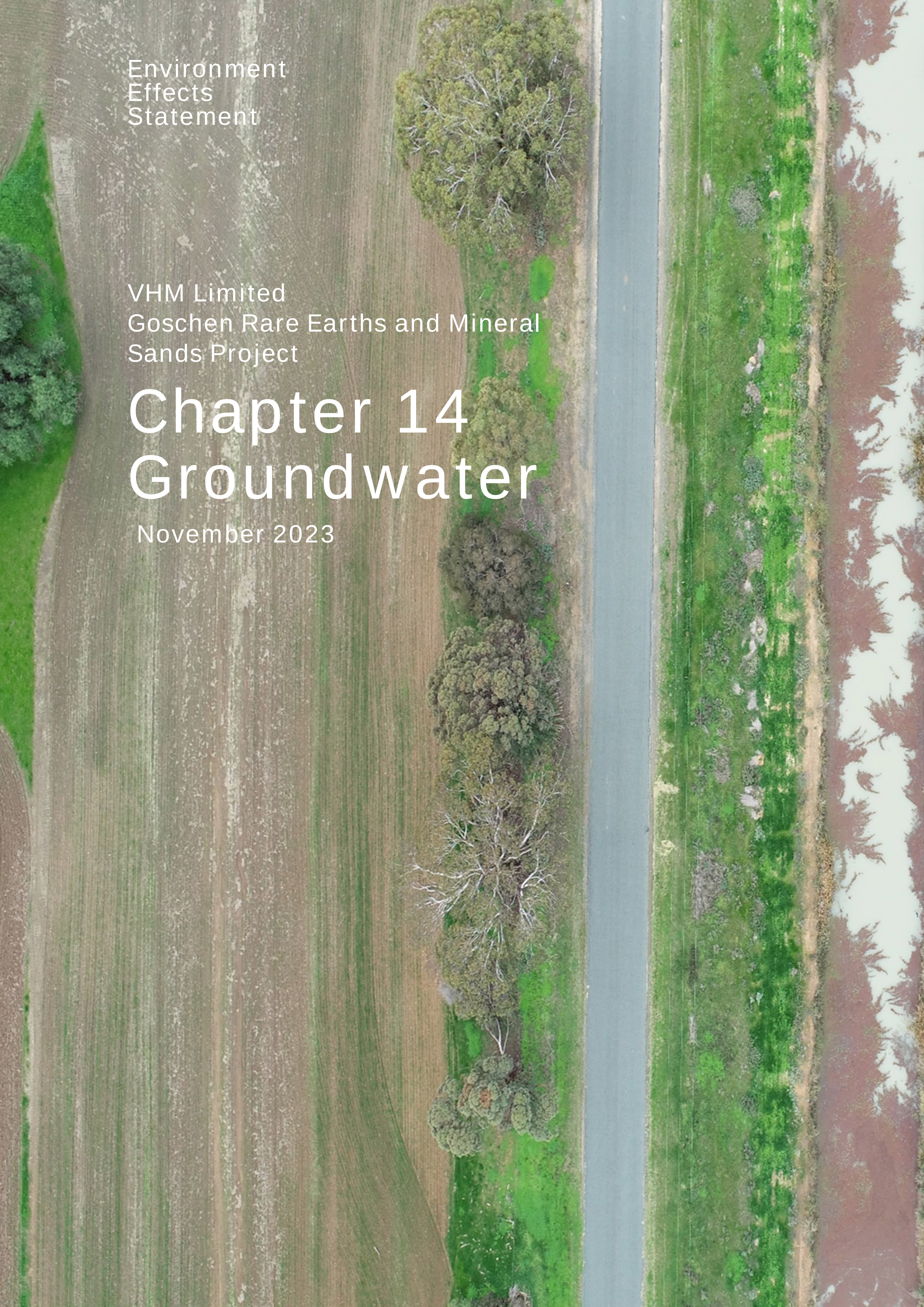

Environment
Effects
Statement

VHM Limited
Goschen Rare Earths and Mineral Sands Project

Chapter 14 Groundwater

November 2023

Table of Contents

14. Groundwater 14-1

14.1 Methodology 14-2

14.2 Study area 14-2

14.3 Existing environment 14-3

14.3.1 Geographical setting 14-3

14.3.2 Geology and hydrogeology 14-5

14.3.3 Groundwater levels and hydraulic properties 14-6

14.3.4 Environmental values 14-9

14.3.5 Numerical groundwater model 14-11

14.4 Operation impact assessment 14-12

14.4.1 Tailings Management 14-12

14.4.2 Dewatering 14-13

14.4.3 Groundwater and surface water 14-14

14.4.4 Groundwater users 14-14

14.4.5 Climate change 14-15

14.5 Closure Impact assessment 14-15

14.5.1 Seepage and Mounding 14-15

14.5.2 Groundwater quality 14-17

14.6 Residual impacts 14-18

14.7 Summary of mitigation measures 14-19

14.7.1 Monitoring and contingency measures 14-21

14.8 Conclusion 14-22

14. Groundwater

This chapter provides an assessment of the groundwater impacts associated with the construction, operation, closure and rehabilitation of the Goschen Rare Earths and Mineral Sands Project (the Project).

This chapter summarises the outcomes of Technical Report I: Groundwater impact assessment prepared in support of the Environment Effects Statement (EES).

Overview

The Project would be located near Lalbert, approximately 35 km south of Swan Hill. The primary geological unit and groundwater aquifer underlying the Project area, the Loxton Parilla Sands, consists of sand, sandstone and clay. The inferred groundwater elevation is 64 metres Australian Height Datum (m AHD), or 48 metres below ground level (m bgl) at the proposed mining location and groundwater flows in a north westerly direction with no known surface water connections nearby.

Groundwater within the Loxton Parilla Sands aquifer is considered saline (equivalent of seawater) and sensitive groundwater receptors, such as nearby groundwater users, were not identified within 10 kilometres of the mine site. Risk of harm to the environmental values of groundwater, in accordance with the Environment Reference Standard (ERS) was not considered to be realised in the Project area based on groundwater properties and uses in the local area, however it is noted that groundwater is an environment itself that must be protected.

In regards the different phases of the Project:

- All construction activities associated with the Project are above the groundwater table and as such potential impacts, including construction of the underground water pipeline from Kangaroo Lake to mine site, have not been identified.
- During operation and rehabilitation of the Project the key impact is that from the mined pits, which would be above the water table, but are progressively backfilled with tailings. The tailings would be approximately 50% saturated once deposited and water recovery assumed to be at least 35% of this water and thus impacts have been conservatively assessed on this basis which will cause a localised increase in groundwater levels, known as a groundwater mound.

The predictive numerical modelling undertaken to understand the potential changes to the Loxton Parilla Sands aquifer levels indicated that groundwater mounding would reach a maximum of approximately 20 metres at year eight of mining operations, if no interception or dewatering was to occur. The model also shows that following closure with the end of tailings deposition the mound will start declining and dissipating within the groundwater aquifer. At 100 years post mining, there is predicted to be a 0.1 metre increase to groundwater levels approximately 4.0 km of the Project area.

The groundwater mounding will cause groundwater to intersect the base of adjacent active mine pits in some areas, which will require mine pits to be dewatered. This groundwater extraction will only occur of the mounded water table and will not occur below the regional, pre-mining, water level, and so not impact natural groundwater levels.

Water that interacts with and is deposited with the solid tailings is known as leachate (or decant water). The analytical testing done of the various tailings water generated from the processing of ore and leach potential show it will be:

- low salinity (less than 5,000 mg/L total dissolved solids - brackish) and non-acidic
- marginally elevated from native groundwater in aluminium, arsenic, cerium, chromium, hexavalent chromium, fluoride, phosphorus, nickel, titanium and vanadium.

The laboratory testing of the tailings and tailings water (leachate) includes any residual (waste) products from the reagents used in the process plant.

It is predicted that the water quality entering groundwater will be initially of a quality of the leachate and will immediately start to mix with the native groundwater and trend to be indistinguishable from that of background groundwater quality within that area predicted by the particle tracking analysis (within 2km from tailings cells).

The seepage from the tailings will be minimised as much as practical through various means, and given tailings will have been largely dewatered and majority of consolidation occurred within 12 months of deposition, seepage will have also reduced to a minor levels in a similar timeframe.

A secondary impact to groundwater quality will result from increasing (mounded) groundwater levels mobilising unsaturated salts in the Loxton Parilla Sands formation. However, given the salinity of mounded water resulting from the leachate is fresh to brackish, it is not anticipated the mobilisation of salts will result in an impact above background (native) groundwater salinity.

The measures to limit as much as practicable the seepage (leachate) losses to groundwater would be implemented to minimise changes to the quality and quantity of the groundwater environment during operations, irrespective of the fact there has been assessed to be no risk of harm to groundwater users, including GDEs within the conservatively predicted area of impact.

Measures to optimise tailings water recovery (and ultimately reduced seepage) include, thickening during processing, use of flocculants to optimise water separation (coagulation/clumping of clays) and decant on tailings to recover water, solar drying prior to backfill and the inclusion of an embankment underdrain (interception). These water recovery measures are captured as commitments within the tailings management plan (which forms part of the Project's Work Plan – refer to Environment Management Framework - Chapter 21).

Groundwater monitoring would be undertaken in accordance with a Groundwater Management Plan during operation and rehabilitation of the mine to identify any changes to groundwater chemistry in comparison to pre-existing (baseline) conditions in the Project area.

EES evaluation objective

The scoping requirements provided by the Minister for Planning for the Project set out the specific environmental matters to be investigated and documented in the project's EES. The scoping requirements inform the extent and scope of the EES technical studies. The following EES evaluation objective is relevant to the groundwater impact assessment:

To minimise effects on water resources and on beneficial and licensed uses of surface water, groundwater and related catchment values (including the Kerang Wetlands Ramsar site) over the short and long-term.

Technical Report I: Groundwater impact assessment was prepared in support of the Project EES. The technical report provides more detailed information on the investigation and impact assessment conducted in response to the EES scoping requirements.

14.1 Methodology

The following approach was adopted for the groundwater impact assessment:

- Establishment of the study area.
- Characterisation of the existing environment.
- Review of the Project description, comprising the key Project components and activities.
- Desktop review of relevant databases, key legislation and previous assessments, including the tailings composition and geochemistry study.
- Determination of contaminants of concern (CoC).
- Undertaking two groundwater monitoring events in August/September 2021 and April 2022.
- Characterisation of key hydrogeological features and development of a hydrogeological numerical model.
- Assessment of impacts to groundwater during operation and rehabilitation of the Project.
- Evaluation of the potential impacts.
- Developing mitigation, monitoring and contingency measures in response to identified impacts, as necessary.
- Evaluating the residual environmental impacts.

14.2 Study area

The Project would be located approximately 35 km south of Swan Hill, Victoria. The Project resides within the Avoca River Basin, which itself resides in the much larger Murray geological basin. The Avoca River is located southeast of the Project, while the Kerang Lakes (including Lake Boga) scatter the landscape to the east and northeast of the Project.

Activities associated with the construction of the Project would not intercept the groundwater and were not considered by the groundwater impact assessment. The potential for groundwater impacts to occur exist during operation and rehabilitation of the Project mine site. As such, the study area for the groundwater impact assessment is the Project mine site, known as the Project area. The Project area is made up of mining Area 1 and Area 3 as presented in Figure 14-1.

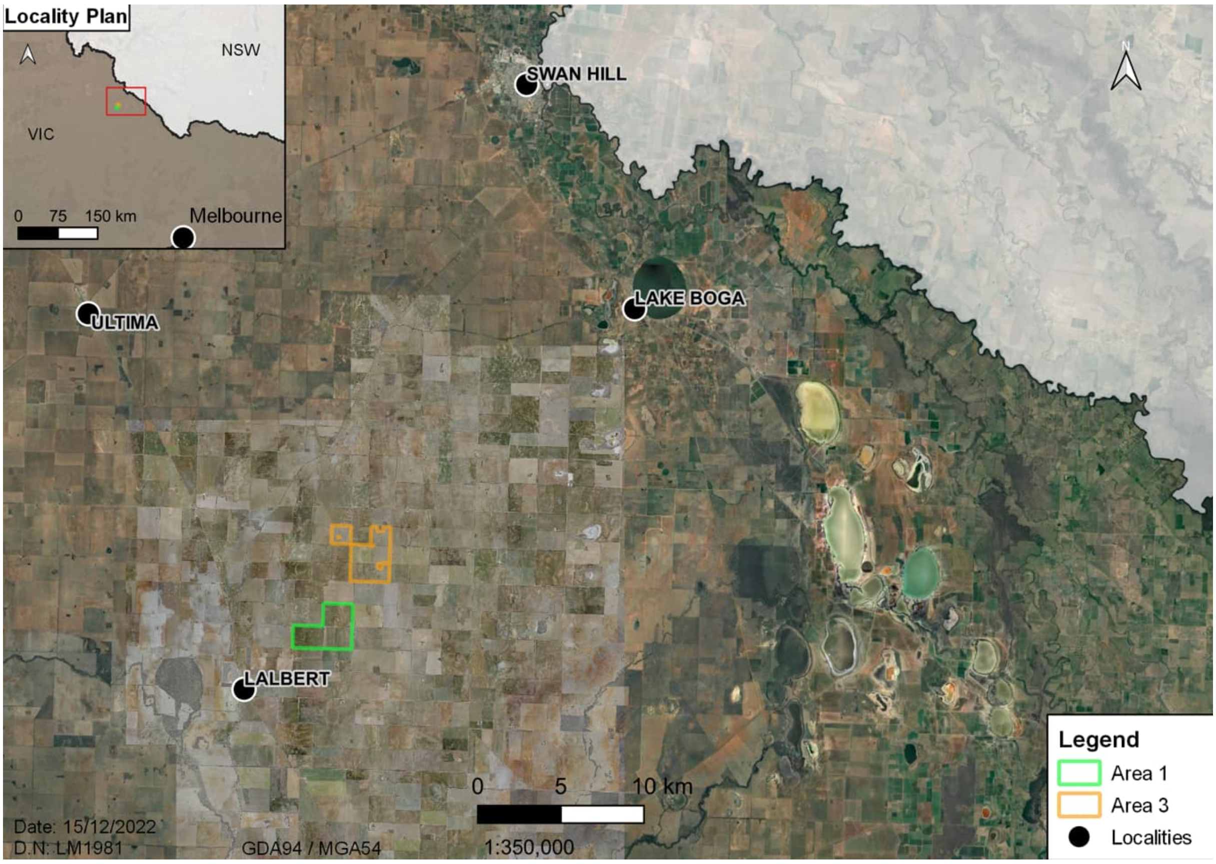

Figure 14-1 Project area

14.3 Existing environment

A comprehensive assessment was undertaken to understand the existing environment of the Project area to inform the groundwater impact assessment. This assessment included database searches, field-based assessments and the creation of a numerical model.

14.3.1 Geographical setting

Climate

Daily rainfall and pan evaporation data is available from the Bureau of Meteorology (BoM) Station ID 77021 at Lake Boga (Kunat), located approximately 10 km northeast of the project area. Mean annual minimum and maximum temperatures range between 9.4 and 24.0°C. Average annual rainfall and evaporation in the area is around 320 mm and 1620 mm, respectively. The Project area experiences a relatively dry climate, where average monthly rates of rainfall are exceeded by evaporation in all months of the year (refer to Figure 14-2 below).

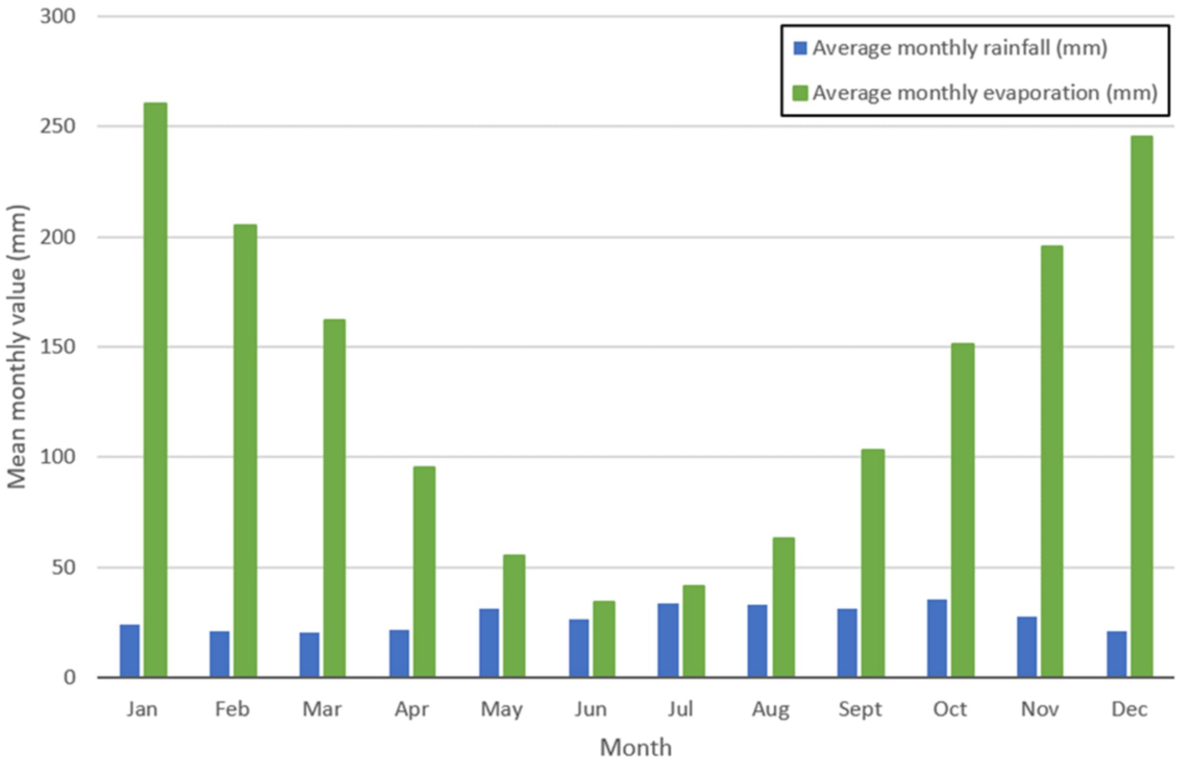

Figure 14-2 Average monthly rainfall and evaporation data (1933 to 2022), Lake Boga (Kunat) (ID 77021)

Topography

The topography in the Project area is characterised by a transecting north-south orientated ridge, elevated around 100 to 125 m AHD (refer to Figure 14-3 below). The average elevation of the Project area is approximately 112 m AHD.

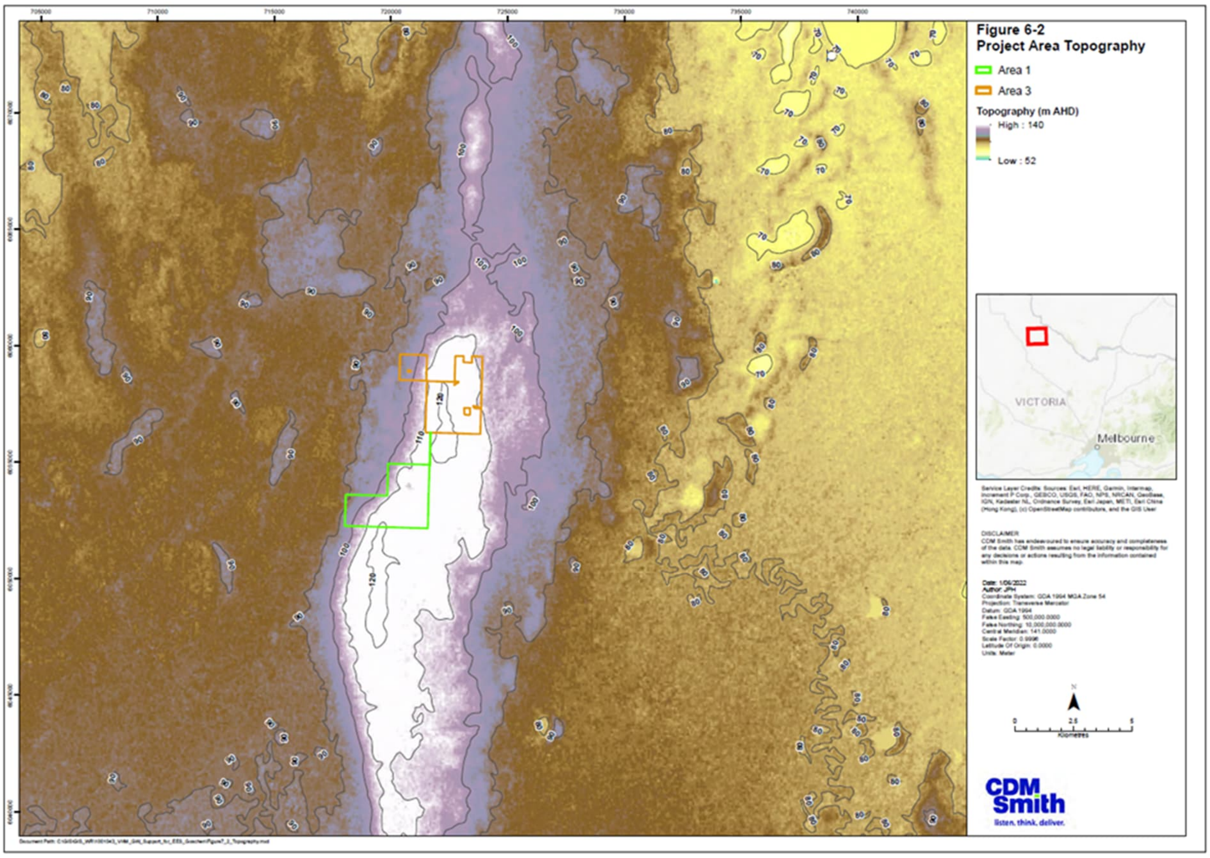

Figure 14-3 Topography of the study area

14.3.2 Geology and hydrogeology

Geology

The outcropping geology of the Project area comprises of a thin quaternary cover of sandy clay, and ranges in thickness from approximately 5 to 10 metres below ground surface. The quaternary material overlays the Loxton Parilla Sands, which hosts the target mineralisation zone. The Loxton Parilla Sands has an average thickness of 50 metres across the basin and consists of an unconsolidated to weakly cemented yellow-brown fine to coarse well-sorted quartz sand, sandstone, and clay.

In the broader study area, the Loxton Parilla Sands is underlain by the Geera Clay, which is underlain by the Renmark Group. The Renmark Group is made up of the Olney Formation and the Warina Sand. A summary of the study area geology is presented in Table 14-1 below.

Table 14-1 Summary of geology in the Project area

Age	Stratigraphic unit	Description
Quaternary	-	Clay, sand, sandy clay.
Pilocene	Loxton Parilla Sands	Unconsolidated to weakly cemented yellow-brown fine to coarse well-sorted quartz sand, sandstone, interstitial white kaolinitic or gibbsite clay matrix towards top; composite sand sheet deposited in strand plain and fluvial environments.
Miocene	Geera Clay	Carbonaceous silts and minor carbonates; massive clays with minor sand and silt layers.
Late Eocene to Miocene	Olney Formation	Unconsolidated to poorly consolidated, thinly-bedded, dark brown, grey, black, carbonaceous sand, silt, clay, brown coal, peat; commonly micaceous, pyritic, ferruginised; intercalated poorly-sorted fine-medium quartz sand and polymictic sand.
Eocene	Warina Sand	Poorly consolidated carbonaceous sand, clay and silt.

Hydrogeology

Drilling and groundwater field assessments undertaken in the study area identified four main hydrogeological units. The Loxton Parilla Sands, Olney Formation and Warina Sand were identified as aquifers, geological formations which hold groundwater. The Geera Clay was identified as an aquitard. An aquitard acts as a geological barrier to the flow of groundwater, limiting its flow between two aquifers.

Loxton-Parilla Sands

The Loxton Parilla Sands form the main aquifer in the Project area. The Loxton Parilla Sands aquifer hosts the regional aquifer and is unconfined. Unconfined aquifers are connected to the atmosphere through open pore spaces in overlaying soil and rock. The Loxton Parilla Sands consist of a coarse grained to gravelly, well sorted, quartz rich sand with interbeds of finer sand and clay and ranges in thickness from 35 to 55 metres.

Geera Clay

The Geera Clay forms a significant aquitard and consists of a dark grey to black clay of low plasticity. The unit serves as an aquitard in the region, separating the Loxton Parilla Sands from the underlying Renmark Group aquifer. Field assessments identified the Geera Clay to be prominent across the Project area. The Geera Clay aquitard ranges in thickness from 32 to 46 metres.

Renmark Group

The Olney Formation forms an aquifer underlying the Geera Clay and consists of a dark grey to black silty clay of medium to low plasticity. The unit becomes increasingly coarser grained/gravelly with depth and the thickness ranges from 13 to 25 metres.

The Warina Sand forms an aquifer underlying the Olney Formation and consist of a poorly consolidated coarse-grained sand, with clayey interbeds, minor quartz and laminated shale. The unit is encountered at depths of approximately 105 metres below ground level (m bgl).

14.3.3 Groundwater levels and hydraulic properties

Groundwater bore network

Eight groundwater monitoring bores were installed in and around the Mine Site Area in July 2021 and were screened across the Loxton Parilla Sands aquifer, or Renmark Group, as presented in Table 14-2. Figure 14-4 shows the location of each bore.

Table 14-2 Groundwater monitoring bores

Bore ID	Easting	Northing	Total depth (m bgl)	Target aquifer
MW001S	718035	6052278	45	Loxton Parilla Sands
MW001D	718040	6052278	118	Renmark Group
MW002	721066	6052192	75	Loxton Parilla Sands
MW005	728795	6053398	58	Loxton Parilla Sands
MW006S	720384	6059699	49	Loxton Parilla Sands
MW006D	720384	6059691	120	Renmark Group
MW007	723888	6058434	78	Loxton Parilla Sands
MW008	722487	6060703	58	Loxton Parilla Sands

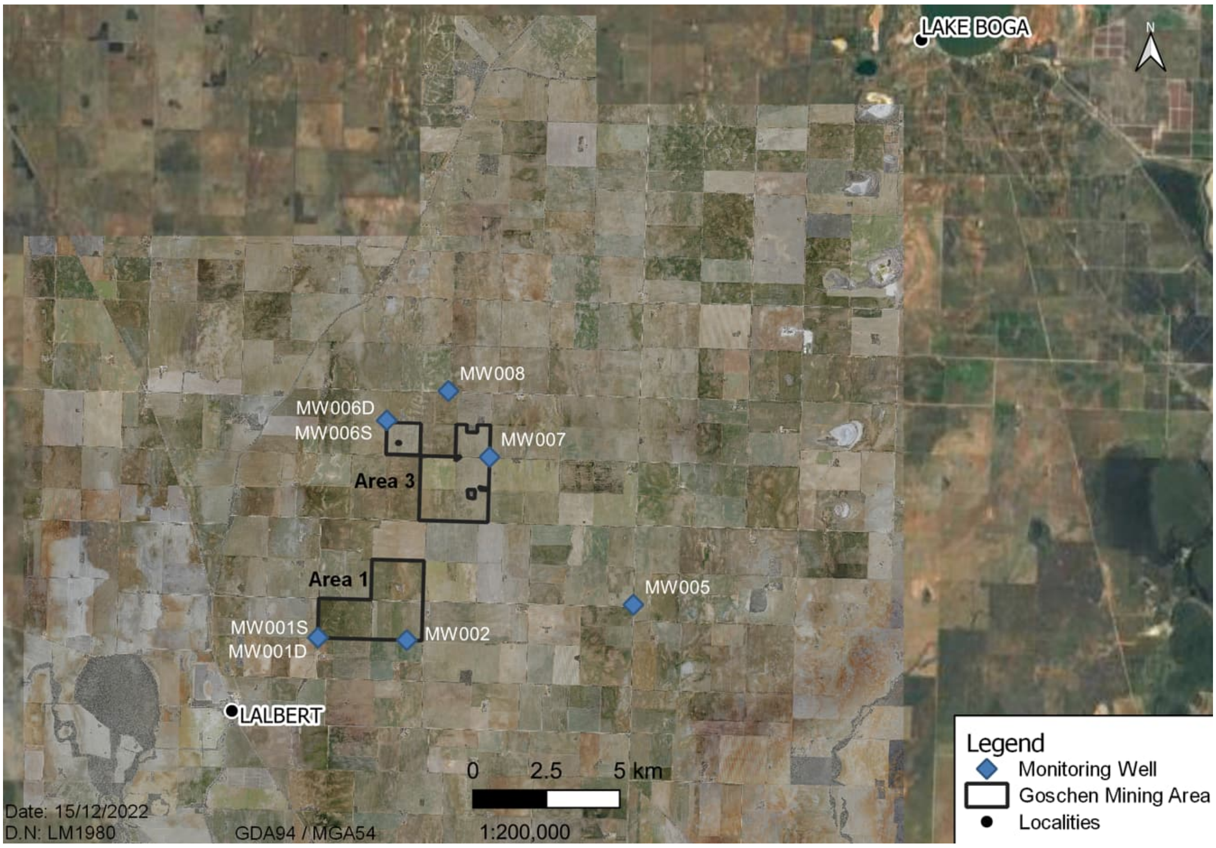

Figure 14-4 Groundwater monitoring bore locations

A desktop search of the Department of Energy, Environment and Climate Action (DEECA) Water Measurement Information System (WMIS) identified 18 existing groundwater bores within 10 kilometres of the Mine Site area. The existing groundwater bores have a listed use of monitoring / observation purposes or non-groundwater / unknown. No bores were listed with the use of domestic / stock bores or licensed bores within 10 kilometres of the Project area.

Groundwater levels

Groundwater monitoring events conducted as part of field assessments in August 2021 and April 2022 measured the groundwater levels in each of the eight groundwater monitoring bores installed. The depth to groundwater is presented in Table 14-3 below. Groundwater levels are presented as a measurement of depth below ground level, or as elevations that have been corrected to the Australian height datum (AHD). Groundwater elevations are used to create contour plots which infer the direction of groundwater flow.

Table 14-3 Groundwater levels

Bore ID	Measurement date	Depth to water (m bgl)	Groundwater elevation (m AHD)	Target aquifer
MW001S	August 2021	30.5	62.5	Loxton Parilla Sands
MW001D	August 2021	29.0	63.8	Renmark Group
MW002	August 2021	47.1	64.6	Loxton Parilla Sands
MW005	August 2021	18.8	67.1	Loxton Parilla Sands
MW006S	August 2021	25.7	63.1	Loxton Parilla Sands
MW006D	August 2021	25.5	63.9	Renmark Group
MW007	August 2021	Dry	Dry	Loxton Parilla Sands
MW008	August 2021	40.4	63.2	Loxton Parilla Sands
MW001S	April 2022	29.20	62.54	Loxton Parilla Sands
MW001D	April 2022	30.45	63.82	Renmark Group

Bore ID	Measurement date	Depth to water (m bgl)	Groundwater elevation (m AHD)	Target aquifer
MW002	April 2022	47.04	64.64	Loxton Parilla Sands
MW005	April 2022	18.81	67.05	Loxton Parilla Sands
MW006S	April 2022	24.93	63.04	Loxton Parilla Sands
MW006D	April 2022	25.72	63.88	Renmark Group
MW007	April 2022	Dry	Dry	Loxton Parilla Sands
MW008	April 2022	39.89	63.15	Loxton Parilla Sands

In addition to the bores installed in July 2021, groundwater level data was available from eight of the 18 existing groundwater bores identified through WMIS. Detailed information of these 18 bores is provided in EES Technical Report I: Groundwater impact assessment. These levels indicated that groundwater elevations varied between approximately 59 m AHD and 67 m AHD for the Loxton Parilla Sands.

By combining groundwater elevation data from monitoring bores installed during the field assessments with existing WMIS monitoring bores, groundwater contours have been developed and the directional flow of groundwater has been inferred. The groundwater elevation contours indicate that groundwater in the Loxton Parilla Sands aquifer flows to the northwest (refer to Figure 14-5). The inferred groundwater elevation at the proposed mining locations is approximately 64 m AHD. Given that the average surface elevation of the Project area is approximately 112 m AHD, the inferred depth to groundwater at the proposed mining locations is approximately 48 metres below ground level (m bgl).

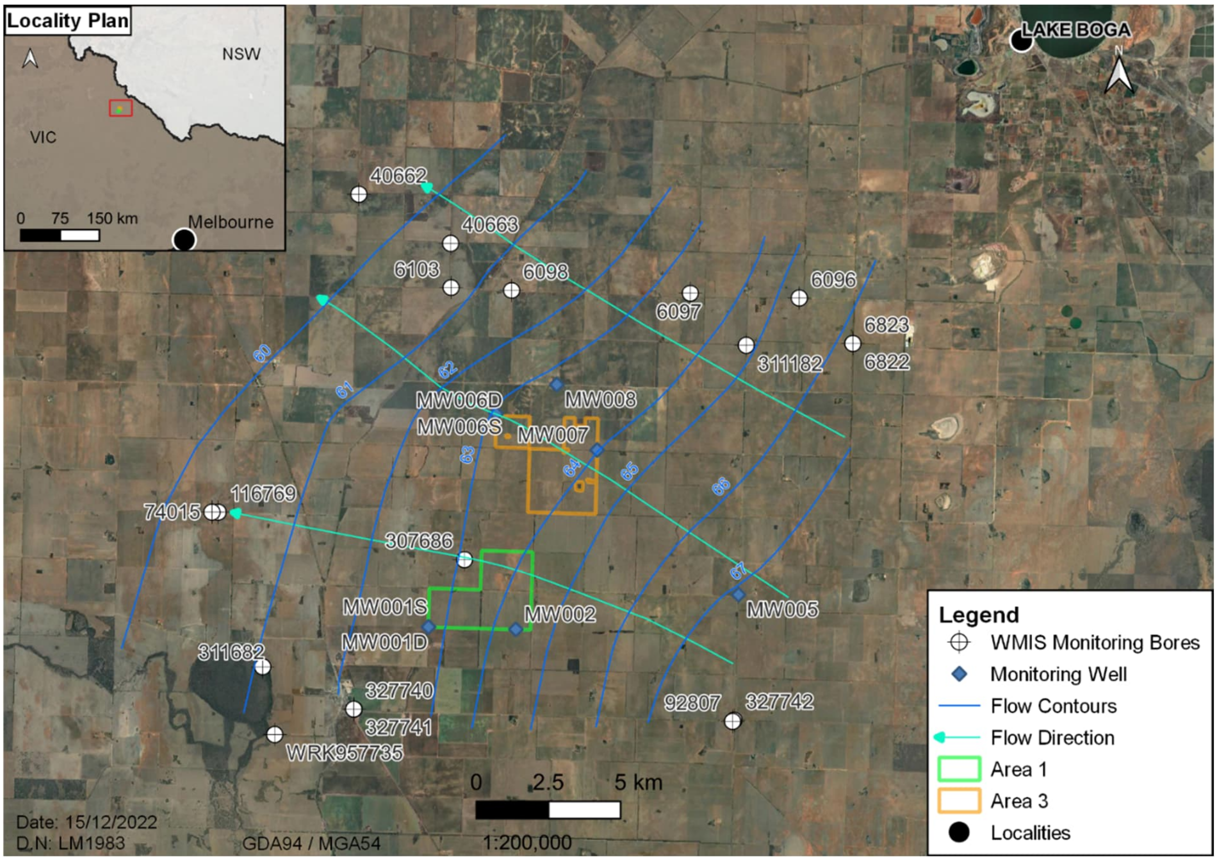

Figure 14-5 Inferred groundwater flow direction (m AHD)

Hydraulic gradients

Groundwater levels range from a high of 67.1 m AHD at monitoring bore MW005 to the east of the Project area, to a low of 59.31 m AHD north of the Project area. The groundwater contours presented in Figure 14-5 show a steady groundwater elevation decline to the northwest at an average gradient of 0.0004, which equates to 7 metres vertically and 17 km horizontally. The low hydraulic gradient suggests low groundwater recharge to the underlying Loxton Parilla Sands aquifer, as is also indicated by a lack of groundwater mounding and relatively low local rainfall.

A positive vertical hydraulic gradient was calculated using the difference in groundwater elevations at nested bores MW001S (Loxton Parilla Sands) and MW001D (Renmark Group). A positive vertical hydraulic gradient indicates that there is a low potential of leakage from the Loxton Parilla Sands aquifer to the underlying Renmark Group aquifer. This is demonstrated by the greater groundwater elevations, and therefore hydraulic head, identified in MW001D and MW006D in comparison to MW001S and MW006S.

Hydraulic conductivity

Hydraulic conductivity is a measure of how easily groundwater can pass through soil or rock. Higher hydraulic conductivities indicate that groundwater has a greater ability to pass through a particular rock, while lower hydraulic conductivities indicate that the rock is less permeable. A slug testing program was undertaken as part of field assessments in August and September 2021 to measure hydraulic conductivity within the Project area. Results of the slug testing indicated that the Loxton Parilla Sands generally demonstrated relatively higher hydraulic conductivities, with estimates ranging from 0.02 to 0.65 m/day. Hydraulic conductivities within the Renmark Group were lower and ranged from 0.006 to 0.15 m/day.

Groundwater recharge and discharge

The primary mechanism of groundwater recharge in the study area is via rainfall infiltration. Considering that the inferred depth to groundwater at the proposed mining locations is approximately 48 m bgl, groundwater recharge via rainfall infiltration is considered to be low.

The primary mechanism of groundwater discharge is related to groundwater throughflow to the northwest of the project area. Groundwater discharge is likely to outfall at the Murray River floodplain, with localised areas of discharge restricted to areas where groundwater occurs at elevations that intersect the ground surface. Lake Tyrell, Lake Wahpool and Lake Tiboram, located 55 km to the northwest, are known groundwater discharge features in the region.

There are no known permanent surface expressions of groundwater within 10 km of the proposed Project area. These might include springs or seeps. Major watercourses in the area such as Lalbert Creek, Tyrell Creek and Avoca River are typically disconnected from groundwater.

Groundwater chemistry

Groundwater data collected during field assessments indicated that groundwater salinity, as total dissolved solids (TDS) ranged from 13,394 to 29,565 mg/L across the project area in the Loxton Parilla Sands aquifer. Groundwater salinity is slightly less in the Renmark Group aquifer, as indicated by a TDS of 13,432 and 13,394 mg/L in MW001D and MW006D, respectively.

Groundwater quality was assessed as part of the groundwater monitoring events undertaken in August/September 2021 and April 2022. pH within the Loxton Parilla Sands was lower than expected for a saline, bicarbonate rich water. Naturally occurring metals such as iron and manganese were reported above the laboratory limit of reporting (LOR) within the groundwater and likely contribute to the acidity within the Loxton Parilla Sands aquifer. Low dissolved oxygen levels within the aquifer suggest that it is dysaerobic[1] to anaerobic. These conditions are suitable for the presence of anaerobic bacteria communities containing species within the sulfate reducing bacteria and/ or iron oxidising bacteria class.

Further information on the existing groundwater geochemistry is presented in EES Technical Report I: Groundwater impact assessment.

14.3.4 Environmental values

Environmental values refer to the uses, attributes and functions of the environment that Victorians value and is the key instrument in shaping the protection of water resources in the environment under the *Environment Protection Act 2017* (Vic). For groundwater, environmental values are determined by its salinity.

Given that the average TDS of the groundwater in the Loxton Parilla Sands exceeds 10,000 mg/L (refer to Section 14.3.3) and in accordance with the Environment Reference Standard (ERS), the environmental values that apply to groundwater in the Project area include:

- Water dependent ecosystems and species.

[1] Having a low concentration of dissolved oxygen

- Water based recreation - primary contact recreation.
- Traditional Owner cultural values.
- Buildings and structures.
- Geothermal properties.

Risk of harm to environmental values associated with geothermal properties, buildings and structures, water based recreation - primary contact recreation and Traditional owner cultural values are unlikely to be realised for the Project area for the following reasons:

- No geothermal properties were identified for groundwater in the Project area. This is due to the absence of geothermal activity in the Project area and groundwater measurements indicating that temperature ranges between approximately 16°C and 23 °C.
- Given the depth to groundwater, no buildings and structures would intersect groundwater levels in the Project area.
- No water based recreation have been identified for groundwater in the Project area.
- Groundwater discharge is likely to occur a considerable distance from the Project area at Lake Tyrell, Lake Wahpool and Lake Tiboram some 55 km to the northwest.
- No specific cultural and spiritual values have been identified for groundwater in the Project area.

Risk of harm to environmental values associated with water dependent ecosystems and species are also unlikely to be realised in the Project area. A search of the Bureau of Meteorology (BoM) groundwater dependent ecosystems (GDE) Atlas showed no high-potential GDE types within 10 km of the Project area. Smaller wetland features exist between the Project area and Lake Lalbert, located approximately 5 km to the west and between the Project area and the Avoca Marshes, approximately 10 km to the east. These features are located in areas where the depth to groundwater is likely to be greater than 10 m bgl and is considered highly saline, ranging from 13,000 to >35,000 mg/L TDS.

Groundwater fauna, such as stygofauna are found across a range of groundwater conditions but are most common in fresh and brackish groundwater and in aquifers with large pore spaces. There is no reported occurrence of stygofauna in the vicinity of the Project's mine site area and field investigations have suggested that the Loxton Parilla Sands aquifer has small or limited pore space and combined with the high groundwater salinity, it is considered unlikely that the aquifer environment is suitable for groundwater fauna.

Lake Lalbert and Lalbert Creek are DIWA listed wetlands (considered nationally important) and are approximately 8 km west of the Project. Lake Lalbert has been dry since 1998. The groundwater table at Lake Lalbert is greater than 20 m bgl and is highly saline. Therefore, groundwater is not expected to contribute to surface water in the lake, or to the wetlands associated with Lalbert Creek.

The Kerang Wetlands are Directory of Important Wetlands in Australia (DIWA) and Ramsar (internationally important) wetlands located approximately 26 km east of the Project area. Given that groundwater flow from the Project area is to the northwest, there is limited groundwater interaction with potential groundwater ecosystems associated with the Kerang Wetlands, located 26 km up hydraulic gradient.

While risk of harm to the aforementioned environmental values may not be realised in the Project area, groundwater is still considered an environment that must be protected and all relevant environmental values are considered to apply at all times. This is consistent with the General Environmental Duty (GED) under the *Environment Protection Act 2017* (EP Act). Central to the EP Act is the GED. The GED is an ongoing duty to prevent the risk of harm to human health and the environment. According to Section 25(1) of the EP Act, the GED requires that a person or entity who is engaging in an activity that may give rise to risks of harm to human health or the environment, to minimise those risks, so far as reasonably practicable.

When determining what is reasonably practicable, Section 6(2) of the EP Act gives regard to the following:

- The likelihood of those risks eventuating.
- The degree of harm that would result if those risks eventuated.
- What a person concerned knows, or ought reasonably to know.
- The availability and sustainability of ways to eliminate or reduce risks.
- The cost of eliminating or reducing risks.

Satisfaction of the GED requires a proactive approach to risk identification, assessment and the implementation of controls to minimise impacts to human health and the environment so far as is reasonably practicable.

Where relevant, mitigation and monitoring measures have been proposed to minimise the potential impact to the groundwater environment. These have been discussed in Section 14.4 and Section 14.5.

14.3.5 Numerical groundwater model

As part of the groundwater impact assessment, a numerical groundwater model was developed. The numerical model allows for the conservative prediction of hydrogeological changes as a result of activities during operation and rehabilitation of the mine. The model includes parameters determined from the existing conditions assessment, such as the average annual rainfall and groundwater levels for the Project area. It is an important tool in the assessment of defining the nature and extent of potential impacts/changes to groundwater from a defined activity.

Groundwater mounding refers to a localised increase in groundwater levels from increased groundwater infiltration, or seepage following the deposition of tailings within the mine pit. It has been assumed that tailings would be 50% saturated once deposited in the mine pit. Dewatering of the tailings would then take place in-situ and the resultant groundwater seepage, together with rainfall infiltration, would cause a localised increase in groundwater levels.

Detail regarding the development of numerical model, including methodology, inputs and assumptions can be found in EES Technical Report I: Groundwater impact assessment.

The outcomes of the numerical model indicate that groundwater mounding from tailings seepage would reach a theoretical maximum of over 20 metres above the existing groundwater level at year eight of mining operations and would remain high until the end of operations at year 20. From year 20, modelled seepage and groundwater mounding declines, but the mounding continues to spread laterally and dissipate within the aquifer.

Figure 14-6 shows the predicted extent of groundwater mounding at the end of mining operations. The mound extended no more than 2 km from the project area over this period.

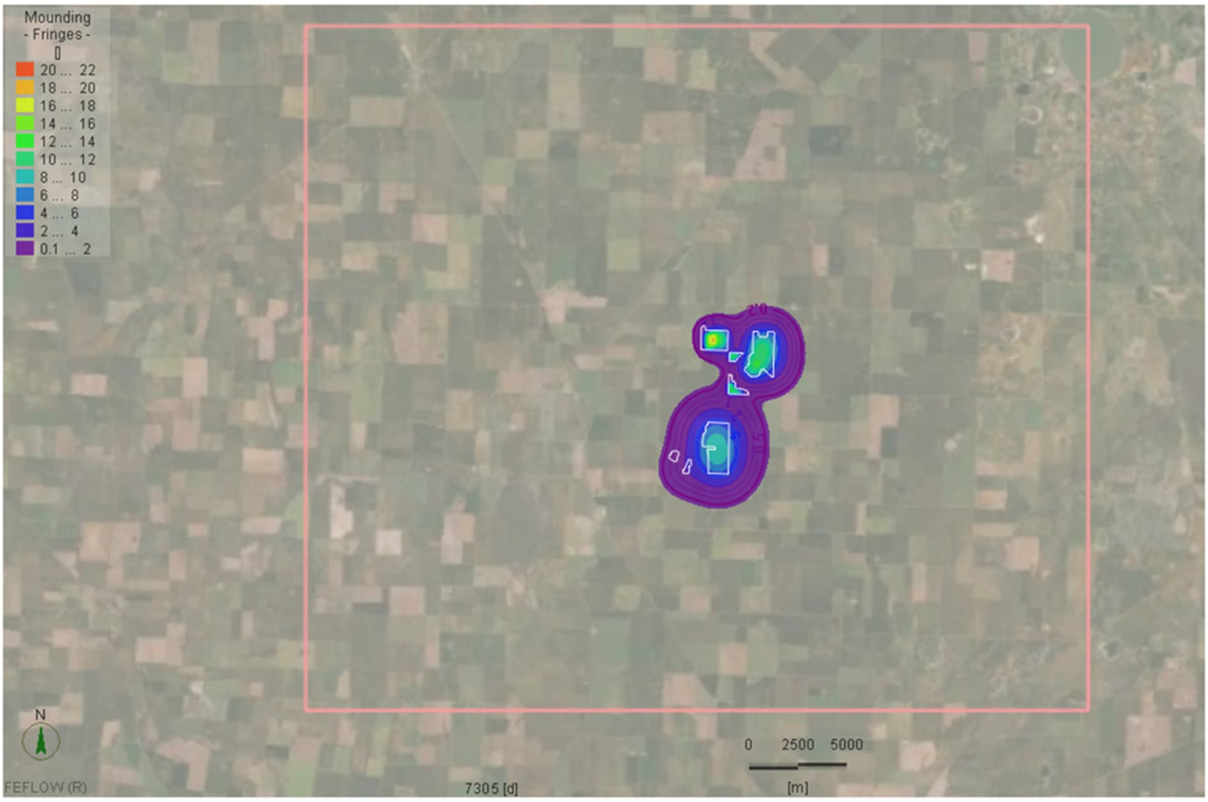

Figure 14-6 Modelled groundwater mounding after 20 years

The numerical model also allows for particle tracking. Particle tracking can assist in visualising the fate of potential solutes leaching into the groundwater from deposited tailings and migrating with groundwater flow. The results indicate that particles would travel approximately 2 km up to 10,000 years post mining (refer to Figure 14-7 below).

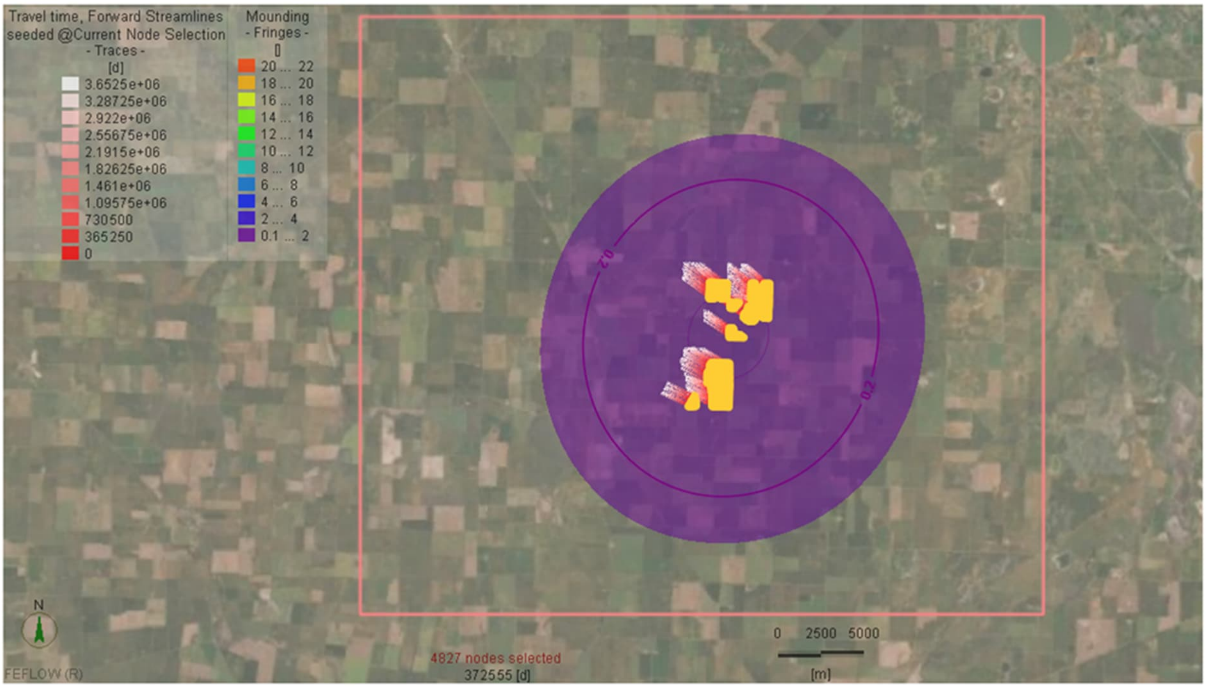

Figure 14-7 Modelled particle tracking

The outcomes of the numerical model have been considered as part of the rehabilitation impact assessment in Section 14.5 below.

14.4 Operation impact assessment

During operation of the Project, pits would be excavated and mined, and ore processed. The assumptions with regards tailings management relevant to potential groundwater impacts are as follows:

14.4.1 Tailings Management

To minimise tailings seepage to groundwater (refer to Section 14.5.1 and Section 14.5.2) and reduce the nature and extent of mounding and the extent to groundwater quality change, tailings water recover would be optimised as much as practicable (MM-GW01) and would be managed as part of a Tailings Management Plan.

The tailings management strategy for the Project to minimise seepage is as follows:

1. homogenising (mixing) and thickening (partially dewatering) the various tailings streams at the process plant prior to being hydraulically transported to open pits for deposition
2. 'dewatering' in-pit deposited tailings through the following:
   - Addition of flocculants to tailings to aid coagulation/clumping of fine/clays to separate the solids and allow decanting of water
   - Set-up and pumping from decant pond and return to process water circuit
   - Allowing for solar drying of exposed tailings
   - Interception of tailings seepage via embankment underdrain
3. progressively backfilling on top of the tailings as soon as practicable with overburden and topsoil to aid consolidation of tailings and allow re-vegetation and re-profile to the pre-existing landform.

The aim of the addition of flocculant to the tailings is to coagulate (clump) suspended solids from the standing water and allow water to be recovered for reuse in ore processing. Polyacrylamide based flocculants are planned to be used and are commonly used in the mineral sands industry and have been for many years. These polyacrylamide flocculant products[2] can contain impurities that result from the manufacturing process, including acrylamide. Acrylamide has been identified as toxic to humans but degrade relatively rapidly through microbially facilitated biodegradation processes. The half-life of acrylamide has been estimated in the order of hours with complete degradation occurring within a range of days to a few weeks. Therefore, the long-term presence of acrylamide in the project area is not anticipated.

It is estimated (as a conservative assumption) that as a minimum of 35% of the entrained water deposited in-pit will be able to be directly recovered, which is the basis for the groundwater impact assessment. Once interred in the pit, seepage will initially percolate through the unsaturated zone to the rising water table, and then eventually a proportion of the tailings in cells located in Area 3 will sit below the water table.

The interception of seepage would add to the tailings water recovery and be in addition to the 35% recovery assumed in the impact assessment and include the following:

- embankment underdrain
- pit interception/dewatering of mounded groundwater

The quality of the tailings water has been geochemically characterised based on the various tailings streams to be homogenised, which includes any residual breakdown products from the various reagents used in the mineral processing. The conclusion is that the initial quality of the seepage (leachate) water will be of low salinity (brackish), neutral pH as the tailings are non-acid forming, but will contain a number of elements at concentrations higher than in groundwater. The consequence is that what seepage does enter the groundwater environment will be initially of a quality of the leachate, but will immediately start to mix with the native groundwater and trend to be indistinguishable from that of background groundwater quality within that area of the groundwater mound and found to be elevated with:

- aluminium, arsenic, cerium, chromium, hexavalent chromium, fluoride, phosphorus (as reactive phosphorus), nickel, titanium and vanadium.

The following are also likely to be CoCs in seepage, but has uncertainty given the limits of reporting in groundwater were not sufficiently low:

- selenium, tin, thorium, thallium, uranium, yttrium, and zircon

The operation impact assessment considers potential impacts to groundwater from any dewatering that may occur where the groundwater table intersects active mine pits, the interaction between groundwater and surface water, potential impacts to groundwater users and potential impacts from climate change. Groundwater mounding and groundwater quality are discussed in Section 14.5.

14.4.2 Dewatering

The proposed mining method for the operation of the Project would be strip-mining. Strip mining refers to the removal of overburden before the removal of underlying ore deposits. As mining operations continue, mine pits would be progressively backfilled with tailings, overburden and rehabilitated.

The depth of mining varies between 28 and 43 m bgl, with Area 1 pit floor at least 20m above the groundwater table and Area 3 at least 3m (approximately 48 m bgl), thus no primary pit dewatering is required for operations.

However as described in Section 14.3.5, groundwater levels are predicted to rise from seepage losses during deposition of tailings. This may lead to mounded groundwater levels intersecting mine pits during mining operations in Area 3. Any groundwater entering the mine pits through the sides or base of the pit would be managed by a collection of sumps or spear points bores. This water would be recovered and returned to the process water circuit along with any recovered tailings water.

A take and use groundwater licence will be required from Grampians Wimmera Mallee Water (GWMWater) for the recovery of in-pit mounded groundwater and an A18 permit would be required from the Environment Protection Authority (EPA) for the infiltration of tailings water to groundwater (refer to EES Chapter 05: Legislation and approvals) (MM-GW02).

There is no potential for a decline in regional groundwater levels due to dewatering of the mounded groundwater as the extent of extraction will be limited to approximately 1 m below base of pit, and thus above the pre-mining

[2] Polyacrylamides are widely applied as flocculating agents in wastewater treatment, papermaking, oil recovery and mining. Since they are bulk chemicals used in large quantities around the world, their fate in nature is of considerable interest and has been the subject of research for a few decades. Recent research has provided considerable insight into the fate and transport of polyacrylamide in the environment.

groundwater levels. Impacts to groundwater from any dewatering activities are considered negligible and no mitigation measures are proposed.

At the cessation of mine operations, mounded groundwater dewatering would cease.

14.4.3 Groundwater and surface water

Groundwater impacts to surface water are considered negligible as a result of the proposed mining method.

Groundwater discharge to surface occurs when groundwater flow intercepts the land surface. The Loxton Parilla Sands aquifer does not discharge to any known wetlands, lakes or surface water features surrounding the Project. Groundwater is relatively deep (>30m below surface) and there are no known permanent surface expressions of groundwater within 10 km of the Project area.

General surface water flows to groundwater would be prevented from entering mine pits via bunding. The mine site would be designed to contain surface water flows from 1 in 20 year rainfall events, with any runoff generated above this to be directed to the active mine pit. Storm water flows diverted into an active mine pit during operations would be recovered as quickly as practicable. The diversion of surface water runoff in pit during extreme rainfall events is discussed in EES Chapter 13: Surface water.

Impacts resulting from the interaction of groundwater and surface water are considered negligible and no mitigation measures are proposed.

14.4.4 Groundwater users

Potential impacts to sensitive groundwater receptors are considered unlikely to occur. Sensitive receptors include any nearby users of groundwater and consider the environmental values of groundwater which must be protected.

Given that the average TDS of the groundwater in the Project area exceeds 12,000 mg/L (refer to Section 14.3.3), the environmental values that apply to groundwater in the Project area include water dependent ecosystems and species, water based recreation – primary contact recreation, Traditional Owner cultural values, buildings and structures and geothermal properties. As presented in Section 14.3.4, risk of harm to these environmental values is not considered to be realised in the Project area for the following reasons:

- No surface water interaction of groundwater within 10km of the mine site, and well outside area of impact from construction, operation and closure of the Project’s activities
- Database searches of groundwater users indicated that no registered stock or domestic groundwater bores exist within 10km of the Project area, which is attributed to the saline nature of the Loxton Parilla Sands aquifer.

Despite the conclusion that there is not predicted to be a risk of harm to listed environmental values, efforts to minimise any changes to groundwater quantity (Section 14.5.1) and groundwater quality (Section 14.5.2) will be implemented. During operation of the Project, tailings water recovery would be optimised as much as practicable to minimise seepage to the underlying aquifer. Measures to optimise tailings water recovery would include, thickening during processing, decant on tailings to recover water, solar drying prior to backfill and the inclusion of an in-pit underdrain. These measures would be captured in a tailings management plan (MM-GW01).

In addition to minimising seepage to groundwater as much as practicable, ongoing groundwater monitoring would be undertaken during operation and rehabilitation of the Project to identify any changes to groundwater chemistry in comparison to pre-existing conditions in the Project area. This would be undertaken in accordance with a Project specific Groundwater Management Plan (GMP) (MM-GW04). Where ongoing groundwater monitoring detects any impacts to groundwater quality outside that predicted, a review of the groundwater data and mining practices that have occurred would be undertaken. Further trigger levels and contingency actions would be detailed as part of the Project GMP (MM-GW04).

Only if required due to changes in groundwater quality as a result of the Project, future users of groundwater may be managed via administrative controls to ensure users are aware of any local groundwater chemistry changes. This may include, but wouldn’t be limited to, notification for those wishing to install a groundwater bore.

The potential impact to current and future sensitive receptors are considered to be suitably low, and will be further reduced with implementation of the proposed mitigation measures.

14.4.5 Climate change

To assess potential climate change impact, the Department of Environment Land Water and Planning (now referred to as the Department of Energy, Environment and Climate Action (DEECA)) guideline for Assessing the Impact of Climate Change on Water Availability in Victoria was reviewed. The guideline lists the requirements to determine an aquifers sensitivity to climate change as follows:

- The aquifer is sedimentary and unconfined with a depth to groundwater of less than 20 m bgl.
- The aquifer is highly responsive to rainfall and/or changes in stream flows.

Based on the available data, the Loxton Parilla Sands aquifer is unlikely to be sensitive to climate change. Beneath the mining areas, the depth to groundwater is approximately 48 m bgl. Long term hydrographs plotting annual rainfall and groundwater elevation in three WMIS groundwater bores indicate that the groundwater table does not respond to rainfall events and is very stable (refer to Figure 14-8 below).

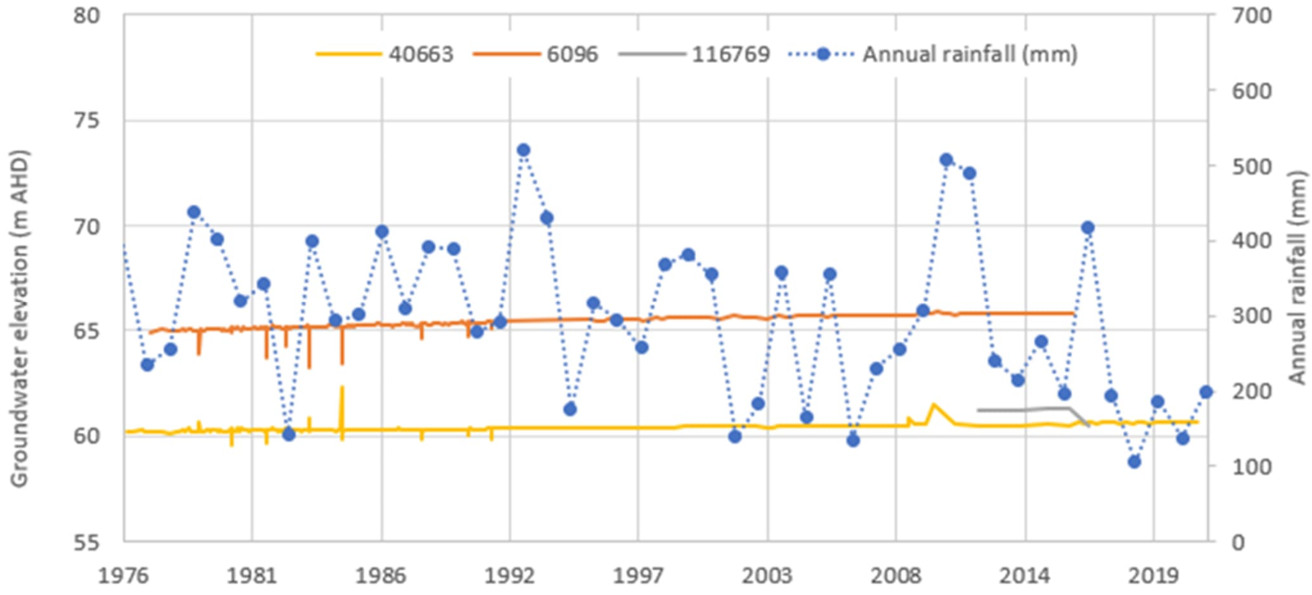

Figure 14-8 Long-term groundwater elevation data

Based on the depth of the groundwater table and the aquifers limited response to rainfall events, the Loxton Parilla Sands aquifer is not considered to be sensitive to climate change impacts and no mitigation measures are proposed.

14.5 Closure Impact assessment

This section discusses the potential groundwater impacts at the end of mining operations, considered to represent the maximum extent of potential impact.

14.5.1 Seepage and Mounding

The numerical model described in Section 14.3.5 conservatively assumed that tailings would be dewatered to 50% saturation (35% recovered and 15% permanently entrained). Based on this assumption, the model simulates an additional 1,875 mm of tailings water to infiltrate the groundwater, resulting in increased groundwater levels and mounding. Figure 14-9 below shows the modelled maximum seepage and resultant mounding predicted at any point within the Project area during mining operations. At its modelled maximum, a groundwater mound of over 20 metres would intersect the base and sides of adjacent operational mine pits, before declining and dissipating within the aquifer.

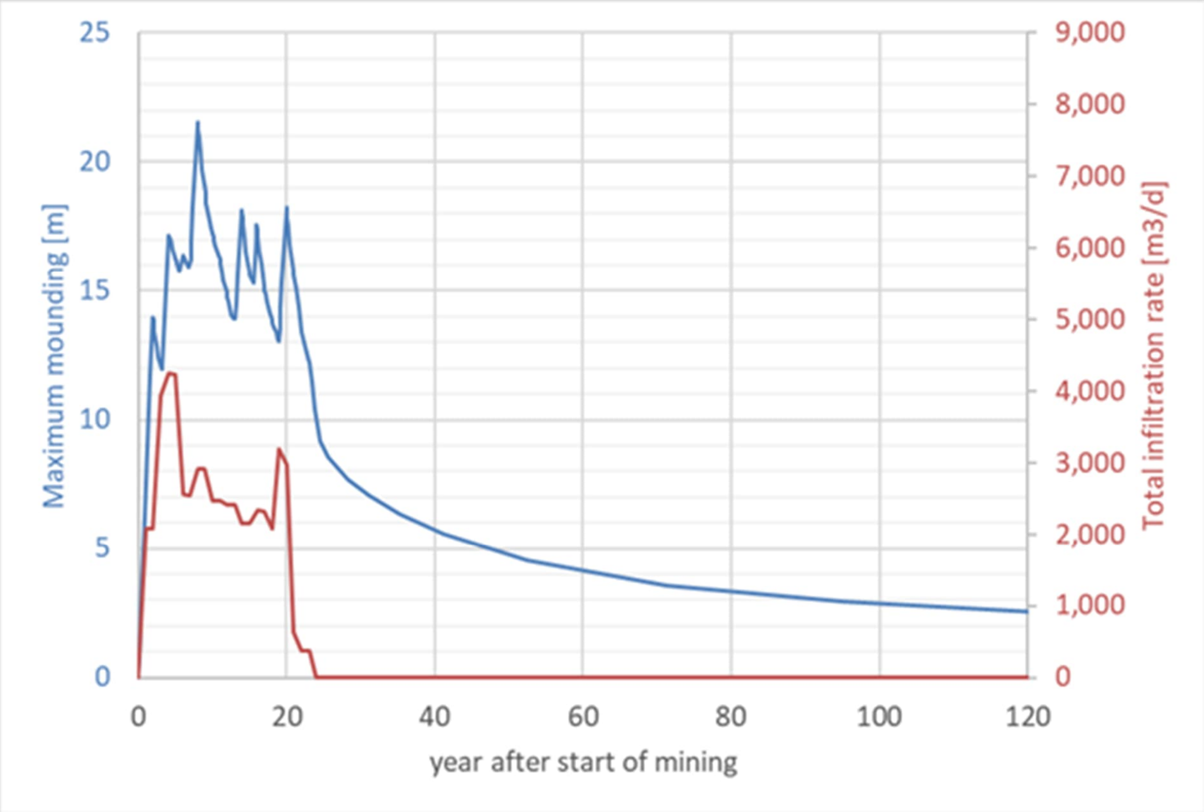

Figure 14-9 Maximum mounding (blue) and seepage (red) modelled

The smallest increase to groundwater levels that the numerical model can predict is 0.1 m. The numerical model demonstrates that by the end of operations, a 0.1 metre increase to groundwater levels would extend no further than 2.0 km from the Project area. At 100 years post mining, there would be a 0.1 metre increase to groundwater levels within 4.0 km of the Project area and this would increase to 10 km after 1000 years, while the residual mounding beneath the mined area would be approximately 0.5 metres (refer to Figure 14-10).

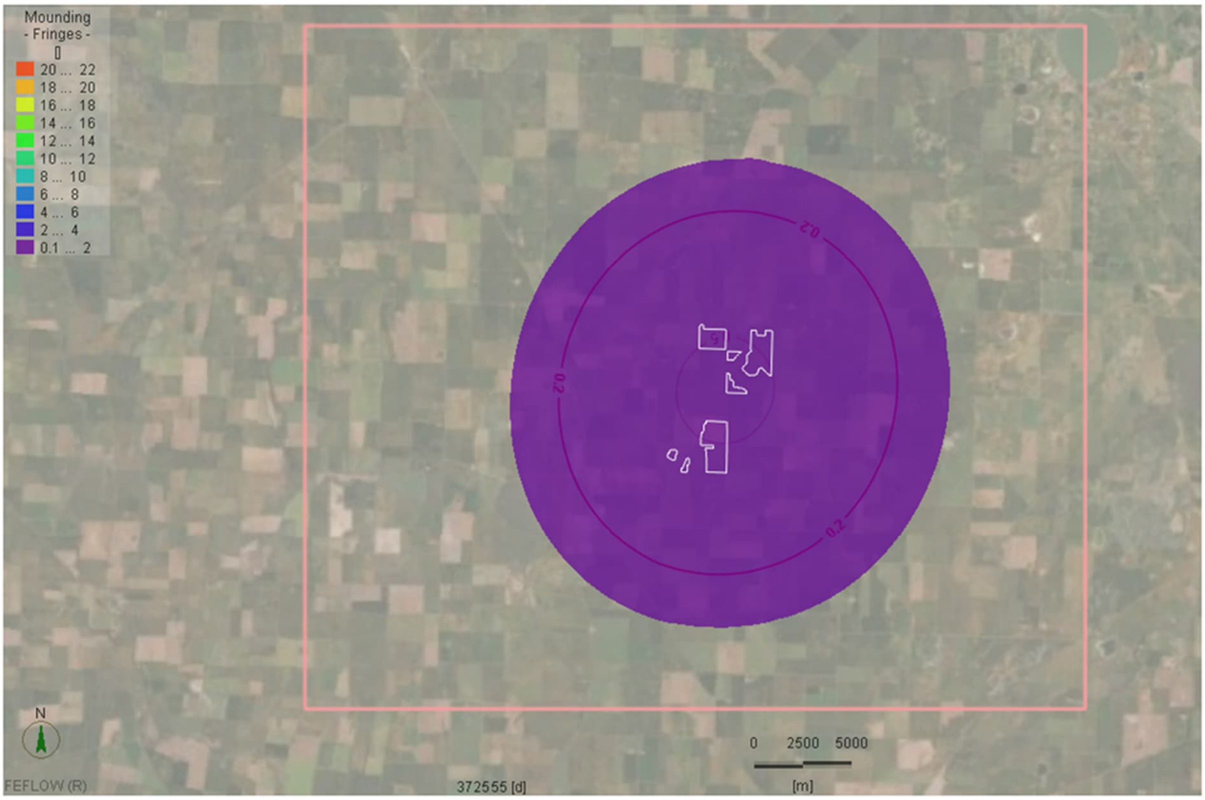

Figure 14-10 Modelled groundwater mounding after 1,000 years

This conservative modelling approach overestimates the potential extent of mounding as it has not considered interception of the seepage from the embankment underdrain and pit dewatering.

The model results demonstrates that any actual groundwater mounding from the deposition of tailings would be localised to the immediate Project area. Despite there being there are no domestic or stock users of groundwater located within 10 km of the Project area and despite mounding being spatially limited beyond the Project area, measures to minimise the potential impact to the groundwater environment would be implemented.

During operation of the Project, tailings water recovery would be optimised as much as practicable to minimise seepage to the underlying aquifer and will be captured in a tailings management plan (MM-GW01).

Groundwater levels would be continually monitored as part of the site-specific GMP and any changes outside that anticipated be able to be picked up prior to .

The impacts related to the mounding of groundwater are considered suitably low, and would be further reduced with implementation of mitigation measures.

14.5.2 Groundwater quality

Water that interacts with deposited tailings and infiltrates (seeps) to the groundwater is known as leachate (also known as decant water). Leachate would initially percolate through the unsaturated zone to the rising water table, and then eventually a proportion of the tailings will sit below the mounded water table.

This seepage (decant) water from the tailings has been geochemically characterised based on the various tailings streams to be homogenised and includes any residual breakdown compounds from the various reagents used in the process plant. The conclusion is that the seepage (leachate) water quality will be of low salinity, neutral pH as the tailings is non-acid forming, but will contain some elements at concentrations higher than in groundwater including aluminium, arsenic, cerium, chromium, hexavalent chromium, fluoride, phosphorus (as reactive phosphorus), nickel, titanium and vanadium and selenium, tin, thorium, thallium, uranium, yttrium and zircon.

As part of the numerical model described in Section 14.3.5, particle tracking was used to show the pathway of a dissolved ion for a pre-defined period of 10,000 years, and showed potential impacts that emerge from the tailings would travel 2 km northwest of the Project area. This extent of groundwater quality change would not impact any groundwater sensitive receptors, such as stock and domestic groundwater users or GDEs which have not been identified within 10 km of the Project. While unlikely, any future users of groundwater surrounding the Project area would be made aware of potential changes to groundwater quality through administrative control(s).

Overall it is predicted that the water quality entering groundwater will be initially of a quality comparable to characterised leachate and within 2km be indistinguishable from that of background quality. This is based on the groundwater impact assessment which determined the maximum distance for migration of impacts (Figure 14-7) but does not taken into account the proposed mitigation measures and the natural geochemical processes in the Loxton Parilla Sands aquifer all of which will reduce the nature and extent of changes to groundwater quality from tailings leachate. The natural attenuation processes likely to occur with the aquifer include the following:

- Aluminium precipitate in the reducing waters of the Loxton Parilla Sands aquifer
- Hexavalent chromium reduce to trivalent chromium
- Vanadium leading to the precipitation of uranium.
- Rare earth elements, such as cerium, lanthanum and yttrium adsorb onto the in-situ clays.
- Attenuation onto iron oxide phases of dissolved nickel, and potentially arsenic and selenium.

Therefore, it is considered that CoCs introduced to the Loxton Parilla Sands aquifer through leachate would migrate within a relatively small distance from the mine and ultimately attenuate and dissipate such that there is unlikely to be any long-term measurable change to groundwater quality surrounding the Project area from the deposition of tailings.

A secondary change to groundwater quality would result from increasing groundwater levels mobilising unsaturated salts in the Loxton Parilla Sands formation. However, given the brackish salinity of the mounded water resulting from the leachate it is not anticipated the mobilisation of salts will result in an impact above background (native) groundwater salinity.

Regarding the addition of flocculants as part of mineral processing, as discussed in Section 14.4.1, impacts to groundwater are not expected. Polyacrylamide based flocculants are planned to be used and can contain impurities that result from the manufacturing process, including acrylamide. Acrylamide has been identified as toxic to humans but degrade relatively rapidly through microbially facilitated biodegradation processes. The half-life of acrylamide has been estimated in the order of hours with complete degradation occurring within a range of days to a few weeks. Therefore, the long-term presence of acrylamide in the project area is not anticipated.

Irrespective of the assessed negligible risk of harm to sensitive groundwater receptors and the likelihood of natural attenuation processes occurring to that will reduce groundwater quality impacts the Project will implement measures to minimise the seepage of leachate to groundwater to minimise impacts to the groundwater environment. During operation of the Project, tailings water recovery would be optimised as much as practicable to minimise seepage to the underlying aquifer (MM-GW01). Measures to optimise tailings water recovery would include, thickening during processing, decant on tailings to recover water, solar drying prior to backfill and the inclusion of an in-pit underdrain. These measures would be captured in a tailings management plan (MM-GW01).

Additionally, a groundwater monitoring program would be developed to monitor CoCs and groundwater quality in the Project area. All groundwater monitoring would be undertaken in accordance with a GMP which would be prepared to manage potential risks to groundwater, and to establish a framework for the proper management and monitoring of groundwater at the Project (MM-GW04). Bi-annual groundwater monitoring is currently scheduled for a period of two years to develop a pre-mining baseline database for groundwater. During mining operations and rehabilitation, groundwater monitoring is proposed to continue bi-annually. Any changes to groundwater quality due to tailings leachate would be compared against the baseline database. If the ongoing groundwater monitoring detects any impacts to groundwater quality outside that predicted, a review of the groundwater data and mining practices that have occurred would be undertaken. Further trigger levels and contingency actions would be detailed as part of the Project GMP (MM-GW04), but as a minimum include measures to intercept and/or drawback impacts.

Impacts related to changes in groundwater quality are considered suitably low, and will be further reduced with the implementation of mitigation measures.

Further detail on mitigation, monitoring and contingency measures is provided in Section 14.7.

14.6 Residual impacts

In summary, the residual groundwater impacts following operation and rehabilitation of the Project would include localised groundwater mounding and changes to groundwater chemistry within a localised area of the Loxton Parilla Sands aquifer.

Mounding

The numerical model demonstrated that residual groundwater level mounding beneath the Project area would be less than 0.5 metre beneath the tailings cells. Marginal increases to groundwater levels beyond the Project area would consist of a 0.1 metre increase within 4.0 km of the Project after 100 years.

After 1,000 years, a 0.1 metre increase may be evident up to 10 km from the Project area, which is considered to be within natural fluctuations and unlikely to be detectable.

Groundwater quality

The geochemical processes in the Loxton Parilla Sands aquifer results in attenuation and dissipation of changes to groundwater quality from tailings leachate within 2km of the mine site. Thus is unlikely to be any long-term measurable change to groundwater quality surrounding the Project area from the deposition of tailings, however unsaturated salts in the Loxton Parilla Sands formation may become mobilised as localised groundwater levels increase due to mounding.

Ongoing groundwater monitoring would capture any potential change in groundwater chemistry during operation and rehabilitation of the Project, compared to baseline monitoring results with the objective to be able to provide definition of the nature and extent of change for potential future users.

Environmental Values

The environmental values that potentially apply to groundwater in the Project area include water dependent ecosystems and species, water based recreation - primary contact recreation, Traditional Owner cultural values, buildings and structures and geothermal properties. However, none of these environmental values exist within at least 10km of the mine site due to the relatively deep depth to groundwater (>30m), its chemistry and its saline nature.

Thus, based on the extent of impact the risk of harm to these environmental values is not considered to be realised.

14.7 Summary of mitigation measures

The proposed mitigation measures are presented in Table 14-4.

Table 14-4 Groundwater mitigation measures

Mitigation Measure ID	Mitigation measure	Project phase implementation
MM-GW01	Tailings water recovery would be optimised as much as practicable to minimise seepage to underlying Loxton Parilla Sand (LPS) aquifer and documented in the Tailings Management Plan. Tailings Management Plan will link to Groundwater Management Plan (MM-GW04), as a minimum specify the following: • Initial spigot design • Initial flocculant application rates • Embankment under drain design • Trigger Action Response Plan (TARP) A thickener and a flocculant dosing system will be used in the primary stage of dewatering to allow the fines to be thickened. Fines will report to the thickener underflow and will be combined (homogenised) with sand tailings and pumped back to the mine void. Clean water overflow from the thickener will be transferred to a process water pond (PWP). The use of flocculants will be optimised to ensure maximum clean water recovery whilst minimising the amount used, so far as reasonably practicable. The flocculants will be used in the process at very low concentrations in line with standard practice within the mineral sands industry. Secondary dewatering will occur at the mine void tails discharge outlet. This will involve adding further polymer flocculant to the slurry exiting the pipe head. The clean water will separate from the tailings beach and will report to a decant sump. The recovered water will be recycled to the process water pond (PWP). This process will be periodically reviewed and enhanced to maximise water recovery, so far as reasonably practicable.	All phases

Mitigation Measure ID	Mitigation measure	Project phase implementation
MM-GW02	Obtain the necessary permits and licences that relate to groundwater activities prior to commencement of operations. As a minimum this will include: • Take and Use licence from GWMWater - Groundwater would be extracted from the mounded LPS aquifer in line with the conditions, timings, and limits detailed in a licence issued by GWMWater. • A18 Permit from EPA – Depositing tailings in-pit triggers the need for an A18 permit for the discharge or deposit of waste to aquifer.	Operation
MM-GW03	Risks to groundwater would be minimised as much as practicable with specification as minimum of the following: • Hazardous waste (as defined by EPA) would be removed from site as soon as practicable by a licensed contractor for treatment or disposal in an approved facility in accordance with licence and regulatory requirements to minimise risk to groundwater. • Any hazardous materials, such as laboratory chemicals, would be stored in designated areas in accordance with their safety data sheets. • Spills of fuels or chemicals would be managed in accordance with Part 3.4 of the EP Act 2017 and requirements set out in the Spill Management Plan. This may include restoration of the affected area (soil and groundwater) to its pre-spill state so far as reasonably practicable.	All phases
MM-GW04	A Groundwater Management Plan (GMP) would be prepared to manage and further mitigate potential risks (if required) to groundwater and establish a framework for the management and monitoring of groundwater. The GMP would capture high risk activities, present relevant controls and management measures, detail contaminants of concern (indicators), the objectives for the appropriate assessment of groundwater, and would detail the groundwater monitoring to be undertaken throughout the life of the Project and would provide trigger levels and contingency actions in the event of trigger exceedances. The exact scope of the contingency action will depend on the nature and extent of any unacceptable impact and risk if was to occur. However, as a minimum the type of contingencies to be considered would be targeted interception and/or pumping of groundwater via a network of bores to stop and draw back groundwater where the quality or elevation has been assessed through the development of a trigger to pose an unacceptable risk in either the short or long term. The GWMP would be developed in consultation with relevant stakeholders and must be subject to approval by the relevant Authority.	All phases

14.7.1 Monitoring and contingency measures

The monitoring and continency measures that are proposed to assess groundwater impacts associated with the project are presented in Table 14-5.

Table 14-5 Groundwater monitoring and contingency measures

Measure ID	Monitoring or contingency measure	Project phase
Baseline groundwater monitoring	Purpose: Further inform baseline conditions to develop a baseline groundwater level and quality database against which changes to groundwater can be monitored. Minimise risk of harm to groundwater during construction. Indicators and objectives: Groundwater quality and levels as set out in the GMP (MM-GW04) and in accordance with the ERS. Groundwater monitoring conducted prior to construction and during construction would further inform baseline conditions. Parameters: Groundwater parameters and chemicals of concern to include, as a minimum, the suite listed in Table 8-11, 8-12 and 8-13 of Groundwater Impact Assessment (CDMSmith, 2023). Locations: As a minimum, the groundwater bores listed in Table 8-10 of Groundwater Impact Assessment (CDMSmith, 2023). Frequency: Groundwater monitoring would be conducted biannually (in accordance with EPA Publication 669.1) for a period of two years prior to commencement of construction.	Construction
Operational phase groundwater monitoring	Purpose: Minimise risk of harm to groundwater during mine operation. Within 6 months of 2 years continuous operation update groundwater modelling predictions undertaken in the Groundwater Impact Assessment based on site monitoring with the aim to: • refine predictions on potential extent of groundwater quality and levels changes during and post operations. • review (and potentially update) groundwater monitoring regime. • establish the nature and extent of natural attenuation process and provide prediction on groundwater quality changes during and post operations. Indicators and objectives: Groundwater quality and levels as set out in the GMP (MM-GW04) and in accordance with the ERS. Parameters: Groundwater parameters and chemicals of concern as set out in the GMP (MM-GW04). Locations: Groundwater monitoring locations would be specified in the GMP (MM-GW04). Frequency: Groundwater monitoring would be conducted biannually (in accordance with EPA Publication 669.1) and in accordance with the GMP (MM-GW04) and based on an ability to determine trends and changes prior to causing an impact on sensitive receptors. Trigger levels and contingency actions: If water level or water quality change is detected or reveals unplanned impacts over the life of operations undertake review of groundwater data and mining practices that have occurred to determine the nature and cause of the impact. Review modelling results with observed data to update and inform a revaluation of impact assessment. Detailed trigger levels and contingency actions would be specified in the GMP (MM-GW04).	Operation

Measure ID	Monitoring or contingency measure	Project phase
Rehabilitation / closure phase groundwater monitoring	Purpose: Minimise risk of harm to groundwater following mine closure and rehabilitation. Indicators and objectives: Groundwater quality and levels as set out in the GMP (MM-GW04) and in accordance with the ERS. Parameters: Groundwater parameters and chemicals of concern as set out in the GMP (MM-GW04). Locations: Groundwater monitoring locations would be specified in the GMP (MM-GW04). Frequency: Groundwater monitoring would be conducted biannually (in accordance with EPA Publication 669.1) and in accordance with the GMP (MM-GW04). Trigger levels and contingency actions: If water level or water quality change is detected or reveals unplanned impacts over the life of operations undertake review of groundwater data and mining practices that have occurred to determine the nature and cause of the impact. Review modelling results with observed data to update and inform a revaluation of impact assessment. Detailed trigger levels and contingency actions would be specified in the GMP (MM-GW04).	Closure

14.8 Conclusion

The assessment has shown that the operation and closure/rehabilitation of the Project can be managed such that the objective of minimising the effects on water resources, and on the beneficial and licensed uses of groundwater, can be met.

The principal risk to groundwater is from the seepage coming out of the slurry tailings being deposited back into the mine voids that change the groundwater levels and groundwater quality.

The outcomes of the predictive modelling of tailings deposition show that groundwater mounding will occur and reach a theoretical maximum of over 20 metres immediately beneath the mine at year eight of mining operations, before declining and dissipating following the cessation of mining operations. This impact would be mitigated through the various measures to enhance water recovery of the tailings prior to seepage occurring.

Mounding resulting from tailings deposition would be spatially limited beyond the Project area, with increases to groundwater levels considered negligible.

The water quality of the seepage from the tailings is shown to be of low salinity and non-acidic and includes aluminium, arsenic, cerium, chromium, hexavalent chromium, fluoride, phosphorus, nickel, titanium and vanadium potentially above background concentrations. However, the natural geochemical processes mean any changes to groundwater quality will be limited to within 2km of the mine site and not impact any sensitive receptors.

A secondary change to groundwater quality would result from increasing groundwater levels mobilising unsaturated salts in the Loxton Parilla Sands formation.

Despite localised groundwater mounding and potential changes to the groundwater chemistry, sensitive groundwater receptors, such as nearby groundwater users, were not identified in proximity to the Project area. In accordance with the ERS, the environmental values that apply to groundwater in the Project area include water dependent ecosystems and species, water based recreation - primary contact recreation, Traditional Owner cultural values, buildings and structures and geothermal properties. Due to the relatively deep depth to groundwater, its chemistry and its saline nature, risk of harm to these environmental values is not considered to be realised at the Project area.

Nonetheless, measures to minimise the infiltration of groundwater would be implemented to minimise impacts to the quality and quantity of the groundwater environment. Tailings water recovery would be optimised as much as practicable to minimise seepage to the underlying aquifer and a tailings management plan would be implemented. Ongoing groundwater monitoring would be undertaken in accordance with a Groundwater Management Plan during operation and rehabilitation of the Project to identify any changes to groundwater chemistry in comparison to pre-existing conditions in the Project area. Where ongoing groundwater monitoring detects any impacts to groundwater quality outside that predicted, a review of the groundwater data and mining practices that have occurred would be undertaken. Further trigger levels and contingency actions would be detailed as part of the Project GMP.

In response to the EES evaluation objective described at the beginning of this chapter, impacts of the Project on groundwater have been assessed and measures have been identified, where necessary, to avoid or minimise adverse effects on water resources, and on the environmental values of groundwater.