

7. Water Resources

7.1 Introduction

The Terms of Reference for the preparation of an EIS (NT EPA 2014) identified the following key risks to ground and surface water resources:

- ▶ potential for Acidic and/or Metalliferous Drainage (AMD) from the waste rock dump, tailings storage facility and other mine infrastructure, to contaminate shared water resources;
- ▶ surface water quality may be impacted by spills to surface water and runoff containing hazardous substances or elevated sediment concentrations;
- ▶ contamination of groundwater could occur through leaks from storages or pipelines and spills during handling of contaminants, chemicals and toxicants; and
- ▶ practically available water sources will not be sufficient to supply the needs of the proposed Project configuration, or will not be sufficient without causing environmental or social impacts.

The environmental objectives pertaining to water resource protection (NT EPA 2014) are:

- ▶ demonstrate that available water supplies will be sufficient to fulfil the Project needs over the predicted life-of-mine, without causing environmental or social impacts;
- ▶ demonstrate that Project configuration will optimise reduction of net water use for the Project and minimise contamination of water resources; and
- ▶ ensure that surface water and groundwater resources and quality are protected both now and in the future, such that ecological health and land uses, and the health, welfare and amenity of people are maintained.

The full Groundwater and Surface Water Assessment Report is provided in Appendix F.

7.2 Mine Site Water Balance

A water balance model was developed to determine the capacities of the various infrastructure components comprising the water supply system. The water balance also informed the sizing of the proposed borefield. The water balance model was developed for two proposed operation stages:

- ▶ Stage 1: processing up to 3 Mtpa of ore (years 1 - 4); and
- ▶ Stage 2: processing up to 6 Mtpa of ore (years 5 - 15).

7.2.1 Key Water Balance Components

The key water balance components associated with the Project are shown in Figure 7-1.

The two main water outflows from the processing plant are associated with the concentrate and tailings. An allowance has also been made for losses within the plant and a contingency for the makeup requirements. An inflow of treated water has been allowed for the pump glands and the balance, after allowing for water entrained in the ore, is made up with water from the process water dam.

Water associated with the underflow from the processing plant via the tailings thickener will be disposed to the tailings storage facility (TSF). Outflows from the TSF comprise water recovered to the process water dam and losses due to seepage and evaporation.



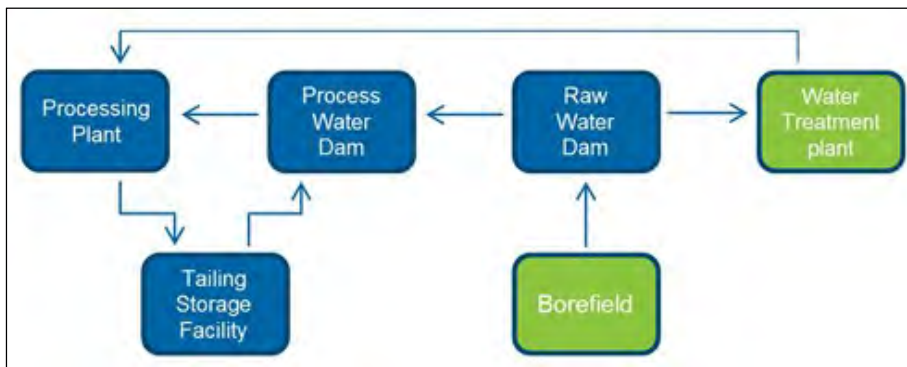


Figure 7-1 Key water balance components

The primary function of the process water dam is to supply makeup water to the processing plant and to receive water recovered from the TSF and brine effluent from the water treatment plant. The only other outflow from the dam is evaporation. Inflows to the dam are water recovered from the TSF and the balancing item of makeup water from the raw water dam.

Outflows from the raw water dam are the makeup water supplied to the process water dam and water supply to the water treatment plant, water abstracted for dust suppression purposes and evaporation losses. The balancing item is the raw water inflow supplied from the borefield.

7.2.2 Water Balance Summary

In summary, raw water requirements for the two operational stages have been estimated at 178 m³/h (1.6 GLpa) for Stage 1 and 300 m³/h (2.6 GLpa) for Stage 2. GHD (2015a) provides a more detailed explanation of this water balance assessment and assumptions. Figure 2-15 provides a detailed water balance for Stage 2. The above water requirements were used to determine the capacities of the infrastructure components comprising the water supply and storage system, including the sizing of the proposed borefield.

7.2.3 Water Supply and Storage

Potable water will be trucked to site during the early stages of construction until supply is established from the borefield and a water treatment plant is constructed. A number of water bores will be established adjacent to the proposed access road to provide road construction water. A permanent construction water supply will be provided through the partial establishment of the main borefield early in the construction program.

The key components of the water supply system for the operational stages of the Project are outlined in Table 7-1 and presented in Figure 7-2.

Based on the results of the groundwater drilling program it was determined that the Hanson River palaeovalley had the capacity to provide Project water supply (GHD 2015a). The borefield will be located along the western bank of the Hanson River (Figure 7-2) and will eventually include up to 10 production and two standby bores to meet Project demand. The borefield will be developed in two stages as summarised in Table 7-2.

Table 7-1 Key water supply system components

| Water supply system component | Stage 1 | Stage 2 |
|--|-----------------------|-----------------------|
| Borefield | 8 x 8.5 L/s bores | 12 x 8.5 L/s bores |
| Raw water transfer pipeline | 40.8 km | 48.8 km |
| Raw water dam | 12.3 ML | 20.7 ML |
| Process water dam | 3.6 | 7.2 ML |
| Water treatment plant | 370 m ³ /d | 650 m ³ /d |
| Potable water tanks at processing plant | 0.5 ML | 1.0 ML |
| Potable water tanks at accommodation village | 0.3 ML | |
| Potable water supply pipeline | 10 km | |

Table 7-2 Summary of proposed borefield

| Item | Stage 1 | Stage 2 | Comment |
|--|-------------------------------|-------------------------------|---|
| Overall water demand | 1.6 GLpa (51 L per second) | 2.6 GLpa (82 L per second) | Total water demand based on water balance. |
| Minimum number of active production bores required | 6 | 10 | Two bores from Stage 2 to augment supply during any reduction in supply from Stage 1 bores (maintenance/failure). |
| Proposed standby bores | 2 | 2 | |
| Proposed spacing of bores | 1800 m | | Aligned on track parallel to river channel. |
| Proposed continuous pumping rate | 8.5 L/s | | Based on pumping and modelling data. |

In addition to the production bores, development of a groundwater monitoring network will occur. This is discussed further in Section 7.4.4.

Approximately 49 km of water supply pipeline will be constructed between the borefield and the raw water dam predominantly along existing tracks. The pipeline will have a diameter of up to 450 mm. Rather than construct a supply pipeline to the Adnera Loadout Facility it is proposed that water will be trucked from the mine site.

The sizing of the raw and process water dams has been based on the requirements for both emergency storage and for buffering of the daily consumptive fluctuations. The dams will most likely be constructed in two stages, in line with production requirements (Table 7-1). Based on modelled water demand, the raw water dam will have a storage capacity of approximately 21 ML with a footprint of 1.5 ha. This water capacity should be sufficient for three days supply. The dam will be constructed adjacent to the process plant to manage project water supply. A 0.9 ha process water dam will also be constructed adjacent to the process plant to provide process water and to receive recovered water from the plant and TSF. Total storage will be around 7 ML, sufficient for two days supply.



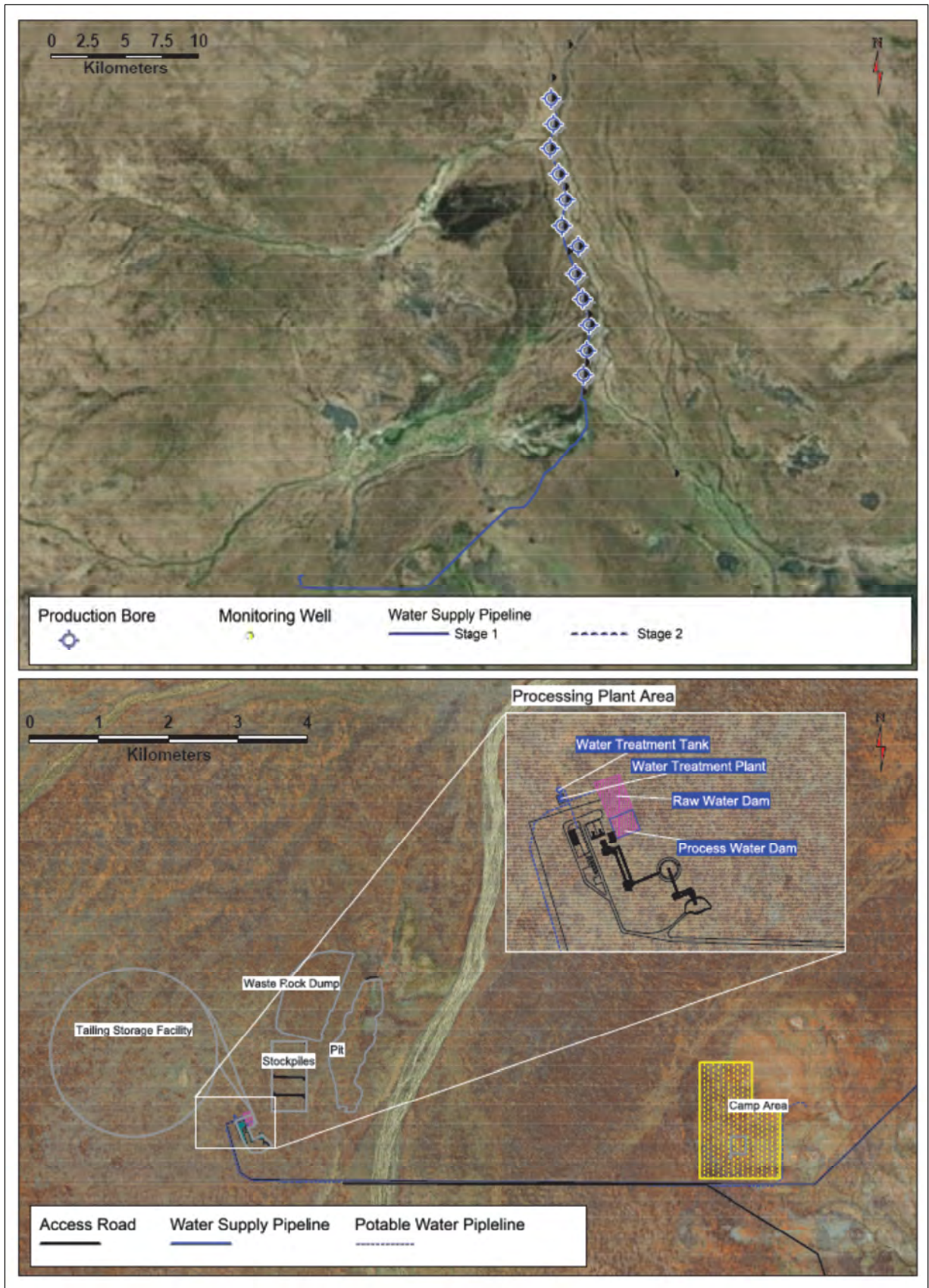


Figure 7-2 Water supply system conceptual plan

Water treatment is required to provide water that is suitable for human consumption, amenity irrigation and the slurry pump glands. Water from the raw water dam will be treated to bring it up to potable water standard. To meet expected demand, the water treatment plant (WTP) will be able to produce 370 m³/d initially, increasing to a capacity of 650 m³/d in Stage 2. Water treatment will comprise:

- ▶ filtration using multi-media filters (MMF);
- ▶ desalination using brackish water reverse osmosis (BWRO);
- ▶ disinfection using sodium hypochlorite or similar; and
- ▶ discharge of the brine reject to the process water dam.

Potable water tanks are proposed at both the processing plant and the accommodation village. Both tanks have been sized to provide emergency storage capacity and to buffer the daily fluctuations in consumption. The ultimate potable water tank requirements at the processing plant will be 1.0 ML, whereas at the accommodation village a 0.3 ML tank will be required. Based on the proposed locations of the WTP and the potable water tank at the accommodation village, a 10 km pipeline will be constructed to transport this water.

7.3 Surface Water

7.3.1 Existing Surface Water Environment

The Project is at the southern extent of the Australian monsoon belt and in the centre of the Australian continent. The climate is arid to semi-arid with an annual rainfall of approximately 320 mm recorded at the Bureau of Meteorology (BoM) Station 15525 at Barrow Creek, which is located approximately 50 km east of the Project site. Annual rainfall is highly variable, with records at Barrow Creek ranging from 70 mm in 1963 to 1,150 mm in 2010. Rainfall is highly seasonal with the majority of rainfall occurring as thunderstorms between November and March. Monthly rainfall statistics at this station are shown in Figure 7-3. Monthly temperature statistics for the same weather station are presented in Figure 7-4. The mean monthly maximum temperature ranges from about 22°C to 37°C, with the mean monthly minimum temperature ranges from 8°C to 24°C. Average annual evaporation for Barrow Creek weather station totals approximately 2,980 mm with average monthly evaporation exceeding rainfall in all months.

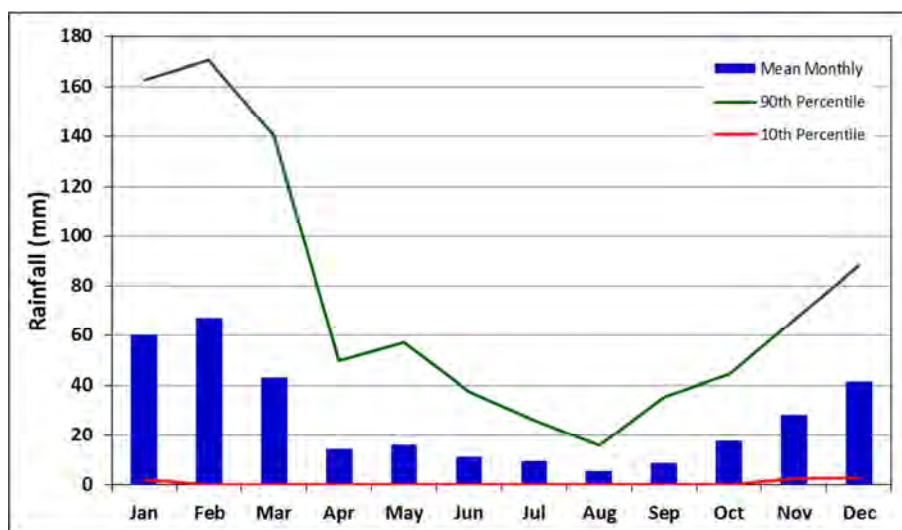


Figure 7-3 Monthly rainfall statistics at Station 15525 (Barrow Creek)

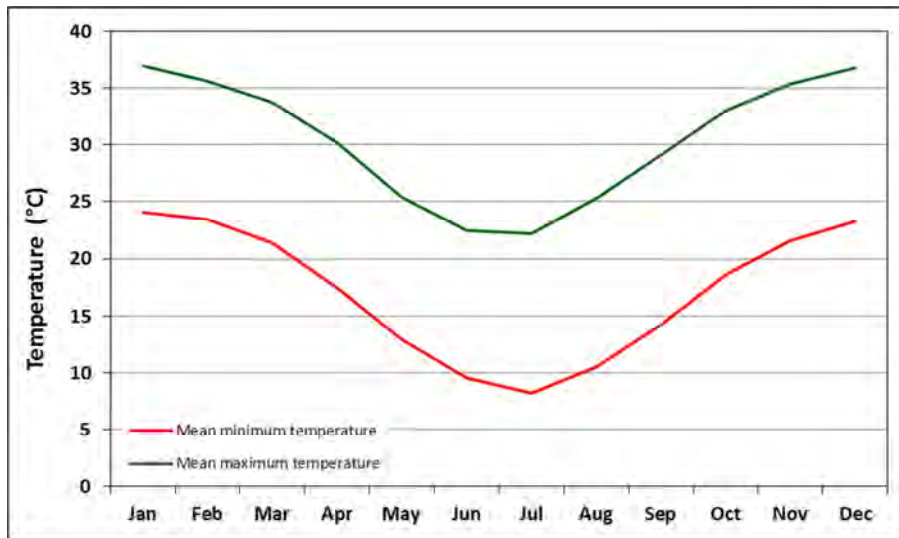


Figure 7-4 Monthly temperature statistics at Station 15525 (Barrow Creek)

The Project is located in the Wiso Basin and overlies the Arunta Province in the Burt Plain Bioregion. The Bioregion covers an area of some 73,600 km² with elevation ranging from 300 to 1,252 m above sea level. The Bioregion is dominated by undulating stepped plains, consisting generally of red soils, with earthy sands and red siliceous sands also occurring extensively across the plain (Neave *et al.* 2006).

Mapping of surface geology by the Department of Natural Resources, Environment, the Arts and Sport (NRETAS 2009, 2009a) identifies predominantly alluvial floodplains in the Project area (Table 7-3).

Table 7-3 Surface geology across the Project area

| Location | Water Course/Feature | Surface Geology |
|---|---|---|
| Headwaters of water courses upstream of the proposed mine site | Anningie Creek Murray Creek Bloodwood Creek | Granite plains and rises |
| Incremental catchments of watercourses downstream of the proposed mine site | Mud Hut Swamp | Alluvial plain Desert sandplain Granite plains and rises Sandstone hills |
| | Murray Creek Hanson River | Alluvial plain Desert sandplain |
| Watercourses intersecting and/or downstream of the proposed access road | Stirling Swamp | Salt pans |
| | Hanson River | Alluvial floodplain Desert sandplain |

The Project is located within the Wiso Surface Water Management Basin (Figure 7-5), which comprises numerous ephemeral dendritic drainage systems across the region. Watercourses generally flow north, with a number of smaller watercourses originating out of rocky outcrops into the surrounding plains. Key water courses near the Project site are Murray Creek and Bloodwood Creek. These are tributaries of the Hanson River, the main watercourse draining the western part of the Ti-Tree Basin.



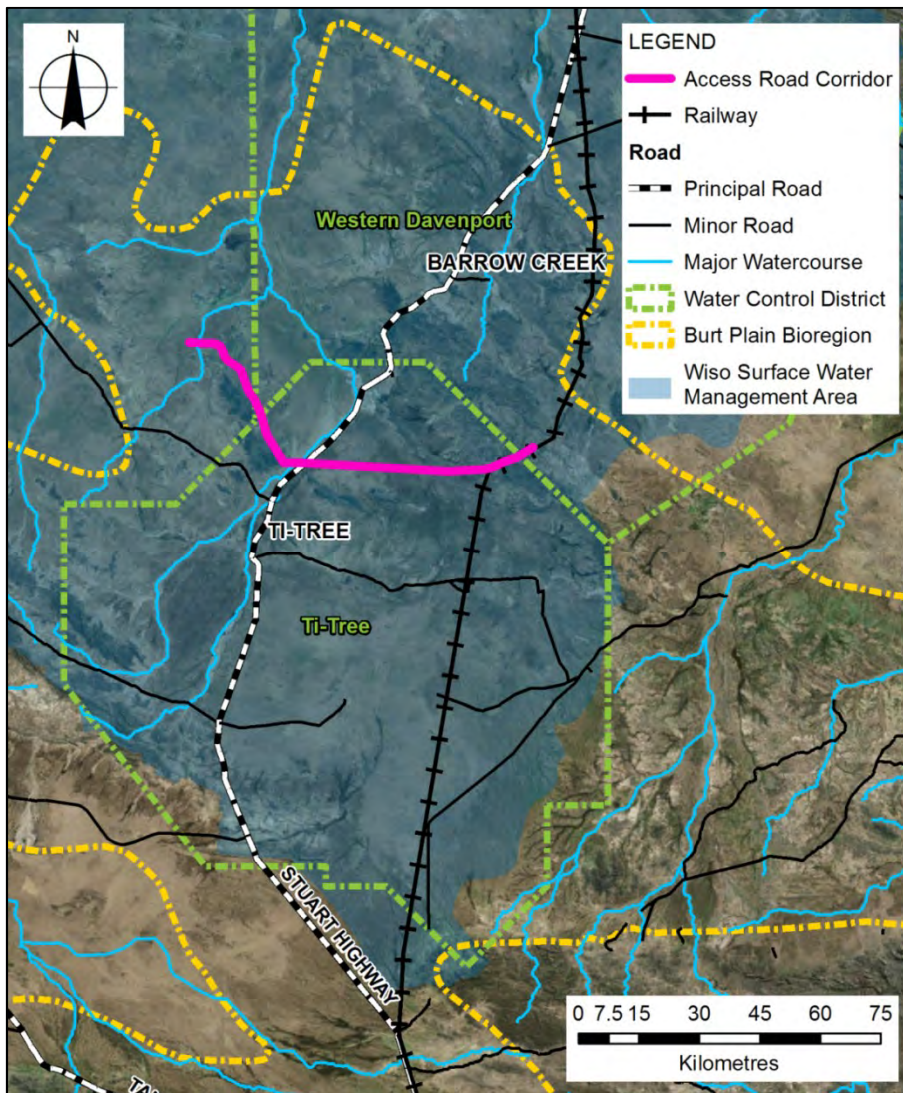


Figure 7-5 Water Management Area and Control Districts

The alluvial floodplains that separate the channels are referred to as floodouts (Duguid *et al.* 2005). Several of the water courses are considered to be joined, with shared floodouts in large flood events. Runoff is ephemeral and likely to be rapid in the foothills but slowing substantially on the plain.

Mud Hut Swamp, located in the floodout area of the Bloodwood Creek, and Stirling Swamp (Anmatyerr North Site), an interim floodout area for the Hanson River, are both listed as Sites of Conservation Significance (NRETAS 2009, 2009a). The channel of the Hanson River becomes ill defined, or braided, in the vicinity of Stirling Swamp, before becoming more defined again downstream.

The Hanson River rises in the Reynolds Range (also referred to as the Anmatijira Range) to the south west of the Project site, and flows north flooding out into the Tanami Desert, west of Tennant Creek.

This floodout area is an important source for groundwater recharge (Duguid *et al.* 2005). The Australian Natural Resources Atlas (ANRA) indicates the Hanson River flows once in every 12 years on average (ANRA 2013) whereas the Department of Infrastructure, Planning and Environment found that regional rivers in the Ti Tree Groundwater Basin are only likely to flow when monthly rainfall exceeds 100 mm, with this threshold being achieved approximately once every two years on average (DIPE 2002).

Surface water in the Wiso Basin is used primarily for stock watering and domestic supply to rural communities, but is not licenced (DIPE 2002).

Drainage from the Reynolds Range tends to transition from annular water courses generally controlled by geology, to highly distributed channels associated with the formation of an extensive alluvial fan known as the Burt Plain. Significant groundwater recharge is likely in the vicinity of this fan.

Water courses near the Project site are sandy and highly braided along reaches. These drainage channels rise in upland areas where surface runoff feeds into clearly defined channels. Surface water flow within the Project area is likely to spread laterally from channels across the extensive floodplain environment as low energy sheetflow. Sediment transport is dependent on the magnitude of the event, with larger events responsible for sediment transport and channel formation. Active processes observed in the Project area included bank erosion and sediment transport in the alluvial creek beds. Disturbed sites are also likely to result in soil erosion and sediment transport. Localised erosion with the potential to alter surface water flow pathways were observed in the vicinity of Mud Hut Swamp (GHD 2015a).

Given the alluvial nature of the Burt Plain, the presence of ephemeral surface water drainage systems with floodout zones and palaeodrainage channels, there is potential for significant surface water - groundwater interactions within the vicinity of the creeks and rivers.

The Hanson River is considered to contribute significant recharge to the Ti Tree Basin aquifer when floodouts are activated (Knapton 2006). Furthermore anecdotal information acquired from sites in the headwaters of the Woodforde River indicates there is surface water - groundwater interaction within the alluvial formations associated with the drainage networks that may form the main recharge mechanism for local aquifer systems in the region (G. Ride, pers. comm. 2011).

The Hanson River flows across the western and northern zones of the Ti Tree Water Control District Boundary. A regional water balance for the study area identifies a contribution of 760 ML from Hanson River flood recharge to the Ti Tree Basin (Knapton 2006).

Groundwater flows in the Ti Tree Basin are from east to west and south to north, with the water table becoming shallower in the northern extent (Knapton 2007). Stirling Swamp is identified as a natural discharge zone for the basin. Knapton (2007) indicates that groundwater dependent ecosystems occur within the basin with vegetation able to access water in areas where the water table occurs within 10 m of the ground surface.

The proposed access road will traverse the Ti Tree Water Control District Boundary in the vicinity of the Hanson River floodout.

Sites of Conservation Significance

There are three surface water sites which have conservation significance in proximity to the Project, namely Mud Hut Swamp, Anmatyerr North and Wood Duck Swamp (Figure 8-1).

Mud Hut Swamp has been identified by NRETAS as a Site of Conservation Significance and is listed in the “*Inventory of sites of international and national significance for biodiversity values in the Northern Territory*”. Mud Hut Swamp is a large, isolated, gum-barked coolabah (*Eucalyptus vitrix*) swamp fed by Bloodwood and Murray Creeks in the south-east and runoff from low hills and rises to the north and west (NRETAS 2009). This is the largest swamp in the Burt Plains bioregion and remains inundated for a relatively long time after flooding, possibly retaining water for several months following inundation. It is likely to support a range of wetland birds, fish and plants. Any interruption or alteration of surface water drainage in the vicinity of the Project area has the potential to adversely affect the downstream ecosystem, including Mud Hut Swamp.



The Anmatyerr North site is located across Stirling, Anningie and Ahakeye Stations. This site includes Stirling Swamp, a large wetland complex comprised of claypans, lignum swamp, semi-saline samphire and temporary open water, and the adjacent Hanson River (NRETAS 2009a). The site extends to low rocky ranges about 20 km south of Stirling Swamp to encompass the known extent of the threatened giant sweet potato (*Ipomoea polpha* subsp. *latzii*). Stirling Swamp is noted to form occasionally at the northern edge of the Ti Tree Basin, storing flood waters discharged from the Hanson River and the ridges to the east of Wilora. This area is believed to act as an evaporation area for the basin.

Wood Duck Swamp is an ephemeral swamp that may hold water for many months in an otherwise dry landscape. It fills periodically after heavy rain. Wood Duck Swamp is dominated by smooth-barked coolabah *Eucalyptus victrix*. It is one of the largest such swamps in the Burt Plains bioregion (NRETAS 2009b). Wood Duck Swamp is entirely pastoral leasehold land within one pastoral lease (Mount Skinner). The main land use within the site and broader catchment is cattle grazing on native pastures. Wood Duck Swamp is located approximately 10 km south of the access road, outside of the Project area.

Water quality (based on sediment analysis)

Sediment sampling was undertaken to characterise sediment quality as a proxy for water quality for the preliminary assessment of ambient conditions at Mount Peake. The accumulation of elements in sediments provides an indicator of baseline sediment quality. This approach was adopted for the following reasons:

- ▶ surface water sampling is only possible during streamflow events. These are rare in the ephemeral systems on the site, with there being the potential for several years occurring between events. There were no opportunities for water quality sampling during the investigation;
- ▶ a water sample may not be representative of streamflow quality. Water quality can vary depending on the nature, timing and location of the runoff from the upstream catchment. Grab samples during an event may miss the progression/change in water quality. Continuous monitoring/sampling may reduce this risk, but would be excessively expensive; and
- ▶ potentially contaminating material is normally associated with sediments following subsidence of flow. This is released from natural sediment traps and trapped again further downstream following successive streamflow events.

This approach is consistent with that adopted by the NT EPA for Waste Discharge Licences for mining activities where ongoing monitoring comprises a combination of sediment and surface water sampling.

Prior to mining commencing water and sediment samples will be collected to establish baseline conditions.

Sediment sampling locations were selected based on the mine plan, access road and environmental site characteristics. Locations were selected that are unlikely to be disturbed by mining activities and the monitoring points would remain active throughout the life of the mine. The sediment sampling locations are presented in Figure 7-6.

Sampling of river bed sediments was based on the Australian Standard - Guide to the investigation and sampling of sites with potentially contaminated soil (AS 4482.1-2005). In the absence of sufficient sediment quality data to determine background sediment concentrations, the ANZECC Sediment quality guidelines were referenced for comparative purposes.



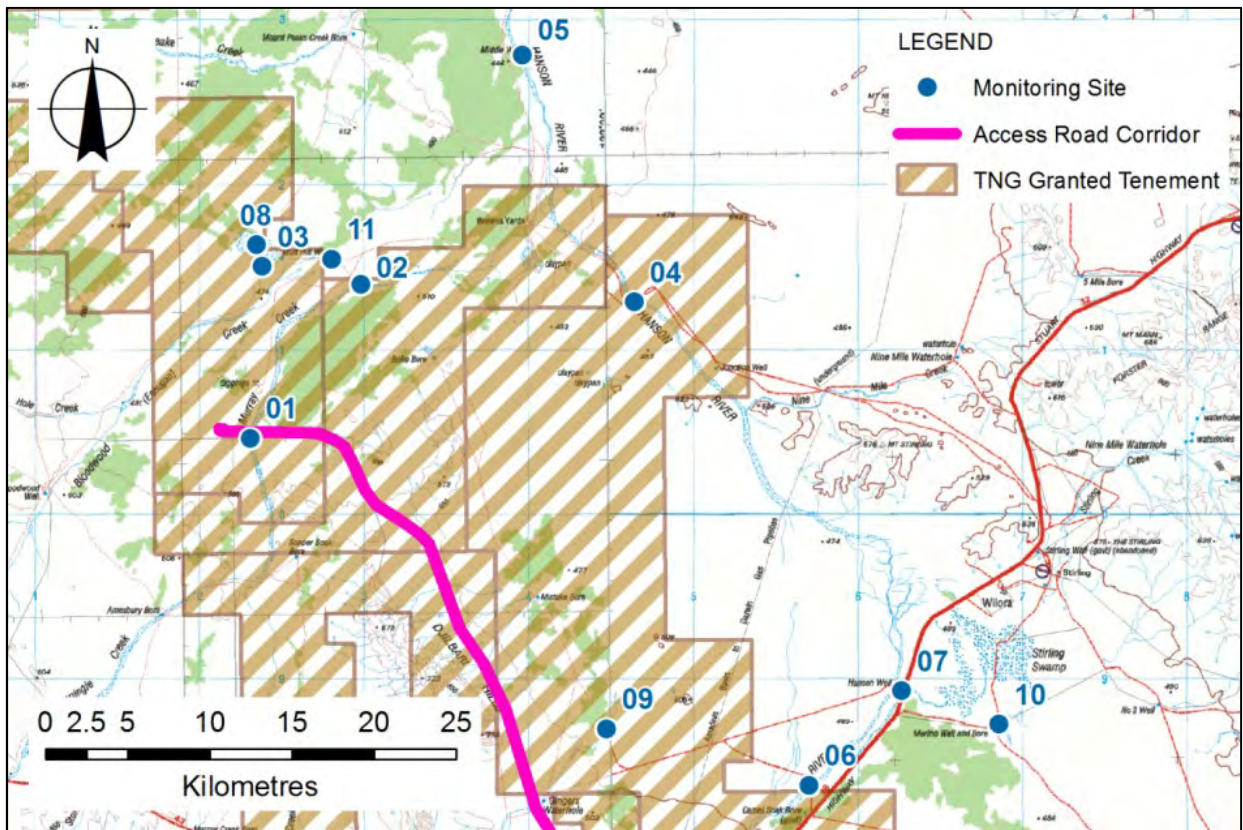


Figure 7-6 Sediment monitoring locations

Samples revealed that particle size distribution ranges from ‘sand and gravel’ to ‘fines and sand’. Sediment pH ranges from neutral to very strongly acid and sediment electrical conductivity was observed to be very low. Whilst metals were detected at concentrations above the Limit of Reporting (LOR) in the fluvial samples, none of the sediment samples exceeded the respective ANZECC sediment guideline for metals. The metals concentrations were within the observed range of background levels reported for Australian soils (Hazelton and Murphy 2007). Concentrations of metal parameters were consistently reported highest at monitoring location 10 (Figure 7-6), corresponding to the site with highest proportion of sediment fines. Consistent with metals detected, Site 10 also reported the highest soil total nutrient (nitrogen and phosphorus) concentrations, filterable reactive phosphorus concentration and EC value. No total recoverable hydrocarbon analytes exceeded their respective LOR.

7.3.2 Hydrological Impact Assessment

GHD (2015a) completed a hydrological assessment to:

- ▶ understand the hydrological regimes of the Hanson River, Murray Creek and Wood Duck Creek to predict the frequency and duration of flooding of the proposed access road;
- ▶ evaluate the potential risks associated with Murray Creek inundating the mine site; and
- ▶ investigate the potential sheetflow shadows resulting from the construction of the access road.

This section focuses primarily on the results of this assessment, with a detailed description of the assessment method and assumptions provided in GHD (2015a).

Predicted river and creek impacts on the access road

An assessment of the hydraulics of the access road floodways was undertaken using the Australian Rainfall and Runoff (ARR) guideline (Institute of Engineers Australia 1987). The location of the road crossings in relation to the above mentioned watercourse are depicted in Figure 7-7. The elevation datasets provided are coarse so the relatively simple Rational Method hydraulic modelling approach was adopted to determine flood peaks. This entailed the determination of runoff coefficients for application in the Rational Method, followed by the estimation of peak discharges by parameter transfer from similar gauged streamflow sites. Streamflow data were sourced from the NT DLRM Water Data Portal (<http://irm.nt.gov.au/water/water-data-portal>) to inform this assessment.

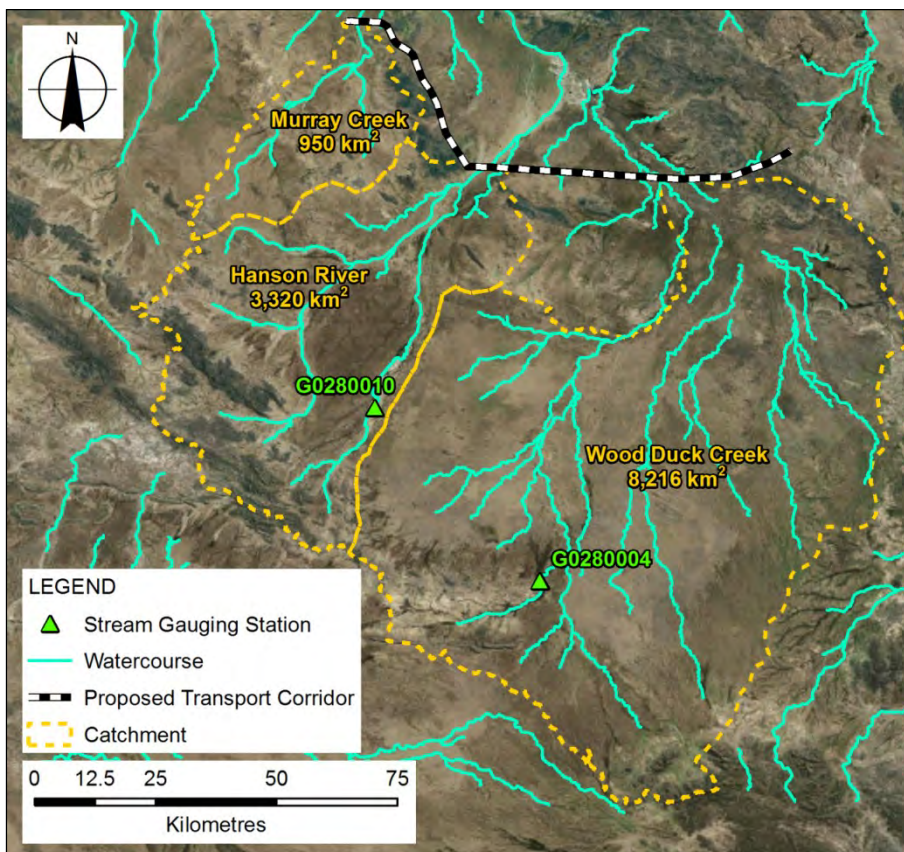


Figure 7-7 Location of road crossings and catchment extents

Peak discharges were estimated at the access road floodways across Murray Creek, Hanson River and Wood Duck Creek. The hydrological characteristics that describe these catchments are summarised in Table 7-4. The peak discharges from these catchments are tabulated in Table 7-5 for varying Average Recurrence Intervals (ARI) (ARI is the average or expected period between exceedances of a given discharge value). Floodway flow depths were estimated using Manning's equation based on the peak discharge estimates. An assessment of flow duration was undertaken for a range of storm events with duration between 24 and 72 hours. The flow-duration hydrographs were then converted to depth-duration hydrographs to determine the amount of time that water levels at the proposed crossings exceed a given threshold value, in this case assuming a flow depth of less than 0.2 m would be trafficable. The resulting flow depths and durations are summarised in Table 7-6.

Table 7-4 Hydrological characteristics of target catchments

| Target catchment | Catchment area (km ²) | Longest flow path | | Time of concentration (hours) |
|------------------|-----------------------------------|-------------------|-------|-------------------------------|
| | | Length (km) | Slope | |
| Murray Creek | 950 | 53 | 1.24% | 24.7 |
| Hanson River | 3,320 | 100 | 2.38% | 57.3 |
| Wood Duck Creek | 8,216 | 141 | 0.81% | 91.4 |

Table 7-5 Estimated peak discharges at target catchments

| Target catchment | Peak discharge (m ³ /s) by ARI | | |
|------------------|---|---------|---------|
| | 10-year | 20-year | 50-year |
| Murray Creek | 44 | 148 | 247 |
| Hanson River | 173 | 309 | 562 |
| Wood Duck Creek | 281 | 502 | 916 |

Table 7-6 Peak flow depths and flow duration

| Target catchment | Peak flow depths (m) by ARI | | |
|------------------|-----------------------------|---------|---------|
| | 10-year | 20-year | 50-year |
| Murray Creek | 0.42 | 0.76 | 0.99 |
| Hanson River | 1.44 | 1.81 | 2.15 |
| Wood Duck Creek | 0.37 | 0.51 | 0.71 |

| Target catchment | Flow duration (hours) by ARI | | |
|------------------|------------------------------|---------|---------|
| | 10-year | 20-year | 50-year |
| Murray Creek | 25-27 | 35-51 | 43-86 |
| Hanson River | 81-129 | 81-129 | 91-129 |
| Wood Duck Creek | 93-104 | 98-117 | 107-148 |

The drainage lines of Murray Creek and the Hanson River are reasonably well defined and relatively narrow (~300 m and ~400 m respectively) and properly constructed floodway type crossings will be installed. Such crossings would not be expected to interrupt natural streamflow and geomorphological processes, but would require ongoing maintenance to ensure accessibility.

There is no evidence of a single specific drainage line associated with Wood Duck Creek and surface flows in this vicinity are likely to present as sheet flow. Given the relatively long length of the crossing (~1,800 m) and the likely long duration of standing water, TNG intends to install regularly spaced culverts along this section of road.

The potential risk of Murray Creek inundating the mine site

A mine site flood risk assessment was undertaken using the HEC-RAS one dimensional hydraulic model. The resulting flooding extents along Murray Creek in the vicinity of the mine site indicate the mine site is not expected to experience any significant flooding for events up to the 50-year ARI. However, it is noted that there is a bench of lower lying topography in the vicinity of the proposed mine pit that may be prone to flooding during more extreme events (Figure 7-8). Detailed design will determine the need for flood protection for the mine pit.



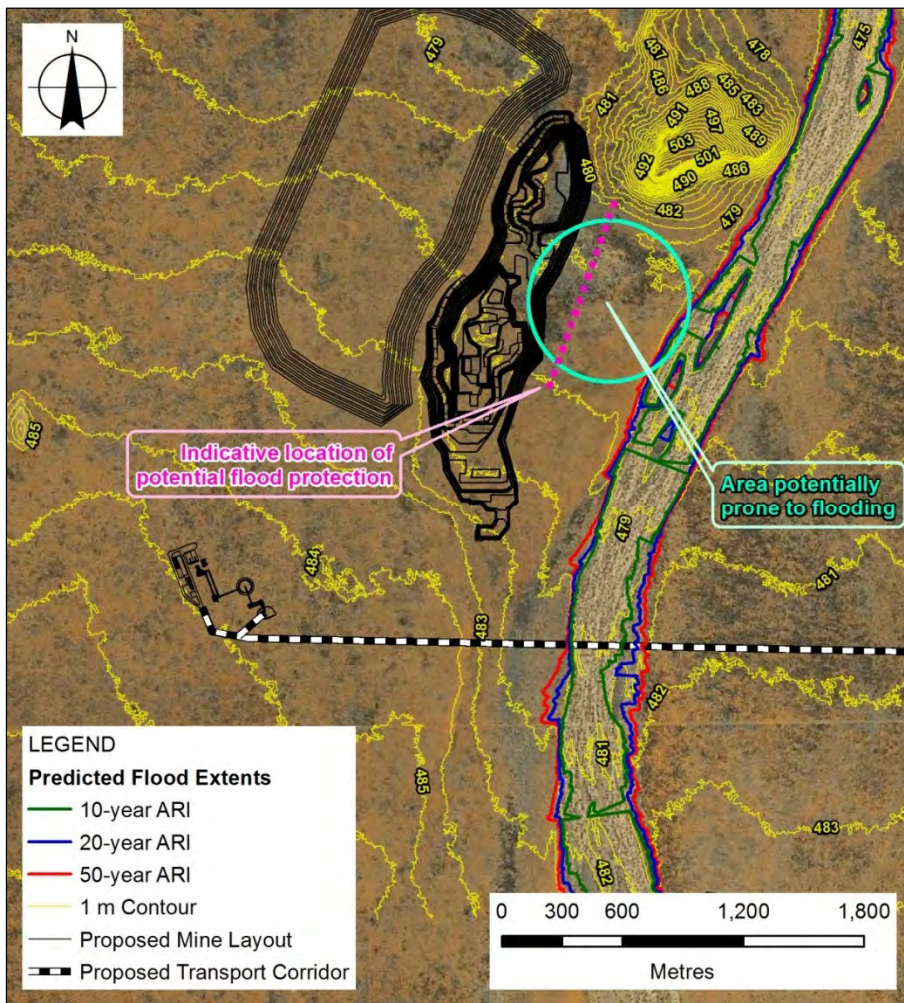


Figure 7-8 Predicted flood extents along Murray Creek

Sheetflow shadows resulting from the access road

An inspection of the elevation data and aerial imagery indicates that the alignment of the access road is associated with areas where sheet flow may be the dominant surface water runoff response. Extensive tracts of Mulga (*Acacia aneura*) dominate the shrublands connected to the alluvial plains to the east of the Stuart Highway. These species are an indicator of sheetflow processes.

The elevation profile along the access road alignment is provided in Figure 7-9, which identifies the locations of the main water course crossings as well as areas where sheet flow may be present. As no specific drainage lines were noted in the areas of potential sheet flow, TNG will regularly space culverts to prevent the creation of sheetflow shadow zones downgradient of the access road.

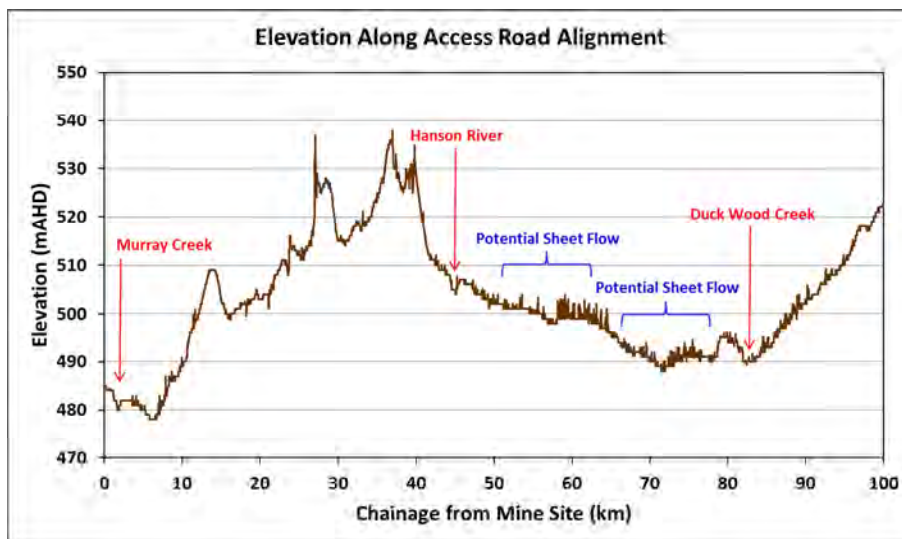


Figure 7-9 Elevation profile along access road

7.4 Groundwater

7.4.1 Existing Groundwater Environment

Geology

The Project area is located predominantly within the northern province of the Palaeoproterozoic Arunta Block, with the eastern area of the Project being within the western margin of the Neoproterozoic Georgina Basin. These two broad geological regions form the main basement geology of the Project area and are most commonly observed forming the outcropping rocks of the ranges. More recent Quaternary and Tertiary aged deposits dominate surface geology and regolith and generally mask the underlying Palaeozoic and Proterozoic units.

The orebody target is the mineralised Mount Peake gabbros, which are contained at relatively shallow depths of around 40 m, and are generally found concealed beneath recent Quaternary sediments. The gabbro unit is located within outliers of Neoproterozoic sediments of the Georgina Basin. The Neoproterozoic sediments rest unconformably on metasediments and granites of the Aileron Province within the Lower Proterozoic Arunta Region. Immediately to the northeast of the proposed pit, a small outcrop of the Mount Stuart Formation is present forming a small rise immediately adjacent to Murray Creek. The same unit also forms the high ground east of the proposed accommodation village area.

The proposed borefield is located on the western bank of the Hanson River. The dominant surface geological unit here is the alluvial deposits of relict fluvial system largely covered by sheet sand and alluvial/red soil plain deposits. The palaeodrainages of the Hanson River have resulted in the alluvial units within the proposed borefield location being significantly thicker in comparison to the general alluvial units found on the plains. It is likely that the thickened alluvial units are geologically equivalent or related to the same units found at depth in the Ti Tree Basin (approximately 70 km to the south).

The access road transects various differing geologies and regolith units. The eastern half of the road alignment is predominately within the Georgina Basin, whereas the western half is within the Arunta Block. The alignment is located on the plains and therefore the surface geology and regolith is mainly comprised of alluvials. In the western area where the alignment is to the east of the ridge line formed from the Stuart Ranges, some localised scree and colluvial fan deposits are present. In the eastern area of the alignment, the road passes through the palaeovalley associated with the Hanson River. In this location, older Cainozoic sediments are mapped, which are expected to include calcrete deposits. Where the road alignment meets the existing rail line, the alluvial plain is relatively narrow with units of the Central Mount Stuart Formation being present both north and south of the road alignment.

Hydrogeology

There have been limited studies into the groundwater potential of the basement rocks of the Arunta and Georgina geological provinces, largely as a result of the regional remoteness. The deep basins may offer groundwater resources, however groundwater drilling investigations have generally focused on providing water for communities or stock watering which only require relatively minor yields that can be obtained at relatively shallow depths (Ryde 2007). Regional aquifer mapping by the Department of Land Resources Management (Tickell 2013) indicates that the general Project area contains two predominant local scale aquifer types:

- ▶ fractured and weathered rocks with minor groundwater resources; and
- ▶ fractured and weathered rocks.

The distribution of these two systems is illustrated in Figure 7-10. The fractured rock aquifers are likely to offer generally low groundwater yields and are unlikely to yield adequate water for mine operations. In addition to the two units that dominate the Project region, the Ti Tree basin is mapped as an aquifer of 'Unconsolidated sediments with intergranular porosity'.

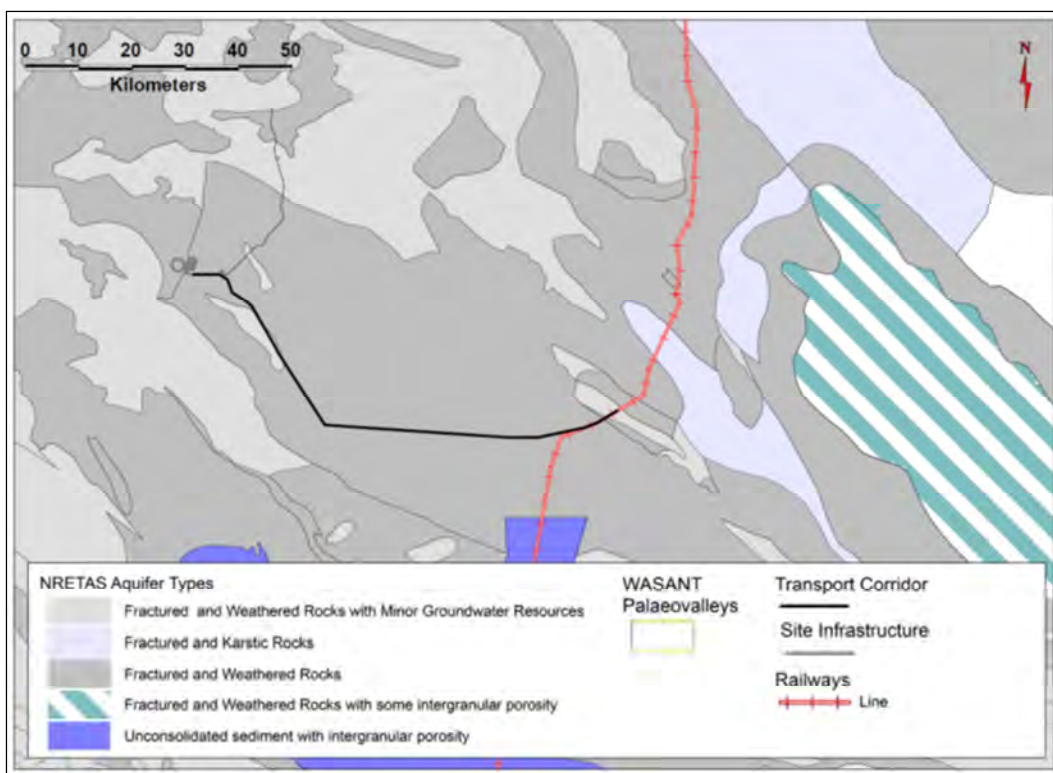


Figure 7-10 Regionally mapped aquifer systems

In addition to the broad fractured rock systems that are mapped as present throughout the study area, a number of significant Cainozoic basins and palaeovalley systems have been identified (Tickell 2013).

The Ti Tree Basin is the most studied and the most exploited groundwater resource in the region. The basin is an intracratonic Cainozoic that is approximately 100 km wide from east to west and 75 km north to south. The basin sediments are known to be in excess of 300 m in depth, however the upper 100 m of sediments is most commonly targeted for groundwater abstraction. Groundwater within the basin generally flows from south to north, with discharge known to occur towards the Hanson River and Stirling Swamp. The Stirling Swamp area may be an expression of discharge from the Ti Tree aquifer where evapotranspiration could be a major component of the water balance for the aquifer (English *et al.* 2012). The primary use of the groundwater is for horticultural purposes, with demand increasing to approximately 4 GLpa in 2005. Demand has since reduced with current abstraction less than 2 GLpa.

The extent of the Hanson River palaeovalley is mapped as continuing from the northern discharge of the Ti Tree Basin, passing through Stirling Swamp and connecting with the existing Hanson River Channel. The channel then passes through the Project area before continuing north for approximately 200 km before it merges with the Palparti palaeovalley. The Hanson River palaeovalley is generally identified as being around 4 km wide, but as narrow as 2 km and as wide as 10 km.

With the exception of work undertaken by TNG there has been no known groundwater investigative drilling undertaken in the area of the Hanson River palaeovalley, other than for installing stock bores. Utilisation of the Hanson River palaeovalley is currently limited to the stock bores, with the majority equipped with solar powered low volume shaft driven pumps, which are used to fill water tanks that keep cattle troughs filled.

The Willowra Basin and associated palaeovalley is located approximately 30 km west of the proposed mine site at the junction of the Lander River and Ingallana Creek. The Willowra Basin was investigated for groundwater resources through a drilling program conducted by the Northern Territory Water Resources section in 1963 to determine the extent of the basin and determine the profile of the potential groundwater resource. The drilling investigation determined that around 25 km south of Willowra Homestead the palaeovalley is about 18 m deep and 3 km wide, deepening to 35 m just north of the homestead. The main aquifer unit was identified as a Quaternary lower sand unit with some local confinement by clay rich floodplain deposits (Magee 2009). This aquifer appears to have low volumes of groundwater storage after long periods of low flow, with the watertable depth in the Willowra Homestead bore varying from about 12 m (in dry periods) to near-surface immediately after streamflow. The only known groundwater use within the Willowra Basin is for stock use, although use for horticultural purposes was identified as having potential, but not pursued.

Water control districts

The Department of Land Resource Management declares Water Control Districts in areas deemed to need water resources management to avoid stressing groundwater reserves, river flows or wetlands. Water Control Districts are subject to water allocation planning that establishes a framework to share water between environmental requirements and human needs for beneficial uses, as defined in the *Water Act 1992*. Of relevance to the Project are the Western Davenport Water Control District, and the Ti Tree Water Control District (Figure 7-5).

The Western Davenport Water Control District covers an area of almost 25,000 km², extending north from the Ti Tree Basin Water Control District for around 200 km, including the community of Mungkarta at its northern edge. From the west it includes the Hanson River and the proposed location of the borefield, and extends east to cover most of Murray Downs Station. The Stuart Highway bisects the District passing through Barrow Creek, Wycliffe Well and Wauchope.



The allocation plan (NREAS 2011) recognises that there are currently no known or significant surface water extraction activities and the total of the current licensed and unlicensed groundwater extraction per annum is estimated to be less than 0.004% of estimated storage. The allocation plan and associated technical documentation also note that further scientific work needs to be undertaken to improve the knowledge about the areas water resources and estimation of their characteristics. In particular, more evenly spread and deeper groundwater drilling investigations are recommended to determine bore yields and consequential sustainable yields of aquifers. Identification and measurement of recharge mechanisms is also recommended.

The Water Control District is separated into five management zones based on a consideration of topography, underlying geology, hydrogeochemistry and stratigraphy. The Territory Government has followed the principle that in the absence of adequate scientific information, total extraction of groundwater over a century should not exceed 80% of the estimated total aquifer storage.

The Project area overlaps with part of the Southern Ranges management zone. This zone has an:

- ▶ area of 8498 km²;
- ▶ estimated storage of 147 GL;
- ▶ estimated annualised recharge of 8.5 GL; and
- ▶ available allocation of 6.8 GLpa.

The Ti Tree Water Control District covers an area of almost 15,000 km², covering the extent of the Ti Tree aquifer and its surface water catchments. The northern area of the district extends to Wilora and Stirling Station, and therefore includes a large section of the access road alignment and the rail siding. Unlike the Western Davenport Water Control District, the Ti Tree area has a significant groundwater use, largely for horticultural purposes and public water supply. Abstraction occurs from the Ti Tree aquifer which is present at relatively shallow depths across the majority of the Water Control District. As a result of the demand and utilisation of the aquifer, a groundwater model has been developed, which has been used to develop allocations and sustainable water use volumes. The Water Control District is separated into four management areas, with the Northern Zone being of relevance to the Project due to its overlap with the access road, the Hanson River and Stirling Swamp. The northern zone is relatively un-utilised in terms of abstraction compared to the other areas, with the only groundwater use by the Wilora community and Stirling Station. It is estimated that a total of 50 MLpa is currently used, with 10 MLpa for Public Water Supply (licenced) and 40 MLpa for rural and domestic use (unlicensed).

Existing groundwater use within the Project area

Although there are relatively few existing groundwater users within the Project area, it is important to identify these so appropriate design and management actions can be incorporated into the Project to minimise potential adverse impacts.

Stirling Station covers most of the Project area, with Anningie Station being immediately to the south of the Project area. Both pastoral stations use stock bores and wells for year-round water supplies. The operational stock bores identified within and around the Project are shown on Figure 7-11. In general, stock bores are relatively evenly distributed around the Project area with typical distance between bores of around 10 km. Most bores are located along existing creek and drainage lines. Due to the relatively low volumes of groundwater required at each location, bores tend to be relatively shallow and generally less than 40 m deep. Due to the widespread nature of these bores, they tend to target different units but are predominately targeting the fresher shallow groundwater associated with recent alluvial sediments. The relatively shallow nature of stock bores means that they have the potential to be impacted by any reduction in groundwater levels.



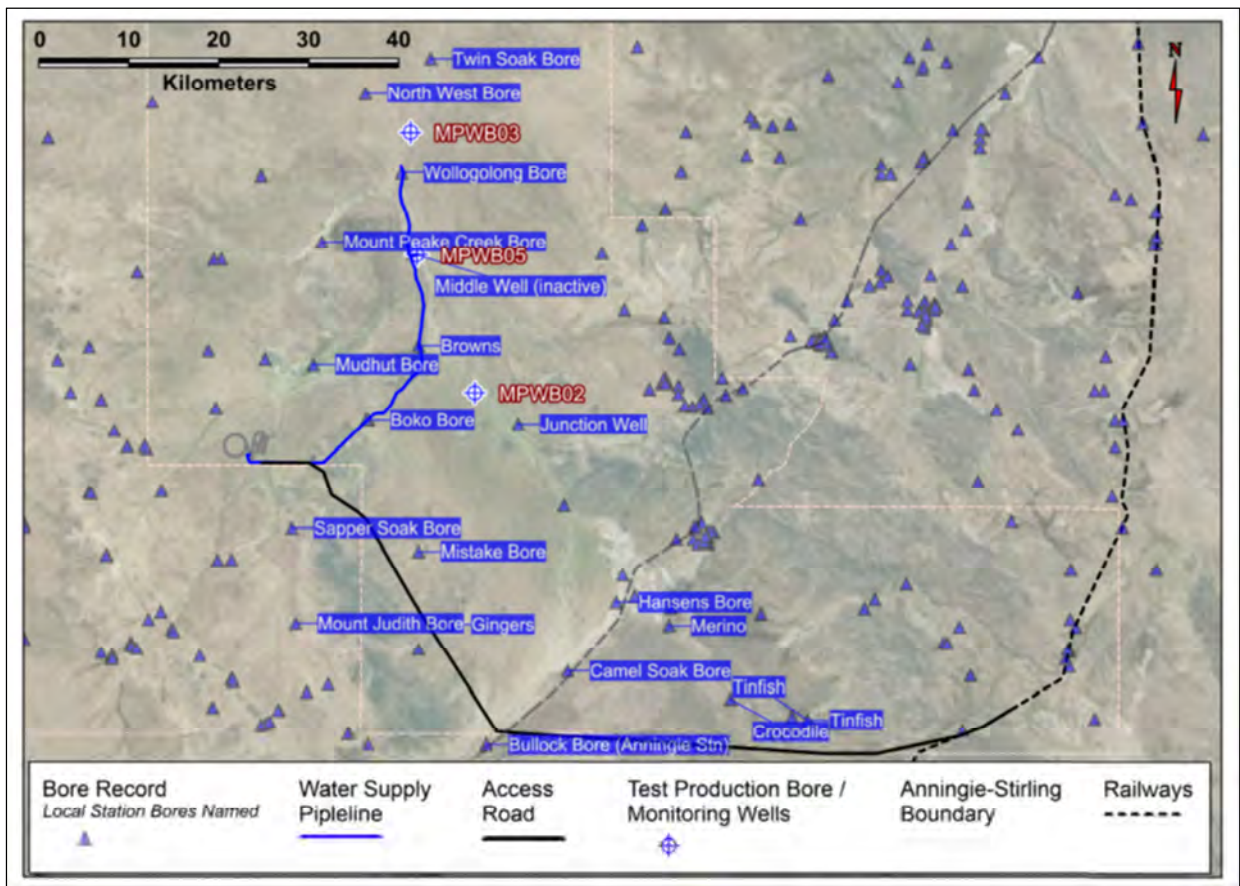


Figure 7-11 Stock bores within and around the Project area

TNG has considered potential impacts on these bores when assessing drawdown impacts from the mine site and from the borefield.

Within the Project area, there are also a number of groundwater abstraction bores for public water supply. These include supply for Stirling Station homestead, Barrow Creek and the Wilora community. All these locations have dedicated bores that provide a permanent water supply. The Wilora community is supplied with groundwater with an existing licence for 40 ML/year (issued to the Power and Water Corporation). Barrow Creek service station is licensed for 1 ML/year. No current licence data is available for Stirling Station homestead.

In addition to anthropogenic needs, groundwater dependent ecosystems also occur in the region. Stirling Swamp, located north of the access road comprises a large network of claypans, lignum swamp, semi-saline samphire and temporary open water, and the adjacent Hanson River. Stirling Swamp is thought to be connected to groundwater through a topographic low forming a 'window' to the relatively shallow Ti Tree aquifer water table. This area is therefore considered a discharge zone of the Ti Tree aquifer. Mud Hut Swamp is located approximately 7.7 km north of the mine site. It is formed from a flood-out of the Bloodwood Creek and, based on its location as an outflow of the creek, it is unlikely that the swamp is maintained by groundwater. There are no known permanent or semi-permanent water holes along the Hanson River, with any pools formed through surface water flow. These are relatively short lived as they are subject to evaporation and drain to the underlying aquifer.

Groundwater levels and recharge

Developing an understanding of the baseline groundwater levels is required to assist in determining the potential for Project related impacts. It is important to understand the seasonal and temporal changes of groundwater levels.

An interrogation of the NRETAS bore database highlighted the lack of bores close to the Project that have a good record of current and historic groundwater levels. Sites where groundwater level data is available are presented on Figure 7-12.

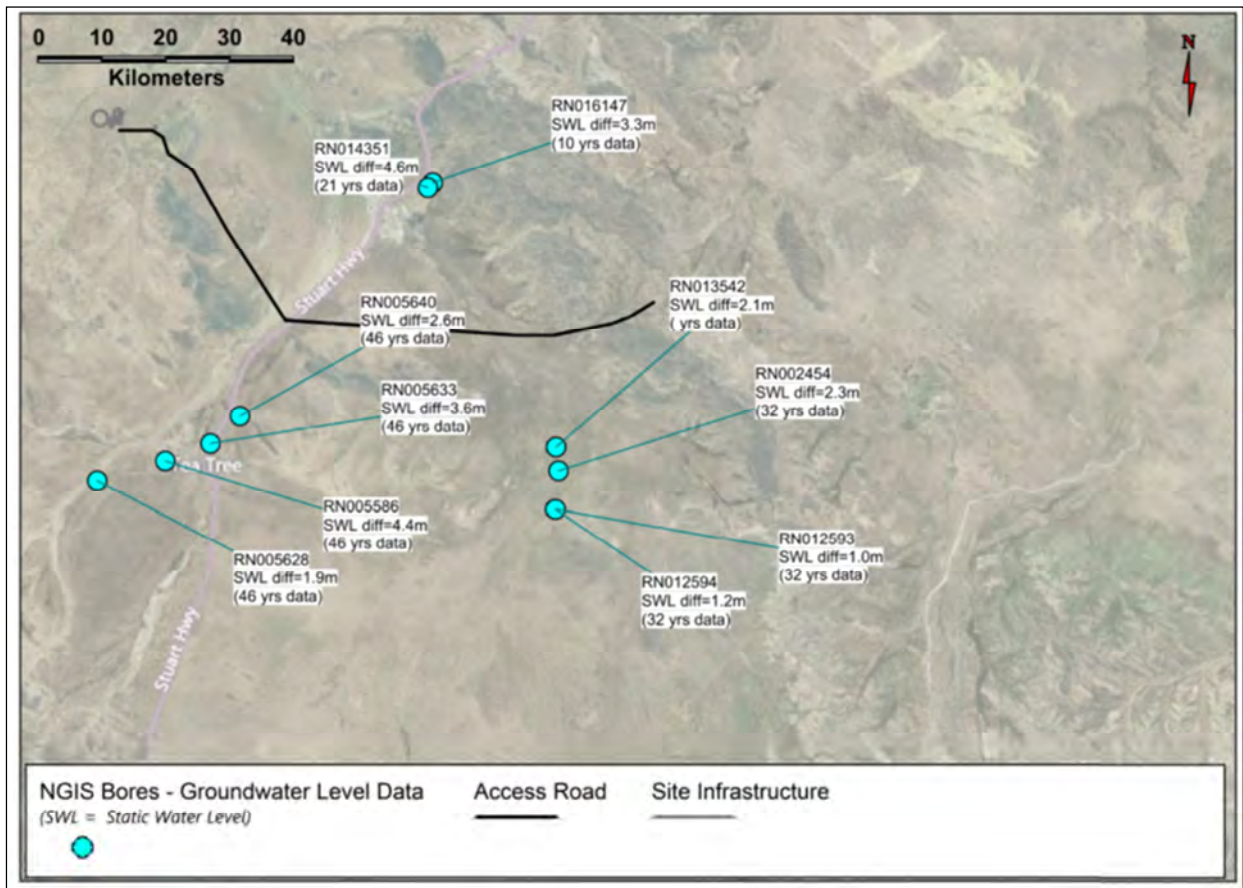


Figure 7-12 Sites with groundwater level data

For some of these sites a good record of groundwater levels is available. Groundwater levels tend to vary by between 2 and 4 m, with the data highlighting the response of the aquifers to large river flow and flood events. Data from the bores indicates that groundwater between these locations has a gradient to the north, comparable to the general topographic elevations.

Aquifer recharge predominantly occurs from direct infiltration of rainfall. Due to the sporadic and minimal amount of rainfall typical of the region, this volume is quite low. Large rainfall events and subsequent flooding is known to significantly increase groundwater levels in areas close to active flow channels. However, a lack of monitoring data for the Hanson River channel means that recharge volumes for this system cannot be accurately quantified.

Project specific groundwater investigations

Two groundwater investigations were undertaken for the Project. One was associated with the proposed mine pit and the other assessed groundwater supply potential of the Hanson River palaeovalley.

An investigation of groundwater potential in the area of the pit was undertaken in March 2014 through airlifting of existing exploration holes. The airlifting program aimed to determine the likely groundwater inflow to the pit area and whether there may be sufficient volumes of water available for mine site water use. This testing also allowed the determination of indicative aquifer parameters through the analysis of groundwater recovery data at each test site.

Eleven holes were assessed at locations both within and adjacent to the pit area. Groundwater occurred at a depth of around 20 to 22 mbgl with salinity generally between 6000 and 8000 mg/L TDS. During airlifting of the exploration holes, low volumes of groundwater were able to be purged with only a low flow volume sustained in five of the sites at rates less than 12 L per minute.

The testing demonstrated that alternative sources of water would be required as there will be insufficient volumes available from the pit to meet Project requirements. From a management perspective, the mine pit is unlikely to be subject to significant groundwater inflow and there is no indication that the pit will require substantial dewatering infrastructure.

A second groundwater investigation was undertaken in March 2015 to assess the groundwater supply potential of the Hanson River palaeovalley. Drilling locations were determined by TNG at targeted locations along the existing Hanson River and at maximum distances from existing stock bores. Drilling locations and field results are presented in Figure 7-13.

Groundwater levels were found to be relatively consistent between sites along the Hanson River palaeochannel at a depth of around 10 mbgl. Water quality was brackish to saline, however this was not considered to be an issue as the main use of the water would be for ore processing which has no salinity restrictions. All drilled bores intersected a sequence of sands and gravels to varying thicknesses overlying a variable basement. In general, an upper silty unit was identified above a coarser grained sand and gravel unit (main aquifer). All bores produced significant water during drilling and 150 mm wells were constructed and pump tested at all sites. Highest yields were found at MPWB01 and as a result a test production bore was installed at this location (MPWB05). A test pumping program was completed on the constructed bores following completion of the drilling program. The key pumping test was on the production bore (MPWB05), which included monitoring of the adjacent monitoring well (MPWB01). The analysis of the 48-hour pump test data allowed the determination of aquifer properties and recommendations for operational pump rates of 8.5 L/s for the production bore. Due to the favourable drilling results, an indicative borefield location was chosen (Figure 7-13).

The results of the desktop assessment and field investigations provide an understanding of the Project region and were used to inform the development of a site conceptual and numerical groundwater model discussed in the following section.



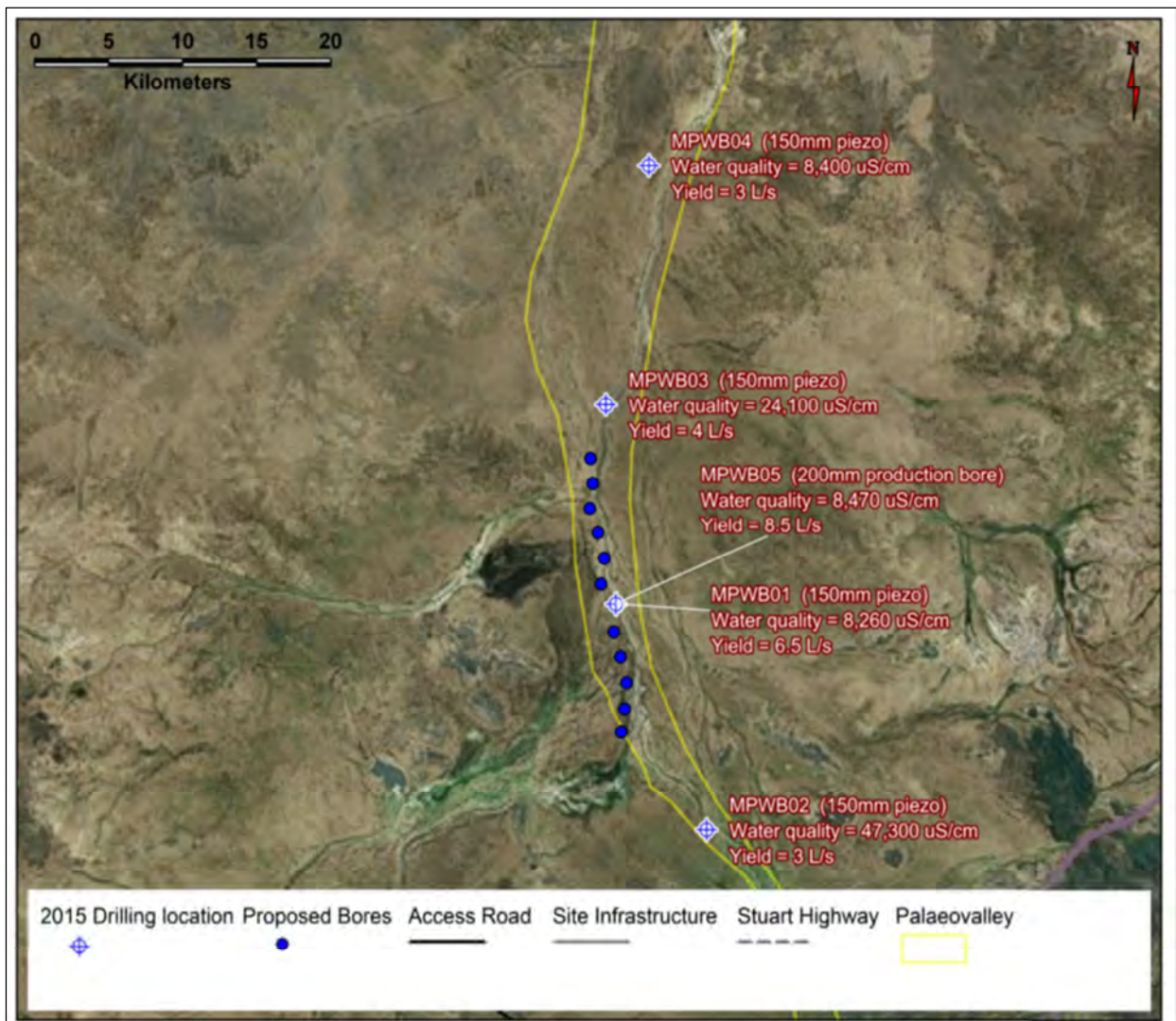


Figure 7-13 Groundwater drilling locations for a potential water supply associated with the Hanson River palaeovalley

7.4.2 Groundwater Model

Groundwater model configuration

Groundwater flow modelling was undertaken to assess the cumulative impact of the operation of the borefield and pit dewatering on nearby groundwater users, such as stock bores and potential groundwater dependent ecosystems. The conceptual hydrogeological model developed was based on the available data, maps and reports to provide a framework for numerical model development. The conceptual model incorporated two broad layers, these being the:

- ▶ mine site - weathered rock underlain by the fresh rock; and
- ▶ palaeovalley area - silty/sandy clay underlain by silty sand/gravel aquifer.

A four layer numerical model was developed to predict the potential cumulative impact of mine dewatering and water supply. The four layers represent the following:

- ▶ Layer 1 represents the extent of the weathered zone in the bedrock outside of the palaeovalley and sandy-silt layer in the palaeovalley;
- ▶ Layer 2 represents a transition zone between the weathered bedrock and fresh bedrock in the area outside of the palaeovalley and lower sand aquifer in the palaeovalley;
- ▶ Layer 3 represents fresh bedrock (igneous and metamorphic) in the area outside of the palaeovalley and sedimentary rock (claystone/sandstone) in the palaeovalley; and
- ▶ Layer 4 represents fresh bedrock throughout the model domain in order to account for the potential vertical flow into proposed mine pit.

The four layer model has been graphically conceptualised in Figure 7-14.

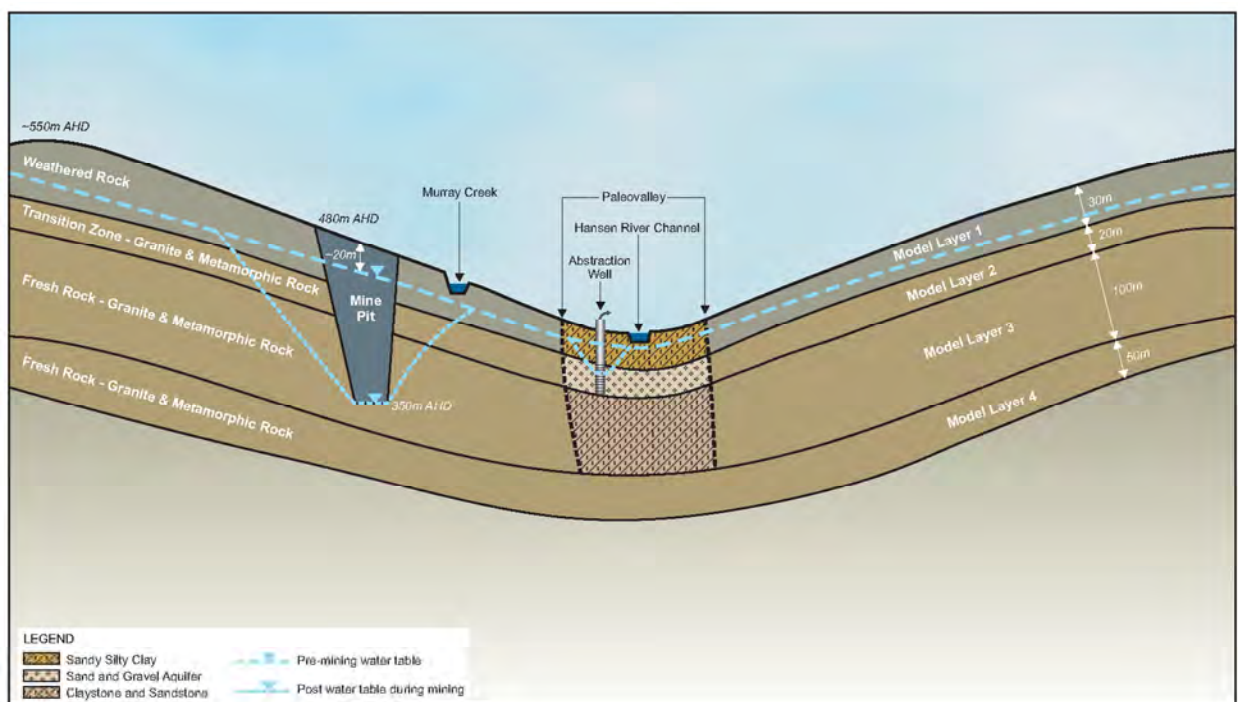


Figure 7-14 Conceptual hydrogeological model

The industry standard numerical groundwater flow modelling code MODFLOW-USG (Pandey *et al.* 2013) was employed to predict groundwater flow. Groundwater Modelling System (GMS v 10.1) was used as a graphical user interface (GUI) for pre and post processing of the data.

Whilst a one or two dimensional model could offer simplified results, taking into account the overall considerations of the Project, a more detailed and defensible three-dimensional model was selected for the simulations. A three-dimensional model was selected as groundwater flow is anticipated in all three directions. A relatively large model domain was chosen, with the model extending approximately 84 km in the east-west direction and 92 km in the north-south direction. The grid size was chosen to be 50 m in the area of the proposed mine location, 200 m in the area of the proposed borefield and 800 m towards the boundaries. The model extent is shown in Figure 7-15.

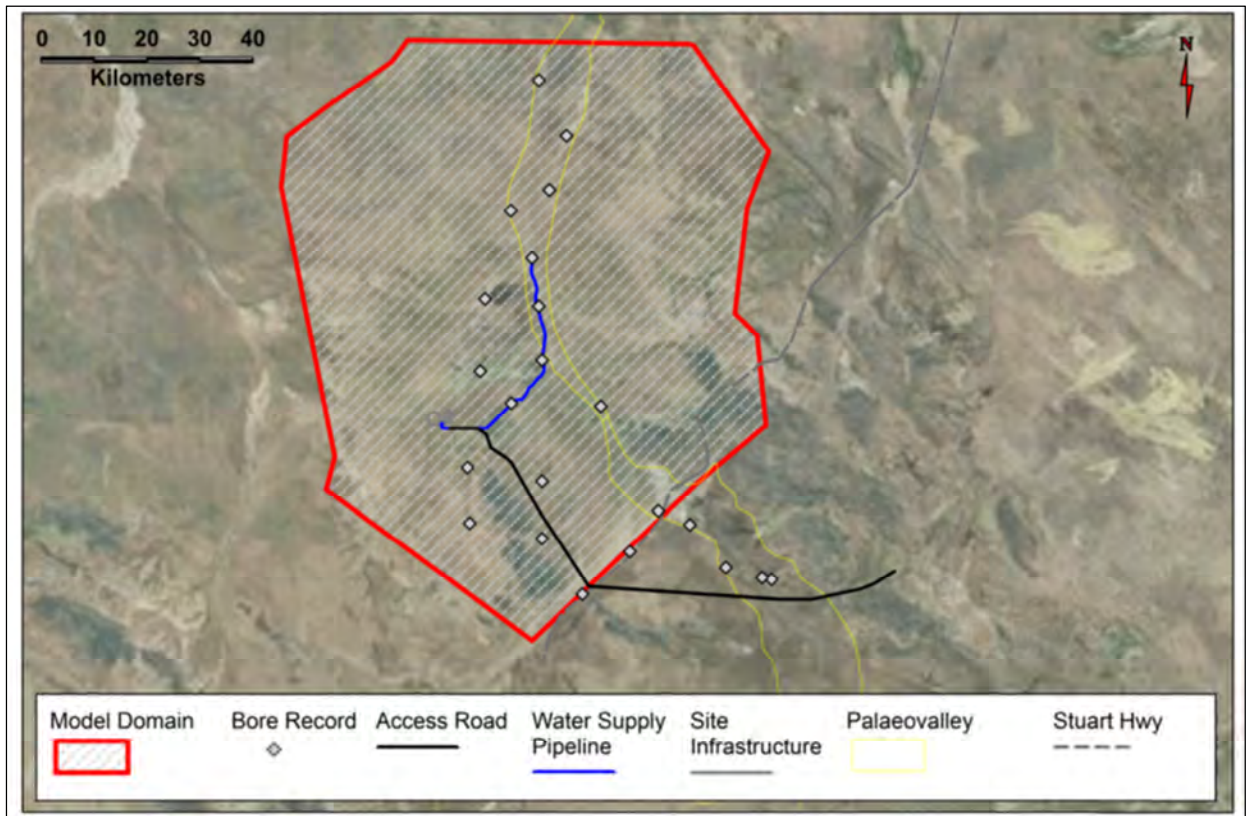


Figure 7-15 Groundwater model domain

Layer thicknesses, hydraulic properties and boundary conditions were determined based on resource drilling within and around the mine site, groundwater drilling and testing in the palaeovalley and lithology data from historic drilling. Both steady state and transient modelling was undertaken. No temporal discretisation was applied to the steady state model, however the transient model used to predict the impact of groundwater pumping from the palaeovalley and pit is assigned with stress periods ranging from 1 year (with 12 time steps) to 60 years (with 30 time steps).

The steady state model was calibrated to fit historical water level observations. Model parameters and boundary conditions were changed to match the measured head with the modelled head. Of note, depth to groundwater in the area of Mud Hut Swamp was modelled as being 15 to 20 mbgl (i.e. conceptually the swamp is not connected to the regional groundwater system).

The model was applied in transient state mode to assess the maximum potential drawdown of the palaeochannel aquifer through borefield abstraction and from incremental pit development. This allowed the simulation of both drawdown and recovery in annual increments over a period of 100 years. The drawdown was assumed to occur over 17 years, with two years of mine pre-production (this is conservative as there will be limited borefield extraction and no pit dewatering during this timeframe) followed by 15 years of mining). Following cessation of mining the model was run for a further 83 years to predict groundwater level recovery. Borefield operation assumed a two stage abstraction volume, with the first stage operating at an abstraction rate of 1.6 GL/year (51 L/s) for the first five years. For the second stage (from year 6 to 17), abstraction was increased to 2.6 GL/year (82 L/s).

7.4.3 Groundwater Impact Assessment

Predicted groundwater impacts during mining

The area proposed for the Mount Peake Borefield falls within the Western Davenport Water Control District but outside of the Surface Water Catchment Divide that defines the main aquifer for the District. The aquifer to be tapped for Mount Peake is not connected with the main Western Davenport Plains aquifer. It does occur down gradient from the Ti Tree aquifer, but at a distance of around 100 kilometres (i.e. extraction from the Mount Peake borefield area will not affect the Ti Tree aquifer).

The predicted maximum drawdown impacts from the Project (both borefield operation and pit dewatering) are illustrated for year 17 in Figure 7-16.

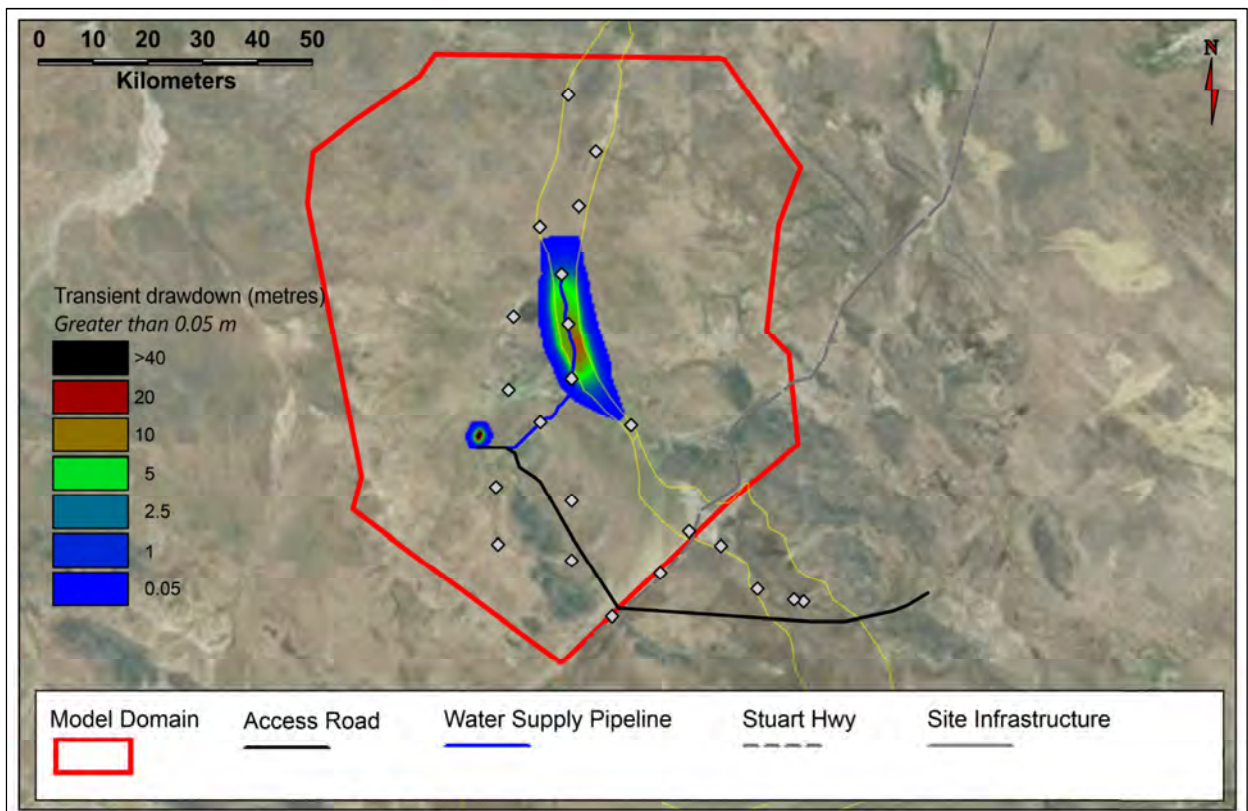


Figure 7-16 Predicted drawdown at end of operation (year 17)

For the mine site, drawdown contours less than 50 m have been plotted. Within the pit, drawdown under transient conditions is predicted to reach 100 m at the conclusion of operation (17 years) and rapidly decrease with distance from the pit. The 1 m drawdown contour was predicted to occur approximately 1 km from the pit edge, with the predicted limit of drawdown (0.05 m) a further 1 km from this. As such, no drawdown impacts at 17 years from the mine pit are expected for potential groundwater sensitive receptors such as Mud Hut Swamp. Similarly, Stirling Swamp and the outflow of the Ti Tree basin will also not be impacted by either borefield abstraction or pit dewatering based on the modelling results.

Maximum groundwater drawdown at the borefield at the end of mining is modelled as being up to 12 m at the location of the operating bores in the centre of the borefield. Drawdown decreases significantly with depth away from the palaeovalley. Although the 1 m drawdown contour extended to around 6 km south of the borefield, this was still a considerable distance (approximately 28 km) from the inflow zone around Stirling Swamp.

The modelling predicts selected pastoral wells (Browns and Wollogolong Bores) are likely to be impacted by borefield operation. These wells are the two closest pastoral wells to the borefield and are expected to have groundwater levels reduced by up to 3.2 m. Although this may lead to water supply problems for these wells, they could be deepened to accommodate this temporary lowering of groundwater level at these locations. The predicted impact to the remaining active pastoral wells in proximity to the borefield is less than a 0.05 m drawdown in groundwater level.

Predicted groundwater impacts post mining

Figure 7-17 presents a plot predicting groundwater level changes over time at a location on the edge of the palaeovalley aquifer. This figure illustrates groundwater levels are slow to recover, largely due to the conservatively low levels of recharge assumed in the model. For locations outside of the palaeovalley, some minor increased drawdown is expected after cessation of abstraction, due to a lag effect.

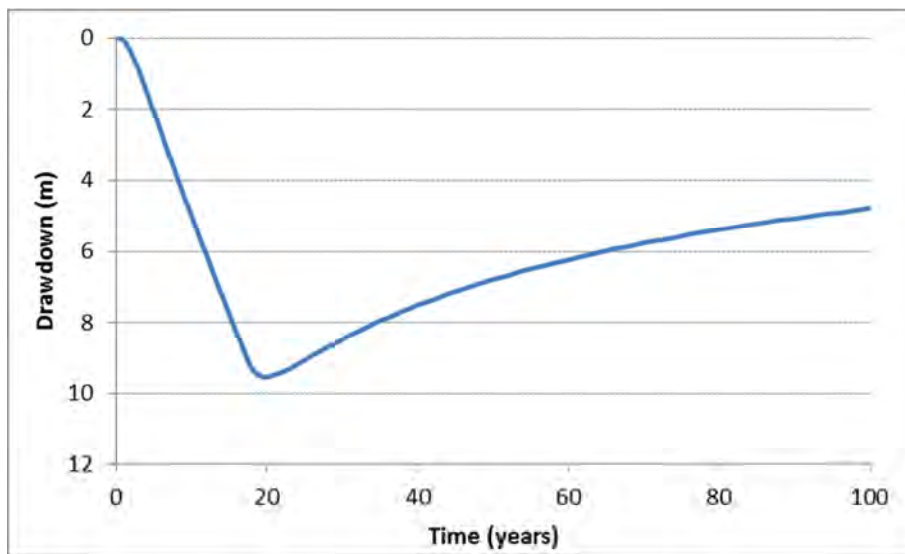


Figure 7-17 Drawdown and recovery at edge of palaeovalley aquifer

Predicted drawdown 100 year following Project commencement is presented in Figure 7-18. The 100 year drawdown plot represents the drawdown and subsequent recovery at the borefield and drawdown around the pit after cessation of mining/abstraction for 83 years.

Although drawdown within the immediate vicinity of the borefield has recovered to generally less than 5 m, the extent of drawdown increases slightly as groundwater from storage reserves drain to the area of the recovering borefield.

In the area of the mine site, the extent of drawdown increases slightly with respect to the 17 year drawdown. The 1 m drawdown contour extends to around 3.5 km from the mine pit. Although noting an increase in drawdown extent, the Project is still unlikely to impact sensitive receptors such as Mud Hut Swamp.

The model predicts a pit lake will form in the mine void following cessation of mining. The predicted inflow to the pit is expected to be relatively low, reflective of the low permeability of the pit wall. Modelling suggests the pit lake water levels would stabilise after about a year, at around 365 mAHD, equivalent to around 10 m deep at its deepest part with inflow becoming equal to evaporation. The pit lake will become increasingly saline as salts from groundwater, surface water and rainfall accumulate. By around 7 years post-closure a salinity of around 35,000 mg/L is predicted.

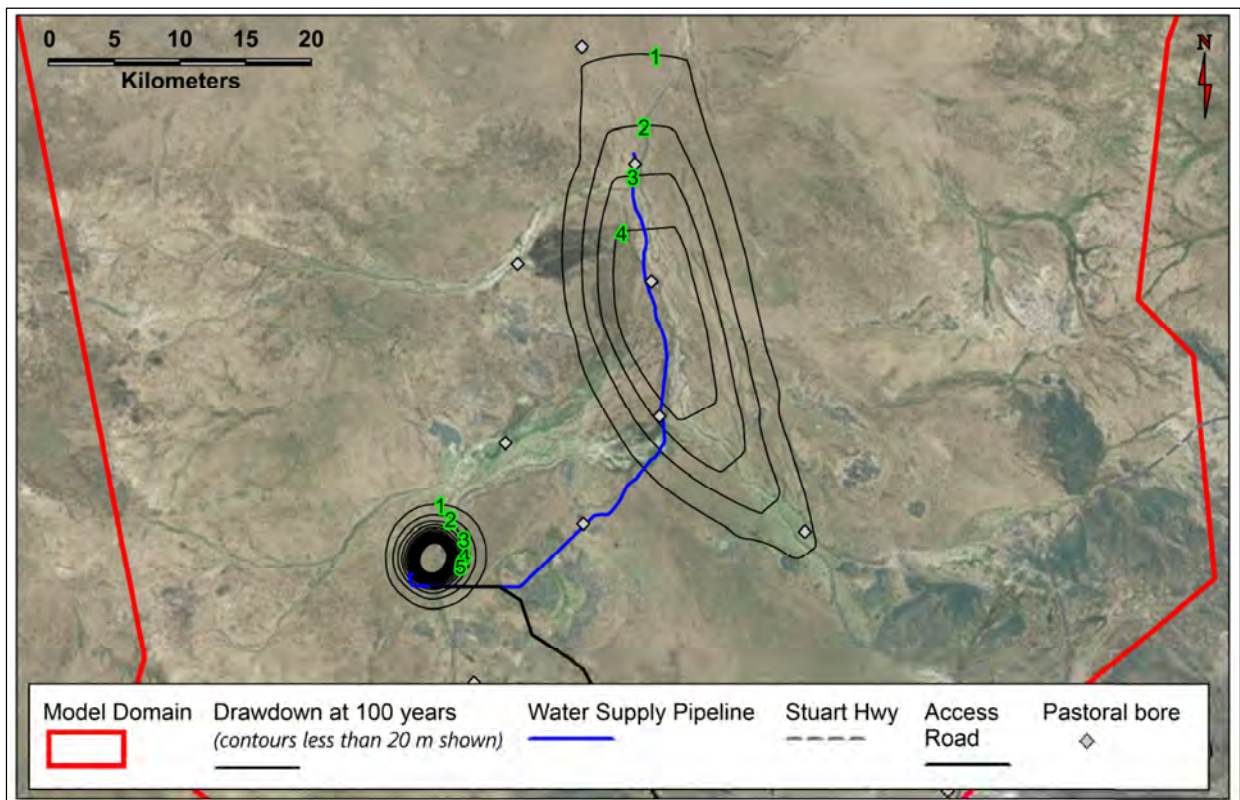


Figure 7-18 Predicted drawdown at 100 years

7.4.4 Borefield Monitoring and Adaptive Management

In addition to the production bores, a groundwater monitoring network will be installed to ensure that aquifer performance can be measured and adapted where necessary. This is essential to safeguard the water supply for the life of the mine whilst ensuring that impacts are minimised. The monitoring network will be consistent with, and complementary to, the borefield design. The monitoring network will be constructed in stages in parallel with production bores. The ultimate monitoring network will include the following:

- ▶ a monitoring well located at each production bore. These will be the investigation holes for each site. The monitoring well will be used to determine aquifer properties from the pump testing and ongoing performance of the aquifer immediately adjacent to the production bore site. One monitoring well has already been established at production bore WB05 (monitoring well WB01);
- ▶ approximately four monitoring wells located between selected production bores to determine the aquifer response to pumping and the cumulative impacts from bores;
- ▶ the installation of monitoring bores to the north and south of the borefield to assist in determining the impacts up and down gradient of the borefield. This is important as it will show impacts on station wells located close the borefield (for example Browns Bore), and to monitoring for potential saline ingress to the borefield from the known high salinity area in the south; and
- ▶ the use of existing bores in regional locations outside the modelled extent of drawdown as control bores. These bores are already in place (WB02 & WB03).

7.5 Water Contamination and Management

Most aspects of the Project have some potential to cause water contamination, such as, but not limited to the ore stockpiles, waste landforms including the waste rock dump (WRD), magnetite stockpiles or TSF. Potential release mechanisms for water contamination include:

- ▶ erosion of disturbed surfaces;
- ▶ inadequate stormwater/runoff separation;
- ▶ leaching from WRD and long term stockpiles;
- ▶ seepage from the TSF;
- ▶ inadequate treatment of waste water prior to discharge; and
- ▶ accidental spills.

Key environmental receptors and endpoints potentially sensitive to changes in water quality include:

- ▶ receiving aquatic systems (waterways, wetlands, groundwater recharge zones, aquifers);
- ▶ fauna and livestock (consumption); and
- ▶ humans (recreation and consumption).

TNG has developed an Erosion and Sediment Control Plan (ESCP) and Water Management Plan to monitor and manage potential water related impacts during operation. The follow provides an overview of some of the details included in these documents.

Ore stockpiles

Extracted ore will be transported to the Run of Mine (ROM) pad for direct processing or to long-term stockpiles. The mineral resource is hosted by a mafic intrusive rock (a gabbro sill) and the orebody comprises the magnetite-rich portion of the sill. The intrusive rock is oxidised resulting in there being negligible magmatic sulphide within this material. Geochemical investigations by TNG have confirmed the orebody does not contain significant Acid Mine Drainage (AMD) materials, with geological logging rarely encountering visible sulphides and, when so, they were in the order of ~2% of the sample over a few metres. Generally the sulphides seen are associated with structural zones and faults/fractures. Accordingly, the ore body is considered to be benign and the ore stockpiles should not pose any discernible risk to sensitive receptors and endpoints. TNG will undertake periodic testing of the stockpiled ore to confirm the absence of potentially acid forming (PAF) material during mining operations.

Runoff separation will be established for ore stockpiles through bunding and drainage ditches to retain runoff from the stockpiles and to prevent inflow of external drainage to the sites. Runoff from the ore stockpiles will be contained and directed to appropriately sized sedimentation ponds for managed release to the environment. Details of these management measures are detailed as part of ESCP.

Waste Rock Dump

A WRD will be developed for the life of mine and located west of the pit within a zone characterised by flat topography. The landform will be designed to be safe, geotechnically stable and non-erodible. The WRD will feature benches to collect stormwater drainage and provide access for closure cover installation, reclamation activities and maintenance. Stormwater collected on benches will be conveyed to a surface water collection and sedimentation pond, which will collect and treat runoff prior to either reuse around the site or discharge to the environment.



The material to be stockpiled in the WRD is likely to have well below 1 wt% sulphide content, while the gabbro ore has a lower sulphide content (less than 0.5 wt% sulphide). This sulphide content will not generate a significant AMD issue. Therefore, the WRD should not pose any discernible risk to the identified receptors and endpoints.

TNG will also complete periodic testing of the WRD to confirm the benign nature of this material.

Concentrate Stockpiles

The Project will produce magnetite concentrate which will be stored in stockpiles at the processing plant and at the Adnera Loadout Facility. Material Safety Data Sheet (Midas METS 2014) identifies that the magnetite (Fe_3O_4) product exhibits low risk with regards to health, flammability, reactivity and contact. Although the concentrate is considered inert and non-toxic and does not constitute a threat to identified receptors and endpoints, a key hazard relates to high level prolonged exposure to dust which may cause lung or airway irritation.

The magnetite concentrate is non-toxic to flora and fauna, insoluble, chemically stable and not regulated for transport (Midas METS 2014). Dust emissions will be managed via the concentrate having an inherent moisture content, use of sprays and dust collection systems and covering concentrate loads during transport. Runoff from the concentrate stockpiles will be contained and the drainage water will be recovered and recycled for dust suppression or processing purposes. Details of the management measures are provided as part of a site Water Management Plan.

Tailings Storage Facility

The tailings stream will consist of non-magnetic silts and sands and will be dewatered using a flocculant in a tailings thickener. The potential hazard of the flocculant to humans is low and there are no known ecotoxicological effects. Water from the surface of the TSF will be decanted to a sump for transfer to the process water dam. All rainfall on the surface of the TSF and internal face of the bund wall will be contained and recovered via an underdrainage system. Runoff from rainfall on the external face of the bund wall will be collected in a drainage ditch and conveyed to an appropriately sized sedimentation pond for managed release to the environment.

The TSF will be unlined but will be constructed with under-drains, toe drains and over drains connected into the sump. There is potential for seepage loss, therefore boreholes will be constructed and monitored to assess the potential interaction between the TSF and the surrounding environment. Details of the management measures and monitoring are detailed in the site Water Management Plan.

Based on the non-toxic nature of the tailings, the impacts from seepage are expected to be negligible. However, as the waste water streams from the multi-media filters and the brackish water reverse osmosis plant will be discharged to the process water dam, there is potential for salt concentrations to build up within the process water cycle resulting in the salinity of the tailings stream increasing over time. Further, cleaning agents used for the filters could also be present in the tailings stream, albeit at extremely low concentrations.

TNG will complete periodic testing of the tailings stream to confirm the stability of the material during the mining operations.

Other Potential Sources of Water Contamination

In addition to the key Project aspects listed above, other features also have a potential to adversely impact water quality. Saline drainage from mine operations, explosives, chemical and hydrocarbon use and storage are other potential sources of water contamination associated with the Project. The ESCP and/or Water Management Plan provide the management actions proposed to mitigate risks.



7.6 Summary of Impacts and Conclusions

7.6.1 Surface Water

The Project site comprises numerous ephemeral dendritic drainage systems with a number of smaller watercourses originating out of rocky outcrops into the surrounding plains. The access road will cross Murray Creek, Wood Duck Creek and the Hanson River. Sites of Conservation Significance occur in the Project area, with Mud Hut Swamp, located in the floodout area of the Bloodwood Creek, and Stirling Swamp (Anmatyerr North Site), an interim floodout area for the Hanson River. Sediment sampling was undertaken to characterise sediment quality as a proxy for water quality given the infrequent nature of flow events within the region. Surface water and sediment samples will be collected prior to mining commencing to better characterise the Project area.

There are potential surface water impacts associated with the access road. TNG will construct at-grade floodways at Murray Creek and the Hanson River, so that natural streamflow and geomorphological processes are maintained. As there is no evidence of a single specific drainage line associated with Wood Duck Creek and surface flows in this vicinity are likely to present as sheet flow, TNG will install regularly spaced and appropriately sized culverts at this location. Sheetflow is also likely to occur along the access road within the alluvial plains to the east of the Stuart Highway. No specific drainage lines have been defined and regularly spaced and appropriately sized culverts will be installed across the access road to prevent the creation of sheetflow shadow zones.

A preliminary flood risk assessment indicates the mine site is not expected to experience any significant flooding for events up to the 50-year ARI. However, a bench of lower lying topography in the vicinity of the proposed mine pit may be prone to flooding during more extreme events. Further investigation is required to establish the need for flood protection measures in this area.

7.6.2 Groundwater

The predominant aquifer type in the vicinity of the pit is comprised of fractured and weathered rocks with minor groundwater resources. Accordingly, dewatering is not expected to yield adequate water for mine operations and alternative sources of water were investigated.

A borefield is proposed on the western bank of the Hanson River. The dominant geological unit here is alluvial deposits of a relict fluvial system largely covered by sheet sand and alluvial/red soil plain deposits. The increased thickness relates to the incised channels of the palaeodrainages of the Hanson River. This system is thought to be the northern discharge of the Ti Tree Basin, passing through Stirling Swamp and connecting with the existing Hanson River Channel. Utilisation of the Hanson River palaeovalley is currently limited to stock bores. Aquifer recharge predominantly occurs from direct infiltration of rainfall. Due to the sporadic and minimal amount of rainfall typical of the region, this volume is quite low. Large rainfall events and subsequent flooding is known to significantly increase groundwater levels in areas close to active flow channels.

Groundwater flow modelling was undertaken to assess the cumulative impact of the operation of the borefield and pit dewatering on nearby groundwater users (stock bores and potential groundwater dependent ecosystems). The MODFLOW-USG model configured in three-dimensional mode was used for simulations of both drawdown and recovery in annual increments over a period of 100 years (17 years of abstraction followed by 83 years of recovery). This also allowed the staging of the borefield operation to be assessed.



The modelling shows there will be groundwater draw down associated with the borefield and mine pit. Maximum groundwater drawdown at the borefield at the end of mining is modelled as being up to 12 m at the location of the operating bores in the centre of the borefield. Drawdown decreases significantly with depth away from the palaeovalley. The 1 m drawdown contour extends to around 6 km south of the borefield. At the end of mining, drawdown reaches a maximum of around 100 m within the location of the pit, and rapidly decreases with distance from the pit. The 1 m drawdown contour is predicted as being approximately 1 km from the pit edge, and the approximate limit of drawdown (0.05 m) a further 1 km from this.

Drawdown is predicted at several pastoral bores located close to the borefield, with groundwater levels expected to experience a drop in water level of greater than 3.0 m, which may lead to water supply problems. However it is proposed these wells could be deepened, if required.

Modelling predicts that Stirling Swamp and the outflow of the Ti Tree basin are unlikely to be impacted by either borefield abstraction or pit dewatering. Similarly, no drawdown impacts are expected at Mud Hut Swamp.

Following cessation of mining a shallow pit lake is predicted to form.

7.6.3 Contamination

The following is noted with regard to the ore and waste characterisation:

- ▶ the ore body and overburden have low sulphide contents and are considered benign in terms of potential acid formation, so the waste rock dump and ore stockpiles should not pose any discernible risk to the identified receptors and endpoints;
- ▶ the magnetite concentrate is inert and non-toxic and does not constitute a threat to identified receptors and endpoints; and
- ▶ the tailings stream will consist of non-magnetic silts and sands and will be dewatered using a flocculant in a tailings thickener. The potential hazard of the flocculant to humans is low and there are no known ecotoxicological effects.

A variety of chemicals and reagents will be used to facilitate construction and operation of the Project and will include explosives and hydrocarbons. Standard storage and handling measures will be implemented to reduce the hazards associated with these products. The Project will not use any environmentally hazardous chemicals that require special storage or handling.

To further reduce potential impacts to the environment, TNG has developed an ESCP and Water Management Plan to support this Project. The ESCP provides a framework for managing the risk of erosion and release of sediments to receiving environment and the contamination of stormwater. The Water Management Plan for mine operation has a particular focus on mine affected water to be retained within the mine water system.

Where there is the potential for the Project to release water to the environment, for example from high level overflow from sediment basins, water storage ponds and the tailings storage facility, TNG will apply for a Waste Discharge Licence from the NT EPA.

