# Application for Works Approval

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

| | |
|---|---|
| **Works Approval Number** | W6734/2022/1 |
| **Applicant** | MARBL Lithium Operations Pty Ltd |
| **ACN** | 637 077 608 |
| **File number** | DER2022/000448 |
| **Premises** | Wodgina Operations<br>L45/443, M45/383, M45/923, M45/1188, M45/1252, G45/321<br>As defined by the premises maps attached to the issued works approval |
| **Date of report** | 10 May 2023 |
| **Decision** | Works approval granted |

Alana Kidd

Digitally signed by Alana Kidd
Date: 2023.05.10 09:03:46 +08'00'

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

# Table of Contents

# 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 W6734/2022/1 has been granted.

# 2. Scope of assessment

## 2.1 Regulatory framework

In completing the assessment documented in this decision report, the Department of Water and Environmental Regulation (the department; DWER) 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 2 September 2022, MARBL Lithium Operations Pty Ltd (the applicant) submitted an application for a works approval to the department under section 54 of the *Environmental Protection Act 1986* (EP Act).

The application is to undertake construction works, commissioning and time-limited operation relating to a new in-pit Tailings Storage Facility (TSF) – Atlas in-pit TSF - consisting of six separate pit areas (Constellation Pit B, Dragon Pits A, B and C; Anson Pits A and B) at the premises (Figure 1). The premises is approximately 110 km south of Port Hedland.

The premises relates to the Category 5 - Processing or beneficiation of metallic or non-metallic ore with assessed production / design capacity under Schedule 1 of the *Environmental Protection Regulations 1987* (EP Regulations) which are defined in works approval W6734/2022/1. The infrastructure and equipment relating to the premises category and any associated activities which the department has considered in line with *Guideline: Risk Assessments* (DWER 2020) are outlined in works approval W6734/2022/1.

Wodgina Lithium is a historical mining project that has been mined for a variety of minerals since 1902. Current operations focus on the extraction of lithium with tailings currently being deposited into the licenced TSF3E.

The proposed new Atlas in-pit TSF is to support and accept tailings from approved Category 5 processes at Wodgina, as approved under Licence L4328/1989/10 (this works approval includes no additional category or capacity changes when compared to L4328/1989/10). The Atlas Pits are relatively close to the Project's beneficiation plant and will provide future tailings storage following the decommissioning of TSF3E.

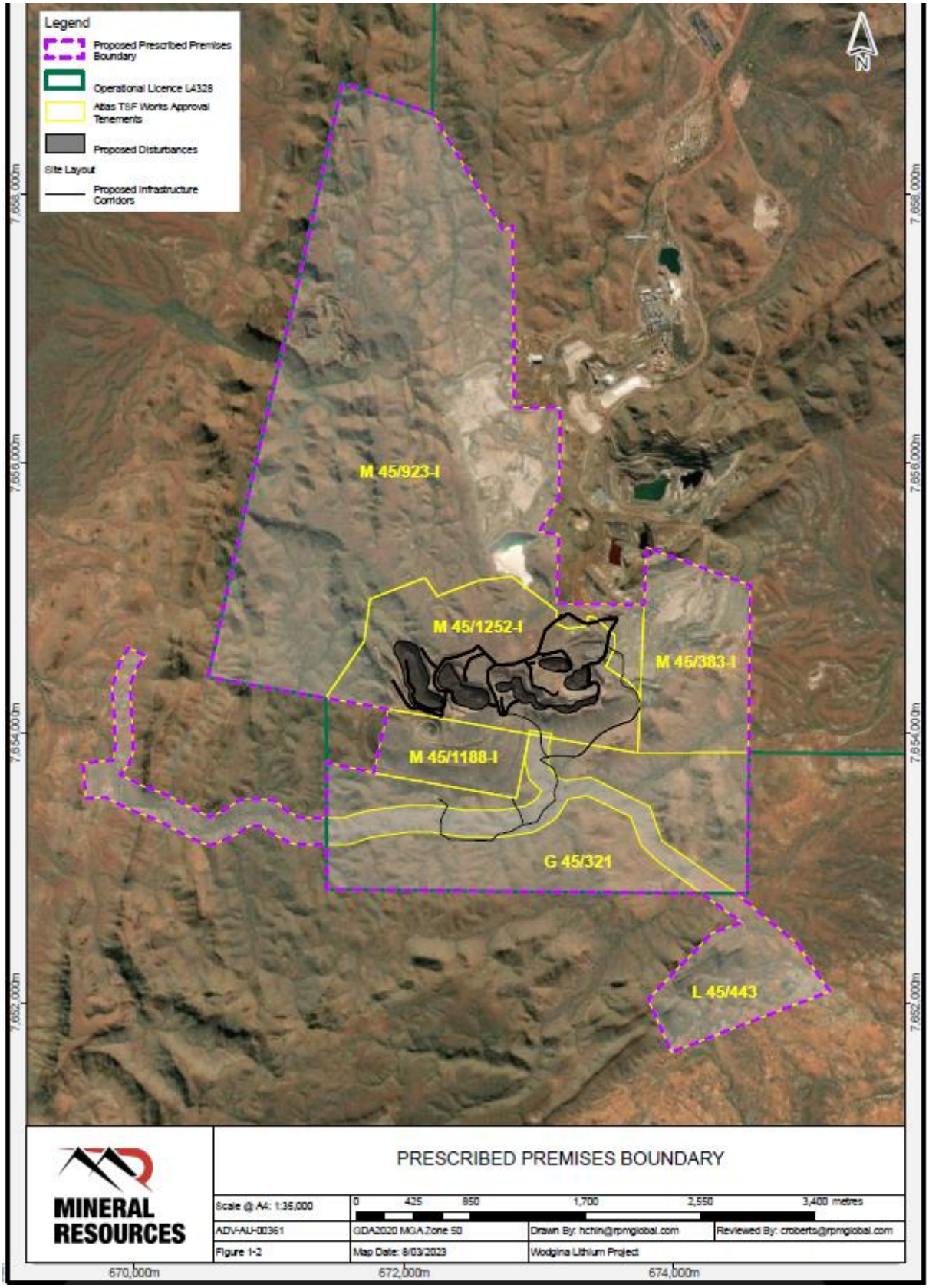


**Figure 1 – Prescribed premises boundary.**

### 2.2.1 ATLAS IN-PIT TSF DESIGN AND OPERATION

The Atlas in-pit tailings facility has been designed by CMW Geosciences Pty Ltd (CMW, 2022) to store a total of 6.3 Mt of tailings over a 1.3-year life, at a maximum tailings rate of 4.8 Mtpa. The facility is located 1.8km SSW of the Project's Beneficiation Plant.

Tailings deposition will be into the pits from a moveable single point discharge. Supernatant water will be removed from the in-pit TSF by a decant pump located on the pit ramp (Figure 3). Return water will be pumped via proposed new pipelines and existing pipelines (Figure 3) directly to beneficiation plant (return water discharged within process water pond).

As the in-pit TSF is filled with tailings, the discharge point will be moved accordingly, with the decant pond and pump moved progressively up the pit ramp. A split deposition or cycled between the pits is proposed to reduce the rate of rise and enable water recovery from smaller 'circular' pits (Dragon A and Constellation B), which have short beach lengths (i.e. a time for settling of the tailings will be required).

Tailings deposition is proposed to be cycled between the pits, such that the three (3) pit areas are filled concurrently. This strategy to cycle between pits would propose the Anson and Arvo Pits receiving tailings 84 % of the time, with Dragon and Constellation Pits receiving tailings 10 % and 6 % of the time, respectively (i.e. 3 and 2 days per month, respectively). The intent of this proposed deposition strategy is to assist in optimising the consolidation of the tailings during operations and therefore, reducing seepage losses and pond sizes from the pits through decreasing the tailings permeability at depth within each pit. It will also provide time for settling of the tailings to enable water recovery from smaller pits.

### 2.2.1 TAILINGS DELIVERY AND RETURN WATER PIPELINE

Tailings is transported from the process plant to the Atlas In-Pit TSF via an HDPE pipeline. At the discharge point the tailings delivery pipe extends a minimum distance of 5 to 10 m over the pit rim crest, from where the tailings are deposited into the facility. A site plan showing the pipeline route is shown in Figure 3. Indicative pipeline corridor and bunding is shown in Figure 4.

The tailings line will be inspected a least once per shift. All tailings' lines will be bunded and fitted with pressure sensors to alert the operators of a serious leak or line failure.

### 2.2.1 WATER RECOVERY SYSTEM

Water will be removed from the facility by a pump deployed from the pit ramp and pumped back to the plant. The minimum capacity of the water recovery system should be a minimum of 260 tph (or nominally 50% average annual water return with an allowance for removal of a large storm event (1:100 yr. AEP 72 hr. event) over 1 month).

The decant pond should be maintained at the smallest practical operational size to maximise water return to the plant. The size of the pond will be governed by the pump type/setup, efficiency of the decant pump in removing water from the tailings storage and settling requirements.

Tailings deposition into the small circular pits (Dragon A and Constellation B) would occur for several days and then the ponded water will be recovered as much as possible. Some experimentation on deposition periods into the small circular pits and settling times will be required.

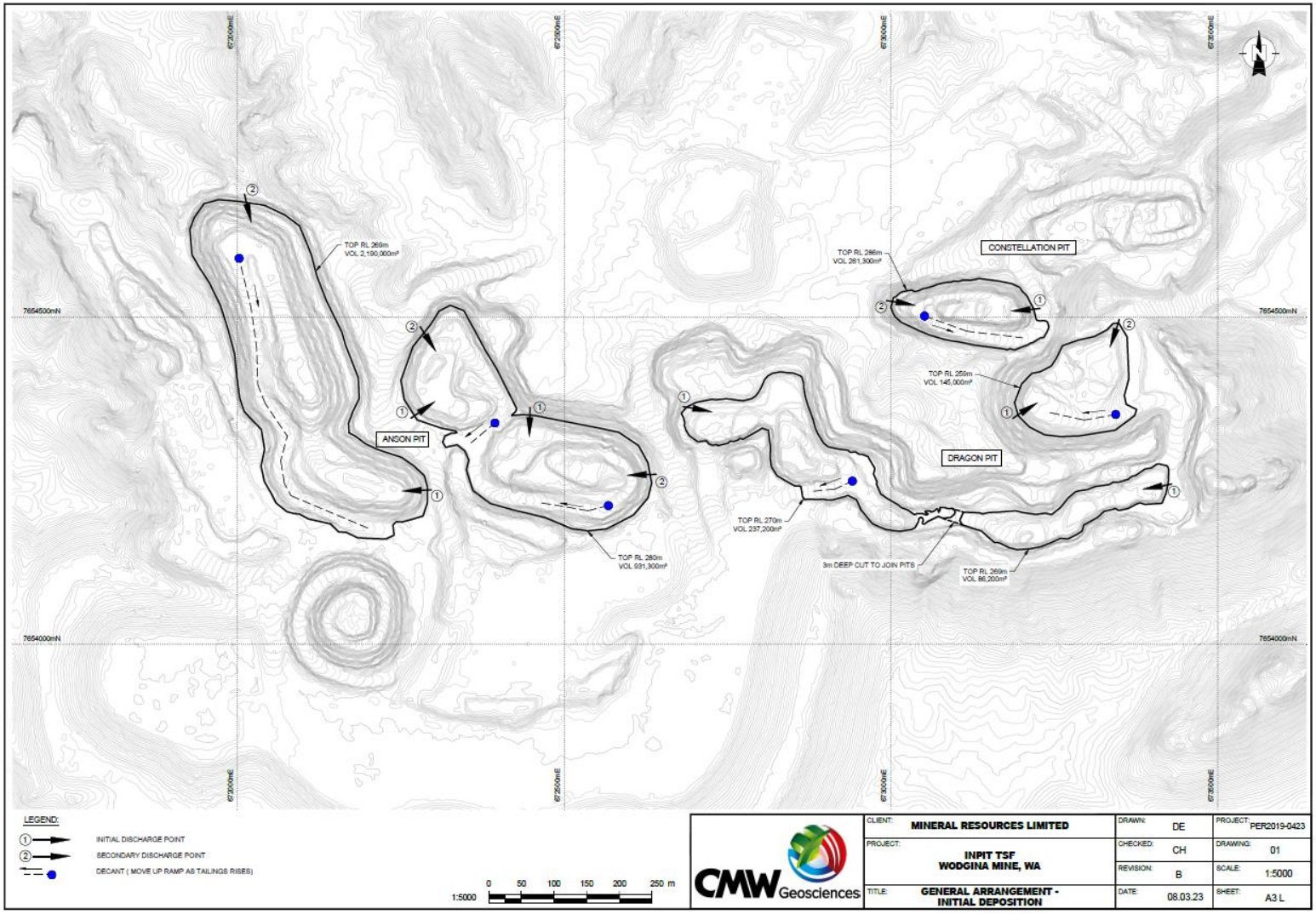


**Figure 2 – General arrangement of tailings slurry deposition.**

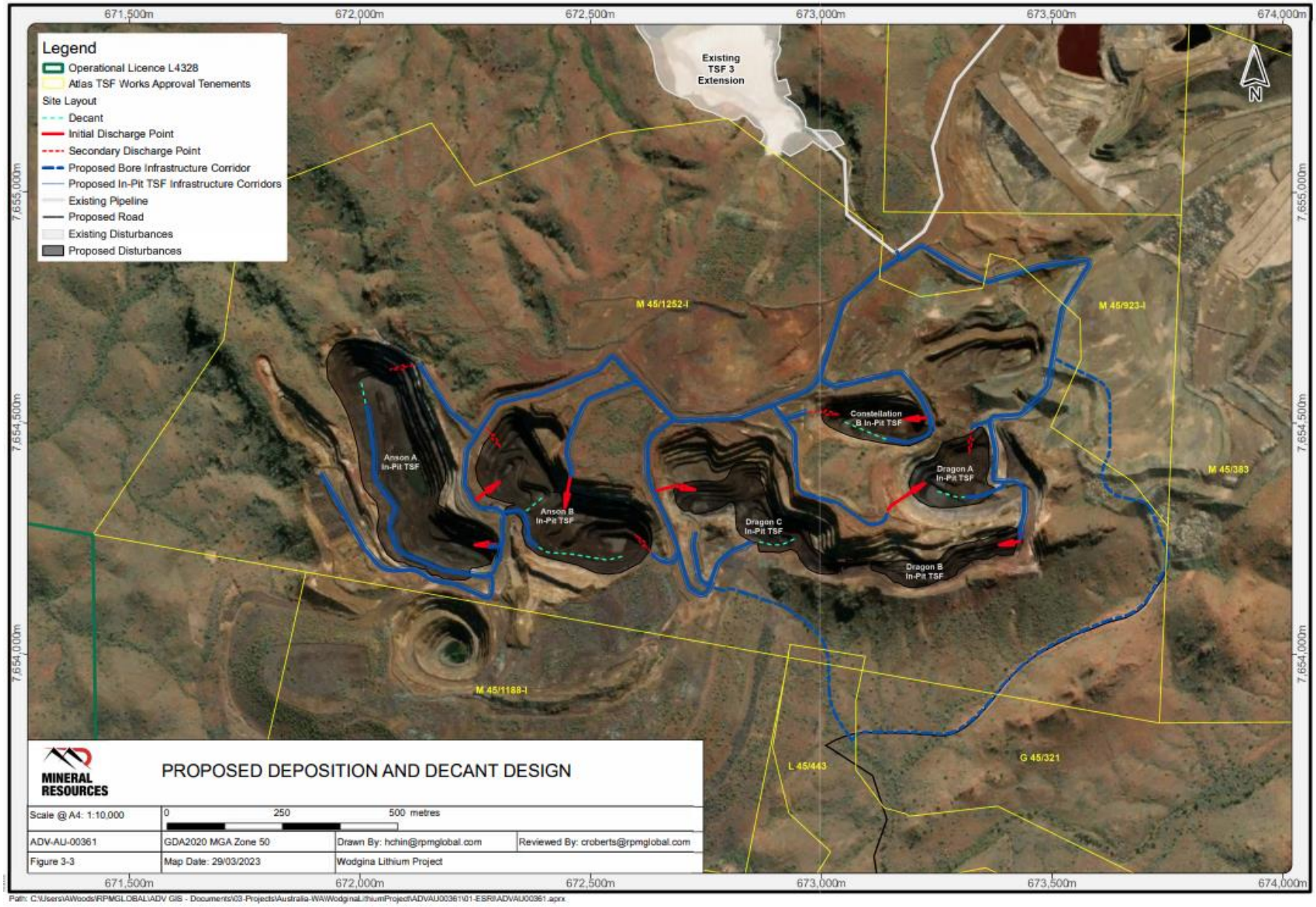


**Figure 3 – Pipeline corridor layout.**

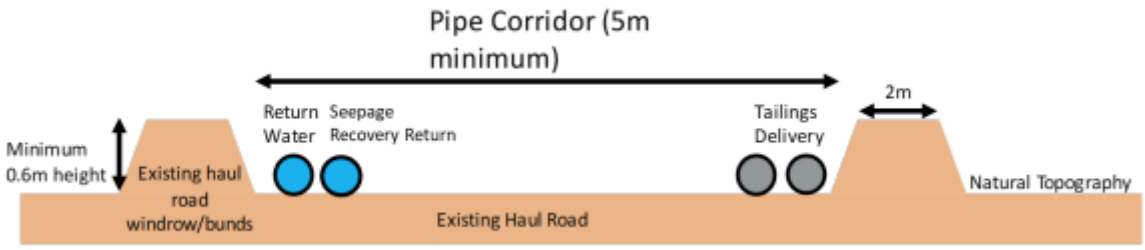


**Figure 4 – Indicative pipeline corridor and bunding**

### 2.2.2 TAILINGS CHARACTERISTICS

**Physical/geotechnical characteristics of tailings**:

The processing of pegmatite ore to create the spodumene concentrate results in the creation of quartz/feldspar tailings. Tailings can be produced in two streams; dry/coarse tailings and wet/fine tailings, or a single Total or Combined stream. The intended normal operating scenario is the production of Dry/Coarse and Wet/Fine streams. The Wet/Fine stream component of tailings will be deposited into Atlas in-pit TSF, while the Dry/Coarse stream is deposited and co-mingled into the Eastern Waste Landform (EWL), consistent with L4328/1989/10. In the event that segregation by cyclone and the dewatering screen is not operational, the Plant will revert to the production of a Total tailings stream (no Dry/Coarse tailings separation) that will be deposited in the Atlas TSF. The desing report (CMW, 2022), has considered both circumstances to facilitate the continuation of operations. Comparison of tailings characteristics between combined and fine tailings streams is provided in Table 1. Both tailings streams are expected to achieve a target of 60% solids under normal operating conditions.

**Table 1 – Comparison between combined and fine tailings stream (CMW, 2022).**

| Engineering Properties | Combined Steam | | Fine Stream | |
|---|---|---|---|---|
| | 2017 | 2019 | 2018 | 2019 |
| Final Tailings Density# | 1.5 t/m³ (dry) | 1.5 t/m³ (dry) | 1.5 t/m³ (dry) | 1.3 t/m³ (dry) |
| Initial Tailings Density | approx. 1.3t/m³ (dry) | approx. 1.3t/m³ (dry) | approx. 1.3t/m³ (dry) | approx. 1.2 t/m³ (dry) |
| Angle of Internal Friction | 18.5° – 35° | 39° | 39° | 42° |
| Particle Size Distribution | 100% passing 425µm sieve<br>37% passing 75µm sieve<br>3% passing 2µm sieve<br>Fines, non-plastic | 100% passing 1.18 mm sieve<br>40% passing 75µm sieve<br>1% passing 2µm sieve<br>Fines, non-plastic | 100% passing 425µm sieve<br>89% passing 75µm sieve<br>5% passing 2µm sieve<br>Fines, non-plastic | 100% passing 425µm sieve<br>99% passing 75µm sieve<br>5% passing 2µm sieve<br>Fines, low-plasticity |
| Hydraulic Conductivity | 1.0 x $10^{-7}$m/s | $10^{-7}$ to $10^{-6}$ m/s | $10^{-7}$ to $10^{-6}$ m/s | $10^{-6}$ to $10^{-5}$ m/s |
| Tailings Beach Slope# | 1% to 1.2% | 1% | 1% to 1.2% | 0.5% |

# assumed parameter

**Geochemical characteristics of tailings:**

The recent assessments of the tailings produced by the Wodgina processing plant include:

• Wodgina Lithium Project Process Streams Geochemical Assessment (MBS, 2018);

• Tailings Storage Facility 3 Expansion – Wodgina Lithium Project Tailings Properties Assessment Report (CMW, 2019); and

• Wodgina Lithium Project Site Production Tailings Geochemical Assessment (MBS, 2019).

The latest report (MBS, 2019) involved the full geochemical assessment of the 93 tailings samples.

In summary the results of the report indicate:

- All Wodgina production tailings (total, dry/coarse and wet/fine) had neither acid producing nor neutralising capability. All tailings streams are classified as Non-Acid Forming (NAF), with a subclassification of 'barren'.
- The potential for significant harm to the environment as a result of seepage generated from the total and fine/wet tailings streams is considered low, with expected species, including lithium and fluoride present in low concentrations and at similar concentrations to existing groundwater in the mineralised zone.
- Assessment of production tailings for radiation potential indicates no radiation risk to human health based on extremely low total activity concentrations of head of chain uranium, thorium and rubidium relative to applicable exemption limits for further investigation.

### 2.2.3 SEEPAGE MODELLING AND ASSOCIATED SEEPAGE RECOVERY INFRASTRUCTURE

Seepage Modelling undertaken by AQ2 (AQ2, 2022a) and provided as part of supporting documents, predicts that the operation of the proposed Atlas in-pit Pit TSF operation could, without controls in place:

- Result in the water table in and around the TSF area rising and some surface ponding occurring on the southern side of the southern WRD (after around 5 to 92 years, depending on elevation point) and to the east of the Dragon A and B pits (after around 10 years).
- Result in seepage pathways from the TSF area are ultimately towards south. These predicted flow paths are associated with very small flow volumes. Estimated seepage to the surface was less than 8 kL/d (i.e. 0.1 L/s) at its peak.

The AQ2 Seepage Assessment (AQ2, 2022a) adopted a conservative approach (i.e. "worst" case scenario) for the tailings deposition and is as follows:

- The Atlas in-Pit TSF are 'instantaneously' filled to the maximum design top of tailings.
- No decant water return from the deposited tailings (i.e. all water stored in the tailings would infiltrate through the unsaturated BIF into the water table).
- The adopted hydraulic properties for the Mixed tailings were as follows:
  Permeability – 1x10- 2 m/d (i.e. ~1x10-7 m/s).
  Sy – 25%.

It is noted by AQ2 that ponding at the surface does not necessarily mean surface expression of seepage water outside of the TSF. Most of the predicted ponding is a hydraulic response to seepage recharging the groundwater table beneath the tailings deposition pits. That is, the water table is "pushed up" by the transmission of hydraulic heads through the aquifer system. Seepage particles migrate much more slowly through the aquifer system compared to the migration of hydraulic heads.

Potential seepage pathways, without controls in place are shown in Figure 5, provided by the applicant.

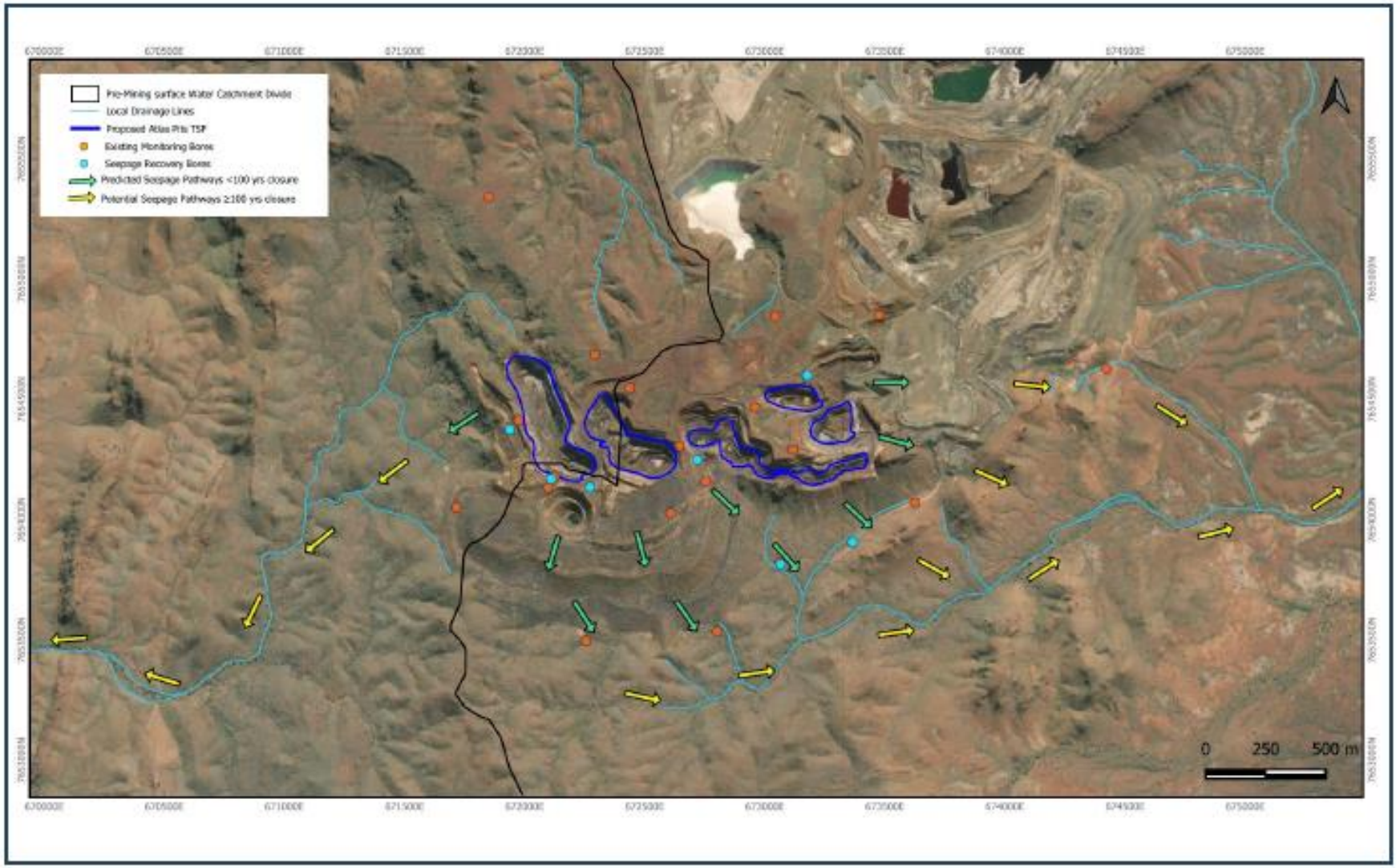


**Figure 5 – Modelled surface pathway of groundwater seepage (without controls) and location of existing and proposed bores.**

The modelling (AQ2, 2022a) concludes that:

Nine seepage recovery bores would be sufficient to mitigate the seepage impacts of Atlas in-pit TSF and prevent it from daylighting over the life of Wodgina mine (30 years). The Atlas in-pit TSF has an operational life of approximately 1.3 years (at maximum production rate), however seepage recovery bores would need to be in place and available for use when required over the life of the mine (30 years).

- The model predicts that total abstraction of up to 60-100 kL/day (i.e. 0.7-1.2 L/s) would be required to successfully mitigate seepage flows.
- Particle tracks show that:
    - Seepage particles from Anson A and Anson B pits are not predicted to travel past WRD to the south or come anywhere near drainage lines to the south.
    - Seepage particles from eastern pits, predicted to reach the southern low-lying areas (but no daylight) on the southern side of the southern WRD, which are mostly associated with the Dragon C pit. This was the main reason why additional bore (REC-7) was required to the south in addition to REC-4 and REC-6 bores near the Dragon C pit.
    - Particles generating from Dragon A and B and Constellation B pits are not predicted to daylight along the drainage lines to the south or to the east.
- It was concluded by AQ2 (AQ2, 2022a) that the Atlas Pits in pit TSF can be operated, as discussed above, in such a way that there will be little to no surface water ponding or daylighting of any seepage that originated from the Atlas Pits.

It is also concluded by AQ2, 2022a that the Atlas Pits in pit TSF will have minimal impact on groundwater quality and that any impact will be confined to the predicted extent of seepage migration (which is all within the immediate Wodgina mine area). However, even within the seepage “plume” the impact of seepage on groundwater quality will be minimal as the volumes of seepage are very low in comparison with the volumes of natural groundwater. As such, there will be physical attenuation of solutes in the seepage by dilution and dispersion as well as hydrogeochemical attenuation (although these processes have not been modelled in the study).

Seepage water recovered via abstraction bores will be sent back to the processing plant (stored in the Wodgina Break Tank (previously referred to Breccia Raw Water Tank and the Beneficiation plant raw water tank) via new pipelines which will be connected to existing pipelines managed under L4328/1989/10 (Figure 1). It should be noted that this works approval does not authorise any construction of new pipelines outside the works approval premises boundary or additional discharge related to seepage recovery not currently covered by an active instrument.

### 2.2.4 SEEPAGE MONITORING

Existing bores located along interpreted seepage pathways, either between Atlas Pits or immediately downstream of Atlas Pits. These bores will be the primary indicators of seepage from the Atlas in-Pit TSF. These bores are: MB19WOD08, MB19ATLAS01, MB19ATLAS03, MB19ATLAS04, MB19ATLAS05, MB19ATLAS08, MB19ATLAS09, MB18Anson03, MB18Anson04, WMB02, WMB03, MB19ATLAS02, MB19ATLAS06 and MB19ATLAS07, which are located surrounding Atlas pits. MB18Anson01, MB18Anson02A, WMB01, WMB04, TINMB05S, TINMB05D and EWL-h are also proposed to be used.

### 2.2.5 WATER BALANCE

A preliminary in-pit water balance was performed as a component of the Atlas in-pit TSF design assessment (CMW, 2022). Inflows and outflows for the in-pit facilities were estimated monthly.

Inflows include rainfall and slurry water. Outflows include evaporation, seepage losses and water retained in tailings (pore water).

Assumptions and other data adopted for the water balance are listed below (CMW, 2022):

- Climate data was obtained from the BoM website. Mean annual rainfall for Indee (335 mm) and mean evaporation figures for Port Hedland (3,590 mm, which is similar to the project area) were obtained.
- Atlas in-pit tailings area of approximately 25 ha (all pits).
- A tailings runoff coefficient of 1.0 was assumed.
- Pool and Running beaches area approximately 1/3 of tailings area.
- Evaporation pan factor of 0.75.
- Average tailings moisture content of 30 % (assumed for both tailings streams).
- Tailings slurry density (optimum under normal operating conditions) of 60 % (Section 2.4).
- Tailings production rate of 4.8 Mtpa.
- Seepage - a estimate based on hydrogeology parameters (Saprolite permeability, 0.005 m/day).
- Tailings permeability likely to control seepage in later stages of pit filling.
- The results of the analysis indicate potential annual average water returns of approximately 50% of the tailings slurry water deposited into the respective in-pit facilities can be expected under average climatic conditions.

The efficacy of the water return system is the key to achieving a higher in-situ tailings dry density within the TSF. The minimum capacity of the water recovery system should be a minimum of 260 tph (or nominally 50% average annual water return with an allowance for removal of a large storm event (1:100 yr. AEP 72 hr. event) over 1 month.

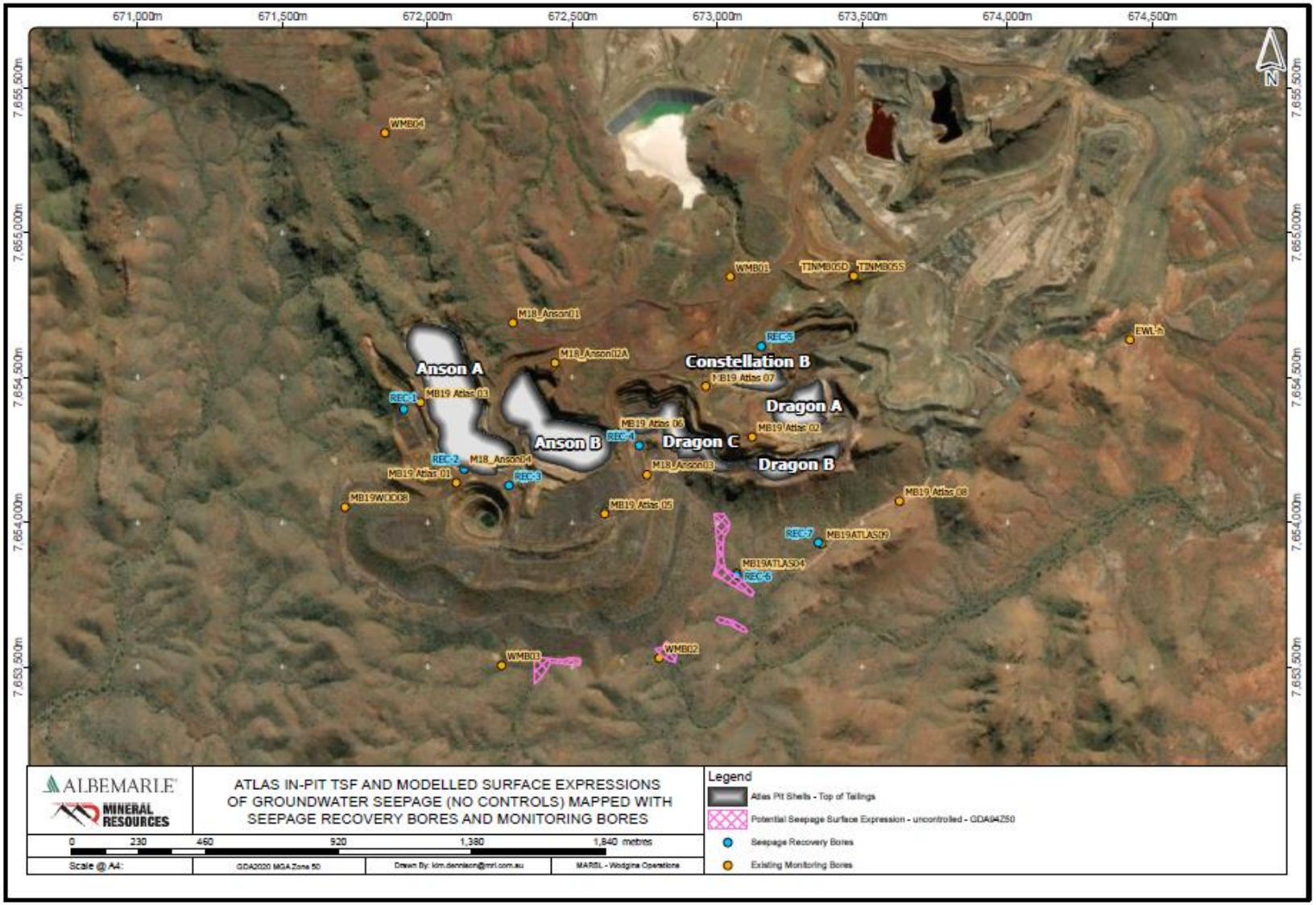


**Figure 6 - Atlas in-pit TSF and modelled potential surface expressions of groundwater seepage (without controls) mapped with seepage recovery bores (in blue) and monitoring bores (in yellow).**

Works Approval: W6734/2022/1

## 2.3 Department of Water and Environmental Regulation – Contaminated Sites Branch - Hydrogeological advice

Internal advice from DWER's hydrogeologist from Contaminated Sites Branch (CSB) was sought regarding tailings characteristics, monitoring network and suitability of seepage analysis to inform and confirm seepage risks related to the proposed in pit TSF and proposed seepage controls. In summary the following advice was received:

- Although the leaching characteristics of the tailings from lithium mining have been undertaken using standard geochemical methods, recent research suggests (Roy *et al*., 2020; 2022) that these methods can underestimate the amount of lithium that is leached from a TSF. Consequently, CSB recommends that additional kinetic testing is undertaken during the operational life of the Atlas in-pit TSF to better quantify the long-term leaching potential of lithium from this facility;
- In the current absence of kinetic test data, CSB recommends that the risk of seepage from the in-pit TSF causing adverse environmental impacts is assessed assuming that the lithium concentration in seepage will be 20 mg/L. Potential water quality criteria for lithium for protecting key environmental receptors near the TSF include:
    - 2.5 mg/L for groundwater within the root-zone of vegetation (i.e., within 3 m of the land surface). This is based on the Australian and New Zealand water quality criterion ( for the irrigation of water containing lithium to crops; and
    - 0.4 mg/L for groundwater reaching the hyporheic zone of nearby creeks. This criterion is based on preliminary toxicity testing for aquatic organisms near the other mine sites.
- The groundwater flow model that has been developed by AQ2 consultants is considered to be technically sound and generally has been developed in accordance with the principles and guidance that is provided in the Australian groundwater modelling guidelines. However, the AQ2 report does not adequately consider the level of uncertainty that is associated with the model predictions. CSB recommends that the current model predictions about the fate of seepage from the TSF are considered to be only the best estimates that are currently available. It is important that sufficient monitoring is undertaken during the life of the in-pit TSF to verify the model predictions. It is particularly important that areas where groundwater could emerge at the land surface are identified with ongoing groundwater monitoring, as these are locations where recovery bores would need to be installed to prevent this taking place.
- Due to the current large level of hydrogeological uncertainty at the Wodgina mine site, CSB recommends that the following measures are undertaken to minimise the risks of adverse environmental impacts taking place from tailings seepage, and to progressively improve the predictive capability of the numerical groundwater flow model for the site:
    - Developing a contingency plan for responses to groundwater trigger value exceedances
    - Undertaking periodic reviews of the suitability of the numerical groundwater model
- The water balance that was provided in the works approval document is suitable for a preliminary assessment for the proposed in-pit facility, but would not be sufficiently accurate to assess seepage rates from the TSF during its operational life. This is because evaporation rates from an offsite weather station have been used in the water balance assessment. It is therefore recommended that a suitable weather station is established within one of the mine voids to measure evaporation rates with a sufficient level of accuracy during the operational life of the facility.

Details on how the technical advice above was considered in the risk assessment and addressed as part of the works approval are detailed in section 3.3 below.

## 2.4 Department of Mines, Industry Regulation and Safety (DMIRS) – technical advice

Advice from DMIRS was sought regarding proposed in-pit TSF. In summary, the following advice was received:

- At the time of advice provided, a mining proposal was under assessment for the proposed new in-pit tailings storage facility – REG ID 113904.
- A DMIRS Geotechnical engineer undertook a review of the design report (CMW, 2022) and In-pit TSF seepage assessment (AQ2, 2022a), as part of the assessment of the Mining Proposal.

  The geotechnical findings were as follows;

  - There are 6 in-pit TSFs under the Atlas project. The In-Pit TSF has sufficient freeboard along with a seepage recovery system where recovery bores will be located at strategic locations defined by geological, structural and hydrogeological parameters.
  - In-pit TSF pit walls will be monitored on a weekly basis and assistance of Geotechnical Engineer will be sought, should significant stability issues be observed.
  - In the seepage study completed by AQ2 (dated 24/08/2022) has concluded that the Atlas In-Pit TSFs will have minimal impact on groundwater quality and that any impact will be confined to the predicted extent of the seepage migration (which is all within the immediate Wodgina mine area).
  - The geotechnical review of In-Pit TSFs has focused on design and strategy and has addressed influence of local ground water.
  - CMW Geoscience assigned the Atlas In-Pit TSFs a hazard of low Category 3 based on the DMP Code of Practice (2013).
  - Ensure regular monitoring of In-Pit TSF (all pits) access and work areas, slope stability including post rainfall events and freeboard (Code of Practice, Mine Safety Management System)

No further clarification was sought from the applicant and no changes were required to the Mining Proposal, as a result of these geotechnical comments. It was expected from a geotechnical point of view that construction, operation and closure of the project can be achieved safely, provided all necessary steps are undertaken as described above.

## 2.5 Department of Planning, Lands and Heritage (DPLH) – technical advice

Advice from DPLH was sought regarding proposed in-pit TSF and associated infrastructure and their location in relation to Aboriginal Heritage sites, including associated approval requirements. DPLH has confirmed via email in February 2023 that a Registered site is located within the disturbance footprint and further engagement with DPLH regarding approvals requirements under the *Aboriginal Heritage Act 1972 (*the AH Act*)* was required. Consultation and evidence of support from the Kariyarra Aboriginal Corporation (KAC) would also be required to be provided to DPLH.

A phone conversation with DPLH later in March 2023 indicated that the applicant has applied for activities within an Aboriginal Site, under Regulation 10 of the *Aboriginal Heritage Regulations 1974.* The Aboriginal site status is also being re assessed by DPLH and the Kariyarra Aboriginal Corporation is being consulted.

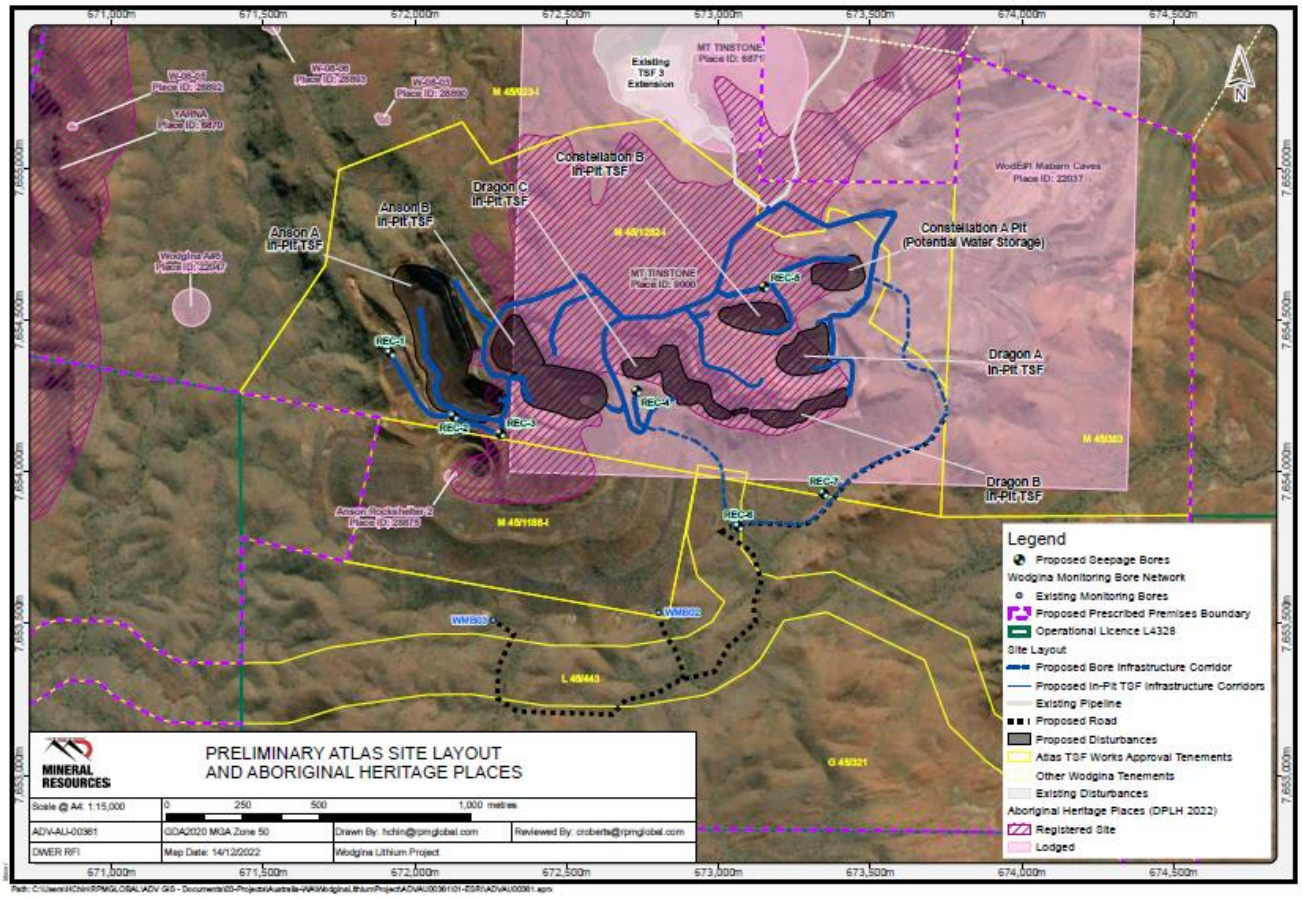


**Figure 7 – Aboriginal Heritage Places within the proposed area of disturbance.**

As part of assessment of the application, an invitation to provide comments was sent to the Kariyarra Aboriginal Corporation. There were no comments received.

The applicant was reminded of their obligations under AH Act.

# 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 2020).

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 / operation which have been considered in this decision report are detailed in Table 2 below. Table 2 also details the control measures the applicant has proposed to assist in controlling these emissions, where necessary.

**Table 2: Proposed applicant controls**

| Emission | Sources | Potential pathways | Proposed controls |
|---|---|---|---|
| **Construction** | | | |
| Dust | Construction activities associated with pipeline placement, roads, bore construction and vehicle movement | Air / windborne pathway | Dust controls during construction includes:<br>• Use of water carts and other dust suppression measures.<br>• Water cart sprays designed and operated to avoid over-spray.<br>• Minimise open cleared area (through staged clearing or progressive rehabilitation).<br>• Ground clearing activities (including topsoil stripping) not undertaken during extremely windy conditions. |
| Noise | Construction activities associated with pipeline placement, roads, bore construction and vehicle movement | Air / windborne pathway | • No controls proposed. |
| Sediment laden stormwater | Construction activities associated with pipeline placement, roads, bore construction and vehicle movement | Overland flow | • Surface water control measures installed during initial stages of clearing activities.<br>• Installation of sedimentation basins or baffling to reduce sediment-laden surface water leaving mine operations.<br>• Sediment basins to be desilted prior to onset of wet season.<br>• Minimising cleared/open areas. |
| **Commissioning and Time limited operations** | | | |
| Dust | Dry tailings (particulates) on exposed beaches potentially | Air / windborne pathway | As per applicant's support document:<br>• Cyclic deposition maintaining a wet beach.<br>• Location within pit will provide natural protection to wind when compared to above ground |

| Emission | Sources | Potential pathways | Proposed controls |
|---|---|---|---|
| | containing concentrations of elements with environmental significance | | TSF.Dust monitoring of surrounding environment down wind.<br>• Progressive capping to TSF beach as a maximum level is approached.<br>• Self-shedding gradient to capping.<br>• Dust suppression techniques.<br><br>Low levels of naturally occurring radioactivity in tailings. Tailings were not considered radioactive as per WA Radiation Safety Regulations 1983 (in acoordance with the Wodgina Radiation Management plan - D700701-SAF-PLN-0014).<br><br>Regulation of radiation safety on mining operations is the responsibility of DMIRS under the Work Health and Safety (WHS) laws. |
| Spillage of tailings and decant return water | Pipeline ruptures | Direct discharges to land and infiltration to soil | As per applicant's support document:<br>• HDPE Pipe (adequate pipe class).<br>• Pressure gauges and pump shutdown switches fitted.<br>• Minimise flow velocity.<br>• Bunding and catchpits to pipeline route.<br>• Periodic replacement of pipeline bends.<br>• Pipe design by specialist.<br>• Operations manual detailing deposition method.<br>• Training of operators.<br>• Deposition Plan |
| Tailings seepage | Deposition of tailings into in-pit TSF | Seepage through pit walls and infiltration to groundwater | As per applicant's support document:<br>• Control of decant pool to minimise seepage volumes.<br>• Implementation of monitoring programme and trigger response action plan.<br>• Installation of seepage mitigation controls, such as monitoring/recovery bores, based on recommendations of AQ2 Report (AQ2, 2022a, 2022b, 2023).<br>• Operation of the 7 Atlas TSF recovery bores (REC1 – REC7), for the purposes of seepage recovery from the Atlas TSF, will be selective based on the seepage recovery bore most proximal to the depositional location, such that 60-100 kL/day is abstracted. This abstraction rate is consistent with the AQ2 seepage assessment (AQ2, 2022a).<br>• Operation of the seepage recovery system outside of the tailings deposition activity, will be in accordance with the Atlas Pits TSF Operational Monitoring and Mitigation Report (AQ2, 2022b and any future updates), through the Wodgina life of mine.<br>• Cycling tailings deposition between the pits will increase consolidation of the tailings during operation and reduce the permeability of the tailings.<br>• Maintenance of a water balance. |

| Emission | Sources | Potential pathways | Proposed controls |
|---|---|---|---|
| | | | • Non-invasive (i.e. visual) observations for any seepage from Atlas Pits TSF along the western and southern edge of Atlas WRD will be undertaken throughout commissioning. Quarterly drone monitoring of the area has been proposed to supplement this non-invasive monitoring program.<br>• Submersible data loggers will be deployed in all monitoring bores detailed, to record static water levels and electrical conductivity at a daily monitoring frequency. |
| Discharge of tailings material | Overtopping | Direct discharges to land and infiltration to soil | As per applicant's support document:<br>• Design limit of tailings deposition level<br>• Daily inspections.<br>• Monthly beach survey by drone with LiDAR.<br>• Implementation of emergency action plan.<br>• The minimum operational freeboard for the respective pits under normal operating conditions is 0.5 m, plus allowance for temporary storage of the 1 % annual exceedance probability (AEP) (previously the 1:100 year average recurrence interval [ARI]) 72-hour storm event (383 mm) whilst maintaining required total freeboard.<br>• The minimum capacity of the water recovery system should be a minimum of 260 tph (or nominally 50% average annual water return with an allowance for removal of a large storm event (1:100 yr. AEP 72 hr. event) over 1 month).<br>• Maintenance of a water balance (updated). |

### 3.1.2 Receptors

In accordance with the *Guideline: Risk Assessment* (DWER 2020), the Delegated Officer has excluded the applicant's employees, visitors, and contractors 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 and Figure 8 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 2020)).

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

| **Human receptors** | **Distance from activity / prescribed premises** |
|---|---|
| Altura Mine Camp (not operated by the Licence Holder) | Approximately 9 km from the proposed Atlas TSF. See figure Figure |
| **Environmental receptors** | **Distance from activity / prescribed premises** |
| Groundwater | The premises is located within the *Rights in Water and Irrigation Act 1914* (RIWI Act) Proclaimed Pilbara Groundwater and Surface Water Areas.<br>No stock bores are in close proximity. The closest bore (not operated by the Applicant) that is for camp use is under groundwater licence GWL184329 (Pilgangoora Operations Pty Ltd). This bore is located more than 10 km from the |

| | |
|---|---|
| | proposed in-pit TSFs.<br><br>Groundwater levels at the Atlas In-Pit TSF area range from 10 mbgl in areas surrounding the greenstone belt to 55 – 95 mbgl within the greenstone belt located on the high ridges. This is below the base of the Atlas pits where base elevations range from 40 to 80 mbgl.<br><br>Groundwater quality: Generally alkaline (pH 7.4 to 8.4), fresh to brackish salinity (510 to 3,200 mg/L total dissolved solids) and very hard (406 to 1,600 mg CaCO3/L).<br><br>• Low environmentally significant metals and metalloids including arsenic, cadmium, cobalt, lead, mercury, selenium and thallium were detected; and<br><br>• Variable in lithium content, ranging from 0.08 mg/L (groundwater in non-lithium bearing ultramafic rocks) to 9.5 mg/L (groundwater associated with pegmatite dykes). |
| Major watercourses/ waterbodies | No permanent surface water systems intersect the proposed activity area, although semi-permanent pools, and permanent pool are located within the premises boundary (approximately 1km south west of Atlas in-pit TSF) .<br><br>The mine operations are predominantly situated within the western sub-catchment of the Turner River that drains generally in a north-east direction towards the Turner River approximately 9 km downstream of the Premises.<br><br>Ephemeral drainage located within premises. As the pits do not have a large catchment of water flowing towards them, no surface water diversions are proposed as part of this Project.<br><br>Refer to Figure 5 and Figure 10 |
| Conservation Significant Flora | There is Priority 3 flora located within the Premises.<br><br>• *Euphorbia clementii* (P3);<br>• *Heliotropium muticum* (P3);<br>• *Terminalia supranitifolia* (P3);<br>• *Triodia chichesterensis* (P3);<br>• *Vigna triodiophila* (P3); and<br>• *Abutilon* aff. *Hanni* (potentially undescribed) (EPA 2016a; 2016b).<br><br>Refer to Figure 9 |
| Threatened/ Priority Fauna | Numerous Threatened and Priority Fauna are located within the premises boundary. |
| Heritage sites | The applicant has indicated as part of the application that two lodged sites were located within the premises, however none of them would be disturbed or impacted by proposed activities.<br><br>Since the submission of the Works Approval application however, the DPLH Aboriginal Heritage Places spatial layer has been updated and Reg Site 9000 has been re-mapped across part of the Atlas Pit areas. The applicant is in consultation with the Native Title Group and DPLH regarding Reg Site 9000 and has been granted a Regulation 10 permit.<br><br>The applicant has indicated that preliminary findings regarding assessment of cultural values in the area, in consultation with Aboriginal Corporation, Traditional Owners and Heritage consultants, indicated there will be no risk of impacts from proposed activities. DWER notes that direct impacts to Aboriginal Heritage Sites are regulated under *Aboriginal Heritage Act 1972,* and the applicant has been reminded of its obligations under the AH Act.<br><br>Location of Aboriginal Heritage places are shown in Figure 7. |

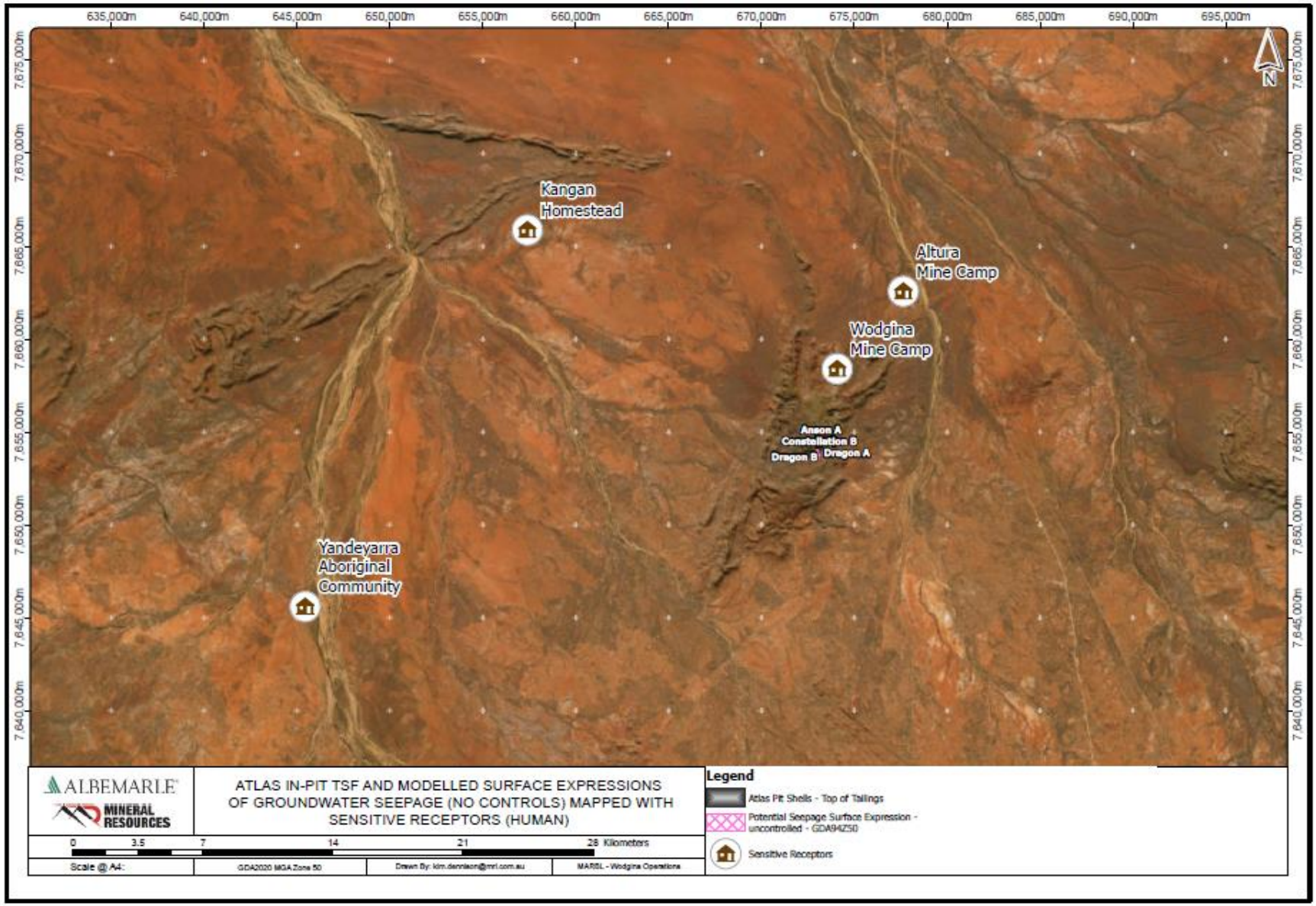


**Figure 8: Distance from in-pit TSF to human receptors**

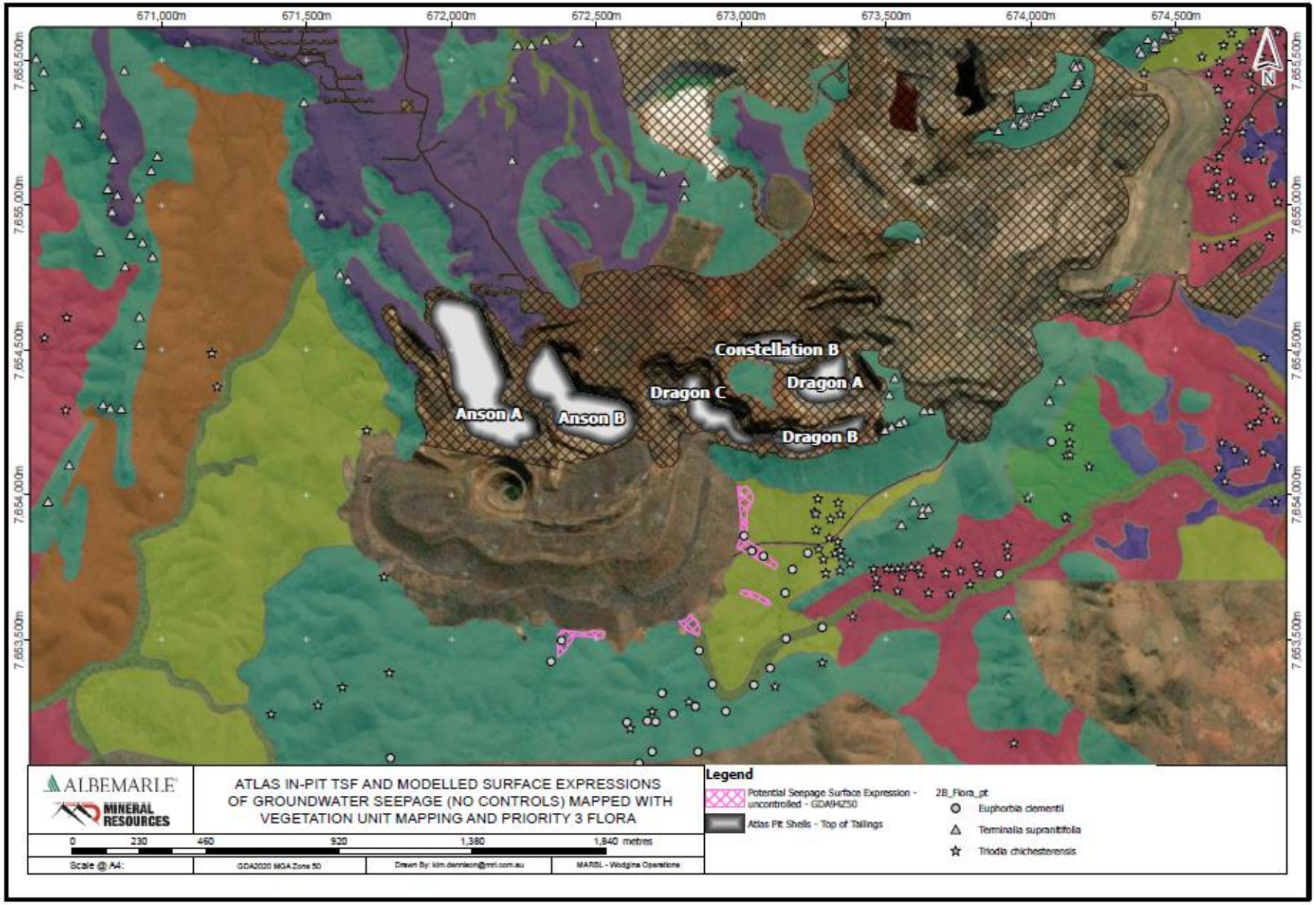


**Figure 9: Priority 3 Flora located surrounding the proposed in-pit TSF area.**

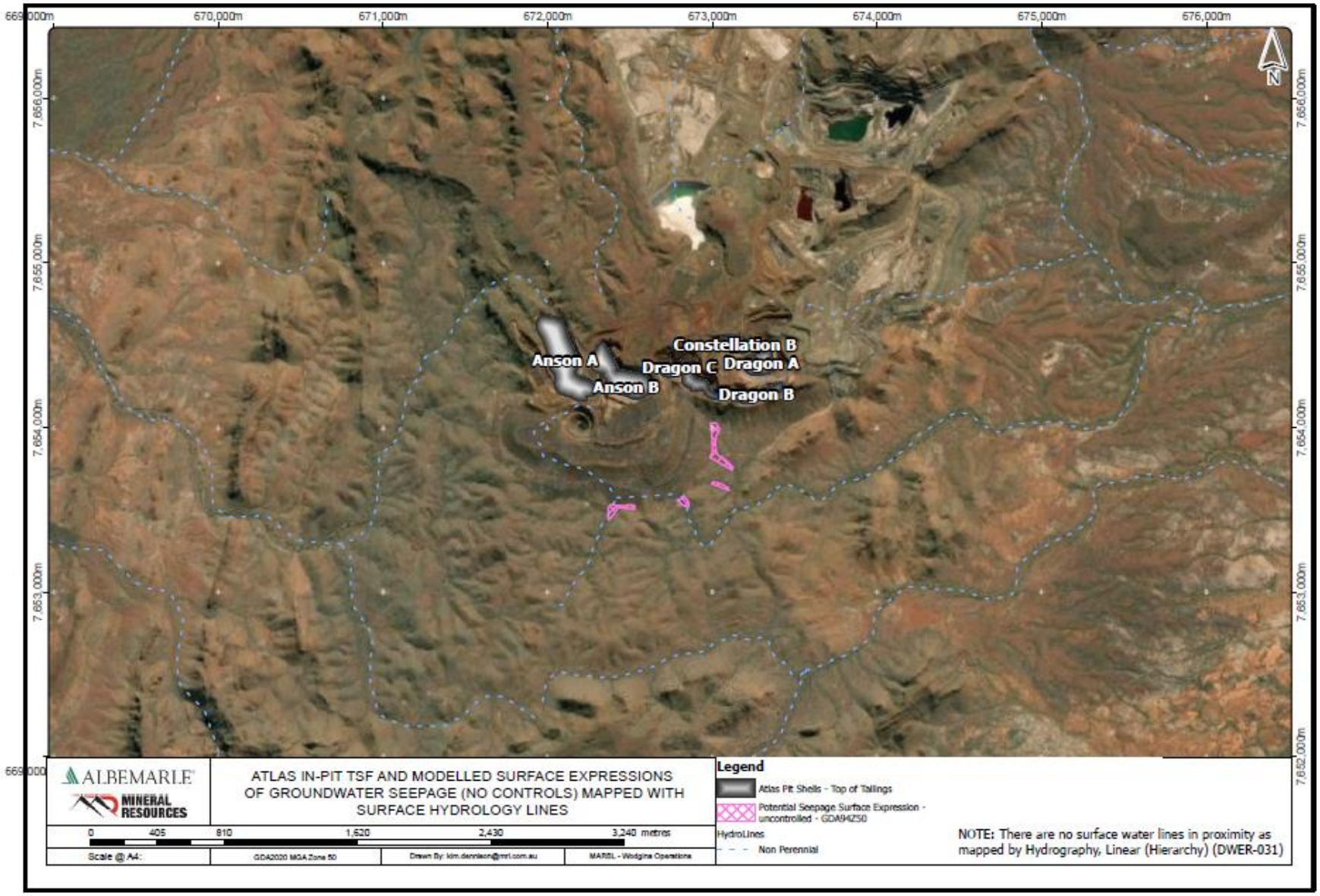


**Figure 10: Modelled surface expression of seepage (without controls) in relation to surface hydrology lines.**

## 3.2 Risk ratings

Risk ratings have been assessed in accordance with the *Guideline: Risk Assessments* (DWER 2020) 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 W6734 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 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 into the Atlas in-pit TSF. 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 application.

**Table 4: Risk assessment of potential emissions and discharges from the premises during construction, commissioning, and operation**

| Risk events | | | | | Risk rating [1] C = consequence L = likelihood | Applicant controls sufficient? | Conditions[2] of works approval | Justification for additional regulatory controls |
|---|---|---|---|---|---|---|---|---|
| **Sources / activities** | **Potential emission** | **Potential pathways and impact** | **Receptors** | **Applicant controls** | | | | |
| **Construction** | | | | | | | | |
| Construction activities associated with Atlas in-pit TSF, including pipeline placement, bore construction and vehicle movement | Dust | Air / windborne pathway causing impacts to vegetation health due to dust deposition leading to reduced ability for photosynthesis and smothering | Surrounding Vegetation, including Priority Flora (P3)<br>Aboriginal Heritage Sites | Refer to Section 3.1 | C = Slight<br>L = Unlikely<br>**Low Risk** | Y | N/A | The Delegated Officer considers that construction works are temporary, and dust and noise risks posed to surrounding environment are low. The provisions of the *Environmental Protection (Noise) Regulations 1997* and section 49 of the EP Act are sufficient to regulate noise and dust emissions during excavations and placement of infrastructure associated with the Atlas in-pit TSF. |
| | Noise | Windborne noise which may disrupt nocturnal foraging behaviour | Conservation significant fauna<br>Aboriginal Heritage Sites | Refer to Section 3.1 | C = Slight<br>L = Unlikely<br>**Low Risk** | Y | N/A | |
| | Sediment laden stormwater | Flooding and runoff from construction area impacting surrounding vegetation and resulting in sedimentation of surface water drainage | Surrounding Vegetation, including Priority Flora (P3)<br>Surface water<br>Aboriginal Heritage Sites | Refer to Section 3.1 | C = Slight<br>L = unlikely<br>**Low Risk** | Y | N.A | N.A |
| **Commissioning and Time-limited operations of Atlas in-pit TSF** | | | | | | | | |
| Deposition of tailings into Atlas in-pit TSF | TSF supernatant containing concentrations of elements with | Seepage / Infiltration of supernatant water through pit walls and base resulting in reduced groundwater quality. | Groundwater (>5 mbgl) with flow to the northeast toward the existing Cassiterite | Refer to Section 3.1 | C = Moderate<br>L = Possible<br>**Medium Risk** | N | **Condition 1, 2, 3, 4, 5, 6 13, 14, 15, 19 to 22.**<br>**Monitoring conditions: 17 and 18**<br>**Reporting conditions 7,** | In accordance with DWER regulatory principles a moderate risk can be tolerated however it is subject to regulatory controls.<br>DWER also notes uncertainty in |

| Risk events | | | | | Risk rating [1]<br>C = consequence<br>L = likelihood | Applicant controls sufficient? | Conditions[2] of works approval | Justification for additional regulatory controls |
|---|---|---|---|---|---|---|---|---|
| **Sources / activities** | **Potential emission** | **Potential pathways and impact** | **Receptors** | **Applicant controls** | | | | |
| | environmental significance | | Pit mine void, to the west-southwest towards the Yule River and to the east- southeast towards Turner River West). | | | | **8; 11, 12; 22 and 23**<br>**Notification and records conditions: 24, 25** | hydrogeological data used to inform risks, thus precautionary principle applies, and management conditions are needed. Further testing and validation/calibration of models are required to ensure controls in place are sufficient to prevent and or/appropriately manage risks.<br>Refer to Section 3.3.<br>The applicant has indicated that preliminary findings regarding assessment of cultural values in the area, in consultation with Aboriginal Corporation, Traditional Owners and Heritage consultants, indicated there will be no risk of impacts from proposed activities.<br>Regulatory conditions are imposed to minimise environmental risks related to the potential emissions due to tailings deposition and pipeline operation.<br>DWER notes that any potential direct impact to Aboriginal Heritage Sites are regulated under *Aboriginal Heritage Act 1972.* The applicant is reminded of its obligations under the AH Act and requirement for continued engagement with the Aboriginal Corporation, and DPLH and requirements (existing and new) under the *Aboriginal Heritage Act 1972* and any related legislation. |
| | | Groundwater mounding resulting in seepage expression on surface, impacting vegetation and reducing surface water quality. | Land/soils<br>Surrounding Vegetation, including Priority Flora (P3)<br>Surface water located south/south east of proposed in-pit TSF, including its potential hyporheic community<br>Aboriginal Heritage Site | Refer to Section 3.1 | C = Moderate<br>L = Possible<br>**Medium Risk** | N | **Condition 1, 2, 3, 4, 5, 6 13, 14, 15, 19 to 22.**<br>**Monitoring conditions: 17 and 18**<br>**Reporting conditions 7, 8; 11, 12; 22 and 23**<br>**Notification and records conditions: 24, 25** | |
| | | Overtopping of tailings resulting in direct discharges to land and infiltration to soil resulting in in reduced soil and surface water quality and impacting health of surrounding vegetation | Surrounding Vegetation, including Priority Flora (P3)<br>Land/soils<br>Surface water located south/south east of proposed in-pit TSF.<br>Aboriginal Heritage Site | Refer to Section 3.1 | C = Moderate<br>L = Unlikely<br>**Medium Risk** | N | **Condition 1 and 15**<br>**Reporting conditions 7, 8; 11, 12; 22 and 23**<br>**Notification and records conditions: 24, 25** | |

| Risk events | | | | | Risk rating [1]<br>C = consequence<br>L = likelihood | Applicant controls sufficient? | Conditions[2] of works approval | Justification for additional regulatory controls |
|---|---|---|---|---|---|---|---|---|
| **Sources / activities** | **Potential emission** | **Potential pathways and impact** | **Receptors** | **Applicant controls** | | | | |
| | Dust | Air / windborne pathway causing impacts to vegetation health due to dust deposition leading to reduced ability for photosynthesis and smothering | Surrounding Vegetation<br>Aboriginal Heritage Site | Refer to Section 3.1 | C = Slight<br>L = Possible<br>**Low Risk** | Y | N.A | N.A |
| Tailings delivery and return water pipelines | Spillage of tailings and decant return water through leaks, pipeline ruptures or failure | Direct discharges to land and infiltration to soil resulting in in reduced soil and surface water quality and impacting health of surrounding vegetation | Land/soils<br>Surrounding Vegetation<br>Surface water<br>Aboriginal Heritage Site | Refer to Section 3.1 | C = Moderate<br>L = Possible<br>**Medium Risk** | Y | **Condition 1, 10, 15, 19**<br>**Reporting conditions 7, 8; 11, 12; 22 and 23**<br>**Notification and records conditions: 24, 25** | Controls to manage risk related to new tailings delivery and return water infrastructure, consistent with current licence requirements and applicant's commitments are imposed as conditions.<br>Existing pipelines and infrastructure within processing plant to be continued to be managed as per current licence L4328. |

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

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

### 3.3.1 Assessment of the geochemical testing that has been undertaken on tailings materials and how it has informed risk assessment.

As mentioned above, internal technical advice (from CSB) has been sought regarding tailings geochemical characterisation undertaken to date (refer to section 2.2.4 above) to inform risks to the environment and suitability of proposed tailings discharge management and controls.

CSB considers that the test procedures used to assess the geochemical behaviour of the tailings materials were undertaken in accordance with international best practice, and were appropriate at the time the testing was undertaken. CSB also considers that a sufficient number of samples was tested to determine the geochemical characteristics of the tailings waste-stream that would be discharged to the proposed Atlas in-pit TSF.

However, recent research on similar tailings materials from spodumene processing in Québec in Canada (Roy *et al*., 2020; 2022) has suggested that some standard static procedures may underestimate the amount of lithium that can be leached from pegmatite tailings. The Canadian researchers have found that lithium could be consistently leached at concentrations in excess of 10 mg/L from otherwise geochemically benign spodumene production tailings, even when minerals in the tailings were relatively unweathered.

This also appears to be taking place at mine sites in similar lithium pegmatite deposits in Western Australia, where groundwater near existing waste rock dumps and tailings deposits often has lithium concentrations in the range of 10-20 mg/L. *This appears to be the case at the Wodgina deposit, where monitoring data provided suggests that lithium concentrations of up to 15 mg/L have been detected in groundwater near historical mine waste dumps in this mining area.*

Correspondence with the lead researcher on the geochemical behaviour of spodumene tailings at the University of Québec, suggests that the best way to resolve some of the problems of using static test procedures to assess spodumene tailings would be to undertake kinetic testing of these materials. Such testing would probably have to take place for a period of at least a year to adequately characterise the leaching behavior of lithium and some other chemical constituents of concern from the spodumene tailings.

Therefore, CSB recommended that kinetic testing is undertaken on suitable samples of the tailings materials that will be discharged to the Atlas in-pit TSF to better quantify the long-term leaching potential of lithium from this facility and ensure there are controls in place to minimise environmental risks.

Following discussions with the applicant, the applicant has confirmed that a consultant has been engaged to commence kinetic column testing of the tailing's material. The work is proposed to be completed in 18 months from commencement of works. As this information is critical to inform long term environmental risks and controls associated with the deposition of tailings into the in-pit TSF, condition 5 has been imposed requesting the additional testing to be undertaken and used to inform continued management of seepage from Atlas in-pit TSF.

The applicant has also engaged MBS (MBS, 2022) to undertake a preliminary review of the geochemical assessments undertaken by Roy et al. 2020; 2022 and proposed actions arising for the Atlas in-pit TSF. The review concluded that it was considered that the most reliable data available for Wodgina conditions (including consideration of Roy et al. 2020; 2022) and extrapolation, are data from TSF3 bore monitoring and the previous low grade kinetic column analysis. Applying this approach gives an extrapolated concentration of 6.4mg/L of lithium for Atlas in-pit TSF seepage at source base of pits. This will be further informed once the results of kinetic testing are obtained. The applicant has committed to include 20 mg/L and 6.4mg/L as two of the initial condition scenarios in further seepage modelling proposed to be undertaken (this commitment is imposed via condition 6). Further details of requirements to undertake

seepage modelling validation and calibration is provided below.

### 3.3.2 Assessment of the seepage analysis that has been undertaken for Atlas in-pit TSF and how it has informed risk assessment and suitability of controls

Advice from DWER Contaminated Sites Branch (CSB) hydrogeologists regarding suitability of seepage modelling undertaken to inform risks to environment and associated controls was also sought as part of the assessment of this application. The suitability of the model was assessed in conjunction with the Australian groundwater modelling guidelines (National Water Commission, 2012), table 9-2.

The CSB assessment indicated that the model had generally been developed in accordance with the principles and guidance that is provided in the Australian groundwater modelling guidelines. The model was based on a sound understanding of the geological and structural setting of the area that formed the model domain. The level of discretisation used to develop the finite-difference grid that was used in the model was appropriate, and modelling was undertaken using a suitable numerical model (MODFLOW).

However, it is inherently very difficult to develop an accurate groundwater flow model in a structurally complex area with fractured rock aquifers, particularly for one with a hydrostratigraphy as complex as the Wodgina area.

CSB recommends that the current model predictions about the fate of seepage from the TSF are considered to be only the best estimates that are currently available. It is important that sufficient monitoring is undertaken during the life of the in-pit TSF to verify the model predictions.

**Additional solute transport modelling**

As was discussed above, CSB considers that there is a significant risk that the concentration of lithium in seepage from the tailings disposal areas has been underestimated by the geochemical testing that has been currently undertaken. Consequently, the potential impacts of high lithium concentrations in shallow groundwater on native vegetation near the Atlas in-pit TSF has not been considered in the modelling that was undertaken by AQ2 consultants.

As a result of this, CSB recommended that the transport and fate of lithium in groundwater near the tailings disposal mine voids is simulated by linking a solute transport model to the existing calibrated MODFLOW model. The modelling should be undertaken assuming that seepage from the mine voids would have a lithium concentration of 20 mg/L (refer to above). The aim of the modelling would be to identify areas with native vegetation near the tailings disposal mine voids where the depth to the water table would be less than 3 metres, and where the lithium concentrations in groundwater could exceed 2.5 mg/L (refer to above). This is because native vegetation in these areas would be particularly vulnerable to lithium toxicity effects.

It is important that such areas are identified as soon as possible so that groundwater levels and water quality in these areas can be monitored and, if necessary, management measures could be implemented to protect native vegetation (such as periodically irrigating these areas with lithium-free freshwater).

The solute transport modelling would also indicate whether lithium concentrations would exceed 0.4 mg/L in the vicinity of significant creeks near the tailing's disposal area. This is because lithium concentrations of this magnitude would have the potential to cause harmful impacts on the hyporheic fauna in sediments beneath the bases of such creeks, even if they rarely carry surface water flows. Such areas may also need to be monitored.

In consultation regarding the above with the applicant, it was raised that the solute transport modelling as CSB comments above is not achievable in a timely manner, and without observational data or kinetic testing would add very little value to seepage forecasts.

The applicant stated that the particle tracing completed as per the AQ2 seepage model defines

the flowpaths of Li and other potential contaminants of concern. The applicant committed to engage a consultant to complete modelling along key identified flowpaths, utilising the consultant preliminary review described above (MBS, 2022) and 20 mg/L Li concentrations recommended by CSB, to provide further guidance on residual Li concentrations and potential receptor risk under uncontrolled seepage conditions. The AQ2 seepage model is proposed to be later validated with observational data, after commencement of tailings deposition, as per the conditions defined in the recently developed Atlas Pits TSF Operational Monitoring and Mitigation Report (AQ2, 2022b).

After review of applicant's response and considering the current large level of hydrogeological uncertainty at the Wodgina mine site, CSB recommends that the following measures are undertaken to minimise the risks of adverse environmental impacts taking place from tailings seepage, and to progressively improve the predictive capability of the numerical groundwater flow model for the site:

**A. Developing a contingency plan for responses to groundwater trigger value exceedances; and**

**B. Undertaking periodic reviews of the suitability of the numerical groundwater model.**

**Developing a contingency plan for responses to groundwater trigger value exceedances**
It is important that the applicant has in place a contingency plan that indicates the responses that would be carried out if groundwater level and water quality exceedances were to take place in monitoring bores at the site. It is important that such a plan would be clearly written and would be understandable by on-site personnel, and that the proposed management responses would protect environmental receptors near the site. Potential responses to trigger value exceedances could include:

- Undertaking additional monitoring to confirm the trigger value exceedances;
- Carrying out on-ground geophysical investigations using electrical or electromagnetic techniques to determine the likely extent, depth and severity of seepage in the subsurface.
- Installing additional monitoring bores at key sites that are identified by geophysical investigations; and
- Installing and operating groundwater recovery bores at key sites that are located by geophysical investigations.

The applicant has recently developed the Atlas Pits TSF Operational Monitoring and Mitigation Report (AQ2, 2022b and its later update AQ2, 2023) and provided to DWER in a response to a request for further information. The report generally addresses the recommendations above. The applicant has also confirmed the following regarding proposed seepage recovery, monitoring and contingency strategies:

- The AQ2 seepage assessment (AQ2, 2022a) presents nominal recovery bore locations within seepage flowpaths, abstracting low yields of 0.5 – 2 L/s, based on the available desktop information at the time. Based on further field assessments, recovery bores REC1 - REC7 have been located to intercept all seepage from the Atlas TSF, targeting key fractures that define flowpaths from the TSF, and yield significantly higher abstraction rates (3-10 L/s). On this basis and the significantly higher recovery rates, the additional recovery bores REC8 and REC9 were deemed unnecessary, and this has been captured in the Atlas Pits TSF Operational Monitoring and Mitigation Report (AQ2, 2022b).
- Operation of the 7 Atlas TSF recovery bores (REC1 – REC7), for the purposes of seepage recovery from the Atlas TSF, will be selective based on the seepage recovery bore most proximal to the depositional location, such that 60-100 kL/day is abstracted.

This abstraction rate is consistent with the AQ2 seepage assessment (AQ2, 2022a).

- Long -term operation of the 7 Atlas TSF seepage recovery bores (REC -1 to REC -7), outside of these abstraction periods and/or above the minimum abstraction rates (as defined in Table 4.1 of AQ2 (2023)), will be undertaken in response to the recommended monitoring and response actions (outlined in Table 4.4 of AQ2 (2023)). The long - term operational strategy will be applicable until cessation of operations at Wodgina (approximately 30 years).
- The AQ2 Atlas Pits TSF Operational Monitoring and Mitigation Report outlines adaptive management steps, which prompts MRL to construct additional recovery bores or downgradient monitoring bores upon triggers being reached over the timeframes specified in the report.
- Trigger levels will be reviewed for effectiveness upon collection of 6 months of observational data, by comparison to model predictions.
- Submersible dataloggers will be deployed in all monitoring bores detailed in the Atlas Pits TSF Operational Monitoring and Mitigation Report, to record static water levels and electrical conductivity at a daily monitoring frequency. Dataloggers will be downloaded during routine monthly water level monitoring activities and calibrated.
- Quarterly (3 months) drone imagery will be undertaken, at an area of interest including all the monitoring bores detailed in the Atlas Pits TSF Operational Monitoring and Mitigation Report to assess vegetation response and indication of seepage at surface.
- The potential application of geophysical investigations to delineate future monitoring bores may be required in response to potential seepage.

Some of the seepage recovery strategy and contingency commitments might be added to the licence once the in-pit TSF is transferred into the licence.

It is also requested that in order to minimise seepage, water recovery is maximised in from all pits at all times (Condition 15). A review of the deposition strategy and water recovery is expected to be undertaken at early stages of the deposition and provided to DWER as part of compliance report (Condition 23).

**Undertaking periodic reviews of the suitability of the numerical groundwater model.**

Guiding Principle number 3.5 on page 34 of the Australian groundwater modelling guidelines states that *"There should be an ongoing process of refinement and feedback between conceptualisation, model design and model calibration such that revisions and refinements to the conceptual model can be made over time"*. This principle recognises that the geological understanding of a site can change over time as more information becomes available from investigations, and that therefore the suitability of a groundwater flow model as a predictive tool would also need to be periodically reassessed.

Consequently, CSB recommends that the applicant is required to reassess the seepage model regularly to determine whether it continues to accurately represent the most up to date understanding of hydrogeological conditions at the site. Such a review would also be necessary to ensure that predicted solute transport rates from TSF seepage are in line with the water quality data that are collected from monitoring bores at the site.

Such a review process would also help prevent the problem of "conceptual surprise" that is often associated with groundwater flow and solute transport modelling in hydrogeologically complex settings.

It is noted that the developed the Atlas Pits TSF Operational Monitoring and Mitigation Report includes strategies to undertake seepage model validation (and calibration as required), including revision of long-term seepage migration prediction (using the validated/re-calibrated model).

Model validation has been added as a condition to the works approvals and will be transferred to the licence, as part of assessment of ongoing operations and management of the facility (post-time limited operations) in further consultation with DMIRS (to ensure adequacy of long-term management of the facility and avoid regulatory duplication).

### 3.3.3 Assessment of suitability of groundwater monitoring network

The locations of the current and proposed monitoring bores for the mine voids that comprise the TSF appear to be suitable, although it is not known whether these bores have been located on structural features that are likely to be significant conduits for groundwater flow in the area.

However, additional monitoring bores may be required in the areas where validation modelling proposed to be undertaken within 6 months of deposition suggests that groundwater could discharge to the land surface due to the large degree of uncertainty that is likely to be associated with the modelling results. If significant groundwater mounding takes place beneath tailings disposal areas, additional monitoring bores may also need to be constructed in the "mullock" hydrostratigraphic unit, as this material has the potential to form a perched aquifer that could be accessible by native vegetation.

It is noted that the applicant recognises that the current network of monitoring bores should not be considered to be fixed but may have to be expanded over time as more information becomes available about the effects that tailings disposal is having on the groundwater flow regime.

It is applicant's responsibility to ensure access to seepage recovery and monitoring bores is maintained.

### 3.3.4 Water balance Assessment for the Atlas in-pit TSF

The monthly water balance for the TSF that was provided in the works approval supporting document is suitable for a preliminary assessment for this facility. However, it would not be sufficiently accurate to track changes in the seepage rate from the facility during its operational life.

This is largely because the evaporation rates used in the water balance were obtained from an offsite meteorological station. However, research by CSIRO (McJannet *et al*., 2017) has shown that actual evaporation rates measured at a mine site often correlate poorly with results obtained from the nearest Bureau of Meteorology station. This research has also shown that evaporation rates from a water surface in a mine void may differ from results measured from a similar water body at the land surface.

In order to obtain accurate estimates of seepage rates from a TSF, it is important that all directly measurable inputs and outputs of water from the facility can be tracked over time with a high level of accuracy. This is generally possible for all components of the water balance other than seepage, provided that evaporation rates are measured on-site. Water balance calculations are generally done using the equation below. Rearranging the equation, and provided all other parameters are appropriately measured, seepage rates can be calculated.

$$\sum \text{Inputs} = \sum \text{outputs} \pm \Delta s$$

$$D + R = DE + E + RE + S$$

Where:
- D = discharge rate
- R = rainfall catchment
- DE = decant
- E = evaporation from the pond area
- RE = water retained in tailings pile
- S = seepage into substrate
- $\Delta s$ = change in ponding storage

It is therefore recommended that a suitable weather station is established in one of the mine voids in the tailings disposal area to provide data to determine the magnitude and variability of evaporation rates in the in-pit TSF. The preferred way of measuring the evaporation rates is through the methods that are outlined in McJannet *et al*. (2017) and in McJannet *et al*. (2022).

CSB recommends that relevant data for the water balance for the in-pit TSF are collected on a monthly basis so that the seepage rate from the facility can be calculated. This would enable the baseline seepage rate from the facility to be estimated with a suitable level of accuracy. It would also enable a trend of increasing seepage rates to be detected that would trigger management responses which could include:

- undertaking a review of groundwater monitoring data to determine whether there is likely to be an impact on environmental receptors; and
- modifying the density of the discharged tailings to reduce the rate of water seepage through the bases of the mine voids.

A condition has been imposed requiring the maintenance of a water balance, ensuring seepage rates can be monitored and any increasing trends identified and appropriately managed.

## 3.4 Summary of additional regulatory controls:

- Condition 1 – Design requirements and proposed controls have been conditioned to ensure they are in place prior to commencement tailings deposition.
- Condition 2 - Design requirements for the construction and installation of monitoring bores have been imposed to ensure bores are installed correctly and able to detect any contamination. Suitability of any existing bores, including location and screens' length must be verified by qualified hydrogeologist. Appropriate baseline data must be obtained.
- Condition 3 - Design requirements for the construction and installation of seepage recovery bores have been imposed to ensure infrastructure are installed correctly and able to collect seepage.
- Condition 4 – Requirement to install meteorologic monitoring unit near Atlas in-pit TSF to assist water balance calculations and seepage rates monitoring.
- Condition 5 – Requirement to undertake long-term kinetic testing as discussed in section 3.3.1.
- Condition 6 – Requirement to complete 2D modelling as committed by applicant in response to response to further information.
- Condition 9, 10 – Commissioning requirements imposed, consistent with applicant commitments.
- Condition 13 to 15 – Time limited operation requirements imposed consistent with the design report and applicant commitments.
- Condition 15 - Table 5 – item 1 – Water return to the plant must be maximised. Cycling of deposition between pits must occur to ensure optimisation of tailings consolidation. Water recovery from all pits, including smaller pits, must be maximised to minimise seepage.
- Condition 15 - Table 5 – item 2 – Outcome-based condition imposed regarding seepage recovery.
- Condition 16 – Specify authorised discharge points.
- Condition 17 and 18 – Groundwater monitoring requirements consistent with current licence, however bimonthly monitoring is requested. This might be modified to quarterly,

based on results of monitoring and once in-pit TSF is transferred to the licence. Applicant must ensure seepage expression on surface does not occur and standing water level is maintained below 4mbgl.

- Condition 19 - Maintenance of a water balance has been included in the works approval. Refer to section 3.3.4.
- Condition 20 – Commitment to undertake validation of seepage modelling for the Atlas in-pit TSF is imposed as a condition. The report must include a review of suitability of current groundwater monitoring and seepage recovery strategy and any response actions to ensure seepage is appropriately monitored and managed.
- Condition 21 – A requirement for a revision of long-term seepage migration prediction is imposed as a condition following expected end of deposition (within 24 months from commencement of deposition) to ensure it accurately represents the most up to date understanding of hydrogeological conditions at the site and can adequately inform long term seepage management strategies. Further conditions related to the periodic review of the numerical groundwater model might be imposed once the in-pit TSF is transferred to the licence, following discussions with DMIRS (to ensure regulatory duplication is avoided).

**Compliance Reporting**

The works approval also requires the following reports to be submitted:

- Environmental Compliance Reports – Condition 7 and 8
- Environmental Commissioning Report – Condition 11 and 12
- Time Limited Operations Report - Condition 22 and 23

Reporting requirements are necessary to meet compliance conditional requirements of the works approval and for the Atlas in-pit TSF and associated infrastructure to be transferred onto the existing Licence L4328/1989/10.

# 4. Consultation

Table 5 provides a summary of the consultation undertaken by the department.

**Table 5: Consultation**

| Consultation method | Comments received | Department response |
|---|---|---|
| Application advertised on the department's website on 24 October 2022 | None received | N/A |
| Town of Port Hedland on 28 October 2022 | None received | N/A |
| Department of Mines, Industry Regulation and Safety (DMIRS) advised of proposal on 28 October 2022 | Refer to section 2.4 | N/A |
| Department of Planning, Lands and Heritage (DPLH) advice sought on 13 December 2022, 18 January 2023, 3 and 6 February 2023 | Refer to Section 2.5 | N/A |
| Kariyarra Aboriginal Corporation, via letter on 8 February 2022. | No comments received | N/A |
| Applicant was provided with draft documents on 27 February 2023 and 21 April 2023 | No comments provided regarding the draft conditions or decision report. Applicant has only provided outstanding information regarding the application. | N/A |

# 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.

# 6. References


1. AQ2 Pty Ltd. (2022a). Wodgina Lithium Project In-Pit TSF Seepage Assessment Atlas Iron Pits. Unpublished report prepared for MARBL, August 2022.
2. AQ2 Pty Ltd. (2022b). Wodgina Lithium Project. Atlas Pits TSF Operational Monitoring and Mitigation Report. December 2022.
3. AQ2 Pty Ltd. (2023). Wodgina Lithium Project. Atlas Pits TSF Operational Monitoring and Mitigation Report. April 2023.
4. CMW Geosciences Pty Ltd. (2019). Tailings Storage Facility 3 Expansion Wodgina Lithium Project Tailings Properties Assessment Report.
5. CMW Geosciences Pty Ltd. (2022). In-Pit Tailings Storage Facilities Atlas Pits -

Constellation, Dragon, Arvo & Anson Wodgina Lithium Project Geotechnical Assessment and Design Report.

6. Anson Wodgina Lithium Project Geotechnical Assessment and Design Report.
7. Department of Environment Regulation (DER) 2015, *Guidance Statement: Setting Conditions*, Perth, Western Australia.
8. Department of Water and Environmental Regulation (DWER) 2020, *Guideline: Environmental Siting*, Perth, Western Australia.
9. DWER 2020, *Guideline: Risk Assessments*, Perth, Western Australia.
10. MBS. (2018). Wodgina Lithium Project Process Streams Geochemical Assessment.
11. MBS. (2019). Wodgina Lithium Project Site Production Tailings Geochemical Assessment
12. MBS 2022, Preliminary Review of Wodgina Spodumene Tailings Source Term for Lithium. Memorandum.
13. McJannet, D., Hawdon, A., van Niel, T., Boadle, D., Baker, B., Trefry, M. and Rea, I., 2017. Measurements of evaporation from a mine void lake and testing of modelling approaches. *Journal of Hydrology*, **555**, 631-647.
14. McJannet, D., Carlin, G., Ticehurst, C., Greve, A. and Sardella, C., 2022. Determination of evaporation from a tailings storage facility using field measurements and satellite observations. *Mine Water and the Environment*, **41**, 176-193.
15. National Water Commission, 2012. *Australian Groundwater Modelling Guidelines*. Waterlines Report, National Water Commission. The report is available from web site https://www.researchgate.net/publication/258245391_Australian_Groundwater_Modelling_Guidelines/link/00b7d527955304b149000000/download.
16. Roy, T., Plante, B., Benzaazoua, M., Demers, I. and Petit, I., 2020. Geochemical and mineralogical study of lithologies and tailings from the Whabouchi lithium mine site, Québec, Canada. *Proceedings of the IMWA 2020 "Mine Water Solutions" Conference*, 77-82. The paper is available from web site www.imwa.de.
17. Roy, T., Plante, B., Benzaazoua, M., Demers, I., Coudert, L. and Turcotte, S., 2022. Geochemistry of decades-old spodumene mine tailings under a humid continental climate. *Applied Geochemistry*, **146**, 105481. The paper is available from web site https://www.sciencedirect.com/science/article/pii/S0883292722002852.

# Appendix 2: Application validation summary

| SECTION 1: APPLICATION SUMMARY | | |
|---|---|---|
| **Application type** | | |
| Works approval | ☒ | |
| Date application received | | 5/09/2022 |
| **Applicant and Premises details** | | |
| Applicant name/s (full legal name/s) | | MARBL Lithium Operations Pty Ltd (ACN: 637 077 608) |
| Premises name | | Wodgina Lithium Project |
| Premises location | | L45/443, M45/383, G45/321, M45/923, M45/1188 and M45/1252 MARBLE BAR WA 6760 |
| Local Government Authority | | Town of Port Hedland |
| **Application documents** | | |
| HPCM file reference number: | | DER2022/000448 |
| Key application documents (additional to application form): | | • Application Form – page 1 of 1007<br>• Attachment 1A – Tenement Summary Reports – page 29 of 1007<br>• Attachment 1B – MARBL Lithium Ops Pty Ltd – ASIC Extract page 37 of 1007<br>• Attachment 1C – Authorisations are supplied for GAM and Atlas for access and activities on M45/283, M45/1188 and M45/1252 – page 40 of 1007<br>• Attachment 2 – Premises map and project layout map – page 46 of 1007<br>• Attachment 3A – Environmental Commissioning Plan – page 49 of 1007<br>• Attachment 3B – Supporting Document – page 58 of 1007<br>  ○ Appendix 1 – In-Pit TSF Atlas Pits - Geochemical Assessment and Design Report (CMW Geosciences 2022) - page 104 of 1007<br>  ○ Appendix 2 - Tailings Properties Assessment Report (CMW Geoscience 2019) – page 215 of 1007<br>  ○ Appendix 3 - Tailings Geochemical Assessment (MBS 2019) – page 636 of 1007<br>  ○ Appendix 4 – Wodgina Lithium Project In-Pit TSF Seepage Assessment (AQ2 2022) – page 919 of 1007<br>  ○ Appendix 5 - Stakeholder Engagement Register – page 999 of 1007<br>• Attachment 7 – Location Map and Siting Map – page 1002 of 1007<br>• Attachment 10 – Cost – page 1005 of 1007 |
| **Scope of application/assessment** | | |

| | |
|---|---|
| Summary of proposed activities or changes to existing operations. | Works approval for the construction of a new in-pit Tailings Storage Facility (TSF) at the Atlas project area. It is proposed that tailings will be deposited into inactive open pits at the Atlas project area comprised of either wet/fine tailings only or a combination of wet/fine and dry/course tailings. The proposed TSF will be a multi-pit facility consisting of six separate pit (TSF) areas including:<br>• Anson A In-Pit TSF;<br>• Anson B In-Pit TSF;<br>• Dragon A In-Pit TSF;<br>• Dragon B In-Pit TSF;<br>• Dragon C In-Pit TSF; and<br>• Constellation B In-Pit TSF. |

**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 |
|---|---|
| Category 5: Processing or beneficiation of metallic or non-metallic ore | 8,750,000 tonnes per annual period (current design capacity for category 5 on L4328/1989/10)<br><br>Tailings rate into Atlas TSF is 4,800,000 tonnes per annual period |

**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:<br>Managed under Part V ☐<br>Assessed under Part IV ☐ |
| Does the applicant hold any existing Part IV Ministerial Statements relevant to the application? | Yes ☐ No ☒ | Ministerial statement No:<br>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 ☐<br>General lease ☐ Expiry:<br>Mining lease / tenement ☒ Expiry:<br>Other evidence ☐ Expiry: |
| Has the applicant obtained all relevant planning approvals? | Yes ☐ No ☐ N/A ☒ | Approval:<br>Expiry date:<br>If N/A explain why? Mining tenure |
| Has the applicant applied for, or have an existing EP Act clearing permit in relation to this proposal? | Yes ☐ No ☒ | CPS No: N/A<br>No clearing is proposed. |
| Has the applicant applied for, or have an existing CAWS Act clearing licence in relation to this proposal? | Yes ☒ No ☐ | It is stated that *"Approximately 3.6 hectares of clearing is required for the installation of two new seepage monitoring/recovery bore on L45/443 and M45/1252-I. This will be undertaken under Item 20 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA) where Schedule 1 describes exemptions for low impact activities. Section 2 (1a) describes an activity is exempt where an approval under Section 5C or 26D of the Rights in Water and Irrigation Act 1914 and the Mining Act is granted for the activity. These approvals will be in place prior to the clearing being undertaken. Details submitted in Mining Proposal REG ID 113904 under assessment with DMIRS."* |

| | | |
|---|---|---|
| Has the applicant applied for, or have an existing RIWI Act licence or permit in relation to this proposal? | Yes ☒ No ☐ | Application reference No:<br>Licence/permit No: GWL154570(20) |
| 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<br>Type: Proclaimed Groundwater Area and Surface Water Area<br>Has Regulatory Services (Water) been consulted?<br>Yes ☐ No ☐ N/A ☒<br>Regional office: North West |
| Is the Premises situated in a Public Drinking Water Source Area (PDWSA)? | Yes ☐ No ☒ | Name: N/A<br>Priority: N/A<br>Are the proposed activities/ landuse compatible with the PDWSA (refer to WQPN 25)?<br>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* | Yes ☒ No ☐ | *Mining Act 1978*<br>*Environmental Protection (Unauthorised Discharges) Regulations 2004* |
| 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 ☐ | Classification: Possibly contaminated – investigation required (PC–IR)<br>Date of classification: 20/05/2011 |