Premises Activities

Operational Activities

A schematic of the Premises activities is shown in Figure 1.

The mining and processing operations incorporate conventional dry mining followed by wet separation to produce a heavy mineral concentrate that contains the garnet using conventional gravity separation. By design, the mine does not intersect the groundwater table, which is mostly below the basement of the resource. The Applicant has advised that groundwater does intersect the resource in limited areas of the deposit; however, these areas are small and have been excluded from mining to avoid the requirement for dewatering.

Further processing in the Mineral Separation Plan (MSP), which uses magnetic separation and screening techniques, upgrades the separated concentrate to produce high grade garnet, ilmenite and non-magnetic mineral products.

The mine void will be backfilled progressively throughout the life-of-mine using tailings.

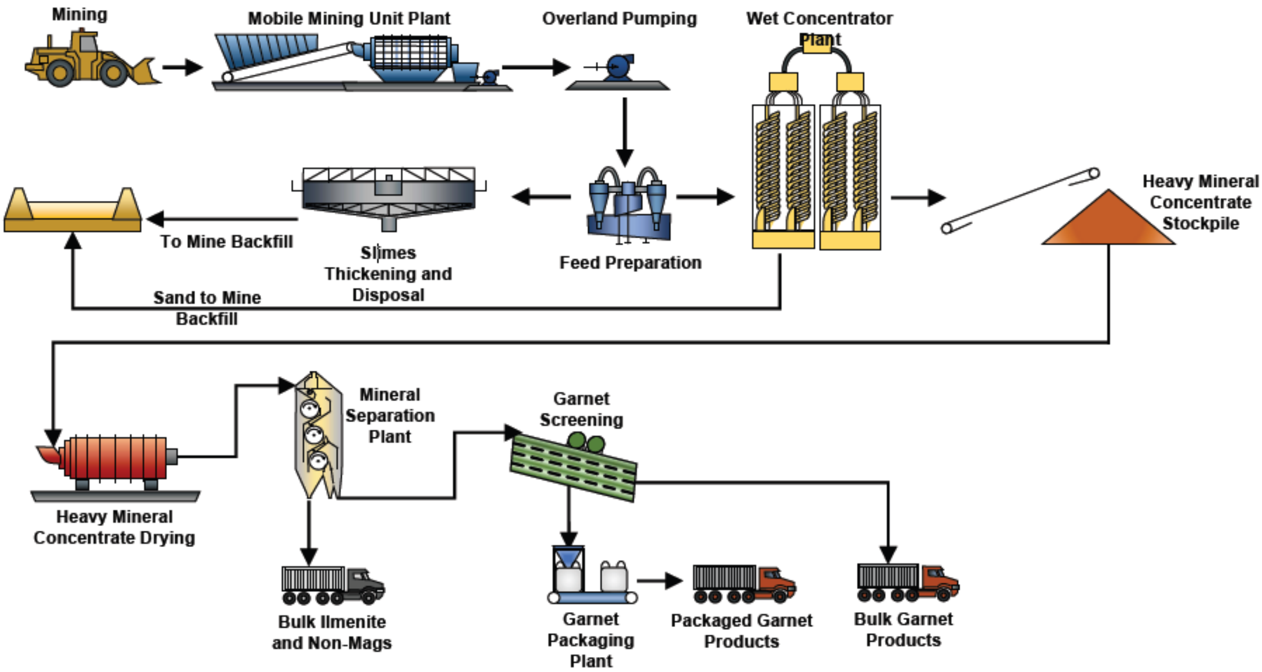

FIGURE 1: OPERATIONAL PROCESS FLOW DIAGRAM

Operational Hours

Mining and processing operations occur on a continuous basis (24-hours per day). Detailed operational hours for mining and processing activities are shown in Table 1 below.

TABLE 1: MINING AND PROCESSING INFRASTRUCTURE OPERATIONAL TIMES

Mining Operations Infrastructure	Start time	Finish time	Operations infrastructure	Day shift start time	Day shift finish time	Night shift start time	Night shift finish time
Office	06:00	18:00	**All offices, control room**	06:00	18:00	18:00	06:00
Workshop	06:00	18:00	**Laboratory**	06:00	18:00	18:00	06:00
			Mechanical, electrical, fabrication	06:00	18:00	18:00	06:00
			Product and ilmenite sheds	06:00	18:00	18:00	06:00
			WCP, MSP, tailings stackers, pumps	06:00	18:00	18:00	06:00
			MUP	06:00	18:00	18:00	06:00
			Tracked dozer	06:00	18:00	-	-
			Production bores, pumps and pipelines	06:00	18:00	18:00	06:00
			Genset(s) – across site for power generation	06:00	18:00	18:00	06:00

Mining Operations

The 'Menari' deposit is a small undeveloped low-strip, medium-grade alluvial garnet deposit. Topsoil and subsoil are pre-stripped and stockpiled separately or placed on areas undergoing rehabilitation. The garnet resource is located close to the surface; therefore, the removal of overburden is minimal.

The Menari deposit is being mined as a single pit, which has been divided into 52 mining blocks. A general overview of the proposed mining sequence is provided in Table 2. Mining will be carried out to a maximum depth of around 45 meters below ground level (mbgl).

TABLE 2: OPERATION TIMING

Mine Block	Timing	Comment
1-12	Dec 2020 – Apr 2022	Start in south of Menari Pit
13-25	May 2022 – Apr 2023	Progression of mine
26-39	May 2023 – Mar 2024	Progression of mine
40-52	Apr 2024 – Apr 2025	Finish Menari Pit on eastern side

The mineralised ore is excavated using typical earth-moving equipment, including a front-end loader, dozer and excavator. The removal of topsoil and relatively minor quantities of overburden prior to excavation of the ore is largely undertaken by dozers. As the pits are excavated to target depths, the active face is directly mined by the FEL, and the material taken to the mobile Mining Unit Plant (MUP).

The MUP is located on the pit floor (basement), which is generally indicated by Tamala Limestone. As the mining face advances a suitable distance (approximately every 100 m), the MUP stops production and is moved closer to the pit face to allow short tramming distance for the FEL. The dozer is used to maintain a safe working ore face of approximately 30 degrees (batter face), clean-up and level the pit floor, and move the MUP. Mining is proceeding from the southern extent of the Mine Pit, and the mining face will be excavated northwards while alternately traversing the east and west width of the deposit.

The ore feed to the MUP is coarsely screened to remove rocks and material greater than 50 mm (comprised of limestone) that could damage the trommel screen. The screened sand is conveyed up to the trommel feed chute where an equal mass of water is added to the ore. The ore is screened in a rotating trommel to remove any oversize rocks, sticks and waste material. The oversize waste is stockpiled in the pit for burial with sand tails. Approximately 11,200 tonnes of oversized material has been stockpiled off the premises (on tenement G 70/269) for use in construction and maintenance activities on the Applicant's tenure (e.g., in road-base for tracks and hardstand).

At the trommel, the slurry is screened at nominally 2.0 mm, with the oversize returning to the pit. There is no garnet present in the oversize material, so this is discarded early in the process. The screen aperture selection can be changed to meet the sand conditions during the life of the operation. The MUP pumps the screen undersize material as a slurry through a network of high-density polyethylene pipes to the Wet Concentrator Plant (WCP) located in the Central Processing Area (CPA).

The MUP is operated in two 12-hour shifts per day, 365 days a year with a target utilisation of 85%.

1.1. Central Processing Area

The CPA is located over Tenements M70/1280 and G70/253. This area contains most of the plant and utilities including the WCP, drier, MSP, Screening and Bagging Plant (SBP), power and utilities (Reverse Osmosis [RO] plant and Wastewater Treatment Plant [WWTP]).

Plant components in the CPA are modular and will be removed at end of LOM.

Wet Concentrator Plant

The WCP can process up to 3.6 Mtpa of ore feed from the MUP. The WCP separates out waste tailings and produces a heavy mineral concentrate (HMC) through several processes, including:

- Desliming - separation of slimes.
- Slimes thickening - flocculant addition to settle out solids and recycle process water.
- Spirals circuit - use of water and gravity induced centrifugal forces to separate garnet product from the lighter reject sand.
- Up-current classifiers (UCC) - size and density separation of intermediate concentrate and additional reject of fine and light minerals.
- Attrition - to remove calcrete coating from the HMC.
- Filtering and product washing - dewatering and rinsing excess chloride from the HMC with RO water.

The WCP is operated in two 12-hour shifts per day, 365 days a year with a target utilisation of 85%. Production of HMC will be the equivalent of 25 tph of dry sand. Overall heavy mineral recovery from the WCP is around 90%, with 85% comprising garnet concentrate and the other 5% as black sand concentrate.

Mineral Separation Plant

Stockpiled HMC from the WCP is further processed at the MSP, which comprises a bin feeding a rotary dryer, followed by Rare Earth Magnetic Separators (**REMS**).

The HMC is fed into the drier feed hopper by conveyor. The dryer's diesel-fired burner and airflow are controlled to automatically maintain a constant discharge temperature regardless of variations in feed rate.

The exhaust from the dryer is drawn through a baghouse with reverse pulse filter cleaning by an induced draft (**ID**) fan. The gas is separated from the dust by the fabric bags and is vented to atmosphere via a 2.8 m high muffled stack, with the dust discharged and collected in drums or kibbles and returned to the WCP. Particulate emissions from the baghouse are expected to be less than 50 mg/m^3 (target concentration below 20 mg/m^3).

The dried material is discharged on to the HMC trash screen that removes the larger than 2 mm oversize material, which is removed to protect the magnets and screens. The screen undersize is transported to the cooler by a bucket elevator.

The dried HMC is delivered to the magnet circuit via the primary screen feed elevator to separate the HMC into garnet, ilmenite and non-magnetic HMC. The primary screen first separates the fine and coarse HMC via a 300 µm screen, removing the coarse HMC and increasing the magnetic separation efficiency. The magnetic separation uses two triple stage Rare Earth Drum (RED) magnets to produce the following materials:

- Strong Magnetics (Mags 1) and Magnetics (Mags 2) –the ilmenite product is pneumatically conveyed and stored on-site in the ilmenite storage shed.
- Non-Magnetics (Non-Mags) – these are diluted with water and run through a spiral to further separate the heavy and light minerals. Heavy mineral is partially dewatered through a dewatering cyclone and stockpiled adjacent to the MSP. Lighter minerals (silica sands) are pumped back to the WCP to the tailings hopper.
- Para-magnetics (Mids) – these are conveyed to the bulk garnet storage silos adjacent to the SBP.

The MSP non-magnetics consist of non-garnet and non-magnetic heavy minerals such as leucoxene, rutile, zircon. These are conveyed to a storage stockpile adjacent to the MSP to be reclaimed by FEL and loaded on to trucks for sale to a third-party processor.

The magnetics stream consists of predominantly ilmenite. The ilmenite is pneumatically conveyed to the covered storage shed adjacent to the MSP to be stockpiled. The ilmenite is reclaimed by FEL and loaded into trucks for sale to a third-party processor.

The paramagnetic product (garnet concentrate) is stored in separate silos in preparation for screening.

Screening and Bagging Plant

The SBP produces final packaged goods ready for market through a primary screen, blast grade screen and water jet screen. The following garnet products are produced at the Premises:

- Blast Grade (**BG**) 20/40# Garnet.
- BG 30/60# Garnet.
- BG 80# Garnet.
- Coarse Water Jet 80# Garnet.
- Fine Water Jet 120# Garnet.

The SBP is in a shed adjacent to the MSP and the bulk of the shed is for packaged goods storage. The high frequency multi-deck screens produce the garnet products, which are transferred to product silos then fed into bagging machines, the 25 kg bagging plant or conveyed to the bulk shipment silo.

The screening circuit is operated as a continuous process to ensure the screens are fed at a constant tonnage, maintaining the screening efficiency and consistent product size distribution.

Sampling and laboratory tests are carried out to ensure that final product quality meets the required standards. Excluding the use of inert flocculant and minor viscosity modifier, the physical separation process does not use any chemicals.

Pipeline Network

Slurried materials are transferred around the Premises using HDPE pipelines, which are constructed in 10 m lengths with flanged sections. Pipelines are constructed in designated pipeline corridors with spillage sumps at suitable locations approximately every 500 m. Pipeline corridors that cross access roads have drainage swales cut out of the roads to allow surface water runoff.

Tailings and Water Management

An overview of the water flow at the Premises is shown in Figure 2.

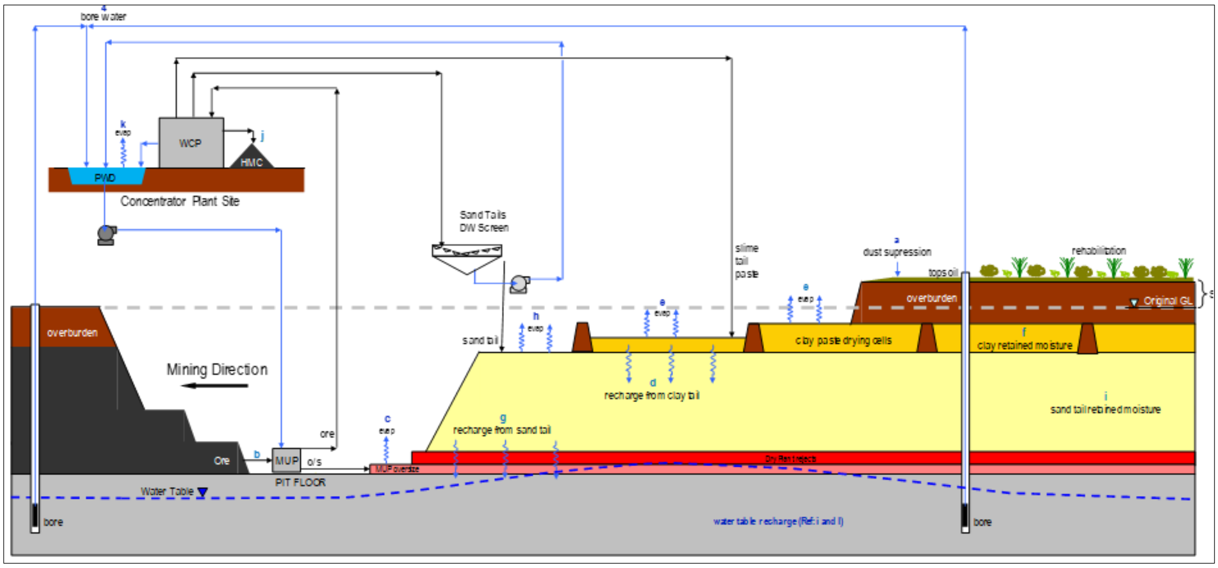

FIGURE 2: WATER FLOW DIAGRAM

Clean Sand Tailings

The Sand Tailings Storage Area is used for the management of clean sand tails pumped from the WCP. Stockpiling occurs in the designated area to store and dry the slurried sand processed through the WCP.

The clean sand tailings generated from the WCP are being initially stockpiled in the designated area until there is enough space in the Mine Pit for progressive direct backfilling. The off-path stockpile area is located to the west of the mining area. The sand tailings are wet-stacked (20% - 30% moisture) at natural repose to a height not exceeding 10 m using a series of 12 cyclone stackers (Figure 3).

FIGURE 3: CYCLONE STACKERS

The stockpile area includes perimeter bunds and drains to capture runoff and minimise washouts. The clean sand tailings are stabilised, which includes the application of a polymer binder to limit dust generation.

Once sufficient space is available in the Mine Pit, future sand tailings will be stacked in the void as part of the progressive mine rehabilitation.

Solar Drying Ponds – Slimes

A series of Solar Drying Ponds are required for the management of clay fines (slimes) from the WCP until they can be placed into the Mine Pit (i.e., tailings replacement operations).

The Works Approval application envisaged a series of solar drying ponds being constructed off the mine-path before being relocated to the Sand Tailings Storage Area once that area was created. The following solar drying ponds are currently envisaged at the premises:

- One large pond to the north of the CPA (existing).
- A series of ponds within the southern part of the Sand Tailings Storage Area (existing and proposed).
- A series of ponds within the Mine Pit (proposed).

When sufficient space is available in the Mine Pit, dried slimes will be excavated from the ponds once they are filled within 1 m of the top of the embankment. The excavated slimes will be returned to the Mine Pit as part of the rehabilitation of the void. Excavated ponds will be put back into operational use, unless they are over-stacked with sand tailings.

The solar drying ponds are a series of single paddock-style dam structures with outer walls at least 1:2 (V:H). The pond floors and walls are constructed from overburden material or similar. The floors of the ponds do not require a slope for effective operation and are, therefore, constructed with flat bases (although all the ponds have a natural fall gradient).

Slimes enter the ponds via pipeline from the WCP and the fine sediment is allowed to settle to the base of the pond. Equipment is available to decant supernatant water from the top surface for return either to the Process Water Pond or the Turkey Nest for reuse. No lining of the ponds is required owing to the inert and self-sealing nature of the slimes.

Additional solar drying ponds are to be constructed within the mining void as space becomes available. The ponds will be constructed in accordance with the existing controls and Works Approval conditions and will be overlain with clean sand tails, prior to rehabilitation. This approach is consistent with the backfilling of the mining void (as per the MP and MCP), avoids the need for additional disturbance for creating solar drying ponds off the mine-path and reduces handling of materials.

Additional solar drying ponds will be required as the mine progresses, and there could be up to six live ponds in operation at any stage to allow for drying and consolidation of the slimes. Approval for additional ponds not included in this licence application will be sought from DWER at the required time.

Water Management

Mining does not occur below the groundwater table and, therefore, dewatering is not required. In addition, due to the high hydraulic conductivity of the ore and surrounds, very little rainfall runoff can be recovered directly from the Mine Pit.

Raw water at the site is brackish (3,000 – 7,000 mg/L total dissolved solids [**TDS**]) and is suitable for ore processing, dust suppression and equipment wash-down. The small RO desalination plant is available to provide potable water for rinsing of the final garnet products and for potable use.

The annual Premises water demand is up to 2.1 GL/yr, with the following major water use categories:

- Ore processing – 2,810,000 kL
- Dust suppression – 300,000 kL
- Feed water to the RO plant –290,000 kL.

The RO plant is expected to produce approximately 203,200 kL/yr of potable water and 86,400 kL/yr of brine. The brine will be combined with elute from product rinsing and discharged to the Process Water Pond for reuse in the process.

Approximately 1,300,000 kL/yr of process water is expected to be lost through seepage from and entrainment in tailings, with a further 1,200,000 kL/yr lost through evaporation and 300,000 kL/yr used for dust suppression. Given the very low fines content of the sand deposits, it is likely that seepage from tailings will drain through the base of the Mine Pit to the underlying groundwater table.

To supplement the mine water demand, production bores have been located close to the sand tailings facilities to intercept/recover a portion of the tailings water lost as seepage. Equipment is available to decant supernatant water from the top surface for return either to the Process Water Pond or the Turkey Nest for reuse.

Water distribution network

Water abstracted from the aquifer via production bores is transferred to the Process Water Pond and process water tank (located near the process plant), from where it will be distributed to processing facilities and associated activities.

Process Water Pond

Process water for operations is provided from production bores and includes recovered site water and stormwater where practicable. The Process Water Pond is an above-ground, four-sided dam constructed using material won from the base of the dam and overburden. The Process Water Pond holds raw water from the borefield, tails sand cyclone overflow, thickener overflow, RO brine, and return water from the Solar Drying Pond and Sand Tailings Storage Area. The pond is fenced to prevent fauna access and is lined with HDPE (1.5 mm thick) to increase water retention and reduce seepage.

Overflow Pond

An Overflow Pond has been constructed in the CPA near the Process Water Pond to provide additional capacity for process water. However, the pond has been decommissioned as there is no current requirement for additional process water storage. The pond will remain in case it is needed for future process water storage. The pond will not be used for the storage of tailings.

Turkey Nest

A turkey nest has been constructed to the south of the dry tails stockpile and east of the Mine Pit to provide water for dust suppression activities. The Turkey Nest is fed by ground water from Bores PB1 and PB9 and has a capacity of 5,994 kL with 500 mm freeboard. It has been constructed with a 1.5 mm thick HDPE liner and has the dimensions 17.7 m x 10 m x 7 m (at base).

Stormwater Management

Due to the high infiltration rates associated with the sand and sandy loam soils present at the Premises (12-13 mm/hr), only events of 1-hour duration for all ARI events and a 6-hour 1:100 year ARI event are likely to exceed the estimated infiltration rates and generate surface water runoff.

All potential drainage lines are directed away from infrastructure and mining areas. Surface water runoff from concrete plant areas and buildings is collected via sumps and returned to the Process Water Pond.

Support Facilities

Support facilities include the site administration building, workshops, crib rooms, laboratory, stores and first aid and training buildings.

Workshop

Three workshops are located on the Premises, including a heavy vehicle workshop, fixed plant workshop and MUP workshop. The heavy vehicle workshop and fixed plant workshop are in the CPA. The MUP workshop is located adjacent to the Mine Pit.

The heavy vehicle workshop comprises a covered work area capable of housing the largest mining equipment on-site, storage buildings, oil storage facility, wash down bay and office/toilet block. The oil storage facility is appropriately bunded storage for new and used oils. Adjacent to this is a dedicated wash down bay with oily water treatment. Bore water is used for the wash down of equipment.

The MUP workshop comprises storage areas, covered work area and crib room/toilet block. The facility is relatively small and designed to be relocated as the mine progresses.

The fixed plant workshop and store building is a 50 m x 20 m shed with access doors and partitions internally. The workshop is for electrical and mechanical repairs to fixed plant and equipment on-site. Within the same building is the warehouse facility, which is used for storage of spare parts and consumables.

A concrete washdown bay is provided in the CPA for cleaning of equipment and vehicles. The washdown bay includes a concrete pad, sump and oily water separation pit. Sediment and oily water will be periodically removed from the sump and pit and removed off-site for disposal.

Fuel Storage Facilities

Two self-bunded 100 kL diesel storage tanks are stationed at the CPA with an additional 100 kL storage at the Mining Workshop adjacent to the Booster Pumps. Diesel fuel storage is required to fuel mining vehicles and diesel gensets.

Diesel is delivered by road trains in lots of 64,000 L due to the constraint of the Premises only being able to handle double carriage road trains. Fuel deliveries are made approximately three times per week.

At peak mining activity, the Premises is expected to use 25,000 L of fuel per day. Fuel dispensing to supply the mining fleet and light vehicles is via packaged refuelling stations (e.g., Transtank T105 units).

All other fuel and lubricants on site are stored in bunded storage and dispensed from a dedicated bunded storage areas. Fuel, oil and lubricant usage is tracked and recorded.

Power

Power is produced on-site from diesel powered generators and from the adjacent wind farm, and distributed at 415 volts.

The CPA uses three Cummins powered C1250D2RCC (1250 kVA) generators directly feeding a transportable switchroom and motor control centre. Power generation is also supplemented by 7 x 600 kW wind turbines installed in an area adjacent to the Premises to the west of the CPA. Depending on the power contribution from the wind turbines, up to two generators are online at any given time with diesel supplied from the CPA diesel fuel storage facility, which pumps from the two 100 kL self-bunded diesel storage tanks to the generators.

There are three fully mobile wheel mounted Volvo TAD1642GE-B Genpac (500 kVA) generators at the MUP directly feeding a fully mobile wheel mounted switchroom and motor control centre. One generator is online at any given time. Diesel is supplied from a self-bunded mobile diesel fuel storage tank.

Reverse Osmosis Plant

The Premises includes a brackish water RO plant capable of producing 440 kL of treated water per day from water abstracted from the Tumbalgooda Sandstone aquifer. The unit is fully contained within one 40-foot container. Approximately 95% of the RO water is used in the MSP to wash product and 5% is used for drinking water and is stored and sterilised separately to the process wash water.

The RO plant produces approximately 140 KL of brine per day, which is recycled into the process water circuit. Chlorine and pH adjusting solution is added to the potable water tank via a recirculating stream. The brine is combined with elute from product rinsing and discharged to the Process Water Pond for reuse.

Wastewater Treatment Plant

A modern, Department of Health (DoH) compliant ablutions sewage system is used to cater for the requirements of the on-site workforce of 30 persons. The Premises has DoH approval for a CE6000 Tristar Water WWTP that can process 6,000 L/day (6 m^3/day). Treated effluent is pumped to a spray field for discharge.

Laydown and Hardstand Area

Project laydowns and hardstand areas are used for waste storage in addition to equipment and machinery storage areas. Waste management is undertaken by licenced local service providers and contractors. Waste containment is appropriate to the waste stream, with waste receptacles covered where required to control windblown litter and fauna access.

Borefield

Project water supply is via groundwater infrastructure located within Tenements M70/1280, M70/1387 and in Miscellaneous Licences L70/166, L70/167, L70/168 and L70/170. Groundwater is effectively abstracted from two borefields, each targeting a different aquifer as licensed under Groundwater Licence (**GWL**) 170860.

The bulk of the water supply is from the Superficial Aquifer, which provides process water from Production Bores PB1-PB9 (refer to **Error! Reference source not found.**). The Superficial Aquifer is located below the Mine Pit and underlies the Premises. The Tumblagooda Sandstone Aquifer lies below the Superficial Aquifer, and the bores are located east of the mining activities. This source provides a fresh water supply for rinsing and processing to potable water from Production Bores TPB1, TPB2 and TPB3 (**Error! Reference source not found.**).

The production borefields from the Superficial Aquifer discharge to the Process Water Pond and process water tank from where the water is reticulated around the Premises. Fire services pumps are located at the Process Water Pond with a diesel backup system.

Closure

A schematic view of the proposed restoration of the Mine Pit is shown in Figure 2.

Progressive rehabilitation will commence in disturbed and no longer required areas via backfilling of the Mine Pit. Backfill is anticipated to commence in Quarter 3, 2024.

The void will be backfilled with tailings direct from the mine face and CPA, consisting of dried sand tailings and slimes. The rehabilitation will require the sand tailings and slimes to be blended to a depth and level of homogeneity that will recreate a soil profile that, together with the topsoil layer, will support productive pastures and not constrain potential future land uses.

The rehabilitation, which is integrated to the mining process, involves the following processes and is shown in Figure 4:

- Sand tails are backfilled (i.e. 'stacked') into the pits to a depth approximately 1 m below the pre-mining surface contour, with blended tailings constructed on top.
- The blending of available overburden, slimes and sand tails will be conducted using heavy earthmoving equipment and will be to a target depth of 750 mm, with a minimum criteria of 500 mm.
- With the subsequent replacement of the topsoil layer, a final depth of 750 mm to 1100 mm of growth zone will be established, which is within the range of the natural soil profile characteristics of the area.

- Blending will be sufficient to result in an average clay content and distribution, soil strength (penetrability) and bulk density that is within final criteria.

FIGURE 4: POST-MINING SOIL PROFILE

Closure of processing and infrastructure areas will include demolition and decommissioning of plant and equipment and return of stockpiled topsoil.

The Applicant will establish rehabilitation trials and monitoring sites to determine the likely performance of post-closure rehabilitation. This will also ensure the testing of the success of different treatments such as depth of growth medium, ratio of sand to clay mixtures, seed mixes and target vegetation species to establish a substantial history of rehabilitation monitoring ahead of closure and support relinquishment at the earliest reasonable time.

The general objective of the rehabilitation is to return all disturbed areas to a self-sustaining condition that can support the designated post mining land uses. Harsh climatic conditions coupled with grazing pressure makes achieving high levels of vegetation cover and biodiversity difficult to sustain over short timeframes. Rehabilitation strategies are, therefore, focused on designs that facilitate the revegetation of disturbed areas over time.