

REPORT

Western Ridge – Crusher Study Area Baseline Assessment

PFAS and TRH Groundwater Baseline Assessment

Submitted to:

BHP Billiton Iron Ore Pty Ltd

125 St Georges Terrace
PERTH WA 6000

Submitted by:

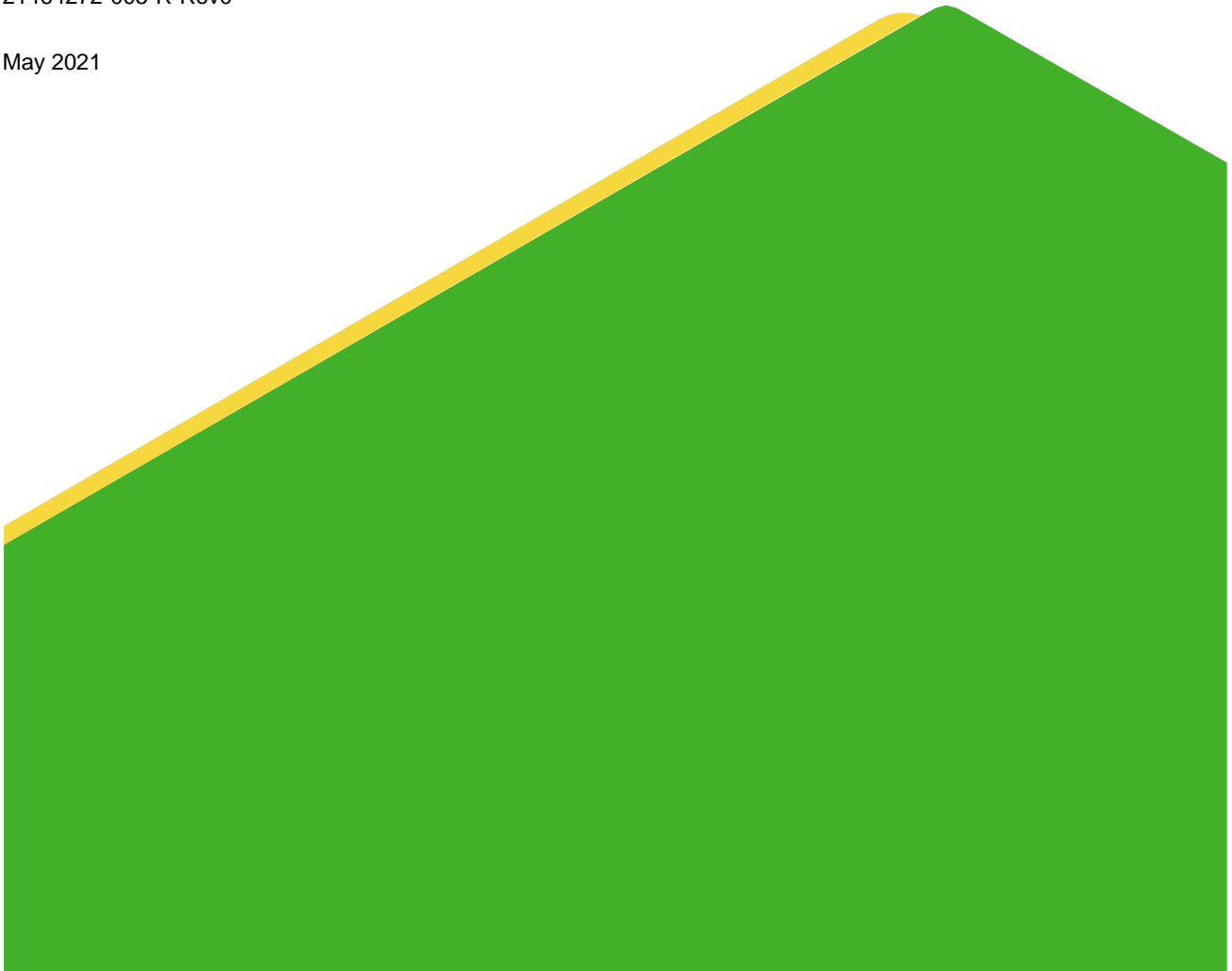
Golder Associates Pty Ltd

Level 3, 1 Havelock Street, West Perth, Western Australia 6005, Australia

+61 8 9213 7600

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1.0 INTRODUCTION

BHP Billiton Iron Ore Pty Ltd (BHP) engaged Golder Associates Pty Ltd (Golder) to conduct a groundwater baseline assessment of per- and poly-fluoroalkyl substances (PFAS) and total recoverable hydrocarbons (TRH) at the Western Ridge exploration area (the site). For this baseline assessment purposes, Western Ridge site is divided into three zones: the Western Ridge Crusher Study (WRCS), the Eastern Syncline, and Afghan Springs. This report presents the baseline findings for the WRCS area (the study area) conducted in April 2021. The baseline assessment for the Eastern Syncline and the Afghan Springs areas are provided under separate covers.

The location plan is presented in Figure 1 and a site plan is presented in Figure 2.

2.0 BACKGROUND

BHP intends to develop the Western Ridge for active mining. The site is located west of the Mount Whaleback mine site where PFAS and TRH contamination have been identified within the groundwater. Therefore, BHP requires a baseline assessment of PFAS and TRH concentrations in the groundwater at the Western Ridge prior to development for mining.

3.0 OBJECTIVES

The objective of the baseline assessment was as follows:

- To evaluate the concentrations of PFAS and TRH in the groundwater at the site to establish a baseline, using the existing bores at the site.

This baseline assessment is not to meet environmental assessment requirements as set out in the Department of Water and Environmental Regulation (DWER) Contaminated Sites Guidelines and the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013 (ASC NEPM). However, the methodologies applied for this assessment are generally consistent with the above guidelines.

This report presents the findings of the baseline assessment for the WRCS area only.

4.0 SCOPE OF WORKS

The scope of works conducted at the study area included the following:

- Obtain groundwater samples using Hydrasleeve® from nine existing groundwater monitoring wells:
 - HWSR0014M
 - HWSR0019M
 - HWSR0020M
 - HWSR0021M
 - HXAN0002M
 - WSR0296M
 - WSR0299M
 - WSR0597M
 - WSR1193RM
- Submit groundwater samples to NATA-accredited environmental testing laboratories for PFAS (to meet the 99% species protection criteria) and TRH analyses.
- Preparation of a factual report (this report) to present baseline PFAS and TRH contamination at the WRCS area.

5.0 SITE OVERVIEW

The site overview information below has been obtained through a desktop review, including from the BHP 'Western Ridge and OB29/30/35 Detailed Hydrogeological Assessment' (BHP, 2020). Additional information obtained during the site visit has also been included. This section covers the bigger Western Ridge exploration area and not specifically focus on the WRCS area.

5.1 Site Identification

The Western Ridge exploration area is located approximately 2 km southwest of the Mount Whaleback mine site, both of which are owned and operated by BHP. These mine sites are located approximately 5 to 7 km west of the Newman Township and approximately 1200 km north-east of Perth, in the Pilbara region of Western Australia. The WRCS area is located in the western portion of the Western Ridge exploration area, as presented in Figure 1 and displayed in more detail on Figure 2.

The site identification details are summarised in Table 1 below.

Table 1: Site Identification

Item	Description	
Site Location	Approximately 5 to 7 km west of Newman	
Allotment/DP	Lot 101 on Deposited Plan 220388 and Crown Land	
Local Government Authority	Shire of East Pilbara	
Zoning	Rural	
Previous Land Use	Rural	
Proposed Land Use	Mining tenement	
WRCS Boundary Coordinates	<i>Easting (m)</i>	<i>Northing (m)</i>
	766300.5441	7412151.856
	766191.8121	7410776.535
	765957.9788	7409508.813
	766053.3028	7407932.114
	764937.4409	7407955.016
	764891.7837	7407349.476
	761014.8316	7407422.014
	761064.1658	7409851.799
	762412.2678	7410822.888

5.2 Site Description

The topography of the Western Ridge is undulating with raised elevation to the north (Bill's Hill and Mount Helen) running east to west and raised elevation to the south (Silver Knight) as displayed in Figure 1.

The WRCS area is predominantly covered by native vegetation with unsealed roads and drill pads from past and current exploration activities throughout the area. Some observed access tracks and areas of drill related clearing have been rehabilitated.

It is important to note that the Western Ridge site is located within a Priority 1 drinking water catchment area (DoW, 2014), which has the fundamental water quality objective of risk avoidance to protect the drinking water source.

5.3 Climate

The Newman Airport weather station (007176) is the nearest weather station to the site and is located approximately 12 km away from the site. The data indicated the mean maximum temperature range is from 22.9°C (July) to 39.1°C (December) and the mean minimum temperature range is from 6.4°C (July) to 25.0°C (January). The mean annual rainfall is 332.6 mm, with the highest mean rainfall during February (71.0 mm) and the lowest during September (3.9 mm). January and February were recorded as the wettest months, with higher mean rainfall data than the remaining months.

The Pilbara climate and subsequent rainfall is typically dominated by the influence of subtropical highs located to the south of the Pilbara. During summer (November to April) the high-pressure cell moves further south, resulting in the Pilbara receiving approximately 70% of its annual precipitation during these summer months. Annual precipitation figures for these zones are much less than the annual potential evaporation (BHP, 2020).

The Pilbara is characterised by high local evaporation rates and a generally low soil infiltration capacity. This results in recharge occurring exclusively during major rainfall events (15-25 mm/d). The closest station that records evaporation is the Wittenoom BoM station, located approximately 190 km north-west of Newman. Annual average evaporation for Wittenoom is 3,142 mm/year, which exceeds annual rainfall by as much as 2,800 mm/year.

5.4 Hydrogeological Setting

5.4.1 Geology

The geological conditions in the region can be summarised as:

- The Silver Knight and Eastern Syncline are mainly hosted by the upper Marra Mamba members, but mineralisation of the overlying Wittenoom and underlying Jeerinah formations can also be seen in the orebodies.
- Bill's Hill and Mount Helen orebodies are hosted in the mineralised Brockman Iron Formation. The orebody aquifer is usually well delineated by the extent of the high-grade ore (assumed high permeability), with a halo of lower grade ore (assumed moderate permeability) around it.

5.4.2 Topography and Surface Water Drainage

The site is located within the Whaleback Creek catchment. The main drainage features are the Whaleback Creek, and its southern tributary which drains the Western Ridge area (referred to as Southern Creek). The Whaleback Creek drains into the Fortescue River, upstream of Ethel Gorge. The Gorge is located downstream (north) of Ophthalmia Dam at the confluence of Homestead, Shovelanna, and Warrawandu Creeks, which merge within the Fortescue River and flow through the Ophthalmia Range in a northerly direction (BHP, 2020).

5.4.3 Aquifer

There are two main aquifer types (BHP, 2020):

- 1) The regional aquifers; which generally comprise weathered dolomite of the Paraburdoo Member of the Wittenoom Formation, which occurs in sub-crop along the Whaleback and Southern Creek valleys.
- 2) The orebody aquifers; which comprise the mineralised Brockman Iron Formation that make up the Bill's Hill and Mount Helen orebodies and the mineralised Marra Mamba that make up Silver Knight and Eastern Syncline orebodies.

5.5 Groundwater Abstraction

Groundwater abstraction at the Western Ridge is currently regulated through the RiWI Act 5C License to Take Water GWL170659(3) which allows the annual abstraction of 45,000 kL/a to be used for exploration drilling operations as well as dust suppression for earthworks and construction purposes only (BHP, 2020).

In order to achieve progressive dewatering to allow mining below the water table, BHP is seeking to amend the 5C licence in the near future.

6.0 PREVIOUS LAND USE

Golder is of the understanding that the area has no known previous land use except for exploration activities and hydrogeological drilling purposes. This is supported by the available historical aerial photographs of the site (see Figures 3A – 3D), which did not indicate any major historical activities or infrastructures at the site.

Based on *pers comm. Andrew Cottrell (BHP hydrogeologist), April 2021*, the Afghan Springs pools were historically used for stock water purposes. There were previously some infrastructures in the area for keeping cattle, i.e., water tanks. Andrew also indicated that there has been a creek diversion, approximately 12 to 24 months ago, which can also be seen on the historical aerial photographs. He indicated that there is no known potentially contaminating activities or events reported at the Western Ridge site.

Golder considers that exploration and hydrogeological assessment activities have the potential to introduce contamination. However, the impacts are likely to be minimal and with groundwater levels considerably deep, contamination impacts to groundwater from site activities on and above ground are considered to be unlikely. It is important to note that the use of additives during drilling (i.e., drilling muds and/or glue for the PVC casing installation of the bores) may result in cross-contamination to the groundwater samples collected and give false positives with regards to PFAS and TRH in groundwater.

7.0 ANALYTICAL SCHEDULE

Groundwater samples collected were analysed for PFAS, which comprised the 28 PFAS suite with appropriate limit of reporting (LOR) for comparison against the 99% species protection level. In addition, groundwater samples were also analysed for TRH and benzene, toluene, ethylbenzene, xylenes, and naphthalene (BTEXN) analyses.

8.0 ASSESSMENT CRITERIA

A summary of the relevant groundwater assessment criteria is provided in Table 2.

Table 2: Groundwater Assessment Criteria

Potential Receptor	TRH, BTEXN	PFAS/PFOA
Human Health	ASC NEPM HSL-D* DER (2014) Drinking Water Health Value**	PFAS National Environmental Management Plan (NEMP) 2.0 (2020) Human Health guideline values: - Drinking water quality guideline value**, and - Recreational water quality guideline value*
Ecological	ANZG (2018) Fresh Water 95%*	PFAS NEMP 2.0 (2020) Ecological water quality guideline values: - Freshwater 99% species protection – high conservation value system*, and - Freshwater 95% species protection – slightly to moderately disturbed system*

Note: * Assessment criteria was selected based on the current and the intent future land use for the site. 99% species protection level for PFAS has also been adopted to account for potential bioaccumulation.

** Assessment criteria was selected as the site is located within a Priority 1 drinking water catchment area.

9.0 GROUNDWATER SAMPLING METHODOLOGY

The groundwater sampling was undertaken between 13 and 16 April 2021 by two Golder field personnel.

Groundwater samples were collected from nine existing groundwater wells within the WRCS area. Groundwater wells WSR1270RM, WSR1241RM, WSR1153RM, WSR0663RM, WSR1248RM, WSR1150RM were dry and WSR1139RM could not be located and therefore these wells could not be sampled. The nine wells which were sampled, HWSR0014M, HWSR0019M, HWSR0020M, HWSR0021M, WSR0296M, WSR0299M, WSR0597M, WSR1193RM, and HXAN0002M were selected to assess the area laterally. While this baseline assessment is limited by the availability of existing bores, Golder considers that the locations of the bores selected are sufficient to provide a 'snapshot' of PFAS and TRH concentrations in groundwater at the site, which is the intention of this baseline assessment. Groundwater well construction logs are provided in Appendix A.

The groundwater monitoring wells were sampled using HDPE Hydrasleeves® (Super/SkinnySleeve). Prior to sampling, an electronic water level meter (BHP supplied 1550T2 BHP 200 m) was used to determine assess the standing water level (SWL). The SWL measurements are displayed in Appendix B.

In general, the HDPE Hydrasleeves® were set to target the well screen, at approximately 3 to 5 m below the groundwater level. For monitoring wells with well screen deeper than the groundwater level, the HDPE Hydrasleeves® were set at approximately 1 m below the top of the screen level. The HDPE Hydrasleeves® were then left for at least a 24-hour period except at HXAN0002M which was left for at least 23 hours to allow the groundwater, within the well column, to stabilise. The HDPE Hydrasleeves® were then retrieved and the groundwater transferred directly into laboratory supplied bottles using Hydrasleeves® straws.

Groundwater field parameters (pH, reduction-oxygen potential (redox), conductivity, temperature, and dissolved oxygen (DO)) were measured using a calibrated YSI water quality meter (19L1002399) by placing the probes into a small aliquot of retrieved groundwater which was poured from the Hydrasleeves® into a container for measurement. Field groundwater monitoring sheets are provided in Appendix B. The YSI calibration certificate and daily bump checks are provided in Appendix C.

New nitrile gloves were worn while preparing the HDPE Hydrasleeves® for deployment and during retrieval. Samples were placed in laboratory supplied eskies and cooled with bags of ice (ice bricks were not used). Between each location, the water level meter was decontaminated with a Liquinox/water solution and deionised water, to reduce the potential of cross contamination.

Groundwater samples were dispatched under chain-of custody (CoC) procedures to ALS (primary laboratory) and Eurofins (secondary laboratory) which are both NATA-accredited laboratories. The CoCs and laboratory certificates are included in Appendix D.

9.1 Sampling Quality Assurance and Quality Control (QA/QC)

The following quality assurance control measures were undertaken during the sampling program:

- Field duplicate or triplicate samples were collected at a minimum rate of 20% (10% duplicates and 10% triplicates).
- Primary and duplicate samples were submitted to NATA-accredited laboratory ALS Environmental. Triplicate samples collected were submitted to an alternate NATA-accredited laboratory Eurofins.
- Water samples were collected whilst wearing a new pair of disposable nitrile gloves for each sample.
- Samples collected were placed in laboratory-supplied bottles appropriate for the relevant analyte.
- No rinsate samples were collected as no non-dedicated sampling equipment was used.

- Trip blanks were submitted for analysis at a rate of one per esky.
- Samples collected in the field were placed in an esky with ice in bags (no ice bricks were used) and delivered to the NATA accredited laboratories for analysis.

9.2 PFAS Sampling Considerations

Due to the widespread use of PFAS compounds in everyday items, the following considerations were implemented by field staff prior and during the collection of samples as per guidance provided by Department of Water and Environmental Regulation (DWER) *Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances* (2017):

- 1) No new clothing, or clothing with rain or waterproof coatings/treated fabric.
- 2) No food or snack containers wrapped with non-compliant materials.
- 3) No Teflon® containing or coated field equipment.
- 4) No Teflon® lined lids on the laboratory supplied sample bottle.
- 5) No Decon or detergent decontamination solutions. Liquinox® was used for decontaminating equipment.
- 6) No ice bricks for sample storage.
- 7) No PFAS containing sun cream.

10.0 RESULTS

10.1 Groundwater Levels and Field Parameters

Groundwater monitoring wells were gauged using an electronic water level meter prior to sampling and groundwater parameters obtained from a sample aliquot using a YSI water quality meter. The depth to groundwater and bore installation details are summarised in Table 3 and the groundwater field parameters recorded of the sampled wells are presented in Table 4.

Table 3: Summary of Groundwater Levels (April 2021) and Borehole Details

Well ID	Depth to Groundwater (m btoc)	Top of PVC Pipe Survey Level (m AHD)	Groundwater Level (m AHD)	Top of Screened Interval (m AHD)	Base of Screened Interval (m AHD)	Drilled/ Installation Date
HWSR0014M	151.77	667.43	515.66	492.50	480.50	October 2020
HWSR0019M	49.35	632.36	583.01	571.52	478.52	October 2020
HWSR0020M	27.93	630.71	602.78	617.93	527.93	October 2020
WSR0296M	117.40	625.26	507.86	523.72	427.72	November 2015
WSR0299M	112.11	621.51	509.40	521.13	437.13	November 2015
WSR0597M	135.37	651.68	516.31	518.70	470.70	May 2016
WSR0663RM	Dry	608.54	-	523.86	517.86	May 2016
WSR1139RM	n/a	634.52	-	572.77	530.77	November 2016
WSR1150RM	Dry	649.23	-	545.78	527.78	November 2016
WSR1153RM	Dry	641.27	-	528.91	504.91	November 2016
WSR1193RM	67.55	636.44	568.89	572.69	548.69	November 2016
WSR1270RM	Dry	606.69	-	521.89	503.89	November 2016
WSR1241RM	Dry	618.37	-	533.35	515.35	December 2016
WSR1248RM	Dry	615.05	-	542.16	524.16	November 2016

Well ID	Depth to Groundwater (m btoc)	Top of PVC Pipe Survey Level (m AHD)	Groundwater Level (m AHD)	Top of Screened Interval (m AHD)	Base of Screened Interval (m AHD)	Drilled/ Installation Date
HWSR0021M	107.91	615.99	508.08	472.63	388.63	March/ April 2021
HXAN0002M	76.70	624.56	547.86	563.63	473.63	February 2021

Notes: n/a = not accessible/could not locate
m btoc = metre below top of casing
m bgl = metre below ground level

It is noted that the water level is above the screen interval for some wells (i.e., HWSR0014M and HWSR0019M). While having the well screen lower than the groundwater level is not ideal, given there is no known previous land use with the exception for exploration and hydrogeological assessment activities, light non-aqueous phase liquid (LNAPL) impacts in groundwater are not expected. Additionally, groundwater level is considerably deep (down to 151 m btoc at HWSR0014M) and subsequently contamination impacts in groundwater from the minimalistic nature of the site activities are unlikely. Therefore, these selected wells are considered to be suitable for the baseline assessment purposes; however, for future environmental and contaminated sites assessment works, Golder recommends the installation of groundwater monitoring wells that meet the requirements as set out in the DWER and NEPM guidelines.

Table 4: Summary of Groundwater Field Parameters – April 2021

Well ID	pH	Temperature (°C)	Redox (mV)	DO (%)	Specific Conductivity (µS/cm at 25°C)	Notes
HWSR0014M	7.15	24.9	164.3	3.76	545	Sample was clear, no odour/sheen, low turbidity.
HWSR0019M	7.47	29.2	-70.0	1.20	3022	Sample was clear, no odour/sheen, low turbidity
HWSR0020M	8.11	27.6	-332.6	0.28	1540	Sample was clear, no sheen, low turbidity
WSR0296M	7.56	29.5	-16.7	2.22	983	Sample was clear, rotten egg odour, no sheen, low turbidity
WSR0299M	7.50	31.2	-1.6	1.85	513	Sample was clear, no odour/sheen, low turbidity
WSR0597M	7.18	25.8	105.9	3.83	1194	Sample was cloudy grey, no odour/sheen, medium turbidity
WSR1193RM	7.42	28.1	-155.1	1.22	1422	Sample was cloudy brown, no odour/sheen, medium turbidity
HWSR0021M	7.27	30.5	17.6	3.24	961	Sample was cloudy brown, no odour, high turbidity
HXAN0002M	7.79	26.7	-205.0	0.66	892	Sample was clear, rotten egg odour, no sheen, low turbidity

10.2 Analytical Results

The following section summaries the laboratory analytical results. The results are presented in Tables A and B at the end of this report and the laboratory reports are displayed in Appendix D.

10.2.1 PFAS

PFAS was detected above laboratory LOR in one groundwater well, HXAN0002M. At the other locations sampled, PFAS was not detected above the LOR.

Concentrations above laboratory LORs are summarised in Table 5 below. No exceedance of adopted assessment criteria (where available) was reported.

Table 5: PFAS Concentration above LOR

Analytes	Concentrations (µg/L)
HXAN0002M	
6:2 Fluorotelomer sulfonic acid (6:2 FTSA)	0.002
Sum of PFAS	0.002

10.2.2 TRH

TRH was detected above laboratory LOR within samples obtained from four locations HWSR0014M, HWSR0019M, HWSR0020M, and HXAN0002M. Toluene was also reported at two locations (HWSR0020M at and HXAN0002M). TRH C₆-C₁₀ F1 was reported at HWSR0014M and HWSR0019M, but from the presence of compounds other than BTEX. Reported concentrations did not exceed relevant screening criteria and are summarised in Table 6.

Table 6: TRH Concentrations above LOR (mg/L)

Well ID	TRH C ₆ -C ₁₀ F1	TRH >C ₁₀ -C ₁₆ F2	TRH >C ₁₆ -C ₃₄ F3	TRH >C ₃₄ -C ₄₀ F4	Toluene
HWSR0014M	0.17	<0.1	<0.1	<0.1	<0.002
HWSR0019M	0.15	<0.1	0.13	<0.1	<0.002
HWSR0020M	0.54	<0.1	0.11	<0.1	0.007
HXAN0002M	0.4	<0.1	<0.1	<0.1	0.007

10.2.3 Summary

While there is no known previous land use (except for exploration activities and hydrogeological drilling purposes), the results from this groundwater baseline assessment indicated that there are detections of PFAS, TRH, and toluene in groundwater at the site. It is noted that PFAS and TRH contamination have been reported within the groundwater at the Mount Whaleback mine site, located 2 km east of the site; however, Golder does not consider for these reported concentrations at the Western Ridge site to be related to those contaminations at the Mount Whaleback mine site.

It is considered likely that the reported PFAS, TRH, and toluene concentrations are related to the drilling additives that were used during drilling and installation of the groundwater wells (i.e., drilling muds and/or glue for the PVC casing installation). This consideration is supported by the following:

- Sarah Stegena (BHP) indicated that the groundwater wells recently installed have not been developed. Given the low yield of the groundwater wells, it is likely that the additives used during drilling and installation are still present within the groundwater. These wells were drilled using reverse circulation (RC) drilling methodology and PVC casing were glued and screwed and were hung from the top of the bore to the correct depth in the drill hole with no annulus backfill.
- The reported contamination appeared only at the recently installed groundwater wells except for HWSR0021M, as also shown in the results from the Afghan Springs area within the Western Ridge site (Golder, 2021). Groundwater wells that were installed over a year ago were not reported with any detectable concentrations of PFAS, TRH and toluene above laboratory LOR. HWSR0021M was recently installed in March/April 2021 and is understood to have been drilled as a production bore. Visual observation of this borehole on site indicates it to be potentially a different construction to the monitoring wells and may explain why TRH and PFAS were not detected at this location despite it being a newer well.

- The chromatographs did not show the typical unresolved complex mixture (UCM) associated with refined petroleum hydrocarbon (diesel, petrol) impacts, which are the typical hydrocarbon contamination identified at a mine site, including at Mount Whaleback. Chromatographs are included as Appendix E.
- Given the depth to groundwater at the site is relatively deep (>25 m bgl), it is unlikely for volatile compounds (i.e., toluene and TRH C₆-C₁₀) to leach to the groundwater from contamination events at surface.

Nevertheless, no exceedance of adopted assessment criteria was reported for any contaminants analysed as part of this groundwater baseline assessment.

11.0 QUALITY ASSURANCE/QUALITY CONTROL

The quality assurance/quality control (QA/QC) procedures adopted during this project are based on the ASC NEPM, DER 2014 guidelines (DER 2014), AS 4482.1 – 2005 (Standards Australia 2005), AS 4482.2 – 1999 (Standards Australia 1999), and PFAS NEMP (HEPA, 2020).

QA involves all the actions, procedures, checks, and decisions undertaken to ensure the representativeness and integrity of samples and accuracy and reliability of analytical results (ASC NEPM). QC involves protocols to monitor and measure the effectiveness of QA procedures.

The precision of the results for each analyte between the primary sample and the field duplicate/triplicate is determined by calculating the RPD. A quantitative measure of the accuracy of the analytical results reported is made by calculating the RPDs in accordance with the procedure described in AS 4482.1 – 2005 using the below calculation.

$$\%RPD = \frac{|A - B|}{\frac{A + B}{2}} \times 200$$

For the purposes of this assessment and in accordance with guidance in the NEPM 2013, an RPD less than or equal to 30% represents good correlation between laboratory results. Where the RPD is greater than 30% and the analytical results are less than five times the LOR, the precision and accuracy are also considered acceptable because the accuracy of laboratory analyses decreases as concentrations approach the LOR.

11.1 Fieldwork Program

RPD results are presented in Table C and trip blank results are presented in Table D at the end of this report. Field QA/QC procedures and compliance during the assessment are summarised in Table 7.

Table 7: Summary of Field QA/QC Compliance

QA/QC Element	Requirement	Requirement Adhered to?	Information/Data Acceptable?
Equipment calibration	Where relevant, all field equipment is to be calibrated by the equipment supplier and certification provided	Yes (Appendix C)	Yes
Sampling methods	All sampling methods outlined in the methodology must be adhered to.	Yes	Yes
Record keeping	Detailed records of field activities were maintained with the use of daily record sheets, and quality control sample registers.	Yes	Yes
Chain of custody documentation	The CoC documentation was completed for each batch of samples, identifying the names of the samplers, the type of sample, the collection date and the analyses performed.	Yes	Yes
Sample labelling	Samples were properly labelled, showing reference number, sample ID, date of collection and sampler.	Yes	Yes

QA/QC Element	Requirement	Requirement Adhered to?	Information/Data Acceptable?
Sample containers	Samples were collected in appropriate laboratory-supplied containers with suitable preservation methods (where required).	Yes	Yes
Sample storage and transport	Samples were stored in a chilled, insulated container immediately after sampling and delivered to the laboratory with CoC documentation.	Yes	Yes (See Note 1)
Analysis of trip blanks	No contamination of trip blanks reported.	Yes	Yes
Decontamination	Reusable field equipment (i.e., water level meter) were appropriately decontaminated using potable water and Liquinox® solution between each sampling location.	Yes	Yes
Duplicate samples	Duplicate and triplicate samples were collected for analysis by the primary and secondary laboratories, respectively (at a frequency of at least one pair per 10 samples).	Yes	Yes
	Relative percent difference (RPD) assessment to adhere to the following protocols: <ul style="list-style-type: none"> ■ 1-5 × laboratory LOR: no limit; ■ >5 × laboratory LOR: 0-30%. 	Yes	Yes (See Note 2)

Notes: 1. Samples were all sent in an insulated container (esky) on ice. However, the ideal temperature could not be maintained throughout transport and elevated temperature inside the esky was noted upon receipt by the laboratory. The temperature of samples on arrival at the laboratory was reported at 21.9°C. This elevated temperature was associated with the remote nature of the site and the heat experienced by the site conditions in the Pilbara, which may affect the results.

2. Three RPDs were reported above 30% for results >5 × laboratory LOR. These RPD breaches are for TRH C₆-C₉ and TRH C₆-C₁₀ F1 and TRH C₆-C₁₀ less BTEX F1 between primary and triplicate samples collected at HWSR0019M. Higher triplicate results have been adopted in Table B to be conservative. All primary and triplicate results for these analytes are below the assessment criteria and therefore these RPD breaches are not considered to affect the outcome of the investigation.

11.2 Laboratory Quality Data Assessment

All samples were submitted to NATA-accredited laboratories in Perth for laboratory analysis. Laboratory QA/QC analysis were reviewed to assess data integrity and confirm reliability of the analytical data. Laboratory QA/QC analysis results were compared to laboratory acceptance criteria.

11.2.1 Holding Time

No analysis holding time outliers were reported.

11.2.2 Laboratory Control Spike

No laboratory control outliers were reported.

11.2.3 Surrogates

No surrogate recovery outliers were reported.

11.2.4 Matrix Spikes

No matrix spike outliers were reported.

11.2.5 Duplicates

No duplicate outliers were reported.

11.2.6 Method Blanks

No method blank value outliers were reported.

11.2.7 Laboratory QC Sample Frequency

Laboratory QC samples frequency outliers were reported for laboratory duplicates for PFAS analysis. Only one laboratory duplicate sample was analysed out of 14 primary samples (7.14%), which did not meet the 10% target. Note that samples not collected by Golder were included in the frequency rate calculation. The one laboratory duplicate analysed was collected by Golder and the 10% target criteria would have been met if no other non-Golder samples included in the frequency rate calculation. Matrix spike frequency outliers for PFAS and TRH – semi volatile fraction were reported as no samples were analysed (0.00%) of an expected 5% target.

As stated in Section 11.2.5, no duplicate outliers were reported in this duplicate sample; therefore, these laboratory QC sample frequency outliers are not considered to have significant impact on the overall data quality or outcome of the investigation.

11.3 Summary

A review of the field and laboratory QA/QC data and procedures confirms an acceptable level of compliance with the general requirements and DQOs. As such, there is an acceptable level of confidence in the data upon which the conclusions in this report have been made.

12.0 CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

The following conclusions are drawn from the data obtained during the baseline assessment:

- The results from this groundwater baseline assessment indicated that there are detections of PFAS, TRH, and toluene in groundwater at the site. It is considered likely that the reported PFAS, TRH, and toluene concentrations are related to the drilling additives that were used during drilling and installation of the groundwater wells (i.e., drilling muds and/or glue for the PVC casing installation).
- The reported contamination appeared only at the recently installed groundwater wells. Groundwater wells that were installed over a year ago were not reported with any detectable concentrations of PFAS, TRH, and toluene above laboratory LOR.
- No exceedance of adopted assessment criteria was reported for any contaminants analysed as part of this groundwater baseline assessment.

12.2 Recommendations

It is considered that the site is suitable to be developed for active mining from contaminated sites perspective.

It is recommended to develop and resample groundwater wells with PFAS, TRH, and toluene detections to confirm the presence of these contaminants prior to development.

13.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled – “Important Information Relating to this Report”, which is included in Appendix F of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder has under the contract between it and its client.

14.0 CLOSING

Should you have any queries concerning this report, please do not hesitate to contact the under-signed.

15.0 REFERENCES

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Signature Page

Golder Associates Pty Ltd



Christian Budimuljono
Senior Environmental Engineer



Ivan Kwan
Principal Environmental Engineer

CB/IYK/hn

A.B.N. 64 006 107 857

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Table A: Western Ridge – WRCS
Groundwater PFAS Analytical Results

		Per- and polyfluoroalkyl substances (PFAS)																																	
		Perfluorodecane sulfonic acid (PFDS)	N-Methyl PFO sulfonamidoethanol (MeFOSE)	N-methyl-PFO sulfonamidoacetic acid (MeFOSAA)	Perfluorooctanoic Acid (PFOA)	Perfluorooctane sulfonic acid (PFOS)	Perfluorohexane sulfonic acid (PFHxS)	Sum of PFHxS and PFOS (lab reported)	Sum of WA DER PFAS (n=10)	Sum of PFASs (n=28 - Lab Reported)	Perfluorobutanoic acid (PFBA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorodecanoic acid (PFDA)	Perfluoropentanoic acid (PFPeA)	Perfluorononanoic acid (PFNA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorotridecanoic acid (PFTTDA)	Perfluorododecanoic acid (PFDoDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorobutane sulfonic acid (PFBS)	4:2 Fluorotelomer sulfonic acid (4:2 FTSA)	6:2 Fluorotelomer sulfonic acid (6:2 FTSA)	8:2 Fluorotelomer sulfonic acid (8:2 FTSA)	10:2 Fluorotelomer sulfonic acid (10:2 FTSA)	N-Ethyl PFO sulfonamide (EFOSA)	N-Ethyl PFO sulfonamidoethanol (EiFOSE)	N-Methyl PFO sulfonamide (MeFOSA)	Perfluorooctane sulfonamide (FOSA)	N-ethyl-PFO sulfonamidoacetic acid (EFOSAA)			
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
LOR		0.0005	0.001	0.0005	0.0005	0.0002	0.0005	0.0002	0.0002	0.0002	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0005	0.0005		
PFAS NEMP 2.0 2020 95% Eco Fresh Water					220	0.13																													
PFAS NEMP 2.0 2020 99% Eco Fresh Water					19	0.00023																													
PFAS NEMP 2.0 2020 Drinking Water					0.56	0.07	0.07	0.07																											
PFAS NEMP 2.0 2020 Recreational Water					10	2	2	2																											

Site ID	Location	Sampled Date	Lab Report	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005		
WRCS	HWSR0014M	16/04/2021	EP2104244	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	
WRCS	HWSR0019M	15/04/2021	EP2104244	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
WRCS	HWSR0020M	15/04/2021	EP2104244	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
WRCS	HWSR0021M	15/04/2021	EP2104244	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
WRCS	HXAN0002M	16/04/2021	EP2104244	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	0.002	0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
WRCS	WSR0296RM	15/04/2021	EP2104244	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
WRCS	WSR0299RM	15/04/2021	EP2104244	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
WRCS	WSR0597RM	16/04/2021	EP2104244	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
WRCS	WSR1193RM	15/04/2021	EP2104244	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

**Table B: Western Ridge – WRCS
Groundwater Organic Analytical Results**

	MAH						PAH	Total Recoverable Hydrocarbons												
	Benzene	Toluene	Ethylbenzene	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total BTEX	Naphthalene	TRH C ₈ -C ₈ Fraction	TRH C ₁₀ -C ₁₄ Fraction	TRH C ₁₆ -C ₂₈ Fraction	TRH C ₂₉ -C ₃₈ Fraction	TRH+C ₁₀ -C ₃₈ (Sum of total) (Lab Reported)	TRH+C ₁₀ -C ₄₀ (Sum of total) (Lab Reported)	TRH C ₆ -C ₁₀ Fraction F1	TRH C ₆ -C ₁₀ Fraction Less BTEX F1	TRH >C ₁₀ -C ₁₆ Fraction F2	TRH >C ₁₀ -C ₁₆ Fraction Less Naphthalene F2	TRH >C ₁₆ -C ₃₄ Fraction F3	TRH >C ₃₄ -C ₄₀ Fraction F4
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
LOR	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.005	0.02	0.05	0.1	0.05	0.05	0.1	0.02	0.02	0.1	0.1	0.1	0.1
DER (2014) Drinking Water Health Value	0.001	0.8	0.3			0.6														
ANZG (2018) Freshwater 95%	0.95				0.35			0.016												
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand																				
2-4m	5	NL	NL			NL		NL							6		NL			
4-8m	5	NL	NL			NL		NL							6		NL			
>8m	5	NL	NL			NL		NL							7		NL			

Site ID	Location	Sampled Date	Lab Report																				
Western Ridge Crusher Study - 21464272	HWSR0014M	16/04/2021	EP2104244	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	0.18	<0.05	<0.1	<0.05	<0.05	<0.1	0.17	0.17	<0.1	<0.1	<0.1	<0.1
Western Ridge Crusher Study - 21464272	HWSR0019M	15/04/2021	EP2104244	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	0.31*	<0.05	0.12	<0.05	0.12	0.13	0.33*	0.33*	<0.1	<0.1	0.13	<0.1
Western Ridge Crusher Study - 21464272	HWSR0020M	15/04/2021	EP2104244	<0.001	0.007	<0.002	<0.002	<0.002	<0.002	0.007	<0.005	0.6	0.11	0.12	<0.05	0.23	0.11	0.54	0.53	<0.1	<0.1	0.11	<0.1
Western Ridge Crusher Study - 21464272	HWSR0021M	15/04/2021	EP2104244	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	<0.02	<0.05	<0.1	<0.05	<0.05	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
Western Ridge Crusher Study - 21464272	HXAN0002M	16/04/2021	EP2104244	<0.001	0.007	<0.002	<0.002	<0.002	<0.002	0.007	<0.005	0.44	0.09	<0.1	<0.05	0.09	<0.1	0.4	0.39	<0.1	<0.1	<0.1	<0.1
Western Ridge Crusher Study - 21464272	WSR0296RM	15/04/2021	EP2104244	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	<0.02	<0.05	<0.1	<0.05	<0.05	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
Western Ridge Crusher Study - 21464272	WSR0299RM	15/04/2021	EP2104244	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	<0.02	<0.05	<0.1	<0.05	<0.05	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
Western Ridge Crusher Study - 21464272	WSR0597RM	16/04/2021	EP2104244	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	<0.02	<0.05	<0.1	<0.05	<0.05	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
Western Ridge Crusher Study - 21464272	WSR1193RM	15/04/2021	EP2104244	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	<0.02	<0.05	<0.1	<0.05	<0.05	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1

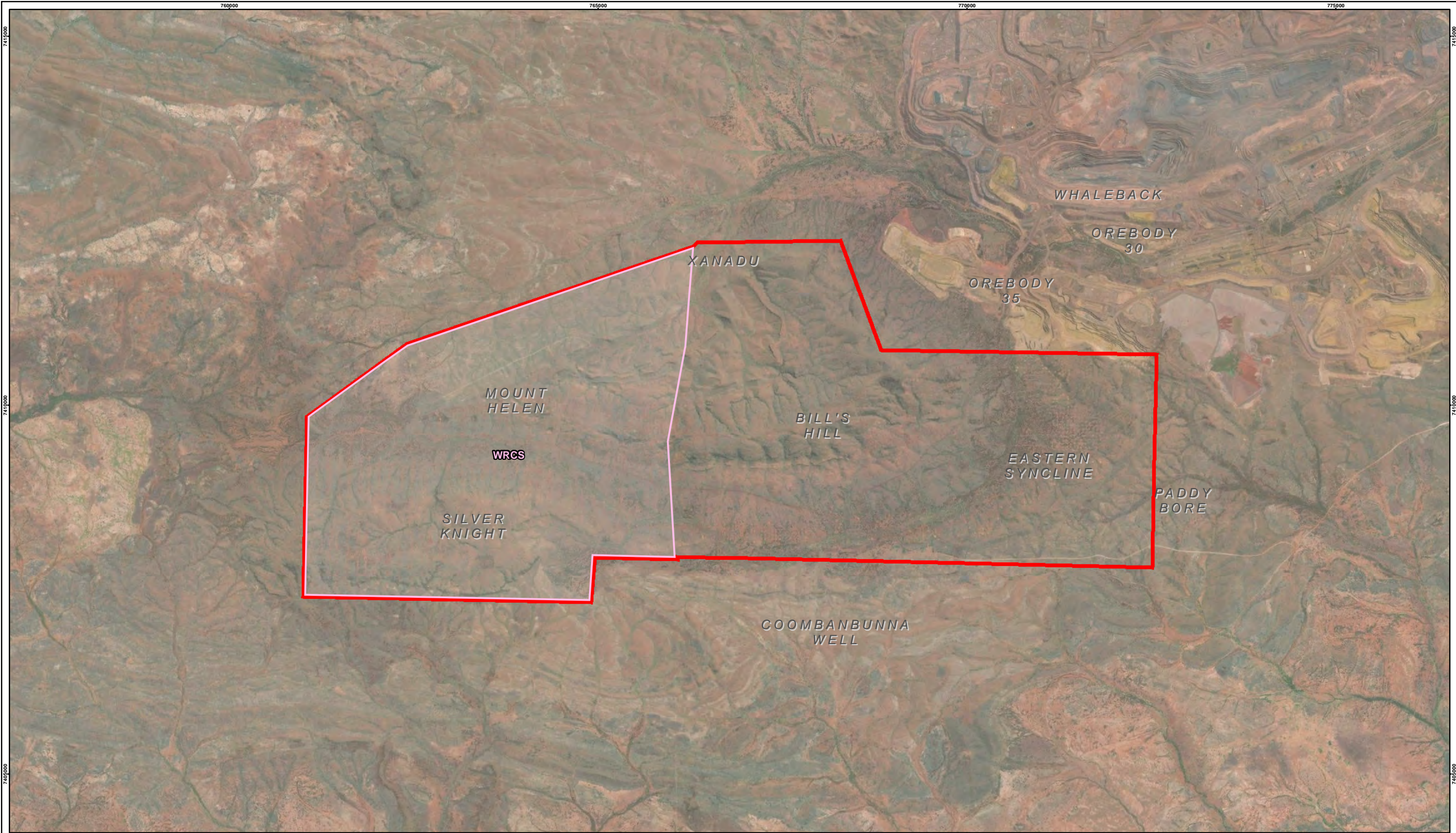
Note: NL indicates the HSL is not limiting
 * Higher triplicate concentrations are adopted to be conservative

RPD ≥30% and one or more values ≥5 × LOR				Lab Report Number	EP2104244	EP2104244		EP2104244	789525	
RPD ≥30% and both values <5 × LOR				Field ID	HWSR0020M	FD01	RPD	HWSR0019M	HWSR0019/59150421	RPD
RPD ≥30% due to differing LORS				Sample Type	Primary	Duplicate		Primary	Triplicate	
				Sampled Date/Time	#####	#####		#####	4/15/2021 12:00	
Chemical Group	Chemical Name	Units	LOR							
Per- and polyfluoroalkyl substances (PFAS)	Perfluorodecane sulfonic acid (PFDS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	N-Methyl PFO sulfonamidoethanol (MeFOSE)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<30	<0.001	<0.005	<30	
	N-methyl-PFO sulfonamidoacetic acid (MeFOSAA)	µg/L	0.0005 : 0.005 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.005	<30	
	Perfluorooctanoic Acid (PFOA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0002 : 0.001 (Interlab)	<0.0002	<0.0002	<30	<0.0002	<0.001	<30	
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Sum of PFHxS and PFOS (lab reported)	µg/L	0.0002 : 0.001 (Interlab)	<0.0002	<0.0002	<30	<0.0002	<0.001	<30	
	Sum of WA DER PFAS (n=10)	µg/L	0.0002 : 0.005 (Interlab)	<0.0002	<0.0002	<30	<0.0002	<0.005	<30	
	Sum of PFASs (n=28 - Lab Reported)	µg/L	0.0002 : 0.005 (Interlab)	<0.0002	<0.0002	<30	<0.0002	<0.005	<30	
	Perfluorobutanoic acid (PFBA)	µg/L	0.002 : 0.005 (Interlab)	<0.002	<0.002	<30	<0.002	<0.005	<30	
	Perfluorohexanoic acid (PFHxA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluorodecanoic acid (PFDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluoropentanoic acid (PFPeA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluorononanoic acid (PFNA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluorotetradecanoic acid (PFTeDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluorotridecanoic acid (PFTrDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluorododecanoic acid (PFDoDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluoroundecanoic acid (PFUnDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluoroheptane sulfonic acid (PFHpS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluoropentane sulfonic acid (PFPeS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.001	<30	
	4:2 Fluorotelomer sulfonic acid (4:2 FTSA)	µg/L	0.001	<0.001	<0.001	<30	<0.001	<0.001	<30	
	6:2 Fluorotelomer sulfonic acid (6:2 FTSA)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<30	<0.001	<0.005	<30	
	8:2 Fluorotelomer sulfonic acid (8:2 FTSA)	µg/L	0.001	<0.001	<0.001	<30	<0.001	<0.001	<30	
	10:2 Fluorotelomer sulfonic acid (10:2 FTSA)	µg/L	0.001	<0.001	<0.001	<30	<0.001	<0.001	<30	
	N-Ethyl PFO sulfonamide (EIFOSA)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<30	<0.001	<0.005	<30	
	N-Ethyl PFO sulfonamidoethanol (EiFOSE)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<30	<0.001	<0.005	<30	
	N-Methyl PFO sulfonamide (MeFOA)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<30	<0.001	<0.005	<30	
	Perfluorooctane sulfonamide (FOSA)	µg/L	0.0005 : 0.005 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.005	<30	
	N-ethyl-PFO sulfonamidoacetic acid (EiFOSAA)	µg/L	0.0005 : 0.005 (Interlab)	<0.0005	<0.0005	<30	<0.0005	<0.005	<30	
	MAH	Benzene	mg/L	0.001	<0.001	<30	<0.001	N/A	-	
		Toluene	mg/L	0.002	0.007	0.008	13	<0.002	N/A	
		Ethylbenzene	mg/L	0.002	<0.002	<0.002	<30	<0.002	N/A	
		Xylenes (m & p)	mg/L	0.002	<0.002	<0.002	<30	<0.002	N/A	
		Xylene (o)	mg/L	0.002	<0.002	<0.002	<30	<0.002	N/A	
		Xylenes (Sum of total) (Lab Reported)	mg/L	0.002	<0.002	<0.002	<30	<0.002	N/A	
Total BTEX		mg/L	0.001	0.007	0.008	13	<0.001	N/A		
PAH	Naphthalene	mg/L	0.005 : 0.01 (Interlab)	<0.005	<0.005	<30	<0.005	<0.01	<30	
Total Recoverable Hydrocarbons	TRH C ₆ -C ₉ Fraction	mg/L	0.02	0.6	0.78	26	0.17	0.31	58	
	TRH C ₁₀ -C ₁₄ Fraction	mg/L	0.05	0.11	<0.05	126	<0.05	0.26	165	
	TRH C ₁₅ -C ₂₈ Fraction	mg/L	0.1	0.12	<0.1	82	0.12	<0.1	82	
	TRH C ₂₉ -C ₃₆ Fraction	mg/L	0.05 : 0.1 (Interlab)	<0.05	<0.05	<30	<0.05	<0.1	<30	
	TRH+C ₁₀ -C ₃₆ (Sum of total) (Lab Reported)	mg/L	0.05 : 0.1 (Interlab)	0.23	<0.05	161	0.12	0.26	74	
	TRH+C ₁₀ -C ₄₀ (Sum of total) (Lab Reported)	mg/L	0.1	0.11	<0.1	75	0.13	<0.1	89	
	TRH C ₆ -C ₁₀ Fraction F1	mg/L	0.02	0.54	0.71	27	0.15	0.33	75	
	TRH C ₆ -C ₁₀ Fraction Less BTEX F1	mg/L	0.02	0.53	0.7	28	0.15	0.33	75	
	TRH >C ₁₀ -C ₁₆ Fraction F2	mg/L	0.1 : 0.05 (Interlab)	<0.1	<0.1	<30	<0.1	<0.05	<30	
	TRH >C ₁₀ -C ₁₆ Fraction Less Naphthalene F2	mg/L	0.1 : 0.05 (Interlab)	<0.1	<0.1	<30	<0.1	<0.05	<30	
	TRH >C ₁₆ -C ₃₄ Fraction F3	mg/L	0.1	0.11	<0.1	75	0.13	<0.1	89	
TRH >C ₃₄ -C ₄₀ Fraction F4	mg/L	0.1	<0.1	<0.1	<30	<0.1	<0.1	<30		

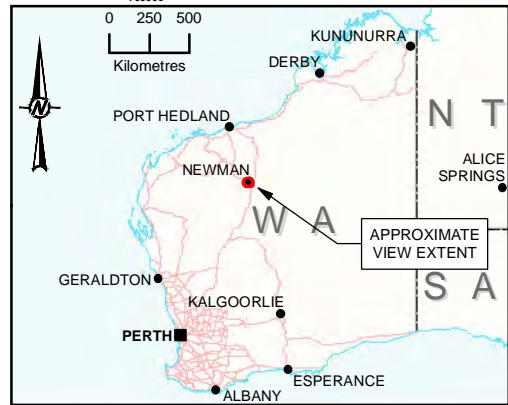
Note: N/A = Not Analysed

Lab Report Number	EP2104244	EP2104244
Field ID	TB319	TBW325
Sampled Date/Time	4/16/2021 15:00	4/16/2021 15:00
Sample Type	Trip Blank	Trip Blank

Chemical Group	Chemical Name	Units	LOR		
MAH	Benzene	mg/L	0.001	<0.001	
	Toluene	mg/L	0.002	<0.002	
	Ethylbenzene	mg/L	0.002	<0.002	
	Xylenes (m & p)	mg/L	0.002	<0.002	
	Xylene (o)	mg/L	0.002	<0.002	
	Xylenes (Sum of total) (Lab Reported)	mg/L	0.002	<0.002	
PAH	Total BTEX	mg/L	0.001	<0.001	
	Naphthalene	mg/L	0.005	<0.005	
Total Recoverable Hydrocarbons	TRH C ₆ -C ₉ Fraction	mg/L	0.02	<0.02	
	TRH C ₆ -C ₁₀ Fraction F1	mg/L	0.02	<0.02	
	TRH C ₆ -C ₁₀ Fraction Less BTEX F1	mg/L	0.02	<0.02	
Per- and polyfluoroalkyl substances (PFAS)	Perfluorodecane sulfonic acid (PFDS)	µg/L	0.0005		<0.0005
	N-Methyl PFO sulfonamidoethanol (MeFOSE)	µg/L	0.001		<0.001
	N-methyl-PFO sulfonamidoacetic acid (MeFOSAA)	µg/L	0.0005		<0.0005
	Perfluorooctanoic Acid (PFOA)	µg/L	0.0005		<0.0005
	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0002		<0.0002
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005		<0.0005
	Sum of PFHxS and PFOS (lab reported)	µg/L	0.0002		<0.0002
	Sum of WA DER PFAS (n=10)	µg/L	0.0002		<0.0002
	Sum of PFASs (n=28 - Lab Reported)	µg/L	0.0002		<0.0002
	Perfluorobutanoic acid (PFBA)	µg/L	0.002		<0.002
	Perfluorohexanoic acid (PFHxA)	µg/L	0.0005		<0.0005
	Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005		<0.0005
	Perfluorodecanoic acid (PFDA)	µg/L	0.0005		<0.0005
	Perfluoropentanoic acid (PFPeA)	µg/L	0.0005		<0.0005
	Perfluorononanoic acid (PFNA)	µg/L	0.0005		<0.0005
	Perfluorotetradecanoic acid (PFTeDA)	µg/L	0.0005		<0.0005
	Perfluorotridecanoic acid (PFTrDA)	µg/L	0.0005		<0.0005
	Perfluorododecanoic acid (PFDoDA)	µg/L	0.0005		<0.0005
	Perfluoroundecanoic acid (PFUnDA)	µg/L	0.0005		<0.0005
	Perfluoroheptane sulfonic acid (PFHpS)	µg/L	0.0005		<0.0005
	Perfluoropentane sulfonic acid (PFPeS)	µg/L	0.0005		<0.0005
	Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005		<0.0005
	4:2 Fluorotelomer sulfonic acid (4:2 FTSA)	µg/L	0.001		<0.001
	6:2 Fluorotelomer sulfonic acid (6:2 FTSA)	µg/L	0.001		<0.001
	8:2 Fluorotelomer sulfonic acid (8:2 FTSA)	µg/L	0.001		<0.001
	10:2 Fluorotelomer sulfonic acid (10:2 FTSA)	µg/L	0.001		<0.001
	N-Ethyl PFO sulfonamide (EtFOSA)	µg/L	0.001		<0.001
	N-Ethyl PFO sulfonamidoethanol (EtFOSE)	µg/L	0.001		<0.001
	N-Methyl PFO sulfonamide (MeFOSA)	µg/L	0.001		<0.001
	Perfluorooctane sulfonamide (FOSA)	µg/L	0.0005		<0.0005
	N-ethyl-PFO sulfonamidoacetic acid (EtFOSAA)	µg/L	0.0005		<0.0005



- LEGEND**
- WESTERN RIDGE STUDY AREA
 - WESTERN RIDGE CRUSHER STUDY (WRCS)



NOTE(S)
 1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE(S)
 1. SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY

CLIENT
BHP

CONSULTANT



YYYY-MM-DD	2021-04-28
DESIGNED	PW
PREPARED	AM
REVIEWED	CB
APPROVED	CB

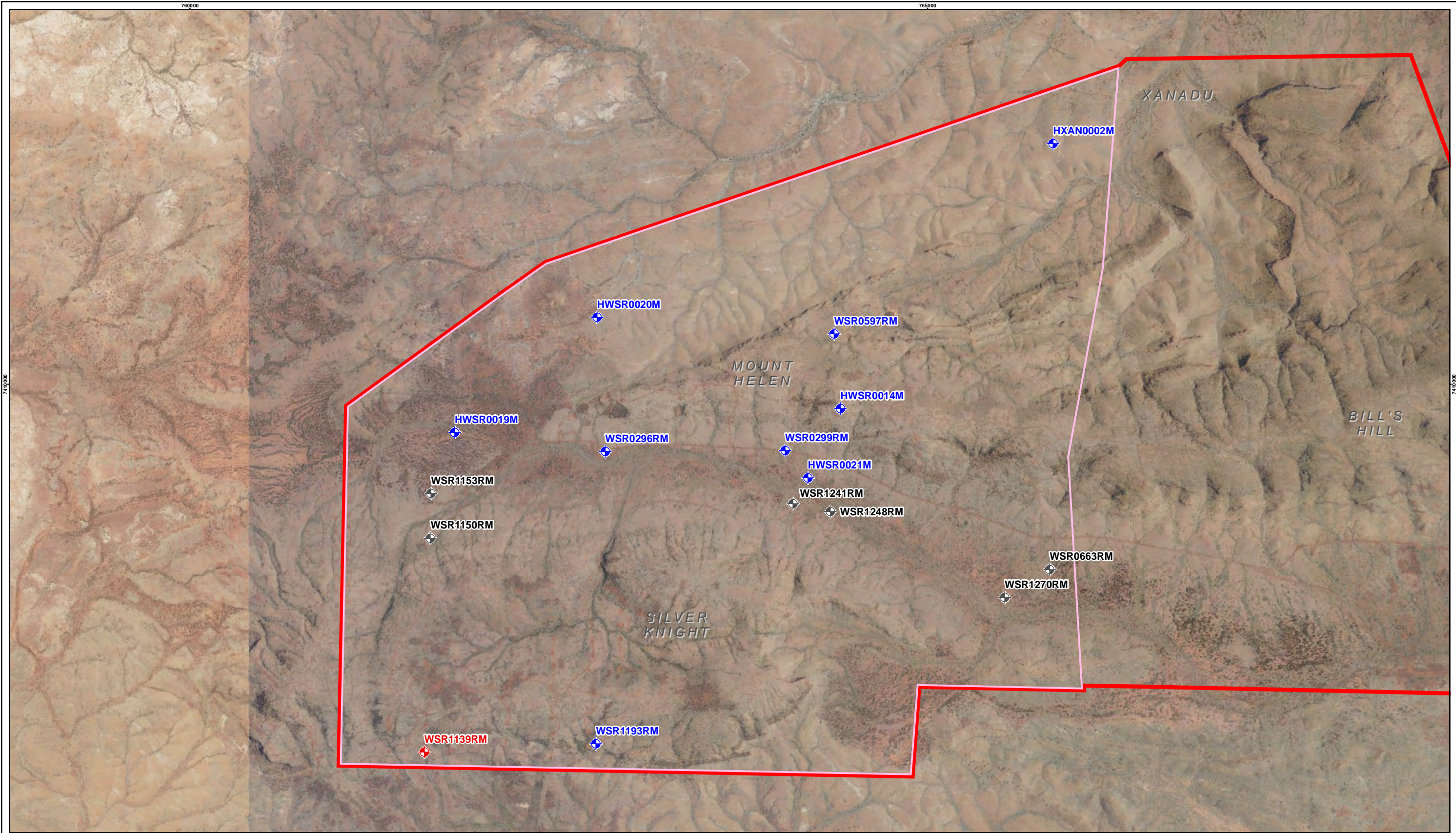
PROJECT
PFAS BASELINE ASSESSMENT - WRCS

TITLE
SITE LOCATION

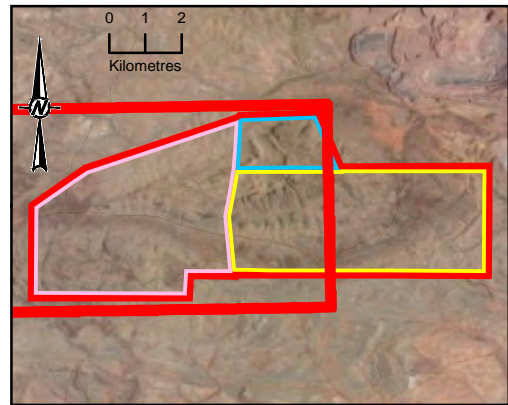
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25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN HOODED FROM 150 X 75



- LEGEND**
- WESTERN RIDGE STUDY AREA
 - WESTERN RIDGE CRUSHER STUDY (WRCS)
- BOREHOLE**
- BOREHOLE DRY
 - BOREHOLE NOT LOCATED
 - GROUNDWATER SAMPLED



NOTE(S)
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE(S)
1. AERIAL IMAGERY SOURCED FROM © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2018)

CLIENT
BHP

PROJECT
PFAS BASELINE ASSESSMENT - WRCS

CONSULTANT



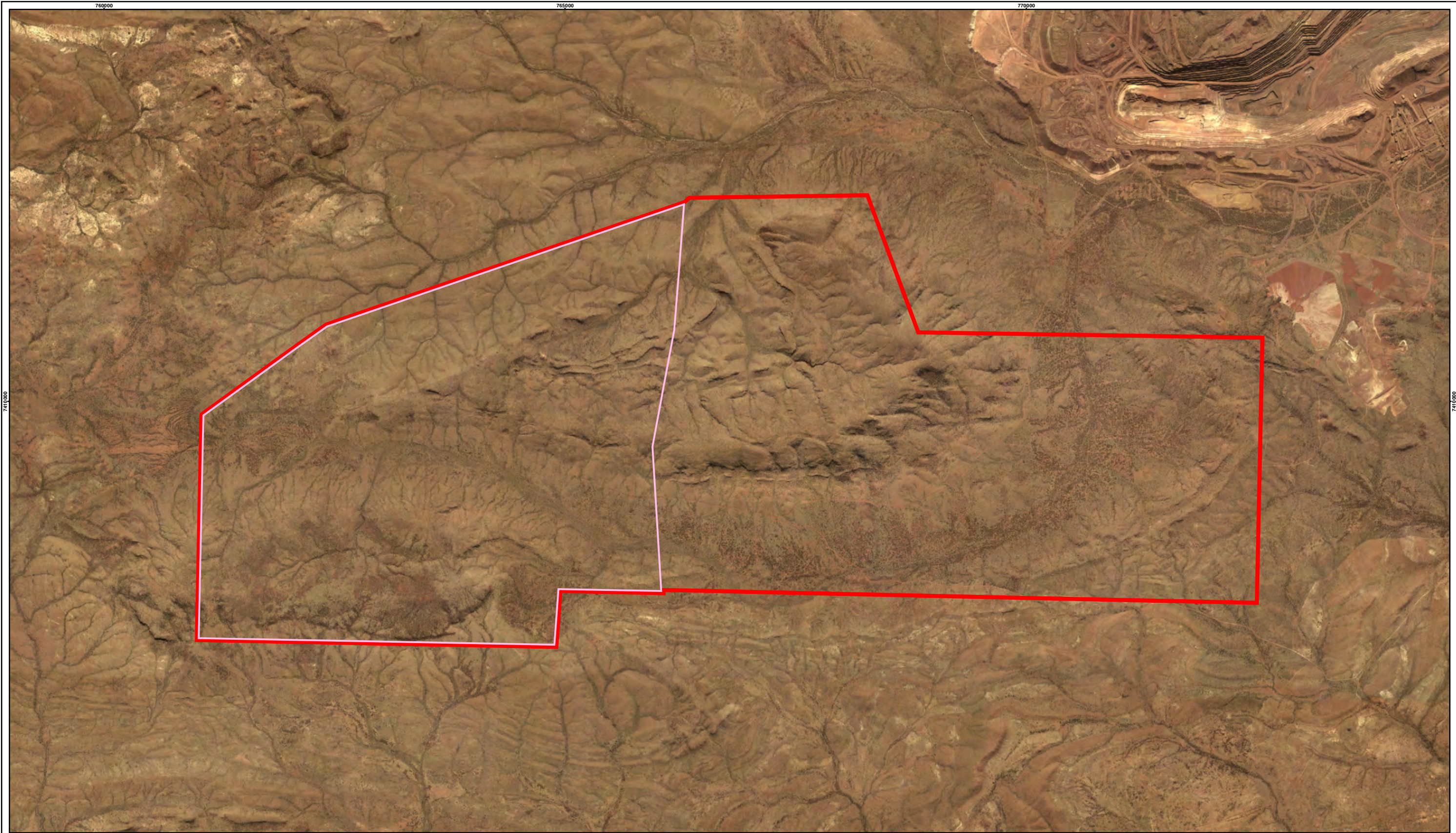
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DESIGNED	PW
PREPARED	AM
REVIEWED	CB
APPROVED	CB

TITLE
SITE PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
21464272	005-R	0	2

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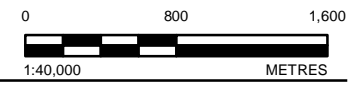
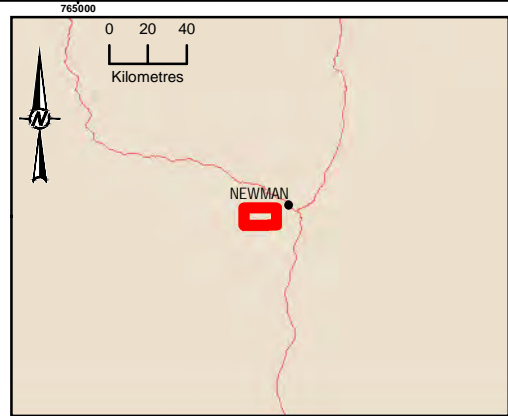
25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN HOODED FROM 150 X 110



LEGEND

WESTERN RIDGE STUDY AREA

WESTERN RIDGE CRUSHER STUDY (WRCS)



NOTE(S)
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE(S)
1. AERIAL IMAGERY SOURCED FROM © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2018)

CLIENT
BHP

CONSULTANT



YYYY-MM-DD	2021-05-03
DESIGNED	PW
PREPARED	AM
REVIEWED	CB
APPROVED	CB

PROJECT
PFAS BASELINE ASSESSMENT - WRCS

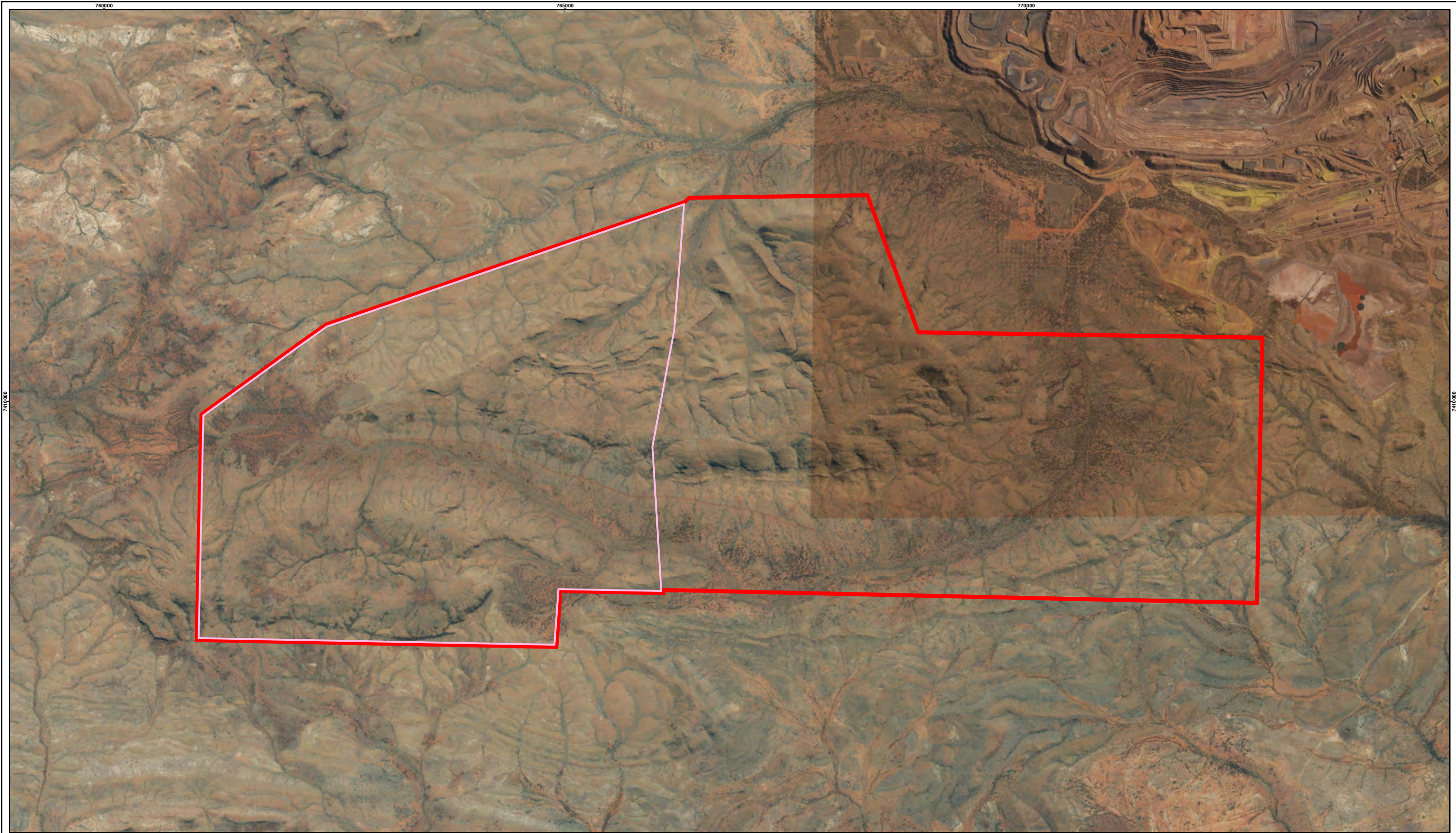
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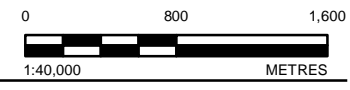
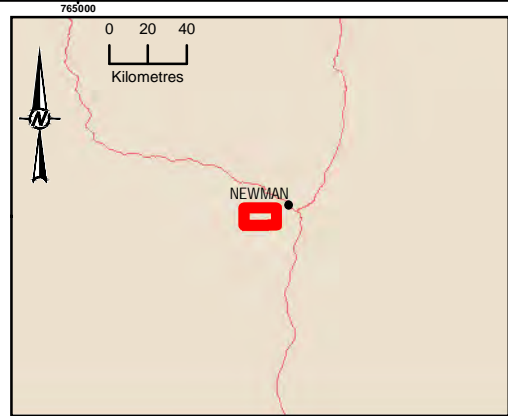
FIGURE
3A

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25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN HOOPED FROM 150 X 75



LEGEND
 WESTERN RIDGE STUDY AREA
 WESTERN RIDGE CRUSHER STUDY (WRCS)



NOTE(S)
 1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE(S)
 1. AERIAL IMAGERY SOURCED FROM © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2018)

CLIENT
BHP

CONSULTANT



YYYY-MM-DD	2021-05-03
DESIGNED	PW
PREPARED	AM
REVIEWED	CB
APPROVED	CB

PROJECT
PFAS BASELINE ASSESSMENT - WRCS

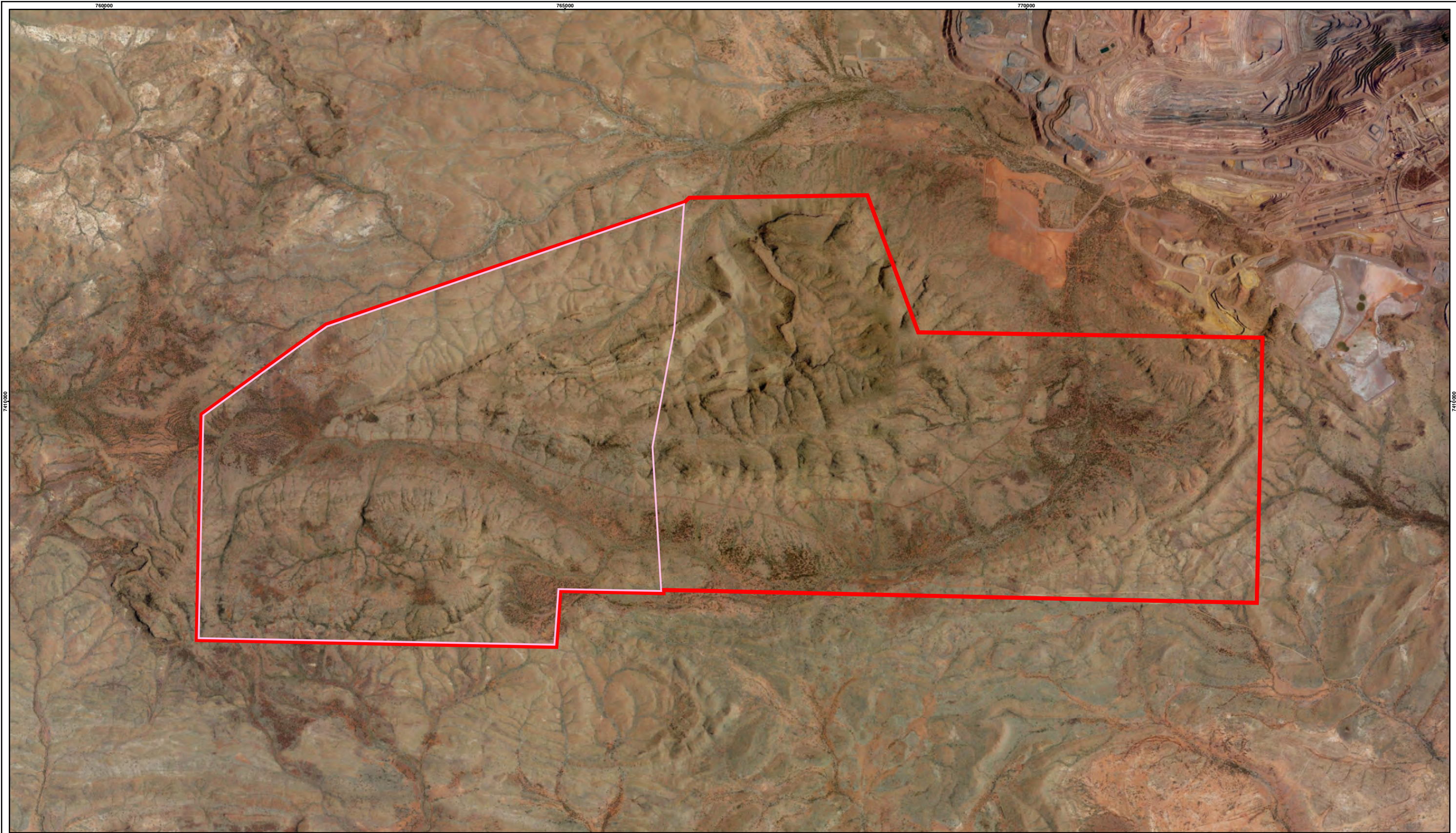
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PROJECT NO.	CONTROL	REV.
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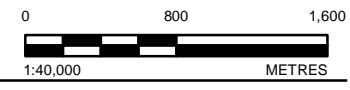
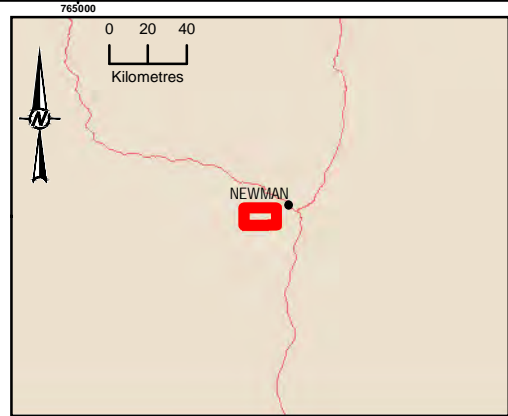
FIGURE
3C

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25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN HOOPED FROM: ISO A3



LEGEND
 WESTERN RIDGE STUDY AREA
 WESTERN RIDGE CRUSHER STUDY (WRCS)



NOTE(S)
 1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE(S)
 1. AERIAL IMAGERY SOURCED FROM © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2018)

CLIENT
 BHP

CONSULTANT



YYYY-MM-DD	2021-05-03
DESIGNED	PW
PREPARED	AM
REVIEWED	CB
APPROVED	CB

PROJECT
 PFAS BASELINE ASSESSMENT - WRCS

TITLE
HISTORICAL IMAGERY - 2014

PROJECT NO.	CONTROL	REV.
21464272	005-R	0

FIGURE
3D

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25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN HOOPED FROM: ISO A3

APPENDIX A

Well Construction Logs

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0014 Hole Length: 252.00

Easting: 764409.32	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409835.27	0.0 - 6.0	WLDRIG5	CH	300		WELLDRIILL	EC6
Surface RL: 666.50	6.0 - 252.0	WLDRIG5	CH	200		WELLDRIILL	EC6
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 11 Nov 20 - 13 Nov 20							
Comments: Installed to 186m due to fallback and hole collapsing.							

TOC RL: 667.43 (Stickup 0.71m) (drilled) SWL: 150.92 MBTOC (14 Nov 20) Dev: N Final pH: -
 TOC RL: 667.43 (Stickup 0.71m) (current) Is Live: Y (-) Date: 11 Nov 2020 Final EC: -

Depth m/gbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0	SZ	ZWS	GY	QC			COBBLE, sandy, (SCREE), Brownish Green, Transported, Non-Cohesive soils. Well graded, Sub-angular. Mixer of sub angular detrital and Bedding material.					CEMENT (0.00-2.00) 206mm BLANK STEEL (0.00-6.00) 51mm BLANK PVC (0.00-174.00)
		WG	S				MINERALISED BIF, (D4), Blackish Brown, Moderately Weathered, Strong Rock. Sub angular to angular chips.big chunks of 3cm seen; variety in size					
10	D4	W	G	S			MINERALISED BIF, (D4), Blackish Brown, Moderately Weathered, Medium Strong Rock. Decrease insize. some porous chips seen. Grade ore. Mostly small sizes: less than 2cm. no big chunk seen.					
		JH	WCG	S			UNMINERALISED BIF, (D4), Blackish Brown, Moderately Weathered, Strong Rock. Unmineralised BIF. Angular to sub Angular chips. Seen bedding in the chips. Big Chunks seen (5cm) from 18-24m. Friable and porpous blue ore (hematite and possible martite). Decrease inseziefrom 26-30m: more porous and fraible material					
20		JHC	S	Q			UNMINERALISED BIF, (D4), Blackish Brown-red, Moderately Weathered, Medium Strong Rock. Sub rounded and smooth chips. smaller chips, no big chunks seen. less than 1 cm					
30	D4	WG	LS				MINERALISED BIF, (D4), Brownish Yellow, Moderately Weathered, Medium Strong Rock. 38-40m: rich in red shale and some big chunks seen. in general small chips size and subrounded. 40-42m: rich in L.					
40		HW	G	S			MINERALISED BIF, (D4), Blackish Brown, Moderately Weathered, Medium Strong Rock. Small and sub rounded chips: less than 1cm. Lots of fines and friable material. Some big chunks seen from 48-52mm. 52-54m: increase in hardness...still rich in fines but transition to harder material					
50												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0014 Hole Length: 252.00

Easting: 764409.32	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409835.27	0.0 - 6.0	WLDRIG5	CH	300		WELLDRILL	EC6
Surface RL: 666.50	6.0 - 252.0	WLDRIG5	CH	200		WELLDRILL	EC6
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 11 Nov 20 - 13 Nov 20							
Comments: Installed to 186m due to fallback and hole collapsing.							

TOC RL: 667.43 (Stickup 0.71m) (drilled) SWL: 150.92 MBTOC (14 Nov 20) Dev: N Final pH: -
 TOC RL: 667.43 (Stickup 0.71m) (current) Is Live: Y (-) Date: 11 Nov 2020 Final EC: -

Depth m	mg/bl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50			HW	G	S			MINERALISED BIF, (D4), Blackish Brown, Moderately Weathered, Medium Strong Rock. Small and sub rounded chips: less than 1cm. Lots of fines and friable material. Some big chunks seen from 48-52m. 52-54m: increase in hardness...still rich in fines but transition to harder material					51mm BLANK PVC (0.00-174.00)
			JW	HGC	S		UNMINERALISED BIF, (D4), Blackish Brown, Moderately Weathered, Strong Rock. Big chunks seen from 54-64m: and 68- 72m: 3-4cm. 54-58m: transition to BIF; still some friable material. Sub angular chips						
60								UNMINERALISED BIF, (D4), Brown, Moderately Weathered, Medium Strong Rock. Unmineralised BIF. In general smaller chips, less than 1cm. From 78-84m, 96-102, 104-106m, 108-110m and 116-118m: chunks of 2-2.5 cm. Chips from sub angular to sub rounded. shale rich layer from 76-80m. Shale and chert rich at 94-96m. Rich in fine from 102-108m (dark brown/blue piles). Few quartz chips seen @ 118-120m.					
70		D4	J		S								
80													
90													
100													

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0014 Hole Length: 252.00

Easting: 764409.32	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409835.27	0.0 - 6.0	WLDRIG5	CH	300		WELLDRIILL	EC6
Surface RL: 666.50	6.0 - 252.0	WLDRIG5	CH	200		WELLDRIILL	EC6
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 11 Nov 20 - 13 Nov 20							
Comments: Installed to 186m due to fallback and hole collapsing.							

TOC RL: 667.43 (Stickup 0.71m) (drilled) SWL: 150.92 MBTOC (14 Nov 20) Dev: N Final pH: -
 TOC RL: 667.43 (Stickup 0.71m) (current) Is Live: Y (-) Date: 11 Nov 2020 Final EC: -

Depth m	mg/bl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
100			J		S			UNMINERALISED BIF, (D4), Brown, Moderately Weathered, Medium Strong Rock. Unmineralised BIF. In general smaller chips, less than 1cm. From 78-84m, 96-102, 104-106m, 108-110m and 116-118m: chunks of 2-2.5 cm. Chips from sub angular to sub rounded. shale rich layer from 76-80m. Shale and chert rich at 94-96m. Rich in fine from 102-108m (dark brown/blue piles). Few quartz chips seen @ 118-120m.					51mm BLANK PVC (0.00-174.00)
110													
120													
130			JG		SL			UNMINERALISED BIF, (D4), Brown, Moderately Weathered, Medium Strong Rock. Unmineralised BIF. Looks Very fractured zone. chips of 3cm found at 130-132m, 146-148m, 150-152m. chips of 4-5cm from 156-162m, 164-166m, 168-170m. (driller decided to change bit). Chips from sub angular to sub rounded. Alternating of porous and smooth chips (ore) with sub angular unmineralised BIF. No chert chips seen but thin layer of cherty					
140													
150													

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0014 Hole Length: 252.00

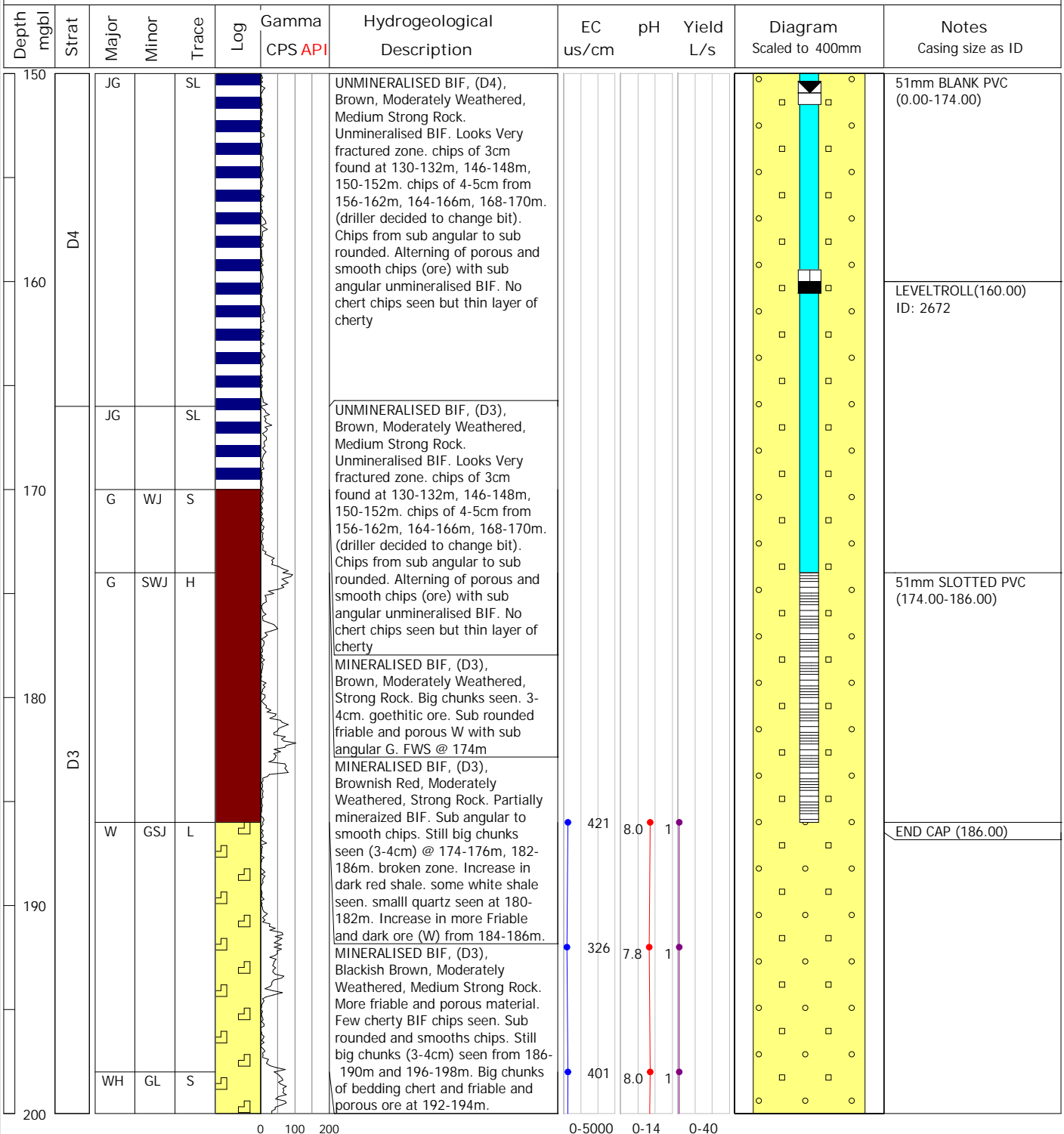
Easting: 764409.32
 Northing: 7409835.27
 Surface RL: 666.50
 Grid Name: MGA94_50
 Incl / Azm: -90-->0

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	300		WELLDRILL	EC6
6.0 - 252.0	WLDRIG5	CH	200		WELLDRILL	EC6

Construct: 11 Nov 20 - 13 Nov 20

Comments: Installed to 186m due to fallback and hole collapsing.

TOC RL: 667.43 (Stickup 0.71m) (drilled) SWL: 150.92 MBTOC (14 Nov 20) Dev: N Final pH: -
 TOC RL: 667.43 (Stickup 0.71m) (current) Is Live: Y (-) Date: 11 Nov 2020 Final EC: -



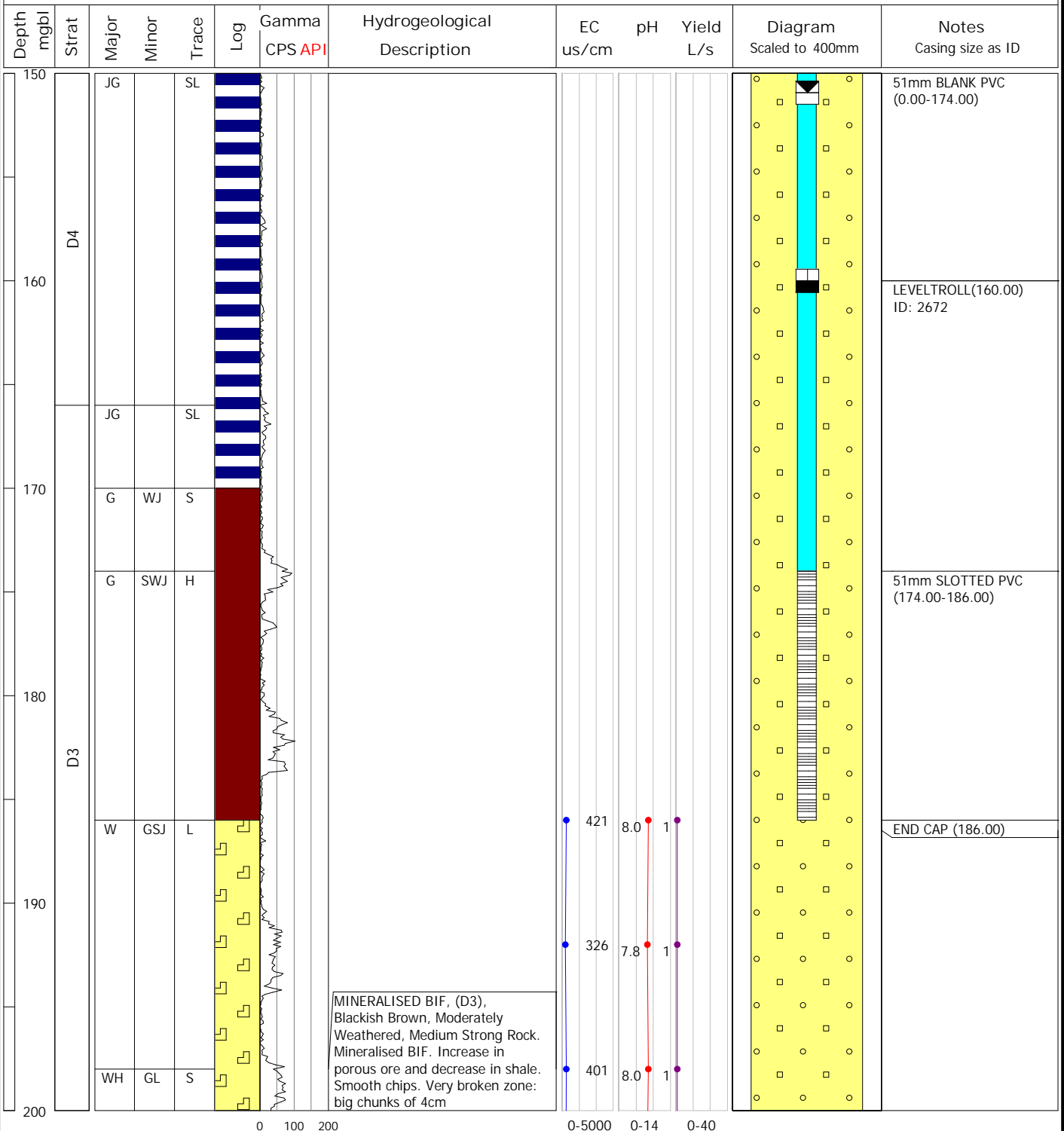
BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0014 Hole Length: 252.00

Easting: 764409.32	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409835.27	0.0 - 6.0	WLDRIG5	CH	300		WELLDRIILL	EC6
Surface RL: 666.50	6.0 - 252.0	WLDRIG5	CH	200		WELLDRIILL	EC6
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 11 Nov 20 - 13 Nov 20							
Comments: Installed to 186m due to fallback and hole collapsing.							

TOC RL: 667.43 (Stickup 0.71m) (drilled) SWL: 150.92 MBTOC (14 Nov 20) Dev: N Final pH: -
 TOC RL: 667.43 (Stickup 0.71m) (current) Is Live: Y (-) Date: 11 Nov 2020 Final EC: -



BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0014 Hole Length: 252.00

Easting: 764409.32	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409835.27	0.0 - 6.0	WLDRIG5	CH	300		WELLDRIILL	EC6
Surface RL: 666.50	6.0 - 252.0	WLDRIG5	CH	200		WELLDRIILL	EC6
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 11 Nov 20 - 13 Nov 20							
Comments: Installed to 186m due to fallback and hole collapsing.							

TOC RL: 667.43 (Stickup 0.71m) (drilled) SWL: 150.92 MBTOC (14 Nov 20) Dev: N Final pH: -
 TOC RL: 667.43 (Stickup 0.71m) (current) Is Live: Y (-) Date: 11 Nov 2020 Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
200		WH	GL	S			MINERALISED BIF, (D3), Blackish Brown, Moderately Weathered, Medium Strong Rock. Mineralised BIF. Increase in porous ore and decrease in shale. Smooth chips. Very broken zone: big chunks of 4cm	394	7.7	1		
		WH	SG	L			MINERALISED BIF, (D3), Blackish Brown, Moderately Weathered, Medium Strong Rock. Mineralised BIF. Porous dark blue ore. Increase in shale (dark pink and yellow). Smooth chips. Very broken zone: big chunks of 4cm. Not many fines seen.	401	7.8	1		
210		WJ	SL	H			MINERALISED BIF, (D3), Blackish Brown, Moderately Weathered, Strong Rock. 4cm chunk of Unmineralized BIF @216-218m. still few chunks seen but more smaller smooth chips.	424	7.7	2		
220		WS	JG	L			MINERALISED BIF, (D3), Blackish Brown, Moderately Weathered, Medium Strong Rock. Porous and friable ore. Smooth chips. red and yellow shale. only few smooth chunk seen, generally small chips.	374	7.8	2		
230	D3							369	7.7	2		
								389	7.7	2		
240		WS	JGL				MINERALISED BIF, (D3), Blackish Brown, Moderately Weathered, Medium Strong Rock. Porous and friable ore. Smooth chips. red and yellow shale. only few smooth chunk seen in it general small chips.	376	7.8	2		
250		WJS	GL				UNMINERALISED BIF, (D3), Blackish Brown, Moderately Weathered, Medium Strong Rock. Partially mineralised BIF. porous and friable material and hard bedded BIF. Increase in chips size, more chunkier	422	7.9	2		

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0014 Hole Length: 252.00

Easting: 764409.32	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409835.27	0.0 - 6.0	WLDRIG5	CH	300		WELLDRIILL	EC6
Surface RL: 666.50	6.0 - 252.0	WLDRIG5	CH	200		WELLDRIILL	EC6
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 11 Nov 20 - 13 Nov 20							
Comments: Installed to 186m due to fallback and hole collapsing.							

TOC RL: 667.43 (Stickup 0.71m) (drilled) SWL: 150.92 MBTOC (14 Nov 20) Dev: N Final pH: -
 TOC RL: 667.43 (Stickup 0.71m) (current) Is Live: Y (-) Date: 11 Nov 2020 Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
250	D3	WJS	GL		□		UNMINERALISED BIF, (D3), Blackish Brown, Moderately Weathered, Medium Strong Rock. Partially mineralised BIF. porous and friable material and hard bedded BIF. Increase in chips size, more chunkier				○ □	
260												
270												
280												
290												
300												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0019 Hole Length: 153.00

Easting: 761794.37	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409673.55	0.0 - 153.0	RANRC09	RHF	140		RANGER	JK3
Surface RL: 631.52							
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 08 Dec 20 - 08 Dec 20							
Comments:							

TOC RL: 632.36 (Stickup 0.45m) (drilled) SWL: 42.79 MBTOC (26 Jan 21) Dev: N Final pH: -
 TOC RL: 632.36 (Stickup 0.45m) (current) Is Live: Y (-) Date: 09 Dec 2020 Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0	SZ	SZ					GRAVEL, (SCREE), Reddish Brown, Transported, Non-Cohesive soils, Poorly graded, Rounded. Rounded to subrounded, chip size range 2-10mm, detrital cover. Very crumbly porous chips, breaks apart easily, chip size range 2-20mm, rounded to subangular.					51mm BLANK PVC (0.00-60.00)
10		S										
20	JN											
30		S					Very crumbly porous chips, breaks apart easily, chip size range 10-30mm, rounded to subangular, very weathered.					
40												
50		D					More competent harder chips, subangular to angular, chip size range 5-30mm, very fine grained.					

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0019 Hole Length: 153.00

Easting: 761794.37	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409673.55	0.0 - 153.0	RANRC09	RHF	140		RANGER	JK3
Surface RL: 631.52							
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 08 Dec 20 - 08 Dec 20							
Comments:							

TOC RL: 632.36 (Stickup 0.45m) (drilled) SWL: 42.79 MBTOC (26 Jan 21) Dev: N Final pH: -
 TOC RL: 632.36 (Stickup 0.45m) (current) Is Live: Y (-) Date: 09 Dec 2020 Final EC: -

Depth mgl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50		D			[Hatched Pattern]		More competent harder chips, subangular to angular, chip size range 5-30mm, very fine grained.				[Cyan Bar]	51mm BLANK PVC (0.00-60.00)
60		ES			[Green V-pattern]		Extremely weathered dolerite, fizzes with acid, chip size range 2-20mm, mostly pulverised chips.				[Hatched Pattern]	51mm SLOTTED PVC (60.00-153.00)
70	JN											
80												
90												
100												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0019 Hole Length: 153.00

Easting: 761794.37	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409673.55	0.0 - 153.0	RANRC09	RHF	140		RANGER	JK3
Surface RL: 631.52							
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 08 Dec 20 - 08 Dec 20							
Comments:							

TOC RL: 632.36 (Stickup 0.45m) (drilled) SWL: 42.79 MBTOC (26 Jan 21) Dev: N Final pH: -
 TOC RL: 632.36 (Stickup 0.45m) (current) Is Live: Y (-) Date: 09 Dec 2020 Final EC: -

Depth m/bpl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
100		ES			▼		Extremely weathered dolerite, fizzes with acid, chip size range 2-20mm, mostly pulverised chips.					51mm SLOTTED PVC (60.00-153.00)
110		DS		/		Weathered dolerite, does not fizz with acid, few competent chips, rounded to subangular, chip size range 2-20mm.						
120		ES			▼		Extremely weathered dolerite, porous chips, breaks apart easily, fizzes with acid.					
130	JN				▼							
140					▼							
150					▼							

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0019 Hole Length: 153.00

Easting: 761794.37	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409673.55	0.0 - 153.0	RANRC09	RHF	140		RANGER	JK3
Surface RL: 631.52							
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 08 Dec 20 - 08 Dec 20							
Comments:							

TOC RL: 632.36 (Stickup 0.45m) (drilled) SWL: 42.79 MBTOC (26 Jan 21) Dev: N Final pH: -
 TOC RL: 632.36 (Stickup 0.45m) (current) Is Live: Y (-) Date: 09 Dec 2020 Final EC: -

Depth m/bpl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
150	JN	ES			<div style="background-color: #808000; width: 10px; height: 10px; display: inline-block; margin-bottom: 2px;">v</div> <div style="background-color: #808000; width: 10px; height: 10px; display: inline-block; margin-bottom: 2px;">v</div> <div style="background-color: #808000; width: 10px; height: 10px; display: inline-block; margin-bottom: 2px;">v</div>		Extremely weathered dolerite, porous chips, breaks apart easily, fizzes with acid.					51mm SLOTTED PVC (60.00-153.00) END CAP (153.00)
160												
170												
180												
190												
200												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0020 Hole Length: 150.00

Easting: 762759.87	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7410453.29	0.0 - 150.0	RANRC09	RHF	140		RANGER	EC6
Surface RL: 629.93							
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 10 Dec 20 - 10 Dec 20							
Comments:							

TOC RL: 630.71 (Stickup 0.45m) (drilled) SWL: 32.54 MBTOC (26 Jan 21) Dev: N Final pH: -
 TOC RL: 630.71 (Stickup 0.45m) (current) Is Live: Y (-) Date: 10 Dec 2020 Final EC: -

Depth m	mg/bl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0			E	S				DOLERITE, (JNE), Whiteish Grey, Highly Weathered, Medium Strong Rock. Weathered Dolerite. Some grey shale seen. Smooth chips					AB FOAM (0.00-2.00) 51mm BLANK PVC (0.00-12.00)
10			E		Q			DOLERITE, (JNE), Whiteish Grey, Moderately Weathered, Strong Rock. Fresh Grey dolerite. Very Fine grains. Some mafic minerals seen. Not the typical green dolerite but definitely volcanics material. From 9 - 21m: 2cm chunks seen. 21-75m: small sub angular chips (some 1.5-2cm chunks at 36-39m). From 75 to the EOH sub angular chunks seen. Big 2.5 cm of quartz at 111-114m. Big Dolerite chunk at 141-144m.					51mm SLOTTED PVC (12.00-102.00)
20		JNE											
30													
40													
50													

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0021 Hole Length: 233.00

Easting: 764181.57	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By	
Northing: 7409365.53	0.0 - 158.0	DR3	DR	600		EASTERNWELL	VL2	
Surface RL: 615.63	158.0 - 233.0	DR3	DR	450		EASTERNWELL	JK3	
Grid Name: MGA94_50								
Incl / Azm: -90-->0								
Construct: 26 Mar 21 - 02 Apr 21	License: 205541							
Comments: Reasonably difficult drilling conditions.								

TOC RL: 615.99 (Stickup 0.16m) (drilled) SWL: 107.76 MBTOC (06 Apr 21) Dev: Y: 25.8 hour(s) Final pH: 8.3
 TOC RL: 615.99 (Stickup 0.16m) (current) Is Live: Y (-) Date: 01 Apr 2021 Final EC: 840.00

Depth m	mg/bl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes Casing size as ID
0		SZ	ZJI	K	QL			GRAVEL, (SCREE), Brownish Grey, Transported, Stiff, Uniform, Sub-rounded, Unconsolidated / unstable ground. Moderately sorted surface detritals with major BIF, pisolites+ minor shales+trace q, limonite.					CEMENT (0.00-2.00) 584mm BLANK STEEL (0.00-13.00) 305mm BLANK STEEL (0.00-143.00)
10	ZK		J				GRAVEL, clayey, (CLAY), Reddish Brown, Transported, Very Stiff, Uniform, Sub-rounded, Unconsolidated / unstable ground. Moderately sorted clay detritals + minor BIF.						
20	ZJI	S				GRAVEL, (SCREE), Brownish Grey, Transported, Hard, Uniform, Sub-rounded, Stable / competent ground conditions. Moderately sorted BIF pisolites + minor shale.							
30	ZJ	K	CL3			GRAVEL, sandy, (SCREE), Brownish Grey, Transported, Firm, Uniform, Sub-rounded, Stable / competent ground conditions. Moderately sorted BIF + minor clays + trace chert, calcrete, limonite. Hard stable ground 26-38m, unconsolidated ground 38-48m.							
40													
50		TD2	ZS	JK	LG			GRAVEL, sandy, (SCREE), Yellowish Brown, Transported, Firm, Uniform, Sub-angular, Unconsolidated / unstable ground. Moderately sorted shales, clays + minor BIF + trace limonite, goethite.					

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0021 Hole Length: 233.00

Easting: 764181.57	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By	
Northing: 7409365.53	0.0 - 158.0	DR3	DR	600		EASTERNWELL	VL2	
Surface RL: 615.63	158.0 - 233.0	DR3	DR	450		EASTERNWELL	JK3	
Grid Name: MGA94_50								
Incl / Azm: -90-->0								
Construct: 26 Mar 21 - 02 Apr 21	License: 205541							
Comments: Reasonably difficult drilling conditions.								

TOC RL: 615.99 (Stickup 0.16m) (drilled) SWL: 107.76 MBTOC (06 Apr 21) Dev: Y: 25.8 hour(s) Final pH: 8.3
 TOC RL: 615.99 (Stickup 0.16m) (current) Is Live: Y (-) Date: 01 Apr 2021 Final EC: 840.00

Depth mgl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes Casing size as ID		
50	TD2	ZS	JK	LG			GRAVEL, sandy, (SCREE), Yellowish Brown, Transported, Firm, Uniform, Sub-angular, Unconsolidated / unstable ground. Moderately sorted shales, clays + minor BIF + trace limonite, goethite.					305mm BLANK STEEL (0.00-143.00)		
		ZJS	K	L			GRAVEL, (SCREE), Reddish Grey, Transported, Stiff, Uniform, Sub-angular, Unconsolidated / unstable ground. Moderately sorted BIF, shales + minor clays + trace limonite.							
60		SK	JL				SHALE, (OC), Whiteish Yellow, Highly Weathered, Medium Strong Rock. Sub rounded shales, clays + minor sub angular BIF, limonite. Unconsolidated ground.							
70		SK					SHALE, (OC), Whiteish Buff, Extremely Weathered, Weak Rock. Clays, very sticky. Very easy for rods to bog. Need to use chemicals + water to continue drilling. Unconsolidated ground.							
80	OC	SK	JL				SHALE, (OC), Greyish Yellow, Highly Weathered, Medium Strong Rock. Sub rounded shales, clays + minor sub angular BIF, limonite. Unconsolidated ground. Perched water strike at 74m @0.5 L/s.							
		S	J	K				SHALE, (OC), Greyish Yellow, Extremely Weathered, Very Weak Rock. Sub rounded very stick shales + minor grey sub angular BIF + trace clays. Unconsolidated ground. Perched water yield increased to 4 L/s, water too sticky to measure EC.	8.0	1			8.1	4
90		S	J					SHALE, (OC), Greenish Light or White, Extremely Weathered, Very Weak Rock. Sub rounded shales + minor BIF. Shales band (118-120m). Unconsolidated ground. No perched water.						
100														

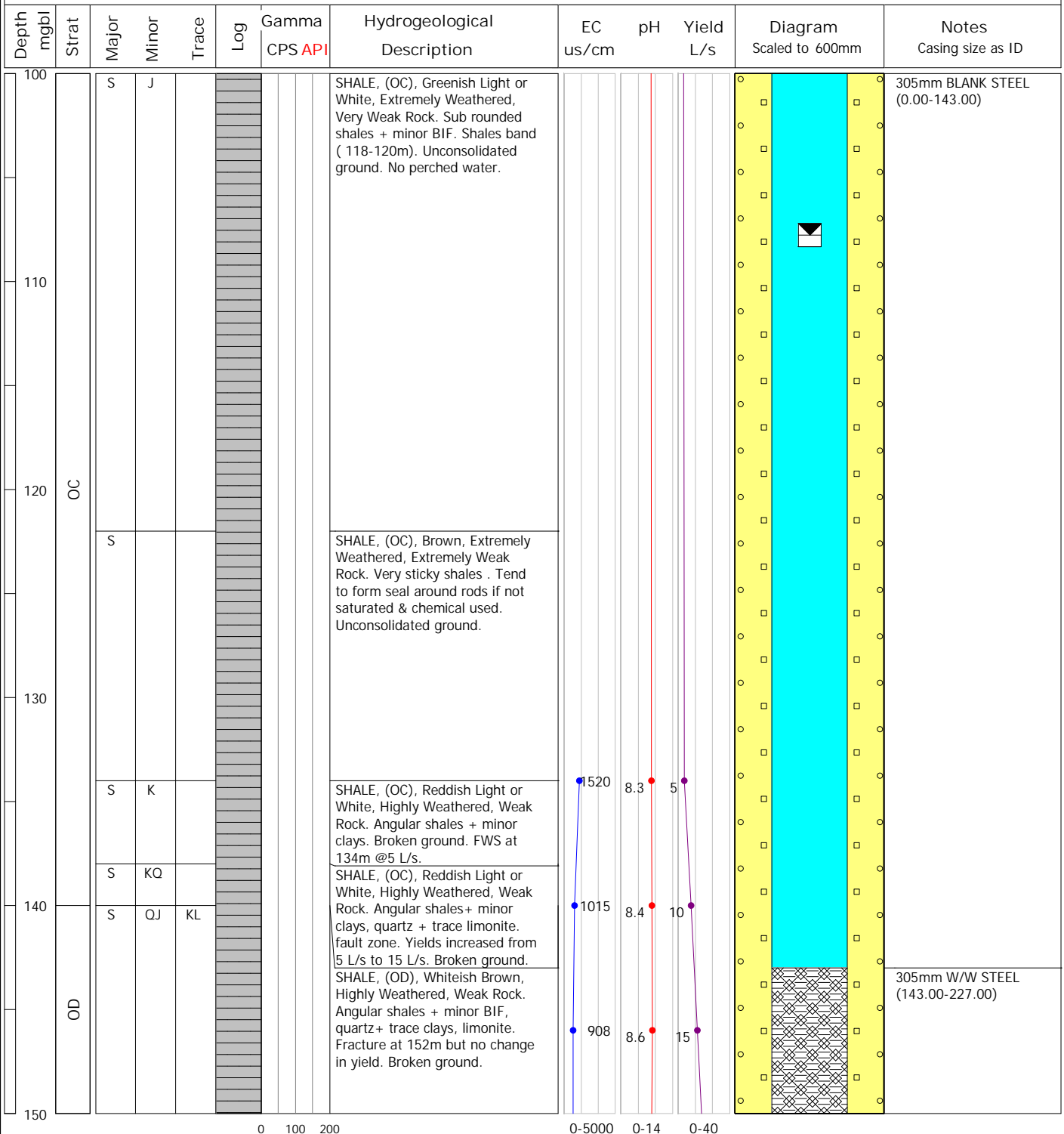
BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0021 Hole Length: 233.00

Easting: 764181.57	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409365.53	0.0 - 158.0	DR3	DR	600		EASTERNWELL	VL2
Surface RL: 615.63	158.0 - 233.0	DR3	DR	450		EASTERNWELL	JK3
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 26 Mar 21 - 02 Apr 21							License: 205541
Comments: Reasonably difficult drilling conditions.							

TOC RL: 615.99 (Stickup 0.16m) (drilled) SWL: 107.76 MBTOC (06 Apr 21) Dev: Y: 25.8 hour(s) Final pH: 8.3
 TOC RL: 615.99 (Stickup 0.16m) (current) Is Live: Y (-) Date: 01 Apr 2021 Final EC: 840.00



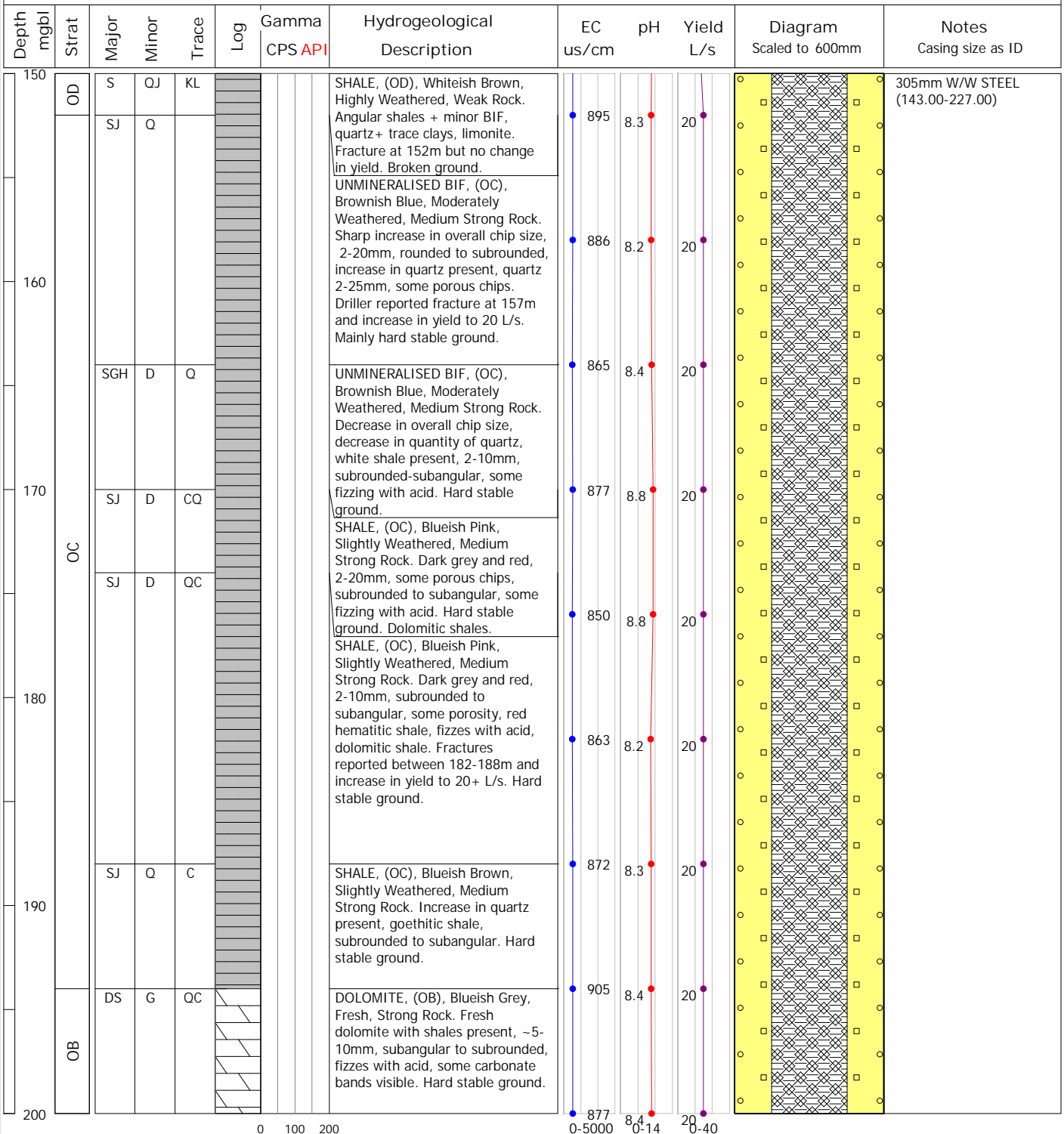
BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0021 Hole Length: 233.00

Easting: 764181.57	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409365.53	0.0 - 158.0	DR3	DR	600		EASTERNWELL	VL2
Surface RL: 615.63	158.0 - 233.0	DR3	DR	450		EASTERNWELL	JK3
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 26 Mar 21 - 02 Apr 21							
Comments: Reasonably difficult drilling conditions.						License: 205541	

TOC RL: 615.99 (Stickup 0.16m) (drilled) SWL: 107.76 MBTOC (06 Apr 21) Dev: Y: 25.8 hour(s) Final pH: 8.3
 TOC RL: 615.99 (Stickup 0.16m) (current) Is Live: Y (-) Date: 01 Apr 2021 Final EC: 840.00



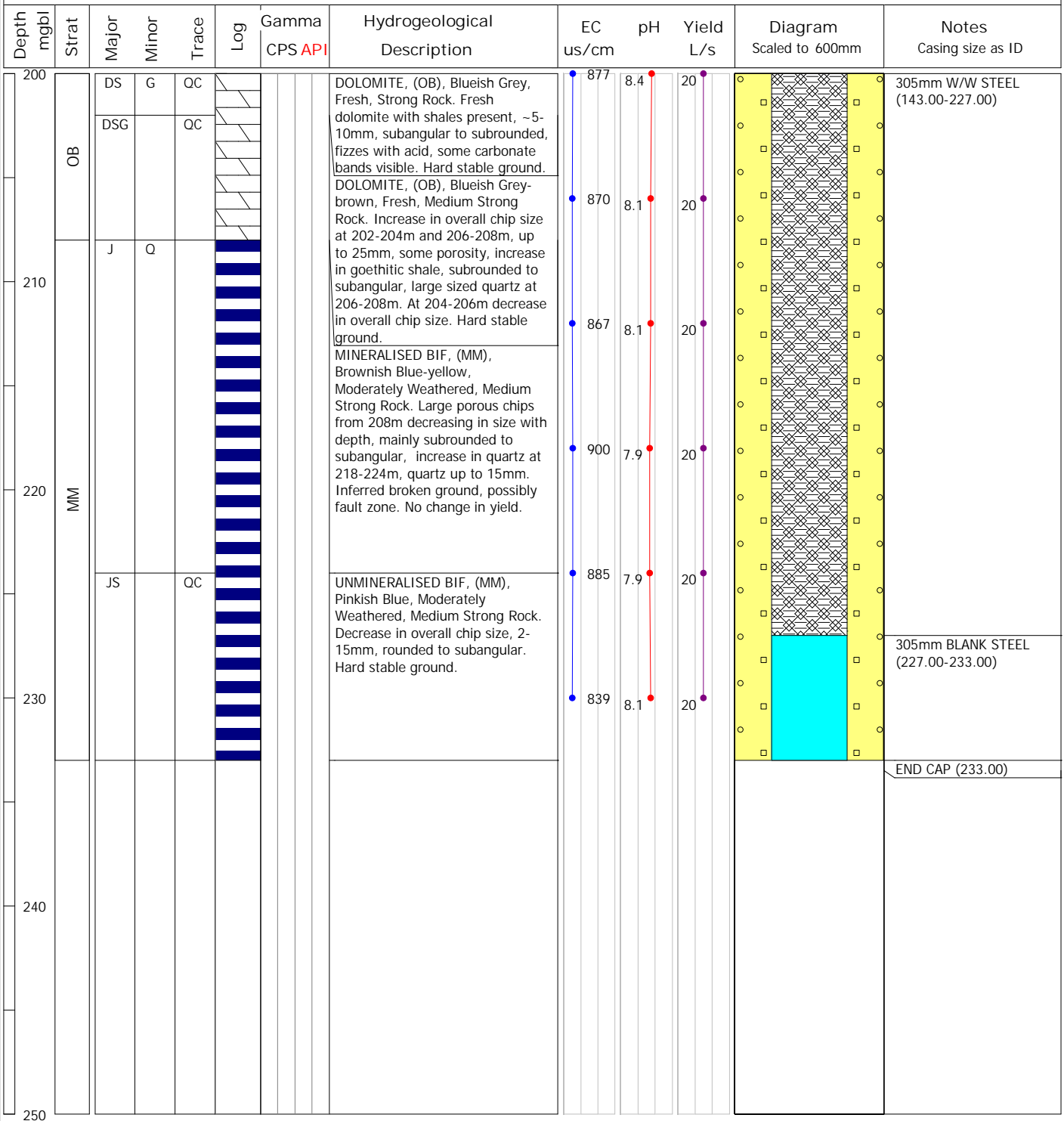
BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: HWSR0021 Hole Length: 233.00

Easting: 764181.57	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409365.53	0.0 - 158.0	DR3	DR	600		EASTERNWELL	VL2
Surface RL: 615.63	158.0 - 233.0	DR3	DR	450		EASTERNWELL	JK3
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 26 Mar 21 - 02 Apr 21							License: 205541
Comments: Reasonably difficult drilling conditions.							

TOC RL: 615.99 (Stickup 0.16m) (drilled) SWL: 107.76 MBTOC (06 Apr 21) Dev: Y: 25.8 hour(s) Final pH: 8.3
 TOC RL: 615.99 (Stickup 0.16m) (current) Is Live: Y (-) Date: 01 Apr 2021 Final EC: 840.00



BHPIO - Hydrogeology Log



Project: WHALEBACK Hole Name: HXAN0002 Hole Length: 150.00

Easting: 765851.23	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7411629.78	0.0 - 150.0	WLSRC50	RHF	146		WLS	JG6
Surface RL: 623.63							
Grid Name: MGA94_50							
Incl / Azm: -90-->0							
Construct: 06 Feb 21 - 06 Feb 21							
Comments:							

TOC RL: 624.56 - (drilled) SWL: Dev: N Final pH: -
 TOC RL: 624.56 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50		O			○		DOLERITE, (JN), Grey, Moderately Weathered, Medium Strong Rock. Light Grey Tuff. Talc on fingers. Becoming more weathered with depth (disintegrates in sieve). Low density. Tuff.				█	51mm BLANK PVC (0.00-60.00)
60					○						█	51mm SLOTTED PVC (60.00-150.00)
70					○						█	
80					○						█	
90					○						█	
100					○						█	

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR0663R Hole Length: 129.00

Easting: 765826.87	Depth: 0.0 - 129.0	Drill Rig: RANRC11	Type: RHF	Size: 146	Fluid:	Drilled By: RANGER	Logged By: NJ
Northing: 7408745.45							
Surface RL: 607.86							
Grid Name: MGA94_50							
Incl / Azm: -89-->136							
Construct: 03 Jun 16 - 03 Jun 16							
Comments: Drilled to test detritals							

TOC RL: 608.54 (Stickup 0.68m) (drilled) SWL: 86.96 MBTOC (15 Jul 16) Dev: N Final pH: -
 TOC RL: 608.54 (Stickup 0.68m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m gbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0	SZ	ZK					Red/white sticky clays					51mm BLANK PVC (0.00-84.00)
10		ZK					Red/white sticky clays					
20	CY3											
30												
40												
50												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR0663R Hole Length: 129.00

Easting: 765826.87	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7408745.45	0.0 - 129.0	RANRC11	RHF	146		RANGER	NJ
Surface RL: 607.86							
Grid Name: MGA94_50							
Incl / Azm: -89-->136							
Construct: 03 Jun 16 - 03 Jun 16							
Comments: Drilled to test detritals							

TOC RL: 608.54 (Stickup 0.68m) (drilled) SWL: 86.96 MBTOC (15 Jul 16) Dev: N Final pH: -
 TOC RL: 608.54 (Stickup 0.68m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50	CY3	ZK					Red/white sticky clays					51mm BLANK PVC (0.00-84.00)
60		ZK					Red/white sticky clays					
	ST3	ZK		G			Yellow clays					
70		ZK		G			Yellow clays					
	VB2	ZGX	K				Some vuggy vit g chips. Good minz, should grade.					
80		ZKG					Too much clays to grade					
		ZK					Sloppy white clay					
		ZK		G								
90		ZKG					Brown/yell/wht clays					
100												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR0663R Hole Length: 129.00

Easting: 765826.87	Depth: 0.0 - 129.0	Drill Rig: RANRC11	Type: RHF	Size: 146	Fluid:	Drilled By: RANGER	Logged By: NJ
Northing: 7408745.45							
Surface RL: 607.86							
Grid Name: MGA94_50							
Incl / Azm: -89-->136							
Construct: 03 Jun 16 - 03 Jun 16							
Comments: Drilled to test detritals							

TOC RL: 608.54 (Stickup 0.68m) (drilled) SWL: 86.96 MBTOC (15 Jul 16) Dev: N Final pH: -
 TOC RL: 608.54 (Stickup 0.68m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
100	VB2	ZKG					Brown/yell/wht clays					
		S	B				Sloppy grey shale					
		S	B				Sloppy grey shale					
		S					Sloppy white shale					
110	OB	F	S	G			Mod hard f shales, light pink shale coating on last two samples					
		S					Soft white shale					
		O					EOH grey/whie sylvia siltstone					
120												
130												
140												
150												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1139R Hole Length: 153.00

Easting: 761590.03	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7407507.47	0.0 - 153.0	RANRC12	RHF	140		RANGER	MC1
Surface RL: 633.97							
Grid Name: MGA94_50							
Incl / Azm: -89-->0							
Construct: 05 Dec 16 - 05 Dec 16							
Comments: HOLE GOES THROUGH jn THEN AN ALTEREN mu ABOVE A DYKE THEN A BAKED MARGIN BELOW BEFORE NORMAL MU AND ...							

TOC RL: 634.52 (Stickup 0.55m) (drilled) SWL: 64.90 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 634.52 (Stickup 0.55m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m/gbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0	SZ	ZK		XY			VERY HARD TO TELL BEDROCK BOUNDARY AS NOT MANY CHIPS, CHIPS THAT THERE ARE, ARE ROUNDED					51mm BLANK PVC (0.00-61.20)
		ZK		XY			VERY HARD TO TELL BEDROCK BOUNDARY AS NOT MANY CHIPS, CHIPS THAT THERE ARE, ARE ROUNDED					
	JN	SF					NO SIGN OF HC, RED SHALES, CONSISTANT					
10												
20												
30		SF	G									
	MU	SF										
		SF		G								
40		SF		G								
50		SG		G			RIGHT ON THE BOUNDARY WITH MU					

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1139R Hole Length: 153.00

Easting: 761590.03	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7407507.47	0.0 - 153.0	RANRC12	RHF	140		RANGER	MC1
Surface RL: 633.97							
Grid Name: MGA94_50							
Incl / Azm: -89-->0							
Construct: 05 Dec 16 - 05 Dec 16							
Comments: HOLE GOES THROUGH jn THEN AN ALTEREN mu ABOVE A DYKE THEN A BAKED MARGIN BELOW BEFORE NORMAL MU AND ...							

TOC RL: 634.52 (Stickup 0.55m) (drilled) SWL: 64.90 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 634.52 (Stickup 0.55m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID	
50		SG					RIGHT ON THE BOUNDARY WITH MU					51mm BLANK PVC (0.00-61.20)	
		HG		M			TRACE MAGNETITE						
		G	L										
		GS	L										
60		H	G	MRN			BEGINNING OF ALTERED ZONE, SOME CHIPS MAGNETIC VERY DARK COLOUR OF PILES						51mm SLOTTED PVC (61.20-103.20)
		H	M	N3			SMALL CALCITE CHIPS LOGGED AS 3						
		HG		MN			LESS ALTERED						
70		H	MG	N3			MAGNATISM MORE, LOOKS LIKE BLACK MANGANESE SHALE OUT OF THE CYCLONE AT TIMES						LEVELTROLL(72.00) ID: 2205
	MU												
		HM	3	N			LARGE CALCITE CRYSTALS SCRACHED BY SCRIBBLE EASILY, MORE MAGNETIC AGAIN						
		HM		NS			CALLING A 0042 AS NO EVIDENCE YET OF Mpl-H						
90		HG	M	NR			PROBABLY THE HIGH P ZONE AT THE EDGE OF THE ALTERATION						
		ER		N			REALLY ALTERED DOLORITE						

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1139R Hole Length: 153.00

Easting: 761590.03	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7407507.47	0.0 - 153.0	RANRC12	RHF	140		RANGER	MC1
Surface RL: 633.97							
Grid Name: MGA94_50							
Incl / Azm: -89-->0							
Construct: 05 Dec 16 - 05 Dec 16							
Comments: HOLE GOES THROUGH jn THEN AN ALTEREN mu ABOVE A DYKE THEN A BAKED MARGIN BELOW BEFORE NORMAL MU AND ...							

TOC RL: 634.52 (Stickup 0.55m) (drilled) SWL: 64.90 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 634.52 (Stickup 0.55m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
100	MU	ER		N			REALLY ALTERED DOLORITE					51mm SLOTTED PVC (61.20-103.20)
110	K	E					SOFT AND SHALE LIKE, BUT SIMILAR IN COLOUR TO HOMESTEAD DOLORITE, SPEARMINT TOOTHPASTE COLOUR					
120		G	MEC				BAKED MARGIN? REALLY HARD TO LOG, DRILLER REPORTS MORE WATER BELOW DYKE					
		G	C	S			MARGINAL AT BEST, SOME MASSIVE G CHIPS					LEVELTROLL(72.00) ID: 2205 END CAP (103.20)
130	MU	J					TYPICAL MU BIF					
		J		N			POSSIBLE RHODOCHROSITE, PINK VEIN MATERIAL					
140		JG										
		BS	R									
150		B	R				ENDS IN ROY HOLL SHALE, LOOKS TO HAVE ALTERATION OF CARBONATE WITHIN IT					

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1139R Hole Length: 153.00

Easting: 761590.03	Depth: 0.0 - 153.0	Drill Rig: RANRC12	Type: RHF	Size: 140	Fluid:	Drilled By: RANGER	Logged By: MC1
Northing: 7407507.47							
Surface RL: 633.97							
Grid Name: MGA94_50							
Incl / Azm: -89-->0							
Construct: 05 Dec 16 - 05 Dec 16							
Comments: HOLE GOES THROUGH jn THEN AN ALTEREN mu ABOVE A DYKE THEN A BAKED MARGIN BELOW BEFORE NORMAL MU AND ...							

TOC RL: 634.52 (Stickup 0.55m) (drilled) SWL: 64.90 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 634.52 (Stickup 0.55m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
150	MU	B	R		█ █ █		ENDS IN ROY HOLL SHALE, LOOKS TO HAVE ALTERATION OF CARBONATE WITHIN IT					
160												
170												
180												
190												
200												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1150R Hole Length: 132.00

Easting: 761630.82	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7408957.13	0.0 - 132.0	RANRC12	RHF	146		RANGER	JT4
Surface RL: 648.38							
Grid Name: MGA94_50							
Incl / Azm: -89-->277							
Construct: 05 Dec 16 - 05 Dec 16							
Comments: EOH magnetic dolerite and black shale. pushed as was unsure what the strat was doing and based on ad...							

TOC RL: 649.23 (Stickup 0.85m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 649.23 (Stickup 0.85m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m/ft	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID	
0	SZ	ZXG	HY				good looking detritals, some vit g.					51mm BLANK PVC (0.00-102.60)	
		G		SL			almost all vit g						
	VB2	FG		L			some vit g						
10		G	FL	C			may be marginal						
		GL	F					stil some vit g.					
		GL	F	S				stil some vit g.					
	MM	CL		SG			very limonitic but too much chert						
30		JC	GL	S									
		LG		C			limonitic ore, may still be newman?? check gamma						

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1150R Hole Length: 132.00

Easting: 761630.82	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7408957.13	0.0 - 132.0	RANRC12	RHF	146		RANGER	JT4
Surface RL: 648.38							
Grid Name: MGA94_50							
Incl / Azm: -89-->277							
Construct: 05 Dec 16 - 05 Dec 16							
Comments: EOH magnetic dolerite and black shale. pushed as was unsure what the strat was doing and based on ad...							

TOC RL: 649.23 (Stickup 0.85m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 649.23 (Stickup 0.85m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50		LG		C			limonitic ore, may still be newman?? check gamma white shales				[Diagram Column]	51mm BLANK PVC (0.00-102.60)
		JC	GL									
		J1		HLG								
		J1		GQ			small quartz chips					
60		J	1	GL								
		CJ	1	Q								
70		CJ		QH			very cherty, possibly football cherts but doesnt have the gamma response					
80												
90		JS	C				shaley bif					
		S	J				yellow shales					
		JS	C	Q			shaley bif					
100		JS	C	Q			shaley bif					

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1150R Hole Length: 132.00

Easting: 761630.82	Depth: 0.0 - 132.0	Drill Rig: RANRC12	Type: RHF	Size: 146	Fluid:	Drilled By: RANGER	Logged By: JT4
Northing: 7408957.13							
Surface RL: 648.38							
Grid Name: MGA94_50							
Incl / Azm: -89-->277							
Construct: 05 Dec 16 - 05 Dec 16							
Comments: EOH magnetic dolerite and black shale. pushed as was unsure what the strat was doing and based on ad...							

TOC RL: 649.23 (Stickup 0.85m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 649.23 (Stickup 0.85m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
100		JS	C	Q			shaley bif					51mm BLANK PVC (0.00-102.60)
110		J	SC									51mm SLOTTED PVC (102.60-120.60)
120	MU	E	B	PQ			dolerite dyke with black shale and sulphides. some very magnetic chips. some green chips 114-117m					END CAP (120.60)
130												
140												
150												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1153R Hole Length: 141.00

Easting: 761633.11	Depth: 0.0 - 141.0	Drill Rig: RANRC12	Type: RHF	Size: 146	Fluid:	Drilled By: RANGER	Logged By: JT4
Northing: 7409258.79							
Surface RL: 639.91							
Grid Name: MGA94_50							
Incl / Azm: -89-->300							
Construct: 14 Dec 16 - 14 Dec 16							
Comments: EOH N1 BIF. Pushed to make sure was in N1, thought went into NS3/4 at 99m so pushed a bit more, then...							

TOC RL: 641.27 (Stickup 1.36m) (drilled) SWL: 123.38 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 641.27 (Stickup 1.36m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m	mg/bl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0		ST3	ZXY	GH				mostly small x-balls (2-3mm). 18-21m larger x-balls.					51mm BLANK PVC (0.00-111.00)
10			ZXY	GH				mostly small x-balls (2-3mm). 18-21m larger x-balls.					
20		GS3	ZGY	SL				g rich, some rounded g x-balls. mixed bag of things					
25			ZGY	SL				g rich, some rounded g x-balls. mixed bag of things					
30		VB2	ZGY	LF				think this is still td2, rounded chips. messy gamma					
35			ZGY	LF				think this is still td2, rounded chips. messy gamma					
40		WA1	ZYK	G				may be coming into shales?? check assays					
42			G	LH				angular chips, so think it is getting out of detritals					
45			SGL	F	H			ns3/4. orange shales. may be marginal shaley ore.					
50			HG	L	Q			good ore					

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1153R Hole Length: 141.00

Easting: 761633.11	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409258.79	0.0 - 141.0	RANRC12	RHF	146		RANGER	JT4
Surface RL: 639.91							
Grid Name: MGA94_50							
Incl / Azm: -89-->300							
Construct: 14 Dec 16 - 14 Dec 16							
Comments: EOH N1 BIF. Pushed to make sure was in N1, thought went into NS3/4 at 99m so pushed a bit more, then...							

TOC RL: 641.27 (Stickup 1.36m) (drilled) SWL: 123.38 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 641.27 (Stickup 1.36m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50	N3	HG	L	Q			good ore					51mm BLANK PVC (0.00-111.00)
		HG	L	Q			good ore					
		J	HL	Q			51-54m may be marginal, almost major H. but a bit of chert					
60		JC	H				chert chips are pitted /altered. possibly altered Quartz?					
70		J1	C	Q			dark MN bif. quite clean					
80		J1	C	Q			dark MN bif. quite clean					
90	N2	JC	SL	H			bif gets more yellow and shaley here but not seen on gamma, thought it was MM or NS3/4 but nothing conclusive on gamma					
100												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1153R Hole Length: 141.00

Easting: 761633.11	Depth: 0.0 - 141.0	Drill Rig: RANRC12	Type: RHF	Size: 146	Fluid:	Drilled By: RANGER	Logged By: JT4
Northing: 7409258.79							
Surface RL: 639.91							
Grid Name: MGA94_50							
Incl / Azm: -89-->300							
Construct: 14 Dec 16 - 14 Dec 16							
Comments: EOH N1 BIF. Pushed to make sure was in N1, thought went into NS3/4 at 99m so pushed a bit more, then...							

TOC RL: 641.27 (Stickup 1.36m) (drilled) SWL: 123.38 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 641.27 (Stickup 1.36m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
100		JC	SL	H			bif gets more yellow and shaley here but not seen on gamma, thought it was MM or NS3/4 but nothing conclusive on gamma					51mm BLANK PVC (0.00-111.00)
110		J1	CG	S			eoh					51mm SLOTTED PVC (111.00-135.00)
120	N2											LEVELTROLL(130.00) ID: 2199
130												END CAP (135.00)
140												
150												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1193R Hole Length: 87.00

Easting: 762750.88	Depth: 0.0 - 87.0	Drill Rig: MCYRC15	Type: RHF	Size: 140	Fluid:	Drilled By: MCKAY	Logged By: GAD
Northing: 7407563.88							
Surface RL: 635.69							
Grid Name: MGA94_50							
Incl / Azm: -89-->18							
Construct: 14 Dec 16 - 14 Dec 16							
Comments: Testing mineralisation close to "fault".							

TOC RL: 636.44 (Stickup 0.75m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 636.44 (Stickup 0.75m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0		GC			SJ		#marginal, brown cherts					51mm BLANK PVC (0.00-63.00)
10		CJ	GL		S							
20												
30	MU											
40		LG	C		J		marginal, still very silicious					
45		C	GJL									
50		J	C									

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1193R Hole Length: 87.00

Easting: 762750.88	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7407563.88	0.0 - 87.0	MCYRC15	RHF	140		MCKAY	GAD
Surface RL: 635.69							
Grid Name: MGA94_50							
Incl / Azm: -89-->18							
Construct: 14 Dec 16 - 14 Dec 16							
Comments: Testing mineralisation close to "fault".							

TOC RL: 636.44 (Stickup 0.75m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 636.44 (Stickup 0.75m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m/bpl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50		J	C									51mm BLANK PVC (0.00-63.00)
60												
70	MU											
80		JC		ST			eoh, testing min close to fault as per Ali's instruction					
90												
												END CAP (87.00)
100												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1241R Hole Length: 153.00

Easting: 764088.18	Depth: 0.0 - 153.0	Drill Rig: RANRC12	Type: RHF	Size: 146	Fluid:	Drilled By: RANGER	Logged By: SDD
Northing: 7409191.26							
Surface RL: 617.35							
Grid Name: MGA94_50							
Incl / Azm: -89-->87							
Construct: 13 Dec 16 - 13 Dec 16							
Comments: closed out newman, depth for pizo hole							

TOC RL: 618.37 (Stickup 1.02m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 618.37 (Stickup 1.02m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m/ft	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0	SZ	ZXY	GS				mixed bag					51mm BLANK PVC (0.00-84.00)
		ZXS	KG				white dentaured shale?? with some x balls					
10		ZYK					red soily balls					
20	ST3											
30												
40												
50												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1241R Hole Length: 153.00

Easting: 764088.18	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409191.26	0.0 - 153.0	RANRC12	RHF	146		RANGER	SDD
Surface RL: 617.35							
Grid Name: MGA94_50							
Incl / Azm: -89-->87							
Construct: 13 Dec 16 - 13 Dec 16							
Comments: closed out newman, depth for pizo hole							

TOC RL: 618.37 (Stickup 1.02m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 618.37 (Stickup 1.02m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50	ST3	ZYK					red soily balls					51mm BLANK PVC (0.00-84.00)
		ZK					yellow brown clays					
	CA2	ZK					yellow brown clays					
60							yellow brown clays					
	VB2	ZK					yellow brown clays					
70		ZK	G				aa, some geothite					
		ZKG					transition zone					
	WA2	ZKG					transition zone					
80		FS					should be in WA now					
		S	G									
90		SL	G									
		G	SL				becoming marginally better					
100											51mm SLOTTED PVC (84.00-102.00)	

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1241R Hole Length: 153.00

Easting: 764088.18	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409191.26	0.0 - 153.0	RANRC12	RHF	146		RANGER	SDD
Surface RL: 617.35							
Grid Name: MGA94_50							
Incl / Azm: -89-->87							
Construct: 13 Dec 16 - 13 Dec 16							
Comments: closed out newman, depth for pizo hole							

TOC RL: 618.37 (Stickup 1.02m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 618.37 (Stickup 1.02m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
100	WA2	G	SL				becoming marginally better					51mm SLOTTED PVC (84.00-102.00)
		GS										
110		S	G									
	WA1	G	S									
120		GH					best sammples, high grade?					
		SG										
130		SC										
		GJ	C									
140												
		S	JC									
150		JC					eoh					

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1241R Hole Length: 153.00

Easting: 764088.18	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409191.26	0.0 - 153.0	RANRC12	RHF	146		RANGER	SDD
Surface RL: 617.35							
Grid Name: MGA94_50							
Incl / Azm: -89-->87							
Construct: 13 Dec 16 - 13 Dec 16							
Comments: closed out newman, depth for pizo hole							

TOC RL: 618.37 (Stickup 1.02m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 618.37 (Stickup 1.02m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
150	WA1	JC			Log		eoh					
160												
170												
180												
190												
200												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1248R Hole Length: 123.00

Easting: 764342.42	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409137.70	0.0 - 123.0	RANRC09	RHF	140		RANGER	GAD
Surface RL: 614.16							
Grid Name: MGA94_50							
Incl / Azm: -71-->190							
Construct: 13 Dec 16 - 13 Dec 16							
Comments: Testing structure and strat							

TOC RL: 615.05 (Stickup 0.89m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 615.05 (Stickup 0.89m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m gbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0	SZ	ZXC	S	C	█							51mm BLANK PVC (0.00-72.00)
10		ZS	K		█							
20	ST3				█							
30					█							
40					█							
50					█							

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1248R Hole Length: 123.00

Easting: 764342.42	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409137.70	0.0 - 123.0	RANRC09	RHF	140		RANGER	GAD
Surface RL: 614.16							
Grid Name: MGA94_50							
Incl / Azm: -71-->190							
Construct: 13 Dec 16 - 13 Dec 16							
Comments: Testing structure and strat							

TOC RL: 615.05 (Stickup 0.89m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 615.05 (Stickup 0.89m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m/bpl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50	ST3	ZS	K									51mm BLANK PVC (0.00-72.00)
		ZSG		K								
60	VB2	ZSG		K								51mm SLOTTED PVC (72.00-90.00)
		ZG	S	T								
70	WA2	ZG	S	T								51mm SLOTTED PVC (72.00-90.00)
		ZG	CS									
		ZG	SN									
80	WA2	S	G									51mm SLOTTED PVC (72.00-90.00)
		S		G								
90	WA2											51mm SLOTTED PVC (72.00-90.00)
		S	JG									
100												END CAP (90.00)

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1248R Hole Length: 123.00

Easting: 764342.42	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7409137.70	0.0 - 123.0	RANRC09	RHF	140		RANGER	GAD
Surface RL: 614.16							
Grid Name: MGA94_50							
Incl / Azm: -71-->190							
Construct: 13 Dec 16 - 13 Dec 16							
Comments: Testing structure and strat							

TOC RL: 615.05 (Stickup 0.89m) (drilled) SWL: Dev: N Final pH: -
 TOC RL: 615.05 (Stickup 0.89m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m/bpl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
100		S	JG									
		S					YELLOW AND LIGHT PINK SHALES					
110	WA2											
		SC					EOH, THOUGHT WAS IN MM,					
120												
130												
140												
150												

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1270R Hole Length: 135.00

Easting: 765523.29	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7408555.02	0.0 - 135.0	RANRC11	RHF	146		RANGER	SDD
Surface RL: 605.88							
Grid Name: MGA94_50							
Incl / Azm: -70-->173							
Construct: 13 Dec 16 - 13 Dec 16							
Comments:							

TOC RL: 606.68 (Stickup 0.80m) (drilled) SWL: 87.56 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 606.68 (Stickup 0.80m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m/gbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
0	SZ	ZXY	G	SK			x balls and silt					51mm BLANK PVC (0.00-84.00)
10		ZXY	G	SK			x balls and silt					
20	ST3											
30												
40												
50	VB2	ZXY	G	SK			x balls and silt					
		SJ					white shales/clay					
		SG	J									

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1270R Hole Length: 135.00

Easting: 765523.29	Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
Northing: 7408555.02	0.0 - 135.0	RANRC11	RHF	146		RANGER	SDD
Surface RL: 605.88							
Grid Name: MGA94_50							
Incl / Azm: -70-->173							
Construct: 13 Dec 16 - 13 Dec 16							
Comments:							

TOC RL: 606.68 (Stickup 0.80m) (drilled) SWL: 87.56 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 606.68 (Stickup 0.80m) (current) Is Live: Y (-) Date: - Final EC: -

Depth m/gbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
50	VB2	SG	J									51mm BLANK PVC (0.00-84.00)
60		SG S	J		GJ		pale white shales					
70	WA2	G	S				marginal					51mm SLOTTED PVC (84.00-102.00)
80		GS										
90		SG										
100		GS										
		G	S									LEVELTROLL(100.00) ID: 2200

BHPIO - Hydrogeology Log



Project: WESTERN RIDGE Hole Name: WSR1270R Hole Length: 135.00

Easting: 765523.29	Depth: 0.0 - 135.0	Drill Rig: RANRC11	Type: RHF	Size: 146	Fluid:	Drilled By: RANGER	Logged By: SDD
Northing: 7408555.02							
Surface RL: 605.88							
Grid Name: MGA94_50							
Incl / Azm: -70-->173							
Construct: 13 Dec 16 - 13 Dec 16							
Comments:							

TOC RL: 606.68 (Stickup 0.80m) (drilled) SWL: 87.56 MBTOC (30 Aug 18) Dev: N Final pH: -
 TOC RL: 606.68 (Stickup 0.80m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mglbl	Strat	Major	Minor	Trace	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes Casing size as ID
100	WA2	G	S									51mm SLOTTED PVC (84.00-102.00)
			GSC									
			GS									
110	WA1	S	G									
			GC				becoming cherty					
			CG				aa					
120												
130												
140												
150												

APPENDIX B

Field Sheets

APPENDIX C

Calibration Certificates

APPENDIX D

Laboratory Certificates

APPENDIX E
Chromatographs

APPENDIX F

Important Information



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