infrastructure requirements - groundwater monitoring bores	Request that the requirement to complete new monitoring bores at least 60 days prior to the SEP WFSF time limited operations be revised to 30 days prior to accommodate constraints on implementing construction within this timeframe.	The department has changed the timeframe to 30 calendar days prior to the commencement of environmental commissioning.
	The applicant has reviewed its conceptualisation and now considers three additional infill bores in advance of environmental commissioning to be adequate to enable radial monitoring for emissions in locations proximate to this facility. The applicant has stated the following: • That the new bores will augment the existing closer network and provide greater monitoring access during operations; and • Three further monitoring bores are planned to be installed distal to SEP by end of year 2021.	The Table 2 has been updated to stipulate three new groundwater monitoring bores rather than six. The Schedule 2: Monitoring table has been updated to reflect this change as well.
	The applicant considers the detail of monitoring bore construction suggested within the ASTM standard exceeds the requirement for water quality sampling bores for the purpose indicated. The applicant requests agreement that constructing monitoring bores according to the normal Australian Drilling Industry Association (ADIA) Standard is sufficient.	The ASTM standard has been retained based on the following advice "*In fractured rock aquifer settings like Tom Price, it is important that monitoring bores adequately target fracture zones that are the main conduits for groundwater flow, and that the screened interval of each monitoring bores adequately targets the zone where most of the groundwater flow (and solute transport) takes place. The ASTM standard meets this requirement much better than the proposal by Rio to use a lesser standard*".
Works Approval Condition 16 and Schedule 2: Monitoring	The department has requested that monthly samples from nine groundwater bores be collected during the environmental commissioning and time limited operations phase. The applicant requests that the monitoring frequency is revised from monthly to quarterly due to safety, access and low potential for seepage.	The department has changed the frequency for the water quality monitoring during environmental commissioning and time limited from monthly to quarterly.

Condition	Summary of applicant's comment	Department's response
Works Approval Condition 17	The Department has requested that the applicant runs column testing for multiple works approvals (Greater Tom Price, Hope Downs 4 and the Mesa A/Warramboo Iron Ore Mines). Given the three projects are commencing over similar timeframes, the laboratory able to complete this work does not have enough columns available to run the tests for all three of these sites at the same time for the minimum 13 week period. The applicant requests that the specified timeframe to complete the least testing (i.e. during commissioning and/or time limited operations) is removed as this may not be achievable considering the resources available at the laboratory. The applicant commits to completing the works under W6409/2020/1 or under the amended Part V licence, L4762/1972/14.	The department has removed "during commissioning and/or time limited operations", noting the applicants commitment to completing this work under W6409/2020/1 or under the amended Part V licence, L4762/1972/14.
Works Approval Condition 21(e)	The applicant requests monitoring be compared against ANZECC (2000) Guidelines for Livestock Drinking Water, taking into consideration background water quality.	As per the department's decision in section 3.4 this will be retained as Australian Drinking Water Guidelines based on the proposed SEP WFSF being located within the Priority 1, Paraburdoo Water Reserve PDWSA.
Decision Report Figure 2	The Licensee requests Figure 2: Layout of the proposed SEP WFSF and deposition infrastructure be updated with Figure 1 which presents a change in route for the first 1800m of tailings line After the completion of a closure study for TSF2A it was determined that filling TSF2A gradually by depositing there once a year during the dry season would provide a better closure outcome, minimising decant pond and building the desired closure profile. This change in operating philosophy means that a separate flushing system is not required (utilising the clarified water to flush as per current process), meaning tie into the line near the thickener is no longer necessary. This allows the tie-in point to be moved away from the plant, simplifying the design and operation. This new route will have better bunding and access as it follows the LV road and utilises the existing decant pipeline corridor, allowing easier monitoring and improved containment.	Figure 2 has been updated with the new figure provided by the applicant.

Appendix 2: Application validation summary

SECTION 1: APPLICATION SUMMARY					
Application type					
Works approval	☒				
Licence	☐	Relevant works approval number:		None	☐
		Has the works approval been complied with?		Yes ☐ No ☐	
		Has time limited operations under the works approval demonstrated acceptable operations?		Yes ☐ No ☐ N/A ☐	
		Environmental Compliance Report / Critical Containment Infrastructure Report submitted?		Yes ☐ No ☐	
		Date Report received:			
Renewal	☐	Current licence number:			
Amendment to works approval	☐	Current works approval number:			
Amendment to licence	☐	Current licence number:			
		Relevant works approval number:		N/A	☐
Registration	☐	Current works approval number:		None	☐
Date application received		22/04/2020			
Applicant and Premises details					
Applicant name/s (full legal name/s)		Pilbara Iron Company (Services) Pty Ltd			
Premises name		Tom Price Iron Ore Mine			
Premises location		Mining Lease (ML) 4SA			
Local Government Authority		Shire of Ashburton			
Application documents					
HPCM file reference number:		DER2020/000195			
Key application documents (additional to application form):		*Tom Price Iron Ore Mine – South East Prongs In-Pit Waste Fines Storage Facility Works Approval Application.* *Tom Price SEP in-pit TSF Part V Support Document (Appendix A).* *RFI response 1.* *RFI response 2 including the South East Prongs*			

	Hydrogeological Conceptualisation.
Scope of application/assessment	
Summary of proposed activities or changes to existing operations.	Construction and operation of an in-pit TSF Facility within the existing South East Prongs (SEP) Pit.

Category number/s (activities that cause the premises to become prescribed premises)

Table 1: Prescribed premises categories

Prescribed premises category and description	**Proposed production or design capacity**	**Proposed changes to the production or design capacity (amendments only)**
Category *5*: Processing or beneficiation of metallic or non-metallic ore	Proposed – 620,000 tonnes per annum	*N/A*

Legislative context and other approvals		
Has the applicant referred, or do they intend to refer, their proposal to the EPA under Part IV of the EP Act as a significant proposal?	Yes ☐ No ☒	Referral decision No: Managed under Part V ☒ Assessed under Part IV ☐
Does the applicant hold any existing Part IV Ministerial Statements relevant to the application?	Yes ☐ No ☒	Ministerial statement No: EPA Report No:
Has the proposal been referred and/or assessed under the EPBC Act?	Yes ☐ No ☒	Reference No:
Has the applicant demonstrated occupancy (proof of occupier status)?	Yes ☒ No ☒	Certificate of title ☐ General lease ☐ Expiry: Mining lease / tenement ☒ Expiry: 24/03/2028 Other evidence ☐
Has the applicant obtained all relevant planning approvals?	Yes ☐ No ☐ N/A ☒	Approval: Expiry date: If N/A explain why? *Iron Ore (Hamersley Range) Agreement Act 1963* and *Mining Act 1978*
Has the applicant applied for, or have an existing EP Act clearing permit in relation to this proposal?	Yes ☒ No ☐	CPS No: 5795 No clearing is proposed under this application.

Has the applicant applied for, or have an existing CAWS Act clearing licence in relation to this proposal?	Yes ☐ No ☒	Application reference No: N/A Licence/permit No: N/A
Has the applicant applied for, or have an existing RIWI Act licence or permit in relation to this proposal?	Yes ☒ No ☐	GWL107418(18)
Does the proposal involve a discharge of waste into a designated area (as defined in section 57 of the EP Act)?	Yes ☒ No ☐	Name: Pilbara Type: Proclaimed Groundwater Area/Surface Water Area Has Regulatory Services (Water) been consulted? Yes ☒ No ☐ N/A ☐ Regional office: North West
Is the Premises situated in a Public Drinking Water Source Area (PDWSA)?	Yes ☒ No ☐	Name: Paraburdoo Water Reserve Priority: P1 Are the proposed activities/ landuse compatible with the PDWSA (refer to WQPN 25)? Regulatory Services (Water) have stated "*Existing and future mining proposals are considered compatible with conditions within the water reserve and should be guided by the Water quality protection guidelines for mining and mineral processing 1–11 and other relevant water quality protection notes published by DWER*". Yes ☒ No ☐ N/A ☐
Is the Premises subject to any other Acts or subsidiary regulations (e.g. *Dangerous Goods Safety Act 2004, Environmental Protection (Controlled Waste) Regulations 2004, State Agreement Act xxxx*)	Yes ☐ No ☒	*Iron Ore (Hamersley Range) Agreement Act 1963*
Is the Premises within an Environmental Protection Policy (EPP) Area?	Yes ☐ No ☒	

Is the Premises subject to any EPP requirements?	Yes ☐ No ☒	
Is the Premises a known or suspected contaminated site under the *Contaminated Sites Act 2003*?	Yes ☒ No ☐	Classification: Possibly contaminated – investigation required Site ID: 9193 Date of classification: May 2017 Reasoning: Due to the hydrogeochemical properties associated with the interaction of Potentially Acid-Forming (PAF) mineral wastes, black shale exposures in wall rock, pit lakes, surface water and groundwater at the Tom Price mine. The SEP pit contains significant exposures of PAF black shale.