

# HYDROGEOLOGICAL INVESTIGATION

Drilling program, Ministers North



EWP20050.001  
Draft A  
09 April 2021

## REPORT

### document status

| Version | Purpose of document     | Authored by | Reviewed by | Approved by | Review date |
|---------|-------------------------|-------------|-------------|-------------|-------------|
| Draft A | Draft for client review | JimDia      | RonCol      | NA          | 30/03/2021  |

### approval for issue

This report was prepared by RPS within the terms of RPS' engagement with its client and in direct response to a scope of services. This report is supplied for the sole and specific purpose for use by RPS' client. The report does not account for any changes relating the subject matter of the report, or any legislative or regulatory changes that have occurred since the report was produced and that may affect the report. RPS does not accept any responsibility or liability for loss whatsoever to any third party caused by, related to or arising out of any use or reliance on the report.

Prepared by:

#### RPS

Jim McDiarmid  
Hydrogeologist

Level 2, 27-31 Troode Street  
West Perth WA 6005

T +61 8 9211 1111  
E jim.mcdiarmid@rpsgroup.com.au

Prepared for:

#### BHP

Nick Quaglia  
Long Term Planner and Coordinator

Level 37 125 St Georges Terrace  
Perth WA 6000

T +61 8 6321 4712  
E nicholas.quaglia@bhpbillion.com

## Contents

|                                                |           |
|------------------------------------------------|-----------|
| <b>Executive summary .....</b>                 | <b>1</b>  |
| <b>1 BACKGROUND .....</b>                      | <b>2</b>  |
| 1.1 Business context .....                     | 2         |
| 1.2 Hydrogeological setting .....              | 2         |
| 1.3 Targeting rationale .....                  | 5         |
| <b>2 DRILLING PROGRAMME .....</b>              | <b>8</b>  |
| 2.1 Safety and environment .....               | 10        |
| 2.2 Pads and access .....                      | 11        |
| 2.3 Hydrogeology .....                         | 12        |
| 2.3.1 Water levels .....                       | 15        |
| 2.4 Water quality .....                        | 18        |
| 2.5 Ground conditions .....                    | 19        |
| <b>3 CONCLUSIONS AND RECOMMENDATIONS .....</b> | <b>22</b> |
| <b>4 REFERENCES .....</b>                      | <b>24</b> |

## Tables

|                                                                                                                                                 |    |
|-------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Table 1: Summary of planned work. ....                                                                                                          | 6  |
| Table 2: Summary of completed work.....                                                                                                         | 8  |
| Table 3: Risks and constraints for the drilling programme.....                                                                                  | 10 |
| Table 4: Hydrogeological observations during drilling .....                                                                                     | 12 |
| Table 5: Final airlift yields, first water strike (FWS) depth, Static water level (SWL) and comparison to pre-drilling prediction in mAHD ..... | 16 |
| Table 6: Field chemistry taken during the drilling programme .....                                                                              | 18 |
| Table 7: Summary of ground conditions .....                                                                                                     | 20 |

## Plates

|                                                                                                           |    |
|-----------------------------------------------------------------------------------------------------------|----|
| Plate 1: Typical headworks completion of monitoring bores (HMN0016M deep and HMN0015M shallow) .....      | 10 |
| Plate 2: Typical headworks completion of the production bores (HMN0013P).....                             | 10 |
| Plate 3: Goethite BIF from 132 m in HMN0009.....                                                          | 14 |
| Plate 4: Fresh magnetic BIF with large vuggy, limonite stained, siliceous chip from 128 m in HN0012 ..... | 14 |
| Plate 5: Final reaming of HMN0003 with extensive use of drilling foam .....                               | 15 |

## Figures

|                                                                                                                                            |   |
|--------------------------------------------------------------------------------------------------------------------------------------------|---|
| Figure 1: Simplified regional geology and structural setting of Ministers North (Kepert (2018)).....                                       | 3 |
| Figure 2: Proposed drill holes in relation to pit shell and the Keystone Fault .....                                                       | 3 |
| Figure 3: Cross section of the Werriba Anticline through the HMN0003 target .....                                                          | 4 |
| Figure 4: Interpreted “pre-mining” water level map based on static water level data taken from Andrszczuk (2019) .....                     | 5 |
| Figure 5: Proposed target location in respect to the proposed Ministers North pit shell, heritage and environmentally sensitive areas..... | 7 |
| Figure 6: Location and airlift yields of drilled monitoring and production bores .....                                                     | 9 |

|           |                                                                                                   |    |
|-----------|---------------------------------------------------------------------------------------------------|----|
| Figure 7: | Water level from all frontier piezo, monitoring bores and production bores in November 2020 ..... | 17 |
| Figure 8: | Expanded Durov diagram showing the water quality and water type of both production bores .....    | 19 |

## Appendices

- Appendix A: Bore construction details
- Appendix B: Bore logs
- Appendix C: Production bore Form 2
- Appendix D: Laboratory water chemistry
- Appendix E: Hydro BCR summary
- Appendix F: Frontier piezo bore logs

DRAFT

## EXECUTIVE SUMMARY

This report summarises the drilling and construction of two production bores and nine monitoring bores at the Ministers North project. The installed production bores are considered capable of supplying sufficient water for both crushing and dust suppression during mining, however test pumping was not undertaken during this programme.

The area to the east of the northern pit shell at HMN0013 had the highest airlift yield (up to 50 L/s) and showed signs of major faulting and fracturing, possibly due to the proximity to the Keystone Fault. Yields were also high on the north-west end of the Northern pit shell, with HMN0003 yielding more than 20 L/s.

A further four monitoring bores were installed for groundwater exploration and to augment the monitoring bore network. The main observation was that ground conditions on the north-western edge of the Northern pit shell become less prospective for dewatering as we moved towards the central pit area, with yields dropping from 8 L/s in HMN0005 to 5 L/s in HMN0009.

Additionally, five monitoring bores were installed to augment the environmental monitoring network around the environmentally sensitive Sanders Seep. Yields were generally relatively low (0.1–6 L/s) and the encountered geology was as expected. The exception was the occurrence of dolomite in HMN0017, and elevated yields (15 L/s) in the McRae Shale intersected the base of the Yandicoogina Creek gorge, west of Sanders Seep. Observed ground conditions suggested the enhanced permeability is likely associated with fracturing along the regional Werriba Anticline hinge axis.

Steep terrain caused some access issues, with earthworks undertaken to increase safety and contain discharge to avoid impacting infrastructure and environment sensitive areas.

Water quality across the project area was very fresh with EC less than 650  $\mu\text{S}/\text{cm}$  indicating that the groundwater is likely very near the point of recharge.

Water levels were depressed by an average of 1.5 m from predicted levels. Broad-scale drawdown has been observed since monitoring was first commenced in 2017, suggesting relatively good connectivity east to west, along strike of the bedding plane. Major impact from the mine dewatering activity to the north is considered unlikely due to the presence of low permeably Weeli Wolli Formation and lack of preferential drawdown along major structural features such as the Keystone Fault. It is suggested that the regional decline may be an expression of limited recharge driven by a lack of major high-intensity cyclonic rainfall events during the monitoring period, reduced recharge to the aquifer.

# 1 BACKGROUND

The Ministers North project is in the Northern Pilbara region, approximately 100 km north-west of the Newman township, between BHP's Mining Area C (MAC) and Yandi hub operations. As it is located along the MAC-Yandi rail line, Minister's North is uniquely positioned to provide options for Yandi volume replacement, utilising the Yandi hub infrastructure.

The Ministers North project is a proposed open cut mine on mining lease M266SA, which is due for development as apart of BHP's five-year mining plan. To accommodate the proposed mining schedule, some preliminary hydrogeological investigations are required to support its development. The development is complicated by a lack of water supply and the potential for adverse impacts to the nearby Sander's Seep, an important eco-hydrological feature to the east of the Ministers North project area.

## 1.1 Business context

To form part of an environmental approval for Ministers North, a hydrogeological investigation has been proposed to update the conceptual model for the project area and gain a more robust understanding of the impact that dewatering will have on nearby environmental receptors. This initial investigation entailed drilling to investigate options for water supply for dust suppression and crushers as well as expanding the environmental monitoring network.

The completed groundwater exploration drilling programme was designed to investigate two key aspects:

- Investigate sites with the potential to develop a water supply.
- Augment the existing monitoring network surrounding Sanders Seep.

Upon completion of the production bores, aquifer testing was to be undertaken to observe if impacts from groundwater abstraction are likely to propagate towards Sanders Seep. However, this phase of work was postponed

## 1.2 Hydrogeological setting

The Minister's North Project is situated within the northern region of the Hamersley Province within the Pilbara. The regional geology of the Ministers North project area is dominated by the Brockman Iron Formation and structurally controlled by the Werriba Anticline. The Werriba Anticline is a broad anticline of presumed Ashburton Orogeny age. It rests between the regional Yandicoogina Syncline to the north and the Yeeribiddy Syncline to the south (Figure 1).

Local topography in the proposed Ministers North project area is dominated by ridges formed by a series of low-lying hills running east-west crosscut with deep gorges. The elevation across the project area rises from 570 mAHD in the valley floor in the east up to more than 650 mAHD along the main ridgelines. The ridge to the south west of the project area rises to more than 800 mAHD.

Maximum daily temperatures at the Yandicoogina mine to the north average 39 °C during summer months, dropping to 23 °C during winter. Mean rainfall is recorded as 310 mm per year, while total evaporation is estimated at 3400 mm. The area is defined by long dry periods followed by short periods of intense rainfall events driven by cyclonic activity. These large rainfall events are the primary mechanism whereby the regional aquifers are recharged.

The main geological feature is the broad doubly plunging, WNW to ESE trending Werriba Anticline, located between the Yandicoogina syncline in the north and Mining Area C in the south (Figure 1). Stratigraphy ranges from the Mount Sylvia Formation underlying the centre of the anticline to the Weeli Wolli Formation located on the distal flanks, with the bulk of the economically significant material hosted within the Brockman Iron Formation (Androszczuk, 2019).

Figure 2 shows the geology overlain on the topography taken from Androszczuk (2019). The centre of the Werriba Anticline is formed by the Mt McRae Shale and likely underlain by the Paraburdoo Member. The limbs of the anticline consist of mineralised Brockman Iron Formation. The Dales Gorge Member sits directly on top of the Mt McRae Shale and as is common throughout Brockman deposits the D2 and D4 units are the main hosts for mineralisation (Thompson, 2017). This is overlain by The Mt Whaleback Shale Member and the Joffre Member.

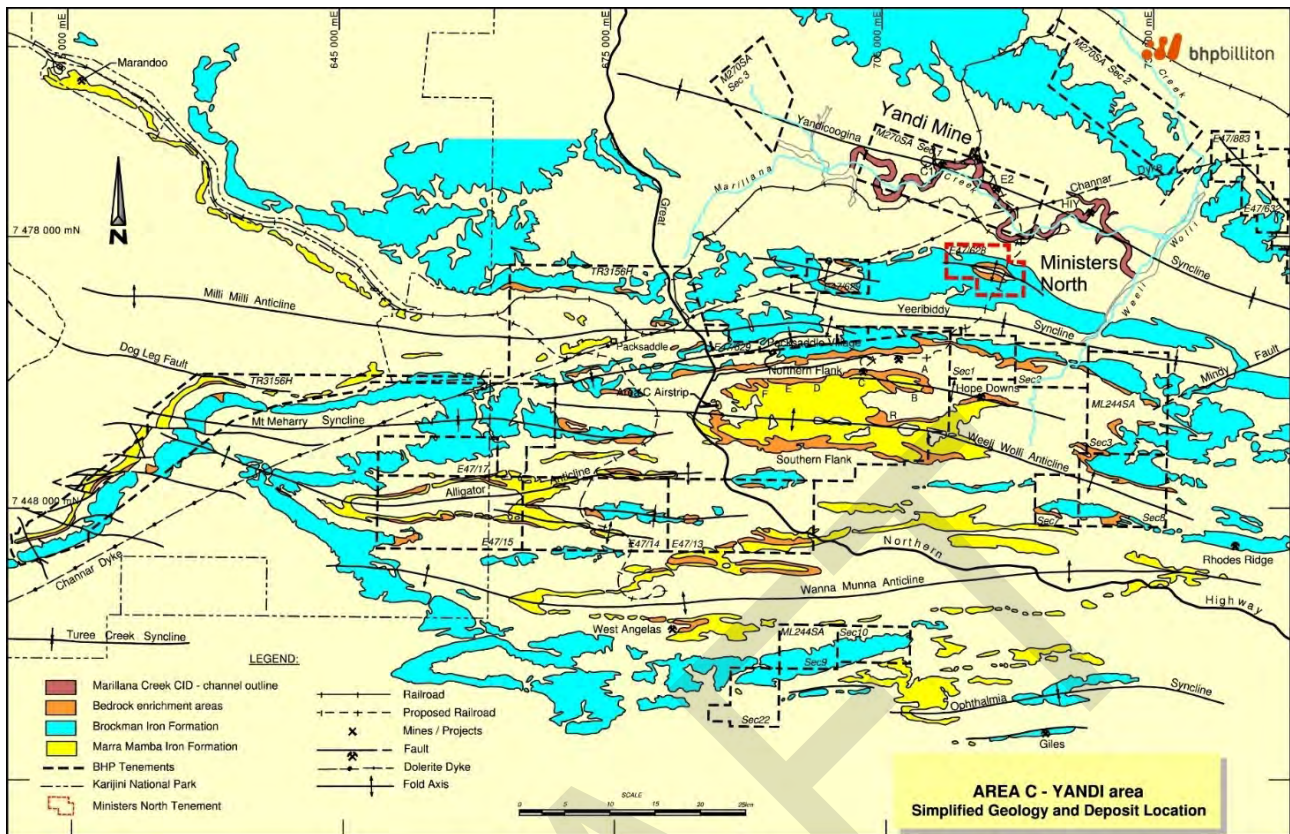


Figure 1: Simplified regional geology and structural setting of Ministers North (Kepert (2018))

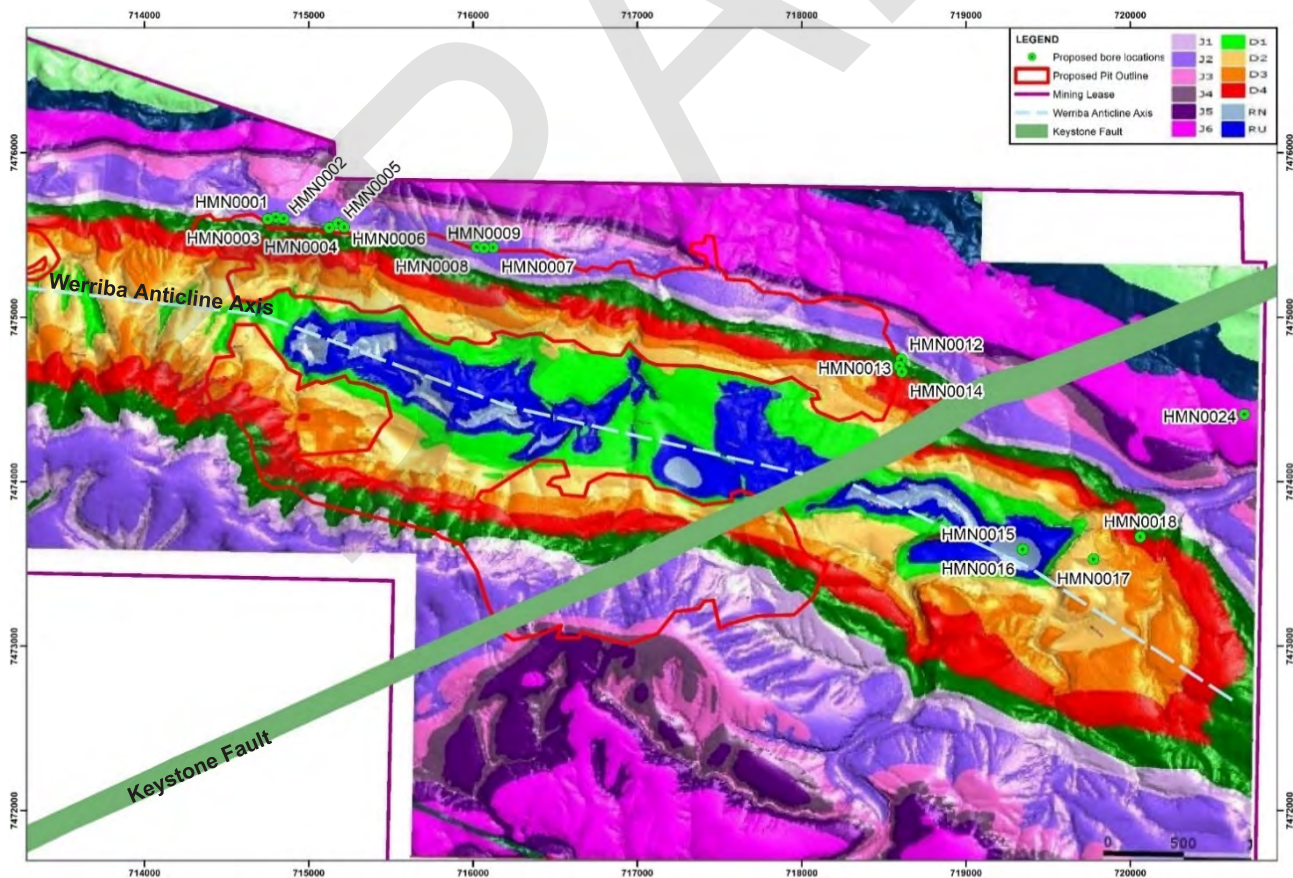


Figure 2: Proposed drill holes in relation to pit shell and the Keystone Fault

The two proposed pit shells target the mineralised Brockman Iron Formation on the limbs of the anticline, which are hosted in broadly WNW–ESE striking bedding, with a moderate dip to the north and a gentle dip to the south. The hinge of the Werriba Anticline is generally more deeply eroded and changes in the east of the deposit from WNW–ESE to NW–SE. The deeper erosion along the centre of the anticline is likely due to preferential weathering along extensional fractures formed within the brittle BIF layers during deformation.

A cross-section of the Werriba Anticline with associated geological units in relation to the proposed pit shells is given in Figure 3.

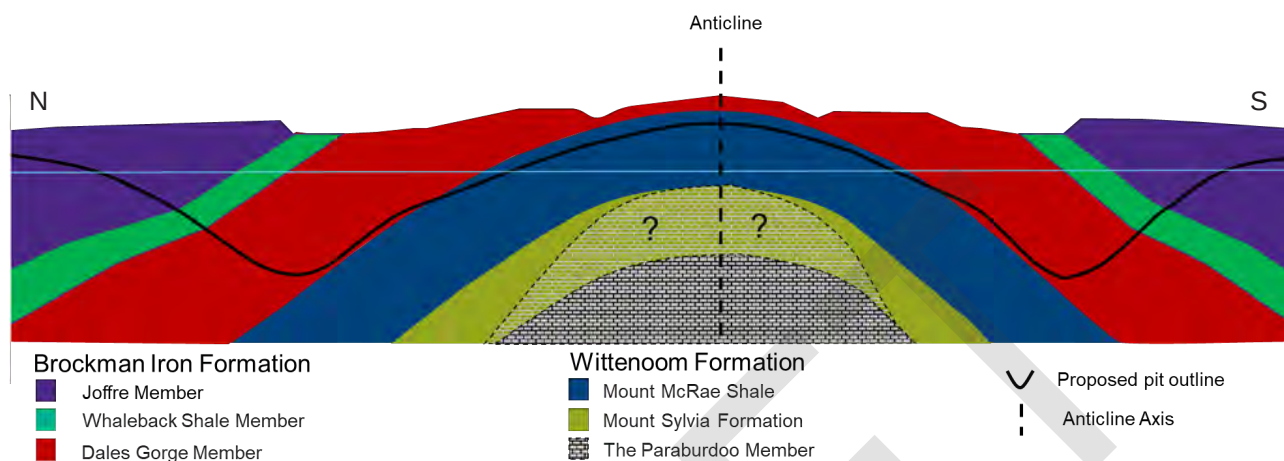


**Figure 3: Cross section of the Werriba Anticline through the HMN0003 target**

Parasitic folding on northern limb of the Werriba Anticline is an important target for drilling as the process thickens up the ore-bearing horizons (D2 and D4) and is inferred to create structurally induced permeability. Mineralisation within the Dales Gorge Member follows the geometry of the Werriba Anticline, extending laterally along strike and down dip to depth.

The mineralisation style is typical Brockman martite-goethite (M-G) composition, considered to be the result of supergene enrichment. The martite-goethite ores are characterised by high porosities (10–30%) (Taylor et al., 2001). The process of mineralisation enrichment enhances porosity within the host rock by the removal of silica (quartz). Weathering is likely to occur to some depth within the main ore bearing zones, with oxidation of the rock destroying primary texture and forming secondary fractures vugs and cavities, which can greatly increase localised porosity.

Further to the north lies the Weeli Wolli Formation, which is comprised of low permeable shales, jaspilite BIF, basalt, and dolerite dykes that form a natural barrier to groundwater flow in this direction.

The Keystone Fault is a major fault which trends NE across the eastern side of the proposed pit shells (Figure 2). The Keystone Fault is a normal fault trending SW–NE with 10–15 m displacement. The anticline axis rotates from roughly NW–SE to NNW–SSE and the anticline begins to plunge (Androszczuk, 2019). The hydraulic properties of the fault are currently unknown; however, it is a potential pathway of preferential flow, driven by increased permeability along fracture pathways. There is potential for enhanced permeability along multiple minor fault zones running through the project area associated with NE–SW trending valleys incised into the landscape that occur as major ridge line incisions.

An array of frontier piezometers was installed during the initial resource drill-out of the Ministers North project in 2017 and 2019. These monitoring points consist of 50 mm PVC casing with variable screen lengths installed in open RC exploration holes. Bore construction is usually completed by suspending the 50 mm casing from 6 m of 150 mm PVC surface casing with metal clamps and a surface seal of two part expanding polyurethane foam is installed. Frontier piezometer bore logs with construction details can be seen in Appendix F. Pressure transducer loggers were installed in these bores for long term water level monitoring.

Interpreted pre-mining water levels at Minister's North were found to range from 562.8 to 564.6 mRL, with a slight groundwater gradient to the north-east where mine dewatering activity off lease has drawn the water table down to 532 mAHD. The Yandicoogina Creek is also thought to act as a drain for groundwater, with water levels likely depressed in areas of topographic low along the base of the gorge.

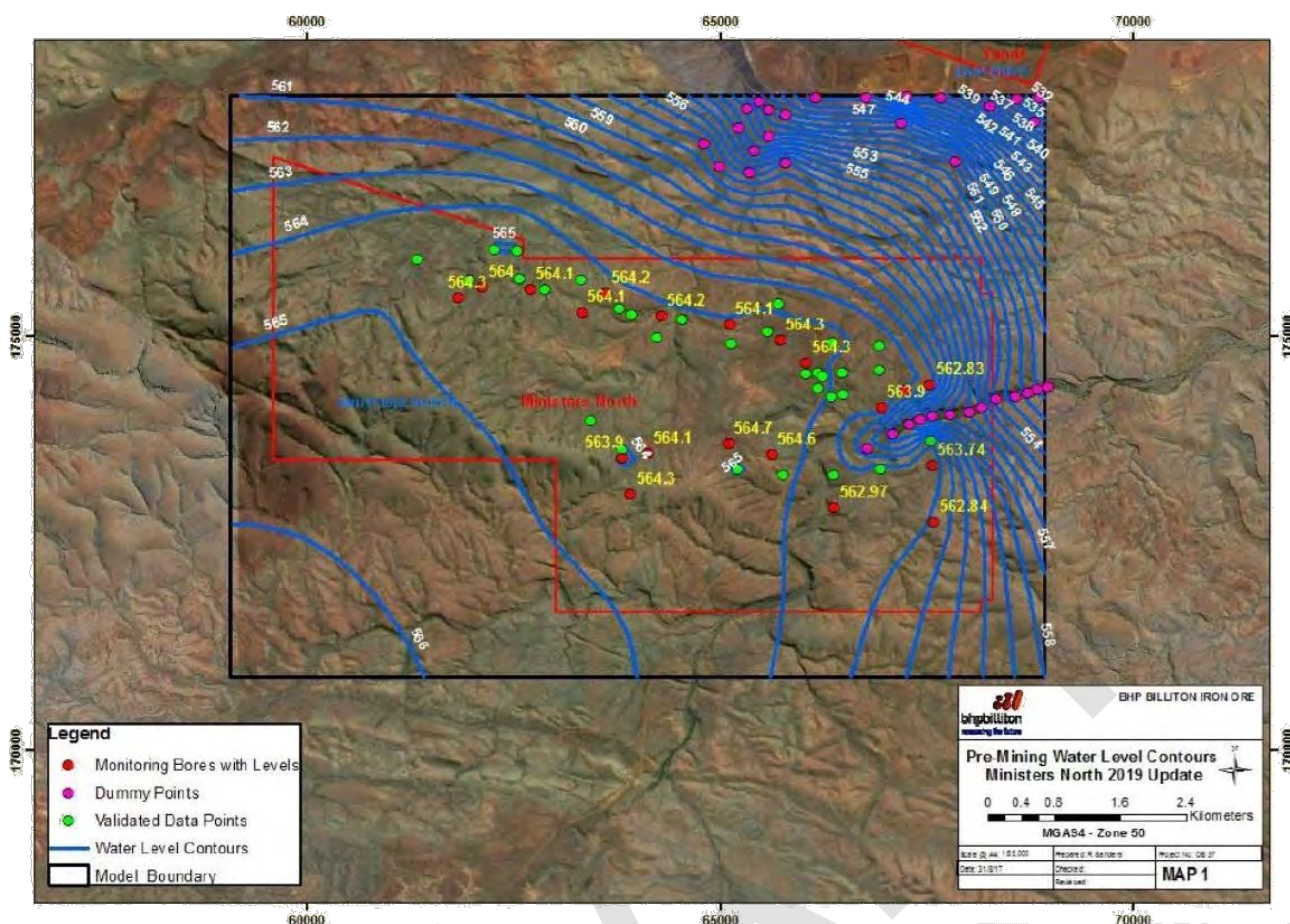


Figure 4: Interpreted “pre-mining” water level map based on static water level data taken from Andrszczuk (2019)

### 1.3 Targeting rationale

The Ministers North project is expected to require two additional 170 m deep production bores for water supply purposes. A production bore location furthest north-west was initially favoured due to proximity to a proposed crushing facility which would be installed near this location. An additional bore was also required in the southern area of the project for supplying dust suppression water during construction and operation. Due to limited knowledge of potential hydrogeological outcomes prior to commencing the current drilling programme, a staged approach was taken to ensure successful placement of the production bores.

Proposed target locations are shown in Figure 5 with respect to the future pit shell as well as heritage and environmentally sensitive area.

The initial programme for drilling envisioned drilling up to 12 pilot holes in four separate groups on the north-western and eastern edge of the northern pit shell (Figure 5). The results of drilling the pilot holes would then be assessed and the best location for providing water in the east and west of the Northern pit shell would be chosen for construction of two water supply production bores. These production bores may also be suitable for future dewatering when mining commences.

Pilot hole locations not chosen for production bores were to be constructed as monitoring bores to augment the environmental monitoring network and enable monitoring of regional drawdowns during pumping tests of the production bores. Hydrogeological information gained from the pumping tests is a key component to informing the conceptual hydrogeological model that contributes to the mining approvals process.

A summary of the proposed drilling programme is provided in Table 1.

**Table 1: Summary of planned work.**

| Programme        | DR no. of holes | DR (m) | Gamma | OTV | ATV |
|------------------|-----------------|--------|-------|-----|-----|
| Monitoring bores | 17              | 2,510  | N     | N   | N   |
| Production bores | 2               | 340    | N     | Y   | Y   |

To enable a better understanding of environmental impacts from future mining and potentially dewatering of the Ministers North project, the existing environmental monitoring network required additional monitoring locations. Sander's Seep is in an area of particular environmental sensitivity and is currently considered to be a natural expression of groundwater. Sanders Seep is located within the environmental sensitive area around Yandicoogina Creek to the east of the Ministers North project. Groundwater is suspected to emerge in the streambed and sustain groundwater dependent ecosystem (GDE).

Targeting of monitoring bores was aimed at increasing the hydrogeological knowledge surrounding Sanders Seep. Evidence provided by Lawton and Sander (2019) for surface pools being supplied by groundwater seepage include:

- The presence of groundwater dependent vegetation (*Melaleuca argentea* open forest)
- Similar electrical conductivity (696  $\mu\text{S}/\text{cm}$ ) in seepage water to that of nearby groundwater samples
- Damp soil supporting sedge grasses at the base of the at the base of the valley walls
- Projected groundwater elevations outcropping at the known elevation of the pools.

The augmentation of the environmental monitoring network consisted of five new monitoring bores at 50–120 m deep around the Sander's Seep area. One location on the base of the gorge was picked to have shallow (50 m) and deep (100 m) monitoring bores to establish the depth to groundwater and any vertical differences in piezometric head. The potential for confined aquifers within the Mt McRae Shale units could be an important contribution to the conceptual hydrological model of the area. Three additional monitoring bore locations on the northern and southern walls of the gorge surrounding Sander's Seep were chosen to target key lithologies that could be hydrologically connected to the seep, and hence offer insight into its hydrogeological behaviour.

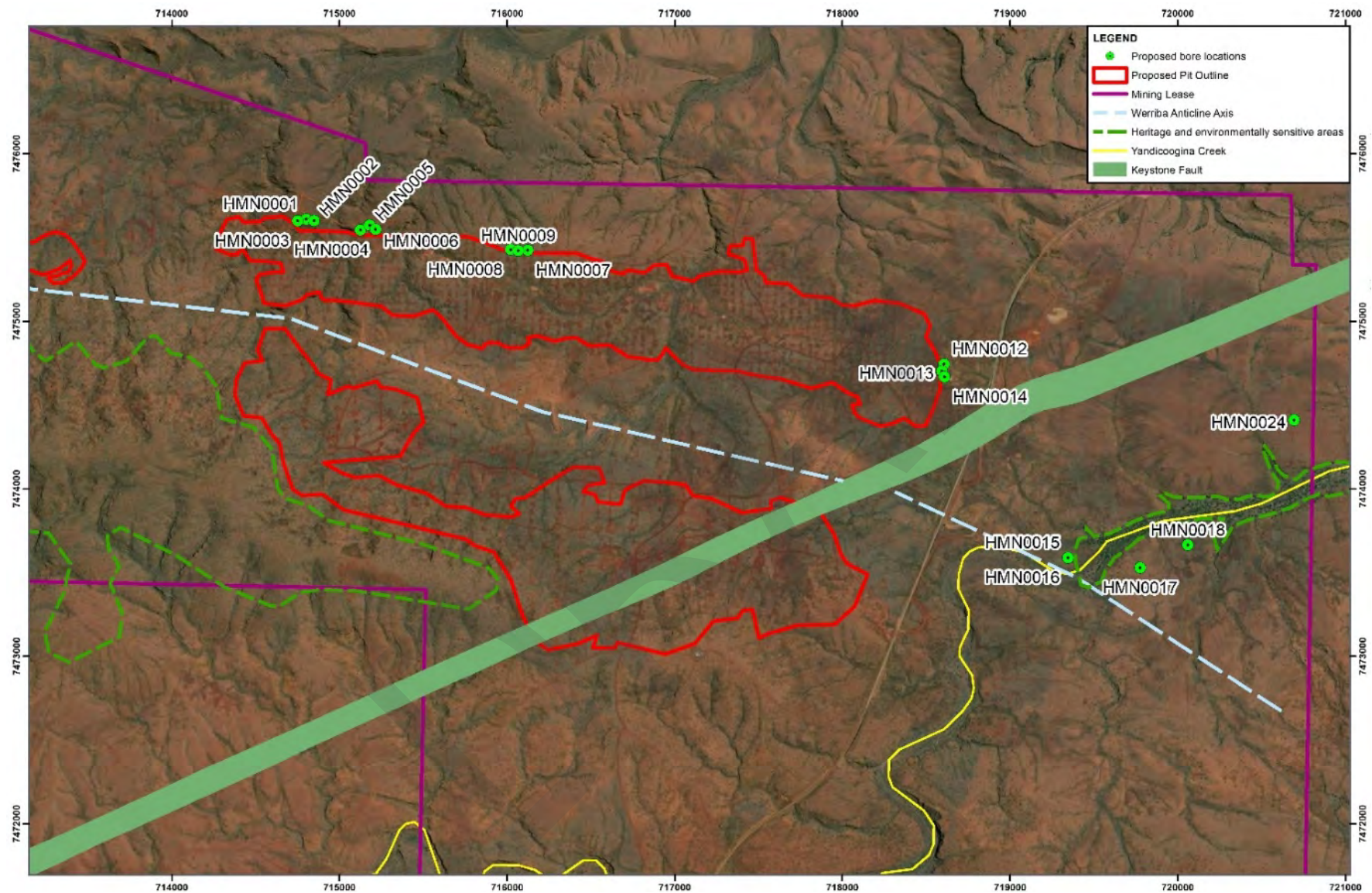


Figure 5: Proposed target location in respect to the proposed Ministers North pit shell, heritage and environmentally sensitive areas

## 2 DRILLING PROGRAMME

The drilling and installation of two production bores and nine monitoring bores was undertaken by Welldrill using a Fraste FS500 conventional hammer (CH) water bore drill rig between 09 June 2020 and 07 August 2020. Final drill locations are shown on Figure 6. Technical supervision was provided by BHP Stewardship and Technical, with RPS' hydrogeologists undertaking geological logging and monitoring of discharge rates and groundwater water quality (pH and EC) during drilling.

A summary of the completed work is provided in Table 2.

**Table 2: Summary of completed work**

| Programme        | DR no. of holes | DR (m) | Gamma | OTV | ATV |
|------------------|-----------------|--------|-------|-----|-----|
| Monitoring bores | 9               | 1,109  | N     | N   | N   |
| Production bores | 2               | 348    | N     | Y   | Y   |

All bores were constructed according to BHP criteria that meet or exceed the mandatory and recommended best practices detailed in the Minimum Construction Requirements for Water Bores in Australia (4th Ed, 2020).

Typical surface completions for the bores are shown in Plate 1 and Plate 2.

Monitoring bores were constructed using 50 mm Class 18 PVC-u within 203 mm diameter drill holes. Slotted 50 mm PVC-u Class 18 with 1 mm aperture was installed from near the water table to varying depths below the water table then completed with 3.2–6.4 mm gravel pack to surface and topped with a cement plinth and steel headworks (Plate 1).

Production bores were drilled in a three-stage process, an initial 203 mm pilot hole, widened out with a 305 mm ream and a final 432 mm ream. The production bores were then constructed using 305 mm steel casing with 50 to 60 m of 305 mm, wire-wound stainless-steel screens with 1 mm aperture installed at the target aquifer depth. The bores were gravel packed to surface with 3.2–6.4 mm gravel pack and topped with a cement plinth and steel headworks (Plate 2).

Full bore construction details are provided in Appendix A and bore construction diagrams in Appendix B. The completed FORM 2 document is also included in Appendix C for production bores and a copy of the water quality laboratory analysis results is included in Appendix D.

After drilling four pilot holes, two on the north-east corner and two on the southern edge of the North pit shell, it was apparent that sufficient water would be available from these locations for water supply purposes. Of the two pilot holes drilled at each location, the best one was chosen for the construction of a production bore, while the other was completed as a monitoring bore. This decision was based on the observed airlift yield, the degree of weathering and alteration/enrichment of the formation that had occurred and extend of fracturing and broken ground noted during drilling.

The remaining two locations (HMN0005, HMN0009) on the north side of the proposed pit shell were drilled as monitoring bores to obtain hydrogeological information and augment the monitoring network. This approach did result in seven unused pads and sumps being constructed but allowed the flexibility to adapt the drilling programme to the ground conditions uncovered during drilling, ensuring the best outcome.

All targets to the east of the project area surrounding Sanders Seep were drilled to planned target depths and installed as monitoring bores and all design criteria and technical objectives were met.

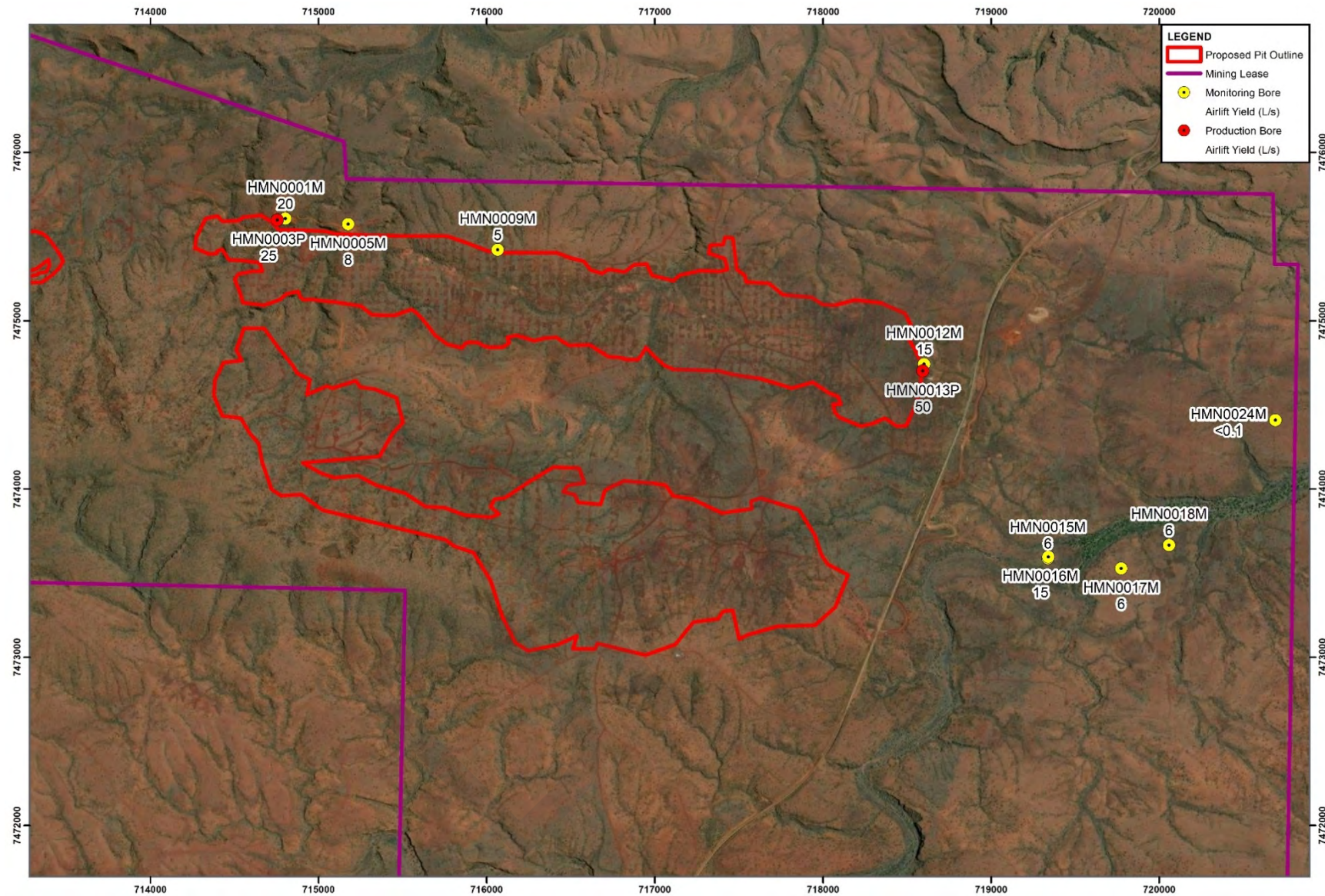


Figure 6: Location and airlift yields of drilled monitoring and production bores



**Plate 1:** Typical headworks completion of monitoring bores (HMN0016M deep and HMN0015M shallow)



**Plate 2:** Typical headworks completion of the production bores (HMN0013P)

## 2.1 Safety and environment

A summary of the anticipate risks and constraints identified during the programme planning stage is presented in Table 3.

**Table 3: Risks and constraints for the drilling programme.**

| Technical risk                       | Risk addressed | Comments / actions                                                                                                                            |
|--------------------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Reactive geology                     | Y              | Reactive geology was expected at two locations, with sumps constructed to contain discharge.                                                  |
| Fibrous Material                     | Y              | Based on the interpreted geology, fibrous intercept is highly unlikely as we are drilling through mineralised Dales Gorge sequence primarily. |
| Discharge management whilst drilling | Y              | High yield anticipated with water quality expected to be well within discharge limits.                                                        |

No major safety incidents occurred during the drilling campaign.

Reactive ground was anticipated, with HMN0015, HMN0016 and HMN0017 intersecting pyritic black shale of the Mt McRae Shale. Data was captured in data tracking and all discharge and drill spoils contained on the pad and within the sump.

No fibrous material was expected or encountered during the drilling programme.

Discharge was managed to ensure field water quality parameters where within discharge management plan limits, and erosion controls were in place. No discharge was allowed from the monitoring bores to the east surrounding Sanders Seep as this had the potential to impact the Sensitive Pilbara Drainage buffer zone.

Drilling was intended to commence at Sander's Seep, but poor communication was identified as a safety risk for drilling in this area, with no mobile or tetra reception. A JHA was implemented to manage communications while drilling around Sander's Seep (i.e. satellite phones at rig and in support vehicles). As tetra radios were out of range for bores around Sanders Seep the supervising hydrogeologist kept a satellite phone powered on to ensure communication with geoscience was possible in case of an emergency event.

The steep terrain around Sanders Seep was the main environmental issue impacting safety with communications and sections of steep access track. On the initial attempt to mobilise the drill rig from HMN0016 and HMN0017 the compressor truck towing an auxiliary compressor trailer was unable to navigate the steep section up Rusty's Ramble, having to back down the steep incline.

WellDrill procured a more capable 8WD support truck to mobilise equipment to the site. Travel of the rig and support trucks through this area was managed by a separate JHA and involved trucks navigating the steep sections one at a time in low gear. This process added additional time to rig moves to and from this area.

Drilling on the valley floor at the HMN0015/HMN0016 location encountered higher than expected yields. This area was also near multiple heritage and environmental exclusion zones, so no ground disturbance or discharge could leave the pad/sump. During the drilling of HMN0016, black shales were intersected which coincided with large yields (>20 L/s). This limited the total discharge to the existing sump as no further earthworks or discharge was possible. During the drilling of HMN0016, the sump was reaching its contaminant capacity at 75 m and the hole was determined to have achieved its technical object and the monitoring bore was terminated 25 m short of target depth. In rod installation was deemed necessary for the best chance of successfully constructing the bore to depth while minimising discharge volumes to ensure water containment. This was necessary due to broken and loose formation which would have required extensive hole development and possible deepening to install the monitoring bore to target depth.

The location was then left to later in the drilling programme to allow the sump to drain before commencing the drilling of HMN0015. HMN0015 was then drilled at this location and successfully installed to a depth of 40 m, with all water contained within the sump.

During the drilling of HMN0013 water was observed exiting the project area and crossing the rail access track. As high volumes of vehicle travel were occurring along this track due to track maintenance being carried out at the time, it was decided to manage the risk and ensure the rail access track remained safe and trafficable. Earthworks were undertaken to manage the discharge of water and contain it within the project area with a large sump, excavated in the gully below the HMN0013 to capture discharge water.

The sump for the HMN0003 was undersized for a production bore. The sump was unable to be extended due to its location at the top of a steep cliff and hard silicious cap rock. Drilling was successfully undertaken but some material exited the sump due to overshooting the walls of the sump when high yields were encountered. The rocky nature of the material used to construct the sump led to seepage from the base of the sump during drilling, which limited the sump's capability to act as a sedimentation pond to limit the solids carried by the drill discharge water. Water exiting the sump flowed down the valley to the north and across the accessway but remained on BHP tenements. Some delays were experienced managing the sump for safe disposal and allowing sediment load to decrease in the discharge water. All water was within prescribed field parameters for safe disposal. Some ponding occurred at the base of Damo's Dip as discharge from drilling crossed the access track during drilling and development of HMN0003. Discharge was managed, with additional drainage created to minimise impact on the track, prevent erosion and ensure the track was safely trafficable as an alternative emergency exit from the project area was not available.

## 2.2 Pads and access

Drill target locations took advantage of existing access tracks to minimise required earthworks and clearance. Where new access tracks had to be pushed in, they were generally well constructed and clear of loose boulders and sticks. Pad size was the standard 30 m by 30 m with adjacent sump layout for conventional hammer drilling. Prepared earthworks were generally acceptable at the commencement of the programme; however, some minor issues require additional attention to safely conduct the drilling programme.

Earthworks were required to revisit sections of the project area to fix up sumps and road access. The additional cost was minimised as the need for additional earthworks was identified early and issues rectified while the earthworks contractor was still in the Ministers North area preparing for an upcoming RC drilling programme.

Three sections of steep terrain were identified at the start of the drill campaign as being high risk for rig movement, Rusty's Ramble, Kiwi Kink and Damo's Dip. Earthworks were remobilised to these sections to decrease the slope angle, remove loose gravel from the track surface and reduce the angle of attack at the base of the gullies.

The pad at HMN0017 was smaller than standard 30 m by 30 m being 24 m wide. Welldrill was able to safely adapt to the smaller pad by backing in the compressor in front of the rig. This was not ideal as it created a restricted pad and additional time was taken mobilising to site and planning a safe pad layout.

Some sumps were built out of loose rock material from pad excavation and were deemed likely to leak during drilling. As there was not an easily achievable solution due to the steep and rocky terrain, the decision was taken to manage discharge during the drilling programme to ensure no negative environmental impacts.

HMN0009 was terminated at 162 m, eight metres short of target depth due to high TSS in uncontrolled discharge from the sump but had achieved its technical objective. Rocky material in the sump wall allowed drainage from the base of the sump with minimal retention of sediment laden water.

The pad on HMN0013 was constructed on the uphill side of the drill pad. As the yields from this bore were high, a blank section of steel casing was dug into a trench across the access track and buried to allow water to exit the sump and maintain safe egress in case of an emergency. The additional earthworks were undertaken by the drill crew utilising their backhoe.

The gully below the production bore HMN0003 (Damo's Dip) required minor additional drainage carried out by the drillers backhoe to ensure the access track remained trafficable during drilling as discharge from this hole was running over the access track.

## 2.3 Hydrogeology

Encountered geology was comparable to the modelled geology on the western side of the railway, adjacent to the proposed pit shells. This was expected due to the extensive resource drilling that has been undertaken in the area. Recorded ground hydrogeological observations for each bore are given in Table 4 with bore construction and hydrogeological details given in Appendix A and Appendix B respectively.

**Table 4: Hydrogeological observations during drilling**

| Bore ID | Monitoring and production bore groundwater observations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HMN0001 | Yield increased from 90 m where a first water strike (FWS) of 2 L/s was observed to between 18 and 20 L/s at 156 m and remained constant at 20 L/s to EOH. A dark grey clay layer was intercepted from 82 to 90 m, believed to be manganese-rich Whaleback Shale, possible confining layer (no pyrite and followed by Dales Gorge so unlikely to be McRae Shale).                                                                                                                                                                                                                                                                                                                                                                                                                            |
| HMN0003 | FWS at 74 m, very minor flow to 1 L/s at 90 m coincided with transition from weathered shale/clay to harder moderately weathered BIF and Chert. Yields then increased sharply at 100 m to 7 L/s in a fracture zone with large blocky chips with heavy staining and minor dissolution vugs. Yields stabilised at 10 L/s towards the base of the fracture zone at 120 m and remained consistent through to 140 m. This low flow section (120–140 m) was predominantly slightly weathered hard, non-fractured BIF and Chert. The formation then became more fractured between 144 to 156 m with large blocky chips and yield increasing to 18 L/s and remaining between 18–20 L/s to EOH. Extensive drillers foam was used to clear cuttings from this section during the final ream (Plate 5). |
| HMN0005 | FWS was observed at 88 m with less than 0.1 L/s with a dark manganese rich shale layer intercepted from 90–102 m yielding 1 L/s. Airlift yields increased to 4–5 L/s between 114–126 m in hard, fresh magnetic chert rich BIF. Between 135 and 170 m yield increased to 8 L/s associated with goethite mineralisation, larger chips and limonite staining. A small fracture zone with larger chunky chert chips and a slight increase in yield was observed at 156–158 m.                                                                                                                                                                                                                                                                                                                    |
| HMN0009 | FWS occurred at 114 m in the hard rock below the base of the Mn-rich Whaleback Shale. Yield increasing from less than 0.5 L/s at 114 m to 3.5 L/s by 138 m in slightly weathered goethite rich BIF, with more fracturing observed below 132 m (Plate 3). Airlift yield then increased to 5 L/s at 148 m to 150 m associated with a broken/layered zone of fresh, very hard magnetic BIF with increased fracturing at depth. Yields then remained consistent to EOH at 162 m.                                                                                                                                                                                                                                                                                                                 |

| Bore ID | Monitoring and production bore groundwater observations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HMN0012 | FWS was encountered at 51 m with a yield of less than 0.1 L/s. Fresh, partially mineralised Cherty BIF was intercepted between 58 to 104 m, which was hard with slow drilling penetration. Yield increased in fracture zones at 74 m, 82 m and 90–94 m. Fractured chert band from 104–108 m increased yield to 12 L/s. Minor increases in yield (15 L/s) at 128 m and 140 m with well-developed vuggs present (Plate 4). Ground became very hard and non-fractured below 144 m. Possible minor fracturing was observed from 160 to 162 m and vuggy silicious fracture infill from 166 to 168 m with no corresponding increase in yield observed.                                                                                                                                                                                                                                                                                      |
| HMN0013 | During drilling of the pilot hole, the FWS of <0.1 L/s was at 54 m, with yield increasing to 6 L/s at 66 m in broken ground. Little to no yield was observed between 70 m and 102 m in extremely broken ground due to loss of air to the formation, extensive foam was used to lift cuttings with poor sample return. A higher flow zone was intersected between 108 m and 120 m, with yields increasing to 10 L/s in broken ground and larger chips with dissolution vuggs. Drilling below 150 m became hard with yields increasing to 13 to 14 L/s. This increase in yield could be due to the hard rock stabilising the airlift yield and allowing return to surface.<br>Airlifts likely underrepresent available yields due to air loss to formation with air escaping from nearby RC holes and monitoring bores up to 200 m away. Final airlift yields during development of the production bore were estimated at up to 50 L/s. |
| HMN0015 | Drilled to 42 m in loose formation with large, brecciated chert cobbles >100 mm. Yield increased below 20 m and remained relatively stable at 7 L/s to EOH, with a slight increase observed during final development, probably due to clearing of hole. Potentially intersected a carbonate turbidite.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| HMN0016 | FWS 12m, broken ground and increasing yield between 24 and 40 m (10 L/s). No yield at 42 m to 48 m due to hole collapsing around drill string. Base of loose material interpreted at 42 m, fine black shale with pyrite (Mt McRae) drilling becoming stable below 52 m with a constant yield of 15 L/s. Sump fill by 75 m with hole producing a steady 15 L/s with no discharge allowed due to pyritic black shale.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| HMN0017 | FWS of 2 L/s at 54 m, slowly increasing to 6 L/s between 68 to 84 m in at the top of a black shale unit (Mt McRae). Yield remained constant to end of hole, with no observed increase in yield in the fresh dolomite intersected in the final 8 m of the hole. Non-pyritic black shale was encountered, no discharge occurred.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| HMN0018 | FWS was noted at 53.5 m with yield increasing gradually with depth down hole from 2 L/s at 54 m to 6 L/s at 100 m. Minor fracturing was observed between 78 and 94 m in fresh, unmineralised magnetic BIF.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| HMN0024 | Minor yield (<0.1 L/s) observed at 90m, with sporadic wet sample below 92 m. Hard, non-fractured fresh rock. Final airlift <0.1 L/s at 120 m. Magnetic BIF intercepted, but no asbestos observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

After drilling the pilot holes at HMN0001 and HMN0003, HMN0003 was chosen for the production bore due to the higher yields and the extent of broken ground at depth, which suggested higher yield potential. Yields in the mineralised D4 unit were around 10 L/s with the most prospective zone of permeability occurring in a zone of broken ground associated with the top section of the D3. Dissolution vuggs and mineral coating on fracture planes within the high flow zones suggest both locations intersect well developed fracture zones at depth. This could be due to their location on the limb of the anticline, or a cross-cutting fault zone.

HMN0005 and HMN0009 were less prospective for developing production bores. The ground was generally poorly weathered, mineralised and fractured at depth. While some permeability was observed in the mineralised sections in HMN0005, the zones of highest yield were associated with harder, fresh cherty BIF units, possibly associated with extensional fractures in the limbs of the anticline in the more brittle/competent BIF units. Airlift yields were lower than anticipated with water levels up to 100 mbgl in HMN0009, which likely limited the ability for airlifting to bring water to the surface without loss to the formation. As such these locations might still prove to be viable dewatering targets.

The targeted drill locations at the eastern edge of the Northern pit shell were located near the known Keystone Fault. Airlifts in HMN0013 during drilling (14 L/s) were significantly impacted by air loss to the formation, with final airlift yields from the completed production bore as high as 50 L/s. Large blocky chips in the D2 goethite zone where association with extensively broken ground and dissolution vuggs. HMN0012 also intersected extensively fractured ground, with a well-developed vugg rich zone towards the end of the hole. While no direct evidence of a major fault zone was observed, the close proximity of the mapped Keystone Fault likely explains the extensive broken, unstable ground and dissolution vuggs encountered at this location.

Intersected geology to the east of the railway, outside of the future Ministers North project area, has had significantly less resource exploration drilling and minor deviations from expected geologies were encountered.

Bores on the ridges surrounding Sanders Seep were found to be generally low yielding, with poorly developed fracture networks. The monitoring bores (HMN0017, HMN0018 and HMN0024) on top of the cliffs surrounding the Sanders Seep were drilled without issue in hard competent rock with minor yields. The lower yields of 6 L/s were attributed to the relatively fresh and unmineralised formation, with HMN0024 having little to no flow during drilling.

Drilling at HMN0017 showed that the black shales of the Mt McRae Shale were unexpectedly truncated by dolomite, likely of the Wittenoom Formation at 92 metres. The Mt McRae Shale was only 24 m thick at this location. Dolomite which has been weathered can have karstic features and high yields. Drilling found the dolomite intersected in HMN0017 to be fresh rock, poorly fractured and produced poor yields.

At the base of the Yandicoogina Creek gorge west of the project area, the Mount McRae Shale was modelled to be intersected between 50 and 100 m. Some uncertainty remains about the exact stratigraphic unit encountered in HMN0015/16, with extensive breccia and loose, broken ground encountered to 42 m. This unit consisted of large angular micro banded cherty BIF in a fine-grained iron rich matrix. It is also possibly fresh carbonate turbidite which is known to occurred on the D1/Mt McRae Shale contact in this area. The large cobbly, broken nature of the formation is likely due to fracturing associated with the Werriba Anticline hinge axis which is mapped at this location.

Plates 3, 4 and 5 provide snapshots from the drilling programme.



**Plate 3:** Goethite BIF from 132 m in HMN0009



**Plate 4:** Fresh magnetic BIF with large vuggy, limonite stained, siliceous chip from 128 m in HN0012



**Plate 5: Final reaming of HMN0003 with extensive use of drilling foam**

### 2.3.1 Water levels

Water levels in each production and monitoring bore were taken after a sufficient period had elapsed to ensure the water levels were fully recovered from drilling and development. Of note was HMN0024, which slowly recovered over the week following construction. This was not unexpected, as the yield in this bore was particularly low with no evidence of major fracturing observed during drilling.

The recorded static water levels were consistently below the predicted water level across the project area as shown in Table 5. A round of data logger retrieval and water level dipping was also undertaken across the project area in November 2020, with all available water levels mapped in Figure 7.

Water levels across the project area are relatively flat lying with no clearly discernible flow direction. Water levels in monitoring bores located within the Ministers North project are generally between 562.2 and 562.6 mAHD. A slight gradient to the east is possibly present, with a slight decline of 0.6 m from the western edge of the northern pit shell to the bores located to the north of Sanders Seep, with bores surrounding Sanders Seep being general below 562.0 mAHD. This observed drop in water levels is most likely driven by changes in topography and the presence of the Yandicoogina Creek gorge, although the Keystone Fault is noted to occur in proximity to where the change in water levels occur.

The consistent groundwater levels across the Ministers North project could be due to the majority of bores being installed along strike of the major bedding plane within the formation, however the recently installed bores within the stratigraphically deeper Mt McRae Shale units also demonstrate a similar water level. This suggests that fracturing along the Werriba Anticline hinge axis is also contributing to groundwater movement.

When comparing the recent water levels in Figure 7 to the historic “pre mining” water levels shown in Figure 4, water levels are depressed across the whole project area, with drawdown averaging 1.5 m since 2019. This would suggest a larger, regional water level depression. The major groundwater users in the region are significant mine dewatering activity in the north at the BHP Yandi and Rio Yandicoogina mine sites. For this abstraction to be impacting groundwater levels uniformly across the project area, there must be good regional hydraulic connectivity across the different formations between Ministers North and the point of abstraction. As noted in Section 1.2, extensive low permeability bedrock of the Weeli Wolli Formation lies to the north of Ministers North, which likely impedes groundwater flow.

The Ministers North project is inferred to be close to the point of recharge so readily influenced by rainfall. As such, the observed declining water levels on the shorter annual time frame may be due to a lack of recharge, as the recharge is driven by periodic cyclone events.

**Table 5: Final airlift yields, first water strike (FWS) depth, Static water level (SWL) and comparison to pre-drilling prediction in mAHD**

| Bore ID | Yield( L/s) | FWS (mbgl) | SWL (mbtoc) | SWL (mAHD) | Predicted WL (mAHD) | Difference (m) |
|---------|-------------|------------|-------------|------------|---------------------|----------------|
| HMN0001 | 20          | 90         | 72.43       | 562.25     | 563.3               | -1.87          |
| HMN0003 | 25          | 90         | 72.43       | 562.60     | 563.1               | -0.99          |
| HMN0005 | 8           | 87         | 75.49       | 562.40     | 562.6               | -0.86          |
| HMN0009 | 5           | 110        | 103.05      | 561.67     | 563.3               | -2.35          |
| HMN0012 | 15          | 51         | 49.27       | 562.63     | 563.4               | -1.66          |
| HMN0013 | 50          | 54         | 47.26       | 562.51     | 562.9               | -0.72          |
| HMN0015 | 6           | 12         | 7.64        | 562.35     | 563.3               | -1.76          |
| HMN0016 | 15          | 12         | 7.52        | 562.36     | 563.3               | -1.71          |
| HMN0017 | 6           | 90         | 46.55       | 562.64     | 563.5               | -1.49          |
| HMN0018 | 6           | 53.5       | 39.21       | 562.28     | 562.9               | -1.42          |
| HMN0024 | <0.1        | 90         | 68.64       | 562.10     | 562.9               | -1.50          |

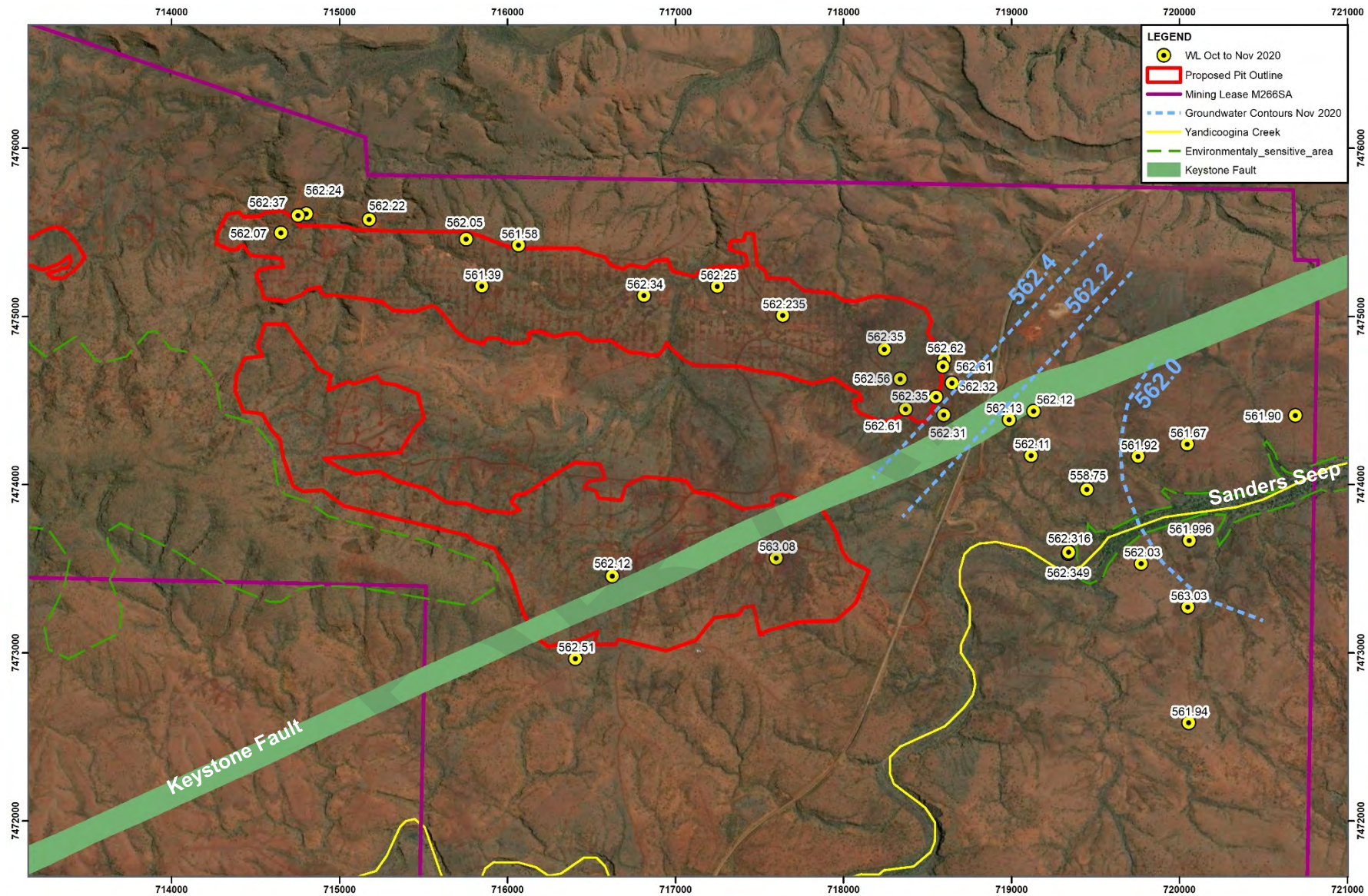


Figure 7: Water level from all frontier piezo, monitoring bores and production bores in November 2020

## 2.4 Water quality

Final field measurements of EC and pH are provided in Table 6, with downhole variation during drilling shown in the bore completion logs in Appendix B. Full laboratory chemistry analysis of samples taken at the completion of airlift development of both production bores is given in Appendix D.

Field measurements of EC were consistently low across the site (Table 6) and was confirmed by laboratory samples taken at the completion of airlift development in the production bores. No analyte in the laboratory analysis of the development sampled from the production bores exceeded the Australian drinking water guidelines (NRMMC, 2011) or freshwater guidelines for slightly - moderately disturbed systems (ANZECC & ARMCANZ, 2000).

The chemistry data was plotted on an Expanded Durov diagram, which is provided in Figure 8. The dominant anions are calcium bicarbonate ( $\text{Ca}(\text{HCO}_3)_2$ ) and cations are indiscriminate which indicates recharging waters. The total dissolved solids within the water are relatively low and the pH is slightly alkaline. The elevated bicarbonate is likely derived from silicate weathering products (clay minerals) as the groundwater signature has not been impacted by the presence of dolomite, with the ratio of calcium to magnesium strongly favouring calcium. The groundwaters physicochemical signature suggests that the aquifer at the Ministers North project is near source and primarily influenced by direct recharge to the local aquifer from rainfall.

The presence of the Mt McRae Shale presents possible future acidification risk to the aquifer. The only known carbonate rich rocks present in the project area are carbonate turbidites, while dolomite of the Paraburdoo Member was intersected in HMN0017 to the east and likely extend under the Mt McRae Shale which outcrops at the centre of the Werriba Anticline axis in the centre of the project area. The presence of carbonate turbidite material in the east of the project area could provide a source of acid neutralising potential (ANP) due to its carbonate rich geochemistry (Ross, 2019). The high pH of the ground water should provide some buffering capacity against the acidification potential from the presence of Pyrite observed within the Mt McRae Shale.

**Table 6: Field chemistry taken during the drilling programme**

| Bore ID | EC ( $\mu\text{S}/\text{cm}$ ) | pH   | Temp (°C) |
|---------|--------------------------------|------|-----------|
| HMN0001 | 592                            | 8.27 | 27        |
| HMN0003 | 605                            | 8.18 | 28.7      |
| HMN0005 | 503                            | 8.14 | 26.2      |
| HMN0009 | 543                            | 8.53 | 24.2      |
| HMN0012 | 610                            | 8.63 | 29.9      |
| HMN0013 | 610                            | 8.54 | 29        |
| HMN0015 | 530                            | 8.2  | 26        |
| HMN0016 | 536                            | 8.29 | 26.1      |
| HMN0017 | 530                            | 8.2  | 26        |
| HMN0018 | 560                            | 8.14 | 28.5      |
| HMN0024 | 600                            | 8.54 | 30.5      |

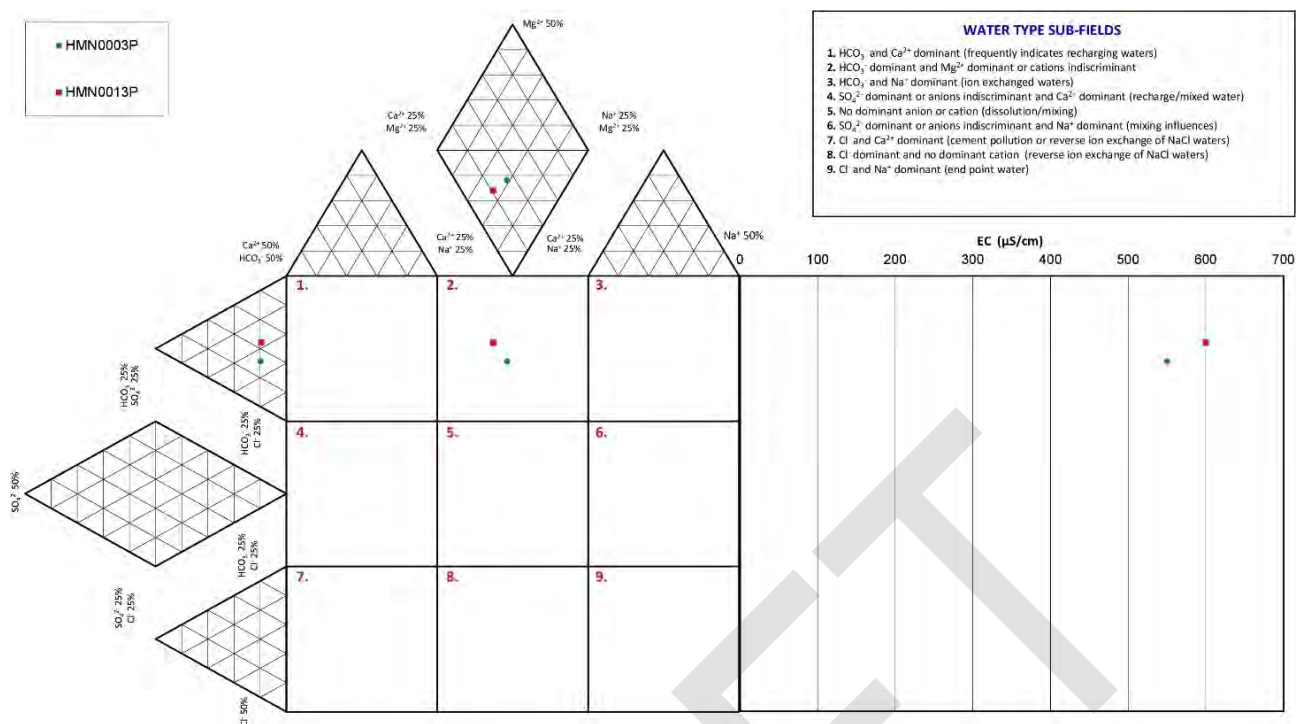


Figure 8: Expanded Durov diagram showing the water quality and water type of both production bores

## 2.5 Ground conditions

Most of the drilling programme was straight forward with the chosen conventional hammer drilling technique capable of dealing with ground conditions. A summary of the ground conditions in individual bores encountered during drilling is given in Table 7.

Loose formation was encountered at depth in both production bore locations (HMN0003 and HMN0013). WellDrill was able to overcome this by using high air volume, drilling foam and conditioning the hole during drilling. WellDrill also drilled up to 8 m below the target install depth to allow fallback to accumulate to the bottom of the hole and not interfere with casing installation.

Fallback was observed in both HMN0001 and HMN0003 locations in the north-west corner of the proposed pit shell. The zones of fallback corresponded to weathered formation overlying harder, broken ground. Sediment load within the discharge water was high during drilling as the unstable sections of the hole continued to collapse. HMN0003 was chosen for the production bore partially due to extensive broken ground. Hole instability below 148 m required the extensive use of foam to clear cuttings from the hole and the final ream was deepened 8 m below target depth to allow fallback to not impede casing installation.

During the drilling of the pilot hole for HMN0013, extensive broken ground was encountered with air loss to formation with little to no sample return between 84 and 92 m. This was attributed to a fracture zone on the contact of the D3 and D2 units and resulted in air loss to the formation with air observed coming out of multiple old RC holes within 100 m of the bore. This portion of the hole experience fall back with the drillers requiring the use of large quantities of drilling foam to achieve some sample return. Reaming of HMN0013 was terminated short of the target depth due to discharge management concerns, with the large volumes of water produced during drilling having to be contained as to not impact access along the rail access track to the east. The bore casing of HMN0013 was installed short of initial target but was seen to have achieved the technical objective. Controlling loose formation did lead to more total water produced as total drilling time was longer, but ultimately the decision to install short of the target depth was due to discharge management.

The nearby monitoring bore HMN0012 also intercepted broken ground with extensive vuggs and fracturing. As this was the first drilled target on this pad, it remained open during the drilling and construction of HMN0013, a period of approximately three weeks. During this time, the hole remained open to depth and the monitoring casing was installed without the need to redrill fall back from the hole.

Monitoring bore HMN0009 was terminated short due to discharge management requirements. The sump of HMN0009 failed to contain drilling discharge as it was built out of rocky material, resulting in water seeping out of the base of the sump with minimal settling time. Water discharged directly from the base of the sump would have exceeded BHP's discharge management guidelines for TSS if drilling had continued to target depth, however this bore did achieve the technical objective.

The drilling of the monitoring bores surrounding Sanders Seep were straight forward in hard competent ground. Some slow drilling was encountered, particularly in HMN0024, due to hard ground conditions while minor broken ground intersected was easily overcome. HMN0016 intercepted higher than anticipated yields and was unable to discharge due to the presence of pyritic shale and proximity of heritage and environmental exclusion zones. HMN0016 was terminated short of planned target depth to ensure BHP's discharge management guidelines were not breached. HMN0015 was a shallow bore in the same pad as HMN0016 and was installed in-rod due to loose collapsing formation. HMN0015 was installed later in the drill programme to allow water to seep out of the sump, to provide sump capacity for discharge during drilling.

**Table 7: Summary of ground conditions**

| Pad name           | Hole name | Summary of ground conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FY20_MN_<br>PAD001 | HMN0001   | <ul style="list-style-type: none"> <li>Quick drilling through soft ground to 90 m, becoming steady, competent ground to at 142 m.</li> <li>Hard fractured ground was intercepted between 142–156 m.</li> <li>Hard competent ground with slower drilling to EOH at 170 m.</li> <li>Drillers pulled back three rods to clear hole, but casing installed 0.5 m short due to fallback.</li> <li>Fallback being washed into hole from higher, soft formation, approx. 60–90 m.</li> </ul>                                                                                                                                                                                                                      |
| FY20_MN_<br>PAD003 | HMN0003   | <ul style="list-style-type: none"> <li>Drilling of the pilot hole was quick in soft, clay and shale rich formation to 90 m.</li> <li>Hard competent ground with slow drilling to 140m, before becoming more broken from 144 to 170 m.</li> <li>Hole instability was experienced below 148 m with extensive use of foam to clear cuttings from hole. Loose formation likely from higher up the hole.</li> <li>8 m of over drill on final ream filled with fallback allowing installation at target depth.</li> </ul>                                                                                                                                                                                       |
| FY20_MN_<br>PAD005 | HMN0005   | <ul style="list-style-type: none"> <li>Difficulty penetrating clays to 90 m.</li> <li>90 m to EOH, hard rock with slow drilling, generally non fractured and stable.</li> <li>Minor broken ground at 120 m and 156 to 158 m.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| FY20_MN_<br>PAD009 | HMN0009   | <ul style="list-style-type: none"> <li>Drilling stable medium to hard ground for most of the hole with some soft layers observed between 144 and 150 m.</li> <li>Hole terminated 8 m short at 162 m due to high TSS discharge through sump wall.</li> <li>Dipped hole, bridged at 135 m, had to run the rods open ended to flush out hole and install casing inside rods.</li> <li>Hole was open underneath the blockage to 157 m, resulting in casing being installed 7 m deeper than final plan as PVC could not be suspended in rod during install.</li> <li>Technical objective was achieved as screens are to desired depth and against higher yielding target aquifer units (D4 and D3).</li> </ul> |
| FY20_MN_<br>PAD015 | HMN0012   | <ul style="list-style-type: none"> <li>Soft, heavily weathered shales and BIF to 58 m.</li> <li>Fresh partially mineralised Cherty BIF from 58 to 104 m, hard slow penetration with bit change at 108 m due to hard ground conditions.</li> <li>104 to 144 m, quicker drilling through competent ground with broken sections at 128 and 140 m, broken ground vuggy chips and iron staining on quartz.</li> <li>Penetration slowing down after 144 m with minor fracturing and vuggs, particulate in the last 6 m of hole (164–170 m).</li> <li>Hole remained open with no fall back and installation of casing was completed in open hole two weeks after drilling.</li> </ul>                            |

| Pad name           | Hole name | Summary of ground conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FY20_MN_<br>PAD016 | HMN0013   | <ul style="list-style-type: none"> <li>Quick drilling due to large blocky broken ground, becoming hard and stable after 148 m with very slow penetration.</li> <li>Extensive unstable ground from 66 to 124 m, fall-back, hole conditionings and freeing bogged rods.</li> <li>Reaming of the bore to install production casing was terminated short at 150 m partially due to ground conditions.</li> <li>High yields with discharge restrictions hindered proper hole development during drilling.</li> <li>High air loss with air exiting old RC holes up to 200 m from bore.</li> <li>10 m of fall-back was unable to be cleared from the hole due to discharge management which resulted in the bores casing being seated at 140 m.</li> </ul> |
| FY20_MN_<br>PAD018 | HMN0015   | <ul style="list-style-type: none"> <li>Loose formation during drilling cleared with foam.</li> <li>Formation collapses to 10 m, unable to clear hole, casing installed in rod.</li> <li>Gravel pack close to estimate required volume suggesting relatively well-developed pack around screens.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| FY20_MN_<br>PAD018 | HMN0016   | <ul style="list-style-type: none"> <li>Loose, broken ground underlain by soft broken shale.</li> <li>Formation collapsed around drill rods between 18 m–42 m, sealing off returns and requiring multiple wiper runs to clear hole.</li> <li>Installed in-rod due to collapse of formation.</li> <li>Hole terminated at 75 m as sump was at max capacity, no discharge allowed due to black/pyritic shale and nearby environmental sensitive receptors.</li> </ul>                                                                                                                                                                                                                                                                                   |
| FY20_MN_<br>PAD019 | HMN0017   | <ul style="list-style-type: none"> <li>Stable hard drilling with slow penetration from 40 m to 68 m and 90 to 100 m.</li> <li>Ground was generally non fractured and stable, remaining open to depth during installation.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| FY20_MN_<br>PAD020 | HMN0018   | <ul style="list-style-type: none"> <li>Moderate to slow drilling, hard ground with some weaker weathered shaley bands</li> <li>ground becoming harder after 68 m, slow to EOH.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| FY20_MN_<br>PAD025 | HMN0024   | <ul style="list-style-type: none"> <li>Hard nonfractured rock with slow penetration. Hole developed with minimal yield for 30 minutes prior to installation.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

### 3 CONCLUSIONS AND RECOMMENDATIONS

This report summarises the drilling and construction of two production bores and nine monitoring bores at the Ministers North project. The installed production bores are considered capable of supplying sufficient water for both crushing and dust suppression during mining, however test pumping was not undertaken.

The area to the east of the northern pit shell at production bore HMN0013 had the highest airlift yield (up to 50 L/s) and showed signs of major faulting and or fracturing, possibly due to the proximity to the Keystone Fault. Yields were also high on the north-west of the Northern pit shell, with HMN0003P yielding more than 20 L/s.

A further four monitoring bores were installed for groundwater exploration and to augment the monitoring bore network. The main observation was that ground conditions on the northern edge of the northern pit shell become less prospective for dewatering towards the centre of the pit area, with airlift yields dropping from 8 L/s in HMN0005 to 5 L/s in HMN0009.

Additionally, five monitoring bores were installed to augment the environmental monitoring network around the environmentally sensitive Sanders Seep. Yields were generally relatively low (0.1–6 L/s) and geology was as expected. The exception was the occurrence of dolomite in HMN0017, and elevated yields (15 L/s) in the McRae Shale intersected at the base of the Yandicoogina Creek gorge, west of Sanders Seep. Hydrogeological observations suggest the enhanced permeability is associated with fracturing along the regional Werriba Anticline hinge axis.

Some unstable ground conditions were encountered during drilling. These were able to be overcome with conventional hammer, however one production bore was unable to be installed to depth, partially due to ground conditions and partially due to restrictions with managing discharge. If future bore locations are expected to encounter unstable ground and high yields, drilling and construction may benefit from the utilisation of the dual rotary drilling technique to better control ground conditions.

Difficulty was encountered by the earthworks contractors building sumps in rocky ground on steep terrain to accommodate the high yields. This led to some uncontrolled discharge due to inadequate sump construction. The bores positioned on the top of the ridges were primarily where this issue was encountered. Low permeable material could be moved from elsewhere on the project area to line sumps to limit seepage. Bore placement should also consider sump and pad construction to ensure that the sump can be on the downhill side of the pad to enable drainage away from the drill site if discharge from the sump is required.

Steep terrain was identified early in the drilling programme, with access tracks causing some issues that were able to be rectified by earthwork contractors as they were still in the area. Due to Minister North's relative remoteness from other BHP mining activity, it is recommended to ensure the drillers have seen all the access tracks, pads and sumps before de-mobilised earthmoving equipment from site.

As drainage patterns on site are variable, it is recommended to assess discharge pathways at likely high yielding bore locations to ensure no infrastructure or environmentally sensitive areas are impacted. Clear and explicit maps with information on expected discharge management requirements are required for field personnel to plan for and effectively manage discharge. This should include maps of potential wetting front distances and location of impacted infrastructure/environmental areas which need to be monitored during discharge to ensure they are not impacted.

No controlled aquifer testing was undertaken during this programme due to discharge management and BHP's concern with the observed depressed groundwater table. This will be remedied in future work packages to understand how drawdown propagates across the site. Of particular interest is whether the Keystone Fault is a pathway for preferential drawdown. Also, of interest is if the potential for the lower permeable shale formations between the two proposed mine shells to limit drawdown in a north–south orientation, and whether drawdown is controlled by the east–west bedding orientation within the Dales Gorge formation.

The conceptual hydrogeological model will benefit from further investigation at the centre of the Werriba Anticline axis. The Mt McRae shale is generally considered to be poorly permeable, and low yielding. Drilling of HMN0016 to the east of the proposed mine area showed that the Mt McRae Shale was highly fractured with relatively high yields. How the centre of the anticline is likely to respond to future dewatering is an important aspect to inform the conceptual hydrogeological model.

The possibility of broad scale drawdown emanating from mine dewatering to the north is considered. During this drilling campaign, it was observed that water levels were relatively flat across the project area and depressed from historic levels. This was of concern to BHP, as the current hydrodynamic model of Sanders

Seep is that it is in hydraulic connection with the groundwater. Groundwater seeps within the Pilbara often form in deep gorges where water can collect in ponds that are partially protected from evaporation by the gorge walls. Seepage water is often sourced from localised recharge infiltrating into weathered, permeable material higher in the topography. Water flows through the permeable units along the contact with less permeable units, seeping out where erosion has cut through the formation. It is unknown if this occurs at Sanders seep, and the exact hydrogeological mechanism for water occurrence should be investigated. Lawton and Sanders (2019) noted that the pools commenced at 562.9 mRL in 2019, with multiply dry pools higher up the valley. As this elevation is below the current ground water level, the seepage zone is likely currently occurring further down the valley than previously recorded. If the seepage is sourced from groundwater; the seepage front would have historically moved up and down the valley floor depending on fluctuations in the naturally occurring groundwater level.

The Ministers North project is near the origin of groundwater recharge to the local aquifer and down gradient hydraulically connected aquifers could be impacted by abstraction and/or dewatering at the project. The observed declining “pre-mining” water levels appear to be widespread and are considered to reflect the regional impact of reducing water in storage between cyclonic events. Ongoing monitoring of the recharge impact from rainfall should be undertaken to establish the relationship between groundwater levels and recharge induced change in storage within the aquifer.

Groundwater levels at the base of the Yandicoogina gorge have likely declined over the last two years during the dry season. The exact elevation of the Sanders Seep ponds is currently unknown and should be considered in relation to the varying water levels within the regional aquifer. The hydraulically connection between Sanders Seep and the regional aquifer should be investigated as groundwater level may currently be below the elevation of Sanders Seep. There is potential for the ponds to be fed by seepage from a local perched aquifer and or seepage from locally sourced discharge at the base of the gorge walls.

DRAFT

## 4 REFERENCES

- Andrzejczak, P., 2019. Mineral Resource Estimation Report Minister's North (MN). BHP Internal Report.
- ANZECC & ARMCANZ (2000): Australian and New Zealand Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy Paper no. 4. Australian and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australia and New Zealand.
- Kepert, D.A., 2018. The mapped stratigraphy and structure of the Mining Area C region, Hamersley province: Geological Survey of Western Australia, Report 185, 282p.
- Lawton, T., Sanders, R., 2019. Ministers North Conceptual Hydrogeological Model, BHP Internal Report - RED NPH Ministers North Conceptual Hydrogeological Model Rev 3.
- NHMRC, NRMCC (2011) Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.
- Perring, C., and Hronsky, J., 2019. The Blue Book II 2019 Edition – Guide to the Geology of the Hamersley Iron Ore Province. BHP Billiton Internal Report.
- Ross, N., 2019. Mapping outcropping Turbidites at Ministers North. BHP internal Report.
- Taylor, D., Dalstra, H.J., Harding, A.E., Broadbent, G. and Barley, M.E., 2001. Genesis of high-grade hematite orebodies of the Hamersley province, Western Australia: Economic Geology, v. 96, p. 837–873.
- Thompson, H., 2017. Ministers North Geological Modelling Report 2017. BHP Billiton Internal Report.
- Zivkovic, Z. BHP Iron Ore Pty Ltd, Annual Report Minister's North E47/628 Period 4 May 2016 to 3 May 2017.

## Appendix A

### Bore construction details

DRAFT

APPENDIX A:     Bore construction details

| Pad ID         | Hole name | Easting (mAHD) | Northing (mAHD) | Surface RL (mAHD) | Top of casing (mAHD) | Days to complete | Planned depth (m) | Total drilled depth (mbgl) | Slotted interval (mbgl) | Screened stratigraphy | Interpreted inflow stratigraphy | Final airlift yield (L/s) | Electrical conductivity (µs/cm) | pH   | Temperature (°C) | SWL (mbtoc) |
|----------------|-----------|----------------|-----------------|-------------------|----------------------|------------------|-------------------|----------------------------|-------------------------|-----------------------|---------------------------------|---------------------------|---------------------------------|------|------------------|-------------|
| FY20_MN_PAD001 | HMN0001   | 714803.1       | 7475608.5       | 633.862           | 634.676              | 3                | 170               | 170                        | 59.5-149.5              | W, D4                 | D4                              | 20                        | 592                             | 8.27 | 27               | 72.43       |
| FY20_MN_PAD003 | HMN0003   | 714754.1       | 7475599.2       | 634.543           | 635.027              | 15               | 170               | 178                        | 110-170                 | D4, D3                | D4, D3                          | 25                        | 605                             | 7.86 | 28.7             | 72.66       |
| FY20_MN_PAD005 | HMN0005   | 715176.3       | 7475575.0       | 637.227           | 637.894              | 4                | 170               | 170                        | 60-150                  | D, D4,D3              | D4, D3                          | 8                         | 503                             | 8.14 | 26.2             | 75.49       |
| FY20_MN_PAD009 | HMN0009   | 716065.7       | 7475422.3       | 664.001           | 664.716              | 4                | 170               | 162                        | 115-157                 | D4, D3                | D4, D3                          | 5                         | 543                             | 8.53 | 24.2             | 103.05      |
| FY20_MN_PAD015 | HMN0012   | 718601.4       | 7474743.5       | 611.014           | 611.897              | 4                | 170               | 170                        | 60-150                  | D4, D3,D2             | D4, D3,D2                       | 15                        | 610                             | 8.63 | 29.9             | 49.27       |
| FY20_MN_PAD016 | HMN0013   | 718593.3       | 7474701.8       | 609.445           | 609.766              | 16               | 170               | 170                        | 92-140                  | D3, D2                | D3, D2, D1                      | 50                        | 610                             | 8.18 | 29               | 47.15       |
| FY20_MN_PAD018 | HMN0015   | 719338.2       | 7473589.3       | 569.176           | 569.986              | 1                | 50                | 42                         | 10-40                   | T/D1                  | T/D1                            | 6                         | 530                             | 8.2  | 26               | 7.64        |
| FY20_MN_PAD018 | HMN0016   | 719341.07      | 7473597.1       | 569.109           | 569.884              | 2                | 80                | 75                         | 56-74                   | RN                    | T, RN                           | 15                        | 536                             | 8.29 | 26.1             | 7.52        |
| FY20_MN_PAD019 | HMN0017   | 719773.2       | 7473529.0       | 608.526           | 609.192              | 3                | 100               | 100                        | 40-100                  | D1, RU, OB            | D1, RU                          | 6                         | 530                             | 8.2  | 26               | 46.55       |
| FY20_MN_PAD020 | HMN0018   | 720058.5       | 7473667.6       | 600.690           | 601.486              | 3                | 100               | 100                        | 40-100                  | D4, D3, D2            | D4, D3                          | 6                         | 560                             | 8.14 | 28.5             | 39.21       |
| FY20_MN_PAD025 | HMN0024   | 720691.0       | 7474410.0       | 630.045           | 630.743              | 3                | 120               | 120                        | 60-120                  | J5                    | N/A                             | <0.1                      | 600                             | 8.54 | 30.5             | 68.64       |

## Appendix B

### Bore logs

DRAFT

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0001 **Hole Length:** 170.00

**Easting:** 714803.06  
**Northing:** 7475608.51  
**Surface RL:** 633.86  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -90-->0

**Construct:** 18 Jul 20 - 18 Jul 20

**Comments:** Monitoring bore. fallback to 149.5m

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 170.0 | WLDRIG6   | CH   | 200  |       | WELLDRIILL | KG2       |
|             |           |      |      |       |            |           |

**TOC RL:** 634.68 (Stickup 0.62m) (drilled) **SWL:** 72.43 MBTOC (19 Jul 20) **Dev:** N **Final pH:** -  
**TOC RL:** 634.68 (Stickup 0.62m) (current) **Is Live:** Y (-) **Date:** 18 Jul 2020 **Final EC:** -

| Depth<br>mglbl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                              | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                                                         |
|----------------|-------|-------|-------|-------|-----|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|------------------------------------------------------------------------------------|
| 0              | TD3   | J     | X     |       |     |                  | GRAVEL, sandy, trace cobble, (MINERALISED BIF), Greyish Blue-red, Transported, Hard, Well graded, Sub-angular, Broken ground. A mix of chips with minor pisolites. Contains magnetic material scattered through (mostly the pisolites). Semi-rounded chips. increasing silty fines from 6m. |             |     |              |                            | CEMENT (0.00-2.00)<br>206mm BLANK STEEL (0.00-6.00)<br>51mm BLANK PVC (0.00-59.50) |
| 10             |       | JC    | S     | X     |     |                  | UNMINERALISED BIF, (J1), Reddish Pink-grey, Slightly Weathered, Strong Rock. Large, hard BIF chips. Abundant chert.                                                                                                                                                                         |             |     |              |                            |                                                                                    |
| 20             |       | JC    | S     |       |     |                  | UNMINERALISED BIF, (J1), Reddish Pink-grey, Slightly Weathered, Strong Rock. Smaller BIF chips. Abundant chert. No magnetic grains or pisolites. Minor yellow Shale microbands.                                                                                                             |             |     |              |                            |                                                                                    |
| 30             | J1    | J     | KC    |       |     |                  | UNMINERALISED BIF, (J1), Greyish Red-pink, Slightly Weathered, Strong Rock. Small BIF chips, predominantly goethitic. Minor chert.                                                                                                                                                          |             |     |              |                            | 51mm SLOTTED PVC (59.50-149.50)                                                    |
| 40             |       | S     | JCH   |       |     |                  | UNMINERALISED BIF, (J1), Greyish Brown, Highly Weathered, Strong Rock. Shale with silty fines, minor goethite-rich BIF chips. Non magnetic                                                                                                                                                  |             |     |              |                            |                                                                                    |
| 50             |       |       |       |       |     |                  | UNMINERALISED BIF, (J1), Brownish Grey-red, Moderately Weathered, Strong Rock. BIF with minor white clays. Minor jaspilite. Sporadic poor sample return throughout and non magnetic.                                                                                                        |             |     |              |                            |                                                                                    |
| 60             | W     |       |       |       |     |                  | SHALE, (W), Reddish Brown, Extremely Weathered, Extremely Weak Rock. Red brown heavily weatehred weak shale with minor BIF becoming more BIF rich from 64m.                                                                                                                                 |             |     |              |                            | 51mm SLOTTED PVC (59.50-149.50)                                                    |
| 70             |       | SC    | K     |       |     |                  | SHALE, (W), Reddish Pink-grey, Extremely Weathered, Extremely Weak Rock. shale and chert with minor clay red brown clay and dark brown manganese dioxide.                                                                                                                                   |             |     |              |                            |                                                                                    |
| 80             |       | K     | SC    |       |     |                  | SHALE, (W), Blackish Brown-yellow, Extremely Weathered, Extremely Weak Rock. Grey to dark grey manganese dioxide-rich clays (Pyrolusite) with chips of yellow chert and shale. No pyrite present (hence likely not McRae).                                                                  |             |     |              |                            |                                                                                    |
| 90             | D4    | J     | C     |       |     |                  |                                                                                                                                                                                                                                                                                             | 377         | 7.7 |              |                            |                                                                                    |
| 100            |       | J     | 1C    | M     |     |                  |                                                                                                                                                                                                                                                                                             | 354         | 7.6 | 2            |                            |                                                                                    |

## BHPIO - Hydrogeology Log

**BHP**
**Project:** MINISTERS NORTH      **Hole Name:** HMN0001      **Hole Length:** 170.00

**Easting:** 714803.06  
**Northing:** 7475608.51  
**Surface RL:** 633.86  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -90-->0

**Construct:** 18 Jul 20 - 18 Jul 20

**Comments:** Monitoring bore. fallback to 149.5m

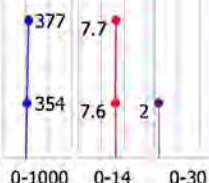
| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 170.0 | WLDRIG6   | CH   | 200  |       | WELDRILL   | KG2       |
|             |           |      |      |       |            |           |

**TOC RL:** 634.68 (Stickup 0.62m) (drilled)      **SWL:** 72.43 MBTOC (19 Jul 20)      **Dev:** N      **Final pH:** -  
**TOC RL:** 634.68 (Stickup 0.62m) (current)      **Is Live:** Y      **Date:** 18 Jul 2020      **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                                                               |
|--------------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|------------------------------------------------------------------------------------------|
| 0            | TD3   | J     | X     |       |     |                  |                                |             |    |              |                            | CEMENT (0.00-2.00)<br>206mm BLANK STEEL<br>(0.00-6.00)<br>51mm BLANK PVC<br>(0.00-59.50) |
| 10           |       | JC    | S     | X     |     |                  |                                |             |    |              |                            |                                                                                          |
| 20           |       | JC    | S     |       |     |                  |                                |             |    |              |                            |                                                                                          |
|              | J1    | G     | C     |       |     |                  |                                |             |    |              |                            | 51mm SLOTTED PVC<br>(59.50-149.50)                                                       |
| 30           |       | S     | GC    |       |     |                  |                                |             |    |              |                            |                                                                                          |
|              |       | J     | KC    |       |     |                  |                                |             |    |              |                            |                                                                                          |
| 40           | W     | S     | JCH   |       |     |                  |                                |             |    |              |                            |                                                                                          |
| 50           |       |       |       |       |     |                  |                                |             |    |              |                            |                                                                                          |
| 60           |       |       |       |       |     |                  |                                |             |    |              |                            |                                                                                          |
| 70           | D4    | SC    | K     |       |     |                  |                                |             |    |              |                            |                                                                                          |
| 80           |       | K     | SC    |       |     |                  |                                |             |    |              |                            |                                                                                          |
| 90           |       | J     | C     |       |     |                  |                                |             |    |              |                            |                                                                                          |
| 100          |       | J     | 1C    | M     |     |                  |                                |             |    |              |                            |                                                                                          |

MINERALISED BIF, (D4),  
Brownish Red-grey, Slightly  
Weathered, Strong Rock. BIF  
with red and brown chert  
microbands and chert chips, minor  
larger vuggy chips. No magnetic  
material. Slower drilling.

MINERALISED BIF, (D4),  
Blackish Blue-yellow, Slightly  
Weathered, Strong Rock. Bluey-  
dark grey BIF chips with minor  
red banded chert. Some large  
chert chips, very hard. Trace  
magnetite.



## BHPIO - Hydrogeology Log

**BHP**
**Project:** MINISTERS NORTH      **Hole Name:** HMN0001      **Hole Length:** 170.00

**Easting:** 714803.06  
**Northing:** 7475608.51  
**Surface RL:** 633.86  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -90-->0

**Construct:** 18 Jul 20 - 18 Jul 20

**Comments:** Monitoring bore. fallback to 149.5m

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 170.0 | WLDRIG6   | CH   | 200  |       | WELLDRIILL | KG2       |
|             |           |      |      |       |            |           |

**TOC RL:** 634.68 (Stickup 0.62m) (drilled)      **SWL:** 72.43 MBTOC (19 Jul 20)      **Dev:** N      **Final pH:** -  
**TOC RL:** 634.68 (Stickup 0.62m) (current)      **Is Live:** Y      **Date:** 18 Jul 2020      **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                                                                                                                                                                                     | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID         |
|--------------|-------|-------|-------|-------|-----|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|------------------------------------|
| 100          | D4    | J     | 1C    | M     |     |                  | MINERALISED BIF, (D4),<br>Blackish Blue-yellow, Slightly<br>Weathered, Strong Rock. Bluey-<br>dark grey BIF chips with minor<br>red banded chert. Some large<br>chert chips, very hard. Trace<br>magnetite.                                                                                                                                                                                                                                        | 335         | 7.7 | 2            |                            | 51mm SLOTTED PVC<br>(59.50-149.50) |
|              |       | J     | 1L    |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 353         | 7.9 | 4            |                            |                                    |
| 110          |       | J     | 1L    |       |     |                  | MINERALISED BIF, (D4),<br>Blackish Blue-yellow, Slightly<br>Weathered, Strong Rock. Bluey-<br>dark grey BIF and yellow<br>limonite chips.                                                                                                                                                                                                                                                                                                          | 377         | 8.0 | 5            |                            |                                    |
| 120          |       |       |       |       |     |                  | MINERALISED BIF, (D4),<br>Blackish Blue-yellow, Slightly<br>Weathered, Strong Rock. Dark<br>grey BIF with minor yellow<br>limonite chips and orange<br>alteration of the BIF. Smaller 1-<br>4mm chips with minor larger<br>>10mm, with the larger chips<br>being geothised chert and<br>jaspillite. Minor pinky-red clays<br>present from 140-142m and red<br>and green jaspillite present 142-<br>144m and 148-150m. Minor<br>magnetite 144-148m. | 405         | 8.1 | 7            |                            |                                    |
| 130          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 407         | 8.2 | 8            |                            |                                    |
| 140          | D3    | JC    | S     |       |     |                  | UNMINERALISED BIF, (D3),<br>Blackish Brown-red, Slightly<br>Weathered, Strong Rock. Bluey-<br>dark grey, red and yellow BIF<br>with chert. Minor red soft shale/<br>clay chips. No magnetic material.                                                                                                                                                                                                                                              | 457         | 8.2 | 10           |                            | END CAP (149.50)                   |
| 150          |       | JC    | K     |       |     |                  | UNMINERALISED BIF, (D3),<br>Brownish Red-light or white,<br>Slightly Weathered, Strong Rock.<br>Multi coloured BIF and shale,<br>dark brown orange white/cream<br>and red. Broken ground with<br>larger blocky chips, alteration on<br>fractures with staining, infill and<br>minor vuggy. Likely to be a high<br>flow/fractured zone.                                                                                                             | 461         | 8.2 | 10           |                            |                                    |
| 160          |       |       |       |       |     |                  | UNMINERALISED BIF, (D3),<br>Blackish Brown-red, Slightly<br>Weathered, Strong Rock. Bluey-<br>dark grey, yellow cherty BIF<br>with minor pink and white clays.<br>Minor magnetic material.                                                                                                                                                                                                                                                         | 499         | 8.3 | 15           |                            |                                    |
| 170          |       | J     | 1LK   |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 541         | 8.3 | 14           |                            |                                    |
|              |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 552         | 8.3 | 18           |                            |                                    |
| 180          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 568         | 8.3 | 20           |                            |                                    |
| 190          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 577         | 8.4 | 20           |                            |                                    |
| 200          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 592         | 8.3 | 20           |                            |                                    |

## BHPIO - Hydrogeology Log

**BHP****Project:** MINISTERS NORTH**Hole Name:** HMN0003**Hole Length:** 178.00**Easting:** 714754.11**Northing:** 7475599.23**Surface RL:** 634.54**Grid Name:** MGA94\_50**Incl / Azm:** -90-->0**Construct:** 24 Jul 20 - 27 Jul 20**Comments:** Fallback at end of hole from 140m reamed to 178m enable install.

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 178.0 | WLDRIG6   | CH   | 425  |       | WELDRILL   | KG2       |
|             |           |      |      |       |            |           |

**License:** 203670**TOC RL:** 635.03 (Stickup 0.30m) (drilled)**SWL:** 72.66 MBTOC (30 Jul 20)**Dev:** Y: 4.0 hour(s)**Final pH:** 7.9**TOC RL:** 635.03 (Stickup 0.30m) (current)**Is Live:** Y (-)**Date:** 29 Jul 2020**Final EC:** 605.00

| Depth<br>m/btl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                            | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 600mm | Notes<br>Casing size as ID                                                                   |
|----------------|-------|-------|-------|-------|-----|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|--------------|----------------------------|----------------------------------------------------------------------------------------------|
| 0              |       | B     | UK    |       |     |                  | UNMINERALISED BIF, (J1),<br>Reddish Brown-grey, Extremely<br>Weathered, Strong Rock.<br>Ferricrete, silicious very fine to<br>vitreous chips. Minor magnetism.                                                                                            |             |    |              |                            | CEMENT (0.00-2.00)<br>445mm BLANK STEEL<br>(0.00-6.00)<br>305mm BLANK STEEL<br>(0.00-110.00) |
| 10             |       | G     | HS    |       |     |                  | MINERALISED BIF, (J1),<br>Greyish Red, Extremely<br>Weathered, Medium Strong Rock.<br>Heavily weathered, larger chips<br>becoming larger and more angular<br>with depth. Microbands present.                                                              |             |    |              |                            |                                                                                              |
| 20             | J1    | S     | CL    |       |     |                  | SHALE, (J1), Reddish Pink,<br>Highly Weathered, Very Weak<br>Rock. Softer drill/broken ground.<br>Reddy brown stained chips of<br>purple-red shales.                                                                                                      |             |    |              |                            |                                                                                              |
| 30             |       | J     | SL    |       |     |                  | UNMINERALISED BIF, (J1),<br>Greyish Yellow, Slightly<br>Weathered, Strong Rock. Quick<br>drill. Buff/yellow limonite stained<br>chips of weathered/altered<br>jaspillite BIF and shale.                                                                   |             |    |              |                            |                                                                                              |
| 40             |       | C     | SJ    |       |     |                  | UNMINERALISED BIF, (W),<br>Reddish Pink-grey, Slightly<br>Weathered, Strong Rock. Red<br>chips marking the J1-W boundary.<br>Broken ground with larger<br>>10mm chert from 40 to 42. Very<br>hard chert chips with minor softer<br>weathered shale chips. |             |    |              |                            |                                                                                              |
| 50             |       | SH    |       |       |     |                  | SHALE, (W), Pinkish Red,<br>Extremely Weathered, Extremely<br>Weak Rock. Soft shale band with<br>minor hard haematite chips.<br>Purpley-red.                                                                                                              |             |    |              |                            |                                                                                              |
| 60             |       | C     | HS    |       |     |                  | UNMINERALISED BIF, (W),<br>Greyish Pink-red, Slightly<br>Weathered, Very Strong Rock.<br>Harder drilling, chert-rich chips.<br>Purpley-red clay coat on chert<br>chips.                                                                                   |             |    |              |                            |                                                                                              |
| 70             | W     | S     | HK    |       |     |                  | SHALE, (W), Greyish Pink-brown,<br>Moderately Weathered, Strong<br>Rock. Softer drilling. Weathered<br>shale content increasing with<br>depth. Chips coated in pink to<br>brown clays.                                                                    |             |    |              |                            |                                                                                              |
| 80             |       | S     | HKF   |       |     |                  | SHALE, (W), Pinkish Red-brown,<br>Extremely Weathered, Extremely<br>Weak Rock. weathered shale<br>with minor BIF chips. Red and<br>pink clays dominating colour.                                                                                          |             |    |              |                            |                                                                                              |
| 90             |       | SJ    | HK    |       |     |                  | SHALE, (W), Brownish Red,<br>Extremely Weathered, Extremely<br>Weak Rock. Shale with BIF chips<br>and clay fines. broken ground,<br>easy drilling                                                                                                         |             |    |              |                            |                                                                                              |
| 100            | D4    | C     | KS    |       |     |                  | SHALE, (W), Reddish Brown,<br>Moderately Weathered, Medium<br>Strong Rock. High clay content<br>with chips of shale and BIF.                                                                                                                              |             |    |              |                            |                                                                                              |
|                |       | WC    | LS    |       |     |                  |                                                                                                                                                                                                                                                           |             |    |              |                            |                                                                                              |

0-1000 0-14 0-30

## BHPIO - Hydrogeology Log

**BHP****Project:** MINISTERS NORTH**Hole Name:** HMN0003**Hole Length:** 178.00**Easting:** 714754.11**Northing:** 7475599.23**Surface RL:** 634.54**Grid Name:** MGA94\_50**Incl / Azm:** -90-->0**Construct:** 24 Jul 20 - 27 Jul 20**Comments:** Fallback at end of hole from 140m reamed to 178m enable install.

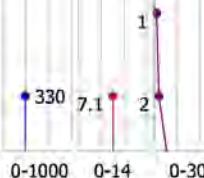
| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 178.0 | WLDRIG6   | CH   | 425  |       | WELDRILL   | KG2       |
|             |           |      |      |       |            |           |

**License:** 203670**TOC RL:** 635.03 (Stickup 0.30m) (drilled)**SWL:** 72.66 MBTOC (30 Jul 20)**Dev:** Y: 4.0 hour(s)**Final pH:** 7.9**TOC RL:** 635.03 (Stickup 0.30m) (current)**Is Live:** Y (-)**Date:** 29 Jul 2020**Final EC:** 605.00

| Depth<br>m/btl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 600mm | Notes<br>Casing size as ID                                                                   |
|----------------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|----------------------------------------------------------------------------------------------|
| 0              |       | B     | UK    |       |     |                  |                                |             |    |              |                            | CEMENT (0.00-2.00)<br>445mm BLANK STEEL<br>(0.00-6.00)<br>305mm BLANK STEEL<br>(0.00-110.00) |
| 10             |       | G     | HS    |       |     |                  |                                |             |    |              |                            |                                                                                              |
| 20             | J1    | S     | CL    |       |     |                  |                                |             |    |              |                            |                                                                                              |
|                |       | J     | SL    |       |     |                  |                                |             |    |              |                            |                                                                                              |
| 30             |       |       |       |       |     |                  |                                |             |    |              |                            |                                                                                              |
| 40             |       | C     | SJ    |       |     |                  |                                |             |    |              |                            |                                                                                              |
| 50             |       | SH    |       |       |     |                  |                                |             |    |              |                            |                                                                                              |
|                |       | C     | HS    |       |     |                  |                                |             |    |              |                            |                                                                                              |
| 60             |       | S     | HK    |       |     |                  |                                |             |    |              |                            |                                                                                              |
| 70             | W     |       |       |       |     |                  |                                |             |    |              |                            |                                                                                              |
| 80             |       | S     | HKF   |       |     |                  |                                |             |    |              |                            |                                                                                              |
|                |       | S     | CHK   |       |     |                  |                                |             |    |              |                            |                                                                                              |
|                |       | SJ    | HK    |       |     |                  |                                |             |    |              |                            |                                                                                              |
| 90             |       | C     | KS    |       |     |                  |                                |             |    |              |                            |                                                                                              |
|                | D4    | WC    | LS    |       |     |                  |                                |             |    |              |                            |                                                                                              |
| 100            |       |       |       |       |     |                  |                                |             |    |              |                            |                                                                                              |

CHERT, (W), Greyish Pink-red, Slightly Weathered, Strong Rock. Predominantly hard chips with minor clay. Pinky red coated grey chips.

MINERALISED BIF, (D4), Greyish Yellow-red, Slightly Weathered, Medium Strong Rock. Haematite and goethite BIF chips with chert, increasing with depth up to 15mm. Evedance of broken ground/ fracture zone with larger blocky chips, limonite staining and clay on fracture planes and minor vuggy/dissolution.



# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0003 **Hole Length:** 178.00

**Easting:** 714754.11  
**Northing:** 7475599.23  
**Surface RL:** 634.54  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -90-->0

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 178.0 | WLDRI6    | CH   | 425  |       | WELDRILL   | KG2       |

**Construct:** 24 Jul 20 - 27 Jul 20

**License:** 203670

**Comments:** Fallback at end of hole from 140m reamed to 178m enable install.

**TOC RL:** 635.03 (Stickup 0.30m) (drilled) **SWL:** 72.66 MBTOC (30 Jul 20) **Dev:** Y: 4.0 hour(s) **Final pH:** 7.9  
**TOC RL:** 635.03 (Stickup 0.30m) (current) **Is Live:** Y (-) **Date:** 29 Jul 2020 **Final EC:** 605.00

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                                                                                                                                                         | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 600mm | Notes<br>Casing size as ID         |
|--------------|-------|-------|-------|-------|-----|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|------------------------------------|
| 100          | D4    | WC    | LS    |       |     |                  | MINERALISED BIF, (D4),<br>Greyish Yellow-red, Slightly<br>Weathered, Medium Strong Rock.<br>Haematite and goethite BIF chips<br>with chert, increasing with depth<br>up to 15mm. Evedance of broken<br>ground/ fracture zone with larger<br>blocky chips, limonite staining and<br>clay on fracture planes and minor<br>vuggy/dissolution.                                                                             | 322         | 7.2 | 7            |                            | 305mm BLANK STEEL<br>(0.00-110.00) |
| 110          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                        | 328         | 7.5 | 7            |                            | 305mm W/W STEEL<br>(110.00-170.00) |
| 120          |       | LC    | WS    |       |     |                  | MINERALISED BIF, (D4),<br>Yellowish Grey-pink, Slightly<br>Weathered, Very Strong Rock.<br>Very hard chert chips amongst<br>pink weathered shales. Yellow<br>limonite and altered BIF chips.<br>Not magnetic.                                                                                                                                                                                                          | 403         | 8.1 | 10           |                            |                                    |
| 130          |       | W     | LC    |       |     |                  | MINERALISED BIF, (D4),<br>Greyish Brown-pink, Slightly<br>Weathered, Strong Rock. Hard<br>chert chips amongst BIF chips.<br>Minor white cherts and clays.                                                                                                                                                                                                                                                              | 424         | 7.4 | 10           |                            |                                    |
| 140          | D3    | W     | HC    |       |     |                  | MINERALISED BIF, (D4),<br>Blueish Grey-red, Slightly<br>Weathered, Strong Rock. Bluey-<br>grey and red banded BIF chips<br>(Jaspilite). Minor yellow and<br>white soft shale. Broken ground<br>with large (20mm) blocky chips .                                                                                                                                                                                        | 531         | 7.3 | 11           |                            |                                    |
| 150          |       | FCG   | WL    |       |     |                  | UNMINERALISED BIF, (D3),<br>Pinkish Blue-lght or white,<br>Slightly Weathered, Strong Rock.<br>Multi coloured shale, chert and<br>BIF chips. Broken ground with<br>fall-back during drilling, highly<br>broken fracture zone 148 to<br>152m. Chip size increasing with<br>depth (up to 40mm). increasing<br>weathering and alteration below<br>152m with dissolution vuggy and<br>mineral build up on fracture planes. | 527         | 7.8 | 11           |                            |                                    |
| 160          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                        | 571         | 7.5 | 15           |                            |                                    |
| 170          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                        | 606         | 7.5 | 6            |                            |                                    |
| 180          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                        | 616         | 7.6 | 20           |                            |                                    |
| 190          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                        | 589         | 7.5 | 18           |                            |                                    |
| 200          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                        | 611         | 7.8 | 18           |                            |                                    |
|              |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                        | 615         | 7.9 | 18           |                            |                                    |

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0005 **Hole Length:** 170.00

**Easting:** 715176.25

**Northing:** 7475574.95

**Surface RL:** 637.23

**Grid Name:** MGA94\_50

**Incl / Azm:** -90-->0

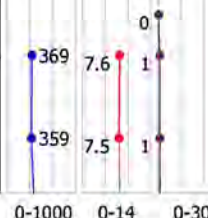
**Construct:** 01 Aug 20 - 01 Aug 20

**Comments:** Monitoring bore.

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 170.0 | WLDRIG6   | CH   | 200  |       | WELDRILL   | KG2       |

**TOC RL:** 637.89 (Stickup 0.54m) (drilled) **SWL:** 75.49 MBTOC (03 Aug 20) **Dev:** N **Final pH:** -  
**TOC RL:** 637.89 (Stickup 0.54m) (current) **Is Live:** Y **Date:** - **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                                                                                                                                                                    | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                           |
|--------------|-------|-------|-------|-------|-----|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|--------------|----------------------------|------------------------------------------------------|
| 0            |       | G     | FL    | M     |     |                  | UNMINERALISED BIF, (J1),<br>Brownish Grey-red, Moderately<br>Weathered, Medium Strong Rock.<br>Goethite-rich BIF with minor<br>weathered shale. Minor limonite.<br>Trace semi-rounded magnetite.<br>Cobble sized chips cropping up<br>from 8m. Limonite-rich band 10-<br>12m. Trace magnetite dropping<br>out from 10 to 20m and then<br>back at 20m. Becoming more<br>clay-rich at depth and minor chert<br>starting to crop up. |             |    |              |                            | CEMENT (0.00-2.00)<br>51mm BLANK PVC<br>(0.00-60.00) |
| 10           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |    |              |                            |                                                      |
| 20           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |    |              |                            |                                                      |
| 30           | J1    | GS    | CK    | M     |     |                  | UNMINERALISED BIF, (J1),<br>Brownish Pink-red, Highly<br>Weathered, Medium Strong Rock.<br>Reddy-brown ferruginous shales<br>and BIF chips in weathered clay/<br>shale. Minor chert. Trace<br>magnetite.                                                                                                                                                                                                                          |             |    |              |                            |                                                      |
| 40           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |    |              |                            |                                                      |
| 50           |       | S     | CK    | M     |     |                  | SHALE, (W), Reddish Grey-pink,<br>Highly Weathered, Strong Rock.<br>Red to pink weathered shale,<br>chert chips and minor BIF. Trace<br>magnetite present until 56m                                                                                                                                                                                                                                                               |             |    |              |                            |                                                      |
| 60           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |    |              |                            | 51mm SLOTTED PVC<br>(60.00-150.00)                   |
| 70           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |    |              |                            |                                                      |
| 80           | W     |       |       |       |     |                  | SHALE, (W), Reddish Pink-buff,<br>Highly Weathered, Strong Rock.<br>Pale pink-red weathered shale,<br>chert chips and minor BIF.<br>SHALE, (W), Blackish Grey-<br>brown, Slightly Weathered,<br>Strong Rock. Goethitic, siliceous<br>BIF with goethised chert and<br>magnetite and pale brown clay.<br>Slow, hard drilling in competent<br>ground.                                                                                |             |    |              |                            |                                                      |
| 90           |       | S     | CJ    |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |    |              |                            |                                                      |
|              |       | CJ    | KG    | M     |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |    |              |                            |                                                      |
|              |       | K     | SCJ   |       |     |                  | SHALE, (W), Blackish Grey-<br>yellow, Moderately Weathered,<br>Strong Rock. Grey to dark grey<br>Mn-rich clay with chips of yellow<br>chert and ferruginous shale. No<br>pyrite present. Low sample return.                                                                                                                                                                                                                       |             |    |              |                            |                                                      |
| 100          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |    |              |                            |                                                      |



## BHPIO - Hydrogeology Log

**BHP****Project:** MINISTERS NORTH**Hole Name:** HMN0005**Hole Length:** 170.00**Easting:** 715176.25**Northing:** 7475574.95**Surface RL:** 637.23**Grid Name:** MGA94\_50**Incl / Azm:** -90-->0**Construct:** 01 Aug 20 - 01 Aug 20**Comments:** Monitoring bore.

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 170.0 | WLDRI6    | CH   | 200  |       | WELLDRIILL | KG2       |
|             |           |      |      |       |            |           |

**TOC RL:** 637.89 (Stickup 0.54m) (drilled)**SWL:** 75.49 MBTOC (03 Aug 20)**Dev:** N**Final pH:** -**TOC RL:** 637.89 (Stickup 0.54m) (current)**Is Live:** Y (-)**Date:** -**Final EC:** -

| Depth<br>m/btl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                       | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID      |
|----------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|---------------------------------|
| 100            | W     | K     | SCJ   |       |     |                  | SHALE, (W), Blackish Grey-yellow, Moderately Weathered, Strong Rock. Grey to dark grey Mn-rich clay with chips of yellow chert and ferruginous shale. No pyrite present. Low sample return.                                          | 407         | 7.6 | 1            |                            | 51mm SLOTTED PVC (60.00-150.00) |
|                |       | JC    | LM    |       |     |                  |                                                                                                                                                                                                                                      | 515         | 8.0 | 1            |                            |                                 |
| 110            |       | M     | C     | LS    |     |                  | UNMINERALISED BIF, (D4), Yellowish Brown-grey, Slightly Weathered, Strong Rock. Fresh hard chert with magnetic BIF. Yellow, brown, grey and white chips, trace red. Smaller chips with slower drilling. Minor green chert from 106m. | 507         | 8.0 | 4            |                            |                                 |
| 120            | D4    |       |       |       |     |                  | UNMINERALISED BIF, (D4), Blackish Grey-red, Fresh, Strong Rock. Magnetised BIF with minor chert. Dark grey-red chips, small <5mm with minor chunks (10mm). Trace yellow and white chips. Paler shale and cherty band at 120-122m.    | 491         | 8.0 | 5            |                            |                                 |
|                |       |       |       |       |     |                  |                                                                                                                                                                                                                                      | 494         | 8.1 | 5            |                            |                                 |
| 130            |       | G     | CLK   | M     |     |                  |                                                                                                                                                                                                                                      | 495         | 8.2 | 6            |                            |                                 |
| 140            |       |       |       |       |     |                  | MINERALISED BIF, (D3), Blackish Grey-yellow, Slightly Weathered, Strong Rock. Limonite-coated goethite-rich BIF and chert with pink and white shale fragments. Dark grey and yellow chips with chunky chert chips from 156-158m.     | 485         | 8.1 | 7            |                            |                                 |
|                | D3    |       |       |       |     |                  |                                                                                                                                                                                                                                      | 489         | 8.1 | 7            |                            |                                 |
| 150            |       |       |       |       |     |                  |                                                                                                                                                                                                                                      | 496         | 8.0 | 8            |                            |                                 |
| 160            |       |       |       |       |     |                  |                                                                                                                                                                                                                                      | 489         | 8.0 | 8            |                            |                                 |
| 170            |       |       |       |       |     |                  |                                                                                                                                                                                                                                      | 491         | 7.9 | 9            |                            |                                 |
|                |       |       |       |       |     |                  |                                                                                                                                                                                                                                      | 499         | 8.0 | 8            |                            |                                 |
|                |       |       |       |       |     |                  |                                                                                                                                                                                                                                      | 503         | 8.1 | 8            |                            | END CAP (150.00)                |
| 180            |       |       |       |       |     |                  |                                                                                                                                                                                                                                      |             |     |              |                            |                                 |
| 190            |       |       |       |       |     |                  |                                                                                                                                                                                                                                      |             |     |              |                            |                                 |
| 200            |       |       |       |       |     |                  |                                                                                                                                                                                                                                      |             |     |              |                            |                                 |

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0009 **Hole Length:** 162.00

|                    |                                                                   |              |                  |             |             |              |                   |                  |
|--------------------|-------------------------------------------------------------------|--------------|------------------|-------------|-------------|--------------|-------------------|------------------|
| <b>Easting:</b>    | 716065.70                                                         | <b>Depth</b> | <b>Drill Rig</b> | <b>Type</b> | <b>Size</b> | <b>Fluid</b> | <b>Drilled By</b> | <b>Logged By</b> |
| <b>Northing:</b>   | 7475422.29                                                        | 0.0 - 162.0  | WLDRIG6          | CH          | 200         |              | WELLDRIILL        | KG2              |
| <b>Surface RL:</b> | 664.00                                                            |              |                  |             |             |              |                   |                  |
| <b>Grid Name:</b>  | MGA94_50                                                          |              |                  |             |             |              |                   |                  |
| <b>Incl / Azm:</b> | -90-->0                                                           |              |                  |             |             |              |                   |                  |
| <b>Construct:</b>  | 05 Aug 20 - 06 Aug 20                                             |              |                  |             |             |              |                   |                  |
| <b>Comments:</b>   | Terminated at 162m due to high TSS discharge seeping through sump |              |                  |             |             |              |                   |                  |

**TOC RL:** 664.72 (Stickup 0.72m) (drilled) **SWL:** 103.05 MBTOC (07 Aug 20) **Dev:** N **Final pH:** -  
**TOC RL:** 664.72 (Stickup 0.72m) (current) **Is Live:** Y (-) **Date:** - **Final EC:** -

| Depth<br>m/btl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                               | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                                                          |
|----------------|-------|-------|-------|-------|-----|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|--------------|----------------------------|-------------------------------------------------------------------------------------|
| 0              | TD3   | Z     | KJ    |       |     |                  | CLAY, cobbled, trace gravel, (SCREE), Brownish Grey-red, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded, Unconsolidated / unstable ground. Loose brown clay with reworked BIF chips, Magnetic material present. |             |    |              |                            | CEMENT (0.00-2.00)<br>206mm BLANK STEEL (0.00-6.00)<br>51mm BLANK PVC (0.00-115.00) |
| 10             |       | JC    | S     |       |     |                  | MINERALISED BIF, (J2), Blackish Grey-red, Slightly Weathered, Strong Rock. Large chips of hard BIF with minor small chips. Fine shale bands present. No magnetic material.                                                   |             |    |              |                            |                                                                                     |
| 20             | J2    |       |       |       |     |                  |                                                                                                                                                                                                                              |             |    |              |                            |                                                                                     |
| 30             | J1    | G     | SK    | L     |     |                  | MINERALISED BIF, (J1), Brownish Red-grey, Slightly Weathered, Strong Rock. Small chips of goethite-rich BIF and shales with clays. Limonite coating on some chips. Chips getting red tinge from 30m.                         |             |    |              |                            |                                                                                     |
| 40             |       |       |       |       |     |                  |                                                                                                                                                                                                                              |             |    |              |                            |                                                                                     |
| 50             | W     | G     | SHC   |       |     |                  | UNMINERALISED BIF, (W), Reddish Brown, Slightly Weathered, Medium Strong Rock. Goethite rich BIF increasing in hematite and shale at depth. Medium hard rock, consistent drilling.                                           |             |    |              |                            |                                                                                     |
| 60             |       | S     | JCK   |       |     |                  | SHALE, (W), Reddish Brown, Extremely Weathered, Strong Rock. Red-brown weathered soft shale bands, becoming purpley red 72-78m. Interbedded with hard chips of chert and BIF.                                                |             |    |              |                            |                                                                                     |
| 70             |       |       |       |       |     |                  |                                                                                                                                                                                                                              |             |    |              |                            |                                                                                     |
| 80             |       |       |       |       |     |                  |                                                                                                                                                                                                                              |             |    |              |                            |                                                                                     |
| 90             |       |       |       |       |     |                  | SHALE, (W), Blackish Grey, Highly Weathered, Weak Rock. Dark grey/black Manganese rich clay, minor cherty BIF, sticky, non plastic. No pyrite present. Possibly confining layer due to high clay fines.                      |             |    |              |                            |                                                                                     |
| 100            |       | K     | CJ    |       |     |                  |                                                                                                                                                                                                                              |             |    |              |                            |                                                                                     |

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0009 **Hole Length:** 162.00

|                                                                                    |              |                  |             |             |              |                   |                  |
|------------------------------------------------------------------------------------|--------------|------------------|-------------|-------------|--------------|-------------------|------------------|
| <b>Easting:</b> 716065.70                                                          | <b>Depth</b> | <b>Drill Rig</b> | <b>Type</b> | <b>Size</b> | <b>Fluid</b> | <b>Drilled By</b> | <b>Logged By</b> |
| <b>Northing:</b> 7475422.29                                                        | 0.0 - 162.0  | WLDRIG6          | CH          | 200         |              | WELDRILL          | KG2              |
| <b>Surface RL:</b> 664.00                                                          |              |                  |             |             |              |                   |                  |
| <b>Grid Name:</b> MGA94_50                                                         |              |                  |             |             |              |                   |                  |
| <b>Incl / Azm:</b> -90-->0                                                         |              |                  |             |             |              |                   |                  |
| <b>Construct:</b> 05 Aug 20 - 06 Aug 20                                            |              |                  |             |             |              |                   |                  |
| <b>Comments:</b> Terminated at 162m due to high TSS discharge seeping through sump |              |                  |             |             |              |                   |                  |

**TOC RL:** 664.72 (Stickup 0.72m) (drilled) **SWL:** 103.05 MBTOC (07 Aug 20) **Dev:** N **Final pH:** -  
**TOC RL:** 664.72 (Stickup 0.72m) (current) **Is Live:** Y **Date:** - **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                   | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                |
|--------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|-------------------------------------------|
| 100          | W     | K     | CJ    |       |     |                  | SHALE, (W), Blackish Grey, Highly Weathered, Weak Rock. Dark grey/black Manganese rich clay, minor cherty BIF, sticky, non plastic. No pyrite present. Possibly confining layer due to high clay fines.                                          |             |     |              |                            | 51mm BLANK PVC (0.00-115.00)              |
| 110          |       | CJS   | GK    |       |     |                  | CHERT, (W), Reddish Brown, Moderately Weathered, Medium Strong Rock. Medium sized BIF chips with brown clay fines from weathered shale.                                                                                                          |             |     |              |                            | 51mm SLOTTED PVC (115.00-157.00)          |
| 120          | D4    | M     | C     |       |     |                  | UNMINERALISED BIF, (D4), Blackish Grey, Slightly Weathered, Strong Rock. Magnetic BIF, hard, stable drilling, unfractured ground with smaller consistent sized chips.                                                                            | 400         | 8.1 | 0            |                            | END CAP (157.00) FALLBACK (157.00-162.00) |
| 130          |       | QC    |       |       |     |                  | CHERT, (D4), Whiteish Pink, Slightly Weathered, Strong Rock, 2m Thick quartz vein or chert band                                                                                                                                                  | 420         | 8.0 | 1            |                            |                                           |
| 140          |       | G     | M     |       |     |                  | MINERALISED BIF, (D4), Yellowish Grey, Slightly Weathered, Very Strong Rock. Goethitic BIF, hard, stable drilling, unfractured. smaller consistent sized chips, becoming larger more fractured and magnetic below 132m.                          | 410         | 8.7 | 2            |                            |                                           |
| 150          | D3    | M     | SC    |       |     |                  | UNMINERALISED BIF, (D3), Blackish Blue-grey, Fresh, Extremely Strong Rock. Magnetic fresh BIF with shale and chert, chips becoming larger with more evidence of fracturing, increase in yield from top of unit. Minor green chert and red shale. | 400         | 8.3 | 3            |                            | END CAP (157.00) FALLBACK (157.00-162.00) |
| 160          |       | J     | CS    |       |     |                  | UNMINERALISED BIF, (D3), Brownish Grey-blue, Fresh, Very Strong Rock. Multi coloured chert rich BIF and shale with consistent drilling.                                                                                                          | 440         | 8.4 | 4            |                            |                                           |
| 170          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                  | 440         | 8.4 | 4            |                            |                                           |
| 180          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                  | 460         | 8.4 | 5            |                            | END CAP (157.00) FALLBACK (157.00-162.00) |
| 190          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                  | 480         | 8.7 | 5            |                            |                                           |
| 200          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                  | 543         | 8.5 | 5            |                            |                                           |

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0012 **Hole Length:** 170.00

**Easting:** 718601.42

**Northing:** 7474743.50

**Surface RL:** 611.01

**Grid Name:** MGA94\_50

**Incl / Azm:** -90-->0

**Construct:** 25 Jun 20 - 26 Jun 20

**Comments:**

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 170.0 | WLDRIG6   | CH   | 200  |       | WELLDRIILL | JNM       |
|             |           |      |      |       |            |           |

**TOC RL:** 611.90 (Stickup 0.88m) (drilled) **SWL:** 49.27 MBTOC (28 Jun 20) **Dev:** N **Final pH:** -  
**TOC RL:** 611.90 (Stickup 0.88m) (current) **Is Live:** Y (-) **Date:** - **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                             | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                                                         |
|--------------|-------|-------|-------|-------|-----|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|------------------------------------------------------------------------------------|
| 0            |       | S     | HC    |       |     |                  | SHALE, (W), Whiteish Brown, Extremely Weathered, Extremely Weak Rock. Soft easy drilling, shale with minor hemi BIF and chert                                              |             |     |              |                            | CEMENT (0.00-2.00)<br>206mm BLANK STEEL (0.00-6.00)<br>51mm BLANK PVC (0.00-60.00) |
| 10           |       | C     | JQS   |       |     |                  | CHERT, (W), Whiteish Brown, Highly Weathered, Strong Rock. Soft broken ground, quick drilling. Chert with minor quartz BIF and shale                                       |             |     |              |                            |                                                                                    |
| 20           | W     | S     | J     |       |     |                  | SHALE, (W), Reddish Brown, Highly Weathered, Very Weak Rock. Silty shale fines with remnant shale chips, minor hemi BIF                                                    |             |     |              |                            |                                                                                    |
| 30           |       | S     |       |       |     |                  |                                                                                                                                                                            |             |     |              |                            |                                                                                    |
| 40           |       | JC    | Q     |       |     |                  | SHALE, (W), Light or White, Extremely Weathered, Extremely Weak Rock. Very weak pale shale, quick drilling                                                                 |             |     |              |                            |                                                                                    |
| 50           |       | M     | G     |       |     |                  | UNMINERALISED BIF, (W), Reddish Brown, Highly Weathered, Strong Rock. Quartz and chert rich un-mineralised BIF, drilling becoming harder but fractured ground              |             |     |              |                            |                                                                                    |
| 60           |       | G     | K     |       |     |                  | UNMINERALISED BIF, (D4), Blackish Brown, Slightly Weathered, Strong Rock. Magnetic BIF partially silicious., geothitic fracture zone at 46m                                |             |     |              |                            |                                                                                    |
| 70           | D4    | MC    |       |       |     |                  | UNMINERALISED BIF, (D4), Reddish Brown, Highly Weathered, Medium Strong Rock. Geothitic BIF with red clay. Minor fracturing. FWS at 51m                                    |             |     |              |                            | 51mm SLOTTED PVC (60.00-150.00)                                                    |
| 80           |       | MG    | C     |       |     |                  | UNMINERALISED BIF, (D4), Blackish Brown, Slightly Weathered, Strong Rock. Larger blocky magnetic BIF with minor limonite staining and dissolution vugs                     | 610         | 8.0 | 1            |                            |                                                                                    |
| 90           |       | M     | C     |       |     |                  | UNMINERALISED BIF, (D4), Blackish Brown, Fresh, Very Strong Rock. Smaller thinly bedded chert and magnetic chips, hard ground with slow penetration. Minor fracture at 90m | 560         | 8.0 | 2            |                            |                                                                                    |
| 100          |       |       |       |       |     |                  |                                                                                                                                                                            | 550         | 8.0 | 2            |                            |                                                                                    |
|              |       |       |       |       |     |                  |                                                                                                                                                                            | 590         | 8.3 | 5            |                            |                                                                                    |
|              |       |       |       |       |     |                  |                                                                                                                                                                            | 605         | 8.4 | 6            |                            |                                                                                    |
|              |       |       |       |       |     |                  |                                                                                                                                                                            | 610         | 8.4 | 8            |                            |                                                                                    |

## BHPIO - Hydrogeology Log

**BHP****Project:** MINISTERS NORTH**Hole Name:** HMN0012**Hole Length:** 170.00**Easting:** 718601.42**Northing:** 7474743.50**Surface RL:** 611.01**Grid Name:** MGA94\_50**Incl / Azm:** -90-->0**Construct:** 25 Jun 20 - 26 Jun 20**Comments:**

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 170.0 | WLDRIG6   | CH   | 200  |       | WELDRILL   | JNM       |
|             |           |      |      |       |            |           |

**TOC RL:** 611.90 (Stickup 0.88m) (drilled)**SWL:** 49.27 MBTOC (28 Jun 20)**Dev:** N**Final pH:** -**TOC RL:** 611.90 (Stickup 0.88m) (current)**Is Live:** Y (-)**Date:** -**Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                        | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID      |
|--------------|-------|-------|-------|-------|-----|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|---------------------------------|
| 100          | D4    | M     | C     |       |     |                  | UNMINERALISED BIF, (D4), Blackish Brown, Fresh, Very Strong Rock. Smaller thinly bedded chert and magnetic chips, hard ground with slow penetration. Minor fracture at 90m                                                                                                            | 600         | 8.2 | 9            |                            | 51mm SLOTTED PVC (60.00-150.00) |
|              |       | C     | M     |       |     |                  | CHERT, (D4), Light or White, Slightly Weathered, Very Strong Rock. Chert band with haematite staining, broken ground and increase in yield.                                                                                                                                           | 610         | 8.2 | 12           |                            |                                 |
| 110          |       | J     | C     |       |     |                  | UNMINERALISED BIF, (D4), Blackish Brown, Fresh, Very Strong Rock. Hard siliceous BIF, increasing in chert at depth                                                                                                                                                                    | 600         | 8.2 | 12           |                            |                                 |
|              | D3    | C     | MS    |       |     |                  | CHERT, (D3), Reddish Brown, Slightly Weathered, Very Strong Rock. Multicolour chert with minor shale, minor fracturing                                                                                                                                                                | 610         | 8.2 | 10           |                            |                                 |
| 120          |       | J     | C     |       |     |                  | MINERALISED BIF, (D3), Dark or Black, Slightly Weathered, Strong Rock. Hard magnetic BIF with minor green chert with limonite staining                                                                                                                                                | 600         | 8.6 | 10           |                            |                                 |
|              |       | SC    | M     |       |     |                  | SHALE, (D3), Whitelish Brown, Moderately Weathered, Weak Rock. Orange/red shale and chert with minor vuggy chips                                                                                                                                                                      | 610         | 8.6 | 12           |                            |                                 |
| 130          |       | J     |       |       |     |                  | UNMINERALISED BIF, (D3), Blackish Red, Slightly Weathered, Strong Rock. Micro banded BIF, siliceous with vuggy quartz and orange staining                                                                                                                                             | 610         | 8.4 | 14           |                            |                                 |
|              |       | SJ    |       |       |     |                  | SHALE, (D3), Pinkish Brown, Slightly Weathered, Weak Rock. Banded shale and BIF predominantly light purple at top, green grey in the middle and orange at the base. Minor magnetic BIF. Fractured ground with quicker penetration.                                                    | 610         | 8.4 | 15           |                            |                                 |
| 140          |       | M     | C     |       |     |                  | UNMINERALISED BIF, (D2), Brownish Blue, Slightly Weathered, Strong Rock. Dark magnetic BIF, hard un-fractured ground with slow drill penetration rate.                                                                                                                                | 610         | 8.4 | 15           |                            |                                 |
|              | D2    | M     | CS    |       |     |                  | UNMINERALISED BIF, (D2), Blackish Blue-red, Fresh, Extremely Strong Rock. Fresh blue grey BIF with red chert bands, hard ground, slow penetration. Minor shale fractured shale bands at 160-162m and vuggy siliceous white fracture infill 166-168m. Very slow penetration in last 6m | 610         | 8.5 | 15           |                            |                                 |
| 150          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                       | 610         | 8.6 | 15           |                            |                                 |
| 160          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                       | 610         | 8.6 | 15           |                            |                                 |
| 170          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                       | 610         | 8.6 | 15           |                            |                                 |
| 180          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                       | 610         | 8.6 | 15           |                            |                                 |
| 190          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                       | 610         | 8.6 | 15           |                            |                                 |
| 200          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                       | 610         | 8.6 | 15           |                            |                                 |

END CAP (150.00)

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0013 **Hole Length:** 170.00

**Easting:** 718593.28  
**Northing:** 7474701.77  
**Surface RL:** 609.45  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -90-->0

| Depth         | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|---------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 150.0   | WLDRI6    | CH   | 425  |       | WELLDRI6   | JNM       |
| 150.0 - 170.0 | WLDRI6    | CH   | 200  |       | WELLDRI6   | JNM       |
|               |           |      |      |       |            |           |

**Construct:** 22 Jun 20 - 25 Jun 20

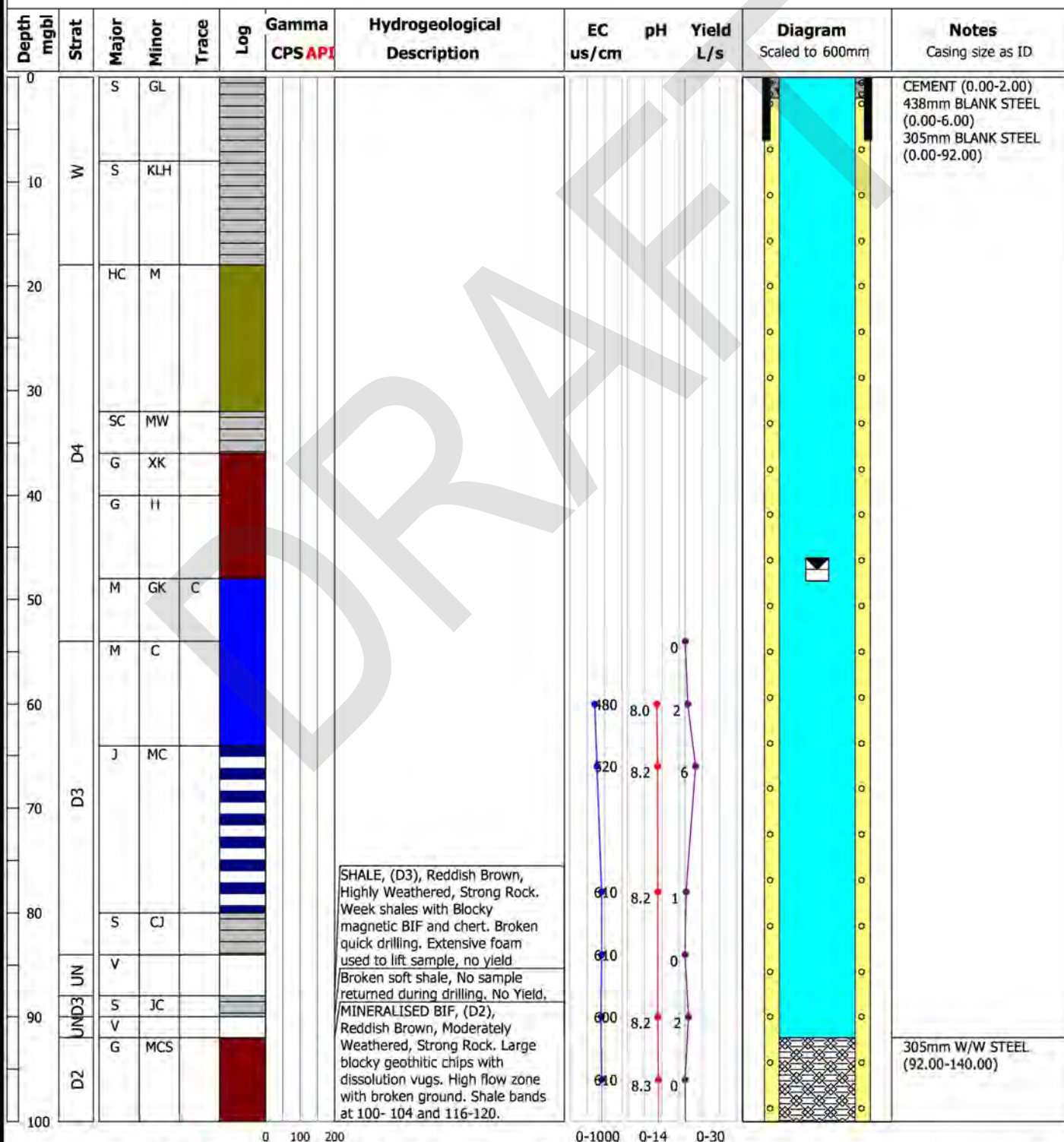
**License:** 203670

**Comments:** Unable to install to target depth due to collapsing ground and high yield discharge management to pr...

**TOC RL:** 609.77 (Stickup 0.31m) (drilled) **SWL:** 47.15 MBTOC (15 Jul 20) **Dev:** Y: 5.0 hour(s) **Final pH:** 8.1  
**TOC RL:** 609.77 (Stickup 0.31m) (current) **Is Live:** Y (-) **Date:** 12 Jul 2020 **Final EC:** 633.00

| Depth<br>m/bbl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 600mm | Notes<br>Casing size as ID                                                            |
|----------------|-------|-------|-------|-------|-----|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|--------------|----------------------------|---------------------------------------------------------------------------------------|
| 0              |       | S     | GL    |       |     |                  | SHALE, (W), Brownish Yellow, Extremely Weathered, Medium Strong Rock. Soft shale, broken, geothitic BIF with limonitic staining and fines, soft broken ground                                                 |             |    |              |                            | CEMENT (0.00-2.00)<br>438mm BLANK STEEL (0.00-6.00)<br>305mm BLANK STEEL (0.00-92.00) |
| 10             | W     | S     | KLH   |       |     |                  | SHALE, (W), Brownish Yellow, Extremely Weathered, Weak Rock. Limonitic shale with minor hematite chip, broken soft ground                                                                                     |             |    |              |                            |                                                                                       |
| 20             |       | HC    | M     |       |     |                  | MINERALISED BIF, (D4), Brown, Moderately Weathered, Strong Rock. Partially magnetic siliceous BIF with minor haematite. Hard rock, slow penetration.                                                          |             |    |              |                            |                                                                                       |
| 30             |       | SC    | MW    |       |     |                  | SHALE, (D4), Red, Highly Weathered, Weak Rock. Shale with minor quartz rich chert, broken, fast drilling                                                                                                      |             |    |              |                            |                                                                                       |
| 40             |       | G     | XK    |       |     |                  | MINERALISED BIF, (D4), Brown, Moderately Weathered, Medium Strong Rock. Geothitic BIF with minor fines, broken ground                                                                                         |             |    |              |                            |                                                                                       |
| 50             |       | M     | GK    | C     |     |                  | MINERALISED BIF, (D4), Brown, Moderately Weathered, Strong Rock. Geothitic BIF becoming fresher at depth, stable un-fractured hard ground, minor haematite staining at 46m                                    |             |    |              |                            |                                                                                       |
| 60             |       | M     | C     |       |     |                  | MINERALISED BIF, (D4), Blackish Brown, Slightly Weathered, Very Strong Rock. Magnetic BIF with very minor Geothitic BIF, staining and clay on fractures. Slow penetration                                     | 8.0         | 2  |              |                            |                                                                                       |
| 70             | D3    | J     | MC    |       |     |                  | UNMINERALISED BIF, (D3), Blackish Brown, Fresh, Very Strong Rock. Fresh magnetic BIF with minor chert micro bands and one large green chert band at 56m                                                       | 8.2         | 6  |              |                            |                                                                                       |
| 80             |       | S     | CJ    |       |     |                  | UNMINERALISED BIF, (D3), Dark or Black, Fresh, Very Strong Rock. Large blocks of fresh BIF, broken unstable ground with fall-back. Poor to no yield and difficulty getting asample return, extensive foam use | 8.2         | 1  |              |                            |                                                                                       |
| 90             | UN3   | V     |       |       |     |                  | SHALE, (D3), Brownish Red, Highly Weathered, Very Weak Rock. Weak shales with Blocky BIF and chert. Broken quick drilling, no yield                                                                           | 8.2         | 2  |              |                            |                                                                                       |
| 100            | D2    | G     | MCS   |       |     |                  | Broken soft shale, No sample returned during drilling.                                                                                                                                                        | 8.3         | 0  |              |                            | 305mm W/W STEEL (92.00-140.00)                                                        |

## BHPIO - Hydrogeology Log

**BHP****Project:** MINISTERS NORTH**Hole Name:** HMN0013**Hole Length:** 170.00**Easting:** 718593.28**Northing:** 7474701.77**Surface RL:** 609.45**Grid Name:** MGA94\_50**Incl / Azm:** -90-->0**Construct:** 22 Jun 20 - 25 Jun 20**License:** 203670**Comments:** Unable to install to target depth due to collapsing ground and high yield discharge management to pr...**TOC RL:** 609.77 (Stickup 0.31m) (drilled)**SWL:** 47.15 MBTOC (15 Jul 20)**Dev:** Y: 5.0 hour(s)**Final pH:** 8.1**TOC RL:** 609.77 (Stickup 0.31m) (current)**Is Live:** Y (-)**Date:** 12 Jul 2020**Final EC:** 633.00

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0013 **Hole Length:** 170.00

**Easting:** 718593.28  
**Northing:** 7474701.77  
**Surface RL:** 609.45  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -90-->0

| Depth         | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|---------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 150.0   | WLDRI6    | CH   | 425  |       | WELDRILL   | JNM       |
| 150.0 - 170.0 | WLDRI6    | CH   | 200  |       | WELDRILL   | JNM       |
|               |           |      |      |       |            |           |

**Construct:** 22 Jun 20 - 25 Jun 20

**License:** 203670

**Comments:** Unable to install to target depth due to collapsing ground and high yield discharge management to pr...

**TOC RL:** 609.77 (Stickup 0.31m) (drilled) **SWL:** 47.15 MBTOC (15 Jul 20) **Dev:** Y: 5.0 hour(s) **Final pH:** 8.1  
**TOC RL:** 609.77 (Stickup 0.31m) (current) **Is Live:** Y (-) **Date:** 12 Jul 2020 **Final EC:** 633.00

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                                                                                   | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 600mm | Notes<br>Casing size as ID        |
|--------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|-----------------------------------|
| 100          | D2    | G     | MCS   |       |     |                  | MINERALISED BIF, (D2),<br>Reddish Brown, Moderately<br>Weathered, Strong Rock. Large<br>blocky goethitic chips with<br>dissolution vugs. High flow zone<br>with broken ground. Shale bands<br>at 100- 104 and 116-120.                                                                                                                           | 610         | 8.4 | 1            |                            | 305mm W/W STEEL<br>(92.00-140.00) |
| 110          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  | 620         | 8.4 | 8            |                            |                                   |
| 120          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  | 600         | 8.2 | 6            |                            |                                   |
| 130          | D1    | J     | GMC   |       |     |                  | UNMINERALISED BIF, (D2),<br>Blackish Brown, Slightly<br>Weathered, Very Strong Rock.<br>Smaller dark chips with chert<br>bands, minor magnetic, hard un-<br>fractured stable ground with slow<br>penetration rate                                                                                                                                | 610         | 8.4 | 10           |                            | 305mm W/W STEEL<br>(92.00-140.00) |
| 140          |       | G     | MS    |       |     |                  | MINERALISED BIF, (D2),<br>Brownish Red, Moderately<br>Weathered, Strong Rock. Quicker<br>drilling through broken ground.<br>Gerthite and red shale with larger<br>blocky chips with minor vugg.<br>Unstable ground with extensive<br>fallback during final ream.                                                                                 | 600         | 8.3 | 10           |                            |                                   |
| 150          |       | J     | MCS   |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  | 600         | 8.2 | 12           |                            |                                   |
| 160          | D1    | M     | CS    |       |     |                  | UNMINERALISED BIF, (D1),<br>Brownish Red, Slightly<br>Weathered, Extremely Strong<br>Rock. Magnetic BIF, jaspillite,<br>very hard stable ground with<br>slow penetration rate (0.5hr for<br>2m). Sample has red shale,<br>possibly contamination.                                                                                                | 610         | 8.2 | 14           |                            | 305mm W/W STEEL<br>(92.00-140.00) |
| 170          |       | M     | GC    | S     |     |                  | UNMINERALISED BIF, (D1),<br>Brownish Red, Moderately<br>Weathered, Strong Rock.<br>Magnetic BIF and red shale,<br>broken larger chips, and glocker<br>drilling                                                                                                                                                                                   | 600         | 8.5 | 14           |                            |                                   |
| 180          |       |       |       |       |     |                  | UNMINERALISED BIF, (D1),<br>Brown, Slightly Weathered,<br>Strong Rock. Magnetic BIF<br>becoming more goethitic and<br>chert rich at depth, minor brown<br>shale posable contamination.<br>stable ground with smaller chips,<br>becoming larger and increasingly<br>broken below 164m. Extensive<br>air-loss with stable final yield 13-<br>14L/s | 610         | 8.8 | 14           |                            |                                   |
| 190          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  | 600         | 8.6 | 14           |                            |                                   |
| 200          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  |             |     |              |                            |                                   |

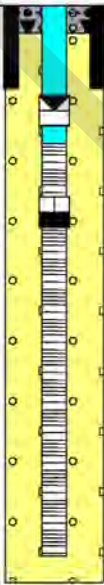
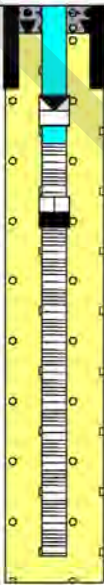
# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0015 **Hole Length:** 42.00

| Easting:           | 719338.18                                    | Depth      | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|--------------------|----------------------------------------------|------------|-----------|------|------|-------|------------|-----------|
| <b>Northing:</b>   | 7473589.25                                   | 0.0 - 42.0 | WLDRI6    | CH   | 200  |       | WELDRILL   | JNM       |
| <b>Surface RL:</b> | 569.18                                       |            |           |      |      |       |            |           |
| <b>Grid Name:</b>  | MGA94_50                                     |            |           |      |      |       |            |           |
| <b>Incl / Azm:</b> | -90-->0                                      |            |           |      |      |       |            |           |
| <b>Construct:</b>  | 10 Jul 20 - 10 Jul 20                        |            |           |      |      |       |            |           |
| <b>Comments:</b>   | Installed in-rod due to collapsing formation |            |           |      |      |       |            |           |

**TOC RL:** 569.99 (Stickup 0.78m) (drilled) **SWL:** 7.64 MBTOC (13 Jul 20) **Dev:** N **Final pH:** -  
**TOC RL:** 569.99 (Stickup 0.78m) (current) **Is Live:** Y **Date:** - **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                                                                                                                             | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm                                                           | Notes<br>Casing size as ID                                                         |
|--------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 0            | TD3   | Z     | KJ    |       |     |                  | CLAY, cobbled, trace gravel, (CLAY), Brown, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded, Unconsolidated / unstable ground. Loose orange clay with sub rounded BIF and chert cobbles                                                                                                                                                                                        |             |     |              |  | CEMENT (0.00-2.00)<br>206mm BLANK STEEL (0.00-6.00)<br>51mm BLANK PVC (0.00-10.00) |
| 10           |       | C     | JK    |       |     |                  | COBBLE, clayey, (CHERT), Brownish Dark or Black, Transported, Non-Cohesive soils, Poorly graded, Angular, Unconsolidated / unstable ground. D1. Micro banded chert with BIF, strong orange staining, broken ground large chips, collapsing formation. black manganese non plastic clay at 18m.                                                                                             | 12          | 8.0 | 1            |                                                                                      | 51mm SLOTTED PVC (10.00-40.00)                                                     |
| 20           | T     | Z     | PBO   |       |     |                  | BRECCIA, (T), Whiteish Dark or Black, Moderately Weathered, Strong Rock. Possibly D1 to 34 and RN 34 to 42m. Large (>100mm) blocky vuggy chips where pyrite has been removed, loose unconsolidated broken ground. Finely banded/laminated white leached chert and black glassy massive chert, iron cemented breccia and black clay with strong black water discoloration on airlift yield. | 17          | 8.1 | 3            |  | WELLCAP(15.00) ID: 2667                                                            |
| 30           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                            | 23          | 8.2 | 6            |                                                                                      |                                                                                    |
| 40           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                            | 42          | 8.3 | 6            |                                                                                      |                                                                                    |
| 50           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                            | 25          | 8.3 | 7            |                                                                                      | END CAP (40.00)                                                                    |

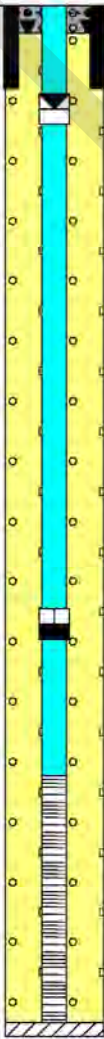
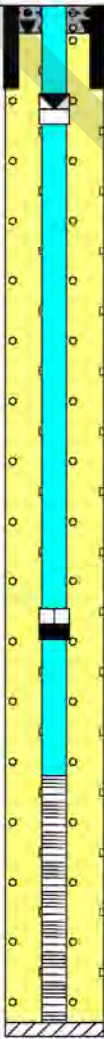
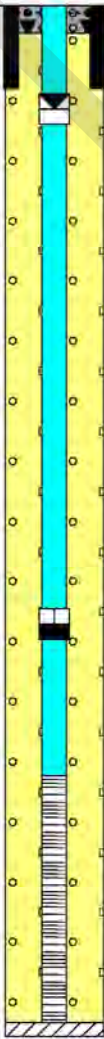
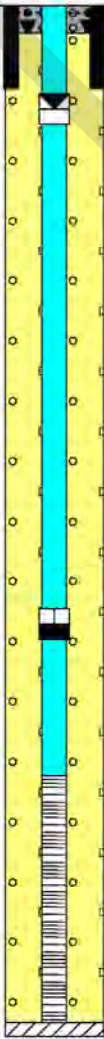
# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0016 **Hole Length:** 75.00

| Easting:           | 719341.07                                                                                               | Depth      | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|--------------------|---------------------------------------------------------------------------------------------------------|------------|-----------|------|------|-------|------------|-----------|
| <b>Northing:</b>   | 7473597.06                                                                                              | 0.0 - 75.0 | WLDRI6    | CH   | 200  |       | WELDRILL   | JNM       |
| <b>Surface RL:</b> | 569.11                                                                                                  |            |           |      |      |       |            |           |
| <b>Grid Name:</b>  | MGA94_50                                                                                                |            |           |      |      |       |            |           |
| <b>Incl / Azm:</b> | -90-->0                                                                                                 |            |           |      |      |       |            |           |
| <b>Construct:</b>  | 28 Jun 20 - 28 Jun 20                                                                                   |            |           |      |      |       |            |           |
| <b>Comments:</b>   | Hole terminated at 75m after drilling into basement, sump full with pyritic shale intersected, no di... |            |           |      |      |       |            |           |

**TOC RL:** 569.88 (Stickup 0.76m) (drilled) **SWL:** 7.52 MBTOC (29 Jun 20) **Dev:** N **Final pH:** -  
**TOC RL:** 569.88 (Stickup 0.76m) (current) **Is Live:** Y **Date:** - **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                                                                                                                         | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm                                                           | Notes<br>Casing size as ID                                                         |
|--------------|-------|-------|-------|-------|-----|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 0            | TD3   | Z     | KJ    |       |     |                  | CLAY, cobbled, trace gravel, (CLAY), Brown, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded, Unconsolidated / unstable ground. Loose orange clay with sub rounded BIF and chert cobbles                                                                                                                                                                                    |             |     |              |  | CEMENT (0.00-2.00)<br>206mm BLANK STEEL (0.00-6.00)<br>51mm BLANK PVC (0.00-56.00) |
| 10           |       | C     | PBO   |       |     |                  | BRECCIA, (T), Whiteish Dark or Black, Moderately Weathered, Strong Rock. D1 12m to 34 and RN 34 to 42m. Large ( >100mm) blocky vuggy chips where pyrite has been removed, loose unconsolidated broken ground. Finely banded/laminated white leached chert and black glassy massive chert, iron cemented breccia and black clay with strong black water discoloration on airlift yield. | 524         | 7.2 | 1            |                                                                                      |                                                                                    |
| 20           | T     |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 519         | 7.8 | 5            |  |                                                                                    |
| 30           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 506         | 8.0 | 10           |                                                                                      |                                                                                    |
| 40           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 500         | 8.1 | 10           |                                                                                      |                                                                                    |
| 50           | RN    | B     | P     |       |     |                  | SHALE, (RN), Dark or Black, Slightly Weathered, Weak Rock. RN. Large blocky black shale chips, broken ground becoming more consolidated with depth                                                                                                                                                                                                                                     | 557         | 7.7 | 2            |  | WELLCAP(45.00) ID: 2668                                                            |
| 60           |       | B     | QP    |       |     |                  | SHALE, (RN), Dark or Black, Fresh, Weak Rock. Stable ground with smaller platy chips. Fine grained black shale with minor pyrite nodules and milky quartz, minor BIF and pisolites likely contamination as higher up hole continuing to collapse requiring multiple re reaming/clearing of material in hole between 25 and 40m                                                         | 542         | 8.3 | 16           |                                                                                      |                                                                                    |
| 70           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 526         | 8.4 | 15           |                                                                                      |                                                                                    |
| 80           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 527         | 8.3 | 15           |  | 51mm SLOTTED PVC (56.00-74.00)                                                     |
| 90           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 536         | 8.3 | 15           |                                                                                      |                                                                                    |
| 100          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        |             |     |              |                                                                                      | END CAP (74.00)<br>FALLBACK (74.00-75.00)                                          |

## BHPIO - Hydrogeology Log

**BHP****Project:** MINISTERS NORTH**Hole Name:** HMN0017**Hole Length:** 100.00**Easting:** 719773.22**Northing:** 7473528.98**Surface RL:** 608.53**Grid Name:** MGA94\_50**Incl / Azm:** -90-->0**Construct:** 08 Jul 20 - 09 Jul 20**Comments:**

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 100.0 | WLDRIG6   | CH   | 200  |       | WELLDRIILL | JNM       |
|             |           |      |      |       |            |           |

**TOC RL:** 609.19 (Stickup 0.66m) (drilled)**SWL:** 46.55 MBTOC (10 Jul 20)**Dev:** N**Final pH:** -**TOC RL:** 609.19 (Stickup 0.66m) (current)**Is Live:** Y (-)**Date:** -**Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                                                    | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                           |
|--------------|-------|-------|-------|-------|-----|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|------------------------------------------------------|
| 0            |       | J     | SC    |       |     |                  | UNMINERALISED BIF, (D3),<br>Reddish Brown, Highly<br>Weathered, Medium Strong Rock.<br>Heavily weathered, broken<br>ground.                                                                                                                                                                                       |             |     |              |                            | CEMENT (0.00-2.00)<br>51mm BLANK PVC<br>(0.00-40.00) |
| 10           | D3    | J     | MS    |       |     |                  | UNMINERALISED BIF, (D3),<br>Blackish Red, Moderately<br>Weathered, Strong Rock. Large<br>>20mm jaspilite BIF with<br>magnetite and minor shale band<br>from 12m                                                                                                                                                   |             |     |              |                            |                                                      |
| 20           |       | C     | S     |       |     |                  | CHERT, (D3), Whiteish Brown,<br>Highly Weathered, Weak Rock.<br>White and red chert with orange<br>shales                                                                                                                                                                                                         |             |     |              |                            |                                                      |
| 30           | D2    | J     | MCK   |       |     |                  | UNMINERALISED BIF, (D2),<br>Reddish Brown, Highly<br>Weathered, Strong Rock.<br>Magnetic BIF and chert with<br>maroon clays/ completely<br>weathered shales.                                                                                                                                                      |             |     |              |                            |                                                      |
| 40           |       | M     | K     |       |     |                  | UNMINERALISED BIF, (D2),<br>Brown, Slightly Weathered, Very<br>Strong Rock. Magnetic BIF with<br>minor clays                                                                                                                                                                                                      |             |     |              |                            | 51mm SLOTTED PVC<br>(40.00-100.00)                   |
| 50           | D1    | C     | SM    |       |     |                  | UNMINERALISED BIF, (D1),<br>Brown, Slightly Weathered, Very<br>Strong Rock. Larger blocky chips<br>of Chert and magnetite, multiple<br>shale bands throughout. green<br>thinly bedded chert at base.<br>Broken ground.                                                                                            | 1175        | 7.8 | 0            |                            |                                                      |
| 60           |       | CS    |       |       |     |                  | UNMINERALISED BIF, (D1),<br>Brownish Dark or Black-red,<br>Fresh, Strong Rock. Multi<br>coloured BIF, chert and shale.<br>Stable, hard drilling with smaller<br>chips.                                                                                                                                            | 912         | 8.8 | 0            |                            |                                                      |
| 70           |       | B     | K     |       |     |                  | SHALE, (RU), Dark or Black,<br>Fresh, Very Weak Rock. RN.<br>Fine grained black shale with<br>black water return and fast<br>drilling. Soft scratchable,<br>laminated chips. Ground<br>becoming more broken with large<br>chips 70-76m with increase in<br>yield. No pyrite observed. Minor<br>sticky black clay. | 946         | 8.1 | 2            |                            |                                                      |
| 80           | RU    |       |       |       |     |                  | SHALE, (RU), Blackish Grey,<br>Fresh, Weak Rock. OB. Mix of<br>larger blocky crystalline dolomite<br>chips with smaller fine grained<br>laminated black shale chips.<br>Possible transition to dolomite.                                                                                                          | 933         | 8.0 | 3            |                            |                                                      |
| 90           |       | B     |       |       |     |                  | DOLOMITE, (OB), Blueish Grey,<br>Fresh, Weak Rock. Crystalline<br>massive blue grey, easy scratch<br>with fizz.                                                                                                                                                                                                   | 910         | 8.0 | 6            |                            |                                                      |
| 90           |       | D     |       |       |     |                  |                                                                                                                                                                                                                                                                                                                   | 945         | 8.2 | 6            |                            |                                                      |
| 90           |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                   | 933         | 8.2 | 6            |                            |                                                      |
| 100          | OB    |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                   | 931         | 8.2 | 6            |                            | END CAP (100.00)                                     |

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0018 **Hole Length:** 100.00

**Easting:** 720058.46

**Northing:** 7473667.56

**Surface RL:** 600.69

**Grid Name:** MGA94\_50

**Incl / Azm:** -90-->0

**Construct:** 05 Jul 20 - 06 Jul 20

**Comments:**

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 100.0 | WLDRIG6   | CH   | 200  |       | WELDRILL   | KG2       |
|             |           |      |      |       |            |           |

**TOC RL:** 601.49 (Stickup 0.78m) (drilled) **SWL:** 39.21 MBTOC (06 Jul 20) **Dev:** N **Final pH:** -  
**TOC RL:** 601.49 (Stickup 0.78m) (current) **Is Live:** Y (-) **Date:** 05 Jul 2020 **Final EC:** -

| Depth<br>mglbl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                       | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                                                         |
|----------------|-------|-------|-------|-------|-----|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|------------------------------------------------------------------------------------|
| 0              | SZ    | Z     | XK    |       |     |                  | SCREE, (SZ), Reddish Brown-yellow, Slightly Weathered, Strong Rock. Small sub-rounded BIF and chert unconsolidated chips                                             |             |     |              |                            | CEMENT (0.00-2.00)<br>206mm BLANK STEEL (0.00-6.00)<br>51mm BLANK PVC (0.00-40.00) |
| 10             | D4    | H     | X     |       |     |                  | UNMINERALISED BIF, (D4), Reddish Brown-grey, Moderately Weathered, Strong Rock. Hard angular BIF chips with maroon clays. Non magnetic.                              |             |     |              |                            |                                                                                    |
| 20             | D4    | S     | CH    |       |     |                  | SHAPE, (D4), Buffish Dark or Black-yellow, Highly Weathered, Very Weak Rock. Heavily weathered pale shales, easily crumbles. Minor chert bands                       |             |     |              |                            |                                                                                    |
| 30             | D4    | HC    | X     | M     |     |                  | UNMINERALISED BIF, (D4), Reddish Yellow-grey, Moderately Weathered, Strong Rock. Angular BIF with trace magnetic grains. Microbands of jaspilite                     |             |     |              |                            |                                                                                    |
| 40             | D3    | S     | MC    | L     |     |                  | SHAPE, (D3), Brownish Yellow-grey, Highly Weathered, Medium Strong Rock. Weathered shales with BIF. Poorly mineralised. Broken ground.                               |             |     |              |                            |                                                                                    |
| 50             | D3    | SC    | MH    |       |     |                  | SHAPE, (D3), Brown, Highly Weathered, Medium Strong Rock. Brown to maroon shales with chert/jaspilite and magnetite BIF chips.                                       |             |     |              |                            |                                                                                    |
| 60             | D3    | M     | C     | H     |     |                  | UNMINERALISED BIF, (D3), Brownish Grey-red, Slightly Weathered, Strong Rock. Red coated grains of magnetite, chert BIF. minor hematite towards base.                 | 512         | 8.0 | 0            |                            |                                                                                    |
| 70             | D2    | MC    |       |       |     |                  | UNMINERALISED BIF, (D2), Blackish Grey-red, Fresh, Strong Rock. Magnetic BIF with jaspilite and minor large green chert chips.                                       | 420         | 7.9 | 2            |                            |                                                                                    |
| 80             | D2    | C     | MH    | L     |     |                  | UNMINERALISED BIF, (D2), Greyish Yellow, Fresh, Very Strong Rock. Chert-rich BIF with minor hematite and magnetite. Minor limonite.                                  | 603         | 8.1 | 3            |                            |                                                                                    |
| 90             | D2    | CM    | L     |       |     |                  | UNMINERALISED BIF, (D2), Greyish Yellow-buff, Slightly Weathered, Very Strong Rock. Magnetite-rich BIF. Trace greenalite and trace limonite staining. Broken ground. | 595         | 8.0 | 3            |                            |                                                                                    |
| 100            | D2    | MC    | S     |       |     |                  | UNMINERALISED BIF, (D2), Blackish Blue-yellow, Fresh, Very Strong Rock. Jaspilite and magnetite BIF with minor orange shale.                                         | 628         | 7.4 | 3            |                            |                                                                                    |
|                |       |       |       |       |     |                  |                                                                                                                                                                      | 566         | 7.6 | 4            |                            |                                                                                    |
|                |       |       |       |       |     |                  |                                                                                                                                                                      | 603         | 7.8 | 4            |                            |                                                                                    |
|                |       |       |       |       |     |                  |                                                                                                                                                                      | 582         | 7.9 | 4            |                            |                                                                                    |
|                |       |       |       |       |     |                  |                                                                                                                                                                      | 560         | 8.1 | 6            |                            |                                                                                    |
|                |       |       |       |       |     |                  |                                                                                                                                                                      |             |     |              |                            | END CAP (100.00)                                                                   |

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0024 **Hole Length:** 120.00

**Easting:** 720690.97

**Northing:** 7474410.03

**Surface RL:** 630.04

**Grid Name:** MGA94\_50

**Incl / Azm:** -90-->0

**Construct:** 01 Jul 20 - 02 Jul 20

**Comments:**

| Depth       | Drill Rig | Type | Size | Fluid | Drilled By | Logged By |
|-------------|-----------|------|------|-------|------------|-----------|
| 0.0 - 120.0 | WLDRIG6   | CH   | 200  |       | WELLDRIILL | JNM       |
|             |           |      |      |       |            |           |

**TOC RL:** 630.74 (Stickup 0.67m) (drilled) **SWL:** 68.64 MBTOC (02 Jul 20) **Dev:** N **Final pH:** -  
**TOC RL:** 630.74 (Stickup 0.67m) (current) **Is Live:** Y (-) **Date:** 01 Jul 2020 **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                             | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                        |
|--------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|--------------|----------------------------|---------------------------------------------------|
| 0            |       | JC    | GL    |       |     |                  | CHERT, (J6), Brown, Slightly Weathered, Strong Rock. Cherty BIF minor limonite staining on fracture plains.                                                                                |             |    |              |                            | CEMENT (0.00-2.00)<br>51mm BLANK PVC (0.00-60.00) |
| 10           |       |       |       |       |     |                  |                                                                                                                                                                                            |             |    |              |                            |                                                   |
| 20           | J6    | JC    | X     |       |     |                  | CHERT, (J6), Brown, Slightly Weathered, Strong Rock. Cherty BIF with bands of orange laminated chert, slightly broken ground 16 to 24m. minor magnetic.                                    |             |    |              |                            |                                                   |
| 30           |       | J     | CMG   |       |     |                  | UNMINERALISED BIF, (J6), Blackish Brown, Slightly Weathered, Strong Rock. BIF, becoming more magnetic, fresher and harder, slower pen rate with depth                                      |             |    |              |                            |                                                   |
| 40           |       |       |       |       |     |                  |                                                                                                                                                                                            |             |    |              |                            |                                                   |
| 50           | J5    | M     | C     |       |     |                  | UNMINERALISED BIF, (J5), Blackish Blue-grey, Fresh, Very Strong Rock. Magnetic BIF, hard stable ground slow drilling.                                                                      |             |    |              |                            |                                                   |
| 60           |       |       |       |       |     |                  |                                                                                                                                                                                            |             |    |              |                            | 51mm SLOTTED PVC (60.00-120.00)                   |
| 70           |       |       |       |       |     |                  |                                                                                                                                                                                            |             |    |              |                            |                                                   |
| 80           |       | M     | K     |       |     |                  | UNMINERALISED BIF, (J5), Blackish Grey, Slightly Weathered, Strong Rock. Magnetic BIF with clay bands, hard stable ground slow drilling.                                                   |             |    |              |                            |                                                   |
| 90           |       | M     | S     |       |     |                  | UNMINERALISED BIF, (J5), Blackish Grey, Fresh, Strong Rock. Magnetic BIF with unweathered shale fragments, hard stable ground slow drilling.                                               |             |    |              |                            |                                                   |
| 100          |       | M     | CH    |       |     |                  | UNMINERALISED BIF, (J5), Blackish Blue-grey, Fresh, Very Strong Rock. Magnetic BIF with micro bands of haematite. Hard stable ground slow drilling with no yield observed during drilling. |             |    |              |                            |                                                   |

0 100 200

0-1000 0-14 0-30

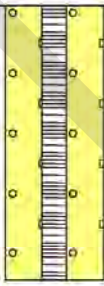
# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** HMN0024 **Hole Length:** 120.00

|                    |                       |              |                  |             |             |              |                   |                  |
|--------------------|-----------------------|--------------|------------------|-------------|-------------|--------------|-------------------|------------------|
| <b>Easting:</b>    | 720690.97             | <b>Depth</b> | <b>Drill Rig</b> | <b>Type</b> | <b>Size</b> | <b>Fluid</b> | <b>Drilled By</b> | <b>Logged By</b> |
| <b>Northing:</b>   | 7474410.03            | 0.0 - 120.0  | WLDRIG6          | CH          | 200         |              | WELDRILL          | JNM              |
| <b>Surface RL:</b> | 630.04                |              |                  |             |             |              |                   |                  |
| <b>Grid Name:</b>  | MGA94_50              |              |                  |             |             |              |                   |                  |
| <b>Incl / Azm:</b> | -90-->0               |              |                  |             |             |              |                   |                  |
| <b>Construct:</b>  | 01 Jul 20 - 02 Jul 20 |              |                  |             |             |              |                   |                  |
| <b>Comments:</b>   |                       |              |                  |             |             |              |                   |                  |

**TOC RL:** 630.74 (Stickup 0.67m) (drilled) **SWL:** 68.64 MBTOC (02 Jul 20) **Dev:** N **Final pH:** -  
**TOC RL:** 630.74 (Stickup 0.67m) (current) **Is Live:** Y (-) **Date:** 01 Jul 2020 **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                            | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 400mm                                                          | Notes<br>Casing size as ID         |
|--------------|-------|-------|-------|-------|-----|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|-------------------------------------------------------------------------------------|------------------------------------|
| 100          |       | M     | CH    |       |     |                  | UNMINERALISED BIF, (J5),<br>Blackish Blue-grey, Fresh, Very<br>Strong Rock. Magnetic BIF with<br>micro bands of haematite. Hard<br>stable ground slow drilling with no<br>yield observed during drilling. |             |     |              |  | 51mm SLOTTED PVC<br>(60.00-120.00) |
| 110          | J5    |       |       |       |     |                  |                                                                                                                                                                                                           |             |     |              |                                                                                     |                                    |
| 120          |       |       |       |       |     |                  |                                                                                                                                                                                                           | 900         | 8.5 | 0            |                                                                                     | END CAP (120.00)                   |
| 130          |       |       |       |       |     |                  |                                                                                                                                                                                                           |             |     |              |                                                                                     |                                    |
| 140          |       |       |       |       |     |                  |                                                                                                                                                                                                           |             |     |              |                                                                                     |                                    |
| 150          |       |       |       |       |     |                  |                                                                                                                                                                                                           |             |     |              |                                                                                     |                                    |
| 160          |       |       |       |       |     |                  |                                                                                                                                                                                                           |             |     |              |                                                                                     |                                    |
| 170          |       |       |       |       |     |                  |                                                                                                                                                                                                           |             |     |              |                                                                                     |                                    |
| 180          |       |       |       |       |     |                  |                                                                                                                                                                                                           |             |     |              |                                                                                     |                                    |
| 190          |       |       |       |       |     |                  |                                                                                                                                                                                                           |             |     |              |                                                                                     |                                    |
| 200          |       |       |       |       |     |                  |                                                                                                                                                                                                           |             |     |              |                                                                                     |                                    |

## Appendix C

### Production bore Form 2

DRAFT



# Information to be provided on completion of a non-artesian well

Information to be provided to the Department of Water under the *Water Agencies (Powers) Act 1984* and Section 26E of the *Rights in Water and Irrigation Act 1914* and Regulation 39 of the *Rights in Water and Irrigation Regulations 2000*

## Please note:

- All information is to be written clearly and in block letters.
- If insufficient room please use a separate piece of paper.
- It is the responsibility of the person carrying out the works to fill out this form.

### Part 1: Details of any licence granted for the work under the *Rights in Water And Irrigation Act 1914* section 26D

Licence number

CAW 203670

☐ Individual ☒ Company

Licensee's full name

BHP BILLITON IRON ORE PTY LTD

### Part 2: Details of person carrying out the works

Company

WELLDRIILL

Driller

Scott Macleod, Ramon Watkins

Driller licence number  
(non-mandatory)

Driller classification  
(non-mandatory)

Postal address

16 Jessie Lee Street Henderson, Perth Western Australia 6008

Telephone

08 9437 4633

Facsimile

08 9437 6188

Email

info@welldrill.com.au

### Part 3: Location of well

A 26D licence will list the premises on which well construction is to occur.

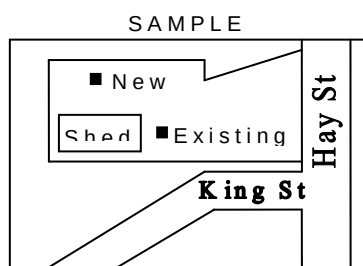
If the physical address of the well is different from the property address listed on the licence, contact the Department of Water prior to the commencement of construction.

Property address of well or other tenure details

MINISTERS NORTH, MINING LEASE M266SA

|      |    |                                                     |                        |                                                 |                                   |
|------|----|-----------------------------------------------------|------------------------|-------------------------------------------------|-----------------------------------|
| Zone | 51 | Easting/<br>latitude<br>Datum<br>(e.g. GDA94/WGS84) | Well coordinates       | <input checked="" type="checkbox"/> GPS reading | <input type="checkbox"/> Estimate |
|      |    |                                                     | Northing/<br>longitude | 175702.880                                      |                                   |
|      |    |                                                     | GPS<br>reliability     | 0.1cm                                           |                                   |

Location plan – in the box below please sketch a plan showing position of well in relation to building, boundaries, road, nearest cross road and any additional information to assist in locating the well.



SEE ATTACHED.

In the box to the right, please sketch a plan showing:

- location of all wetlands / watercourses / wells / soaks (existing and proposed).
- major improvements (house, large sheds etc).
- shaded sections to indicate areas under development.

**Part 4: Construction details (All measurements are to be taken from ground level.)**

| Production casing detail |              |                   |                     |          |        |
|--------------------------|--------------|-------------------|---------------------|----------|--------|
| Material                 | Nominal bore | Diameter O.D (mm) | Wall thickness (mm) | Depth    |        |
|                          |              |                   |                     | From (m) | To (m) |
| steel                    | 12"          | 324               | 9.6                 | 0        | 110    |
|                          |              |                   |                     |          |        |
|                          |              |                   |                     |          |        |

Please complete well construction diagram in box provided below. If insufficient room please attach on separate piece of paper.

SEE ATTACHED BORE LOG.

| Screens/slots              |                   |               |                   |                      |
|----------------------------|-------------------|---------------|-------------------|----------------------|
| Screens/slot (type)        | Diameter O.D (mm) | Aperture (mm) | Top of screen (m) | Bottom of screen (m) |
| Stainless steel wire wound | 324               | 1             | 110               | 170                  |
|                            |                   |               |                   |                      |
|                            |                   |               |                   |                      |

| Gravel pack details |          |        |
|---------------------|----------|--------|
| Gravel size (mm)    | From (m) | To (m) |
|                     | 3.2      | 6.4    |

| Annular fill  |          |        |
|---------------|----------|--------|
| Material type | From (m) | To (m) |
| Cement grout  | 0        | 2      |
| Gravel        | 2        | 172    |
| Fallback      | 172      | 178    |

| Cementing detail                                 |                                  |        |
|--------------------------------------------------|----------------------------------|--------|
| <input type="checkbox"/> Pressure cement grouted | <input type="checkbox"/> Tremmie |        |
| Casing diameter (mm O.D)                         | Depth                            |        |
|                                                  | From (m)                         | To (m) |
|                                                  |                                  |        |
|                                                  |                                  |        |
|                                                  |                                  |        |

Total depth drilled (from ground level)

178

Geophysical log required as condition of licence?

☐ Yes ☐ No

Geophysical log taken? (attach log and contractor details)

☐ Yes ☒ No

| From (m) | To (m) | Strata description (If insufficient room attach on separate page) |
|----------|--------|-------------------------------------------------------------------|
|          |        | SEE ATTACHED BORE LOG.                                            |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |

## Part 5: Particulars of well

Drilling start date refers to the date drilling begins. Do not include set up date.

Drilling completion date includes well development and testing.

|                       |                                                                                                                                                                                                                                         |                     |            |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| Well name / number    | HMN0003P                                                                                                                                                                                                                                |                     |            |
| Drilling start        | 13/07/2020                                                                                                                                                                                                                              | Drilling completion | 27/07/2020 |
| Drilling method used  | <input checked="" type="checkbox"/> Rotary air <input type="checkbox"/> Cable tool <input type="checkbox"/> Auger <input type="checkbox"/> Rotary mud<br><input type="checkbox"/> Sludge <input type="checkbox"/> Other (specify) _____ |                     |            |
| Final status of well  | <input checked="" type="checkbox"/> Ready to operate <input type="checkbox"/> Decommissioned<br><input type="checkbox"/> Other (specify) _____                                                                                          |                     |            |
| Purpose (use) of well | <input checked="" type="checkbox"/> Production <input type="checkbox"/> Investigation <input type="checkbox"/> Monitoring<br><input type="checkbox"/> Other (specify) _____                                                             |                     |            |

## Part 6: Well development

|                                                       |                                                                                                                                             |                         |         |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------|
| Date (dd/mm/yy)                                       | 28/07/2020                                                                                                                                  | Duration of development | 7 hours |
| Method                                                | <input checked="" type="checkbox"/> Airlift <input type="checkbox"/> Pump <input type="checkbox"/> Jetting <input type="checkbox"/> Surging |                         |         |
| Development pump rate (e.g. L/s, m <sup>3</sup> /day) | 20 L/s                                                                                                                                      |                         |         |

## Part 7: Pump testing (If applicable)

|                                                                                                          |                                                                                                                                           |                                               |  |                  |       |
|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|--|------------------|-------|
| Date start (dd/mm/yy)                                                                                    |                                                                                                                                           | Date end (dd/mm/yy)                           |  | Duration of test | hours |
| <input type="checkbox"/> Step test <input type="checkbox"/> Constant rate <input type="checkbox"/> Other |                                                                                                                                           |                                               |  |                  |       |
| Constant rate - pump rate (e.g. m <sup>3</sup> /day)                                                     |                                                                                                                                           | Pump type (e.g. submersible)                  |  |                  |       |
|                                                                                                          |                                                                                                                                           | Water rest level prior to test (m)            |  |                  |       |
| Measurements taken from                                                                                  | <input type="checkbox"/> top of casing (TOC) <input type="checkbox"/> ground level (GL)<br><input type="checkbox"/> other (specify) _____ |                                               |  |                  |       |
| Elevation of measurement reference point if known (metres AHD)                                           | <input type="checkbox"/> GPS <input type="checkbox"/> Estimate<br><input type="checkbox"/> other (specify) _____                          |                                               |  |                  |       |
| Final drawdown                                                                                           | m                                                                                                                                         | Recommended supply (e.g. m <sup>3</sup> /day) |  |                  |       |

Final drawdown is the distance between the static water level measured prior to the test and the water level measured at the end of the pumping test.

Comments.....

## Part 8: Field samples

Specify unit measurements.

|                                             |                |                                                                                                                   |         |
|---------------------------------------------|----------------|-------------------------------------------------------------------------------------------------------------------|---------|
| Collection method (e.g. pump test, airlift) | airlift        |                                                                                                                   |         |
| Conductivity (e.g. mS/m)                    | 605 $\mu$ S/cm | <input checked="" type="checkbox"/> Temperature compensated<br><input type="checkbox"/> Temperature uncompensated | pH 7.86 |
| Water temperature at test                   | 28.7           |                                                                                                                   |         |

Comments.....

## Part 9: Lab samples

Lab samples taken (Please attach) ☒ Yes ☐ No

TDS (e.g. mg/l)

Please submit samples separately to form if not received before the 1 month submission deadline.

**Part 10: Water levels**

SWL (Static water level) 72.66 m Water cut at 90 m

Measurements taken from ☒ top of casing (TOC) ☐ ground level (GL)  
☐ other (specify) \_\_\_\_\_

Date of reading (dd/mm/yy) 30/07/2020

Comments TOC 635.027mAHD

**Part 11: Declaration and signature**

Capacity of person making declaration:

- ☐ An individual who carried out the work  
☐ An officer who is a director or secretary of a corporation that carried out the work.  
☐ Other (describe).....

I, James McDiarmid (name of person making declaration) declare that the information provided on this form is true and correct.

**Important information**

- All information must be completed on the form unless otherwise indicated as optional for example; provision of the drillers licence number and classification fields are not mandatory and can be filled in at the drillers discretion. Provision of non-mandatory details would greatly assist the department in completion of its data set.
- Failure to complete all mandatory details and to submit the form to the department is an offence under the *Rights in Water and Irrigation Act 1914*.
- Under section 26E and regulation 39 within 1 month of completion of the construction of or deepening of the well, the person carrying out the work for a 26D licence must submit this form.
- Non-artesian wells in proclaimed areas require a licence unless exempted under the *Rights in Water and Irrigation Exemption (S26C) Order 2007*.

**Where and how to submit this form**

This form can be submitted by fax, post or in person to the appropriate Department of Water regional office. For assistance in completing this form contact your regional office.

**Kimberley Region**

Kununurra Regional Office  
 27 Victoria Hwy  
 Kununurra WA 6743  
 Tel: 08 9166 4100  
 Fax: 08 9168 3174  
 PO Box 625  
 Kununurra WA 6743

**Midwest Gascoyne Region**

Geraldton Regional Office  
 94 Sandford Street  
 Geraldton WA 6531  
 Tel: 08 9965 7400  
 Fax: 08 9964 5983  
 Po Box 81  
 Geraldton WA 6531

**Carnarvon**

Carnarvon District Office  
 211 Robinson Street  
 Carnarvon WA 6701  
 Tel: 08 9941 6100  
 Fax: 08 9941 4931  
 PO Box 81  
 Carnarvon WA 6701

**Kwinana Peel Region**

Mandurah Regional Office  
 107 Breakwater Parade  
 Mandurah WA 6210  
 Tel: 08 9550 4222  
 Fax: 08 9581 4560  
 PO Box 332  
 Mandurah WA 6210

**South West Region**

Bunbury Regional Office  
 35-39 McCombe Road  
 Bunbury WA 6230  
 Tel: 08 9726 4111  
 Fax: 08 9726 4100  
 PO Box 261  
 Bunbury WA 6231

**Busselton**

Busselton District Office  
 Suite 2, 72 Duchess Street  
 Busselton WA 6280  
 Tel: 08 9781 0188  
 Fax: 08 9754 4335  
 PO Box 269  
 Busselton WA 6280

**South Coast Region**

Albany Regional Office  
 5 Bevan Street  
 Albany WA 6330  
 Tel: 08 9842 5760  
 Fax: 08 9842 1204  
 PO Box 525  
 Albany WA 6331

**Pilbara Region**

Karratha Regional Office  
 Lot 4608 Cherratta Road  
 Karratha Industrial Estate  
 Karratha WA 6714  
 Tel: 08 9144 2000  
 Fax: 08 9144 2610  
 PO Box 836  
 Karratha WA 6714

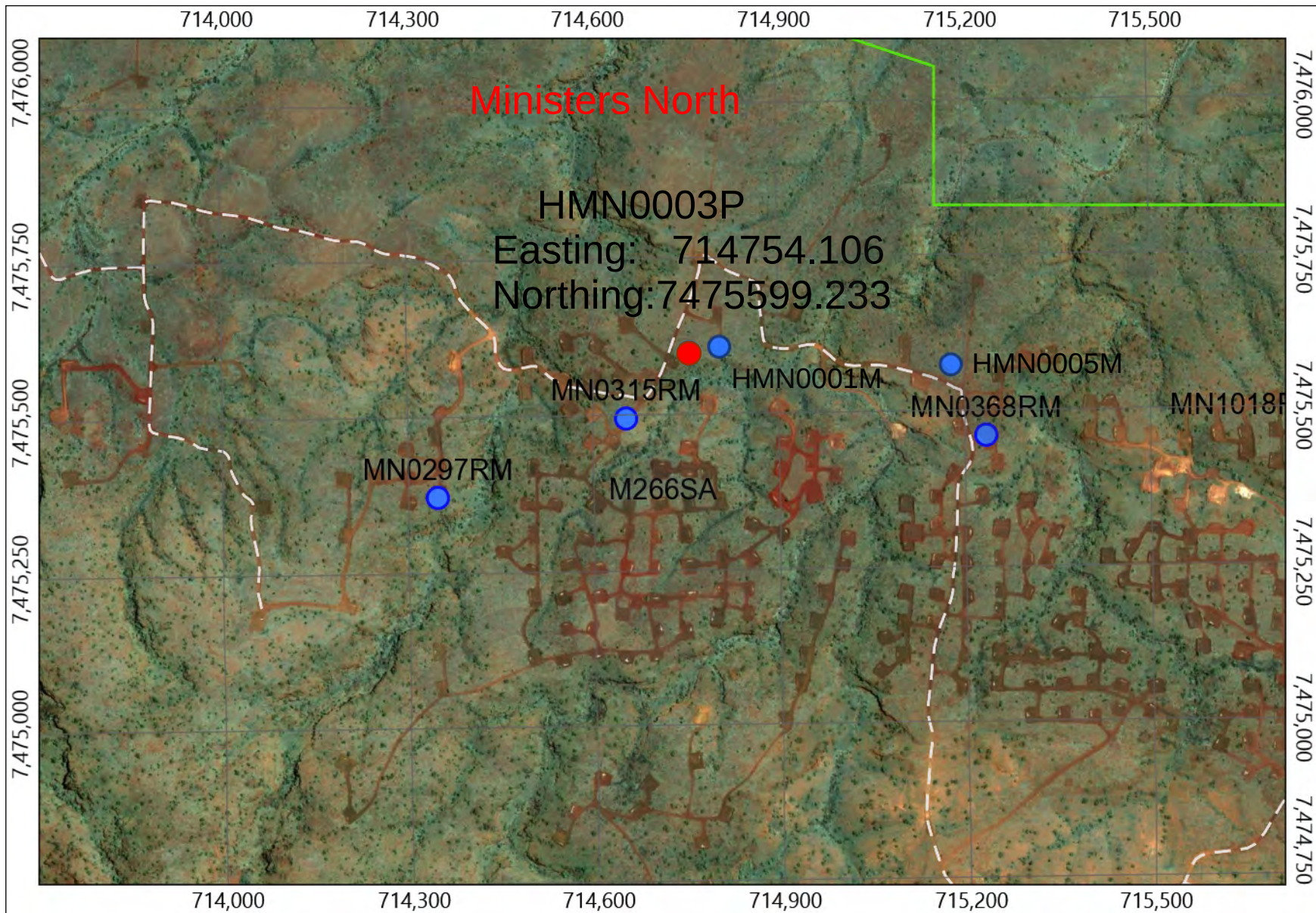
**Swan Avon Region**

Victoria Park Regional Office  
 7 Ellam Street  
 Victoria Park WA 6100  
 Tel: 08 6250 8000  
 Fax: 08 6250 8050

**Warren Blackwood District**

Manjimup Regional Office  
 52 Bath Street  
 Manjimup WA 6528  
 Tel: 08 9771 1878  
 Fax: 08 9771 4335

Please retain a copy of this form for your records



**Legend**

- BHP Tenements - Granted
- Monitoring Bore
- Production Bore
- Highways 8-15K
- Major Roads 8-15K
- Haul Roads 5K-10K
- Minor Roads 8-15K
- Tracks 8-25K
- + Rail Scale <50K
- Projects

508.0 0 254.00 508.0 Kilometres



## BHPIO - Hydrogeology Log

**BHP**
**Project:** MINISTERS NORTH      **Hole Name:** HMN0003      **Hole Length:** 178.00

|                    |                                                                  |              |                  |             |             |              |                   |                  |
|--------------------|------------------------------------------------------------------|--------------|------------------|-------------|-------------|--------------|-------------------|------------------|
| <b>Easting:</b>    | 714754.11                                                        | <b>Depth</b> | <b>Drill Rig</b> | <b>Type</b> | <b>Size</b> | <b>Fluid</b> | <b>Drilled By</b> | <b>Logged By</b> |
| <b>Northing:</b>   | 7475599.23                                                       | 0.0 - 178.0  | WLDRIG6          | CH          | 425         |              | WELLDRIILL        | KG2              |
| <b>Surface RL:</b> | 634.54                                                           |              |                  |             |             |              |                   |                  |
| <b>Grid Name:</b>  | MGA94_50                                                         |              |                  |             |             |              |                   |                  |
| <b>Incl / Azm:</b> | -90-->0                                                          |              |                  |             |             |              |                   |                  |
| <b>Construct:</b>  | 24 Jul 20 - 27 Jul 20                                            |              |                  |             |             |              |                   |                  |
| <b>Comments:</b>   | Fallback at end of hole from 140m reamed to 178m enable install. |              |                  |             |             |              |                   |                  |
|                    |                                                                  |              |                  |             |             |              | <b>License:</b>   | 203670           |

**TOC RL:** 635.03 (Stickup 0.30m) (drilled)      **SWL:** 72.66 MBTOC (30 Jul 20)      **Dev:** Y: 4.0 hour(s)      **Final pH:** 7.9  
**TOC RL:** 635.03 (Stickup 0.30m) (current)      **Is Live:** Y (-)      **Date:** 29 Jul 2020      **Final EC:** 605.00

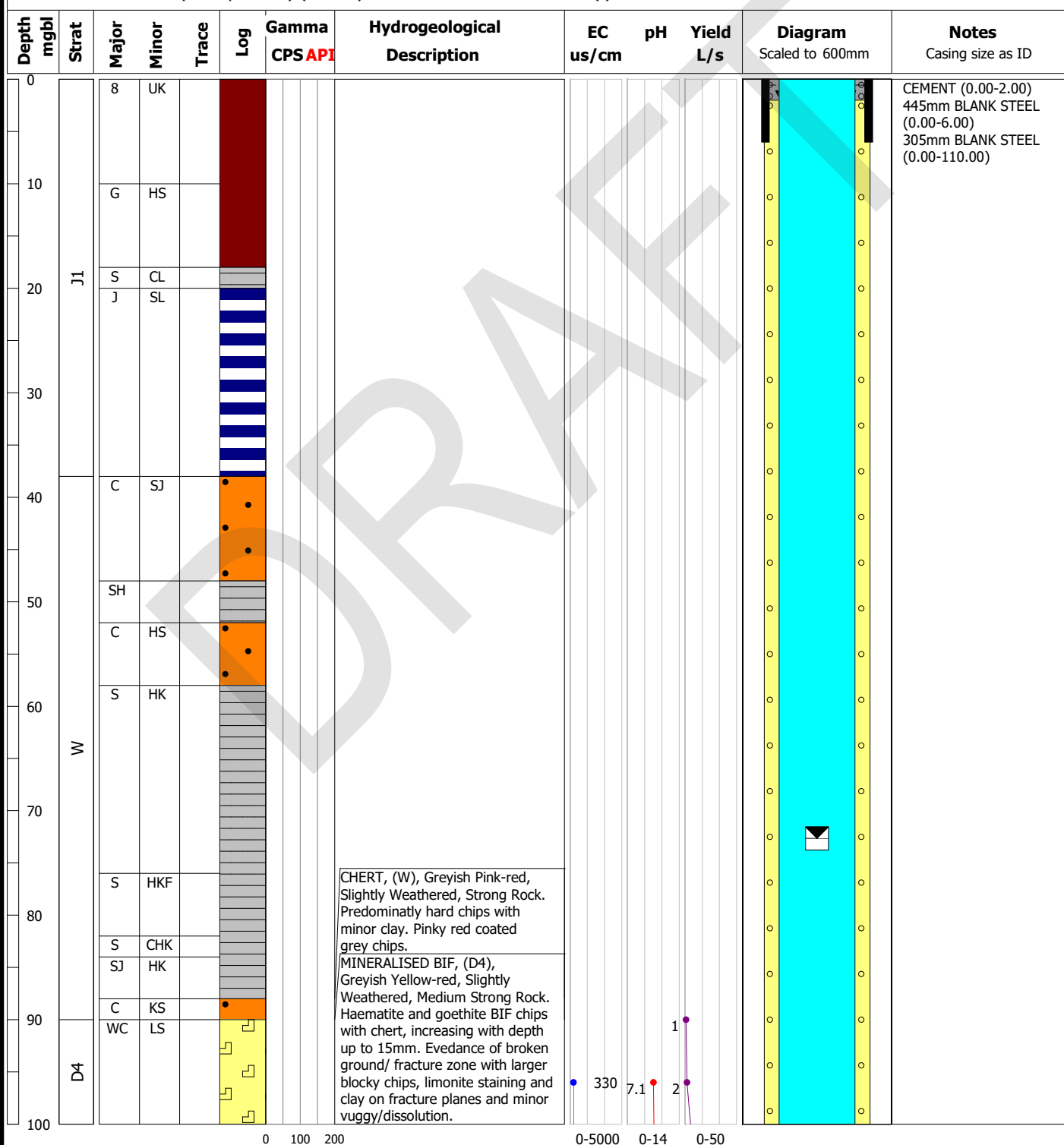
| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                            | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 600mm | Notes<br>Casing size as ID                                                                   |
|--------------|-------|-------|-------|-------|-----|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|--------------|----------------------------|----------------------------------------------------------------------------------------------|
| 0            | J1    | 8     | UK    |       |     |                  | UNMINERALISED BIF, (J1),<br>Reddish Brown-grey, Extremely<br>Weathered, Strong Rock.<br>Ferricrete, silicious very fine to<br>vitreous chips. Minor magnetism.                                                                                            |             |    |              |                            | CEMENT (0.00-2.00)<br>445mm BLANK STEEL<br>(0.00-6.00)<br>305mm BLANK STEEL<br>(0.00-110.00) |
| 10           |       | G     | HS    |       |     |                  | MINERALISED BIF, (J1),<br>Greyish Red, Extremely<br>Weathered, Medium Strong Rock.<br>Heavily weathered, larger chips<br>becoming larger and more angular<br>with depth. Microbands present.                                                              |             |    |              |                            |                                                                                              |
| 20           |       | S     | CL    |       |     |                  | SHALE, (J1), Reddish Pink,<br>Highly Weathered, Very Weak<br>Rock. Softer drill/broken ground.<br>Reddy brown stained chips of<br>purpley-red shales.                                                                                                     |             |    |              |                            |                                                                                              |
| 30           |       | J     | SL    |       |     |                  | UNMINERALISED BIF, (J1),<br>Greyish Yellow, Slightly<br>Weathered, Strong Rock. Quick<br>drill. Buff/yellow limonite stained<br>chips of weathered/alterred<br>jaspilite BIF and shale.                                                                   |             |    |              |                            |                                                                                              |
| 40           | W     | C     | SJ    |       |     |                  | UNMINERALISED BIF, (W),<br>Reddish Pink-grey, Slightly<br>Weathered, Strong Rock. Red<br>chips marking the J1-W boundary.<br>Broken ground with larger<br>>10mm chert from 40 to 42. Very<br>hard chert chips with minor softer<br>weathered shale chips. |             |    |              |                            |                                                                                              |
| 50           |       | SH    |       |       |     |                  | SHALE, (W), Pinkish Red,<br>Extremely Weathered, Extremely<br>Weak Rock. Soft shale band with<br>minor hard haematite chips.<br>Purpley-red.                                                                                                              |             |    |              |                            |                                                                                              |
| 60           |       | C     | HS    |       |     |                  | UNMINERALISED BIF, (W),<br>Greyish Pink-red, Slightly<br>Weathered, Very Strong Rock.<br>Harder drilling, chert-rich chips.<br>Purpley-red clay coat on chert<br>chips.                                                                                   |             |    |              |                            |                                                                                              |
| 70           |       | S     | HK    |       |     |                  | SHALE, (W), Greyish Pink-brown,<br>Moderately Weathered, Strong<br>Rock. Softer drilling. Weathered<br>shale content increasing with<br>depth. Chips coated in pink to<br>brown clays.                                                                    |             |    |              |                            |                                                                                              |
| 80           | D4    | S     | HKF   |       |     |                  | SHALE, (W), Pinkish Red-brown,<br>Extremely Weathered, Extremely<br>Weak Rock. weathered shale<br>with minor BIF chips. Red and<br>pink clays dominating colour.                                                                                          |             |    |              |                            |                                                                                              |
| 90           |       | SJ    | HK    |       |     |                  | SHALE, (W), Brownish Red,<br>Extremely Weathered, Extremely<br>Weak Rock. Shale with BIF chips<br>and clay fines. broken ground,<br>easy drilling                                                                                                         |             |    |              |                            |                                                                                              |
|              |       | C     | KS    |       |     |                  | SHALE, (W), Reddish Brown,<br>Moderately Weathered, Medium<br>Strong Rock. High clay content<br>with chips of shale and BIF.                                                                                                                              |             |    |              |                            |                                                                                              |
| 100          |       | WC    | LS    |       |     |                  |                                                                                                                                                                                                                                                           |             |    |              |                            |                                                                                              |

## BHPIO - Hydrogeology Log

**BHP**
**Project:** MINISTERS NORTH      **Hole Name:** HMN0003      **Hole Length:** 178.00

|                                                                                   |                        |                  |             |             |              |                   |                  |
|-----------------------------------------------------------------------------------|------------------------|------------------|-------------|-------------|--------------|-------------------|------------------|
| <b>Easting:</b> 714754.11                                                         | <b>Depth</b>           | <b>Drill Rig</b> | <b>Type</b> | <b>Size</b> | <b>Fluid</b> | <b>Drilled By</b> | <b>Logged By</b> |
| <b>Northing:</b> 7475599.23                                                       | 0.0 - 178.0            | WLDRI6           | CH          | 425         |              | WELLDRIILL        | KG2              |
| <b>Surface RL:</b> 634.54                                                         |                        |                  |             |             |              |                   |                  |
| <b>Grid Name:</b> MGA94_50                                                        |                        |                  |             |             |              |                   |                  |
| <b>Incl / Azm:</b> -90-->0                                                        |                        |                  |             |             |              |                   |                  |
| <b>Construct:</b> 24 Jul 20 - 27 Jul 20                                           | <b>License:</b> 203670 |                  |             |             |              |                   |                  |
| <b>Comments:</b> Fallback at end of hole from 140m reamed to 178m enable install. |                        |                  |             |             |              |                   |                  |

|                                                 |                                     |                            |                         |
|-------------------------------------------------|-------------------------------------|----------------------------|-------------------------|
| <b>TOC RL:</b> 635.03 (Stickup 0.30m) (drilled) | <b>SWL:</b> 72.66 MBTOC (30 Jul 20) | <b>Dev:</b> Y: 4.0 hour(s) | <b>Final pH:</b> 7.9    |
| <b>TOC RL:</b> 635.03 (Stickup 0.30m) (current) | <b>Is Live:</b> Y (-)               | <b>Date:</b> 29 Jul 2020   | <b>Final EC:</b> 605.00 |



## BHPIO - Hydrogeology Log

**BHP**
**Project:** MINISTERS NORTH      **Hole Name:** HMN0003      **Hole Length:** 178.00

|                    |                                                                  |              |                  |             |             |              |                   |                  |
|--------------------|------------------------------------------------------------------|--------------|------------------|-------------|-------------|--------------|-------------------|------------------|
| <b>Easting:</b>    | 714754.11                                                        | <b>Depth</b> | <b>Drill Rig</b> | <b>Type</b> | <b>Size</b> | <b>Fluid</b> | <b>Drilled By</b> | <b>Logged By</b> |
| <b>Northing:</b>   | 7475599.23                                                       | 0.0 - 178.0  | WLDRI6           | CH          | 425         |              | WELLDRIILL        | KG2              |
| <b>Surface RL:</b> | 634.54                                                           |              |                  |             |             |              |                   |                  |
| <b>Grid Name:</b>  | MGA94_50                                                         |              |                  |             |             |              |                   |                  |
| <b>Incl / Azm:</b> | -90-->0                                                          |              |                  |             |             |              |                   |                  |
| <b>Construct:</b>  | 24 Jul 20 - 27 Jul 20                                            |              |                  |             |             |              |                   |                  |
| <b>Comments:</b>   | Fallback at end of hole from 140m reamed to 178m enable install. |              |                  |             |             |              |                   |                  |

**License:** 203670
**TOC RL:** 635.03 (Stickup 0.30m) (drilled)      **SWL:** 72.66 MBTOC (30 Jul 20)      **Dev:** Y: 4.0 hour(s)      **Final pH:** 7.9  
**TOC RL:** 635.03 (Stickup 0.30m) (current)      **Is Live:** Y (-)      **Date:** 29 Jul 2020      **Final EC:** 605.00

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                                                                                                                         | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 600mm | Notes<br>Casing size as ID      |
|--------------|-------|-------|-------|-------|-----|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|---------------------------------|
| 100          | D4    | WC    | LS    |       |     |                  | MINERALISED BIF, (D4), Greyish Yellow-red, Slightly Weathered, Medium Strong Rock. Haematite and goethite BIF chips with chert, increasing with depth up to 15mm. Evedance of broken ground/ fracture zone with larger blocky chips, limonite staining and clay on fracture planes and minor vuggy/dissolution.                                                                        | 322         | 7.2 | 7            |                            | 305mm BLANK STEEL (0.00-110.00) |
| 110          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 328         | 7.5 | 7            |                            | 305mm W/W STEEL (110.00-170.00) |
| 120          |       | LC    | WS    |       |     |                  | MINERALISED BIF, (D4), Yellowish Grey-pink, Slightly Weathered, Very Strong Rock. Very hard chert chips amongst pink weathered shales. Yellow limonite and altered BIF chips. Not magnetic.                                                                                                                                                                                            | 403         | 8.1 | 10           |                            |                                 |
| 130          |       | W     | LC    |       |     |                  | MINERALISED BIF, (D4), Greyish Brown-pink, Slightly Weathered, Strong Rock. Hard chert chips amongst BIF chips. Minor white cherts and clays.                                                                                                                                                                                                                                          | 424         | 7.4 | 10           |                            |                                 |
|              |       | W     | HC    |       |     |                  | MINERALISED BIF, (D4), Blueish Grey-red, Slightly Weathered, Strong Rock. Bluey-grey and red banded BIF chips (Jaspilite). Minor yellow and white soft shale. Broken ground with large (20mm) blocky chips .                                                                                                                                                                           | 531         | 7.3 | 11           |                            |                                 |
| 140          | D3    | FCG   | WL    |       |     |                  | UNMINERALISED BIF, (D3), Pinkish Blue-light or white, Slightly Weathered, Strong Rock. Multi coloured shale, chert and BIF chips. Broken ground with fall-back during drilling, highly broken fracture zone 148 to 152m. Chip size increasing with depth (up to 40mm). increasing weathering and alteration below 152m with dissolution vuggy and mineral build up on fracture planes. | 527         | 7.8 | 11           |                            |                                 |
| 150          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 571         | 7.5 | 15           |                            |                                 |
| 160          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 606         | 7.5 | 6            |                            |                                 |
| 170          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 616         | 7.6 | 20           |                            |                                 |
|              |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 589         | 7.5 | 18           |                            |                                 |
|              |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 611         | 7.8 | 18           |                            |                                 |
|              |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        | 615         | 7.9 | 18           |                            |                                 |
| 180          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        |             |     |              |                            | END CAP (170.00)                |
| 190          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        |             |     |              |                            | FALLBACK (172.00-178.00)        |
| 200          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                                                        |             |     |              |                            |                                 |



## Information to be provided on completion of a non-artesian well

Information to be provided to the Department of Water under the *Water Agencies (Powers) Act 1984* and Section 26E of the *Rights in Water and Irrigation Act 1914* and Regulation 39 of the *Rights in Water and Irrigation Regulations 2000*

### Please note:

- All information is to be written clearly and in block letters.
- If insufficient room please use a separate piece of paper.
- It is the responsibility of the person carrying out the works to fill out this form.

### Part 1: Details of any licence granted for the work under the *Rights in Water And Irrigation Act 1914* section 26D

Licence number

CAW 203670

☐ Individual ☒ Company

Licensee's full name

BHP BILLITON IRON ORE PTY LTD

### Part 2: Details of person carrying out the works

Company

WELLDRIILL

Driller

Scott Macleod, Ramon Watkins

Driller licence number  
(non-mandatory)

Driller classification  
(non-mandatory)

Postal address

16 Jessie Lee Street Henderson, Perth Western Australia 6008

Telephone

08 9437 4633

Facsimile

08 9437 6188

Email

info@welldrill.com.au

### Part 3: Location of well

A 26D licence will list the premises on which well construction is to occur.

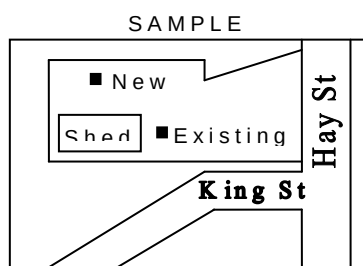
If the physical address of the well is different from the property address listed on the licence, contact the Department of Water prior to the commencement of construction.

Property address of well or other tenure details

MINISTERS NORTH, MINING LEASE M266SA

|      |    |                                                     |                        |                                                                                   |
|------|----|-----------------------------------------------------|------------------------|-----------------------------------------------------------------------------------|
| Zone | 51 | Easting/<br>latitude<br>Datum<br>(e.g. GDA94/WGS84) | Well coordinates       | <input checked="" type="checkbox"/> GPS reading <input type="checkbox"/> Estimate |
|      |    |                                                     | Northing/<br>longitude | 7474701.766                                                                       |
|      |    |                                                     | GPS<br>reliability     | 0.1cm                                                                             |

Location plan – in the box below please sketch a plan showing position of well in relation to building, boundaries, road, nearest cross road and any additional information to assist in locating the well.



SEE ATTACHED.

In the box to the right, please sketch a plan showing:

- location of all wetlands / watercourses / wells / soaks (existing and proposed).
- major improvements (house, large sheds etc).
- shaded sections to indicate areas under development.

**Part 4: Construction details (All measurements are to be taken from ground level.)**

| Production casing detail |              |                   |                     |          |        |
|--------------------------|--------------|-------------------|---------------------|----------|--------|
| Material                 | Nominal bore | Diameter O.D (mm) | Wall thickness (mm) | Depth    |        |
|                          |              |                   |                     | From (m) | To (m) |
| steel                    | 12"          | 324               | 9.6                 | 0        | 92     |
|                          |              |                   |                     |          |        |
|                          |              |                   |                     |          |        |

Please complete well construction diagram in box provided below. If insufficient room please attach on separate piece of paper.

SEE ATTACHED BORE LOG.

| Screens/slots              |                   |               |                   |                      |
|----------------------------|-------------------|---------------|-------------------|----------------------|
| Screens/slot (type)        | Diameter O.D (mm) | Aperture (mm) | Top of screen (m) | Bottom of screen (m) |
| Stainless steel wire wound | 324               | 1             | 92                | 140                  |
|                            |                   |               |                   |                      |
|                            |                   |               |                   |                      |

| Gravel pack details |          |        |
|---------------------|----------|--------|
| Gravel size (mm)    | From (m) | To (m) |
|                     | 3.2      | 6.4    |

| Annular fill  |          |        |
|---------------|----------|--------|
| Material type | From (m) | To (m) |
| Cement grout  | 0        | 2      |
| Gravel        | 2        | 141    |
| Fallback      | 141      | 170    |

| Cementing detail                                 |                                  |        |
|--------------------------------------------------|----------------------------------|--------|
| <input type="checkbox"/> Pressure cement grouted | <input type="checkbox"/> Tremmie |        |
| Casing diameter (mm O.D)                         | Depth                            |        |
|                                                  | From (m)                         | To (m) |
|                                                  |                                  |        |
|                                                  |                                  |        |
|                                                  |                                  |        |

Total depth drilled (from ground level)

170

Geophysical log required as condition of licence?

☐ Yes ☐ No

Geophysical log taken? (attach log and contractor details)

☐ Yes ☐ No

| From (m) | To (m) | Strata description (If insufficient room attach on separate page) |
|----------|--------|-------------------------------------------------------------------|
|          |        | SEE ATTACHED BORE LOG.                                            |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |
|          |        |                                                                   |

## Part 5: Particulars of well

Drilling start date refers to the date drilling begins. Do not include set up date.

Drilling completion date includes well development and testing.

|                              |                                                                                                                                                                                                                                         |                            |            |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|------------|
| <b>Well name / number</b>    | HMN0013P                                                                                                                                                                                                                                |                            |            |
| <b>Drilling start</b>        | 11/06/2020                                                                                                                                                                                                                              | <b>Drilling completion</b> | 25/06/2020 |
| <b>Drilling method used</b>  | <input checked="" type="checkbox"/> Rotary air <input type="checkbox"/> Cable tool <input type="checkbox"/> Auger <input type="checkbox"/> Rotary mud<br><input type="checkbox"/> Sludge <input type="checkbox"/> Other (specify) _____ |                            |            |
| <b>Final status of well</b>  | <input checked="" type="checkbox"/> Ready to operate <input type="checkbox"/> Decommissioned<br><input type="checkbox"/> Other (specify) _____                                                                                          |                            |            |
| <b>Purpose (use) of well</b> | <input checked="" type="checkbox"/> Production <input type="checkbox"/> Investigation <input type="checkbox"/> Monitoring<br><input type="checkbox"/> Other (specify) _____                                                             |                            |            |

## Part 6: Well development

|                                                            |                                                                                                                                             |                                |         |
|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|
| <b>Date (dd/mm/yy)</b>                                     | 12/07/2020                                                                                                                                  | <b>Duration of development</b> | 5 hours |
| <b>Method</b>                                              | <input checked="" type="checkbox"/> Airlift <input type="checkbox"/> Pump <input type="checkbox"/> Jetting <input type="checkbox"/> Surging |                                |         |
| <b>Development pump rate (e.g. L/s, m<sup>3</sup>/day)</b> |                                                                                                                                             | 40 L/s                         |         |

## Part 7: Pump testing (If applicable)

|                                                                                                          |                                                                                                                                           |                                                    |  |                         |       |
|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|--|-------------------------|-------|
| <b>Date start (dd/mm/yy)</b>                                                                             |                                                                                                                                           | <b>Date end (dd/mm/yy)</b>                         |  | <b>Duration of test</b> | hours |
| <input type="checkbox"/> Step test <input type="checkbox"/> Constant rate <input type="checkbox"/> Other |                                                                                                                                           |                                                    |  |                         |       |
| <b>Constant rate - pump rate (e.g. m<sup>3</sup>/day)</b>                                                |                                                                                                                                           | <b>Pump type (e.g. submersible)</b>                |  |                         |       |
| <b>Water rest level prior to test (m)</b>                                                                |                                                                                                                                           |                                                    |  |                         |       |
| <b>Measurements taken from</b>                                                                           | <input type="checkbox"/> top of casing (TOC) <input type="checkbox"/> ground level (GL)<br><input type="checkbox"/> other (specify) _____ |                                                    |  |                         |       |
| <b>Elevation of measurement reference point if known (metres AHD)</b>                                    | <input type="checkbox"/> GPS <input type="checkbox"/> Estimate<br><input type="checkbox"/> other (specify) _____                          |                                                    |  |                         |       |
| <b>Final drawdown</b>                                                                                    | m                                                                                                                                         | <b>Recommended supply (e.g. m<sup>3</sup>/day)</b> |  |                         |       |

Final drawdown is the distance between the static water level measured prior to the test and the water level measured at the end of the pumping test.

Comments.....

## Part 8: Field samples

Specify unit measurements.

|                                                    |                |                                                                                                                   |                |
|----------------------------------------------------|----------------|-------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Collection method (e.g. pump test, airlift)</b> | airlift        |                                                                                                                   |                |
| <b>Conductivity (e.g. mS/m)</b>                    | 633 $\mu$ S/cm | <input checked="" type="checkbox"/> Temperature compensated<br><input type="checkbox"/> Temperature uncompensated | <b>pH</b> 8.06 |
| <b>Water temperature at test</b>                   | 30.4           |                                                                                                                   |                |

Comments.....

## Part 9: Lab samples

**Lab samples taken (Please attach)**    ☐ Yes    ☐ No

**TDS (e.g. mg/l)**

Please submit samples separately to form if not received before the 1 month submission deadline.

**Part 10: Water levels**

SWL (Static water level) 47.26 m      Water cut at 54 m

Measurements taken from ☒ top of casing (TOC) ☐ ground level (GL)  
☐ other (specify) \_\_\_\_\_

Date of reading (dd/mm/yy) 27/06/2020

Comments TOC 609.766mAHD

**Part 11: Declaration and signature**

Capacity of person making declaration:

- ☐ An individual who carried out the work
- ☐ An officer who is a director or secretary of a corporation that carried out the work.
- ☐ Other (describe).....

I, James McDiarmid (name of person making declaration) declare that the information provided on this form is true and correct.

**Important information**

- All information must be completed on the form unless otherwise indicated as optional for example; provision of the drillers licence number and classification fields are not mandatory and can be filled in at the drillers discretion. Provision of non-mandatory details would greatly assist the department in completion of its data set.
- Failure to complete all mandatory details and to submit the form to the department is an offence under the *Rights in Water and Irrigation Act 1914*.
- Under section 26E and regulation 39 within 1 month of completion of the construction of or deepening of the well, the person carrying out the work for a 26D licence must submit this form.
- Non-artesian wells in proclaimed areas require a licence unless exempted under the *Rights in Water and Irrigation Exemption (S26C) Order 2007*.

**Where and how to submit this form**

This form can be submitted by fax, post or in person to the appropriate Department of Water regional office. For assistance in completing this form contact your regional office.

**Kimberley Region**

Kununurra Regional Office  
 27 Victoria Hwy  
 Kununurra WA 6743  
 Tel: 08 9166 4100  
 Fax: 08 9168 3174  
 PO Box 625  
 Kununurra WA 6743

**Midwest Gascoyne Region**

Geraldton Regional Office  
 94 Sandford Street  
 Geraldton WA 6531  
 Tel: 08 9965 7400  
 Fax: 08 9964 5983  
 Po Box 81  
 Geraldton WA 6531

**Carnarvon**

Carnarvon District Office  
 211 Robinson Street  
 Carnarvon WA 6701  
 Tel: 08 9941 6100  
 Fax: 08 9941 4931  
 PO Box 81  
 Carnarvon WA 6701

**Kwinana Peel Region**

Mandurah Regional Office  
 107 Breakwater Parade  
 Mandurah WA 6210  
 Tel: 08 9550 4222  
 Fax: 08 9581 4560  
 PO Box 332  
 Mandurah WA 6210

**South West Region**

Bunbury Regional Office  
 35-39 McCombe Road  
 Bunbury WA 6230  
 Tel: 08 9726 4111  
 Fax: 08 9726 4100  
 PO Box 261  
 Bunbury WA 6231

**Busselton**

Busselton District Office  
 Suite 2, 72 Duchess Street  
 Busselton WA 6280  
 Tel: 08 9781 0188  
 Fax: 08 9754 4335  
 PO Box 269  
 Busselton WA 6280

**South Coast Region**

Albany Regional Office  
 5 Bevan Street  
 Albany WA 6330  
 Tel: 08 9842 5760  
 Fax: 08 9842 1204  
 PO Box 525  
 Albany WA 6331

**Pilbara Region**

Karratha Regional Office  
 Lot 4608 Cherratta Road  
 Karratha Industrial Estate  
 Karratha WA 6714  
 Tel: 08 9144 2000  
 Fax: 08 9144 2610  
 PO Box 836  
 Karratha WA 6714

**Swan Avon Region**

Victoria Park Regional Office  
 7 Ellam Street  
 Victoria Park WA 6100  
 Tel: 08 6250 8000  
 Fax: 08 6250 8050

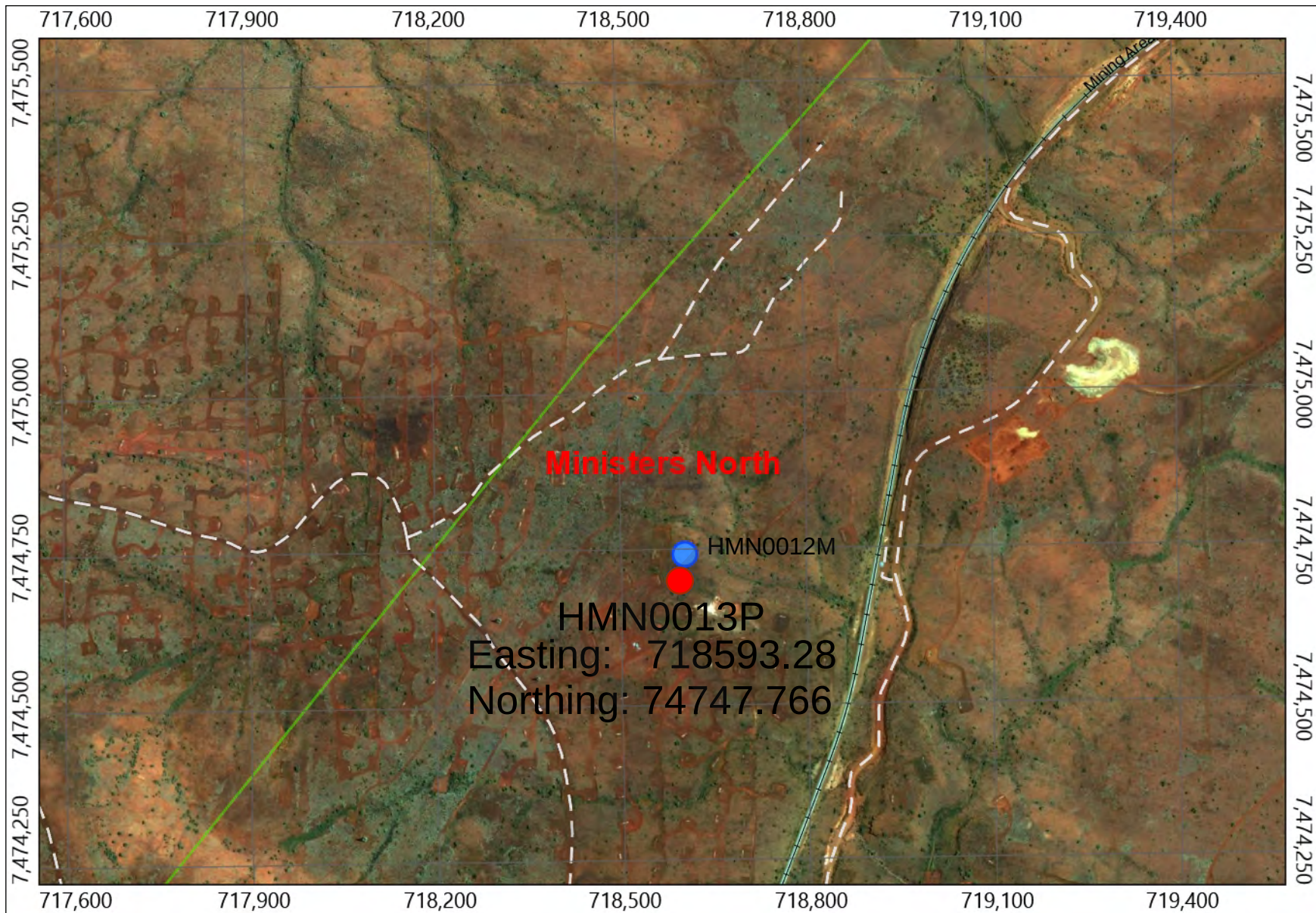
**Warren Blackwood District**

Manjimup Regional Office  
 52 Bath Street  
 Manjimup WA 6528  
 Tel: 08 9771 1878  
 Fax: 08 9771 4335

Please retain a copy of this form for your records



# Ministers North Bore Location HMN0013P



## Legend

- BHP Tenements - Granted
- Monitoring Bore
- Production Bore
- Highways8-15K
- Major Roads 8-15K
- Haul Roads5K-10K
- Minor Roads8-15K
- Tracks 8-25K
- Rail Scale <50K
- Projects

## Notes

This map was produced using ioMAPS  
Resource Planning

508.0 0 254.00 508.0 Kilometres

1: 10,000



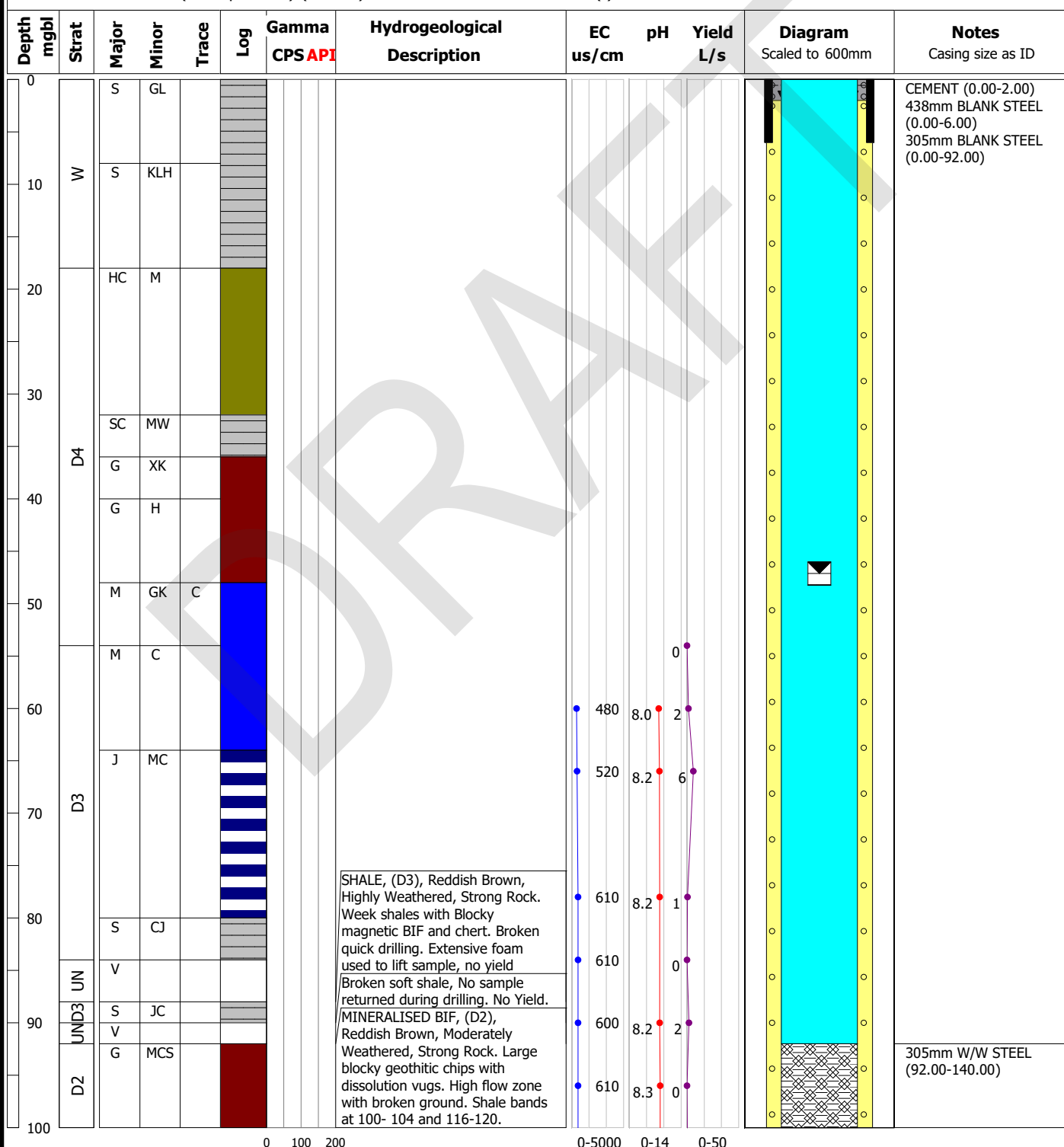
## BHPIO - Hydrogeology Log

BHP

**Project:** MINISTERS NORTH      **Hole Name:** HMN0013      **Hole Length:** 170.00
**Easting:** 718593.28**Northing:** 7474701.77**Surface RL:** 609.45**Grid Name:** MGA94\_50**Incl / Azm:** -90-->0**Construct:** 22 Jun 20 - 25 Jun 20**License:** 203670**Comments:** Unable to install to target depth due to collapsing ground and high yield discharge management to pr...
**TOC RL:** 609.77 (Stickup 0.31m) (drilled)      **SWL:** 47.15 MBTOC (15 Jul 20)      **Dev:** Y: 5.0 hour(s)      **Final pH:** 8.1  
**TOC RL:** 609.77 (Stickup 0.31m) (current)      **Is Live:** Y (-)      **Date:** 12 Jul 2020      **Final EC:** 633.00

| Depth<br>m/bbl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 600mm | Notes<br>Casing size as ID                                                            |
|----------------|-------|-------|-------|-------|-----|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|---------------------------------------------------------------------------------------|
| 0              | W     | S     | GL    |       |     |                  | SHALE, (W), Brownish Yellow, Extremely Weathered, Medium Strong Rock. Soft shale, broken, geothitic BIF with limonitic staining and fines, soft broken ground                                                 |             |     |              |                            | CEMENT (0.00-2.00)<br>438mm BLANK STEEL (0.00-6.00)<br>305mm BLANK STEEL (0.00-92.00) |
| 10             |       | S     | KLH   |       |     |                  | SHALE, (W), Brownish Yellow, Extremely Weathered, Weak Rock. Limonitic shale with minor hematite chip, broken soft ground                                                                                     |             |     |              |                            |                                                                                       |
| 20             |       | HC    | M     |       |     |                  | MINERALISED BIF, (D4), Brown, Moderately Weathered, Strong Rock. Partially magnetic siliceous BIF with minor haematite. Hard rock, slow penetration.                                                          |             |     |              |                            |                                                                                       |
| 30             | D4    | SC    | MW    |       |     |                  | SHALE, (D4), Red, Highly Weathered, Weak Rock. Shale with minor quartz rich chert, broken, fast drilling                                                                                                      |             |     |              |                            |                                                                                       |
| 40             |       | G     | XK    |       |     |                  | MINERALISED BIF, (D4), Brown, Moderately Weathered, Medium Strong Rock. Geothitic BIF with minor fines, broken ground                                                                                         |             |     |              |                            |                                                                                       |
| 50             |       | M     | GK    | C     |     |                  | MINERALISED BIF, (D4), Brown, Moderately Weathered, Strong Rock. Geothitic BIF becoming fresher at depth, stable un-fractured hard ground, minor haematite staining at 46m                                    |             |     |              |                            |                                                                                       |
| 60             |       | M     | C     |       |     |                  | MINERALISED BIF, (D4), Blackish Brown, Slightly Weathered, Very Strong Rock. Magnetic BIF with very minor Geothitic BIF, staining and clay on fractures. Slow penetration                                     | 480         | 8.0 | 2            |                            |                                                                                       |
| 70             | D3    | J     | MC    |       |     |                  | UNMINERALISED BIF, (D3), Blackish Brown, Fresh, Very Strong Rock. Fresh magnetic BIF with minor chert micro bands and one large green chert band at 56m                                                       | 520         | 8.2 | 6            |                            |                                                                                       |
| 80             |       | S     | CJ    |       |     |                  | UNMINERALISED BIF, (D3), Dark or Black, Fresh, Very Strong Rock. Large blocks of fresh BIF, broken unstable ground with fall-back. Poor to no yield and difficulty getting asample return, extensive foam use | 610         | 8.2 | 1            |                            |                                                                                       |
| 90             |       | V     |       |       |     |                  | SHALE, (D3), Brownish Red, Highly Weathered, Very Weak Rock. Weak shales with Blocky BIF and chert. Broken quick drilling, no yield                                                                           | 610         |     | 0            |                            |                                                                                       |
| 100            | D2    | G     | MCS   |       |     |                  | Broken soft shale, No sample returned during drilling.                                                                                                                                                        | 610         | 8.3 | 0            |                            | 305mm W/W STEEL (92.00-140.00)                                                        |

## BHPIO - Hydrogeology Log

**BHP**
**Project:** MINISTERS NORTH      **Hole Name:** HMN0013      **Hole Length:** 170.00
**Easting:** 718593.28**Northing:** 7474701.77**Surface RL:** 609.45**Grid Name:** MGA94\_50**Incl / Azm:** -90-->0**Construct:** 22 Jun 20 - 25 Jun 20**License:** 203670**Comments:** Unable to install to target depth due to collapsing ground and high yield discharge management to pr...**TOC RL:** 609.77 (Stickup 0.31m) (drilled)**SWL:** 47.15 MBTOC (15 Jul 20)**Dev:** Y: 5.0 hour(s)**Final pH:** 8.1**TOC RL:** 609.77 (Stickup 0.31m) (current)**Is Live:** Y (-)**Date:** 12 Jul 2020**Final EC:** 633.00

## BHPIO - Hydrogeology Log

**BHP**
**Project:** MINISTERS NORTH      **Hole Name:** HMN0013      **Hole Length:** 170.00
**Easting:** 718593.28**Northing:** 7474701.77**Surface RL:** 609.45**Grid Name:** MGA94\_50**Incl / Azm:** -90-->0**Construct:** 22 Jun 20 - 25 Jun 20**License:** 203670**Comments:** Unable to install to target depth due to collapsing ground and high yield discharge management to pr...**TOC RL:** 609.77 (Stickup 0.31m) (drilled)**SWL:** 47.15 MBTOC (15 Jul 20)**Dev:** Y: 5.0 hour(s)**Final pH:** 8.1**TOC RL:** 609.77 (Stickup 0.31m) (current)**Is Live:** Y (-)**Date:** 12 Jul 2020**Final EC:** 633.00

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                                                                                                                                                                                   | EC<br>us/cm | pH  | Yield<br>L/s | Diagram<br>Scaled to 600mm | Notes<br>Casing size as ID                                                                                                                                                                                        |
|--------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|--------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 100          | D2    | G     | MCS   |       |     |                  | MINERALISED BIF, (D2),<br>Reddish Brown, Moderately<br>Weathered, Strong Rock. Large<br>blocky goethitic chips with<br>dissolution vugs. High flow zone<br>with broken ground. Shale bands<br>at 100- 104 and 116-120.                                                                                                                           | 610         | 8.4 | 1            |                            | 305mm W/W STEEL<br>(92.00-140.00)                                                                                                                                                                                 |
| 110          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  | 620         | 8.4 | 8            |                            |                                                                                                                                                                                                                   |
| 120          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  | 600         | 8.2 | 6            |                            |                                                                                                                                                                                                                   |
| 130          |       | J     | GMC   |       |     |                  | UNMINERALISED BIF, (D2),<br>Blackish Brown, Slightly<br>Weathered, Very Strong Rock.<br>Smaller dark chips with chert<br>bands, minor magnetic. hard un-<br>fractured stable ground with slow<br>penetration rate                                                                                                                                | 610         | 8.4 | 10           |                            |                                                                                                                                                                                                                   |
| 140          | D1    | G     | MS    |       |     |                  | MINERALISED BIF, (D2),<br>Brownish Red, Moderately<br>Weathered, Strong Rock. Quicker<br>drilling through broken ground.<br>Gerthite and red shale with larger<br>blocky chips with minor vugg.<br>Unstable ground with extensive<br>fallback during final ream.                                                                                 | 600         | 8.3 | 10           |                            | END CAP (140.00)<br>FALLBACK: Difficulty<br>clearing fall back due to<br>discharge management<br>and full containment<br>sump. (141.00-150.00)<br>FALLBACK: Pilot hole<br>not reamed to depth.<br>(150.00-170.00) |
| 150          |       | J     | MCS   |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  | 600         | 8.2 | 12           |                            |                                                                                                                                                                                                                   |
| 160          |       | M     | CS    |       |     |                  | UNMINERALISED BIF, (D1),<br>Brownish Red, Slightly<br>Weathered, Extremely Strong<br>Rock. Magnetic BIF, jaspilite,<br>very hard stable ground with<br>slow penetration rate (0.5hr for<br>2m). Sample has red shale,<br>possibly contamination.                                                                                                 | 610         | 8.2 | 14           |                            |                                                                                                                                                                                                                   |
| 170          |       | M     | GC    | S     |     |                  | UNMINERALISED BIF, (D1),<br>Brownish Red, Moderately<br>Weathered, Strong Rock.<br>Magnetic BIF and red shale,<br>broken larger chips, and clocker<br>drilling                                                                                                                                                                                   | 610         | 8.8 | 14           |                            |                                                                                                                                                                                                                   |
| 180          |       |       |       |       |     |                  | UNMINERALISED BIF, (D1),<br>Brown, Slightly Weathered,<br>Strong Rock. Magnetic BIF<br>becoming more goethitic and<br>chert rich at depth, minor brown<br>shale posable contamination.<br>stable ground with smaller chips,<br>becoming larger and increasingly<br>broken below 164m. Extensive<br>air-loss with stable final yield 13-<br>14L/s | 600         | 8.6 | 14           |                            |                                                                                                                                                                                                                   |
| 190          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  |             |     |              |                            |                                                                                                                                                                                                                   |
| 200          |       |       |       |       |     |                  |                                                                                                                                                                                                                                                                                                                                                  |             |     |              |                            |                                                                                                                                                                                                                   |

## Appendix D

### Laboratory water chemistry

DRAFT

## APPENDIX D: Laboratory water chemistry

| Analyte name                                | Units                   | Detection limit | HMN0003P | HMN0013P |
|---------------------------------------------|-------------------------|-----------------|----------|----------|
| 1,2-Dichloroethane D4 (surrogate)           | %                       | 0               | 83.8     | 104.593  |
| Aluminium, Al                               | mg/L                    | 0.005           | <0.005   | <0.005   |
| Arsenic, As                                 | mg/L                    | 0.001           | <0.001   | <0.001   |
| Barium, Ba                                  | mg/L                    | 0.001           | 0.004    | 0.026    |
| Benzene                                     | mg/L                    | 0.0005          | <0.0005  | <0.0005  |
| Bicarbonate alkalinity as HCO <sub>3</sub>  | mg/L                    | 5               | 230      | 280      |
| Boron, B                                    | mg/L                    | 0.005           | 0.13     | 0.14     |
| Cadmium, Cd                                 | mg/L                    | 0.0001          | <0.0001  | <0.0001  |
| Calcium, Ca                                 | mg/L                    | 0.2             | 37       | 46       |
| Chloride, Cl                                | mg/L                    | 1               | 50       | 41       |
| Chromium, Cr                                | mg/L                    | 0.001           | <0.001   | <0.001   |
| Conductivity @ 25 C                         | µS/cm                   | 2               | 550      | 600      |
| Copper, Cu                                  | mg/L                    | 0.001           | <0.001   | <0.001   |
| Dibromofluoromethane (surrogate)            | %                       | 0               | 80.995   | 101.998  |
| Ethylbenzene                                | mg/L                    | 0.0005          | <0.0005  | <0.0005  |
| Fluoride by ISE                             | mg/L                    | 0.1             | 0.4      | 0.3      |
| Gross alpha                                 | Bq/L                    | 0               | 0.018    | 0.259    |
| Gross beta (excluding K-40)                 | Bq/L                    | 0               | 0.039    | 0.104    |
| Iron, Fe                                    | mg/L                    | 0.005           | <0.005   | <0.005   |
| Lead, Pb                                    | mg/L                    | 0.001           | <0.001   | 0.002    |
| m&p-xylenes                                 | mg/L                    | 0.0005          | <0.0005  | <0.0005  |
| Magnesium, Mg                               | mg/L                    | 0.1             | 26       | 24       |
| Manganese, Mn                               | mg/L                    | 0.001           | 0.005    | 0.044    |
| Mercury                                     | mg/L                    | 0.00005         | <0.00005 | <0.00005 |
| Molybdenum, Mo                              | mg/L                    | 0.001           | <0.001   | <0.001   |
| Naphthalene                                 | mg/L                    | 0.0005          | <0.0005  | <0.0005  |
| Nickel, Ni                                  | mg/L                    | 0.001           | <0.001   | <0.001   |
| Nitrate, NO <sub>3</sub> as NO <sub>3</sub> | mg/L                    | 0.05            | 0.37     | 0.7      |
| o-Xylene                                    | mg/L                    | 0.0005          | <0.0005  | <0.0005  |
| pH                                          | pH units                | 0.1             | 8.1      | 8.5      |
| Potassium, K                                | mg/L                    | 0.1             | 8.3      | 9.7      |
| Reactive silica, SiO <sub>2</sub>           | mg/L                    | 0.1             | 16       | 20       |
| Selenium, Se                                | mg/L                    | 0.001           | <0.001   | <0.001   |
| Silver, Ag                                  | mg/L                    | 0.001           | <0.001   | <0.001   |
| Sodium, Na                                  | mg/L                    | 0.5             | 33       | 30       |
| Soluble silicon as silica, SiO <sub>2</sub> | mg/L                    | 0.05            | 15       | 18       |
| Sulfate, SO <sub>4</sub>                    | mg/L                    | 1               | 27       | 29       |
| Sulfide                                     | mg/L                    | 0.5             | <0.5     | <0.5     |
| Toluene                                     | mg/L                    | 0.0005          | <0.0005  | <0.0005  |
| Toluene-d8 (surrogate)                      | %                       | 0               | 104.483  | 103.886  |
| Total alkalinity as CaCO <sub>3</sub>       | mg/L                    | 5               | 190      | 230      |
| Total cyanide                               | mg/L                    | 0.004           |          | <0.004   |
| Total dissolved solids                      | mg/L                    | 10              | 290      | 330      |
| Total hardness by calculation               | mg CaCO <sub>3</sub> /L | 1               | 200      | 220      |
| Total suspended solids                      | mg/L                    | 5               | 7        | 9        |
| Total TRH C10-C36 - silica                  | µg/L                    | 50              | <50      | <50      |
| TRH C10-C14 - silica                        | µg/L                    | 10              | <10      | <10      |
| TRH C15-C28 - silica                        | µg/L                    | 50              | <50      | <50      |
| TRH C29-C36 - silica                        | µg/L                    | 50              | <50      | <50      |
| Turbidity                                   | NTU                     | 0.5             | 0.9      | 1.8      |
| Xylenes                                     | mg/L                    | 0.001           | <0.001   | <0.001   |
| Zinc, Zn                                    | mg/L                    | 0.005           | <0.005   | <0.005   |

## Appendix E

### Hydro BCR summary

DRAFT



## Hydro BCR Summary

Show/hide report description

**Project:** MINISTERS NORTH  
**Purpose:** HYDRO  
**Drill Program:** 4534 - Ministers North FY20 Water Supply and Monitoring

| Ministers North FY20 Water Supply and Monitoring |      |                |                               |                               |                                 |                                                                                                                                                                                                                                                 |
|--------------------------------------------------|------|----------------|-------------------------------|-------------------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hole Name                                        | Type | Pad Name       | Draft                         | Final                         | Asbuilt                         | Chip                                                                                                                                                                                                                                            |
| HMN0001                                          | M    | FY20_MN_PAD001 | BCR_HMN0001_20200716_DRAFT_V1 | BCR_HMN0001_20200718_FINAL_V1 | BCR_HMN0001_20200720_ASBUILT_V1 | HMN0001_000.000_020.000<br>HMN0001_020.000_040.000<br>HMN0001_040.000_060.000<br>HMN0001_060.000_080.000<br>HMN0001_080.000_100.000<br>HMN0001_100.000_120.000<br>HMN0001_120.000_140.000<br>HMN0001_140.000_160.000<br>HMN0001_160.000_170.000 |
| HMN0003                                          | P    | FY20_MN_PAD003 | BCR_HMN0003_20200719_DRAFT_V2 | BCR_HMN0003_20200723_FINAL_V1 | BCR_HMN0003_20200802_ASBUILT_V1 | HMN0003_000.000_020.000<br>HMN0003_020.000_040.000<br>HMN0003_040.000_060.000<br>HMN0003_060.000_080.000<br>HMN0003_080.000_100.000<br>HMN0003_100.000_120.000<br>HMN0003_120.000_140.000<br>HMN0003_140.000_160.000<br>HMN0003_160.000_170.000 |
| HMN0005                                          | M    | FY20_MN_PAD005 | BCR_HMN0005_20200729_DRAFT_V1 | BCR_HMN0005_20200801_FINAL_V1 | BCR_HMN0005_20200805_ASBUILT_V1 | HMN0005_000.000_020.000<br>HMN0005_020.000_040.000<br>HMN0005_040.000_060.000<br>HMN0005_060.000_080.000<br>HMN0005_080.000_100.000<br>HMN0005_100.000_120.000<br>HMN0005_120.000_140.000<br>HMN0005_140.000_160.000<br>HMN0005_160.000_170.000 |

## Hydro BCR Summary

|         |   |                |                                                                |                               |                                 |                                                                                                                                                                                                                                                 |
|---------|---|----------------|----------------------------------------------------------------|-------------------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HMN0009 | M | FY20_MN_PAD009 | BCR_HMN0009_20200802_DRAFT_V1                                  | BCR_HMN0009_20200805_FINAL_V1 | BCR_HMN0009_20200807_ASBUILT_V1 | HMN0009_000.000_020.000<br>HMN0009_020.000_040.000<br>HMN0009_040.000_060.000<br>HMN0009_060.000_080.000<br>HMN0009_080.000_100.000<br>HMN0009_100.000_120.000<br>HMN0009_120.000_140.000<br>HMN0009_140.000_160.000<br>HMN0009_160.000_162.000 |
| HMN0012 | M | FY20_MN_PAD015 | BCR_HMN0012_20200608_DRAFT_V1                                  | BCR_HMN0012_20200624_FINAL_V1 | BCR_HMN0012_20200629_ASBUILT_V1 | HMN0012_000.000_020.000<br>HMN0012_020.000_040.000<br>HMN0012_040.000_060.000<br>HMN0012_060.000_080.000<br>HMN0012_080.000_100.000<br>HMN0012_100.000_120.000<br>HMN0012_120.000_140.000<br>HMN0012_140.000_160.000<br>HMN0012_160.000_170.000 |
| HMN0013 | P | FY20_MN_PAD016 | BCR_HMN0013_20200611_DRAFT_V1<br>BCR_HMN0013_20200614_DRAFT_V2 | BCR_HMN0013_20200622_FINAL_V2 | BCR_HMN0013_20200713_ASBUILT_V1 | HMN0013_000.000_020.000<br>HMN0013_020.000_040.000<br>HMN0013_040.000_060.000<br>HMN0013_060.000_080.000<br>HMN0013_080.000_100.000<br>HMN0013_100.000_120.000<br>HMN0013_120.000_140.000<br>HMN0013_140.000_160.000<br>HMN0013_160.000_170.000 |
| HMN0015 | M | FY20_MN_PAD018 | BCR_HMN0015_20200628_DRAFT_V1                                  | BCR_HMN0015_20200711_FINAL_V1 | BCR_HMN0015_20200711_ASBUILT_V1 | HMN0015_000.000_020.000<br>HMN0015_020.000_040.000                                                                                                                                                                                              |
| HMN0016 | M | FY20_MN_PAD018 | BCR_HMN0016_20200624_DRAFT_V1                                  | BCR_HMN0016_20200628_FINAL_V1 | BCR_HMN0016_20200629_ASBUILT_V1 | HMN0016_0.000_20.000<br>HMN0016_20.000_40.000<br>HMN0016_40.000_60.000<br>HMN0016_60.000_74.000                                                                                                                                                 |
| HMN0017 | M | FY20_MN_PAD019 | BCR_HMN0017_20200706_DRAFT_V1                                  | BCR_HMN0017_20200709_FINAL_V1 | BCR_HMN0017_20200711_ASBUILT_V1 | HMN0017_000.000_020.000<br>HMN0017_020.000_040.000<br>HMN0017_040.000_060.000<br>HMN0017_060.000_080.000<br>HMN0017_080.000_100.000                                                                                                             |
| HMN0018 | M | FY20_MN_PAD020 | BCR_HMN0018_20200628_DRAFT_V1                                  | BCR_HMN0018_20200705_FINAL_V1 | BCR_HMN0018_20200708_ASBUILT_V1 | HMN0018_000.000_020.000<br>HMN0018_020.000_040.000<br>HMN0018_040.000_060.000<br>HMN0018_060.000_080.000<br>HMN0018_080.000_100.000                                                                                                             |

## Hydro BCR Summary

|         |   |                |                               |                               |                                 |                                                                                                                                                      |
|---------|---|----------------|-------------------------------|-------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| HMN0024 | M | FY20_MN_PAD025 | BCR_HMN0024_20200629_DRAFT_V1 | BCR_HMN0024_20200701_FINAL_V1 | BCR_HMN0024_20200707_ASBUILT_V1 | HMN0024_0.000_20.000<br>HMN0024_20.000_40.000<br>HMN0024_40.000_60.000<br>HMN0024_60.000_80.000<br>HMN0024_80.000_100.000<br>HMN0024_100.000_120.000 |
|---------|---|----------------|-------------------------------|-------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|

DRAFT

## Appendix F

### Frontier piezo bore logs



## BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN1474R **Hole Length:** 143.00

**Easting:** 718647.17 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7474603.05 0.0 - 143.0 WLSRC32 RHF 140 WLS SB5  
**Surface RL:** 609.48  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -89-->295

**Construct:** 22 Jan 19 - 22 Jan 19

**Comments:** sump leakage, last sample 2m - stopped at black shale. pH= , TDS= TSS= Water hit at ...

**TOC RL:** 610.10 (Stickup 0.62m) (drilled) **SWL:** [] **Dev:** N **Final pH:** -  
**TOC RL:** 610.10 (Stickup 0.62m) (current) **Is Live:** Y **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID         |
|------------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|------------------------------------|
| 0          | W     |       |       |       |     |                  | mixed with sz                  |             |    |              |                            | 51mm BLANK PVC<br>(0.00-48.00)     |
| 10         |       |       |       |       |     |                  | cherty<br>cherty               |             |    |              |                            |                                    |
| 20         | D4    |       |       |       |     |                  | bif                            |             |    |              |                            |                                    |
| 30         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 40         |       |       |       |       |     |                  | trace pink shale               |             |    |              |                            |                                    |
| 50         | D3    |       |       |       |     |                  | shaly                          |             |    |              |                            | 51mm SLOTTED PVC<br>(48.00-102.00) |
| 60         |       |       |       |       |     |                  | cherty                         |             |    |              |                            |                                    |
| 70         |       |       |       |       |     |                  | cherty with good wand g        |             |    |              |                            |                                    |
| 80         |       |       |       |       |     |                  | shaly                          |             |    |              |                            | LEVELTROLL(72.00) ID:<br>2425      |
| 90         | D2    |       |       |       |     |                  | shaly                          |             |    |              |                            |                                    |
| 100        |       |       |       |       |     |                  | shaly                          |             |    |              |                            |                                    |
|            |       |       |       |       |     |                  | bif                            |             |    |              |                            |                                    |

## BHP

Hole Length: 143.00

Logged By

SB5

**Comments:** sump leakage, last sample 2m- stopped at black shale. pH= , TDS= TSS= Water hit at ...

Final pH: -

**Final EC:** -

[illegible]

## BHP

Hole Length: 93.00

Logged By

MK7

**Comments:** Drilled to planned depth, lots of waste - important peiso hole

**Final EC:** -

[illegible]

## BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN1503R **Hole Length:** 84.00

**Easting:** 720046.95 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7474238.93 0.0 - 84.0 RANRC12 RHF 140 RANGER AJ  
**Surface RL:** 633.39  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -89-->171

**Construct:** 01 Dec 18 - 01 Dec 18

**Comments:** HOLE REQUESTED TO BE PUSHED TO TARGET DEPTH BUT UNABLE TO ACHIEVE TARGET DEPTH DUE TO MAG BIF, NO WA...

**TOC RL:** 634.00 (Stickup 0.84m) (drilled) **SWL:** 71.40 mbtoc (12 Jun 18) **Dev:** N **Final pH:** -  
**TOC RL:** 634.00 (Stickup 0.84m) (current) **Is Live:** Y (-) **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                         | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID        |
|------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------|-------------|----|--------------|----------------------------|-----------------------------------|
| 0          | J5    |       |       |       |     |                  | SHALEY, A BIT OF CHERT,<br>MAY NOT EVEN GRADE          |             |    |              |                            | 51mm BLANK PVC<br>(0.00-54.00)    |
| 10         | J4    |       |       |       |     |                  | SHALE BAND                                             |             |    |              |                            |                                   |
| 20         |       |       |       |       |     |                  | BIF                                                    |             |    |              |                            |                                   |
| 30         | J3    |       |       |       |     |                  | SOME SPECULARITE, MAY<br>GRADE                         |             |    |              |                            |                                   |
| 40         |       |       |       |       |     |                  | SHALE BAND                                             |             |    |              |                            |                                   |
| 50         |       |       |       |       |     |                  | SPECULARITE, COULD<br>POSSIBLY GRADE                   |             |    |              |                            |                                   |
| 60         | J2    |       |       |       |     |                  | BIF                                                    |             |    |              |                            |                                   |
| 70         |       |       |       |       |     |                  | BIF                                                    |             |    |              |                            |                                   |
| 80         |       |       |       |       |     |                  | SLIGHTLY WEATHERED                                     |             |    |              |                            | 51mm SLOTTED PVC<br>(54.00-84.00) |
| 90         |       |       |       |       |     |                  | BIF, SOME MAG, NOTHING<br>MAJOR                        |             |    |              |                            |                                   |
| 100        |       |       |       |       |     |                  | mag bif, riebeckite, dint push to<br>target depth, eoh |             |    |              |                            | LEVELTROLL(84.00) ID:<br>2241     |

**BHP**

Hole Length: 117.00

AHS

**Final EC:** --

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID         |
|------------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|------------------------------------|
| 0          |       |       |       |       |     |                  |                                |             |    |              |                            | 51mm BLANK PVC<br>(0.00-85.00)     |
| 10         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 20         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 30         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 40         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 50         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 60         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 70         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 80         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 90         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 100        |       |       |       |       |     |                  |                                |             |    |              |                            | 51mm SLOTTED PVC<br>(85.00-115.00) |

**BHP**

Hole Length: 117.00

AHS

**Final EC:** --

[illegible]

## BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN1648R **Hole Length:** 102.00

**Easting:** 717076.01 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7473365.88 0.0 - 102.0 WLSRC32 RHF 140 WLS AH8  
**Surface RL:** 691.67  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -89-->75

**Construct:** -**Comments:** Testing D4, Geo (AH8) wrongly entered incorrect hole depth. Correct depth is 102 m as per the plod ...

**TOC RL:** - (drilled) **SWL:** [] **Dev:** N **Final pH:** -  
**TOC RL:** - (current) **Is Live:** U **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID |
|------------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|----------------------------|
| 0          |       |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 10         | J2    |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 20         |       |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 30         | J1    |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 40         |       |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 50         |       |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 60         |       |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 70         | W     |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 80         |       |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 90         |       |       |       |       |     |                  |                                |             |    |              |                            |                            |
| 100        | D4    |       |       |       |     |                  |                                |             |    |              |                            |                            |

Depth was put wrongly at 108 m earlier by Geo AH8 during logging. The correct depth is 102m. Change was done by the Geologist (SB5) after checking the plod/ bag numbers

## BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN2310R **Hole Length:** 156.00

**Easting:** 714896.11 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7474307.14 0.0 - 156.0 WLSRC50 RHF 140 WLS LP2  
**Surface RL:** 679.72  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -89-->298

**Construct:** 06 Oct 20 - 06 Oct 20

**Comments:** Logged off model. Black shale intercepted

**TOC RL:** 680.82 - (drilled) **SWL:** [] **Dev:** N **Final pH:** -  
**TOC RL:** 680.82 - (current) **Is Live:** Y **Date:** - **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID          |
|--------------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|-------------------------------------|
| 100          | RU    |       |       |       |     |                  | BLACK SHALE                    |             |    |              |                            | 51mm BLANK PVC<br>(0.00-114.00)     |
| 110          |       |       |       |       |     |                  |                                |             |    |              |                            | 51mm SLOTTED PVC<br>(114.00-156.00) |
| 120          |       |       |       |       |     |                  |                                |             |    |              |                            |                                     |
| 130          |       |       |       |       |     |                  |                                |             |    |              |                            |                                     |
| 140          |       |       |       |       |     |                  |                                |             |    |              |                            |                                     |
| 150          |       |       |       |       |     |                  |                                |             |    |              |                            |                                     |
| 160          |       |       |       |       |     |                  |                                |             |    |              |                            | END CAP (156.00)                    |
| 170          |       |       |       |       |     |                  |                                |             |    |              |                            |                                     |
| 180          |       |       |       |       |     |                  |                                |             |    |              |                            |                                     |
| 190          |       |       |       |       |     |                  |                                |             |    |              |                            |                                     |
| 200          |       |       |       |       |     |                  |                                |             |    |              |                            |                                     |

0 100 200

0-5000

0-14

0-50

## BHP

Hole Length: 156.00

LFM

**Final EC:** --

[illegible]



## BHP

Hole Length: 108.00

**Comments:**

Logged By

LFM

**Final EC:** -

[illegible]







**BHP**

Hole Length: 60.00

Logged By

LP2

Final pH: -

Final EC: --

[illegible]

**BHP**

Hole Length: 123.00

Logged By

DS1

**Comments:** piezo installed

Final pH: -

Final EC: --

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                  | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID                                       |  |
|--------------|-------|-------|-------|-------|-----|------------------|-------------------------------------------------------------------------------------------------|-------------|----|--------------|----------------------------|------------------------------------------------------------------|--|
| 0            | GS3   | ZXY   |       |       |     |                  | Typical td3                                                                                     |             |    |              |                            | 150mm BLANK PVC<br>(0.00-6.00)<br>50mm BLANK PVC<br>(0.00-96.00) |  |
|              |       | ZXY   |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | ZX    | Y     |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | ZX    | Y     |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | ZX    |       | Y     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 10           | W     | ZX    |       | Y     |     |                  | Transitioning into bedrock. May even be td2..?                                                  |             |    |              |                            |                                                                  |  |
|              |       | ZGX   | K     | Y     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | ZG    | K     | L     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | ZK    |       | G     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | ZKG   |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       | SF    |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | GF    | S     | T     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | F     | T     | G     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       | FS    |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       | W     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 20           | D4    | G     | W     |       |     |                  | Dirty marginal material. Might be hardcapped bedrock...                                         |             |    |              |                            |                                                                  |  |
|              |       | ZK    |       | G     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | ZKG   |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       | SF    |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | GF    | S     | T     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | F     | T     | G     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       | FS    |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       | W     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     | W     |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G1    | F     | S     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 30           | D4    | G     |       | S1    |     |                  | Transitional. Most of the sample is sticky yellow white clay / shale. Might actually be bedrock |             |    |              |                            |                                                                  |  |
|              |       | GW    | L     | F1    |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | W     | G     | L     |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | GW    |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | WG    |       | FS    |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     | WS    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | GW    |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | GW    |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     | FW    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     | FW    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 40           | D3    | G     |       | FW    |     |                  | Competent red and pink chips of shale                                                           |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 50           | D3    | G     | WF    |       |     |                  | Half w                                                                                          |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 60           | D3    | G     | WF    |       |     |                  | Great mineralisation                                                                            |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 70           | D3    | G     | WF    |       |     |                  | Slight siliceous nature to the g chips...                                                       |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 80           | D3    | G     | WF    |       |     |                  | Great mineralisation                                                                            |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 90           | D3    | G     | WF    |       |     |                  | Most of the shale lost as fines                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 100          | D3    | G     | WF    |       |     |                  | Lots of f in fines. Ds12?                                                                       |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 110          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 120          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 130          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 140          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 150          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 160          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 170          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 180          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 190          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 200          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 210          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 220          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
| 230          | D3    | G     | WF    |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |
|              |       | G     |       |       |     |                  |                                                                                                 |             |    |              |                            |                                                                  |  |

## BHP

Hole Length: 123.00

Logged By

DS1

**Comments:** piezo installed

**Final EC:** --

[illegible]

**BHP**

Hole Length: 123.00

Logged By

DS1

---

**Comments:** piezo installed. bedding next to pad dipping 20 degrees towards 170. drilled a lot of bif this hole...

Final pH: -

Final EC: -

[illegible]

**BHP**

Hole Length: 123.00

Logged By

DS1

**Construct:** 08 Jul 14 - 08 Jul 14

**Comments:** piezo installed. bedding next to pad dipping 20 degrees towards 170. drilled a lot of bif this hole...

Final pH: -

Final EC: -

[illegible]

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN0057R **Hole Length:** 93.00

**Easting:** 719450.33 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7473970.00 0.0 - 93.0 GD6 RHF 140 BLY DS1  
**Surface RL:** 606.65  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -70-->180  
**Construct:** 10 Jul 14 - 10 Jul 14  
**Comments:** Piezo installed. 9 lengths of blanks and 4 of slotted. 78m

**TOC RL:** 607.66 (Stickup 1.01m) (drilled) **SWL:** 47.17 MBTOC (16 Mar 18) **Dev:** N **Final pH:** -  
**TOC RL:** 607.66 (Stickup 1.01m) (current) **Is Live:** U (-) **Date:** - **Final EC:** -

| Depth<br>m/bl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                    | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID      |
|---------------|-------|-------|-------|-------|-----|------------------|-----------------------------------------------------------------------------------|-------------|----|--------------|----------------------------|---------------------------------|
| 0             | GS3   | ZX    | G     | Y     |     |                  | Transitional                                                                      |             |    |              |                            | 150mm BLANK PVC:<br>(0.00-6.00) |
|               |       | ZXG   |       | Y     |     |                  | Sloppy sample - mostly fines.<br>Small grey cherts                                |             |    |              |                            | 50mm BLANK PVC:<br>(0.00-54.00) |
| 10            | D3    | S     | C     |       |     |                  | White shales and cherts                                                           |             |    |              |                            |                                 |
|               |       | SC    |       |       |     |                  | Shaley cherty bif. Bit of a mixed bag                                             |             |    |              |                            |                                 |
|               |       | SJC   |       | W     |     |                  | Surprisingly looks decent. Yellow competent shale chips and some nice g...Strange |             |    |              |                            |                                 |
| 20            |       | G     | S     |       |     |                  | Back to bif...Red chert bands                                                     |             |    |              |                            |                                 |
|               |       | J     |       | F     |     |                  | Pretty stock standard bif                                                         |             |    |              |                            |                                 |
|               |       | C     | F     | J     |     |                  |                                                                                   |             |    |              |                            |                                 |
| 30            |       | J     |       |       |     |                  |                                                                                   |             |    |              |                            |                                 |
|               |       | J     |       | S     |     |                  |                                                                                   |             |    |              |                            |                                 |
|               |       | JCF   |       |       |     |                  | Sticky balls of f                                                                 |             |    |              |                            |                                 |
| 40            |       | J     |       |       |     |                  | Hard bif - good banding of red chert                                              |             |    |              |                            |                                 |
|               |       | J     | W     |       |     |                  | Some nice w but pretty characteristic of d4 bif                                   |             |    |              |                            |                                 |
|               |       | J     | W     |       |     |                  | Goethitic haematite banded bif                                                    |             |    |              |                            |                                 |
| 50            | D2    | J     |       | S     |     |                  | Shale band in d4                                                                  |             |    |              |                            |                                 |
|               |       | J     |       |       |     |                  |                                                                                   |             |    |              |                            |                                 |
|               |       | JW    |       |       |     |                  |                                                                                   |             |    |              |                            |                                 |
| 60            |       | J     | W     | S     |     |                  | Minor enrichment                                                                  |             |    |              |                            |                                 |
|               |       | J     |       | SW    |     |                  |                                                                                   |             |    |              |                            |                                 |
|               |       | J     |       | M     |     |                  |                                                                                   |             |    |              |                            |                                 |
| 70            |       | J     |       | W     |     |                  |                                                                                   |             |    |              |                            |                                 |
|               |       | J     |       | M     |     |                  |                                                                                   |             |    |              |                            |                                 |
|               |       | JCS   |       | M     |     |                  | Colour changing to a lighter brown                                                |             |    |              |                            |                                 |
| 80            |       | JCS   |       | M     |     |                  | Colour changing to a lighter brown                                                |             |    |              |                            |                                 |
|               |       | JC    | S     |       |     |                  |                                                                                   |             |    |              |                            |                                 |
|               |       | J     | CS    |       |     |                  |                                                                                   |             |    |              |                            |                                 |
|               |       | JC    | S     |       |     |                  |                                                                                   |             |    |              |                            |                                 |
| 90            |       | JC    | SG    |       |     |                  |                                                                                   |             |    |              |                            |                                 |
|               |       | JC    | SG    |       |     |                  |                                                                                   |             |    |              |                            |                                 |
| 100           |       |       |       |       |     |                  |                                                                                   |             |    |              |                            |                                 |

LEVELTROLL(54.00) ID:  
2115  
50mm SLOTTED PVC:  
(54.00-78.00)

END CAP: (78.00)

## BHP

Hole Length: 201.00

Logged By

EK3

**Comments:** Planned Hole: MN\_2015\_0043, Piezo, pad 0024;

**Final EC:** -

[illegible]

## BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN0068R **Hole Length:** 201.00

**Easting:** 716405.56 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7472964.26 0.0 - 201.0 ED1520 RHF 146 ANW EK3  
**Surface RL:** 717.21  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -89-->236  
**Construct:** 04 Oct 15 - 04 Oct 15  
**Comments:** Planned Hole: MN\_2015\_0043, Piezo, pad 0024;

**TOC RL:** 718.02 (Stickup 0.81m) (drilled) **SWL:** 154.45 MBTOC (16 Mar 18) **Dev:** N **Final pH:** -  
**TOC RL:** 718.02 (Stickup 0.81m) (current) **Is Live:** U (-) **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                             | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID           |
|------------|-------|-------|-------|-------|-----|------------------|------------------------------------------------------------|-------------|----|--------------|----------------------------|--------------------------------------|
| 100        | J2    | J     | C     | S     |     |                  | BIF, varying amounts of shales                             |             |    |              |                            | 51mm BLANK PVC:<br>(0.00-135.00)     |
| 110        | J2    | J     | C     | S     |     |                  | BIF, varying amounts of shales<br>Slightly increased shale |             |    |              |                            |                                      |
| 120        | J1    | J     | C     | S     |     |                  |                                                            |             |    |              |                            |                                      |
| 130        | J1    | J     | C     | S     |     |                  |                                                            |             |    |              |                            |                                      |
| 140        | J1    | J     | C     | S     |     |                  |                                                            |             |    |              |                            |                                      |
| 150        | J1    | J     | C     | S     |     |                  | Slightly increased shale                                   |             |    |              |                            | 51mm SLOTTED PVC:<br>(135.00-201.00) |
| 160        | J1    | J     | C     | S     |     |                  |                                                            |             |    |              |                            |                                      |
| 170        | J1    | J     | C     | S     |     |                  |                                                            |             |    |              |                            |                                      |
| 180        | J1    | J     | C     | S     |     |                  | Central chert band                                         |             |    |              |                            |                                      |
| 190        | J1    | J     | C     | S     |     |                  |                                                            |             |    |              |                            |                                      |
| 200        | D4    | J     | C     | S     |     |                  | Dark weighty chips, v silicious<br>and biffy. EOH          |             |    |              |                            | LEVELTROLL(161.00)<br>ID: 2116       |



# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN0088R **Hole Length:** 129.00

**Easting:** 720056.52 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7472583.15 0.0 - 129.0 MCYRC15 RHF 146 MCKAY EK3  
**Surface RL:** 653.43  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -90-->0

**Construct:** 21 Oct 15 - 21 Oct 15

**Comments:** PG requested hole be pushed to depth to install piezo. ground was not drilled for mineralisation. Pi...

**TOC RL:** 654.30 (Stickup 0.87m) (drilled) **SWL:** 90.83 MBTOC (22 Oct 16) **Dev:** N **Final pH:** -  
**TOC RL:** 654.30 (Stickup 0.87m) (current) **Is Live:** U **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID         |
|------------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|------------------------------------|
| 0          |       | J     |       |       |     |                  |                                |             |    |              |                            | 51mm BLANK PVC<br>(0.00-42.00)     |
| 5          |       | S     | C     |       |     |                  |                                |             |    |              |                            |                                    |
| 10         |       | J     | F     |       |     |                  |                                |             |    |              |                            |                                    |
| 20         | D4    | J     |       |       |     |                  |                                |             |    |              |                            |                                    |
| 30         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 40         |       | J     |       |       |     |                  |                                |             |    |              |                            |                                    |
| 45         |       | C     |       |       |     |                  |                                |             |    |              |                            |                                    |
| 50         |       | CS    |       | F     |     |                  |                                |             |    |              |                            | 51mm SLOTTED PVC<br>(42.00-126.00) |
| 55         |       | J     |       |       |     |                  |                                |             |    |              |                            |                                    |
| 60         | D3    | C     | JS    |       |     |                  |                                |             |    |              |                            |                                    |
| 65         |       | J     |       |       |     |                  |                                |             |    |              |                            |                                    |
| 70         |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 80         |       | J     | F     |       |     |                  |                                |             |    |              |                            |                                    |
| 85         |       | J     | F     |       |     |                  |                                |             |    |              |                            |                                    |
| 90         | D2    | J     |       |       |     |                  |                                |             |    |              |                            |                                    |
| 100        |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
|            |       |       |       |       |     |                  | bif, red laminations, eoh      |             |    |              |                            |                                    |

LEVELTROLL(100.00)  
ID: 2245

## BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN0088R **Hole Length:** 129.00

**Easting:** 720056.52 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7472583.15 0.0 - 129.0 MCYRC15 RHF 146 MCKAY EK3  
**Surface RL:** 653.43  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -90-->0  
**Construct:** 21 Oct 15 - 21 Oct 15  
**Comments:** PG requested hole be pushed to depth to install piezo. ground was not drilled for mineralisation. Pi...

**TOC RL:** 654.30 (Stickup 0.87m) (drilled) **SWL:** 90.83 MBTOC (22 Oct 16) **Dev:** N **Final pH:** -  
**TOC RL:** 654.30 (Stickup 0.87m) (current) **Is Live:** U (-) **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log                                                                                | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm                                                                        | pH                                                                                  | Yield<br>L/s                                                                         | Diagram<br>Scaled to 400mm                                                           | Notes<br>Casing size as ID         |
|------------|-------|-------|-------|-------|------------------------------------------------------------------------------------|------------------|--------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------|
| 100        | D2    | J     |       |       |  |                  | bif, red laminations, eoh      |  |  |  |  | 51mm SLOTTED PVC<br>(42.00-126.00) |
| 110        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |
| 120        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |
| 130        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |
| 140        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |
| 150        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |
| 160        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |
| 170        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |
| 180        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |
| 190        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |
| 200        |       |       |       |       |                                                                                    |                  |                                |                                                                                    |                                                                                     |                                                                                      |                                                                                      |                                    |

LEVELTROLL(100.00)  
ID: 2245  
END CAP (126.00)

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN0117R **Hole Length:** 111.00

**Easting:** 718860.22 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7472766.12 0.0 - 111.0 ED1523 RHF 146 ANW JTS  
**Surface RL:** 610.34  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -90-->0

**Construct:** 12 Oct 15 - 12 Oct 15

**Comments:** MN\_0045, closed due to major sump overflow onto pad - unsafe, could not close D2 possible min, JTS r...

**TOC RL:** 611.18 (Stickup 0.84m) (drilled) **SWL:** 47.54 MBTOC (22 Oct 15) **Dev:** N **Final pH:** -  
**TOC RL:** 611.18 (Stickup 0.84m) (current) **Is Live:** U (-) **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                                                                                                                                | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID        |
|------------|-------|-------|-------|-------|-----|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|--------------|----------------------------|-----------------------------------|
| 0          | J1    | G     | WS    | L     |     |                  | could be hardcap wbsh, just not<br>v. shaley, vit g, quite limonitic                                                                                                          |             |    |              |                            | 51mm BLANK PVC<br>(0.00-36.00)    |
| 10         |       | G     | WS    | L     |     |                  | could be hardcap wbsh, just not<br>v. shaley, vit g, quite limonitic                                                                                                          |             |    |              |                            |                                   |
|            |       | S     | GL    | CQ    |     |                  | white friable chert, vit g, limonitic<br>shale.                                                                                                                               |             |    |              |                            |                                   |
|            |       | G1    | FL    | CQ    |     |                  | more goeth in first 3m, vit g,<br>hardcapped                                                                                                                                  |             |    |              |                            |                                   |
| 20         |       | SC    | JF    |       |     |                  | cherty, looks a little leached                                                                                                                                                |             |    |              |                            |                                   |
| 30         |       | K     | S     |       |     |                  | looks like white clay, very<br>smooth talc consistency, strange<br>gamma above - driller said<br>broken ground (confident not<br>cavity?) rough creek level of<br>gully below |             |    |              |                            | 51mm SLOTTED PVC<br>(36.00-96.00) |
| 40         |       | JC    | S     | FG    |     |                  | not typical ws1, more cherty                                                                                                                                                  |             |    |              |                            |                                   |
|            |       | JG    | C     | Q     |     |                  |                                                                                                                                                                               |             |    |              |                            |                                   |
|            |       | J     | C     | S     |     |                  | leached bif, some good minx chips<br>- lots of greenish chert                                                                                                                 |             |    |              |                            |                                   |
| 50         |       |       |       |       |     |                  | leached bif, some good minx chips<br>- lots of greenish chert                                                                                                                 |             |    |              |                            |                                   |
|            |       |       |       |       |     |                  | homogenous bif, variably<br>magnetic, red chert banding?<br>some porosity through leaching<br>of cherts                                                                       |             |    |              |                            |                                   |
| 60         |       |       |       |       |     |                  |                                                                                                                                                                               |             |    |              |                            | LEVELTROLL(60.00) ID:<br>2244     |
| 70         |       |       |       |       |     |                  |                                                                                                                                                                               |             |    |              |                            |                                   |
| 80         |       |       |       |       |     |                  |                                                                                                                                                                               |             |    |              |                            |                                   |
| 90         |       | J     | C     | S     |     |                  | homogenous bif, variably<br>magnetic, red chert banding?<br>some porosity through leaching<br>of cherts                                                                       |             |    |              |                            |                                   |
|            |       | JG    | C     | S     |     |                  | cherty bif                                                                                                                                                                    |             |    |              |                            |                                   |
|            |       | SJ    | F     | GC    |     |                  | ds11?                                                                                                                                                                         |             |    |              |                            |                                   |
| 100        |       | JG    | C     | S     |     |                  | cherty bif                                                                                                                                                                    |             |    |              |                            |                                   |

## BHP

Hole Length: 81.00

Logged By

JM9

**Comments:** MN\_0053. Piezo Hole, OH could not be collected.;

**Final EC:** --

| Depth<br>mgbf | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                           | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID     |
|---------------|-------|-------|-------|-------|-----|------------------|----------------------------------------------------------|-------------|----|--------------|----------------------------|--------------------------------|
| 0             | ST3   | ZXY   | G5    | C     |     |                  | rounded colluvial clasts in silt,<br>moving into hardcap |             |    |              |                            | 61mm BLANK PVC<br>(0.00-15.00) |
|               | D3    | 1G    | C     |       |     |                  | hardcap on bit, marginal                                 |             |    |              |                            |                                |
|               |       | 1G    | C     |       |     |                  | hardcap on bit, marginal                                 |             |    |              |                            |                                |
| 10            |       | 1G    | C     |       |     |                  | hardcap on bit, marginal                                 |             |    |              |                            |                                |
|               |       | SC    |       |       |     |                  |                                                          |             |    |              |                            |                                |
|               |       | J     | S     |       |     |                  | shale bands                                              |             |    |              |                            |                                |
| 20            |       |       |       |       |     |                  |                                                          |             |    |              |                            |                                |
|               | D2    | J     |       | S     |     |                  |                                                          |             |    |              |                            |                                |
| 30            |       |       |       |       |     |                  |                                                          |             |    |              |                            |                                |
|               |       | J     |       | S     |     |                  |                                                          |             |    |              |                            |                                |
| 40            |       |       |       |       |     |                  |                                                          |             |    |              |                            |                                |
|               | D1    | C     | S     | J     |     |                  |                                                          |             |    |              |                            |                                |
| 50            |       |       |       |       |     |                  |                                                          |             |    |              |                            |                                |
|               |       | B     | C     |       |     |                  |                                                          |             |    |              |                            |                                |
| 60            |       | B     | C     |       |     |                  |                                                          |             |    |              |                            |                                |
|               | RU    |       |       |       |     |                  |                                                          |             |    |              |                            |                                |
| 80            |       |       |       |       |     |                  |                                                          |             |    |              |                            |                                |
| 90            |       |       |       |       |     |                  |                                                          |             |    |              |                            |                                |
| 100           |       |       |       |       |     |                  |                                                          |             |    |              |                            |                                |

**BHP**

Hole Length: 84.00

LP2

Final EC: -

[illegible]

**BHP**

Hole Length: 69.00

Logged By

JLS

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

|         |   |   |           |          |     |     |       |   |           |   |
|---------|---|---|-----------|----------|-----|-----|-------|---|-----------|---|
| TOC RL: | - | - | (drilled) | SWL:     | [ ] | [ ] | Dev:  | N | Final pH: | - |
| TOC RL: | - | - | (current) | Is Live: | U   | (-) | Date: | - | Final EC: | - |

[illegible]

**BHP**

Hole Length: 105.00

Logged By

JLS

1

1

100

\_\_\_\_\_

Final pH: -

Final EC: --

[illegible]



**BHP**

Hole Length: 87.00

Logged By

JLS

**Comments:** close LG shell, top of D2 min in MN0040R;

Final pH: -

Final EC: -

| Depth<br>mgtl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                               | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID     |
|---------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------------|-------------|----|--------------|----------------------------|--------------------------------|
| 0             | W     | SF    | GL    | K     |     |                  | small subround soft shales, some pale-pink/white             |             |    |              |                            | 51mm BLANK PVC (0.00-72.00)    |
| 10            | D4    | GW    |       |       |     |                  |                                                              |             |    |              |                            |                                |
| 20            |       | TF    | GW    |       |     |                  | #MARGINAL, DS16                                              |             |    |              |                            |                                |
| 30            |       | GW    |       | LC    |     |                  | dark, hard chips, some dusty streaking dull grey overll good |             |    |              |                            |                                |
| 40            |       | G     | J     | C     |     |                  | #MARGINAL, aa, dustier, more jaspalitic DS11                 |             |    |              |                            |                                |
| 50            |       | JIG   | L     |       |     |                  | cherty BIF                                                   |             |    |              |                            |                                |
| 60            |       | JCG   |       |       |     |                  | cherty BIF                                                   |             |    |              |                            |                                |
| 70            | D3    | JCG   |       |       |     |                  | cherty BIF                                                   |             |    |              |                            |                                |
| 80            |       | FS    | CJG   | K     |     |                  | DS 9                                                         |             |    |              |                            |                                |
| 90            |       | CJG   |       |       |     |                  | cherty BIF                                                   |             |    |              |                            |                                |
| 100           |       | SF    | CJG   |       |     |                  | DS6                                                          |             |    |              |                            |                                |
| 110           |       | GCJ   |       |       |     |                  | cherty BIF                                                   |             |    |              |                            | 51mm SLOTTED PVC (72.00-84.00) |
| 120           |       | JF    | SC    | G     |     |                  | DS5                                                          |             |    |              |                            | LEVELTROLL(80.00) ID: 2117     |
| 130           |       | GCJ   |       |       |     |                  | cherty BIF                                                   |             |    |              |                            | END CAP (84.00)                |
| 140           |       | FS    | GCJ   |       |     |                  | EOH, DS4                                                     |             |    |              |                            |                                |

**BHP**

**Hole Length: 129.00**

Logged By

275

**Construct:** 13 Dec 16 - 13 Dec 16

**Comments:** 0181 close D2 min logged to the south;

Final pH: -

Final EC: --

| Depth<br>m/gbl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                           | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID     |
|----------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------------------------|-------------|----|--------------|----------------------------|--------------------------------|
| 0              |       | GS    | F     |       |     |                  | #marginal min upper wb sha?<br>quite ferrug. no bleached white<br>shales |             |    |              |                            | 51mm BLANK PVC<br>(0.00-72.00) |
| 10             |       | S     | F     | C     |     |                  | pink/white/red shale                                                     |             |    |              |                            |                                |
|                |       | G     | S     | L     |     |                  | poss min cchert., v. strange for<br>wb - looks like good m-g min?        |             |    |              |                            |                                |
| 20             |       | S     | F     | C     |     |                  | bleached pink white shales                                               |             |    |              |                            |                                |
| 30             |       | JG    |       |       |     |                  | jaspilitic bif                                                           |             |    |              |                            |                                |
|                |       | JG    |       |       |     |                  | jaspilitic bif                                                           |             |    |              |                            |                                |
| 40             |       | JG    | S     |       |     |                  | PINK WHIT SHALE                                                          |             |    |              |                            |                                |
| 50             |       | G     | L     | S     |     |                  | MIN BIF, interbedded with yel<br>shales                                  |             |    |              |                            |                                |
| 60             |       | GJ    |       |       |     |                  | #marginal getting jaspilitic                                             |             |    |              |                            |                                |
|                |       | JG    |       | CS    |     |                  |                                                                          |             |    |              |                            |                                |
| 70             |       | JC    | S     | G     |     |                  | cherty bif, with pink/red shales,<br>barren - no enrichment              |             |    |              |                            |                                |
|                |       | JC    | S     | G     |     |                  | cherty bif, with pink/red shales,<br>barren - no enrichment              |             |    |              |                            |                                |
| 80             |       |       |       |       |     |                  |                                                                          |             |    |              |                            |                                |
| 90             |       | GS    | F     |       |     |                  | #marginal transisional Ds6 sample<br>- more goethitic                    |             |    |              |                            |                                |
|                |       | G     | W     | S     |     |                  | #marginal nice m-g min, pink<br>shbale flecks                            |             |    |              |                            |                                |
| 100            |       | GJ    |       | SF    |     |                  | #marginal, slight banding<br>appearing in chips, more angular            |             |    |              |                            |                                |

## BHP

Hole Length: 129.00

Logged By

JT5

**Comments:** \_0181 close D2 min logged to the south;

Final EC: --

[illegible]

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN0439R **Hole Length:** 153.00

**Easting:** 716143.71 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7475398.16 0.0 - 153.0 ED1525 RHF 146 ANW JTS  
**Surface RL:** 668.35  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -89-->159

**Construct:** 13 Dec 16 - 13 Dec 16

**Comments:** drilled to top of D3 to test continuity of D4 min proximal to historic hole;

**TOC RL:** 669.05 (Stickup 0.70m) (drilled) **SWL:** 104.89 MBTOC (09 Mar 17) **Dev:** N **Final pH:** -  
**TOC RL:** 669.05 (Stickup 0.70m) (current) **Is Live:** U (-) **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                                  | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID      |
|------------|-------|-------|-------|-------|-----|------------------|-----------------------------------------------------------------|-------------|----|--------------|----------------------------|---------------------------------|
| 0          |       | G     | L     | S     |     |                  | #marginal vit g, whitish mineral<br>as vuggy infill? soft chips |             |    |              |                            | 51mm BLANK PVC<br>(0.00-102.00) |
| 10         | J2    | SL    | G     | F     |     |                  | #marginal lots of peachy limonitic<br>shales                    |             |    |              |                            |                                 |
| 20         |       | G     |       | SL    |     |                  |                                                                 |             |    |              |                            |                                 |
| 30         |       | GSL   |       |       |     |                  | lim/pink shale band                                             |             |    |              |                            |                                 |
| 40         | J1    | G     | W     | SL    |     |                  |                                                                 |             |    |              |                            |                                 |
| 50         |       | JG    | S     | F     |     |                  | bif with pink shales                                            |             |    |              |                            |                                 |
| 60         |       | JG    |       |       |     |                  |                                                                 |             |    |              |                            |                                 |
| 70         |       | JG    | S     |       |     |                  | bif, with slight increase in orange/<br>brown shale content     |             |    |              |                            |                                 |
| 80         |       | SFC   | G     |       |     |                  | pink/orange shale with chert                                    |             |    |              |                            |                                 |
| 90         |       | SFC   | G     |       |     |                  | pink/orange shale with chert                                    |             |    |              |                            |                                 |
| 100        | W     | SB    | F     | C     |     |                  | black carbonaceous shale, still<br>aprtially ox, no pyrite      |             |    |              |                            |                                 |

## BHP

Hole Length: 153.00

Logged By

JT5

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

**Comments:** drilled to top of D3 to test continuity of D4 min proximal to historic hole;

Final EC: -

[illegible]

## BHP

Hole Length: 147.00

188

Final EC: --

[illegible]

## BHP

Hole Length: 147.00

188

Final EC: -

[illegible]

# BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN0599R **Hole Length:** 198.00

**Easting:** 717639.71 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7475004.30 0.0 - 198.0 ED1524 RHF 146 ANW JTS  
**Surface RL:** 635.68  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -89-->227

**Construct:** 13 Dec 16 - 13 Dec 16

**Comments:** \_641, overdrill in R due to poor comms from driller, ;

**TOC RL:** 636.36 (Stickup 0.86m) (drilled) **SWL:** 72.23 MBTOC (09 Mar 17) **Dev:** N **Final pH:** -  
**TOC RL:** 636.36 (Stickup 0.86m) (current) **Is Live:** U (-) **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                            | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID      |
|------------|-------|-------|-------|-------|-----|------------------|-----------------------------------------------------------|-------------|----|--------------|----------------------------|---------------------------------|
| 0          | J1    | G     | S     | JC    |     |                  | #marginal - hardcap min whaleback?                        |             |    |              |                            | 51mm BLANK PVC (0.00-72.00)     |
| 10         |       | G     | SC    | J     |     |                  | #marginal - hardcap min whaleback?                        |             |    |              |                            |                                 |
| 20         |       | GS    |       |       |     |                  | #marginal light pink shales, well min goeth chips         |             |    |              |                            |                                 |
| 30         |       | SG    | C     | F     |     |                  | unusual - partially mineralised, lots of big white cherts |             |    |              |                            |                                 |
| 40         | W     | G     |       | S     |     |                  | #marginal - mineralised central chert?                    |             |    |              |                            | 51mm SLOTTED PVC (72.00-120.00) |
| 50         |       | S     | G     | C     |     |                  | ws2/1?                                                    |             |    |              |                            |                                 |
| 60         |       | JG    |       | S     |     |                  |                                                           |             |    |              |                            |                                 |
| 70         |       | JG    |       | S     |     |                  |                                                           |             |    |              |                            |                                 |
| 80         | D4    | GW    |       |       |     |                  | bigger cherty band, blocky cchips                         |             |    |              |                            |                                 |
| 90         |       | GW    |       |       |     |                  |                                                           |             |    |              |                            |                                 |
| 100        |       | GW    | S     |       |     |                  | pink shales                                               |             |    |              |                            |                                 |
| 110        |       | GW    |       |       |     |                  |                                                           |             |    |              |                            |                                 |
| 120        | D3    | GW    | S     | L     |     |                  | yellow shales                                             |             |    |              |                            |                                 |
| 130        |       | GW    |       | S     |     |                  |                                                           |             |    |              |                            |                                 |
| 140        |       | JG    |       |       |     |                  |                                                           |             |    |              |                            |                                 |
| 150        |       | JGS   | F     |       |     |                  | ds11 pink shales                                          |             |    |              |                            |                                 |
| 160        | D3    | JG    |       |       |     |                  |                                                           |             |    |              |                            |                                 |
| 170        |       | JGS   | F     |       |     |                  | ds9 - ferrug shales                                       |             |    |              |                            |                                 |

**BHP**

Hole Length: 198.00

Logged By

JTS

**Comments:** 641, overdrill in R due to poor comms from driller, ;

Final pH: -

Final EC: -

[illegible]

**BHP**

Hole Length: 159.00

Logged By

0.0 - 159.0

ED1525

RHF

146

ANV

JT5

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

[illegible]

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

Final pH: -

Final EC: -

[illegible]

**BHP**

Hole Length: 159.00

Logged By

JT5

Construct: 13 Dec 16 - 13 Dec 16

**Comments:** 768, closing d1 to the south, ;

Final pH: -

Final EC: --

[illegible]



## BHP

Hole Length: 129.00

Logged By

MC5

---

Final pH: -

**Final EC:** -

[illegible]



## BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN0786R **Hole Length:** 123.00

**Easting:** 715847.85 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7475178.87 0.0 - 123.0 ED1521 RHF 146 ANW MLW  
**Surface RL:** 661.36  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -88-->54

**Construct:** 13 Dec 16 - 13 Dec 16

**Comments:** check gamma, for mcrae sequence, waste characterisation, piezo, paf;

**TOC RL:** 662.30 (Stickup 0.94m) (drilled) **SWL:** 98.17 MBTOC (09 Mar 17) **Dev:** N **Final pH:** -  
**TOC RL:** 662.30 (Stickup 0.94m) (current) **Is Live:** U (-) **Date:** - **Final EC:** -

| Depth<br>m | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description   | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID         |
|------------|-------|-------|-------|-------|-----|------------------|----------------------------------|-------------|----|--------------|----------------------------|------------------------------------|
| 0          |       | GH    | F     |       |     |                  | hardcapped variable grade        |             |    |              |                            | 51mm BLANK PVC<br>(0.00-98.70)     |
| 10         | D4    | GH    |       |       |     |                  | still semi hardcapped            |             |    |              |                            |                                    |
| 20         |       | GH    |       |       |     |                  | still semi hardcapped            |             |    |              |                            |                                    |
| 30         | D3    | GH    | F     |       |     |                  | shale bands will be lower grade  |             |    |              |                            |                                    |
| 40         |       | GH    |       |       |     |                  |                                  |             |    |              |                            |                                    |
| 50         | D2    | GH    |       |       |     |                  |                                  |             |    |              |                            |                                    |
| 60         |       | GH    |       |       |     |                  |                                  |             |    |              |                            |                                    |
| 70         |       | GH    |       |       |     |                  |                                  |             |    |              |                            |                                    |
| 80         | D1    | GH    | F     |       |     |                  | lower grade, shaley material     |             |    |              |                            |                                    |
| 90         |       | G     | L     | C     |     |                  | #marginal, cherts coming through |             |    |              |                            |                                    |
|            |       | CS    | B     |       |     |                  | black shale coming through       |             |    |              |                            |                                    |
|            |       | SB    |       |       |     |                  |                                  |             |    |              |                            |                                    |
|            |       | B     |       |       |     |                  |                                  |             |    |              |                            |                                    |
|            |       | B     |       |       |     |                  |                                  |             |    |              |                            |                                    |
| 100        | RU    | B     |       | C     |     |                  |                                  |             |    |              |                            | 51mm SLOTTED PVC<br>(98.70-104.70) |





## BHPIO - Hydrogeology Log

**BHP****Project:** MINISTERS NORTH**Hole Name:** MN0848DTM**Hole Length:** 90.00**Easting:** 716812.56**Northing:** 7475122.77**Surface RL:** 603.72**Grid Name:** MGA94\_50**Incl / Azm:** -89-->167**Construct:** 20 Dec 16 - 20 Dec 16**Comments:****Depth****Drill Rig****Type****Size****Fluid****Drilled By****Logged By**

0.0 - 90.0

ANWDD54

D

PQ3

ANW

JL5

**TOC RL:** 604.33 (Stickup 0.61m) (drilled)**SWL:** 40.35 MBTOC (16 Mar 18)**Dev:** N**Final pH:** -**TOC RL:** 604.33 (Stickup 0.61m) (current)**Is Live:** U (-)**Date:** -**Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID     |
|--------------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|--------------------------------|
| 0            | W     | GF    |       | SY    |     |                  |                                |             |    |              |                            | 51mm BLANK PVC<br>(0.00-42.00) |
| 10           |       | W     | GH    | S     |     |                  |                                |             |    |              |                            |                                |
|              |       | TS    | LG    |       |     |                  |                                |             |    |              |                            |                                |
|              |       | ST    | LF    | G     |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    |       | L     |     |                  |                                |             |    |              |                            |                                |
| 20           |       | SL    | G     |       |     |                  |                                |             |    |              |                            |                                |
|              |       | WG    |       | L     |     |                  |                                |             |    |              |                            |                                |
|              |       | S     | FK    | L     |     |                  |                                |             |    |              |                            |                                |
|              |       | W     | G     |       |     |                  |                                |             |    |              |                            |                                |
|              |       | SL    | F     |       |     |                  |                                |             |    |              |                            |                                |
| 30           |       | GW    |       |       |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    |       |       |     |                  |                                |             |    |              |                            |                                |
|              |       | S     | FL    |       |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    |       |       |     |                  |                                |             |    |              |                            |                                |
| 40           |       | S     | KF    |       |     |                  |                                |             |    |              |                            |                                |
|              |       | J     | SC    | TF    |     |                  |                                |             |    |              |                            |                                |
|              |       | G     | WL    |       |     |                  |                                |             |    |              |                            |                                |
|              |       | S     | FK    |       |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    |       |       |     |                  |                                |             |    |              |                            |                                |
| 50           |       | S     | FK    | L     |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    |       |       |     |                  |                                |             |    |              |                            |                                |
|              |       | S     | FL    |       |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    |       |       |     |                  |                                |             |    |              |                            |                                |
|              |       | LG    | FS    |       |     |                  |                                |             |    |              |                            |                                |
| 60           |       | WG    |       |       |     |                  |                                |             |    |              |                            |                                |
|              |       | FS    | TG    |       |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    |       |       |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    |       |       |     |                  |                                |             |    |              |                            |                                |
|              |       | FL    | G     |       |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    |       | LF    |     |                  |                                |             |    |              |                            |                                |
|              |       | FL    | SG    |       |     |                  |                                |             |    |              |                            |                                |
| 70           |       | GW    |       |       |     |                  |                                |             |    |              |                            |                                |
|              |       | LG    |       | F     |     |                  |                                |             |    |              |                            |                                |
|              |       | GL    | W     |       |     |                  |                                |             |    |              |                            |                                |
|              |       | GW    | L     |       |     |                  |                                |             |    |              |                            |                                |
|              |       | S     | LF    | G     |     |                  |                                |             |    |              |                            |                                |
| 80           |       | GS    | JLF   | C     |     |                  |                                |             |    |              |                            |                                |
|              |       | SG    | FJ    |       |     |                  |                                |             |    |              |                            |                                |
|              |       | SG    | FJ    |       |     |                  |                                |             |    |              |                            |                                |
|              |       | S     | FLG   |       |     |                  |                                |             |    |              |                            |                                |
|              |       | SG    | J     | CFK   |     |                  |                                |             |    |              |                            |                                |
|              |       | J     |       | SG    |     |                  |                                |             |    |              |                            |                                |
| 90           |       | JS    | CGL   |       |     |                  |                                |             |    |              |                            |                                |
|              |       | JS    | CGL   |       |     |                  |                                |             |    |              |                            |                                |
| 100          |       |       |       |       |     |                  |                                |             |    |              |                            |                                |

#MARGINAL, alternately banded  
pale white-pastle soft powdery  
shale and very hard faintly  
laminated deep blueAA, larger pale shale zones, often  
almost brecciated look

aa

#MARGINAL, aa, more L shales  
interbedded soft pale pastel  
shales and hard, interstitially  
cherty laminationscherty BIF, unlike above, very  
little shalesEOH, softer shales more  
prevalent, white powderEOH, softer shales more  
prevalent, white powder51mm SLOTTED PVC  
(42.00-84.00)LEVELTROLL(47.00) ID:  
2122

END CAP (84.00)

**BHP**

Hole Length: 138.00

Logged By

NJ

| STG | STG | STG | STG | STG | STG | STG |
|-----|-----|-----|-----|-----|-----|-----|
|     |     |     |     |     |     |     |

Comments:

Final pH: -

**Final EC:** --

| Depth<br>mgtl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID         |
|---------------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|------------------------------------|
| 0             | J2    |       |       |       |     |                  | pesolitic red silt             |             |    |              |                            | 51mm BLANK PVC<br>(0.00-90.00)     |
| 10            | J1    |       |       |       |     |                  | bitty                          |             |    |              |                            |                                    |
| 20            |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 30            |       |       |       |       |     |                  | cherty, interbedded shales     |             |    |              |                            |                                    |
| 40            |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 50            |       |       |       |       |     |                  | cherty, interbedded shales     |             |    |              |                            |                                    |
| 60            |       |       |       |       |     |                  | f shale                        |             |    |              |                            |                                    |
| 70            | W     |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 80            |       |       |       |       |     |                  |                                |             |    |              |                            |                                    |
| 90            |       |       |       |       |     |                  | black shale                    |             |    |              |                            |                                    |
|               |       |       |       |       |     |                  | cherty                         |             |    |              |                            |                                    |
|               | D4    |       |       |       |     |                  |                                |             |    |              |                            | 51mm SLOTTED PVC<br>(90.00-138.00) |
| 100           |       |       |       |       |     |                  | jaspilitic clean bif           |             |    |              |                            |                                    |

## BHPIO - Hydrogeology Log

**BHP**

**Project:** MINISTERS NORTH **Hole Name:** MN1018R **Hole Length:** 138.00

**Easting:** 715754.17 **Depth** **Drill Rig** **Type** **Size** **Fluid** **Drilled By** **Logged By**  
**Northing:** 7475458.72 0.0 - 138.0 WLSRC32 RHF 140 WLS NJ  
**Surface RL:** 655.67  
**Grid Name:** MGA94\_50  
**Incl / Azm:** -89-->108  
**Construct:** 20 Jan 19 - 20 Jan 19

**Comments:**

**TOC RL:** - - (drilled) **SWL:** [] [] **Dev:** N **Final pH:** -  
**TOC RL:** - - (current) **Is Live:** Y (-) **Date:** - **Final EC:** -

| Depth<br>mgl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description                         | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID         |
|--------------|-------|-------|-------|-------|-----|------------------|--------------------------------------------------------|-------------|----|--------------|----------------------------|------------------------------------|
| 100          |       |       |       |       |     |                  | jaspilitic clean bif                                   |             |    |              |                            | 51mm SLOTTED PVC<br>(90.00-138.00) |
| 110          |       |       |       |       |     |                  | minor Mn                                               |             |    |              |                            |                                    |
| 120          | D4    |       |       |       |     |                  | shaley min                                             |             |    |              |                            |                                    |
| 130          |       |       |       |       |     |                  | has a slight grey/silver Mn coating                    |             |    |              |                            |                                    |
| 140          | D3    |       |       |       |     |                  | has a slight grey/silver Mn coating<br>cherty bif, eoh |             |    |              |                            |                                    |
| 150          |       |       |       |       |     |                  |                                                        |             |    |              |                            |                                    |
| 160          |       |       |       |       |     |                  |                                                        |             |    |              |                            |                                    |
| 170          |       |       |       |       |     |                  |                                                        |             |    |              |                            |                                    |
| 180          |       |       |       |       |     |                  |                                                        |             |    |              |                            |                                    |
| 190          |       |       |       |       |     |                  |                                                        |             |    |              |                            |                                    |
| 200          |       |       |       |       |     |                  |                                                        |             |    |              |                            |                                    |

0 100 200

0-5000 0-14 0-50

**BHP**

Hole Length: 135.00

Logged By

MS7

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

Final pH: -

Final EC: -

| Depth<br>m | mgbl | Strat | Major | Minor | Trace | Log | Gamma<br>CPS API | Hydrogeological<br>Description | EC<br>us/cm | pH | Yield<br>L/s | Diagram<br>Scaled to 400mm | Notes<br>Casing size as ID      |
|------------|------|-------|-------|-------|-------|-----|------------------|--------------------------------|-------------|----|--------------|----------------------------|---------------------------------|
| 0          |      | J2    |       |       |       |     |                  | some chert                     |             |    |              |                            | 51mm BLANK PVC<br>(0.00-108.00) |
| 10         |      |       |       |       |       |     |                  |                                |             |    |              |                            |                                 |
| 20         |      |       |       |       |       |     |                  |                                |             |    |              |                            |                                 |
| 30         |      | J1    |       |       |       |     |                  | high shale, trace chert        |             |    |              |                            |                                 |
| 40         |      |       |       |       |       |     |                  | trace Mn                       |             |    |              |                            |                                 |
| 50         |      |       |       |       |       |     |                  | f shale                        |             |    |              |                            |                                 |
|            |      |       |       |       |       |     |                  | f shale, lim shale             |             |    |              |                            |                                 |
|            |      |       |       |       |       |     |                  | f shale                        |             |    |              |                            |                                 |
| 60         |      |       |       |       |       |     |                  | slightly leached f shale       |             |    |              |                            |                                 |
| 70         |      | W     |       |       |       |     |                  | min f shale and l shale        |             |    |              |                            |                                 |
| 80         |      |       |       |       |       |     |                  | leached shale                  |             |    |              |                            |                                 |
|            |      |       |       |       |       |     |                  | trace jasp                     |             |    |              |                            |                                 |
| 90         |      | D4    |       |       |       |     |                  | trace jasp                     |             |    |              |                            |                                 |
| 100        |      |       |       |       |       |     |                  |                                |             |    |              |                            |                                 |

## BHP

Hole Length: 135.00

Logged By

MS7

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

**Comments:** no geo

Final pH: -

**Final EC:** -

[illegible]

## BHP

Hole Length: 93.00

Logged By

113

**Comments:** 622. EH hole. Cancelled @ 93m due to black shale in WB with a leaking sump

**Final pH:** -

**Final EC:** -

[illegible]

**BHP**

Hole Length: 75.00

**Comments:**

Logged By

KDS

**Final EC:** --

51mm BLANK PVC  
(0.00-55.00)

## BHP

Hole Length: 135.00

Logged By

KDS

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

**Comments:** no geo set depth21

Final pH: -

**Final EC:** -

[illegible]

## BHP

Hole Length: 135.00

Logged By

KDS

**Comments:** no geo set depth21

Final pH: -

Final EC: -

[illegible]

