Government of Western Australia
Department of Water and Environmental Regulation

Amendment Report

Application for Licence Amendment

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

Licence Number	L8457/2010/2
Licence Holder	Silver Lake (Integra) Pty Limited
ACN	093 278 436
File Number	2012/006865
Premises	Salt Creek Processing Facility Mount Monger Road EMU FLAT WA 6431 Legal description – Mining tenements M25/71, M25/125, M25/133, M25/307, M25/347 General purpose lease L25/27, L25/31, L25/33, L25/41 Miscellaneous licence G25/02 As defined by the Premises maps attached to the Revised Licence
Date of Report	07 November 2023
Decision	Revised licence granted

Christine Pustkuchen
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A/MANAGER, RESOURCE INDUSTRIES REGULATORY SERVICES
an officer delegated under section 20 of the *Environmental Protection Act 1986* (WA)

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1. Decision summary

Licence L8457/2010/2 is held by Silver Lake (Integra) Pty Limited (Licence Holder) for the Salt Creek Processing Facility (the premises), located on mining Tenements M25/71, M25/125, M25/133, M25/307, M25/347, general purpose leases L25/27, L25/31, L25/33, L25/41, miscellaneous licence G25/02.

This Amendment Report documents the assessment of potential risks to the environment and public health from proposed changes to the emissions and discharges during the operation of the Premises. As a result of this assessment, revised licence L8457/2010/2.

2. Scope of assessment

2.1 Regulatory framework

In completing the assessment documented in this Amendment 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

On 2 May 2023, the Licence Holder submitted an application to the department to amend licence L8457/2010/2 under section 59 and 59B of the *Environmental Protection Act 1986* (EP Act). The following amendments are being sought:

- To amend the authorised embankment heights of tailings storage facility (TSF) 2 (refer to Section 2.2.1); and
- To authorise the operation of TSF2 Stage 2 embankment (refer to Section 2.2.2).

This amendment is limited only to changes to Category 5 activities from the existing licence, with no change to the assess production/design capacity authorised in the existing licence. No changes to the aspects of the existing licence relating to Category 6 and 64 have been requested by the Licence Holder.

2.2.1 Authorised TSF2 embankment heights

The department authorised the construction of TSF2 Stage 1 to Stage 3 embankments under works approval W6316/2019/1. At the time of assessment, the embankment heights authorised in the works approval were based on the design report provided to support the assessment of the works approval (Coffey 2019). However, during the on-ground construction works, the Licence Holder noticed elevation discrepancy of approximately four metres between the design drawings the premises' local network (SLR 2021) (Table 1).

Table 1: Erroneous and corrected TSF2 embankment heights

Stage	Erroneous embankment height	Corrected embankment height	Status
Stage 1	RL 308.0 m	RL 304.0 m	Constructed and operational.
Stage 2	RL 311.0 m	RL 307.0 m	Constructed with operation authorised under this amendment.
Stage 3	RL 314.0 m	RL 310.0 m	Construction to commence in 2023. Operation not authorised.

The correct embankment height was reflected in the construction compliance document and as-built drawings provided to the department following completion of the TSF2 starter embankment construction (Coffey 2020). In response, the Licence Holder applied to amend works approval W6316/2019/1 to detail the correct embankment heights authorised for construction (DWER 2023).

This licence amendment intends to clarify and clearly detail the correct embankment heights authorised for operation at TSF2 (i.e., tailings deposition).

2.2.2 Operation of TSF2 Stage 2 embankment

In 2021, upon completion of the Stage 1 starter embankment, the department authorised the operation of TSF2 under licence L8457/2010/1 (DWER 2021). At the time, additional monitoring bores were installed as a result of the decommissioning of several existing monitoring bores due to the construction of the Stage 1 starter embankment. Since then, monitoring of these bores have indicated ongoing issues with groundwater mounding and recently, surface expression of hypersaline groundwater.

As part of this amendment, the Licence Holder has requested authorisation to operate the Stage 2 embankment, which was fully constructed in March 2023. Through this amendment, the department intended to review the existing requirements for the operation of TSF2. Furthermore, the department considered existing groundwater mounding at the facility, as well as whether the operation of the Stage 2 embankment will lead to further seepage and groundwater mounding that may impact surrounding sensitive receptors.

2.3 Environmental incidents at TSF2

In January 2021, TSF2 Stage 1 starter embankment was constructed at the premises. The TSF2 was constructed on the footprint Salt Creek Pit, which was originally an open cut mine pit that had been used as an in-pit TSF since 2015. Tailings deposition into TSF2 was authorised in July 2021. Tailings were deposited until capacity of the in-pit TSF was reached and begin the fill aboveground, contained by the starter embankment. Since commencing operations at TSF2, several environmental concerns have become apparent:

1. Groundwater mounding; and
2. Surface expression of hypersaline groundwater.

Section 2.3.1 to Section 2.3.3 provides further detail on these issues, as well as actions taken by the Licence Holder to date to manage them. These should be considered in any seepage-related risks assessed for the continued operation of TSF2, at the Stage 2 embankment and beyond.

2.3.1 Groundwater mounding

During operation of the TSF2 Stage 1 embankment, surrounding groundwater monitoring bores began displaying clear upward trends in standing water level (SWL). Monitoring bores MB001 and MB002 exceeded their SWL limit of four metres below ground level (mbgl) since the March 2021. Monitoring bore NMB02, which was newly installed along with the TSF2 Stage 1 embankment, had also exceeded the limit in that same monitoring event, which was also the first monitoring event at NMB02. These monitoring bores have continued to exceed their respective SWL limits during each subsequent monitoring event. Further SWL analysis is detailed in Section 3.3.5.

Over time, other monitoring bores (e.g., NMB01, NMB06) have also exceeded their SWL limit. While the remaining monitoring bores around TSF2 have not exceeded their SWL limit (e.g., BH02, NMB03, IGRSM006), a rising trend was observed nonetheless and are likely to exceed their SWL limit as well in the near future, at their current trajectory.

2.3.2 Groundwater management plan

Shortly after TSF2 had commenced operation, the Licence Holder was required to design and submit a Groundwater Management Plan (GMP) in response to the SWL exceedances. The GMP (Coffey 2021), submitted in October 2021, detailed measures to manage groundwater mounding at TSF2, which was assessed through a licence amendment (DWER 2022). The proposed measures included the following:

1. Amending the SWL limit for NMB02 and NMB03 to better reflect pre-mining ambient SWLs (i.e., 0.9 mbgl and 1.5 mbgl, respectively).
2. Construction and operation of a seepage recovery drain (North Groundwater Recovery Drain) to intercept seepage along the north-western corner of TSF2.
3. Construction of a piezometer NMB05 to measure SWL directly hydraulically downgradient of the seepage recovery drain.
4. Additionally, the department required the Licence Holder to construct a replacement groundwater monitoring bore NMB06, which is approximately 20 m hydraulically downgradient from the seepage recovery drain and piezometer NMB05 to replace monitoring bore MB001, which was decommissioned due to the construction of the seepage recovery bore.

While monitoring bores NMB02 and NMB03 were compliant with their modified SWL limit, continued groundwater mounding at both locations resulted in the former bore exceeding its modified limit during the June 2023 monitoring event.

The North Groundwater Recovery Drain has been operating since November 2022. However, there was no clear, significant reduction in SWL. The recovery drain intercepted monitoring bore MB001, where mounding was most severe and groundwater was closest to the surface. Monitoring bore MB001 had to be decommissioned to construct the recovery drain. Despite operation of the recovery drain for over six months, the shallow piezometer NMB05 installed at the drain and replacement bore NMB06, which was installed 20 m hydraulically downgradient of the recovery drain, continued to show SWLs comparable to MB001. Specifically, SWL at monitoring bore NMB06 have been shallower than 0.6 mbgl since December 2022. This suggested that the North Groundwater Recovery Drain had limited efficacy in reducing the effects of groundwater mounding in its immediate vicinity.

In the Annual Environmental Report (AER) for the 2022 annual period, the Licence Holder reported that the health of large Eucalypts at the toe of the TSF2 drain have declined in health, with more individuals displaying signs of stress during the Quarter 1 2023 monitoring event, compared to the previous quarter (SLR 2023). A rising water table was the reason cited for the decline. Overall, specifies richness has declined at three of the eight quadrats monitored since 2021 (Stantec 2023).

In the same quarter of 2023, an inspection conducted by the Department of Mine, Industry Regulation and Safety (DMIRS) on 21 March 2023 found vegetation stress and potentially death on the northern boundary of TSF2, which was advised to be a result of the rising SWL (Figure 1a). The TSF2 toe drain was also showed to be filled with seepage water, which suggested that recovery pumping may not have been undertaken adequately to reduce water level at the drain (Figure 1b).

2.3.3 Surface expression of hypersaline groundwater

On 8 May 2023, the Licence Holder encountered an area of light-discoloured soil directly west of the TSF2. The area was thought to be impacted by groundwater mounding and surface expression of hypersaline groundwater, resulting in a salt crust (Figure 1c) and degradation of vegetation (Figure 1d).

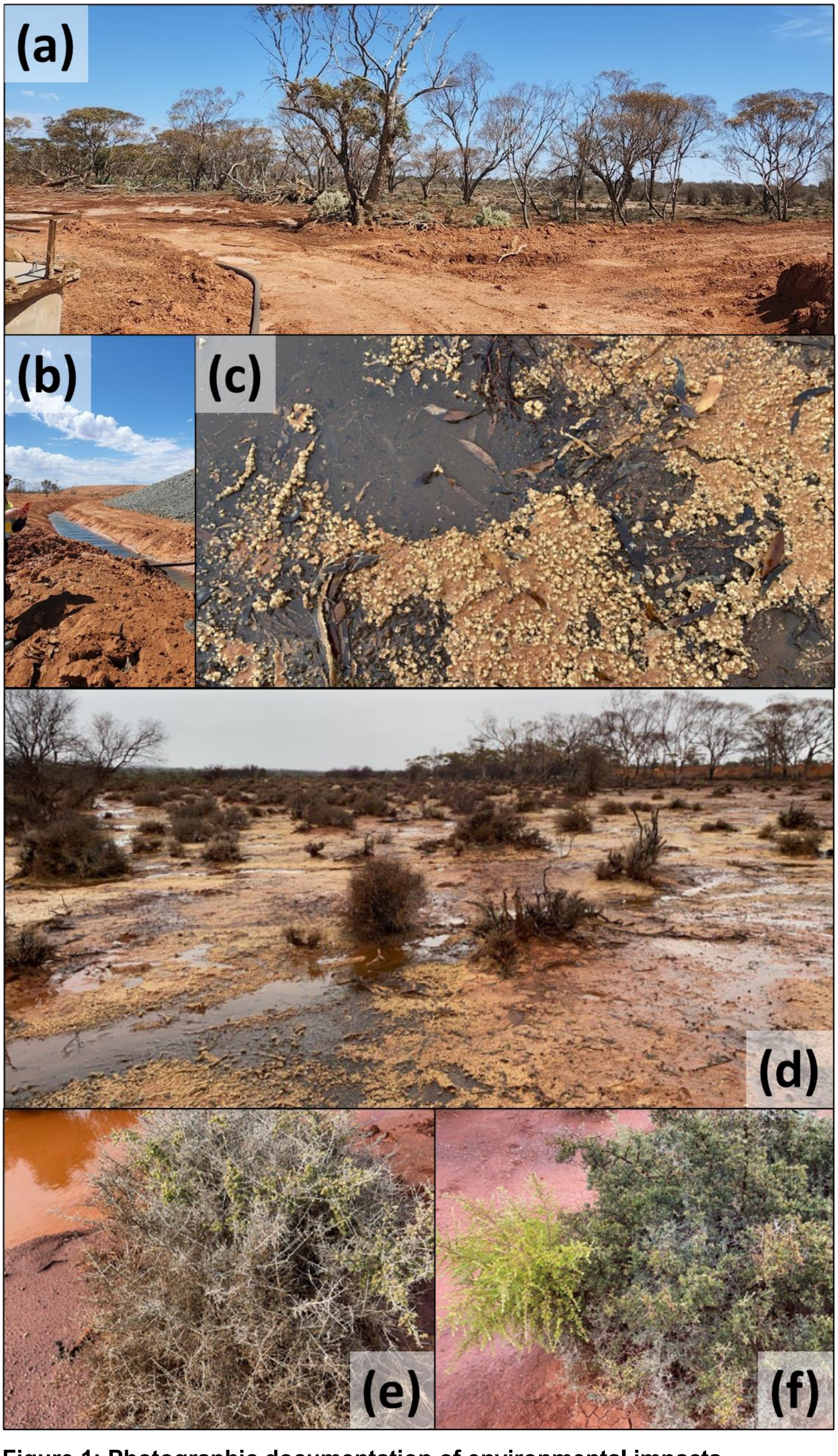

Figure 1: Photographic documentation of environmental impacts

Surface expression was evident at two locations: the largest area of primary impact is adjacent to TSF2, including parts of Salt Creek, while a smaller, secondary area is groundwater discharging out of a decommissioned un-grouted bore standpipe adjacent to the topsoil stockpile, approximately 100 m north of the primary impact area (Figure 2). The Licence Holder formally notified the department through an N1 form on 9 May 2023.

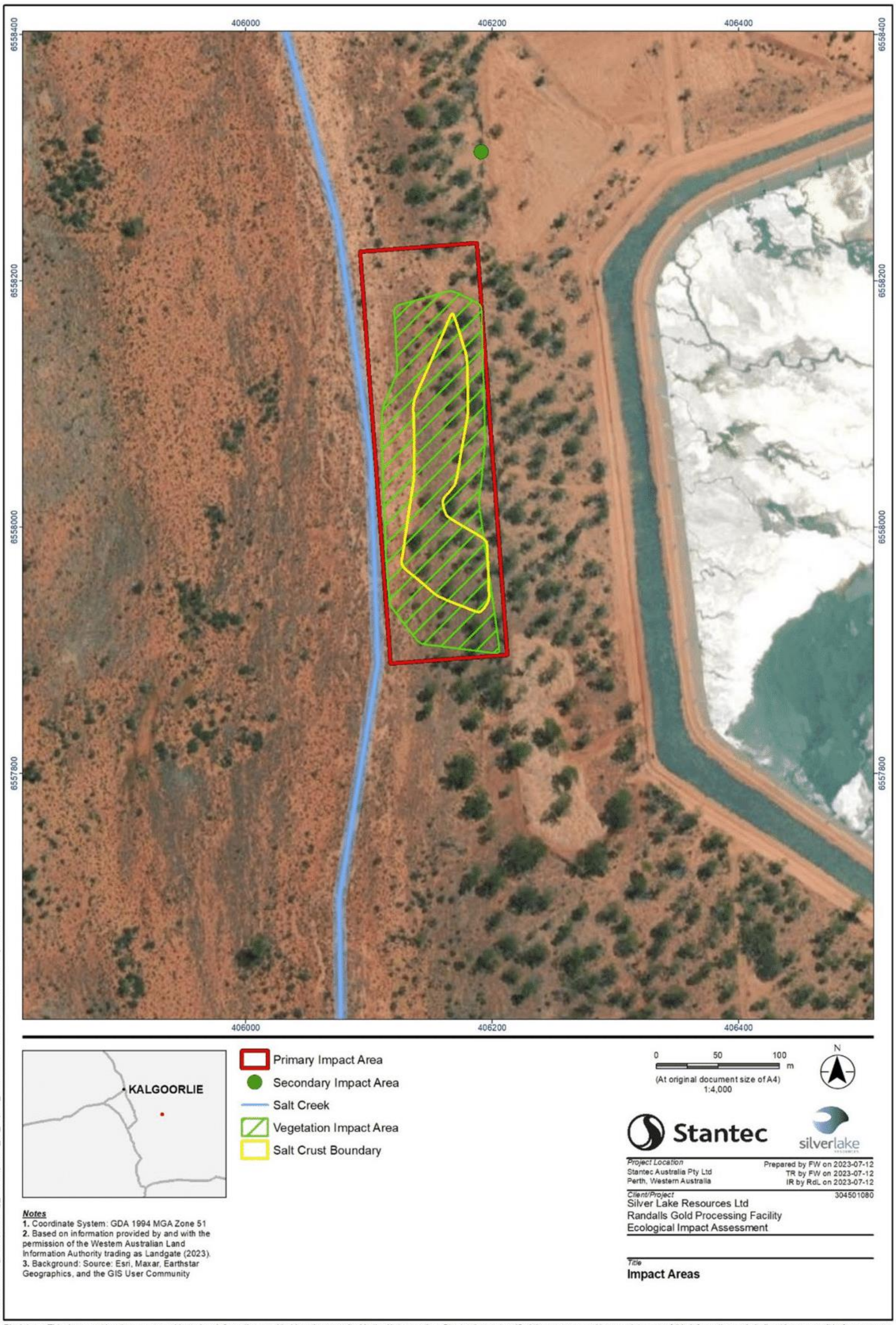

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Figure 2: Extent of vegetation impact and salt crusting

In response to this incident, the Licence Holder constructed an open seepage recovery drain (West Groundwater Recovery Drain) along the eastern boundary of the primary impact area. The recovery drain is approximately 200 m long, extending adequately north to capture groundwater discharging from the decommissioned bore. The recovery drain has a depth between 1.8 mbgl to 3.5 mbgl, excavated to refusal at the calcrete cap rock subsurface layer, and grades towards a sump. Recovered water from the sump is pumped at approximately 180 m^3/day.

In addition to the West Groundwater Recovery Drain, the Licence Holder has also taken the following actions to address surface expression of hypersaline groundwater, including:

1. Commissioning an ecological impact assessment to assess impacts of the surface expression incident in May 2023 on surrounding sensitive ecological receptors, including taking water and sediment samples for analysis (Stantec 2023);
2. Commissioning an addendum to the GMP, which included a review of existing seepage management practices and recommendations for future tailings deposition and embankment raises at TSF2 (Coffey 2023b);
3. Undertaking fortnightly drone capture of the impacted vegetation area to identify any further surface expression and/or expansion of the impacted area; and
4. Undertaking monthly vegetation monitoring around the boundaries of the impacted areas to better understand the extent of vegetation stress.

Since the incident in May 2023, there has not been any further surface expression reported, though saturation of surface soils and pooling of water has been observed after rainfall events (Coffey 2023a).

Findings from the ecological impact assessment indicate the following (Stantec 2023):

1. Salt crusting at the primary impact area causes salinisation of surface runoff, which results in more saline streamflow at Salt Creek, compared to water quality upstream of the primary impact area.
2. Sample locations where high surface water salinity was observed correlated with area with high sediment salinity.
3. Similar to surface water quality, vegetation stress and death were observed at the primary impact area (Figure 1e), with vegetation condition classified as ‘good’ outside the primary impact area (i.e., individual plants appearing healthy and displaying new growth) (Figure 1f).
4. The assessment concluded that the cause of vegetation stress and death at the primary impact area was likely due to waterlogging and salt loading outside the species tolerance limit due to groundwater mounding and surface expression of hypersaline groundwater.

The assessment recommended natural recovery by rainfall to dissipate and flush salt crusts from the impacted soils and sediments as it would cause the least disturbance to the environment (Stantec 2023). While the timeframe for natural recovery will depend on climactic conditions, this was not considered a significant issue as there are no significant or unique ecological values in the area.

As part of this amendment, the department considered the findings and recommendations from the GMP addendum, which included the construction and operation of a cut-off drain parallel to the West Groundwater Recovery Drain (East Groundwater Recovery Drain) (refer to Section 3.3 for detailed risk assessment).

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 *Guideline: Risk assessments* (DWER 2020b).

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 operation which have been considered in this Amendment Report are detailed in Table 2 below. Table 2 also details the proposed control measures the Licence Holder has proposed to assist in controlling these emissions, where necessary.

Table 2: Licence Holder controls

Emission	Sources	Potential pathways	Proposed controls
Tailings supernatant water	Tailings deposition to TSF2 Stage 2 embankment	Vertical infiltration and lateral migration through the base and embankment wall of TSF2	**<u>Existing controls (previous assessed)</u>** • Operation of the existing North Groundwater Recovery Drain (Figure 3); • Seepage recovery drains lead to a sump, where seepage is pumped to TSF2 supernatant pond; • Downstream toe drains have been installed to capture seepage flow at the toe of the TSF2 embankment and will continue to be pumped back to the TSF2 supernatant pond; • Quarterly vegetation monitoring will continue to be undertaken, in accordance with licence L8457/2010/2; • Groundwater monitoring will continue to be undertaken, in accordance with licence L8457/2010/2; and • Supernatant pond at TSF2 will be maintained to be as small as possible and adjacent to the Integrated Waste Landform to minimise hydrostatic pressure. **<u>Additional controls proposed.</u>** • Ecological Impact Assessment has been conducted to inform impacts to sensitive receptors from historical seepage and groundwater mounding at TSF2 (Stantec 2023); • An addendum to the Groundwater Management Plan has been undertaken reviewing seepage management measures at TSF2 going forward (Coffey 2023b); • Continued operation of the open West Groundwater Recovery Drain on the western portion of TFS2 (Figure 3); • Pumping rates of seepage recovery drain sumps has been increased through pump upgrade and will be

Emission	Sources	Potential pathways	Proposed controls
			continued to induce a steeper hydraulic gradient, allowing for capture of greater seepage volumes; • Standing water level within the seepage recovery drains will be maintained at 4 mbgl or deeper; • Standing water levels will be monitored weekly at monitoring bores near the seepage recovery drains to assess their efficacy; • An additional cut-off drain (East Groundwater Recovery Drain) that extends through the superficial soils into the underlying rock layer will be installed parallel to the open seepage recovery drain, located between the existing open seepage recovery drain and the TSF2 western embankment (Figure 3); • Existing production bores PB1 and PB5 will be investigated and if determined to be operable, equipped with submersible pumps for seepage recovery. If neither are operable, drilling should be undertaken in the area to intersect the same water yielding target; • Vegetation monitoring will be undertaken at the boundary of the impacted zone on an ongoing monthly basis; • Groundwater expression at the decommissioned turkeys nest North Dam (i.e., located north of TSF2, adjacent to NMB01) will be pumped out, where water is observed; and • Recovery drain water will continue to be used preferentially to minimise volume of bore water added to the TSF to ‘make up’ the volume required to form the TSF2 supernatant pond for pumping back to the processing facility. As additional seepage collected from the seepage recovery drains will be pumped back to the supernatant pond, less bore water will be required. • Toe drain sumps for the Stage 2 embankment will be connected to the existing West Groundwater Recovery Drain via a trench and backfilled with crushed rock material so that recovered seepage will continue to be collected while the toe drains are covered during and after the construction of the Stage 3 embankment.

Figure 3: Existing and proposed groundwater recovery drains at TSF2

3.1.2 Receptors

In accordance with the *Guideline: Risk assessments* (DWER 2020b)*,* the Delegated Officer has excluded employees, visitors and contractors of the Licence Holder's from its assessment*.* Protection of these parties often involves different exposure risks and prevention strategies and is provided for under other state legislation.

Table 3 below provides a summary of potential human and environmental receptors that may be impacted as a result of activities upon or emission and discharges from the prescribed premises *(Guideline: Environmental siting* (DWER 2020a)).

Table 3: Sensitive human and environmental receptors and distance from prescribed activity

Human receptors	Distance from prescribed activity
None	N/A
Environmental receptors	**Distance from prescribed activity**
Native vegetation	A vegetation survey of the premises identified *Maireana*, *Eremophila*, *Eucalyptus*, *Acacia* and *Atriplex* as the dominant genera (Outback Ecology 2009b). Vegetation communities at the premises were considered typical of the Goldfields region and was well represented outside the premises. Recent vegetation quadrat monitoring showed vegetation conditions ranging from 'Degraded' to 'Very Good', with the majority of the quadrats rated as 'Poor' or 'Degraded'. Evidence of grazing from goats and sheep are the likely cause of the altered vegetation composition and structure, particularly at the shrubs, herb and grass strata. Riparian vegetation, including *Cratystylis subspinescens*, *Maireana pyramidata* and *Tecticornia* species were sighted along Salt Creek (Outback Ecology 2009a), which are common species on saline clay pans (Western Australian Herbarium 2023).

Surface water body	Salt Creek, a tributary of Lake Randall, is located approximately 200 m west of the TSF2 western embankment. The creek is ephemeral, flowing from the north to the south periodically for short periods following extreme rainfall events. The morphology of Salt Creek is characterised by braided channeling. Previous studies have found diatom species from sediments at Salt Creek, with *Navicula symmetrica* and *Nitzschia palea* being the most dominant species (Outback Ecology 2009a), which are generally associated with low salinity lakes and creeks (John 1998; Taukulis & John 2009). Only one algal specimen was observed in a non-flowing pool during a recent site visit (Stantec 2023). Algal, inverberate, vegetation and fauna associated with salt creek were not considered to be unique and were typical of inlands lakes throughout the semi-arid region of Western Australia (Outback Ecology 2009a). Salt Creek flows into Lake Randall, a major ephemeral playa within the Lefroy paleodrainage located approximately 4.5 km south of TSF2.
Groundwater aquifer	The regional hydrogeology is characterised by weathered and fractured Archean and Proterozoic bedrock of the Yilgarn-Goldfields fractured groundwater province, overlain by widespread Tertiary sedimentary rocks in paleochannels and Cainozoic alluvium and lake deposits (GRM 2014). The regional water table occurs at a depth ranging from less than one metre below ground level (mbgl) around the low-lying Lake Randall to over 50 mbgl in elevated areas. Regional groundwater flows towards Lake Randall, where the water table is closest to the surface). At the premises, groundwater depths ranging from 0.47 mbgl to 25.33 mbgl were observed during the most recent monitoring event (June 2023). Groundwater at the premises has been influenced by seepage and groundwater mounding, especially at bores near TSF2. Field groundwater pH ranged from 2.74 pH unit to 6.52 pH unit, indicating acidic conditions. Field total dissolved solid (TDS) concentrations ranged from 34,060 mg/L to 112,840 mg/L (dominated by sodium chloride), which is considered saline to hypersaline and characteristic of the regional groundwater quality.

3.2 Risk ratings

Risk ratings have been assessed in accordance with the *Guideline: Risk Assessments* (DWER 2020b) for those emission sources which are proposed to change and takes into account potential source-pathway and receptor linkages as identified in Section 3.1. Where linkages are incomplete they have not been considered further in the risk assessment.

Where the Licence Holder 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 Licence Holder's proposed controls to be critical to maintaining an acceptable level of risk, these will be incorporated into the licence as regulatory controls.

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

The revised licence L8457/2010/2 that accompanies this Amendment Report authorises emissions associated with the operation of the Premises i.e., tailings deposition at TSF2.

The conditions in the Revised Licence have been determined in accordance with *Guidance Statement: Setting Conditions* (DER 2015).

Table 4. Risk assessment of potential emissions and discharges from the Premises during operation

Risk Event					Risk rating[1] C = consequence L = likelihood	Licence Holder's controls sufficient?	Conditions[2] of licence	Justification for additional regulatory controls
Source/Activities	**Potential emission**	**Potential pathways and impact**	**Receptors**	**Licence Holder's controls**				
Operation								
Tailings deposition to TSF2 Stage 2 embankment (RL 307.0 m)	Tailings leachate	***Pathway:*** Vertical infiltration and lateral migration through the base and embankment walls ***Impact:*** Impact to environment, including groundwater mounding and deterioration of groundwater quality	Native vegetation Surface water body Groundwater aquifer	Refer to Section 3.1	C = Moderate L = Possible Medium Risk Refer to Section 3.3	N	**<u>Condition 3</u>** – Containment infrastructure requirements Condition 6 – Inspection requirements **<u>Condition 7</u>** – Management of intercepted seepage **<u>Condition 15</u>** – Ambient groundwater monitoring requirement **<u>Condition 16</u>** – Water balance monitoring requirement **<u>Condition 17</u>** – Vegetation condition monitoring requirement **<u>Condition 18</u>** – Specified action requirements **<u>Condition 22</u>** – AER reporting requirements Condition 25 – Construction requirement for East Groundwater Recovery Drain	Refer to Section 3.3

Note 1: Consequence ratings, likelihood ratings and risk descriptions are detailed in the *Guideline: Risk assessments* (DWER 2020b).

Note 2: Proposed Licence Holder's controls are depicted by standard text. **<u>Bold and underline text</u>** depicts additional regulatory controls imposed by department.

3.3 Detailed risk assessment for seepage from TSF2 Stage 2

3.3.1 Overview of risk events

With the operation of TSF2 Stage 2 embankment, it is anticipated that tailings seepage from TSF2 will continue to be released to the environment through infiltration to the base and embankment walls of the TSF. Tailings seepage has the potential to impact surrounding environmental receptors, including nearby native vegetation, surface water body (i.e., the neighbouring Salt Creek) and the local groundwater aquifer.

As detailed in Section 2.3, seepage from TSF2 has already been released to the environment during the current operation of the Stage 1 embankment, resulting in mounding of the local water table as well as other associated issues. A detailed risk assessment is necessary to assess the risk events associated with continued tailings deposition into TSF2 up to the Stage 2 embankment height, including:

1. Seepage from TSF2 infiltrating into the subsurface environment, causing localised mounding of the water table and potentially inundating the root zone of surrounding native vegetation.
2. Seepage from TSF2 infiltrating into the subsurface environment, causing contamination of the unconfined aquifer and potentially impacting surrounding vegetation health through uptake of seepage contaminants.
3. Seepage from TSF2 infiltrating into the subsurface environment, causing contamination of the unconfined aquifer and potentially migrating to the nearby ephemeral Salt Creek.

3.3.2 Water management at TSF2

The water balance is a critical component to managing the volume of seepage generated from TSF2. From January 2021 to March 2023, the monthly volume of tailings deposited into TSF2 has ranged from 109,975 m^3 to 144,042 m^3. Future depositional rates are expected to remain within this range. Based on the average tailings density (%) and specific gravity of tailings supernatant of 1.12, the annual volume of water inputted into TSF2 during this period ranged from 949,848 m^3 to 1,252,320 m^3.

In addition to tailings slurry, the Licence Holder is also authorised to deposit bore water to TSF2 in order to achieve the minimum supernatant pond size necessary to return 'clear water' to the processing facility for reuse. The bore water is sourced from the Lucky Bay production bores, located approximately 4.3 km south of the premises along the northern boundary of Lake Randall. As the premises is located within the Goldfields Groundwater Area, abstraction is authorised under groundwater licence GWL171076.

In 2019, a predictive water balance was provided to the department to support the construction and operation of TSF2 (Coffey 2019). The water balance considered return water rates with and without the addition of bore water. During the predicted Stage 1 scenarios, the addition of approximately 805,920 m^3/annum of bore water would enable a return water rate of 1,314,000 m^3/annum (Table 5). This return water rate was significantly higher than if no bore water was added to TSF2, which would only yield 504,576 m^3/annum. That being said, after accounting for the addition of bore water, the residual return water rate (i.e., 508,080 m^3) was comparable to the scenario where no bore water was added (i.e., 504,576 m^3).

In using the Licence Holder's monthly water balance to validate these estimates, it was identified that, in the 2022 calendar year, the actual volume of return water from TSF2 was only 803,420 m^3, despite similar volumes of bore water added to TSF2 (Table 5). As a result, after accounting for the addition of bore water, only 45,196 m^3 of residual water was removed from TSF2, which was significantly lower than the estimated 508,080 m^3.

Based on the predictive water balance, the operation of the Stage 2 embankment would require a greater volume of bore water to be added into TSF2 just to maintain return water rates (Table 5), suggesting a greater volume of residual water that would be retained within TSF2 and be potentially released to the environment as seepage.

Table 5: Estimated and actual water balance comparison

Parameter	Stage 1 (estimated)	Stage 1 (actual; 2022)	Stage 2 (estimated)	Stage 3 (estimated)
Water rate (m^3/hour)				
Return water with no bore water input	57.00	N/A	56.16	55.01
Return water with bore water input	150[1]	89	150[1]	150[1]
Bore water input	92	86.6	93.4	94.5
Return water after accounting for bore water input	58	2.4	56.6	55.5
Annual total water throughput (m^3)				
Return water with no bore water input	504,576	N/A	491,962	482,501
Return water with bore water input	1,314,000[1]	803,420	1,314,000[1]	1,314,000[1]
Bore water input	805,920	758,224	818,184	827,820
Return water after accounting for bore water input	508,080	45,196	495,816	486,180

Note 1: The estimated return water rate and annual total water throughput is fixed at 150 m^3/hr and 1,314,000 m^3, respectively.

In evaluating the TSF2 monthly water balance in greater detail, the monthly proportion of water inputted (i.e., from tailings slurry and bore water) that was reclaimed from the supernatant pond as return water varied from 17% to 103% (Figure 4a). In 2021, the average proportion of water reclaimed was 65%. However, the average proportion of water reclaimed in 2022 was significantly lower at 40%.

Furthermore, in 2022, the water removed from TSF2 via return water pumping was roughly comparable with the volume of bore water inputted into TSF2 (Figure 4b). In some months, the volume of bore water added exceeded the volume of return water recovered. After accounting for bore water addition, only a proportion of tailings slurry supernatant was removed from TSF2, with over 50% tailings water reclaimed in most months in 2021 (Figure 4b). However, the volume of tailings slurry supernatant removed was significantly lower in 2022.

In summary, although the addition of bore water was required to achieve return water pumping rates, after accounting for this addition, the volume of return water pumped from TSF2 was significantly less than the volume of water inputted into TSF2 as tailings slurry (Figure 4b). The residual tailings supernatant that is not removed from TSF2 via return water pumping represent potential seepage that could be released into the environment. In addition to seepage, tailings supernatant could typically also be lost through evaporation on the TSF surface or retained within the tailings matrix as pore water.

In the water balance provided, the department noted that a pan evaporation factors of 0.5 and 0.88 was utilised for the supernatant pond and tailings beach, respectively. However, the rate of evaporation from the surface of a hypersaline water body is typically lower than for a similar freshwater body. Measurements taken from TSFs with hypersaline water in the Goldfields region have indicated pan evaporation factors of about 0.4 and 0.2 for supernatant pond and tailings beach in the region (Newson and Fahey 2003). The same investigation also indicated that tailings beaches that are covered with salt crusts are likely to have a pan factor of less than 0.2. In those respects, the pan evaporation factors utilised in the existing water balance likely overestimates evaporation from TSF2, meaning there is a greater volume of water in the TSF that could potentially infiltrate as seepage.

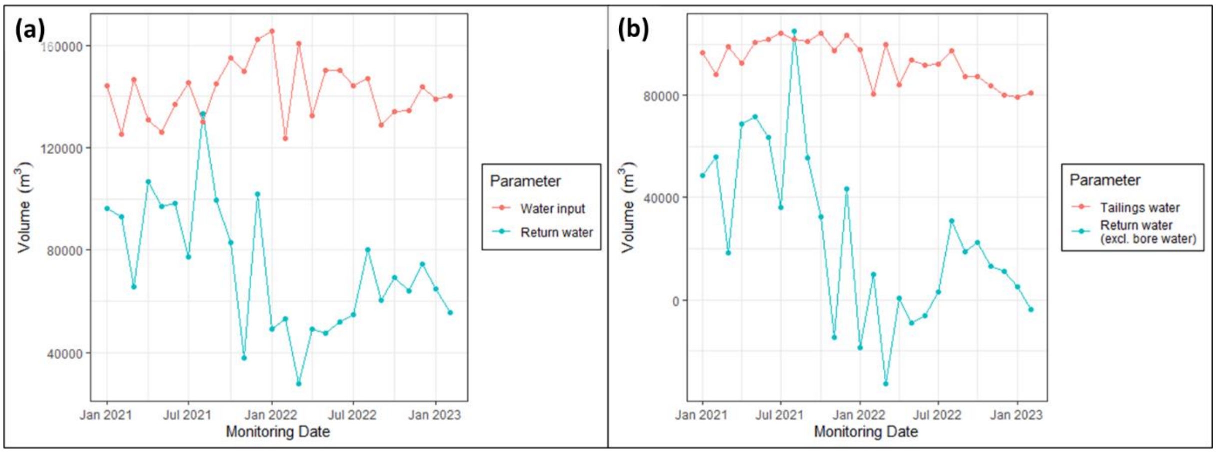

Figure 4: Comparison of water inputted into TSF2 and return water

In 2019, seepage analysis was undertaken to support the construction and operation of TSF2 (Coffey 2019). The analysis indicated seepage rates of approximately 14 m^3/day and 34 m^3/day under normal operating conditions[1] for the Stage 1 and Stage 3 embankments, respectively. The analysis assumed that the embankment material was isotropic in nature due to limited information on anisotropy and the spatial variability in permeability of the embankment material.

Monthly seepage estimates in the water balance, which were based on seepage analysis outputs, have ranged from 36,000 m^3 to 40,000 m^3 (data not shown). However, seepage estimated using the current methodology does not consider temporal variations of the other parameters in the water balance (i.e., inputs, outputs). As the seepage in the water balance was derived from seepage analysis outputs, it is not possible to validate the seepage analysis output. Due to the current seepage derivation method, monthly seepage volumes have minimal variations, despite relatively greater degrees of fluctuation in other components of the water balance.

Using the current methodology of deriving seepage volumes, there is limited value in the water balance. The methodology of seepage estimation in the water balance should be revised to produce more realistic outputs, using the 'input minus output' approach and a lower pan evaporation factor.

Nevertheless, based on active water addition (i.e., tailings deposition, bore water) and removal (i.e., return water pumping) at TSF2, it is clear that a large proportion of water might not be captured by the return water system. Furthermore, despite the addition of bore water to encourage return water pumping, the volume of water reclaimed is relatively low compared to the total volume of water inputted into TSF2. These observations suggest that a large volume of tailings supernatant (albeit diluted by bore water to a certain degree) could be seeping through the TSF2 base and embankment walls into the subsurface environment.

3.3.3 Source characterisation: Tailings seepage

Tailings seepage is largely characterised by the properties of the source tailings slurry, which

[1] Normal operating conditions assumed the supernatant pond boundaries were at least 200 m away from the perimeter embankments of TSF2. Estimates were considered conservative as decreasing permeability with increasing consolidation of tailings over time was not considered in the seepage analysis.

depends on the ore type, as well as chemical reagents added during mining and processing.

Tailings that are proposed to be deposited into TSF2 Stage 2 embankment are produced at the Randalls Gold Processing Facility, located within the premises. Currently, the processing facility utilises conventional carbon-in-pulp processes to recover gold from varying grade ore sourced from the Karonie, Atreides and Tank open pits, as well as well as the Daisy Milano, Cock-eyed Bob, Santa and Maxwell underground mines (SLR 2023**)**.

Tailings produced at the premises were characterised in 2009 to support their deposition into the now-inactive Integrated Waste Landform and subsequently, the Salt Creek In-Pit TSF (which underlies the current active TSF2) (Golder 2009). The Licence Holder has not undertaken further characterisation works since then as the ore type and processing method has not been modified (Coffey 2019).

Based on the existing tailings characterisation report (Golder 2009), tailings being deposited into TSF2 are expected to have the following properties:

- Tailings slurry density was between 45% to 50% solids. Recent water balance monitoring between January 2021 to March 2023 indicated that tailings slurry remained in this range, with densities ranging between 47% to 54%. Tailings slurry densities have been consistently above 50% solids since April 2022.
- Settled/dry tailings density was 1.4 t/m^3, with various testing methods yielding densities ranging from 1.3 t/m^3 to 1.85 t/m^3.
- *In situ* moisture content of tailings ranged between 30% to 40%.
- Hydraulic conductivity of tailings ranged between 1 x 10^{-7} m/s to 1 x 10^{-8} m/s, based on consolidated tests of expected tailings height of 15 m.
- Particle size distribution of tailings was found to be slightly coarser than typical gold tailings produced in Western Australia, suggesting that tailings material was likely to have somewhat higher permeability and hence, more favourable consolidation properties. However, permeability is expected to decrease logarithmically with the increasing tailings height.
- Total elemental analysis indicated that tailings were relatively enriched with arsenic and sulfur.
- Peroxide oxidation leaching tests suggests potential leaching of chloride, fluoride, magnesium, potassium, sodium, manganese, iron, molybdenum, vanadium, and arsenic under acidic conditions after sulfide weathering. In general, leachate concentrations of other elements generally correlated with total concentrations.
- Based on the tailings storage data sheet, the concentrations of WAD CN in tailings slurry are typically <5 mg/L at discharge and <1 mg/L in the return water.
- Based on the tailings storage data sheet, tailings supernatant is expected to be saline to hypersaline, with TDS ranging from 1,000 mg/L to 350,000 mg/L as the ore is processed using local groundwater, which is known to be hypersaline.

3.3.4 Pathway characterisation: Hydrogeology

The TSF2 area is characterised by limited groundwater occurring at the base of the weathered profile, which can typically be at least 30 metres thick in the region, and in fractures in the upper portion of the underlying fresh bedrock. Groundwater may occur in three distinct aquifers, including a shallow perched aquifer, an aquifer in the saprolite and saprock at the base of the weathered profile, and an aquifer formed by interconnected fractures in the underlying bedrock. In the weathered profile, groundwater flow typically not uniform due to the heterogeneous nature of regolith materials.

Previous groundwater exploration in the Salt Creek valley to the north and west of TSF2 intersected over 50 m of sedimental material, with lithology ranging from clay to gravel. Most of this sequence had relatively low hydraulic conductivity and only two minor aquifers inferred to occur (Integra Mining Limited 2009). Surface soils were considered non-saline, with salinity levels typically increasing with depths (Integra Mining Limited 2009).

Groundwater levels were also found to be irregular and did not represent a consistent spatial distribution, which may be caused by either regolith heterogeneity or disturbance from drilling activities (Integra Mining Limited 2009). However, groundwater elevation and flow direction were thought to generally mirror the regional topography.

The aquifer of primary concern is the unconfined weathered aquifer, which is closest to the surface, and thus, most likely to be impacted by seepage infiltrating from TSF2. The local water table is considered relatively shallow. Groundwater monitoring bores installed throughout the north of TSF2 ranged between 4.7 mbgl and 8.9 mbgl, with depths increasing to the east, away from the Salt Creek (Integra Mining Limited 2009). These measurements were taken around 2008 and represented the pre-mining water table conditions. Recent bore installations at NMB04 and NMB06 encountered water strike at 15 mbgl and 9 mbgl, respectively, during the operation of TSF2. Subsequent groundwater monitoring at these locations indicated shallower standing water levels. The local hydrogeology at TSF2 represents a challenging environment for groundwater management due to the naturally shallow water table, resulting in susceptibility to groundwater mounding and potential surface expression of groundwater.

3.3.5 Pathway characterisation: Groundwater assessment

The three risk events described in this detailed risk assessment depends on whether (and if so, the extent of) the local aquifer has been impacted by seepage, which could result in either mounding and/or contamination of the aquifer. Routine groundwater monitoring is a useful tool for assessing and detecting potential changes in aquifer characteristics.

Groundwater monitoring has been undertaken at the TSF2 surroundings since commencement of mining operations. Prior to the operation of TSF2, groundwater was monitored as part of the operation of the underlying Salt Creek In-Pit TSF. At this time, monitoring of the four bores[2] closest to the in-pit TSF crest (i.e., SC01, SC02, SC03, BH05; Figure 5a) indicated that the water table was experiencing mounding. Groundwater depths at SC03, BH05 and other bores north of the in-pit TSF were shallower than at SC01 and SC02. Standing water level at these bores may have been influenced by residual seepage and mounding from the nearby integrated waste landform (i.e., TSF1).

Nevertheless, the mounded water table was considered sufficiently deep that it did not pose a significant risk to native vegetation. This was primarily due to the localised hydraulic gradient being controlled by the tailings and supernatant elevation within the TSF, which remained belowground for the life of the in-pit TSF.

Consistent with previous observations, the operation of the aboveground TSF2, which resulted in tailings and supernatant elevation being raised above subsurface levels, have contributed to local groundwater mounding above the standing water level limit required by licence L8457/2010/2 in the adjacent monitoring bores (Figure 6). Standing water level at monitoring bore NMB02 was measured at 3.88 mbgl during its first monitoring event in March 2021.

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[2] Monitoring bores SC01, SC02, SC03 and BH05 were decommissioned and destroyed in 2020 as they were located on part of the proposed TSF2 footprint. As part of the construction of the TSF2 Stage 1 starter embankment, additional monitoring bores NMB01, NMB02 and NMB03 were constructed adjacent to the TSF2 embankment to continue groundwater monitoring.

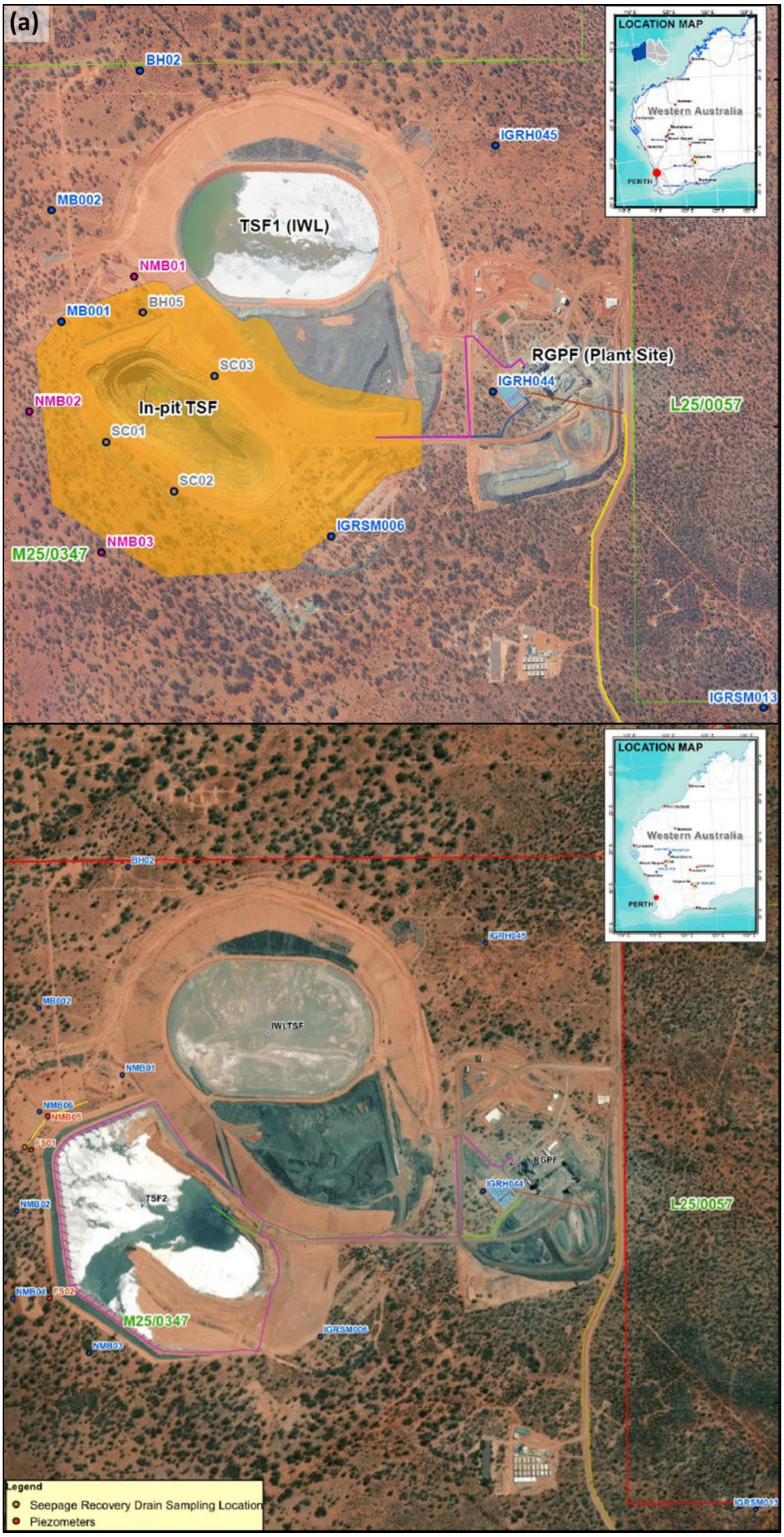

Figure 5: Groundwater monitoring network (a) before and (b) after construction of TSF2

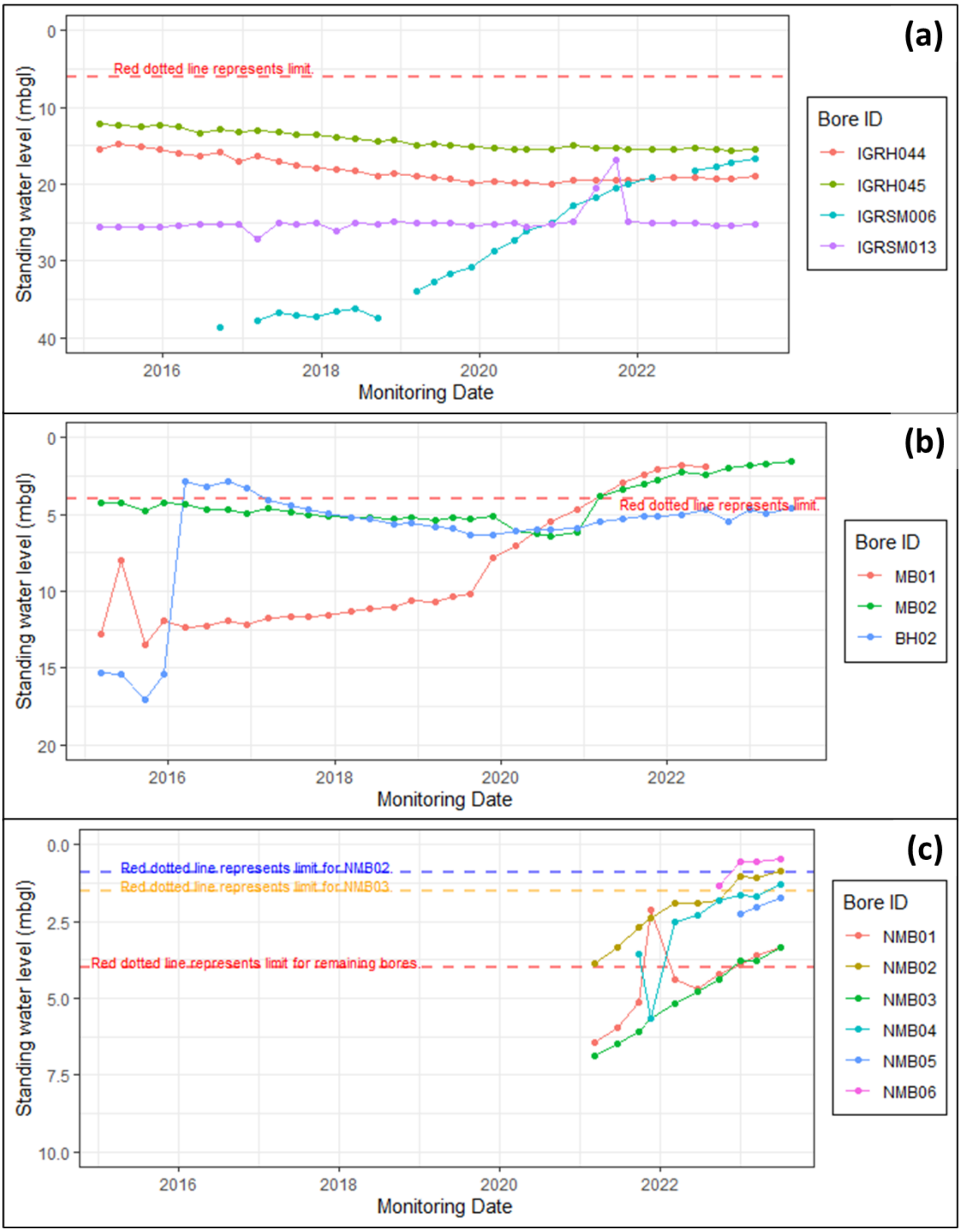

Figure 6: Standing water level trends at groundwater monitoring bores (a) east of TSF2, (b) west of TSF2 (pre-TSF2) and (c) west of TSF2 (recently installed to monitor TSF2)

By December 2022, standing water levels at all monitoring bores[3] surrounding the western portion of TSF2 were detected above 4.0 mbgl (Figure 6b and Figure 6c). Groundwater was

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[3] Monitoring bores included MB002, NMB01, NMB02, NMB03, NMB04 and NMB06.

closest to the surface along the north-west and south-west of the premises. In March 2023, monitoring bores NMB06 (i.e., north-west) and NMB02 (i.e., west) had standing water levels at 0.47 mbgl and 0.86 mbgl, respectively. Contouring of groundwater elevation data from this monitoring event indicated that the local water table was present between RL 292.0 m and RL 296.0 m[4], flowing in primarily a south-westerly direction (Figure 7).

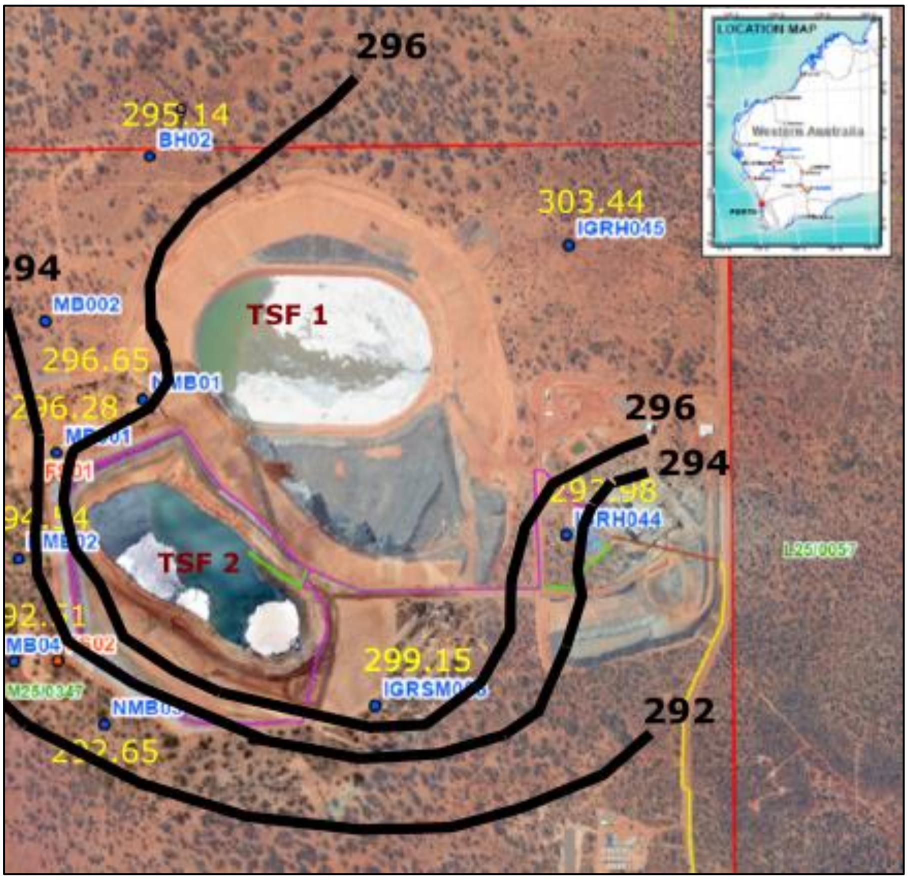

Figure 7: Groundwater elevation contour from March 2023 monitoring event

Based on groundwater chemistry data from 2015 to 2023, the following observations were made:

- No significant temporal trends were observed in groundwater chemistry in relation the groundwater mounding observed around TSF2 that was apparent in standing water level data. Parameters such as alkalinity, sulfate and salinity appeared driven by the bore depth (i.e., depth of groundwater sampled), with concentrations increasing with depth.
- Metals and metalloids, such as arsenic, cadmium, chromium, copper, lead, molybdenum, mercury, selenium and zinc were detected below their respective limits of reporting.

Since 2017, WAD CN has historically been detected below the limit of reporting. However, detectable concentrations of WAD CN have been observed in monitoring bores BH02, MB002, NMB02 and NMB06 during groundwater monitoring events in 2023 (Figure 8). Earlier, in 2022, WAD CN was also detected in monitoring bores NMB01 and MB001.

[4] Based on bore installation data, ground elevation along the western portion of TSF2 varied between RL 295.0 m and RL 300.0 m.

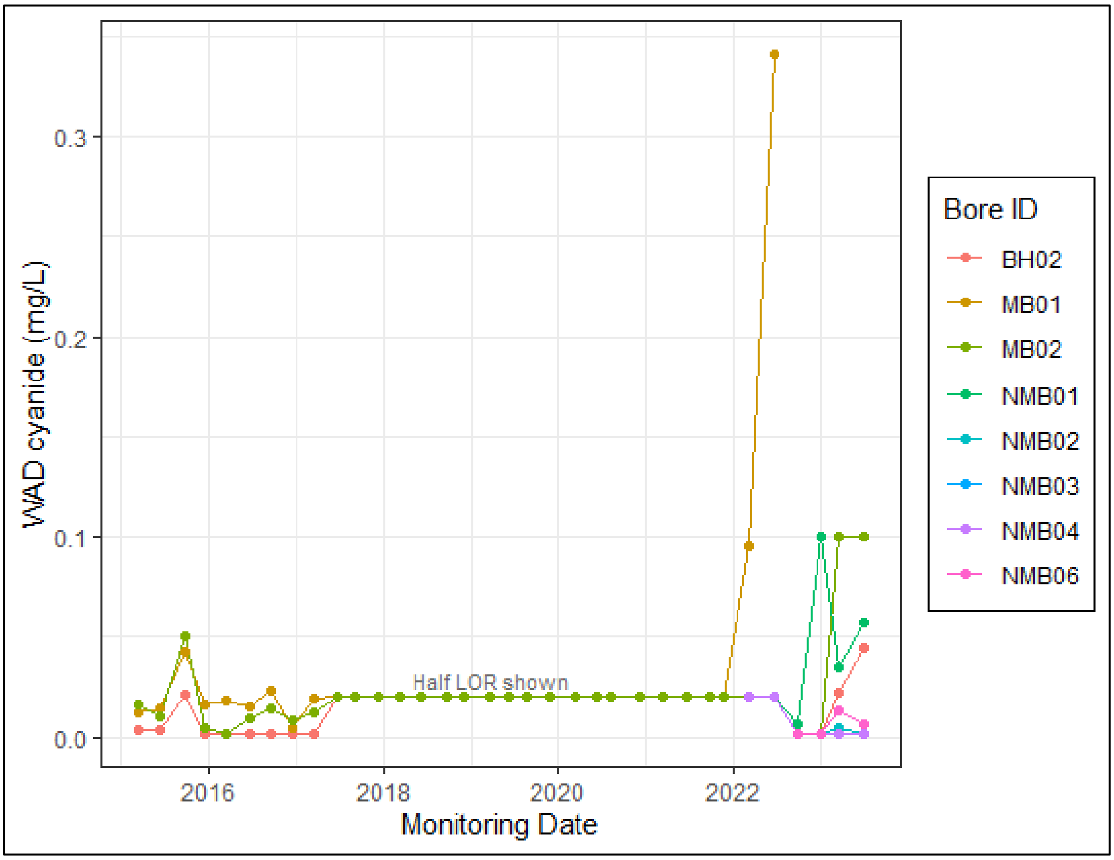

Figure 8: Weak acid dissociable cyanide concentrations

Despite the lack of temporal trends observed in the existing groundwater monitoring data, the recent detection of WAD CN in groundwater monitoring bores may be indicative of seepage from TSF2. That being said, seepage influences on the aquifer may have occurred long before WAD CN was detected in groundwater samples as cyanide may be bound up in metal-complexes that is not detected in WAD CN analytical procedures. Additionally, WAD CN can be rapidly degraded by subsurface microorganisms in some geological environments, resulting in a short half-life.

A monitoring bore of potential concern was the now-decommissioned MB001 located north-west of TSF2, which had reported the shallowest groundwater, not only has the standing water level at this bore location increase logarithmically since 2019 (Figure 6) and WAD CN concentrations up to 0.34 mg/L in 2022 (Figure 8), changes in the groundwater chemistry had also been observed (Figure 9). Specifically, field pH appeared to have increased from historically around 3 pH units to 5 pH units in the 2021 monitoring events onward. In addition, dissolved metal concentrations of copper, nickel, manganese and cadmium, as well as sulfate concentrations also became elevated during this period. Heavy metals, such as copper and nickel, are known to form strong complexes with cyanide ions and are readily leached from minerals during gold ore processing (Rees & van Deventer 1999). No significant changes in TDS were observed. No further monitoring is possible at this location as the monitoring bore was decommissioned in 2022 to construct the North Groundwater Recovery Drain.

A shallower replacement monitoring bore NMB06 was installed in September 2022 approximately 35 m away from MB001. Groundwater sampled at this monitoring bore was less acidic, with sulfate concentrations comparable to MB001 (Figure 9). Of note was that elevated metal concentrations previously identified in MB001 were not elevated in monitoring bore NMB06, despite being a shallower bore (and thus, able to detect impacts from seepage from immediately). Continued monitoring is required to better understand the groundwater in this area, given previous observations at MB001.

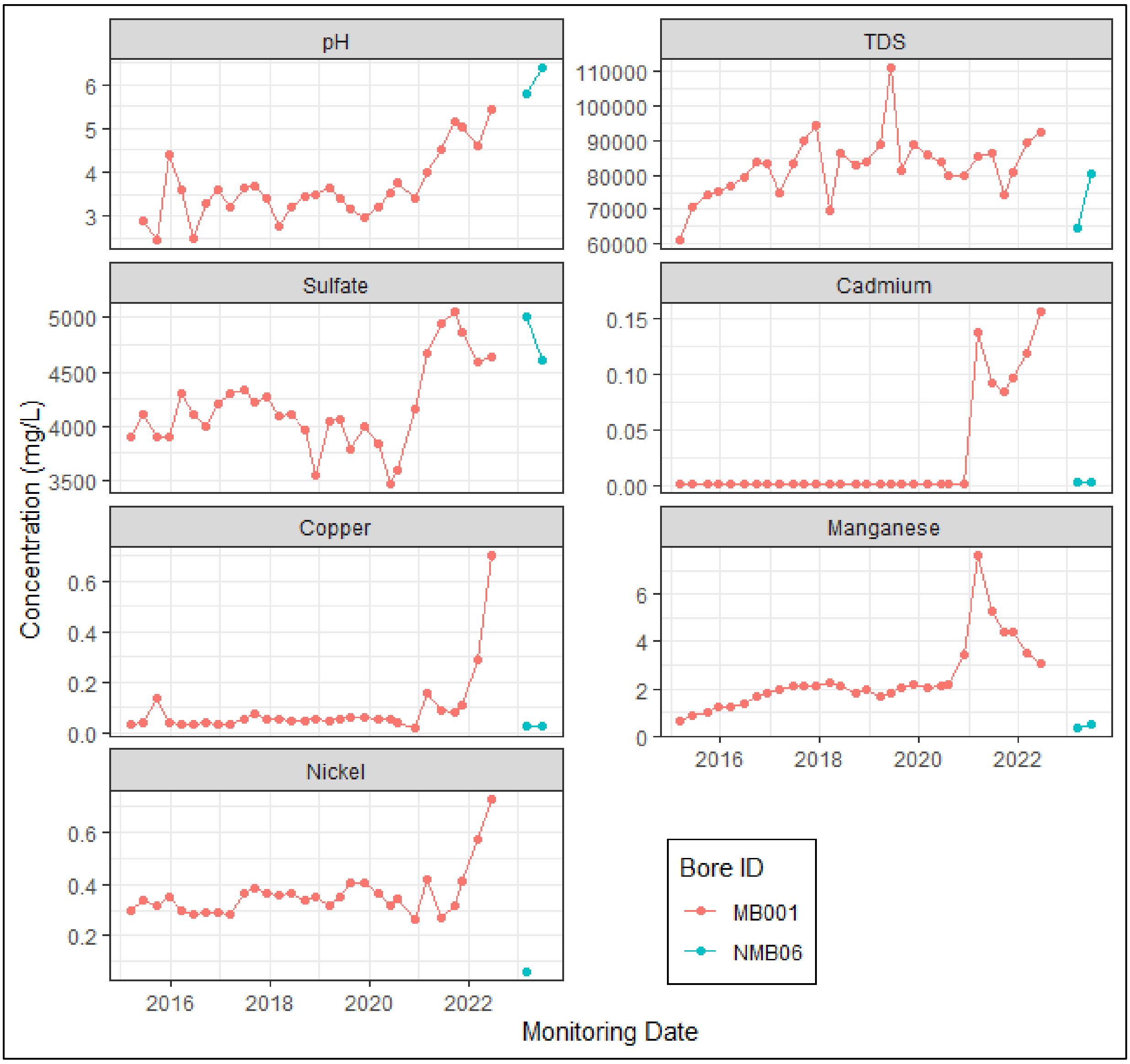

Figure 9: Groundwater chemistry plots at monitoring bore MB001 and replacement bore NMB06

3.3.6 Potential adverse impacts of tailings seepage

Seepage that occurs as a result of tailings deposition into the TSF2 Stage 2 embankment could adversely impact sensitive receptors through several mechanisms (i.e., risk events). Primarily, seepage influences the characteristics of the unconfined aquifer underlying the TSF2 footprint, by altering its physical (i.e., groundwater mounding) and chemical (i.e., groundwater quality) properties. The groundwater monitoring data discussed in Section 3.3.5 have indications of these impacts. In this respect, the unconfined aquifer is considered both a receptor that could be impacted, as well as a pathway mechanism for impacting other environmental receptors (i.e., native vegetation, surface water bodies etc.).

Groundwater mounding impacting native vegetation

Groundwater mounding around TSF2 may impact surrounding native vegetation if it occurs to the extent where the root zone becomes inundated. Waterlogged soils become deficient in oxygen, which disrupts root respiration and normal cellular processes, causing plant stress and potentially death (Pan *et al.* 2021). Furthermore, high salinity conditions may exacerbate plant stress (Craig *et al.* 1990; Barrett-Lennard 2003).

A groundwater assessment in 2019 indicated that, while groundwater mounding was likely to occur as a result of continued tailings deposition at TSF2, the mounding was not anticipated to impact sensitive receptors (Coffey 2019), because:

- The mounding was only expected to be notable within the immediate vicinity of the TSF2 boundary, with a maximum extent of approximately 800 m from TSF2.
- The predicted groundwater levels were expected to remain at approximately 3.0 mbgl (assuming ground surface at RL 300.0 m), and the local vegetation type unlikely to access water from deeper than 5.0 mbgl.
- There are no groundwater dependent ecosystems of registered third-party groundwater users within the predicted maximum extent of groundwater mounding.

While the maximum extent of groundwater mounding is relatively small compared to the extent of the prescribed premises boundary, it does not discount the presence of native vegetation surrounding TSF2 that may be impacted by seepage and groundwater mounding.

Vegetation stress and deaths have been observed along the western portion of TSF2 on several occasions in 2022, including as part of the Licence Holder's quarterly vegetation condition monitoring during the fourth quarter of 2022 (Stantec 2023), during a site inspection by the DMIRS in March 2023 and during the environmental incident where hypersaline expression occurred in May 2023 (refer to Section 2.3.3). The cause of death was inferred to be due to waterlogging and exposure to salinity outside the species tolerance limits (Stantec 2023).

The surface expression of groundwater was likely not predicted during the groundwater assessment in 2019 because surface elevation was generalised at RL 300.0 m, whereas in reality, surface elevation around the primary impact area was as low as RL 295.4 m[5]. Furthermore, the potential for heavy rainfall events to cause surface pooling of water due to the saturated state of subsurface soil was likely not considered. Under the current mounded water table, saturation of surface soils is more likely to occur during rainfall events, and it is likely to remain saturated for longer durations post-rainfall events. This has been observed on several occasions (Coffey 2023a; Stantec 2023).

Contaminated groundwater impacting native vegetation

The local groundwater may be contaminated by tailings seepage. The contaminants of potential concern would depend on the tailings geochemistry. As detailed in Section 3.3.3, contaminants from seepage at TSF2 may include arsenic, manganese, molybdenum and cyanide. Major ions, such as sulfate, chloride, fluoride, magnesium, potassium and sodium, were also found to be leachable. Therefore, changes in the ionic composition of groundwater may be indicative of seepage influence, though these parameters are not currently being monitored, aside from sulfate.

While there are no human receptors or third-party groundwater users in the immediate vicinity of TSF2, surrounding native vegetation may be exposed to seepage contaminants through the mounded water table. Arsenic is of particular concern due to its toxicity to ecological health as well as its relatively high total and leachable concentrations during tailings characterisation (Golder 2009). However, dissolved arsenic concentrations have consistently been reported below the limit of reporting during groundwater monitoring events to date.

Surface water and sediment sampling at the primary impact area, where groundwater expression had occurred, found dissolved metal, metalloid and WAD CN concentrations to be

[5] Surface elevation datum from NMB02 siting (Coffey 2023b).

below their respective guideline values[6], with the exception of dissolved cobalt concentrations ranging between 0.19 mg/L and 0.23 mg/L[7] (Stantec 2023).

Routine groundwater monitoring and investigative sampling undertaken to date suggest that contaminant exposure and uptake may carry a lower risk to surrounding native vegetation compared to waterlogging and salinity from groundwater mounding, because:

1. Contaminant exposure and uptake is only possible when the root zone is inundated with groundwater due to mounding in the first place.
2. Native vegetation stress and death is likely to occur at a greater rate from the waterlogging and salinity that occur during groundwater mounding, compared to contaminant uptake.
3. There are no clear significant changes observed in groundwater chemistry[8] that suggest contaminants are present in groundwater at significant concentrations.

Contaminated groundwater impacting ephemeral surface water body

The ephemeral Salt Creek is located approximately 200 m west of the TSF2 western embankment. Due to groundwater mounding, it is possible for groundwater to express more readily at the Salt Creek bed, which has a lower elevation than its surroundings. Alternatively, groundwater expression closer to TSF2 may also enter Salt Creek as overland runoff. The expressed groundwater may introduce high salt loading, as well as contaminants associated with seepage.

Sampling undertaken as part of the ecological impact assessment demonstrated that sediment and surface water quality upgradient of TSF2 contained lower TDS compared samples taken cross- and downgradient of TSF2 (Stantec 2023)(Table 6). Dissolved cobalt was also detected in a Salt Creek water sample located downgradient of TSF2, which mirrored the dissolved cobalt concentrations in surface water pooling at the primary impact area. These observations are likely due to the salinisation and contamination of surface runoff at the primary impact area, prior to flowing into Salt Creek.

The ecology of Salt Creek, and thus, impacts to its ecological health, is not well understood. That being said, the emission of seepage-impacted groundwater into Salt Creek is likely to have impacts to the downstream environment.

Diatoms communities and salt-tolerant aquatic biota were previously characterised at Salt Creek (Outback Ecology 2009a). In June 2023, no aquatic fauna was observed in the creek during an opportunistic visit, though pools of water were found in some of the deeper channels of the creek. A small amount of green algae was recorded in one of the pools, adjacent to the primary impact area (Stantec 2023).

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[6] Metal and metalloid parameters analysed included: arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, and zinc.

For surface water samples, guideline values for metals and metalloids were based on the ANZG (2018) DGV for 80% protection of species in marine waters. Parameters analysed. Guideline value for WAD CN was 0.5 mg/L, based on the ICMC (2020).

For sediment samples, guideline values for metals and metalloids were based on the ANZG (2018) DGV for GV-High.

[7] Cobalt DGV for 80% protection of species in marine water is 0.15 mg/L.

[8] With the exception of the increasing concentrations of copper, nickel, manganese and cadmium at monitoring bore MB001 from 2021 to 2022, when it was decommissioned and destroyed. WAD CN has recently been detected above its limit of reporting at several monitoring bores but have not exceeded the limit of 0.5 mg/L specified in licence L8457/2010/2. Refer to Section 3.3.5.

Table 6: Surface water and sediment quality at primary impact area and along Salt Creek

Parameter	Unit	Primary impact area	Salt Creek (location relative to primary impact area)			
			Upgradient	Cross-gradient	Downgradient	Further downgradient
Surface water						
pH	pH unit	7.6	7.4	7.8	7.5	7.7
Total dissolved solids	mg/L	120,000 – 130,000	11,000	85,000	61,000	98,000
Dissolved arsenic	mg/L	<0.05	<0.005	<0.05	<0.02	<0.05
Dissolved cobalt	mg/L	0.19 – 0.23	<0.005	0.061	<0.02	0.15
WAD CN	mg/L	<0.004	<0.004	<0.004	---	<0.004
Sediment						
pH	pH unit	7.9 – 8.5	9.1	8.5	8.4	8.4
TDS	mg/kg	24,000 – 46,000	2,600	15,000	29,000	33,000
Arsenic	mg/kg	2 – 10	3	2	3	2
Cobalt	mg/kg	12 – 17	18	13	13	20
WAD CN	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5

3.3.7 Risk assessment and additional regulatory controls

In considering the source characteristics, pathway, sensitivity of receptors, previous monitoring and incident reports and the Licence Holder’s proposed controls, a risk rating has been assigned to each risk event, as detailed in Table 7.

Table 7: Risk rating for seepage from TSF2

Risk event	Consequence	Likelihood	Risk rating
Seepage from TSF2 infiltrating into the subsurface environment, causing localised mounding of the water table and potentially inundating the root zone of surrounding native vegetation.	**Moderate** Vegetation stress and/or death.	**Possible** Groundwater is already naturally shallow and hypersaline, making it more susceptible to mounding. Addition of bore water into TSF2 and insufficient return water pumping may result in additional seepage generated. Limits on standing water level have been exceeded quarterly since 2021 with trends of groundwater mounding evident. Incident involving surface expression of hypersaline groundwater and vegetation death	**Medium risk** Additional regulatory controls required.

Risk event	Consequence	Likelihood	Risk rating
		reported in 2023. Groundwater recovery trenches do not appear to be reducing standing water level. While proposed East Groundwater Recovery Drain may contribute to seepage recovery, there is uncertainty in whether it is adequate to manage groundwater mounding around TSF2. Similar uncertainties exist for trialling groundwater recovery using existing production bores.	
Seepage from TSF2 infiltrating into the subsurface environment, causing contamination of the unconfined aquifer and potentially impacting surrounding vegetation health through uptake of seepage contaminants.	**Moderate** Vegetation stress and/or death.	**Unlikely** While groundwater mounding is present, impacts to groundwater quality are not apparent in the monitoring data, except at the decommissioned MB001. Replacement bore NMB06 was installed near decommissioned bore MB001. WAD CN was observed at detectable concentrations in 2023. As a result of groundwater mounding, native vegetation will likely be more impacted by waterlogging and salinity than contaminant exposure.	**Medium risk** Additional regulatory controls required.
Seepage from TSF2 infiltrating into the subsurface environment, causing contamination of the unconfined aquifer and potentially migrating to the nearby ephemeral Salt Creek.	**Moderate** Downstream migration of contaminants and impacts to creek biota. Salt Creek biota not well understood.	**Possible** No surface expression of groundwater within Salt Creek reported to date. However, groundwater may express closer to TSF2 and enter Salt Creek as runoff. Impacts to surface soil may also cause contamination and salinisation of overland runoff entering Salt Creek.	**Medium risk** Additional regulatory controls required.

Given the risk rating for the assessed risk events, the Delegated Officer considered additional regulatory controls to be required, in addition to existing controls in licence L8457/2010/2 and controls proposed by the Licence Holder in Table 8. The additional regulatory controls and justification are detailed in Table 8.

Table 8: Additional regulatory controls and justifications to manage seepage from TSF2

Condition	Additional regulatory controls	Justification
Condition 3	Requirement to maintain supernatant pond boundary at least 200 m away from the northern, western and southern embankments of TSF2.	The separation distance between the supernatant pond boundary and the embankments is also an important assumption in the seepage analysis (Coffey 2019). The Delegated Officer has conditioned this requirement to ensure that TSF2 is operating in accordance with its design considerations (Coffey 2019).
Condition 15	Inclusion of additional parameters (e.g., total nitrogen, sodium, potassium, magnesium and calcium) as part of groundwater monitoring requirements.	Total nitrogen may be assessed as an indicator of seepage from TSF2 in groundwater, as it is typically associated with explosives residue and cyanide degradation products. The addition of sodium, potassium, magnesium, and

Condition	Additional regulatory controls	Justification
		calcium complements the existing suite of major anions that are already being monitored. Shifts in ionic composition may be an indicator of seepage from TSF2 in groundwater.
Condition 16	Amendment to existing condition to specify method of estimating seepage.	The current methodology for estimating seepage is relatively static and does not consider other components of the water balance. Furthermore, seepage calculations are based on estimates produced from seepage analyses (Coffey 2019) and thus, is not empirical data that can be validated against model estimates.
	Specification of pan evaporation factor to be applied to the water balance.	The pan evaporation factor currently being applied is considered higher than previously recorded (Newson and Fahey 2003), which may lead to overestimation of evaporation and under-reporting of seepage.
Condition 17	Inclusion of additional locations (e.g., BH02, NMB02, NMB03, NMB04 and IGRSM006) for vegetation condition monitoring.	The Delegated Officer has required additional vegetation condition monitoring locations, specifically to reflect the location of groundwater monitoring bores. Monitoring at these additional locations would enable vegetation condition to be better correlated with groundwater monitoring data.
Condition 18	Specified action (Item 1) to prepare an action plan for actions and timeframes to reduce water contained within TSF2, either by increasing return water, reducing bore water addition or increasing tailings density.	Based on Section 3.3.2, there appears to be a significant volume of water being retained at TSF2, which could potentially be released as seepage emissions. To address this issue, the Delegated Officer requires the Licence Holder to investigate measures to reduce water being discharged and/or retained within TSF2. This is considered a critical component to reducing potential seepage emitted from TSF2.
	Specified action (Item 2) to prepare a groundwater management plan/strategy to review existing groundwater management controls and outline how groundwater mounding will be managed for the remaining operational life of TSF2.	While the implementation of additional controls (Table 2), including the construction and operation of the East Groundwater Recovery Drain, will likely contribute to mitigating the impacts of groundwater mounding around TSF2, there is uncertainty on whether it will be sufficient for ensuring no further impacts will occur. Therefore, the Delegated Officer has required a review of seepage management controls and their effectiveness on managing groundwater mounding. The review will be considered in determining the risk of operating the TSF2 Stage 3 embankment. As detailed in Section 3.3.5, standing water levels are currently in breach of their respective limits required by licence L8457/2010/2. The Delegated Officer has required a plan and/or strategy be designed on how the Licence Holder intends to become and remain compliant with these limits, with due consideration given to potential seepage due to planned embankment raises.
	Specified action (Item 3) to investigate the extent of groundwater mounding at TSF2 and review the adequacy of existing groundwater monitoring bore network.	While groundwater mounding has been detected at the western portion of TSF2, the extent and nature of the mounding has not been fully characterised. In particular, there may be inadequate groundwater monitoring bores to the north, south and east of TSF2. Therefore, the Delegated Officer has required an investigation to characterise the groundwater mound

Condition	Additional regulatory controls	Justification
		around TSF2, with particular focus on identifying any zones of high permeability and preferential flow pathways. The review should also give consideration of the adequacy of the groundwater monitoring bore network around TSF2 and make recommendations for new monitoring bores, where required to better characterise and track groundwater mounding.
	Specified action (Item 4) to investigate the feasibility of converting existing production bores to groundwater recovery bores.	Despite unfavourable conditions during previous groundwater recovery investigations in 2015, the Licence Holder has identified existing pumping bores near TSF2 and are investigating the feasibility of converting these bores for groundwater recovery. The addition of active pumping may improve groundwater recovery efforts on the western portion of TSF2, where groundwater mounding is most severe. Therefore, the Delegated Officer has required the Licence Holder to investigate the feasibility of groundwater recovery bores.
Condition 22	Amendment to existing condition to include assessment of groundwater monitoring, vegetation condition monitoring and water balance monitoring data in AER.	Existing requirements for the AER do not require an assessment of historical monitoring data. Interpretation and assessment of data have been limited in previous AERs. However, with previous environmental incidents at TSF2, there needs to be a better understanding of local hydrogeology and water management at TSF2. Therefore, the condition was amended to require annual reviews of monitoring data.

4. Consultation

Table 9 provides a summary of the consultation undertaken by the department.

Table 9: Consultation

Consultation method	Comments received	Department response
Department of Mines, Industry Regulation and Safety (DMIRS) advised of proposal on 29 June 2023.	The DMIRS responded on 27 July 2023, providing details on a recent site inspection (March 2023) and information being requested by DMIRS to better understand TSF-related issues at the premises. On 3 October 2023, DMIRS provided the department with the most recent copy of the TSF2 annual audit report (Coffey 2023a).	The department has considered the information provided in informing the detailed risk assessment in Section 3.3.
Licence Holder was provided with draft amendment on 20 October 2023.	The Licence Holder provided comments on the draft amendment on 31 October 2023. Refer to Appendix 1.	Refer to Appendix 1.

5. Conclusion

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

5.1 Summary of amendments

Table 10 provides a summary of the proposed amendments and will act as record of implemented changes. All proposed changes have been incorporated into the revised licence as part of the amendment process.

Table 10: Summary of licence amendments

Condition no.	Proposed amendments
General	Updated conditions wording to align with current licensing format.
Condition 3	Updated Table 2 to: • update requirements for TSF2 with operating requirements; • include operation of North Groundwater Recovery Drain, West Groundwater Recovery Drain and East Groundwater Recvoery Drain. • include location of containment infrastructure; • remove Note 1, which is no longer referenced in Table 2; and • added text to outline that IWLTSF has been decommissioned and no longer accepts tailings.
Condition 6	Updated Table 3 to correct referencing error.
Condition 9	Previously condition 11 in existing licence L8457/2010/2. Updated Table 5 to include emission point location.
Condition 14	Previously condition 16 in existing licence L8457/2010/2. Updated Table 6 to include emission point location.
Condition 15	Previously condition 17 in existing licence L8457/2010/2. Updated Table 7 to: • specify monitoring of dissolved metals and metalloids; • include additional monitoring parameters (e.g., total nitrogen, sodium, potassium, magnesium, and calcium); • include monitoring bore locations; • update Note 1 to specify sampling taken from piezometer NMB05 as monitoring bore MB001 has been decommissioned.
Condition 16	Previously condition 8 in existing licence L8457/2010/2. Moved to condition 16, under the Monitoring section. Updated condition to: • specify evaporation pan factor of 0.4 and 0.2 for supernatant pond and tailings beach area, respectively; • specify that the use of other pan factor values must be site-specific and have adequate justification provided for its derivation; and • specify the method for estimating seepage (i.e., total output – total input).
Condition 17	Previously condition 9 in existing licence L8457/2010/2. Moved to condition 17, under the Monitoring section. Updated condition to: • include Table 8, which specifies monitoring point reference, monitoring location, parameter, frequency and method; and • include additional monitoring locations (e.g., BH02, NMB02, NMB03, NMB04 and

	IGRSM006) to reflect locations of groundwater monitoring bores.
Condition 18	Previously condition 18 in existing licence L8457/2010/2. Removed existing improvement conditions 18 and 19 (i.e., installation of additional monitoring bore and submission of bore construction report, respectively). Updated Table 9 to include new specified actions: • prepare and submit an action plan to reduce water input into TSF2; • prepare and submit an operational strategy for complying with standing water level limits at groundwater monitoring bores around TSF2; • undertake an investigation to characterise extent of groundwater mounding at TSF2 and review adequacy of existing groundwater monitoring bore network; • prepare a review of existing seepage management controls and their efficacy in managing groundwater mounding around TSF2; and • undertake an investigation on feasibility of converting existing production bores to groundwater recovery bores.
Condition 22	Previously condition 23 in existing licence L8457/2010/2. Updated Table 9 to include additional reporting parameters in the Annual Environmental Report for ambient groundwater monitoring data, monthly water balance and vegetation condition monitoring.
---	Previously condition 24 in existing licence L8457/2010/2. Deleted condition 24 to avoid duplication with condition 22, which has been amended to require the relevant information be provided in the Annual Environmental Report.
Condition 24	Previously condition 26 in existing licence L8457/2010/2. Update Table 12 to: • remove infrastructure construction requirements for 'seepage recovery drain'; • addition of infrastructure construction requirements for 'East Groundwater Recovery Drain'.
---	Updated Table 13 to include definitions for *Keighery scale* and *suitably qualified engineer*.
---	Updated Schedule 1: Maps to: • include additional figures (Figures 4 and 5) for the location of groundwater recovery drains and vegetation condition monitoring, respectively; and • remove existing figures (Figures 6, 7 and 8) for the construction of the seepage recovery drain. Included Schedule 2: Construction drawings to: • include additional figures (Figures 8, 9 and 10) for the construction of the East Groundwater Recovery Drain.

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

Condition	Summary of Licence Holder's comment	Department's response
Condition 3	The Licence Holder clarified that the *Integrated Waste Landform Tailings Storage Facility (IWLTSF)* is not decommissioned, as access is required to harvest tailings and may be required for future deposition strategies (subject to future approvals) or in a temporary manner. The Licence Holder requested that the IWLTSF be retained in Table 2 of the amended licence.	The department understands that the IWLTSF has not been decommissioned as tailings from the IWLTSF are currently being utilised for the construction of the TSF2 embankment raises and the reclaimed capacity may be utilised for tailings deposition in the future. The operating height of the IWLTSF will not increase without future assessment and authorisation under a works approval or licence. As such, the department has retained IWLTSF in Table 2.
	The Licence Holder requests that the following draft requirement for *Tailings Storage Facility 2 (TSF2)* be removed from Table 2 of the amended licence: • *Downstream drain on the western side of the Stage 2 embankment must be maintained, with collection sumps returning water to the TSF2 supernatant pond or process ponds*. The rationale for the removal is that the condition cannot be met while the Stage 3 embankment is being constructed, as it will be the Stage 3 embankment will be constructed over the existing toe drain. To maintain seepage recovery, it was proposed that each toe drain sump be connected to the West Groundwater Recovery Drain via a trench. The toe drains and trench will be backfilled with crushed rock to allow drainage to be maintained during and after construction of the Stage 3 embankment (in addition to the Stage 3 toe drains).	The department understands that construction of the TSF2 Stage 3 embankment is scheduled to commence in November 2023. As such, the relevant Stage 2 toe drains will likely cease operations in the near future. The department considers the proposed control to be adequate and have removed the requirement from Table 2. The requirement will be considered for the Stage 3 toe drains.
Condition 18	The Licence Holder requests that the specified action requirements of Item 1 (*TSF2 Water Reduction Action Plan*) not be constrained by the three existing operations and a fourth option be included (i.e., '*or by any other method*').	The department has amended the specified action requirements for Item 1 of Table 9 to include flexibility in the method to achieve water reduction at TSF2. Item 1 has also been modified to specify the intent of the action plan.

Condition	Summary of Licence Holder's comment	Department's response
	For the specified action requirements of Item 4, the Licence Holder clarified that PB5 had been tested and found to be not operational. Other bores were being tested at the time. The Licence Holder requested that reference to PB5 be removed from the specified action requirements.	The department has removed reference to production bores to be investigated in the specified action requirements of Item 4. However, it is expected that all investigated bores, including those that have failed, be included in the relevant report. The report should also specify the cause or suspected cause of the unfeasibility of those bores to be converted into groundwater recovery bores.
Condition 24	The Licence Holder clarified a typological error in Table 12.	The department has amended Table 12 to correct this error.

Appendix 2: Application validation summary

SECTION 1: APPLICATION SUMMARY (as updated from validation checklist)			
Application type			
Amendment to licence	☒	Current licence number:	L8457/2010/2
		Relevant works approval number:	N/A
Date application received		25 May 2023	
Applicant and Premises details			
Applicant name/s (full legal name/s)		Silver Lake (Integra) Pty Limited	
Premises name		Salt Creek Processing Facility	
Premises location		Mining Tenements M25/71, M25/125, M25/133, M25/307, M25/347 General Purpose Lease L25/27, L25/31, L25/33, L25/41 Miscellaneous Licence G25/02	
Local Government Authority		City of Kalgoorlie-Boulder	
Application documents			
HPCM file reference number:		2012/006865-1	
Key application documents (additional to application form):		Response to Request for Information, dated 12 June 2023.	
Scope of application/assessment			
Summary of proposed activities or changes to existing operations.		*Licence amendment* Operation of TSF2 Stage 2 embankment.	
Category number/s (activities that cause the premises to become prescribed premises)			

Table 1: Prescribed premises categories

Prescribed premises category and description	**Assessed 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	1,700,000 tonnes per annual period	No change
Category 6: Mine dewatering	700,000 tonnes per annual period	No change
Category 64: Class II or Class III putrescible landfill site	1,000 tonnes per annual period	No change

Legislative context and other approvals

Has the applicant referred, or do they intend to refer, their proposal to the EPA	Yes ☐ No ☒	N/A

under Part IV of the EP Act as a significant proposal?		
Does the applicant hold any existing Part IV Ministerial Statements relevant to the application?	Yes ☐ No ☒	N/A
Has the proposal been referred and/or assessed under the EPBC Act?	Yes ☐ No ☒	N/A
Has the applicant demonstrated occupancy (proof of occupier status)?	Yes ☒ No ☐	Mining lease / tenement: M25/347 Expiry: 31 August 2030
Has the applicant obtained all relevant planning approvals?	Yes ☐ No ☐ N/A ☒	Prescribed premises is located on mining tenement, regulated under *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: CPS 8519
Has the applicant applied for, or have an existing CAWS Act clearing licence in relation to this proposal?	Yes ☐ No ☒	N/A
Has the applicant applied for, or have an existing RIWI Act licence or permit in relation to this proposal?	Yes ☒ No ☐	Licence/permit No: GWL 168088
Does the proposal involve a discharge of waste into a designated area (as defined in section 57 of the EP Act)?	Yes ☒ No ☐	Name: Goldfields Groundwater Area Type: Proclaimed Groundwater Area
Is the Premises situated in a Public Drinking Water Source Area (PDWSA)?	Yes ☐ No ☒	N/A
Is the Premises subject to any other Acts or subsidiary regulations?	Yes ☒ No ☐	Mining Act 1978, Mine Inspection and Safety Act 1994
Is the Premises within an Environmental Protection Policy (EPP) Area?	Yes ☐ No ☒	N/A
Is the Premises subject to any EPP requirements?	Yes ☐ No ☒	N/A
Is the Premises a known or suspected contaminated site under the *Contaminated Sites Act 2003*?	Yes ☐ No ☒	N/A