Report

Iron Bridge Mine Area Hydrogeological Assessment

Strategic Planning

10/03/2023
IB-5700-RP-WM-0002 Rev 0

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EXECUTIVE SUMMARY

A hydrogeological assessment has been completed to support an application for an increase in the allocation and purposes of the Iron Bridge mine area groundwater abstraction licence. The assessment has been undertaken in accordance with DWER guidance documentation and consultation.

Technical information from several years of studies at Iron Bridge have been consolidated to form an updated conceptual model of the area's groundwater resource, both in terms of water quality and quantity, and potential groundwater dependent receptors such as vegetation and pools. A numerical groundwater model has subsequently been developed to simulate the potential drawdown impact of proposed abstraction on the water resource and receptors; and investigate the model sensitivity to the heterogeneous nature of the fractured rock aquifers of the area.

The outcomes of the impact assessment highlight the model uncertainty and its inability to adequately predict expected groundwater level outcomes. The range of outcomes from sensitivity analysis has therefore been used to develop a risk-based approach to setting adaptive management strategies, monitoring and recommendations for future work, in order to meet the objectives of:

1. No unauthorised impact to identified environmental groundwater receptors, beyond natural variability;
2. Groundwater quality and level trends are in line with expectation; i.e. that unexpected aquifer trends are identified and investigated;
3. Successful and safe dewatering of below water table pits; and
4. Water supply abstraction optimised to contribute to overall mine water balance.

With appropriate management, impacts to groundwater receptors can be avoided, although it is acknowledged this may require a reduction in abstraction or intervention such as supplementation. The target of sustainable water supply abstraction may also require careful management of a fractured rock water resource with limited storage.

TABLE OF CONTENTS

EXECUTIVE SUMMARY 3

1. INTRODUCTION 9
   - 1.1 Scope 10
   - 1.2 Existing Licenses 10
   - 1.3 DWER Consultation 11
   - 1.4 Proposed Amendment 12

2. CLIMATE 13

3. SITE LOCATION REFERENCES 16

4. GEOLOGY 17

5. HYDROGEOLOGY 19
   - 5.1 Drilling 19
   - 5.2 Test Pumping 19
   - 5.3 Groundwater Catchment, Levels and Flow 22
   - 5.4 Groundwater Recharge and Discharge 23
   - 5.5 Groundwater Trends 26
   - 5.6 Groundwater Chemistry 27
   - 5.7 Hydrostratigraphy 30
   - 5.8 Aquifer Connectivity 32

6. ENVIRONMENTAL AND SOCIAL VALUES 33
   - 6.1 Heritage Value 33
   - 6.2 Groundwater Dependent Ecosystems 33
   - 6.3 Stygofauna 33
   - 6.4 Groundwater Dependent Vegetation 34
   - 6.5 Groundwater – Surface Water – Vegetation Interaction 35
   - 6.6 Pools 36

7. EXISTING USE 43
   - 7.1 Mine Water Balance 43

8. GROUNDWATER MODELLING 46

9. RECOVERY OF SEEPAGE 47

10. CONSTRUCTION AND FOUNDATION DEWATERING 49

11. ASSESSMENT OF IMPACTS 50

11.1 Groundwater Levels 50

11.1.1 Impacts on Bore Yields 50

11.1.2 Impacts to Other Users 50

11.1.3 Impacts to the Environment 51

11.1.3.1 Stygofauna 52

11.1.3.2 Groundwater Dependent Vegetation 54

11.1.3.3 Site 12 Pool 54

11.1.3.4 Mundagoora Pool 55

11.1.3.5 Fig Pool and Cow Springs 56

11.1.3.6 Astrid Bee Cave; Craig's Pool; Dingo Lair Pool; Zane's Gorge Pool 58

11.2 Impacts to Groundwater Quality 58

12. GROUNDWATER AND VEGETATION MONITORING 59

13. MANAGEMENT APPROACH 61

14. CONCLUSIONS 65

List of Tables

Table 1: North Star 5C Licence History 10
Table 2: Summary of DWER Consultation 11
Table 3: Summary of Iron Bridge climate data 15
Table 4: Development of New Site Location References (overlap is approximate) 16
Table 5: Primary Phases of Groundwater Investigations and Assessments at Iron Bridge Mine 19
Table 6: Summary of Testing Detail for IB_SB_P03 and IB_SB_P04 20
Table 7: Rainfall Recharge Analysis of NS-0664 25
Table 8: Summary of geology and hydrostratigraphy 31
Table 9: Water related heritage values of the Iron Bridge Mine area 33
Table 10: Pools of the Iron Bridge Mine Area (adopted from Iron Bridge (2022) and Hydrobiology (2023)) 37
Table 11: TSF monitoring and seepage recovery bore details 47
Table 12: Proposed "plug" seepage monitoring bores 48
Table 14: Summary of potential impacts and inherent risk to environmental groundwater receptors from groundwater level changes 51
Table 13: Summary of potential impacts and inherent risks to groundwater quality 58
Table 15: Additional Monitoring to Support Revised Licence 59
Table 16: Groundwater Management under Other Approval Instruments 62
Table 17: Groundwater Management Recommended under RIWI Act Groundwater Operating Strategy (from Appendix 10) 63

List of Figures

Figure 1: Cumulative deviation from the mean rainfall for Indee and Wallareenya Stations (1908 – 2022) 13
Figure 2: Iron Bridge climate data – January 2011 to December 2022 14
Figure 3: Schematic representation of Iron Bridge Mine geology 18
Figure 4: Summary hydraulic conductivity values from aquifer testing at Iron Bridge (from FMG(2022)) 21
Figure 5: IB_SB_P03 Constant Rate Test Results 22
Figure 6: IB_SB_P04 Constant Rate Test Results 22
Figure 7: Typical recharge response hydrographs for bores in the Project area 24
Figure 8: Hydrograph of response to rainfall for NS-0664 25
Figure 9: Cross plot of rainfall and runoff for NS-0664 monitoring data 26
Figure 10: Representative Hydrograph for NS_BH05A 27
Figure 11: Piper diagram of all available groundwater and pool samples at Iron Bridge 28

Figure 12: **Piper diagram of selected groundwater flow path, indicated in associated map** 29
Figure 13: **Conceptual schematic of generalised groundwater, surfacewater and vegetation interaction at Iron Bridge Mine (adapted from Bourke *et al.* (2023))** 36
Figure 14: **Iron Bridge Design Water Balance** 45
Figure 15: **Conceptual schematic of Site 12 Pool, showing relative water levels in upstream catchment and pool system (adapted from Bourke *et al.* (2023))** 54
Figure 16: **Conceptual schematic of Mundagoora Pool, showing relative water levels in upstream catchment, the pool and downstream (adapted from Bourke *et al.* (2023))** 55
Figure 17: **Water level and temperature responses from Cow Spring and Fig Pool.** 56
Figure 18: **Piper diagram comparing water chemistry in Fig Pool and Cow Springs with nearby groundwater** 57
Figure 19: **Schematic illustration of fracture flow groundwater source for Cow Spring and Fig Pool (adapted from Bourke *et al.* (2023)).** 58
Figure 20: **Adaptive Management Framework in the Context of Iron Bridge Groundwater Management** 61

List of Maps

Map 1: Regional Project Overview 68
Map 2: Local Project Overview 69
Map 3: Site Naming Conventions 70
Map 4: Site Geology 71
Map 5: Hydrogeological Drilling Undertaken 72
Map 6: Hydrogeological Test Work Undertaken 73
Map 7: Site Hydrogeological Features 74
Map 8: Water Sampling Undertaken 75
Map 9: Stygofauna Habitat Modelling and Species Occurrence 76
Map 10: Groundwater, Surface Water and Vegetation Interactions 77
Map 11: Iron Bridge TSF Seepage Recovery 78
Map 12: WRD Seepage Recovery Map 79
Map 13: Predicted drawdown in the context of Vegetation and Pools 80
Map 14: Predicted drawdown impacts in the context of Stygofauna 81
Map 15: Groundwater and other Monitoring Sites 82

LIST OF APPENDICES

Appendix 1: Groundwater Licence 176289 and 164321 Details
Appendix 2: Groundwater Bore Details
Appendix 3: Compiled Borelogs
Appendix 4: 2022 Iron Bridge Hydrogeological Investigation Summary
Appendix 5: Test Pumping data and analysis for IB_SB_PB03 and IB_SB_PB04
Appendix 6: Tabulated water quality data statistics for Iron Bridge
Appendix 7: Groundwater Modelling Report
Appendix 8: Inherent Risk Assessment with no Management / Controls
Appendix 9: Existing Groundwater Monitoring and Triggers (Iron Bridge, 2023)
Appendix 10: Residual Risk Assessment with Adaptive Management / Controls

1. INTRODUCTION

Iron Bridge Operations Pty Ltd (IBO) has been developing the Iron Bridge iron ore mine (also referred to as North Star) since November 2013. The Iron Bridge site is located approximately 100 km south of Port Hedland and 25 km east of the existing Fortescue rail line to Port Hedland, shown on Map 1. Iron Bridge is located within Mining Tenements M45/1226 and M45/1244 and Miscellaneous Licences L45/294, L45/397 and L45/361, in the northern portion of a large magnetite orebody.

The Iron Bridge operations consist of two operationally distinct phases of mining operations: the Stage 1 North Star Hematite mine and the Stage 2 North Star Magnetite mine.

Stage 1 commenced in November 2013 and involved the construction of a processing plant and other aspects associated with mining of the orebody to process up to 10 million tonnes of ore each year. Ore was mined until April 2016, then operations were restricted, with full-scale operations put under suspended operations from April 2016 to July 2019.

In August 2019, IBO began construction of the Stage 2 Project with the construction of an aerodrome and associated access road, the expansion of the Iron Bridge accommodation village (up to 2,000 persons), the construction of water pipelines and infrastructure, and the development/widening of sections of existing site access road to process up to 20 million tonnes of ore each year. These project elements are illustrated in Map 2. The Stage 2 mine is projected to enter production in 2023.

The mine's ongoing water balance requires over 23 GL/a of water input, the majority of which is planned to be supplied by the West Canning Basin Borefield (GWL175700). IBO has been operating a near mine water supply borefield, initially to meet construction demands, but also to supplement water during operations. Between 2020 and 2022, these demands have been met with an annual water allocation of 2.5 gigalitres per annum (GL/a), approved for use in accordance with 5C groundwater license GWL179289. Operational data and ongoing borefield development indicates the local aquifer system can sustain higher annual abstraction for limited periods, whilst managing risks to environmental receptors under the North Star Groundwater Operating Strategy (Iron Bridge, 2023).

In addition to water demands, life of mine plans indicate the need for groundwater abstraction to facilitate mine dewatering, seepage recovery abstraction, and potentially foundation dewatering. GWL 179289 therefore requires an amendment to support the future development of the mine.

1.1 Scope

The primary objectives of this H3 Hydrogeological assessment is to support the licence application and consolidate the groundwater impact and risk assessment. The scope to achieve this objective is:

- Outline the proposed changes to Iron Bridge Mine's groundwater abstraction activities, and associated licensing;
- Provide a consolidated summary of hydrogeological works completed at Iron Bridge Mine;
- Identify relevant groundwater receptors in the Iron Bridge Mine area;
- Establish management objectives to address risks of unapproved impacts to these receptors;
- Present the most recent hydrogeological conceptualisation and associated numerical representation thereof;
- Assess likely impacts from proposed dewatering and water supply abstraction on the identified receptors, including seepage recovery abstraction; and
- Present appropriate management strategies, including monitoring and contingency actions, to meet the stated management objectives and mitigate risks.

This H3 Level Hydrogeological report has been prepared in accordance with the DoW guidelines "Operation Policy No. 5.12 – Hydrogeological Reporting Associated with a Groundwater Well Licence".

1.2 Existing Licenses

Groundwater abstraction at Iron Bridge mine is subject to two Groundwater Well Licences; GWL179289, and GWL164321, which allow abstraction of 2,500,000 kL/annum and 90,000 kL/annum respectively. Licence documentation is provided in Appendix 1, and a history of each licence is summarised in Table 1.

The proposed licence amendment associated with this H3 Assessment includes amalgamation of GWL179289 and GWL164321, simply to reduce administration of two licenses with overlapping tenements, bores and purposes.

Table 1: North Star 5C Licence History

DoW Licence	Annual Allocation (kL)	Licence Approval	Licence Expiry	Source Tenements	Licensed Aquifer	Purpose
GWL179289 (1)	450,000	27 Oct 2014	31 Jan 2015	M45/1226 L45/361	Pilbara Fractured Rock	Dust suppression, hydro pressure

DoW Licence	Annual Allocation (kL)	Licence Approval	Licence Expiry	Source Tenements	Licensed Aquifer	Purpose
						testing, camp water supply
GWL179289 (2)	450,000	06 Nov 2014	31 Jan 2015			As above with Ore processing and other mining uses
GWL179289 (3)	750,000	10 Dec 2014	02 Mar 2015			
GWL179289 (4)	2,500,000	13 July 2016	12 July 2021	M45/1226 L45/361 M45/1244		Operational usage and camp water supply
GWL179289 (5)	2,500,000	23 Oct 2020	22 Oct 2030			
GWL179289 (6)	2,500,000	16 Feb 2023	22 Oct 2030			As above
GWL164321	90,000	9 Sep 2014	29 Aug 2024	M45/1226[1]	Pilbara – Fractured Rock	Camp water supply

[1] This tenement is not correct and FMG contacted DWER regarding amending this licence in 2023; a decision to amalgamate with GWL 179289 was decided instead.

1.3 DWER Consultation

Fortescue has engaged in consultation with DWER on the proposed changes to the Iron Bridge Mine's groundwater abstraction licence since December 2021. Table 2 provides a summary of the main points of consultation.

Table 2: Summary of DWER Consultation

Date	Format	Outcomes
17/12/2021	Meeting	DWER agreed on including additional 4.5 GL of dewatering into licence amendment.
01/02/2022	Email	Confirmation that licence amendment: - Will increase annual entitlement. - Includes dewatering as an authorised activity. - Makes the GWOS consistent with the Site 12 Pool Plan
02/02/2022	Email	Dewatering volumes for RIWI Act approval not to incorporate incident rainfall and runoff into the pit. Only to account for groundwater inflow.
22/03/2023	Email	TSF return and Seepage recovery not required to be regulated under RIWI Act. The latter was clarified via telephone call in late March as referring to seepage that had not yet reported back to groundwater. Any seepage to groundwater would require RIWI Act approval to re-abstract. Adaptive management agreed to owing to model uncertainty. GWOS requirements for trigger and response framework made clear.

Date	Format	Outcomes
03/07/2023	Meeting	Fortescue presented a technical summary of the H3 assessment, to assist DWER with navigating the document once received. No specific outcomes relevant to the assessment were noted, apart from an agreement to proceed with submission of the H3 report and GWOS.

1.4 Proposed Amendment

The proposed licence amendment is to:

- Increase the allocation of this licence from 2.5 GL/a to 8.5 GL/a;
- Incorporate approved activities of dewatering and seepage recovery alongside the existing water supply abstraction purposes; and
- Amalgamate GWL179289 with GWL164321

The single licence allocation will be comprised of:

- Groundwater abstraction for water supply of 3.5 GL/a, an increase of 1 GL/a from the existing licence;
- Pit dewatering of up to 4.5 GL/a. This aligns with the Part IV limit under Ministerial Statement 993; and
- Groundwater seepage recovery up to 0.5 GL/a from water management activities across Iron Bridge Mine, which currently include downstream of the TSF, approved under Works Approval W6322/2019/1, and future planned seepage recovery from the “Plug” downstream of the Waste Rock Dump (approved under Mining Proposal 93044).

As per correspondence with DWER, recovery of water which seeps or decants into a Return Water Pond or other engineered feature (i.e. does not return to groundwater), does not require abstraction regulation under the RIWI Act. Inclusion of these values would require a much higher licence allocation to account for potential stormwater runoff decanted into the Pond.

2. CLIMATE

The climate of the Pilbara is subtropical dry, characterised by low and variable rainfall, high daily temperatures, high diurnal temperature variability and high evaporation rates. Monthly maximum daily temperatures between October and April consistently exceed 35°C. Months between May and September have temperatures ranging from approximately 7°C to 23°C.

Average annual rainfall is approximately 318.8 mm, as measured by the Bureau of Meteorology (BoM) at the weather station Wallareenya, (BoM station 004038). The majority of rainfall in the area is largely derived from cyclonic events and as a result, is highly episodic, generally concentrated around the wet season (October to March), and variable between years. Average annual (pan) evaporation in the area is between 3,200 and 3,600 mm per year (BoM, 2020), which greatly exceeds annual rainfall and consequently contributes to the arid environment.

Figure 1 illustrates an assessment of long-term monthly deviation from mean monthly rainfall, indicating patterns of drying, wetting and stable rainfall trends. This assessment considers data from Wallareenya and Indee (BoM station 004016) rainfall stations. The data indicates the region has experienced a long term cycle of drying, stable and wetting trends, each spanning 30 – 50 years. Notable periods of change include:

- Significant drought in the late 1940's
- Several years of well above average rainfall (steep upward trend) in the late 1990's, through into early 2000's.

More recently, the data indicates a continuation of the latest wetting cycle, albeit with a gradual reduction in the rate of change.

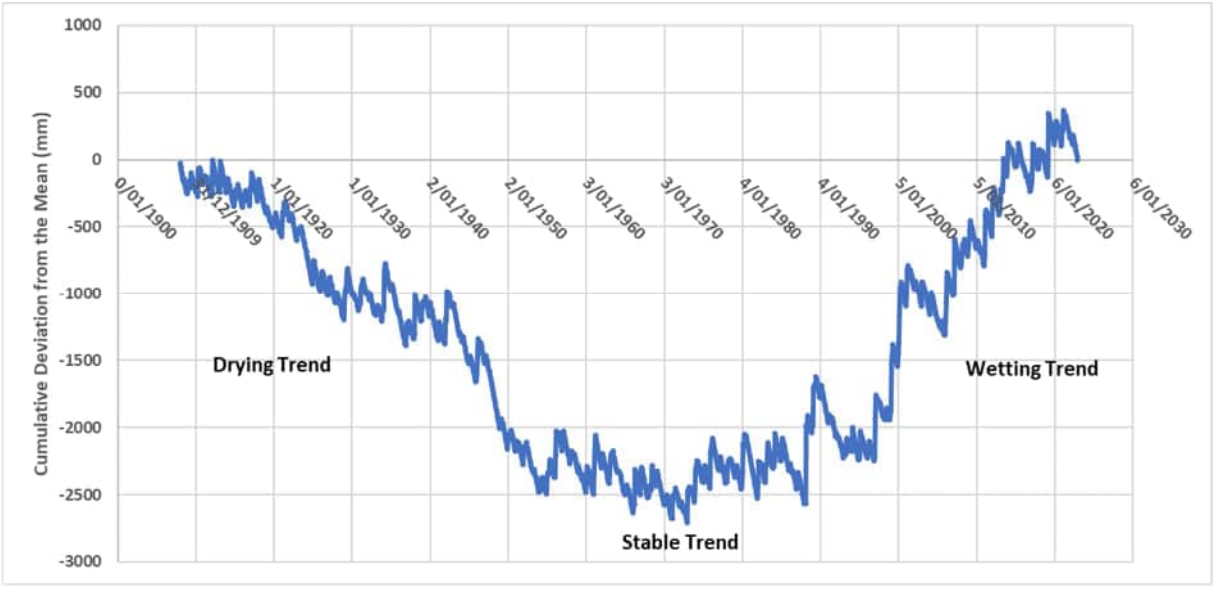


Figure 1: Cumulative deviation from the mean rainfall for Indee and Wallareenya Stations (1908 – 2022)

Onsite weather data is currently collected through NS_Nate_WE-WS_01 automatic weather station and previously (Mar 2011 – May 2017) from the North Star Rain Gauge. Historical rainfall data and temperature is displayed in Figure 2, and summarised in Table 3. The climate is typical for expected temperature and rainfall in the Pilbara, with frequent low-intensity rainfall throughout the year associated with thunderstorms and high-volume cyclonic rainfall occurring in wet season months (i.e. March 2019 which was associated with Cyclone Veronica).

The Iron Bridge mine is located on the boundary between the Turner River and Shaw River catchments. The area consists of numerous sub-catchments that are characterised as hilly. The dominant vegetation is eucalyptus woodland and hummock grassland. Rainfall runoff flows predominantly into the Turner River to the west. Stream flow measurements are not available within the study area.

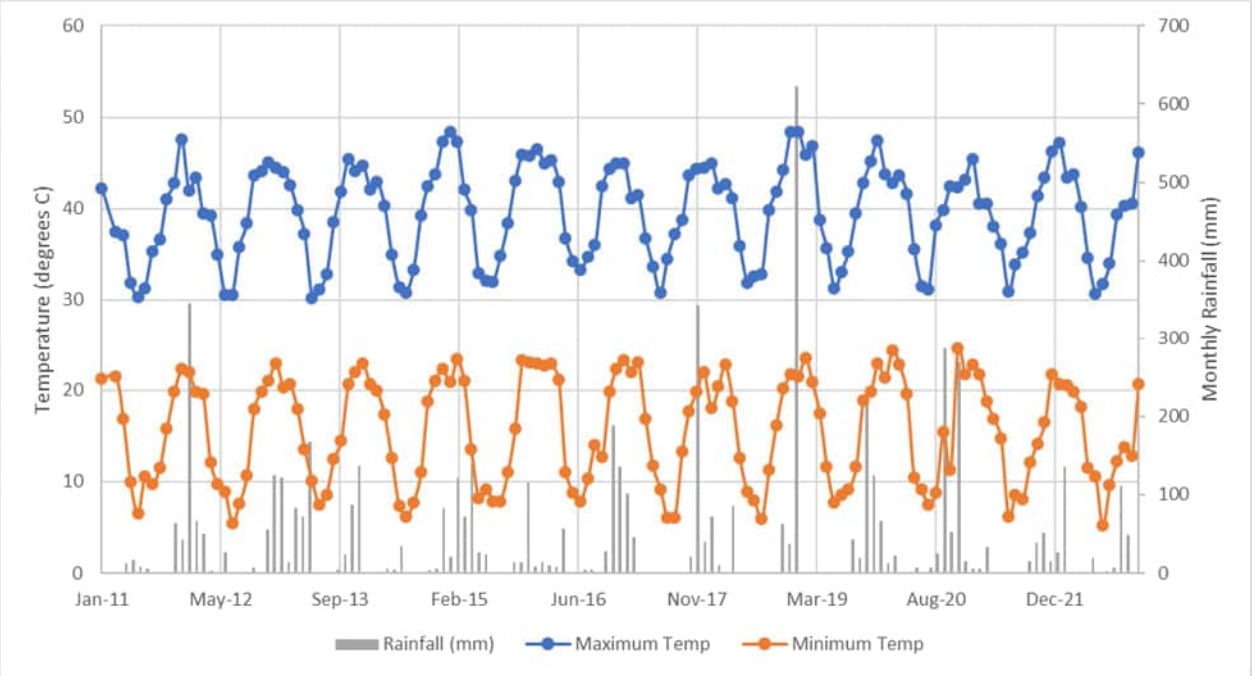


Figure 2: Iron Bridge climate data – January 2011 to December 2022

Table 3: Summary of Iron Bridge climate data

Month	Mean Monthly Rainfall (mm)	Mean Minimum Temperature	Mean Maximum Temperature
Jan	151.3	45.3	21.8
Feb	82.8	43.5	21.7
Mar	94.1	42.4	21.2
Apr	26.5	39.7	17.2
May	29.7	35.0	11.5
Jun	35.9	31.3	8.6
Jul	5.5	32.2	7.5
Aug	0.7	35.0	8.3
Sep	2.5	38.5	12.2
Oct	2.1	42.2	15.6
Nov	13.8	43.9	19.9
Dec	43.5	45.9	22.0

3. SITE LOCATION REFERENCES

In previous reports for Iron Bridge, reference was made to the Northern, Southern, Eastern and Western Borefields. Whilst appropriate at the time, the progressive development and management of the site warrants a revised approach. New areas and revised boundaries have been developed with consideration of abstraction locations, key site activities and receptors.

Map 3 illustrates the updated site location references. Table 4 summarises the relationship between the new and old naming conventions.

Table 4: Development of New Site Location References (overlap is approximate)

Previous Nomenclature	Current Nomenclature
Northern Borefield	Northern Borefield
Southern Borefield	Southern Borefield
Western Borefield	Western Borefield
	North Star Pit Area
	TSF and RWP Area
Eastern Borefield	Northern Valley
	Waste Rock Dump 1 Area
Development	Site 12 Pool Area
	Glacier Valley Pit Area
Previously unassigned	Mundagoora Area

4. GEOLOGY

Map 4 shows the geological complexes and structures of the IB site, which are illustrated schematically in Figure 3. The stratigraphic sequence, from oldest to youngest, is as follows:

- Sulphur Springs Group, comprised of:
    - the Leilira Formation (A-SSl-s), composed of metamorphosed quartz sandstone and minor layered quartz carbonate rock and siltstone, overlain by
    - the Kunagunarrina Formation (A-SSk-b), composed of greenschist facies, dominantly of komatiitic, high-Mg and tholeiitic metabasalt, and
    - the Kangaroo Caves Formation (A-SSc-xf-s), representing a differentiated volcanic-volcaniclastic pile of mainly tholeiitic magmatic affinity, varying from basalt to rhyolite, with comagmatic granite. It includes chert, local polymictic mega breccia and iron-formation, and calc-alkaline rhyodacite. The Pincunah Banded-iron Member (A-SScp-ci) occurs at the top of this unit and comprises metamorphosed jaspilitic banded-iron formation (BIF) with minor layered chert and shale.
- The Corboy Formation of the Gorge Creek Group (A-SOc-s),
    - Predominantly sandstone and conglomerate sequence, with some locally interbedded siltstone and shale in part. Pebbles in the conglomerate consist mostly of chert. In the Pincunah Belt, the basal portion of the Corboy Formation is made-up of a transitional sequence from the underlying Pincunah Hill Formation of quartzite interbedded with siltstone, wackes and shaley siltstone, progressing upward to lithic sandstone or greywacke.

There is no mapped Cainozoic geology in the region from the 1:250,000 or 1:100,000 map sheets provided by the Geological Survey of Western Australia, owing to the limited presence and extent of this material. Sheetwash deposits composed of silt, sand, and pebbles, are deposited on distal fans with no defined drainage, whilst creeks and other drainage features contain unconsolidated silt, sand, coarse sand, and gravel (Van Kranendonk, 2000).

The bedded geological units are sub-vertical, with oxidation commonly 50 – 70 m from surface, although this could be deeper in some areas. Conceptually, the pit area is sandwiched between what could be described as highly recessive, poorly exposed shales of the Kangaroo Formation to the west, and inter-bedded shales, mudstones, cherts, BIF and quartzite of the Corboy Formation to the east. In Figure 3 they are presented as West and East Shales.

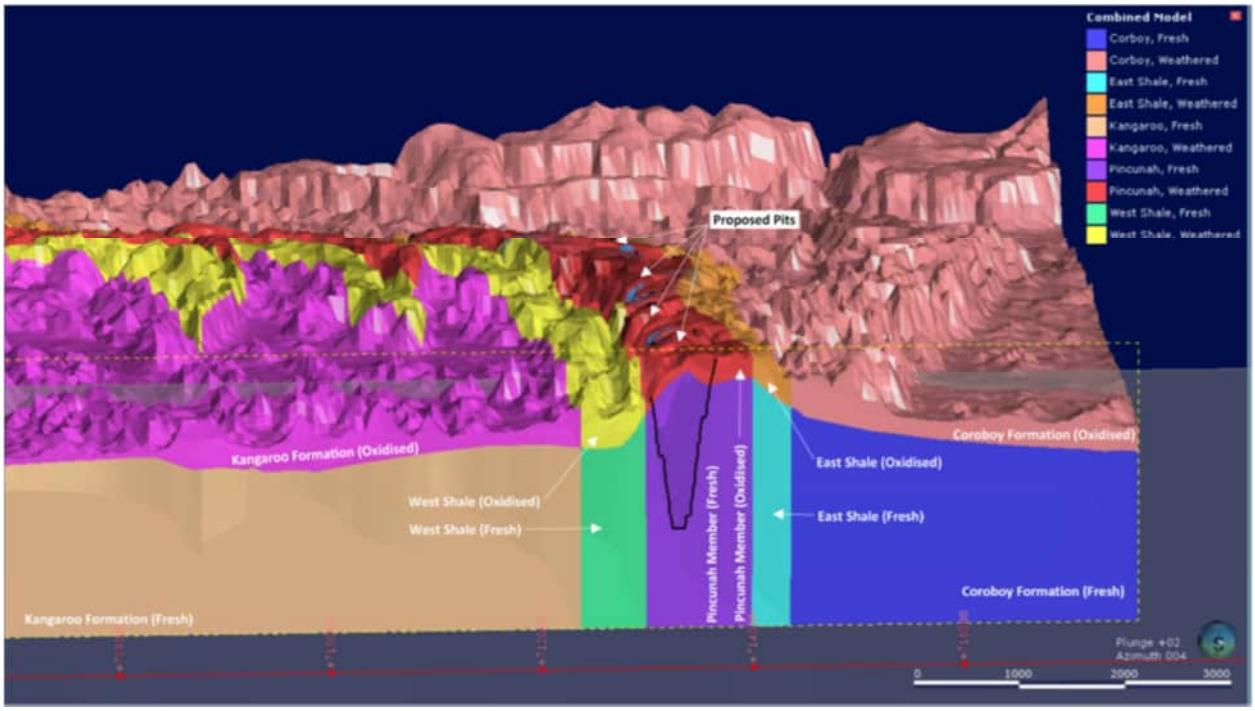


Figure 3: Schematic representation of Iron Bridge Mine geology

As indicated in Map 4, the Iron Bridge area is structurally complex. Faults within the Southern and Northern Borefields generally trend in a north-northwest – south-southeast direction, while faults in the North Star Pit/TSF Catchment area trend in a north-east – south-west direction. Faulting is concentrated within the Southern Borefield area (Map 4)

5. HYDROGEOLOGY

Hydrogeological investigations have been undertaken at Iron Bridge Mine since 2012. Table 5 outlines the main investigation programs, their area of activity and primary objective. Additional drilling and testing has occurred independently to structured programs, whilst compliance and operational groundwater monitoring continues to add to the body of groundwater knowledge at the site. Groundwater monitoring summaries and reports submitted to DWER as part of obligations for GWL 179289 document this ongoing data collection.

Table 5: Primary Phases of Groundwater Investigations and Assessments at Iron Bridge Mine

Program	Year	Area of Activity	Objective
Worley Parsons Preliminary Pit Dewatering Assessment	2012	Orebody, TSF Area	Define hydraulic parameters in the pit area and estimate pit dewatering volumes
Iron Bridge Stage 1 Near Mine Water Supply Borefield Investigation	2015	Western Borefield, Southern Borefield, Northern Borefield, TSF Area	Investigate and establish the near-mine water supply
Iron Bridge Near Mine Falling Head Test and Test Pumping Program	2018	Orebody, TSF Area	Further define hydraulic parameters in the pit and TSF area
Iron Bridge Stage 2 Near Mine Water Supply Borefield Investigation	2020	Southern Borefield, Northern Borefield, TSF Area	Investigate and increase the available near-mine water supply capacity
Iron Bridge Near Mine Falling Head Test Program	2020	Orebody	Further define hydraulic parameters in the pit area
North Star Hydrogeology and Pit Dewatering Volume – Support for Section 45C Application	2020	Orebody	Modelling assessment to support Part IV amendment for inclusion of 5 GL of pit dewatering

The following sections describe the main components of Iron Bridge Mine's hydrogeology, based on site works to date.

5.1 Drilling

A total of 142 groundwater exploration, monitoring and abstraction bores are registered as having been drilled in the Iron Bridge Mine Area. As indicated above, the drilling has been undertaken as part of structured investigation programs, and for targeted purposes such as increases borefield capacity or environmental monitoring. Bore locations are illustrated in Map 5, and tabulated in Appendix 2. The compilation of available bore logs is included as Appendix 3.

5.2 Test Pumping

A compilation of all hydraulic testing undertaken at Iron Bridge Mine is contained within the memorandum, *2022 Iron Bridge Hydrogeological Investigation Summary* (Appendix 4). Aquifer testing to date comprises:

- 51 Constant rate tests
- 20 Falling head tests; and
- 5 Packer tests

These tests have been undertaken across the site, including the pit area, TSF area, and water supply borefields (Map 6). Statistical analysis of the test results, grouped by Hydrostratigraphic unit (refer to Section 5.7), is illustrated in Figure 4 below.

Additional tests have been completed since the sitewide review, on bores IB_SB_P03 and IB_SB_P04, drilled in February and March 2023, respectfully. The results of these tests are summarised in Table 6 and Figure 5 and 6 below, with test pumping analysis included in Appendix 5.

Table 6: Summary of Testing Detail for IB_SB_P03 and IB_SB_P04

Bore	Test	Rate(s) L/s	Drawdown (m)	Interpretation
IB_SB_P03 (SWL @ 25 mbgl, pump setting @ 127 mbgl)	SRT (4 x 60 mins)	30 / 35 / 40 / 45	32.8 / 43.8 / 55.4 / 68.1	Inefficient well but capable of high flow rates
	CRT (540 mins)	15	12.45	Single fracture flow with high conductivity (~10 m/d); well may be partially penetrating.
IB_SB_P04 (SWL @ 36.1 mbgl, pump setting @ 89.7 mbgl)	SRT (4 x 60 mins)	45 / 50 / 55 / 60	16.4 / 18.9 / 21.5 / 24.1	Efficient well capable of high flow rates
	CRT (2880 mins)	55	23.32	

The findings of test pumping and other aquifer tests to date have indicated the presence of structural control, likely in the form of faults and/or permeability contrasts from the sub-vertical geological units.

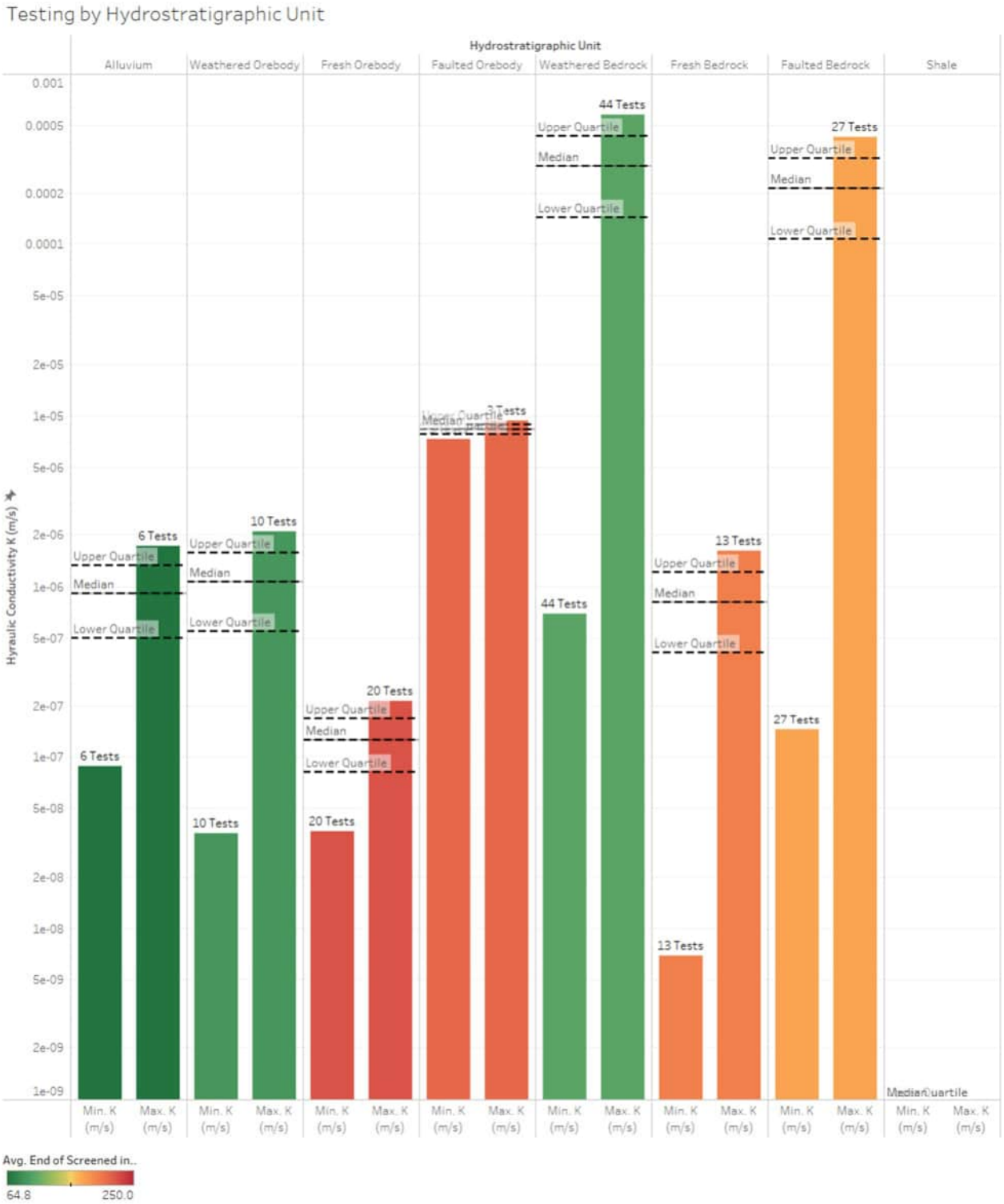


Figure 4: Summary hydraulic conductivity values from aquifer testing at Iron Bridge (from FMG(2022))

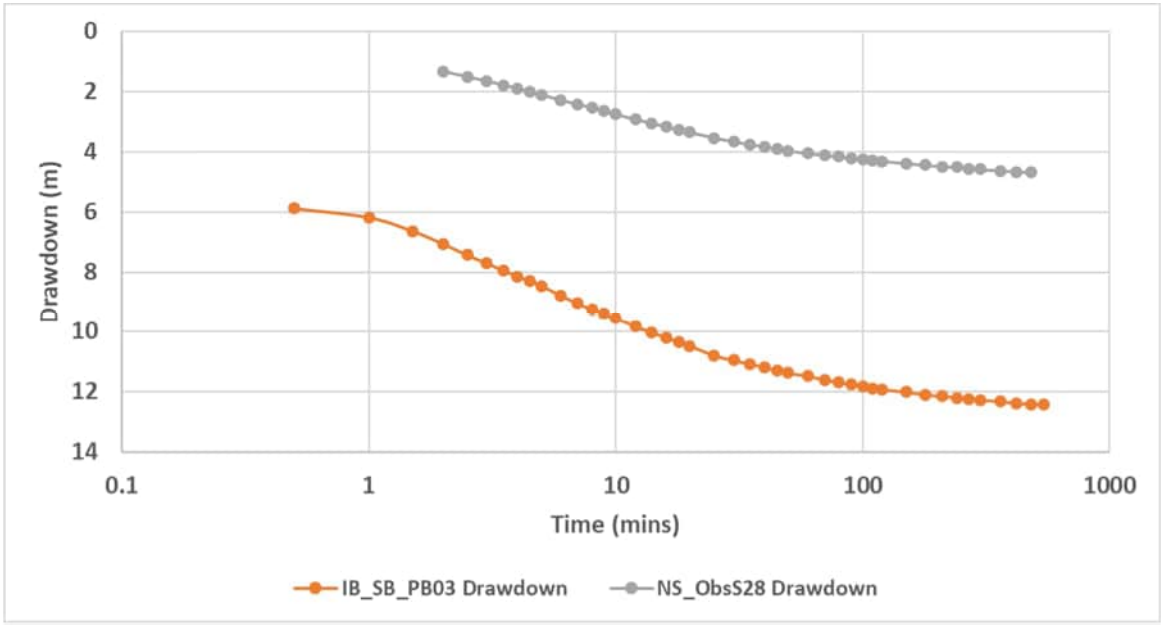


Figure 5: IB_SB_P03 Constant Rate Test Results

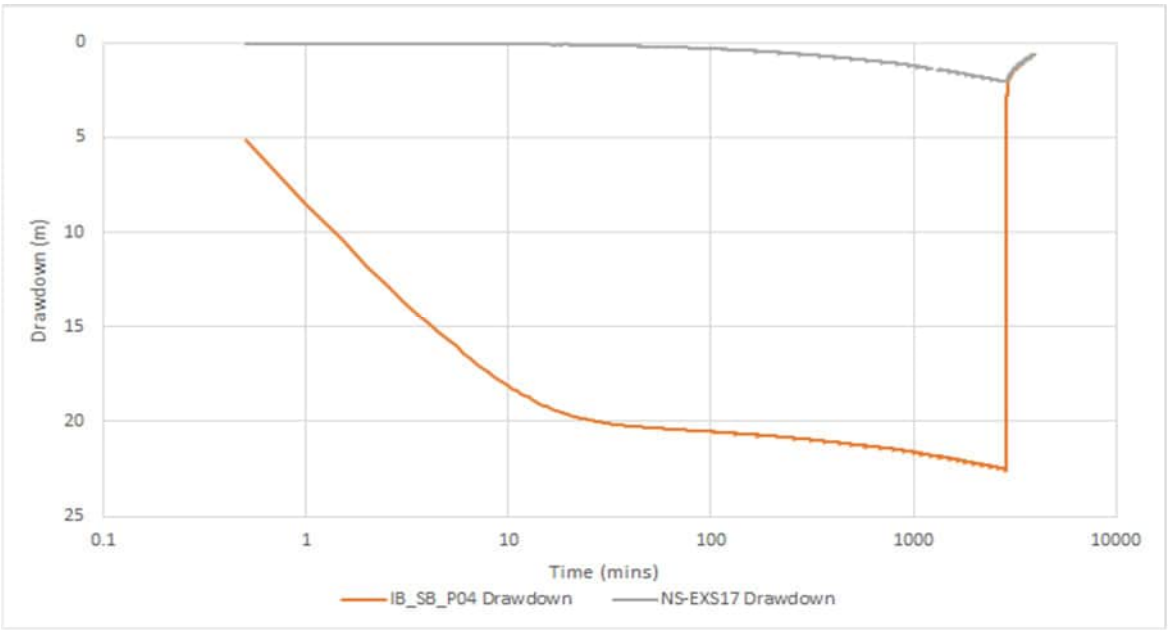


Figure 6: IB_SB_P04 Constant Rate Test Results

5.3 Groundwater Catchment, Levels and Flow

The IB area lies primarily within the Turner River groundwater catchment defined by DWER, with the eastern extent of the site at the boundary of the Shaw and Strelley River catchments. An inferred water table, developed from 2020 – 2022 data, is presented in Map 7. In general, the water table approximately follows the surface morphology, declining downslope with the ground surface. It forms a divide along the topographical plateau at the IB orebody where the

water table exceeds 300 mAHD, declining away from the plateau westward into the Northern Valley – Chinnamon Creek area, the Northern Borefield and the Southern borefield, and will continue to decline toward the Turner River, through the Western Borefield. On the east of the divide, the water table declines eastwards towards the Shaw and Strelley Rivers.

Groundwater flow, which is normal to the water table contours, flow down the hydraulic gradient, moving predominantly away from the plateau and toward the main surface valleys and drainage features. The rate of groundwater flow will be dependent upon the hydraulic gradient and permeability of the fractured-rock aquifer system.

In the capture area of the Western borefield, groundwater levels are relatively flat. This decrease in hydraulic gradient in the Western borefield is probably a result of higher aquifer transmissivity; reduced through flow from the Northern Borefield and limited recharge. There is a relatively steep hydraulic gradient at the eastern end of the Western Borefield, suggesting relatively impermeable formations between the Northern and Western borefield. In addition, granite basement formations are encountered to the west, effectively reducing outflow of groundwater from the Western borefield to the west.

In the Southern borefield, where the geology is relatively complex, the direction of groundwater flow is generally to the south-west. However, given that granite basement forms an impermeable boundary to groundwater flow to the southwest; it is likely that groundwater will follow existing drainages, which have been shown to be areas of increased transmissivity, and flow northwest into the Western borefield.

5.4 Groundwater Recharge and Discharge

Groundwater recharge is primarily driven by infiltration of rainfall associated with cyclonic events and the interaction with intermittent stream flows occurring during the wet season. Bores closer to drainage lines and with shallow depths to water, such as in the northern and western borefields, show more distinct responses to rainfall events (Figure 7), which likely indicates higher recharge rates resulting from the infiltration of flood water. However, as the drainage lines comprise a very small portion of the area, it is likely that this is a relatively small contribution to the overall groundwater recharge. In general, groundwater recharge rates are anticipated to be lower than the average in the more elevated areas and higher than average for the lower areas where surface runoff is concentrated.

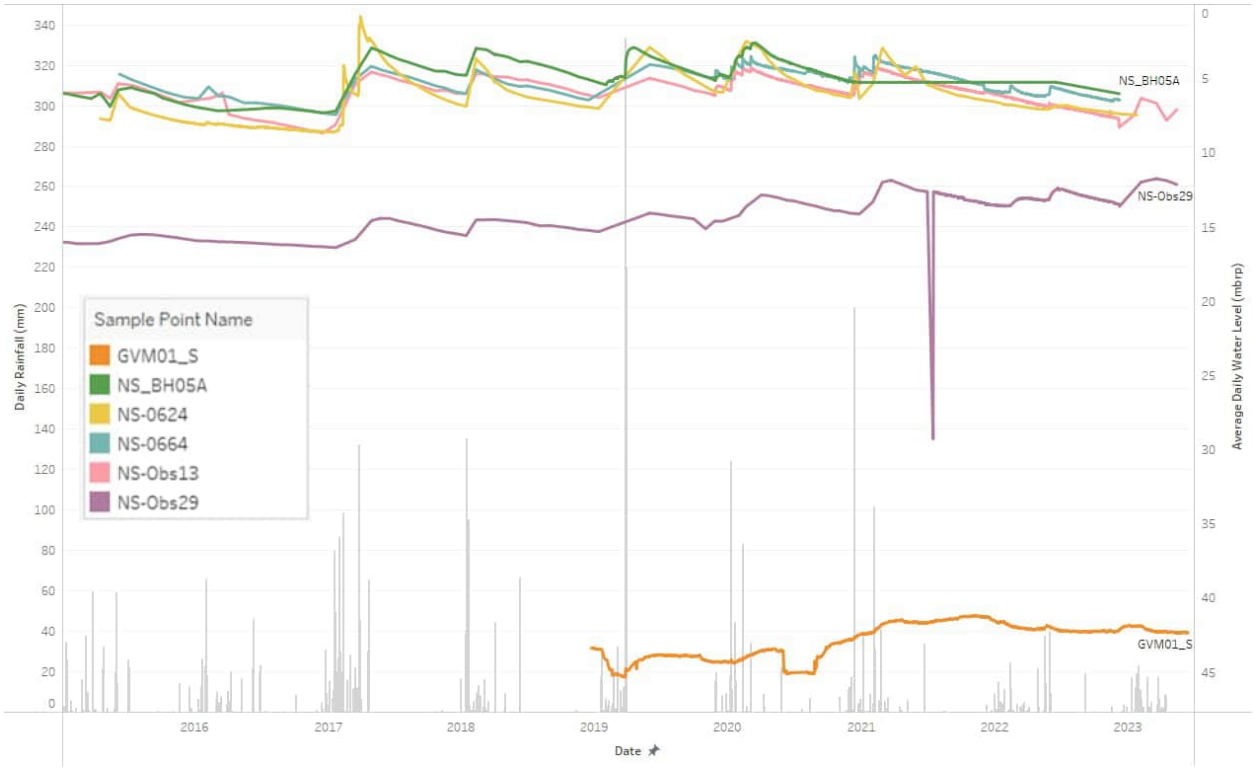


Figure 7: Typical recharge response hydrographs for bores in the Project area

A detailed analysis of bore NS-0664's hydrograph (Figure 8) for data from 2019 to 2022 has been undertaken to determine likely rainfall / recharge relationships (**Table 7**). Figure 9 below illustrates the measured rise in water level within the bore against the magnitude of the rainfall event at a local rain gauge. The analysis indicates an approximately linear relationship of 5% between rainfall and recharge (assuming a porosity of 0.01), along with the threshold of approximately 20 mm below which no recharge is expected. Rainfall events below 20 mm may contribute to recharge, albeit a lesser percentage of total rainfall, but this would be dependent on antecedent conditions and depth to water.

Table 7: Rainfall Recharge Analysis of NS-0664

Event Date	Average Intensity (mm/hr)	Rainfall (mm)	Hydrograph Recharge (m)	Recharge as a % of Rainfall (0.01 Porosity)
26/11/2019	0.27	19.2	0.545	28%
8/01/2020	0.09	124	0.86	7%
18/01/2020	0.5	44.6	0.54	12%
8/02/2020	0.18	76.8	0.43	6%
1/03/2020	0.6	30	0.61	20%
26/11/2020	0.25	12.6	0.26	21%
10/12/2020	0.22	242.8	1.58	7%
4/01/2021	0.25	38	0.28	7%
1/02/2021	0.08	103.4	0.798	8%
5/02/2021	0.1	34.8	0.16	5%
10/02/2022	0.6	24.6	0.43	17%
29/05/2022	0.05	69.8	0.51	7%

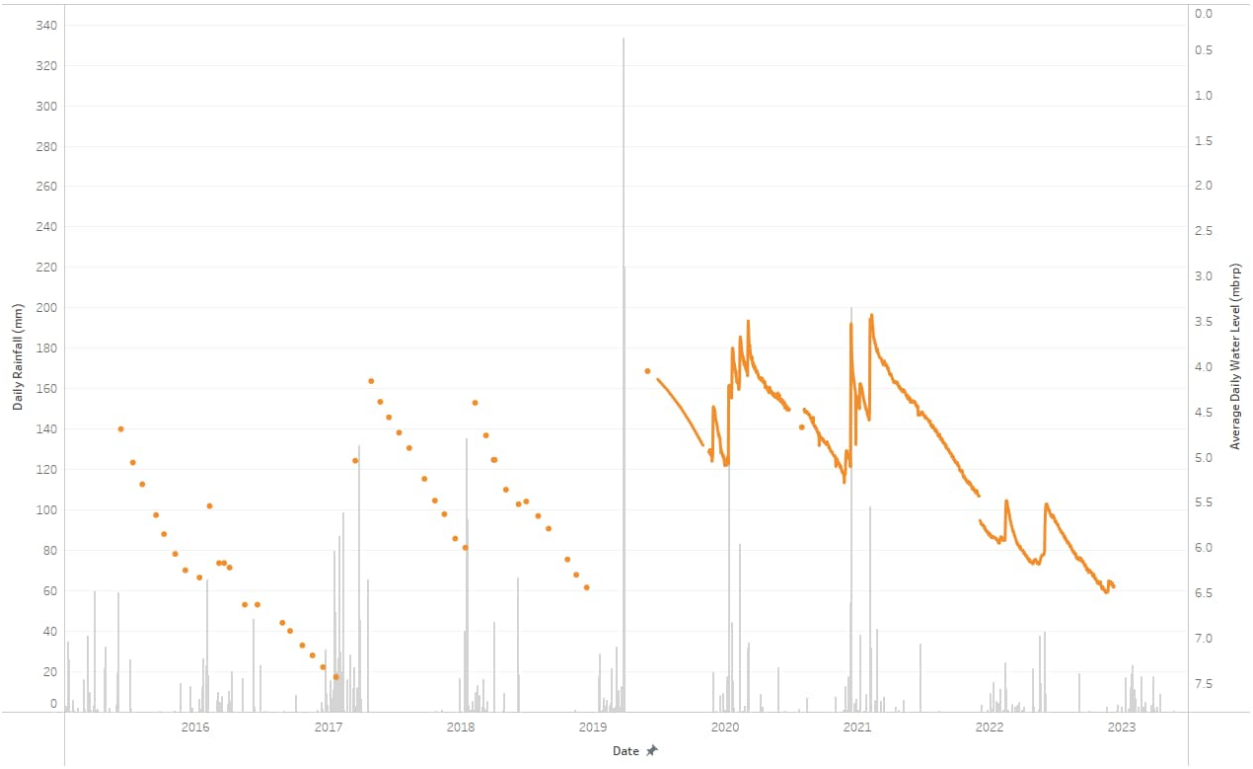


Figure 8: Hydrograph of response to rainfall for NS-0664

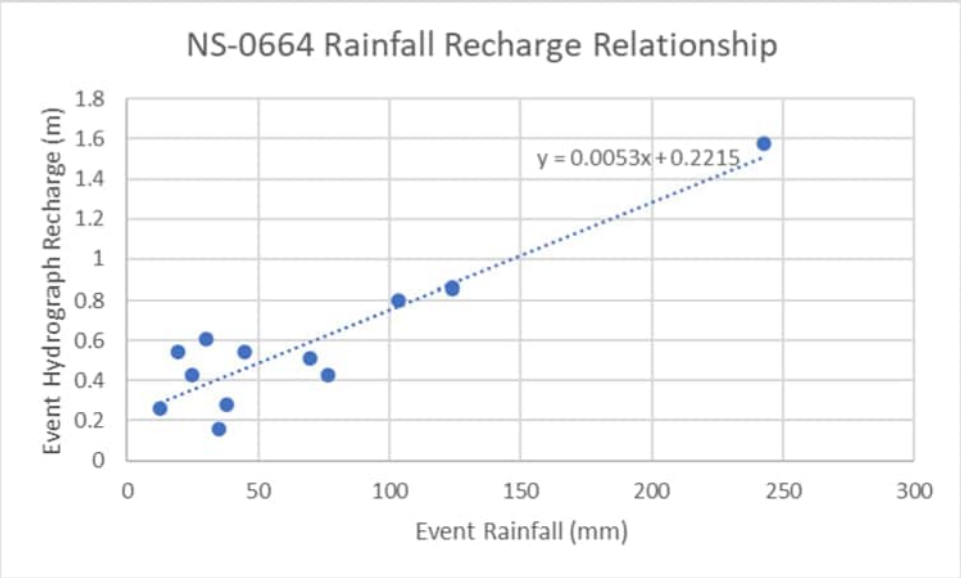


Figure 9: Cross plot of rainfall and runoff for NS-0664 monitoring data

The main discharge mechanisms are conceptualised as:

- Seepage into creek beds resulting from converging groundwater flow at shallow depths, particularly after significant recharge events; and
- Evapotranspiration in areas of shallow groundwater levels and suitable vegetation assemblages (refer to Section 6.5).

5.5 Groundwater Trends

Groundwater trends can be categorised as baseline trends and operational trends, depending on the location and timeframe of monitoring results.

The predominant baseline trend is the cyclical pattern of rapid rises in groundwater levels following recharge events (refer to Section 5.4), with declining water levels between events (Fortescue Metals Group, 2020). Figure 10 demonstrates this trend for bore NS_BH05A.

Operational groundwater trends are discussed in the annual or triennial aquifer reviews completed to date. Predominant trends include (Fortescue Metals Group, 2020):

- Drawdown and recovery within borefield areas are correlated with abstraction rates;
- Western borefield area water levels are not impacted by abstraction from Northern, Southern or Eastern borefield; and
- Salinity does not appear affected by abstraction rates or changes in water level.

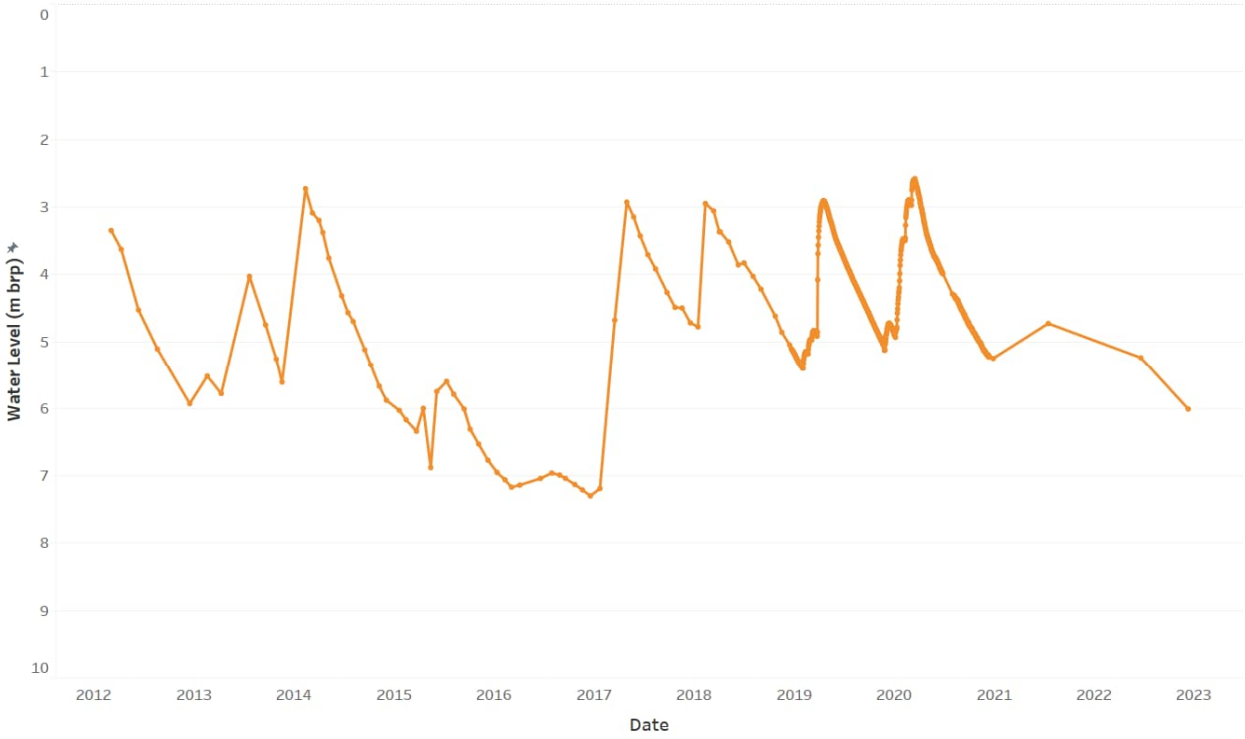


Figure 10: Representative Hydrograph for NS_BH05A

5.6 Groundwater Chemistry

Sampling of groundwater has been undertaken at Iron Bridge since 2009, with over 370 samples taken from 92 bores (Map 8). Water samples have also been obtained from surface water bodies across the site. Appendix 6 tabulates key statistics of samples collected up to the end of 2022.

Figure 11 illustrates the characterisation of groundwater through the use of major ions. The majority of water sampled is at the Project is generally of a magnesium bicarbonate type water. The majority of bores tend to show similar signatures of mixed bicarbonate over the dataset although there are examples of variability. Samples from June 2022 for assessed for a nominal groundwater flow path from the Southern Borefield along modern drainage to the Western Borefield. The bores in the flow path were attributed from upstream to downstream as Order 1, 2, 3, 4, 5 and 6 (Figure 12). The resulting piper diagram indicates that there is a potential pattern of increasing Na-Cl dominance along the flow path, although there are examples of bores not fitting this trend.

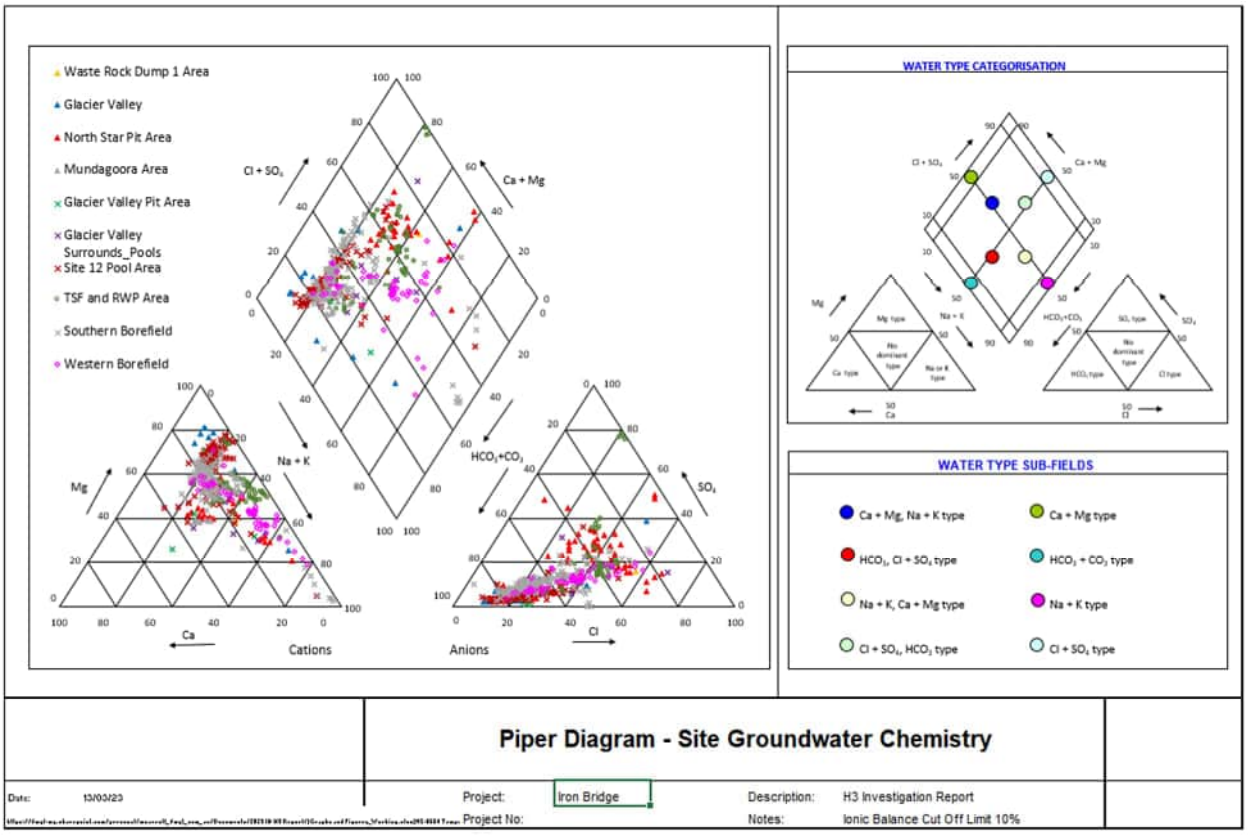


Figure 11: Piper diagram of all available groundwater and pool samples at Iron Bridge

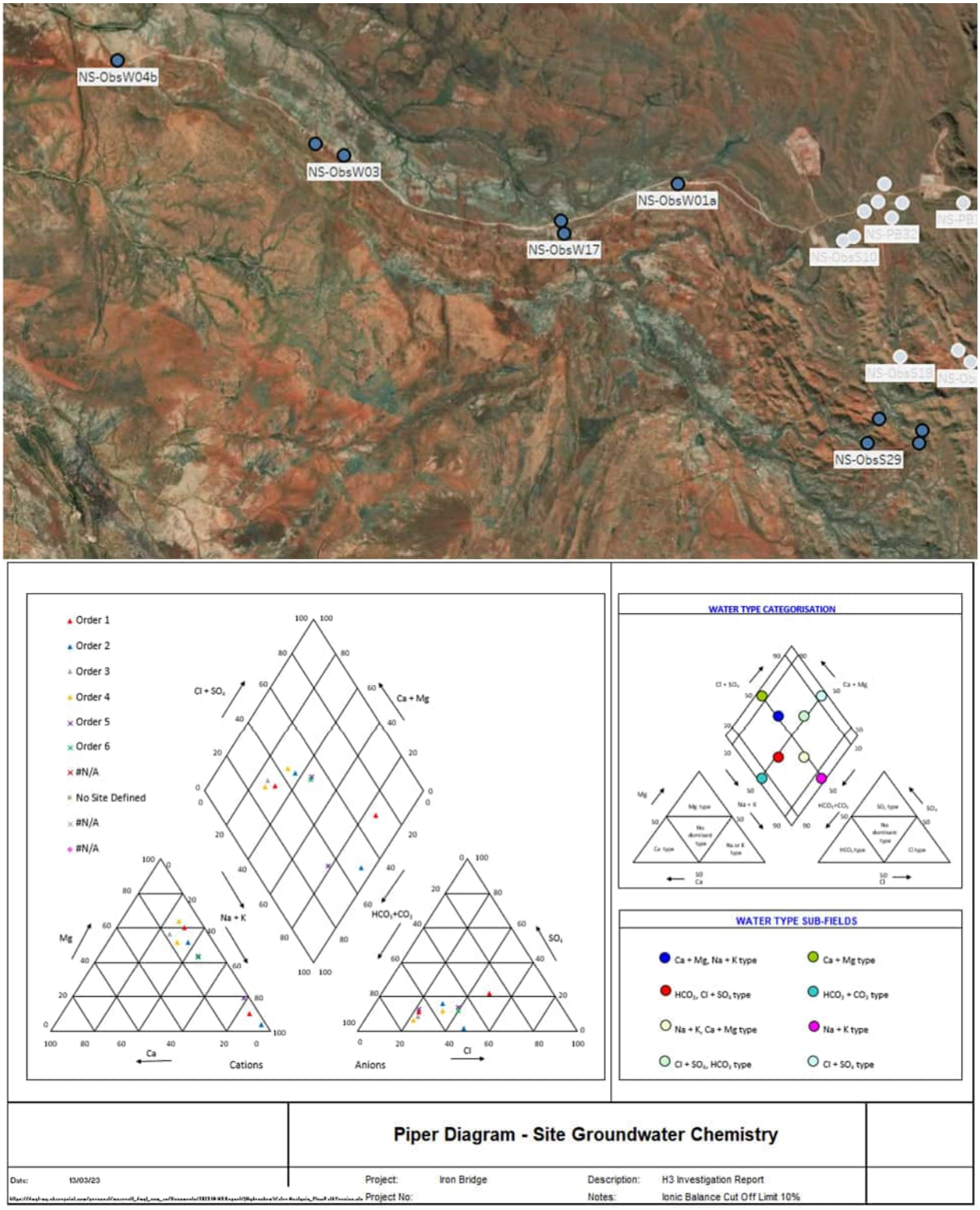


Figure 12: Piper diagram of selected groundwater flow path, indicated in associated map

5.7 Hydrostratigraphy

Results from drilling and test pumping have been consolidated to describe key hydrostratigraphic units as follows:

- Alluvial sand and gravel deposits adjacent to some creeks. They are a few metres thickness, mostly restricted to the immediate stream channel area, and intermittently saturated following major rainfall events. These units are predominantly drilled in the TSF Area and Northern Valley. Hydraulic conductivity values of the alluvial aquifer are relatively high (8.8E-08 m/s < K < 1.7E-06 m/s) and the storage capacity is considered reasonably high, however, this unit is not extensive across the site. Calcrete has not been intersected within the Mine area, but it likely to occur in the Turner River valley to the west
- The Pincunah Banded-Iron Member of the Kangaroo Caves Formation that hosts the orebody and is bound by shale units of the Kangaroo Caves Formation and Corboy Formation. This unit is separated into a surficial weathered zone, extending up to 60-70m in depth, and an underlying fresh zone that is open at depth.
    - Groundwater storage within the weathered zone is predominantly within interconnected fracture networks, and larger regional structures. Hydraulic conductivity values are low, increasing where significant geological structures are present (3.6E-08 m/s < K < 2.1E-06 m/s).
    - The underlying fresh zone has little to no transmissivity or storage, except along very localised geological structures. In absence of any structures, hydraulic conductivity values are low (1E-9 m/s < K < 2.2E-07 m/s). Packer testing on short intervals of the fresh orebody predominantly showed no transmissivity. Where geological structures have been intersected, hydraulic conductivity values are one to two orders of magnitude higher (7.4E-06 m/s < K < 9.4E-06 m/s).
- The Archean units outside of the orebody, consisting of various greenstone rocks of mainly igneous basalt, ultramafic and andesitic tuff, and sedimentary rocks of sandstone, siltstone, shale, chert and banded iron-formation (i.e. Corboy Formation, Kangaroo Caves Formation, Kunagunarrina Formation and Leilira Formation). These units are separated into a surficial weathered zone, extending up to 60-70m in depth, and an underlying fresh zone that is open at depth.
    - Fractured rock aquifers within the weathered profile present transmissivity values that can be locally high, but generally low. It is considered a poor aquifer in terms of storage and transmissivity and is highly reliant on rainfall recharge. The hydraulic conductivity values of the weathered rock mass (6.9E-07 m/s < K < 5.8E-04 m/s) are higher than the underlying fresh bedrock.
    - The underlying fresh bedrock has no appreciable transmissivity and water storage, except along very localised geological structures. Hydraulic conductivity values are significantly lower than the weathered area (6.7E-09 m/s < K < 1.6E-06 m/s). Where regional faults are intersected below the weathered zone, hydraulic

conductivity values are approximately one order of magnitude higher (1.5E-07 m/s < K < 4.3E-04 m/s). Intersection of faults were primarily recorded in the Southern Borefield area, where regional faults were targeted during the 2015 and 2020 water supply drilling programs.

- The shale units, that structurally sandwich the host BIF in a syncline (i.e. western shale of the Kangaroo Formation and Eastern inter-bedded shales of the Corboy Formation), form a poorly developed aquifer(s). The shale units are over 400m thick on both sides of the ore body and generally present very low permeability values (K < 1E-9 m/s). Where major fractures are encountered, the permeability values can increase by up to 2 orders of magnitude (1E-7 m/s < K < 1E-6 m/s). Water yield from storage in this unit is expected to be very low, especially at depth.

Table 8 summarises the relationship between the local geology and hydrostratigraphy, along with key attributes of each hydrostratigraphic unit. In the Mine area, groundwater is found mainly within the weathered rock mass and fractured bedrock. The fractured-rock aquifers in the Project area are compartmentalised (i.e. boundaries identified from test pumping analysis) and present variable transmissivity values (1.9 < T <2,000 m2/day) that are constrained by the local fault(s) and fracturing rather than by lithology. Water supply bores drilled to date have attempted to target fractured zones.

Table 8: Summary of geology and hydrostratigraphy

Geological Group	Geological Formation	Geological Member or Unit	Hydrogeological Unit	Key Attributes*
Tertiary			Alluvium	Relative high K and S but limited saturated thickness and extent
Gorge Creek Group	Corboy Formation	Corboy Shale	East Shale	Thick, low K (<1E-9) unless major fractures exist. Low S
Sulphur Springs Group	Leilira Formation		Weathered Basement	Variable K (1E-6 to 1E-3) with limited S. Reliant on recharge
			Faulted Basement	Elevated K where major faults occur 1E-7 to 1E-4. Discrete areas, not well mapped
			Fresh Basement	Low K (1E-8 –to 1E-6) and S
	Kangaroo Caves Formation		Weathered Basement	Variable K (1E-6 to 1E-3) with limited S. Reliant on recharge
			Faulted Basement	Elevated K where major faults occur 1E-7 to 1E-4. Discrete areas, not well mapped
			Fresh Basement	Low K (1E-8 –to 1E-6) and S
			West Shale	Thick, low K (<1E-9) unless major fractures exist. Low S
		PIncunah BIF Member	Weathered Orebody	Low K, tied to fracture neworks (1E-8 to 1E-6)
			Faulted Orebody	Elevated K (1E-5)
			Fresh Orebody	Low K (1E-9 to 1E-7) with low S
	Kunagunarrina Formation		Weathered Basement	Variable K (1E-6 to 1E-3) with limited S. Reliant on recharge

Geological Group	Geological Formation	Geological Member or Unit	Hydrogeological Unit	Key Attributes*
			Faulted Basement	Elevated K where major faults occur 1E-7 to 1E-4. Discrete areas, not well mapped
			Fresh Basement	Low K (1E-8 –to 1E-6) and S

*** To limit characters, K is used to represent hydraulic conductivity (m/s) and S is for storage (dimensionless). Scientific notation used for figures, where E is equivalent to *x* 10^{xx}.**

5.8 Aquifer Connectivity

The hydrostratigraphic profile, which can be generalised as a weathered and fractured basement overlain by unconsolidated alluvium, indicates that there is no widespread disconnection of groundwater flow, with groundwater in direct connection with the units directly above and below. However, drilling and test pumping results do indicate that high yielding fractures may occur within low permeability host rock, effectively compartmentalising groundwater flow by faulting and fracturing, rather than lithology. It is expected that this connectivity will follow the orientation of the structural domain prevalent in the area (Section 4).

6. ENVIRONMENTAL AND SOCIAL VALUES

6.1 Heritage Value

Fortescue has engaged with the Traditional Owners of the Iron Bridge Mine area, the Nyamal People, to consult on aboriginal cultural heritage values associated with water in the area. The primary water related values, and the factors for consideration, are outlined in Table 9 (from Iron Bridge (2022)). Receptors associated with these values are discussed in the relevant environmental section below; with the majority of the water related values being contained in Section 6.6 (Pools).

Table 9: Water related heritage values of the Iron Bridge Mine area

Aboriginal Cultural Heritage Values	Water Related Factors for Consideration
Important water sources connection Nyamal people to Country and the activities of their ancestors	Water quality Water flow Water catchment stability
Mythological connection to the surrounding cultural landscape through creeks and tributaries	Water catchment stability Water flow Heritage place integrity
Hunting, fishing and resource collection	Health of flora and fauna Water quality

6.2 Groundwater Dependent Ecosystems

6.3 Stygofauna

Surveys for subterranean fauna (stygofauna and troglofauna) were undertaken between March and July 2011 (Subterranean Ecology, 2012), June 2020 and May 2021 (Bennelongia, 2023a). The surveys undertaken were consistent with EPA Guidance Statement No. 54A (2007) and spanned over the wet and dry seasons. The survey effort met or exceeded the EPA guidance survey effort for troglofauna and stygofauna. However, the scopes of both studies were focussed on mine dewatering and did not consider the near mine water supply borefield and its associated impact.

To address the scope of this H3 assessment, Fortescue commissioned Bennelongia to undertake a review of existing data to provide an indication of Stygofauna occurrence in the Mine Area more broadly. Fortesuce also undertook additional habitat modelling, using the following rationale adopted by Bennelongia (2023):

- Suitable habitat is confined to the oxidised zone, defined by the depth of weathering or occurrence of fractured zones

- A maximum depth to water of 40 m bgl was adopted as an additional limit of potential stygofauna habitat. This limit is considered conservative as sampling records indicate species occurring in areas with groundwater levels deeper than 40 m bgl. It is therefore more reflective of a depth above which greater species diversity is likely to occur. Habitat connectivity for specific species may need to be considered on a case by case basis.

To uplift the Bennelongia study for relevance to the scope of this H3 assessment, weathering data from the hydrogeological drilling undertaken (Section 5.1) was used to extend the weathering profile surface from the orebody area. A total volume of 1.6 $x10^9$ m^3 of suitable habitat was calculated using this model from within the study area. The extent of this habitat is illustrated in Map 9.

The key findings from the Bennelongia (2023b) review are:

- Based on an analysis of the factors affecting stygofauna occurrence at the broad scale across the Pilbara, the Iron Bridge area may have an intermediate likelihood rich stygofauna communities, which might be better expressed as having high likelihood of intermediate richness of stygofauna;
- a rich stygofauna community is unlikely to be found in the area of significant groundwater drawdown where the water table is deep;
- the limited presence of porous geology may restrict the number of species likely to occur, although two worm and two copepod species were collected from fissures in the fractured rock aquifer where the water table was deep, showing that fractured rock geology can support stygofauna;
- areas with a water table of less than 40 m bgl and any areas of alluvium or calcrete might be expected to support a rich fauna assemblage;
- Transmissivity associated with the ability to abstract water for dewatering or water supply would be expected to support stygofauna; and
- Whilst fractured rock is unpredictably prospective for habitat, its nature may result in a higher number of species across the borefield than what is found in one specific area.

6.4 Groundwater Dependent Vegetation

Flora and vegetation surveys were also conducted across the Project area in 2011 in support of the Ministerial Approval process for the Stage 2 project (Ecologia Environment, 2012). As part of the 33 vegetation communities identified, only one was described as “groundwater dependent”, specifically EvCC (*Eucalyptus victrix* (Coolibah) +- *Eucalyptus camadulensis* (River Red Gum) open mid-woodland over *Cenchrus ciliaris* tussock grassland) which occurs within the Western Borefield. Subsequent survey by Ecoscape (2018, 2020) undertaken in association with the North Star Extension project area mapped EvApTl (*Eucalyptus victrix* over *Acacia pyrifolia* over *Triodia longiceps*) and EvAtCc (*Eucalyptus victrix mid woodland* over *Acacia tumida)* within the Southern Borefield. Both communities are considered as potentially

groundwater dependent as they are characterised by *Eucalyptus victrix*. *Eucalyptus victrix* is regarded to be either a facultative phreatophyte (meaning it may access groundwater when available, but can also meet its water requirements through uptake from the unsaturated zone) or vadophyte (reliant on soil moisture) depending on local conditions (Rio Tinto, 2018), and as a resilient species that is able to survive rapid change in groundwater level as well as extended periods of drought (Batini, 2009). *Eucalyptus camaldulensis* subsp. *refulgens* (a facultative phreatophyte known to be dependent on groundwater at various times) was recorded opportunistically by Ecoscape but it was not a dominant or characteristic component of any vegetation type and occurred as isolated individual plants or small populations (Ecoscape, 2020). Mapped communities are shown in Map 9.

Potential impacts to groundwater dependent vegetation through changes in shallow groundwater level are currently managed by a trigger level system defined within the North Star Borefield Operating Strategy (Iron Bridge, 2023) that is attached to GWL 179289. Analysis to date indicates that there has been no impact to the mapped vegetation communities owing to abstraction (FMG (2020), FMG (2023)). This is consistent with the understanding of *E. victrix* being a facultative phreatophyte.

6.5 Groundwater – Surface Water – Vegetation Interaction

Map 9 illustrates the occurrence of the vegetation type EvCC, EvApTl and EvAtCC in the context of interpreted depth to groundwater and defined drainage features. Monitoring data to date indicates:

- Shallow depths to groundwater occur in areas of mapped potentially groundwater dependent vegetation; these coincide with drainage features in the landscape

  Recharge and discharge mechanisms (Section 5.3) imply a cyclical connection between surface water and groundwater systems. The conceptual interrelationship between these three aspects of the environment is illustrated schematically in Figure 13, and align with the Upland Channel Zone ecohydrogeological unit proposed by MWH (2015).

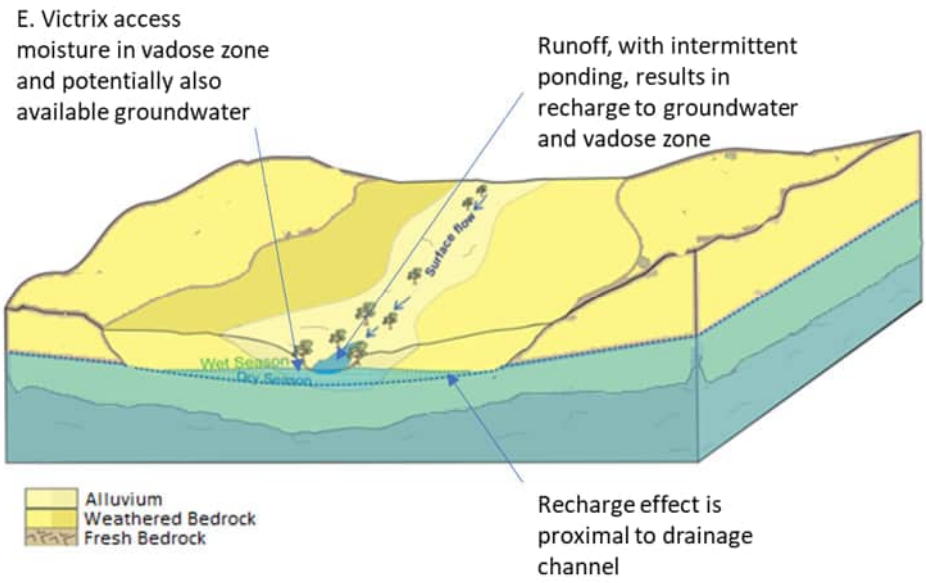


Figure 13: Conceptual schematic of generalised groundwater, surfacewater and vegetation interaction at Iron Bridge Mine (adapted from Bourke *et al.* (2023))

As indicated in Section 6.2, the shallow depth to groundwater may not itself indicate any groundwater dependency. The keystone species, *E. victrix* is known to be resilient to groundwater level change and long periods of drought (Batini, 2009).

6.6 Pools

A number of pools exist in the IB Mine area, and have been reported in Iron Bridge (2022). The location of these pools are indicated in Map 9, with key features, including environmental and heritage value, summarised in Table 10.

Table 10: Pools of the Iron Bridge Mine Area (adopted from Iron Bridge (2022) and Hydrobiology (2023))

Pool	Description	Representative Photograph
Mundagoora Pool	A relatively deep permanent pool located at the base of an intermittent waterfall, the pool appears to flow only during high rainfall events. The pool water level is controlled by a sill at the downstream edge. Water levels remain relatively consistent within the pool except for short duration peaks during high rainfall. The pool contains a hard bottom (rock) at the inflow point, likely to be scoured out during high-flow events. Downstream of the pool is dominated by dense emergent vegetation (reeds and sedges), which extends down a shallow braided channel downstream for several hundred metres from the pool. The monitoring survey data (e.g., water level, EC and temperature throughout wet and dry season) indicates the pool is largely sustained by groundwater with periodic flushing by fresh surface water flows after rainfall events. Depending on each rainfall event, the groundwater displaces the surface water flows. The pool is slightly brackish (~850 µS/cm) with moderate oxygenation (5.61 mg/L). No metals were recorded above ANZG (2018) and were predominantly below detection limits. Nutrients were low, with Total Nitrogen at 0.5 mg/L and Total Phosphorus at 0.01 mg/L and a moderate (4 mg/L) level of Dissolved Organic Carbon (DOC). The pool provides habitat to an abundance of fish, macroinvertebrates, and extensive beds of macrophytes and established riparian vegetation. This pool also provides habitat for a number or fauna species including the Pilbara Olive Python. It has been identified as a place of significance for aesthetic, cultural and social values. This place is valued as a water source and hunting/fishing place and contains resources for bush medicine and bush foods;	

Pool	Description	Representative Photograph
Site 12 Pool	Site 12 Pool is part of a series of shallow pools that lie to the east of the Mine Area, on a small tributary to the upper Six Mile Creek. Site 12 Pool is connected to both surface water and groundwater sources and typically sustained by groundwater until the local groundwater level drops below the pool base level over the late dry season. The pool is frequently perennial, though has been known to dry out following small wet seasons. The pool is fresh to brackish within predominantly bedrock habitat that supports fish, macroinvertebrates, algal communities, macrophytes and riparian vegetation. The water quality for Site 12 Pool was found to be slightly alkaline (mean pH 8.5) and typically slightly brackish (1,100 – 1,300 µS/cm). The water type was a magnesium-bicarbonate (Ca/Mg-HCO3) with low sulphates (SO4). During rainfall events it is expected that the pool would temporarily become fresh (<100 µS/cm). Management of impacts Site 12 Pool is conditioned under MS 993, through the establishment of a water quality and quantity management plan (Iron Bridge, 2021). This plan was approved in January 2022.	
Fig Pool	Fig Pool an isolated small pool that lies at the base of a rockface with a small catchment area of 0.16 km2. It is characterised by stable water levels maintained by fresh groundwater, and is periodically flushed with fresh surface water flows after rainfall events. A relatively low abundance and diversity of aquatic flora and fauna inhabit the pool, likely due to it being naturally acidic (pH 3.4 and 16 mg/L as CaCO3) and dominated by sodium sulphate. The pool is typically fresh (~200 µS/cm) except during a surface water flow event when it would become extremely fresh (<20 µS/cm). The low pH is potentially due to the lack of buffering capacity in the low conductivity water and is likely to be mediated by biological processes in the root mats that surround the pool. Fish and macrophytes are absent in the pool. In a bedrock dominated habitat, the primary structural complexity is provided by the roots of *Melaleuca leucadendra* (weeping paperbark tree) roots.	

Pool	Description	Representative Photograph
Cow Spring Pool	A small pool (~8 m by 4 m, average of 1 m depth) confined by bedrock habitat dominated by macrophytes and benthic algal cover. The pool is likely to be sustained by groundwater and has established macrophyte habitat and an abundance of *M. australis*, despite relatively acidic water quality. The Cow Spring Pool is a slightly acidic (pH 5.72 and 10 mg/L as CaCO3) and typically fresh (456 µS/cm). It has a mixed balance major ion distribution that is not dominated by any particular ions. No metals or metalloids exceeded the ANZG (2018) default water quality guidelines. Due to the shaded positioning of the pool, the water temperature tends to be more stable than other pools in the region, ranging between 20-30°C over the annual cycle.	
Astrid Bee Cave; Craig's Pool; Dingo Lair Pool; Zane's Gorge Pool.	No data exists for these pools; however they are located in similar topographical settings to Cow Spring Pool, albeit much further westwards along the bedrock ridgeline.	
Pool_SWGV (GV_SW_Pool_SW or GV_Pool or Glacier Valley Spring)	This is a series of small pools located in a cut across an adjacent ridgeline. The pool supports fish likely to have migrated upstream during the wet season. Although similar in setting to Mundagoora Pool, surface water flows appear to dominate the water balance, and pools have been observed to dry out (Hydrobiology, 2022). The water quality of Pool_SWGV was similar to other ephemeral pools in the region during with a slightly alkaline pH (pH 7.88) and moderately brackish salinity (EC = 1444 µS/cm conductivity), increasing during evapoconcentration. The pool was well oxygenated (Dissolved Oxygen 7.99 mg/L) and clear when full, but drying of the pool had an impact on water quality (Hydrobiology, 2023). Sodium bicarbonate (Na-HCO3) was the dominant water type that is saturated with respect to calcite precipitation. Culturally, the pool is associated with Mundagoora Pool and and is said to be an impressive example of the how the Njamal ancestors lived and is a place that the Njamal Traditional Owners would like to share in its natural current state with future generations.	

Pool	Description	Representative Photograph
Honeyeater Creek Pool (GV_SW_Pool_NJA21-006-US)	This pool exhibits a typical lowland surface water dependent characteristic of rapid filling following large rainfall events, with subsequent trailing water level declines fed by receding flows through the alluvium (hyporheic zone) from the catchment. The Njamal Traditional Owners expressed that this watercourse is ethnographically significant as the water source holds mythological significance. It has been described as having a permanent spring, which in consideration of the water quality characteristics, is likely fed by shallow alluvial recharge.	
GV_SW_Pool GR	Pool_GR is comprised of a deep rock plunge pool along a creek line that descends through a small gorge from creeks on top of the Glacier Valley escarpment serving as one of the southern tributaries discharging into GV_SW_Pool_Mundagoora_SS from the east. It had a depth of around 65cm at the time of survey in June 2023 but appears to fill to between 2-3 m, as indicated on surrounding rock colouring, after rainfall and flow events. Groundwater is approximately 30 m bgl at this location and does not contribute to the pool water balance	

Pool	Description	Representative Photograph
GV_SW_Pool_NJA19_002	NJA19_002 is a small intermittent, surface water dependent pool located approximately 2.8 km south-west of Honeyeater Creek Pool, with the pool feeding into this catchment on the eastern face of the Glacier Valley ridgeline.	
GV_SW_Pool_NJA19_004	NJA19_004 is a small ephemeral pool located on the eastern face of the Glacier Valley ridgeline. The pool tends to fill during rain/flow events then quickly dries. During the Late Wet 2021, Late Dry 2021, the pool was completely dry	

Pool	Description	Representative Photograph
Central Creek Pool	Central Creek Pool is a shallow pool that lies on deep alluvial sediments on Cockatoo Creek, which experiences high flows in the wet season. The pool is predominantly sustained by surface/hyporheic water and consequently undergoes high rates of evapo-concentration and has minimal established macrophyte habitat. The water quality is relatively turbid in comparison to other Iron Bridge pools and there is evidence of cattle visitation.	

7. EXISTING USE

Iron Bridge is the only industrial, pastoral or residential user of groundwater within the expected footprint of abstraction activities. The Mine water balance is described in the following section.

7.1 Mine Water Balance

The Iron Bridge operational water balance is shown in Figure 14. Based upon a process plant throughput of 20 Mtpa, a total raw water demand of 22.4 GL/a will be required. Key elements of the water balance are provided below:

- Raw Water supply of up to 22.5 GL/a (23.5 GL/a if the proposed licence amendment is granted) will be provided through a combination of the 20 GL/a Canning Basin Borefield (GWL175700) and the mine area water supply (GWL179289). Any abstraction over 2.5 GL/a from the mine area water supply will be used to offset abstraction from the Canning Basin Borefield.
- Stage 2 Losses and Other Users (dust suppression, camp, lab, workshop, and evaporation) of 2.6 GL/a, with this number likely to rise as dust suppression demands increase.
- 11.1 GL/annum of water required to transport Stage 2 concentrate slurry to the Port Hedland CHF plant. Up to 9.1 GL/a of this water will be filtered and returned to the Stage 2 beneficiation plant for re-use via a dedicated pipeline. Of the 2 GL/a that remains after filtration, 0.2 GL/a is lost to evaporation and other uses and 1.8 GL/a remains in the concentrate as residual moisture.
- Approximately 17.5 GL/a of water is lost through tailings disposal. No tailings decant return is assumed for the first few years of operations due to low beaching angles and high evaporation, but potential decant water return is estimated at 4.2 GL/a. Seepage may occur beneath the TSF return water pond; and this will too be returned to the OPF for reuse (refer to Section 0).
- Loss to dry rejects of 0.3 GL/a.

As a hub area for Fortescue Metals Group Limited, it is expected the Iron Bridge's established water infrastructure (i.e. standpipes) may also be utilised for surrounding projects such as construction of power generation (solar and wind farm) facilities, and associated road dust suppression. This area of usage is in development but unlikely to represent a major percentage of the water balance.

It is expected that Iron Bridge will consistently experience the risk of a water deficit. Water use efficiency, water re-use, and opportunistic extraction of available water are therefore considered critical components for the operational water balance. Increasing the licence allocation for the near mine water supply borefield at Iron Bridge Mine is one component to taking advantage of available water following periods of recharge. Recovery of seepage, whilst partly a compliance

requirement, also fulfils this objective. Mine dewatering may also play a part in later provision of water, but will not feature in the early years of operation.

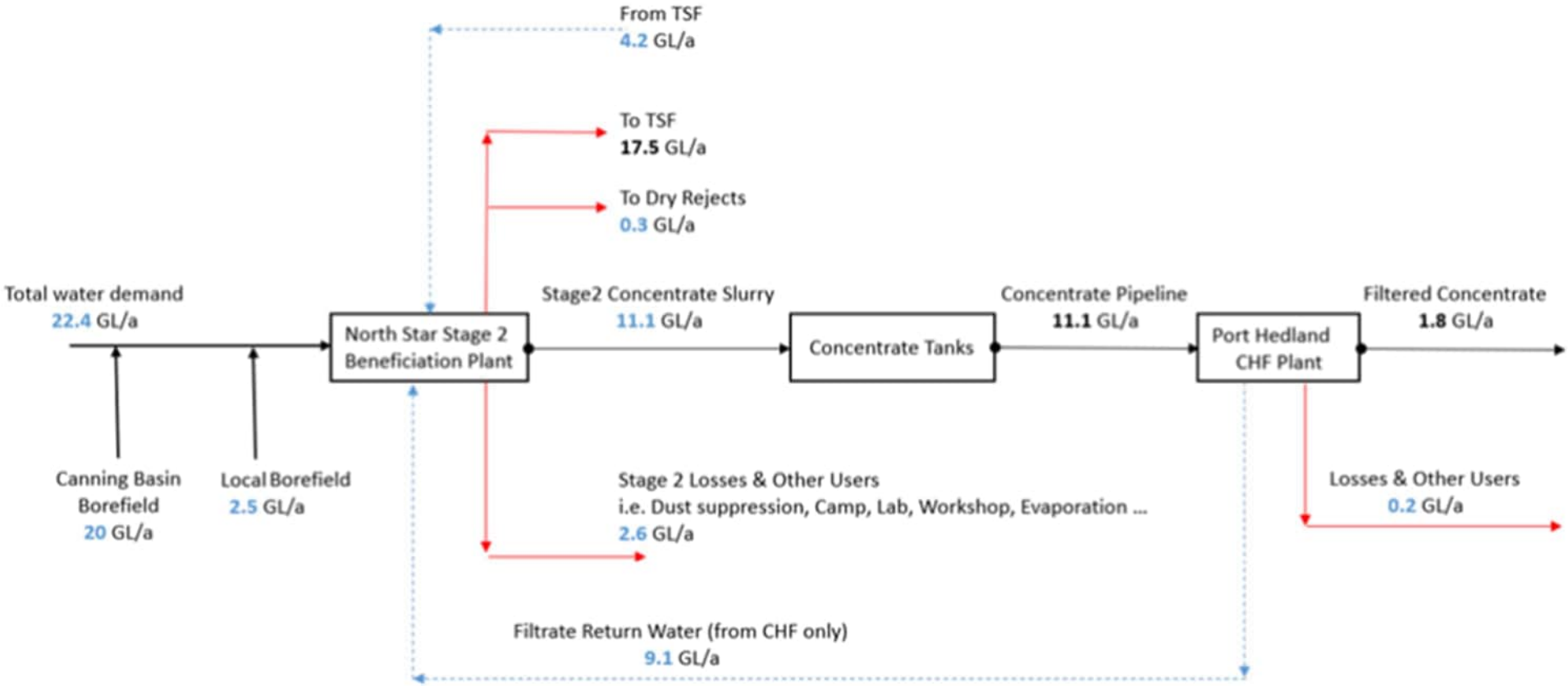


Figure 14: Iron Bridge Design Water Balance

8. GROUNDWATER MODELLING

Groundwater modelling has been undertaken by Groundwater Consulting Pty Ltd, to support the impact assessment for water supply and dewatering abstraction. Appendix 7 contains the groundwater modelling report, which includes detail on the following:

- A summary of the conceptual model;
- Calibrated aquifer and recharge parameters;
- Predicted drawdown from groundwater abstraction; and
- Sensitivity analysis for recharge and storage.

The impact assessment component of the groundwater modelling exercise is detailed in Section 10 of this report.

The primary findings of the groundwater modelling include:

- The heterogeneity and discrete flow paths observed in the field are difficult to represent in a regional layered flow model;
- Sustainable yield is very sensitive to assigned storage and recharge parameters
- Drawdown extent, whilst sensitive to storage and recharge, remains bounded by the shales of the Corboy Formation; and
- Bore locations are not the primary determinant of drawdown extent – similar impact outcomes could be obtained within the range of uncertainty if other bore locations or abstraction regimes were modelled.

The groundwater model, whilst not suitable as a predictor of absolute impacts, indicates the importance of adaptively managing aquifer drawdown from a resource sustainability and receptor risk perspective.

9. RECOVERY OF SEEPAGE

Seepage may occur within the tailings storage facility (TSF) and waste rock dump landforms. Recovery of seepage downstream of these landform features may be required to mitigate any potential risk to downstream water quality. Whilst abstraction of seepage may not be regulated under the *RIWI* Act (refer to Section 1.3), the following section provides context to the planned activity in the event regulation is required.

Works approval W6322/2019/1 contains conditions for the establishment of a minimum of 6 bores downstream of the TSF and associated return water pond (RWP), along with the development of a seepage monitoring plan. The *Tailings Storage Facility Monitoring Procedure*, *662NS-0000-PR-EN-0020* (Iron Bridge, 2022), includes details on the baseline water quality downstream of the RWP, monitoring frequency, parameters, receptors and thresholds. Map 10 indicates the location of the bores in the context of the TSF and RWP facilities.

Analysis by engineers ATC Williams indicates that seepage rates from the RWP are likely to be low, in the order of 5 L/s; however the recovery bores also provide contingency in the event of seepage bypass of the installed grout curtain and/or leakage from the RWP. The bores detailed in Table 11 are primarily monitoring bores, but could be equipped with pumps if data indicates the presence of TSF seepage.

Table 11: TSF monitoring and seepage recovery bore details

Bore Name	Easting	Northing	Top of Concrete Reduced Level (RL)	Top of PVC Reduced Level (RL)	Top of Steel Bore Casing Reduced Level (RL)	Bore Depth (mBGL)	Screened Interval (mBGL)
IB_RWP_MB1	710534	7654522	250.078	250.178	250.178	20.9	3.5 – 20.8
IB_RWP_MB2	710512	7654459	247.967	248.067	248.121	21.07	3.5 – 20.97
IB_RWP_MB3	710479	7654455	247.206	247.306	247.398	21.07	3.5 – 20.97
IB_RWP_MB4	710453	7654460	246.591	246.691	246.736	22.055	3.5 – 21.95
IB_RWP_MB5	710399	7654347	241.484	241.584	241.484	20.9	3.5 – 20.6
IB_RWP_MB6	710361	7654339	243.962	244.062	244.141	20.7	3.5 – 20.7

A second location where seepage management may be implemented is associated with the Waste Rock Dump (WRD1), illustrated in Map 11. A low permeability ‘plug’ has been designed as part of the management of surface water quality for Site 12 Pool (Iron Bridge, 2022). Whilst analysis indicates it is unlikely for seepage to occur beyond the plug, recovery bore(s) may be installed in the event monitoring data suggests seepage is occurring. Monitoring of seepage is proposed at the locations outlined in Table 12; however the number and exact locations of bores is still subject to further study.

Table 12: Proposed "plug" seepage monitoring bores

Indicative Bore Name	Approx Easting	Approx Northing	Likely Bore Depth (mBGL)	Objective
IB_WRD_M03	715,171	7,649,098	Tbd	Monitoring of seepage in fractured rock beneath "plug"
IB_WRD_M04	715,177	7,649,257	Tbd	
IB_WRD_M05	715,184	7,649,325	Tbd	
IB_WRD_M06	715,222	7,649,376	Tbd	

10. CONSTRUCTION AND FOUNDATION DEWATERING

In addition to dewatering for mining purposes, there are instances where localised dewatering will be required for construction periods and also during operations.

Rainfall recharge may result in periods of elevated groundwater levels around the footings of constructed facilities and there is concern regarding long-term shifting of fine sediment and the potential for increased settlement as a result.

Periodic abstraction of shallow water is proposed to mitigate this risk. Designs have not been progressed; however the locations of these facilities are within the overall near mine water supply borefield and / or dewatering cone of depression, which is discussed in the following sections.

As a result, there is no proposed increase in the risk of impact associated with this activity. No additional monitoring is recommended beyond abstraction volumes water levels in abstraction bores when operating (i.e. what is currently required in the groundwater operating strategy). For operational flexibility, abstraction bores used for dewatering will not require prior amendment to the groundwater operating strategy but will be reported within the annual monitoring summary/review and incorporated into the next available operating strategy amendment.

11. ASSESSMENT OF IMPACTS

11.1 Groundwater Levels

Within the range of uncertainty and sensitivity, it is evident that the proposed groundwater abstraction will result in depletion of aquifer storage localised to the below water table pits and water supply abstraction borefield. Drawdown will be bounded by shales of the Corboy Formation, and likely also oriented along structural corridors and alignments.

11.1.1 Impacts on Bore Yields

The modelling assessment, and monitoring to date, clearly indicates that proposed abstraction will result in abstraction bore drawdown and a reduction in bore yield over time. The risk of a reduction in water supply is being managed by Fortescue through the implementation of the West Canning Basin borefield, along with groundwater reuse across such in the form of:

- Return water from magnetite concentrate dewatering in Port Hedland;
- Return water from the Tailings Storage Facility, via both a return water pond and seepage capture bores;
- Stormwater harvesting on waste rock dumps.

Additional bores should be considered if appropriate to reduce “per bore” abstraction rates, and manage localised drawdown.

Drawdown is the main objective of dewatering and reduced yields in dewatering bores can be considered a sign of success. However, if dropping bore yields are not associated with a reduction in groundwater levels beneath the pit, then additional bores, or pit wall seepage management (with abstraction via in pit sumps), will be implemented.

In both cases, if new bores are within the extent of existing borefields; operate at similar total yields to what has been predicted; and do not otherwise change the likely impacts/risk profile to receptors, then no prior approval will be sought from DWER (similar to how borefield development is managed at other Fortescue operational sites).

11.1.2 Impacts to Other Users

As described in Section 6, there are no other groundwater users within the IB Mine area, nor within the drawdown extents resulting from base case and sensitivity scenarios. The uses of Traditional Owners are considered within the “Environmental” context below. It is appropriate to include monitoring of groundwater levels and quality outside of the immediate borefield extent, to validate this expected outcome.

11.1.3 Impacts to the Environment

Map 12 illustrates the predicted drawdown for the base case scenario, 30% increased recharge and 30% decreased recharge, in the context of:

- Known pools; and
- Areas of mapped groundwater dependent or potentially groundwater dependent vegetation where groundwater depth is less than 20 m.

Table 13 summarises the potential range of expected impacts at potential environmental groundwater receptors, taken from further analysis of recharge modelling uncertainty. Further discussion for these receptors are included below.

Table 13: Summary of potential impacts and inherent risk to environmental groundwater receptors from groundwater level changes

Receptor	Sensitivity to Groundwater Level Change	Predicted Range of Drawdown (m)	Predicted Rate of Drawdown (m/yr)	Risk of Impacts (refer to Appendix 9)
Stygofauna	Potentially sensitive. Drawdown will deplete approximately 50% of the habitat (based on volume) within the study area but: • large size of the borefields means they may encompass whole ranges of some species; and • all areas with >2-5 m# drawdown should be treated as total loss of habitat, Therefore, greater than 50% of habitat is highly likely to be impacted. Borefield is prospective for stygofauna but unsampled; species richness and extent of occurrence is unknown.	Loss of theoretical habitat volume (declining from 1.6 x 10^9 m^3 to 0.8 x 10^9 m^3); however all areas with >2-5 m drawdown may be unsuitable for stygofauna		Extreme
Western borefield potentially groundwater dependent vegetation	Moderate to low sensitivity. Vegetation community unlikely to be dependent on groundwater, with high resilience to change (refer Section 6.2)	0 – 45	0 - 2	High
Southern borefield potentially groundwater vegetation		75 – 95	3.4 - 4.3	High
Mundagoora Pool	Moderate to high sensitivity. Pool is groundwater dependent but also has surface water contribution. Baseline suggests pool is permanent	50 – 62	2.3 - 2.8	Very High
Site 12 Pool	Moderate. Pool is known to dry out and has contribution from surface water. A drop in upstream catchment bore NS-0664 groundwater level beyond 279.25 mAHD is associated with a drop in pool levels (Iron Bridge, 2021).	0 – 6	0 - 0.3	Medium
Fig Pool		9 – 16	0.4 - 0.7	Low

Receptor	Sensitivity to Groundwater Level Change	Predicted Range of Drawdown (m)	Predicted Rate of Drawdown (m/yr)	Risk of Impacts (refer to Appendix 9)
Cow Spring Pool	High. However, whilst pool is groundwater dependent, pool elevation is above regional groundwater level and considered perched.	26 – 34	1.2 - 1.5	Low
Astrid Bee Cave; Craig's Pool; Dingo Lair Pool; Zane's Gorge Pool		various		Low

11.1.3.1 Stygofauna

The comparison of current habitat extent with the extent and thickness of habitat at the end of the life of the mine, based on the base case drawdown, is illustrated in Map 13. This illustrates the likely loss of suitable habitat in the Southern and Northern borefield areas, along with a predicted reduction in the Western borefield and, to a lesser degree, in the Northern Valley and TSF areas. However, the contours of predicted drawdown are considered a more suitable determinant of likely impact (Bennelongia, 2023b). It is common to assume drawdown of >2 m threatens stygofauna unless stratigraphic profiles are uniform, a case can be put forward that drawdown of up to 5 m (or even more) is non-threatening.

Based on the very limited distributional information for stygofauna at Iron Bridge and its surrounds, a relatively high proportion of the stygofauna species in the borefield may be widespread but this information comes mostly from species in areas of shallow water tables. Species in fractured rock may have very small ranges. The complex geology of the borefield areas, with significant faulting, may further contribute to a lack of habitat connectivity within the borefield for stygofauna species in rock aquifers (Bennelongia, 2023b).

Lack of extra targeted genetic work makes it difficult to determine the actual ranges of the species collected by Subterranean Ecology (2012) that appear to have small distributions. However, Bennelongia (2023) collected one species, Tubificidae 'BOL066', known only from the 2 m drawdown cone around the Stage 2 mine pit. In addition, Atopobathynella `BSY214` was collected from alluvium in the Southern Borefield with a water table of 3 m bgl. Drawdown of >150 m will occur at this site when the borefield is operating and the species is highly unlikely to persist at the site. In contrast, Tubificidae 'BOL066' was collected where the water table is currently 35 m bgl and a drawdown of <10 m is predicted (from mine drawdown). Given that >235 m of aquifer in fractured rock will remain saturated, it might be confidently expected that Tubificidae 'BOL066' will persist; but in fact the species would be at risk if it occupies fissures in only the first few metres below water table. Survey to identify the species occurring in the borefields area is needed, together with detailed bore logs that provide information about where in the water column species may occur.

Generally, habitat extent and thickness persists at the Western and Eastern boundaries of the study area, providing connectivity with the weathered bedrock and alluvial habitats of the Turner

and Shaw Rivers. It is the centre of the borefield, where the highest magnitude of drawdown is predicted, that is most at risk.

11.1.3.2 Groundwater Dependent Vegetation

Impacts to groundwater dependent or potentially groundwater depedent vegetation associated with groundwater drawdown is considered a high risk, given the magnitude of drawdown expected in the vicinity of the vegetation communities in both the Southern and Western Borefields. However, as outlined in Section 6, it is considered likely that the vegetation communities are not, in fact, dependent on groundwater. Further work is required to validate this concept, and appropriate monitoring and management needs to be implemented as a precaution until the extent of the vegetation's groundwater dependency is better understood.

11.1.3.3 Site 12 Pool

As outlined in Iron Bridge (2021), Site 12 pool is connected to both surface water and groundwater, with localised fracture flow and laterally constrained flow from upstream likely contributing to the water balance (Figure 15). The pools themselves are located on exposed bedrock, following topography, with water levels of 278 mAHD in the upper portion of the pools and 269 mAHD in the lower portions.

From a groundwater perspective, land-use and dewatering activities are the activities which may impact groundwater quality and quantity. The Site 12 Pool Water Quality and Quantity Monitoring Plan includes trigger levels to manage these potential impacts (Iron Bridge, 2021). This conditional management plan is considered appropriate to manage the risks to the pool identified in this assessment; increased abstraction from the water supply borefield not alter the risk initially assessed (which is owing to pit dewatering abstraction).

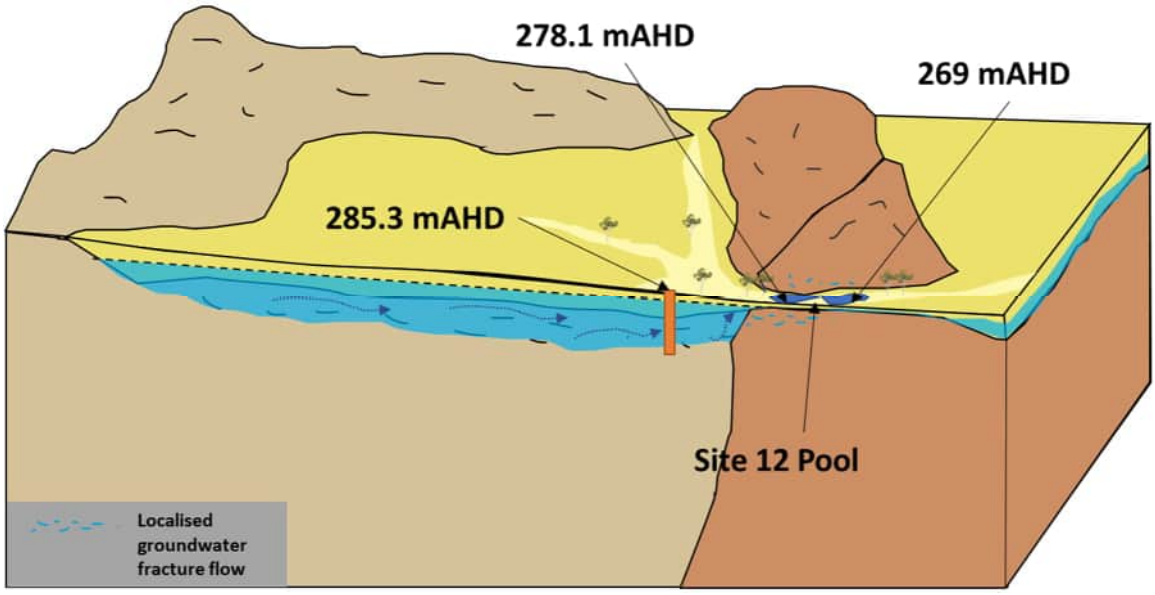


Figure 15: Conceptual schematic of Site 12 Pool, showing relative water levels in upstream catchment and pool system (adapted from Bourke *et al.* (2023))

11.1.3.4 Mundagoora Pool

Mundagoora Pool's conceptual setting has been outlined in Hydrobiology (2022) and summarised in Table 10. This information, plus recently collected water level data for pools and nearby monitoring bores, has been collated into the conceptual schematic shown in Figure 16. In the context of this schematic, the groundwater component of the water balance of Mundagoora pool can be impacted by:

a. Drawdown of water upstream in the upstream catchment leading to a reduction in seepage rates into the pool. Whilst any change in water would have a correspondence change to seepage rate, it is unclear with available data at this stage whether there would be a material impact on the overall water balance. Further monitoring is required to associate upstream groundwater and pool water levels.

b. Drawdown of water downstream of the pool, which may lead to an increase in throughflow out of the pool and potential impacts on riparian vegetation associated with the pool.

Changes in the pool water balance may also impact the overall pool water chemistry, and it is acknowledged that surface water inflows to the pool have a notable impact on water balance and water chemistry (Hydrobiology, 2022).

It is recommended that an initial management hierarchy is developed using the pool water level itself, whilst more information is gained on the relationship between upstream and downstream groundwater levels and their impact on pool water levels.

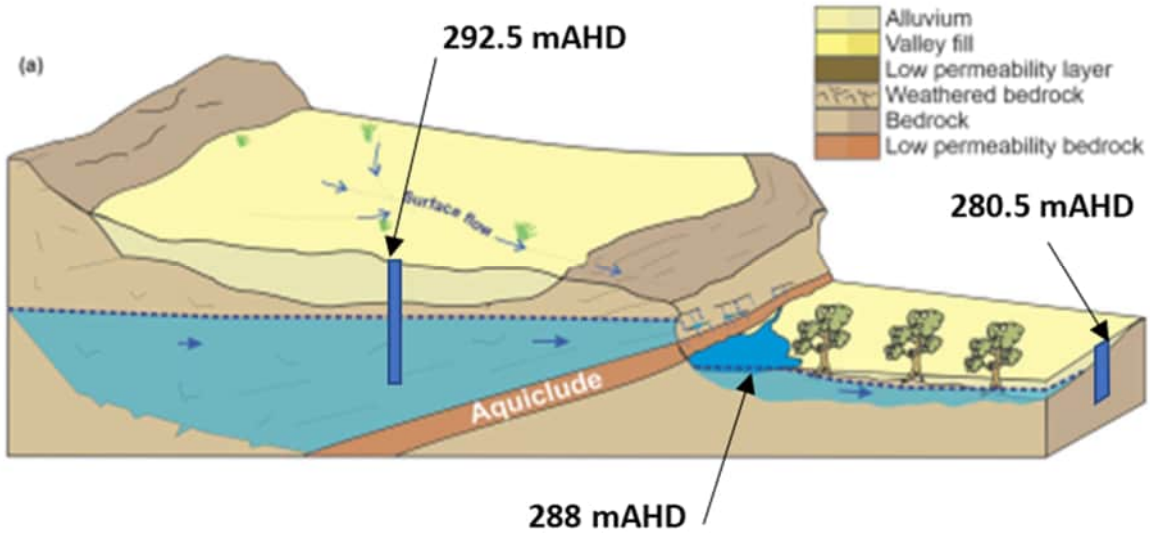


Figure 16: Conceptual schematic of Mundagoora Pool, showing relative water levels in upstream catchment, the pool and downstream (adapted from Bourke *et al.* (2023))

11.1.3.5 Fig Pool and Cow Springs

Fig Pool and Cow Springs pools are small pools, characterised as groundwater fed through stable water levels and water chemistry data (Table 10).

As groundwater fed pools, there is a potential that groundwater drawdown may impact the source aquifer for both pools. However, monitoring data to date indicates that neither pool has demonstrated a reduction in water levels (Figure 17), despite abstraction and drawdown in downstream bores over time. In addition, a comparison of water quality data from Fig Pool with nearby bore NS-Obs29, and Cow Springs with NS-Obs23 (Figure 18) indicate a separate water chemistry in both locations. Fig Pool does have a broader chemical range, perhaps indicative of mixed surface water inputs captured during its larger data set compared to Cow Springs, but it is not alike to NS-Obs29. It is highly likely that the pools source their water from local fracture networks and storage associated with structural lineaments and contacts between adjacent geological formations. This is reflected in the conceptual schematic shown in Figure 19.

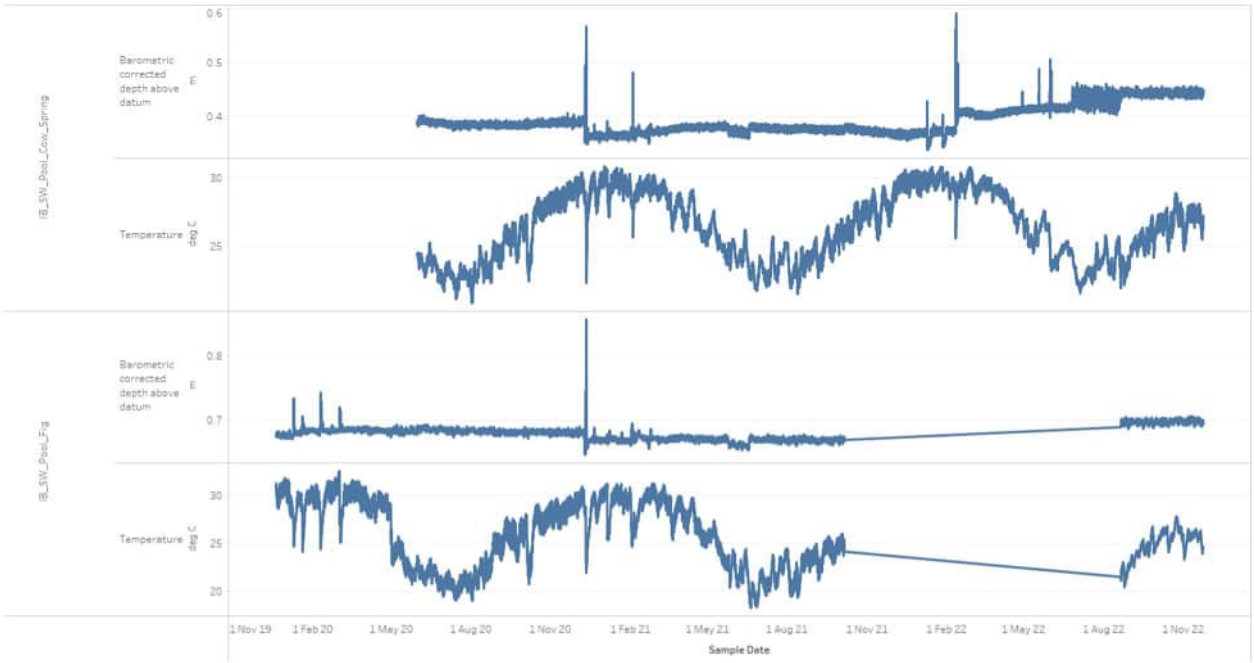


Figure 17: Water level and temperature responses from Cow Spring and Fig Pool.

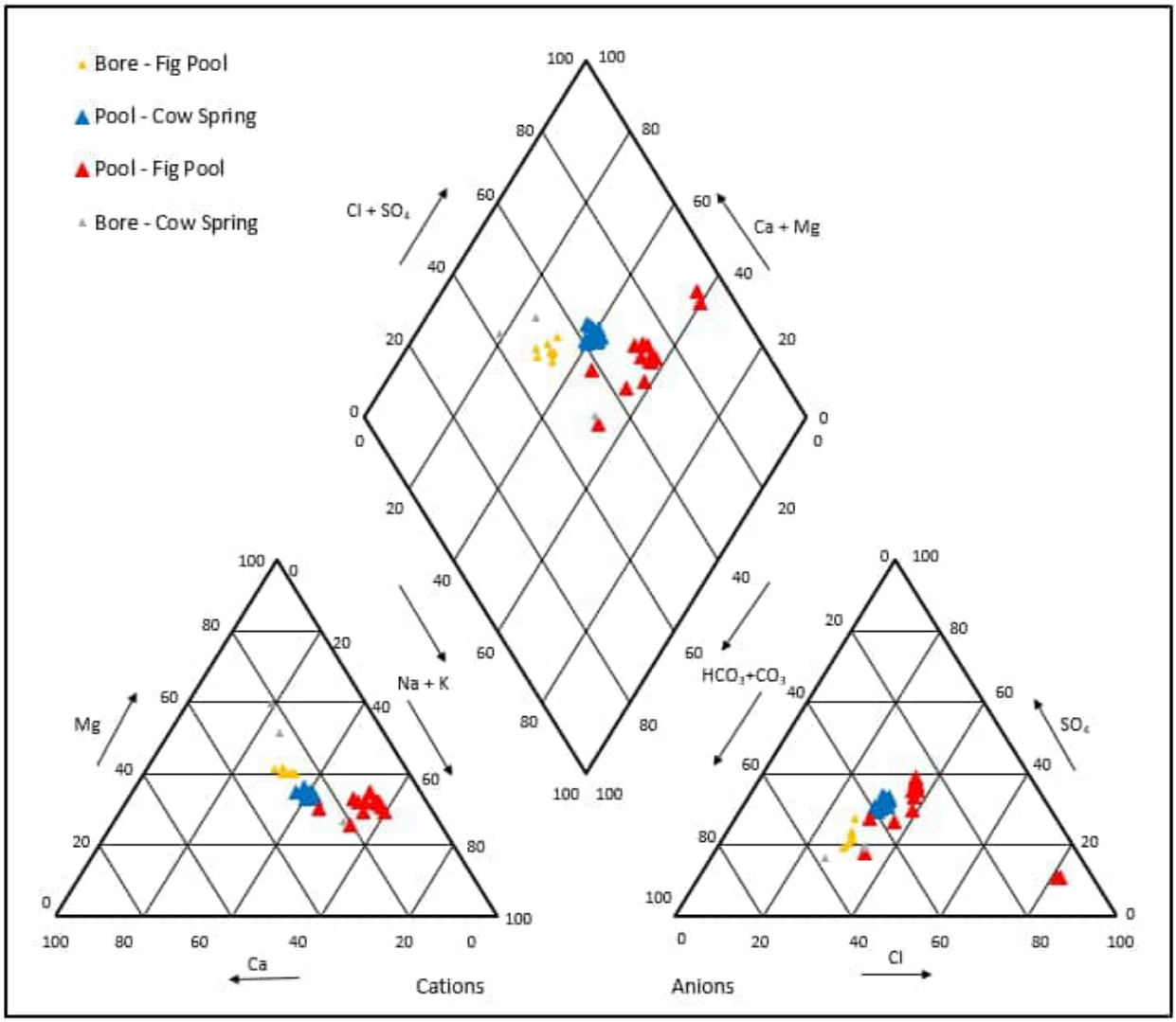


Figure 18: Piper diagram comparing water chemistry in Fig Pool and Cow Springs with nearby groundwater

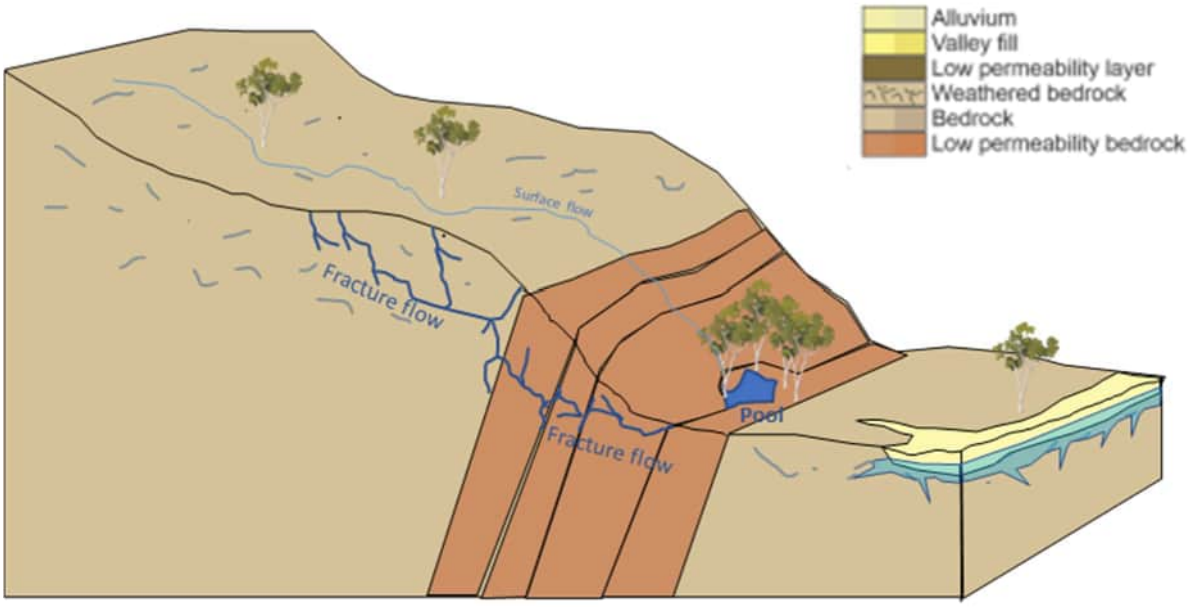


Figure 19: Schematic illustration of fracture flow groundwater source for Cow Spring and Fig Pool (adapted from Bourke *et al.* (2023)).

11.1.3.6 Astrid Bee Cave; Craig's Pool; Dingo Lair Pool; Zane's Gorge Pool.

Whilst no data exists for these pools, their position in the landscape is considered a strong indication of conceptual similarity to Cow Springs and Fig Pools. Modelled drawdown does extend to these areas; however the conceptual setting (as with Fig and Cow Springs Pool) indicates a very low risk of impact.

The behaviour of Cow Springs Pool can be utilised as an indicator of whether additional studies are required on these pools.

11.2 Impacts to Groundwater Quality

Field investigations and analysis have not identified any risks to groundwater quality associated with dewatering or water supply abstraction. Management may be required to address the risks of seepage from waste rock dumps and tailings facilities on groundwater (refer to Table 14 below).

Table 14: Summary of potential impacts and inherent risks to groundwater quality

Activity / Source	Potential Risk	Risk of Impacts (refer to Appendix 8)
Seepage from Tailings Storage Facility	Changes to groundwater quality downstream of TSF.	Low
Seepage from Waste Rock Dump	Changes to groundwater quality in Site 12 pool. WRD may contain PAF material	Medium

12. GROUNDWATER AND VEGETATION MONITORING

Groundwater monitoring is currently undertaken in support of the existing licence revision for GWL178289, and the approved Groundwater Operating Strategy. The detail of the monitoring is included in Appendix 9. As outlined in Fortescue Metals Group (2023), monitoring to date has been adequate to determine whether management objectives have been met with the current abstraction regime.

To support the proposed amendment to the licence (which is primarily the inclusion of dewatering, plus additional water supply abstraction), and based on the potential impacts identified, additional monitoring (including vegetation monitoring) outlined in Table 15 is to be added to a new revision of the Groundwater Operating Strategy or other suitable plan. These locations are illustrated in Map 13.

Table 15: Additional Monitoring to Support Revised Licence

Monitoring Name	Type	Easting	Northing	Purpose	Recommended Frequency and Parameters
NS-Obs14	Trigger Monitoring Bore	712,615	7,649,148	Bore with known restricted Stygofauna (Atopobathynella `BSY214`)	Monthly water level Quarterly water quality suite as per existing GWOS
IB_GVS_M01	Trigger Monitoring Bore	713,945	7,644,272	Nearest bore to known restricted Stygofauna (Tubificidae `BOL066`). Located nearer to future cone of depression	Monthly water level Quarterly water quality suite as per existing GWOS
NS_VH_PGDV_I1 NS_VH_PGDV_I2 NS_VH_PGDV_I3 NS_VH_PGDV_R1 NS_VH_PGDV_R2 NS_VH_PGDV_R3 (all indicative locations)	Vegetation Health Monitoring Plots	708,616 710,878 705,928 713,799 697,417 695,256	7,644,179 7,644,657 7,647,701 7,663,806 7,650,388 7,647,949	Assess health of PGDV and keystone tree species (*Eucalyptus victrix*) within Western (I1) and Southern Borefield (I2 and I3) and local reference comparison areas (R1 to R3)	Annual (Dry Season) Vegetation Condition (per site) Visual Tree Health Assessment (10 trees per site) Leaf Water Potential (3 samples per tree, 10 trees per site)
NS-EXS23	Monitoring Bore	709,377	7,643,734	Southern borefield pGDE monitoring	Monthly water level
IB_MP_M01	Monitoring Bore	712,846.95	7,645,936.42	Mundagoora Pool Upstream	Monthly water levels. Quarterly water quality suite as per existing GWOS

Monitoring Name	Type	Easting	Northing	Purpose	Recommended Frequency and Parameters
IB_MP_M02	Monitoring Bore	712,143.54	7,645,669.39	Mundagoora Pool Downstream	Monthly water levels. Quarterly water quality suite as per existing GWOS
GV_SW_Pool_Mundagoora_SS	Pool	712,554.35	7,645,679.30	Mundagoora Pool	Daily Logger water levels, downloaded as required. Quarterly water quality suite as per existing GWOS
IB_SW_Pool_Fig	Pool	711,676.17	7,650,628.50	Fig Pool	Daily Logger water levels, downloaded as required. Quarterly water quality suite as per existing GWOS
IB_SW_Pool_Cow_Spring	Pool	711,100	7,648,583.20	Cow Springs Pool	Daily Logger water levels, downloaded as required. Quarterly water quality suite as per existing GWOS
Site 12 Pool and Monitoring Bore		*Locations and parameters/frequency already defined in* (Iron Bridge, 2021)			
TSF Seepage Monitoring		*Refer to Table 11 for details*			
WRD Plug Monitoring		*Refer to Table 12 for details*			

13. MANAGEMENT APPROACH

Given the fractured rock aquifer setting and associated numerical uncertainty, adaptive management should be adopted, supported by the proposed monitoring, to ensure the following objectives are met:

1. No unauthorised impact to identified environmental groundwater receptors, beyond natural variability;
2. Groundwater quality and level trends are in line with expectation; i.e. that unexpected aquifer trends are identified and investigated;
3. Successful and safe dewatering of below water table pits; and
4. Water supply abstraction optimised to contribute to overall mine water balance.

The adaptive management framework can be simplified as per the schematic in Figure 20 below.

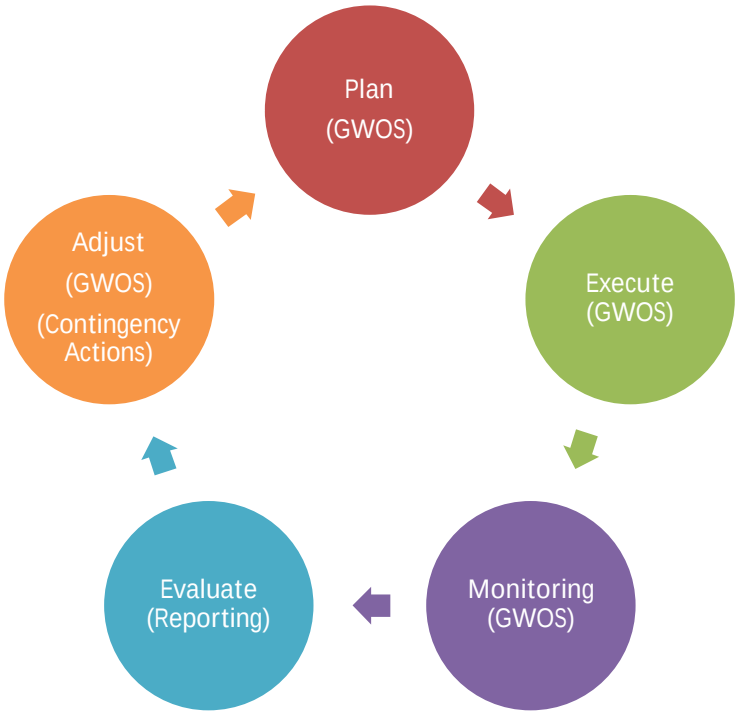


Figure 20: Adaptive Management Framework in the Context of Iron Bridge Groundwater Management

To support the adjust phase of the adaptive management framework, contingency actions and appropriate trigger levels, in addition to those already with the current operating strategy (Appendix 9), should be developed in a revised groundwater operating strategy. Other aspects

of the framework should also be addressed through the groundwater operating strategy document.

Some aspects of groundwater management are already included within other regulatory instruments; Table 16 summarises the relevant documents which address these. Although vegetation monitoring will be included in the *Iron Bride Vegetation Health Monitoring and Management Plan,* it is considered more appropriate for groundwater related adaptive management actions to be documented within the groundwater operating strategy.

Table 16: Groundwater Management under Other Approval Instruments

Broad Objective	Approval Condition	Management Plan	Explanation
No unauthorised impact to identified environmental groundwater receptors, beyond natural variability;	Addresses commitments made in the North Star Stage 2 (Amendment 2) Mining Proposal (Iron Bridge, 2022)	(Iron Bridge vegetation health monitoring and management plan. 662NS-0000-PL-EN-0004)	Plan identifies vegetation management and monitoring measures to minimise the impact on conservation significant vegetation and flora within, and adjacent to, the North Star mine. The environmental outcomes and measures/targets of the Plan reflect commitments made in the North Star Stage 2 (Amendment 2) Mining Proposal.
	Condition 12 of MS 993 (ensure implementation of the proposal within the catchment of Site 12 Pool that is located within the MDE does not have a detrimental impact on the water quality or hydrological regime of Site 12 Pool)	(Site 12 Pool Water Quality and Quantity Monitoring Plan. 662MI-5700-PL-WM-0001)	Plan contains monitoring, trigger criteria, response actions and reporting, to achieve the environmental outcome (approval condition)
Groundwater quality and level trends are in line with expectation; i.e. that unexpected aquifer trends are identified and investigated;	Condition 9 of Works Approval W6322/2019/1	(Tailings Storage Facility Monitoring Procedure , 662NS-0000-PR-EN-0020.)	Plan contains monitoring and reporting commitments, including assessment of data against water quality threshold values

A second risk assessment (Appendix 11), has been completed with recommended adaptive management options. Table 17 below summarises the key outcomes of this assessment, which should form the basis of the final framework developed in the Groundwater Operating Strategy.

Table 17: Groundwater Management Recommended under RIWI Act Groundwater Operating Strategy (from Appendix 10)

Receptor	Risk Scenario	Adaptive Management Strategy	Residual Risk	Further Actions
Stygofauna	Groundwater drawdown from water supply or dewatering reduces available habitat and/or connectivity for Stygofauna species, particularly those within limited known range, but also in areas without survey where species assemblage is unknown	a. Undertake additional regional surveys to better understand species occurrence; and b. Adopt adaptive management, with strategies as follows: bi. Alteration of abstraction regime from nearest bores bii. Groundwater injection to mitigate localised drawdown and increase groundwater availability biii. Reduced abstraction from borefield	Medium	• Commit to additional surveys to better understand stygofauna throughout borefield drawdown extent • Update impact assessment and GWOS with uplifted stygofauna study outcomes
Groundwater Dependent Vegetation (both Southern and Western Borefields)	Groundwater abstraction from near mine water supply borefield reduces groundwater availability for mapped GDE or pGDE	a. Alteration of abstraction regime from nearest bores b. Direct supplementation to creekline to increase soil moisture availability c. Groundwater injection to mitigate localised drawdown and increase groundwater availability d. Reduced abstraction from borefield	Low	• Progress approvals to allow supplementation to creekline so that this can commence if required, with minimal delay.
Mundagoora Pool	Groundwater abstraction from Water Supply or Dewatering reduces water levels below baseline.	a. Alteration of abstraction regime from nearest bores b. Direct supplementation to pool c. Groundwater injection to mitigate localised drawdown d. Reduced abstraction from borefield	Medium	• Further analysis of baseline water levels from pool and bores. • Investigate potential for structural geology assessment of the pool's setting, supported by non-destructive geophysical surveys • Progress approvals to allow for supplementation?

Receptor	Risk Scenario	Adaptive Management Strategy	Residual Risk	Further Actions
Fig Pool and Cow Springs	Groundwater abstraction from Water Supply or Dewatering dries out pools.	a. Alteration of abstraction regime from nearest bores b. Direct supplementation to pool	Low	• Progress approvals to allow for supplementation infrastructure to be constructed if required, with no further delay.
Astrid Bee Cave; Craig's Pool; Dingo Lair Pool; Zane's Gorge Pool	Groundwater abstraction from Water Supply dries out pools.	a. Alteration of abstraction regime from nearest bores b. Direct supplementation to pool	Low	• If analysis of Cow Springs Pool indicates a impacts, commence investigation of these pools
All ephemeral pools identified as surface water dependent in Hydrobiology (2023)	Groundwater abstraction from Water Supply or Dewatering reduces water levels below baseline.	No immediate adaptive strategy required; update plan if pool data indicates groundwater dependency	Low	• Further analysis of baseline water levels from pools. • If warranted by above, consider whether monitoring bores are necessary to establish groundwater triggers in the vicinity of the pool (a bore is already planned for Honeyeater Creek and Pool_SWGV)
Site 12 Pool	Groundwater abstraction from Dewatering leads to long term drying of pool (beyond the period of drying observed in baseline).	a. Alteration of abstraction regime from nearest dewatering bores b. Direct supplementation to pool c. Groundwater injection to mitigate localised drawdown d. Reduced abstraction from dewatering borefield	Low	• Progress approvals to allow for supplementation infrastructure to be constructed if required, with no further delay.
N/A	Over-extraction of water supply leading to loss of yield	a. Implement Groundwater Operating Strategy, which includes: ai. Annual aquifer reviews aii. Maintain ongoing tracking of borefield performance (yield vs drawdown) aiii. cycling of bore use as required to manage bore yields and drawdown. b. Establish robust, high frequency water balance reporting tool for operational decision making	Low	

14. CONCLUSIONS

The Iron Bridge mine requires dewatering, water supply and seepage recovery abstraction over the life of the mine. The annual rate of abstraction is expected to be up to 8.5 GL/a, sourced from what is a fractured rock groundwater resource. Actual annual abstraction will vary dependent on mining progression; the mine site water balance; and recharge, particularly from large cyclonic rainfall events.

Environmental receptors, comprised of pools, subterranean fauna and potentially groundwater dependent vegetation, have been identified within the footprint of these abstraction activities. The risk of groundwater impacts on some of these receptors are required to be adaptively managed to address the heterogeneity encountered during extensive field investigations, and the uncertainty established during groundwater modelling simulations.

An adaptive management process incorporates monitoring, triggers and contingency actions. Monitoring, in addition to that already undertaken under GWL 179289(6) has been proposed for at-risk receptors, whilst trigger and contingency actions should be developed and included in an updated Groundwater Operating Strategy. This document will form the management plan for execution of the planned abstraction activity.

Additional investigations are required to reduce the risk of drawdown to Stygofauna and Mundagoora Pool from “Medium” to “Low”. Studies and ongoing monitoring should be reviewed as part of annual reporting to ensure changes to conceptual understanding of any receptor is considered in adaptive management.

REFERENCES

Batini, F. (2009). *Eucalyptus vitrix, Karijini National Park Report to the EPA.* Report prepared for the Environmental Protection Authority.

Bennelongia. (2023a). *Noth Star Subterranean Fauna Desktop and Survey Report.* Report prepared for Fortescue Metals Group.

Bennelongia. (2023b). *Stygofauna in Iron Bridge Near Mine Borefields.* Letter prepared for Fortescue Metals Group.

Bourke, S. A., Shanafield, M., Hedley, P., Chapman, S., & Dogramaci, S. (2023). A hydrological framework for persistent pools along non-perennial rivers. *Hydrology and Earth System Science, 27*, 809-836. Retrieved March 20, 2023, from https://hess.copernicus.org/articles/27/809/2023/hess-27-809-2023.pdf

Ecologia Environment. (2012). *Pityrodia sp. Marble Bar Targeted Flora Survey.*

Ecoscape. (2020). *North Star Extension Flora and Vegetation Survey.* Unpublished report prepared for FMG Iron Bridge.

Fortescue Metals Group. (2020). *North Star Groundwater Monitoring Summary - February 2017 to January 2020. NS-16018-AN-HY-0003.*

Fortescue Metals Group. (2023). *North Star Triennial Groundwater Monitoring Summary - January 2020 to December 2022. NS-16016-AN-HY-0006.*

Hydrobiology. (2022). *Iron Bridge: Surface Water Monitoring & Aquatic Ecology Baseline Report - Late Wet 2019 to Late Dry 2021. Report prepared for FMG Iron Bridge (Aust) Pty Ltd.*

Hydrobiology. (2023). *Iron Bridge: Surface Water Monitoring & Aquatic Ecology Baseline Report - Late Wet 2019 to Late Dry 2022.* Report prepared for FMG Iron Bridge (Aust) Pty Ltd.

Iron Bridge. (2021). *Iron Bridge - Site 12 Pool Hydrogeology. Internal memorandum published for Fortescue Metals Group.*

Iron Bridge. (2021). *Site 12 Pool Water Quality and Quantity Monitoring Plan. 662MI-5700-PL-WM-0001.*

Iron Bridge. (2022). *Iron Bridge vegetation health monitoring and management plan. 662NS-0000-PL-EN-0004.*

Iron Bridge. (2022). *Mining Proposal: North Star Stage 2 (Amendment 2). NS-AP-EN-0012.*

Iron Bridge. (2022). *Section 38 Significant Amendment to Approved Proposal - Environmental Review Document. North Star Magnetite Project. 662NS-0000-AE-EN-0001.* Fortescue Metals Group.

Iron Bridge. (2022). *Tailings Storage Facility Monitoring Procedure , 662NS-0000-PR-EN-0020.*

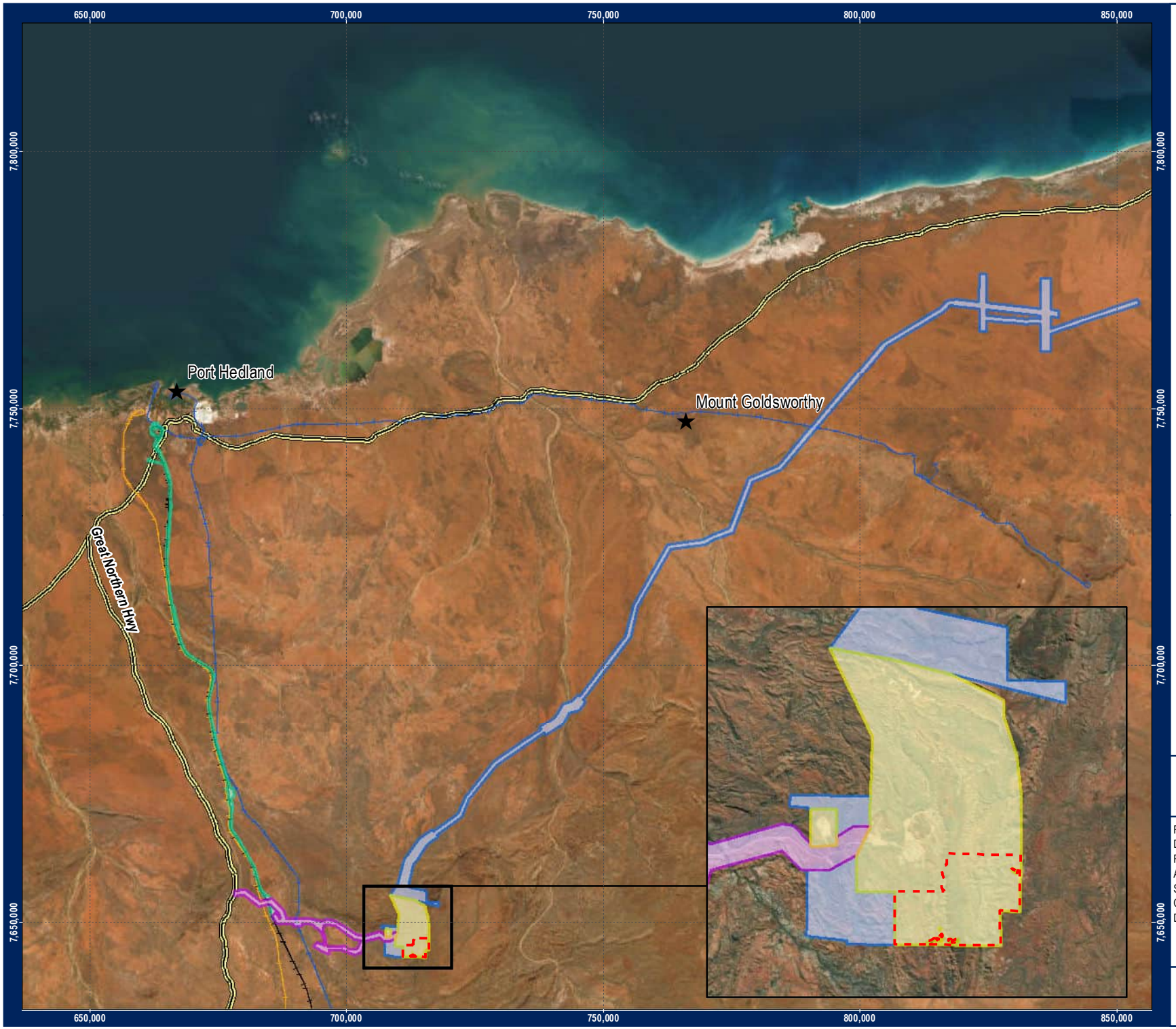
Iron Bridge. (2023). *North Star Groundwater Operating Strategy: Near Mine Groundwater Supply Scheme.* Fortescue Metals Group.

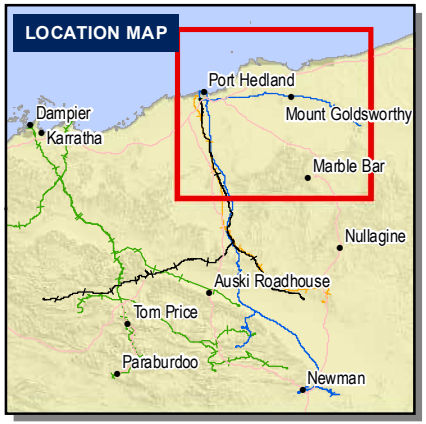
MWH. (2015). *Development of Pilbara Landscape Ecohydrological Units.* Report prepared for BHP Billiton Iron Ore. https://www.bhp.com/-/media/bhp/regulatory-information-media/iron-ore/western-australia-iron-ore/0000/report-appendices/160316_ironore_waio_pilbarastrategicassessment_state_appendix7_appendixa.pdf.

Rio Tinto. (2018). *Assessment of Groundwater Dependent Vegetation distribution of the Robe River - Targeted Riparian Survey - Stage 1.* Rio Tinto Iron Ore. https://www.epa.wa.gov.au/sites/default/files/PER_documentation2/A5%20Assessment%20of%20Groundwater%20Dependent%20Vegetation%20%28Rio%20Tinto%202017a%29%20Part%201.pdf.

Subterranean Ecology. (2012). *North Star Subterranean Fauna assessment.*

Van Kranendonk, M. (2000). *Geology of the North Shaw 1:100 000 sheet.* Geological Survey of Western Australia.





LEGEND

- Highway
- FMG Railway
- BHP Railway
- Rio Tinto Railway
- Roy Hill Railway
- Infrastructure Development Envelope
- Slurry Corridor Development Envelope
- Water Corridor Development Envelope
- Mine Development Envelope

Data Source(s):
Aerial; Esri, 2023
Towns; Landgate, 2023
Alll other data; FMGL, 2023

N

0 7.5 15 22.5 30
Kilometres

Project Layout

Requested By: Vladimir Rios vera
Drawn By: Russ Hall
Revised By: rushall
Approved By: P. Mastalir
Scale: 1:1,000,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 662NS_0000_MP_EN_0294.001

Date: 19/01/2023
Size: A4L
Revision: 0
Confidentiality: 0

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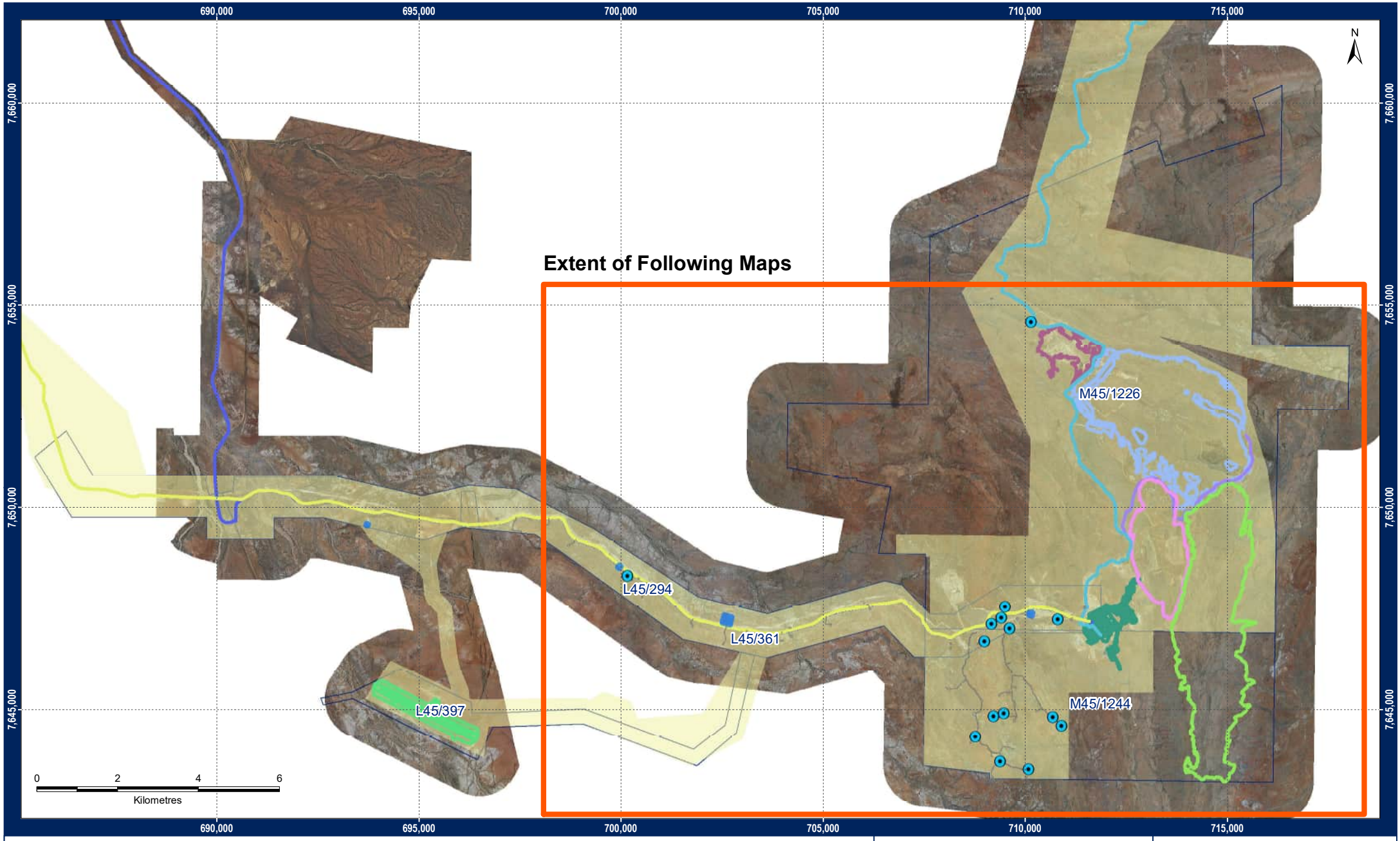
Iron Bridge



LEGEND

- GWOS Abstraction Bores
- Airport
- Canning Basin Pipeline
- Concentrate Pipeline
- Mine Access Road
- North Star Pit
- Return Water Pipeline
- Stage 2 Plant
- TSF LOM
- TSF Return Water Pipeline
- TSF Return Water Pond
- Tailings Pipeline LOM
- Waste Rock Dump
- Borefield
- Dam - Fresh Water
- Development Envelopes
- FMG Managed Tenements

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:120,468
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map2

Date: 30/05/2023
Size: A4L
Revision: 0
Confidentiality: 1

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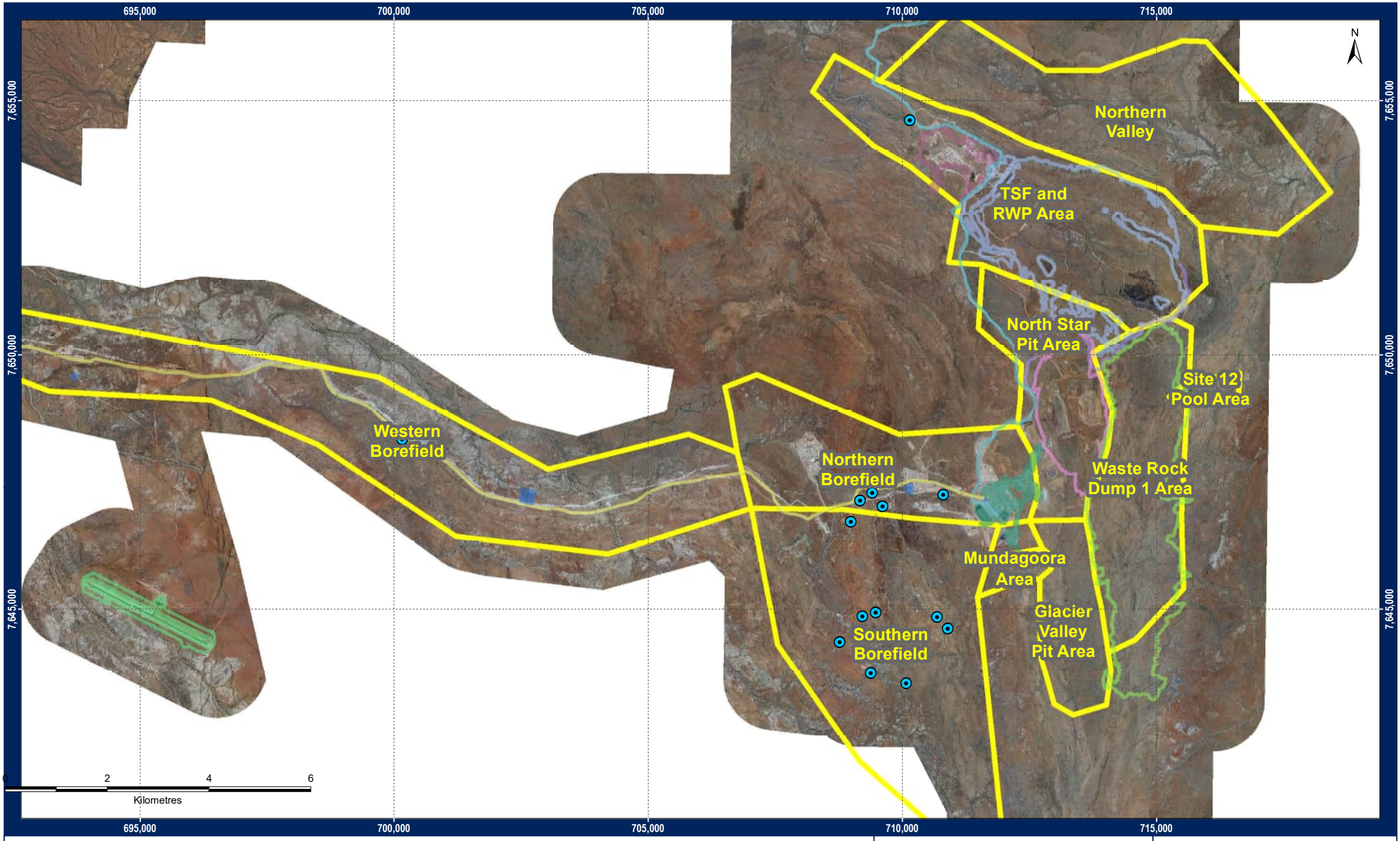
IB Near Mine H3
Local Project Overview

FMG Fortescue



LEGEND

- GWOS Abstraction Bores
- Airport
- Canning Basin Pipeline
- Concentrate Pipeline
- Mine Access Road
- North Star Pit
- Return Water Pipeline
- Stage 2 Plant
- TSF LOM
- TSF Return Water Pipeline
- TSF Return Water Pond
- Tailings Pipeline LOM
- Waste Rock Dump
- Borefield
- Dam - Fresh Water
- Location Reference Areas

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:95,605
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map3

Date: 30/05/2023
Size: A4L
Revision: 0
Confidentiality: 1

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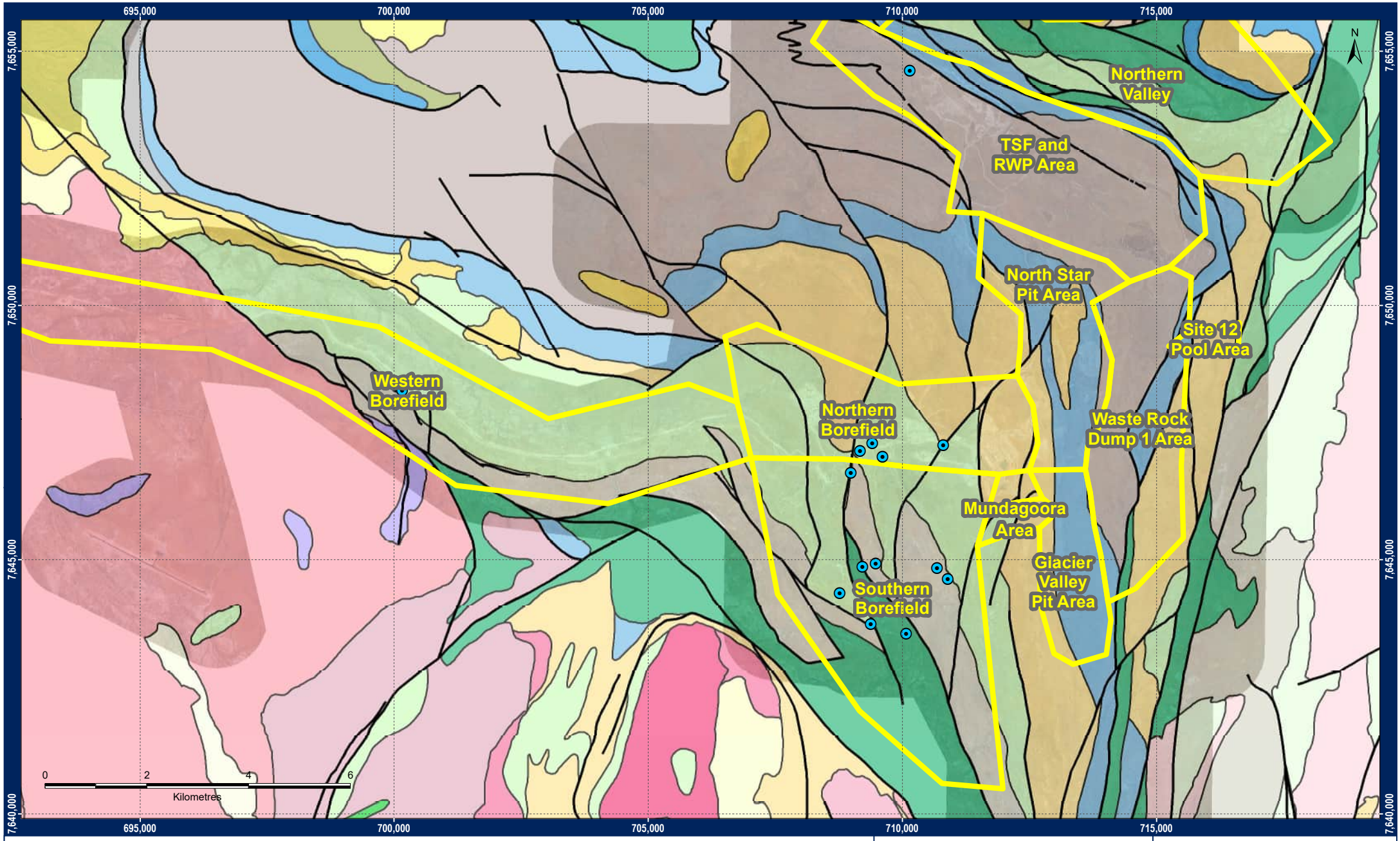
IB Near Mine H3
Site Naming Conventions

Fortescue



LEGEND

- GWOS Abstraction Bores
- Location Reference Areas
- Structure

GSWA Geology

A-CDl-st
A-CE-g
A-CE-mgtn
A-CEka-mgg
A-CEst-gm
A-DA-xo-a
A-GCe-ca
A-GCf-stq
A-KEe-b
A-Pl-mu
A-Pl-xmb-m
A-SOc-s
A-SRnu-gmp
A-SS-od
A-SSc-xf-s
A-SScp-ci
A-SSk-b
A-SSl-s
A-STpi-gmp
A-STwo-gm
A-TApe-mgt
A-mty-P
EN-_rb-cip
P_-MW-od
_A1
_A2
_C2
_R3
_W1

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:95,605
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map4

Date: 30/05/2023
Size: A4L
Revision: 0
Confidentiality: 1

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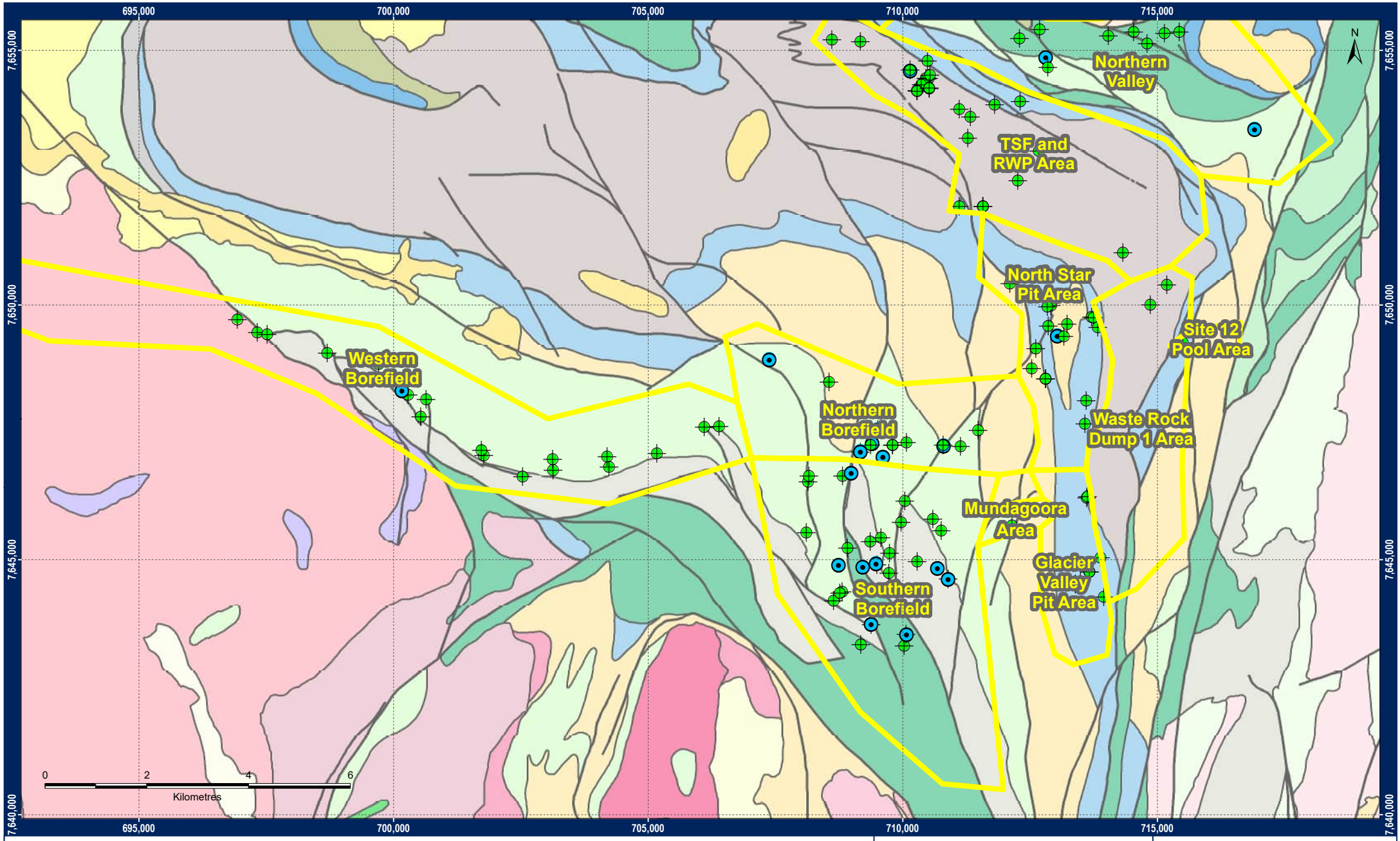
IB Near Mine H3
Surface Geology

Fortescue



LEGEND

Hydro Drilling

- Monitoring Bore
- Abstraction Bore
- Location Reference Areas
- Structure

GSWA Geology

A-CDl-st	A-CEst-gm	A-Pl-mu	A-SSc-xf-s	A-STwo-gm	_A1
A-CE-g	A-DA-xo-a	A-Pl-xmb-m	A-SScp-ci	A-TApe-mgt	_A2
A-CE-mgtn	A-GCe-ca	A-SOc-s	A-SSk-b	A-mty-P	_C2
A-CEka-mgg	A-GCf-stq	A-SRnu-gmp	A-SSl-s	EN-_rb-cip	_R3
	A-KEe-b	A-SS-od	A-STpi-gmp	P_-MW-od	_W1

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:95,605
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map5

Date: 30/05/2023
Size: A4L
Revision: 0
Confidentiality: 1

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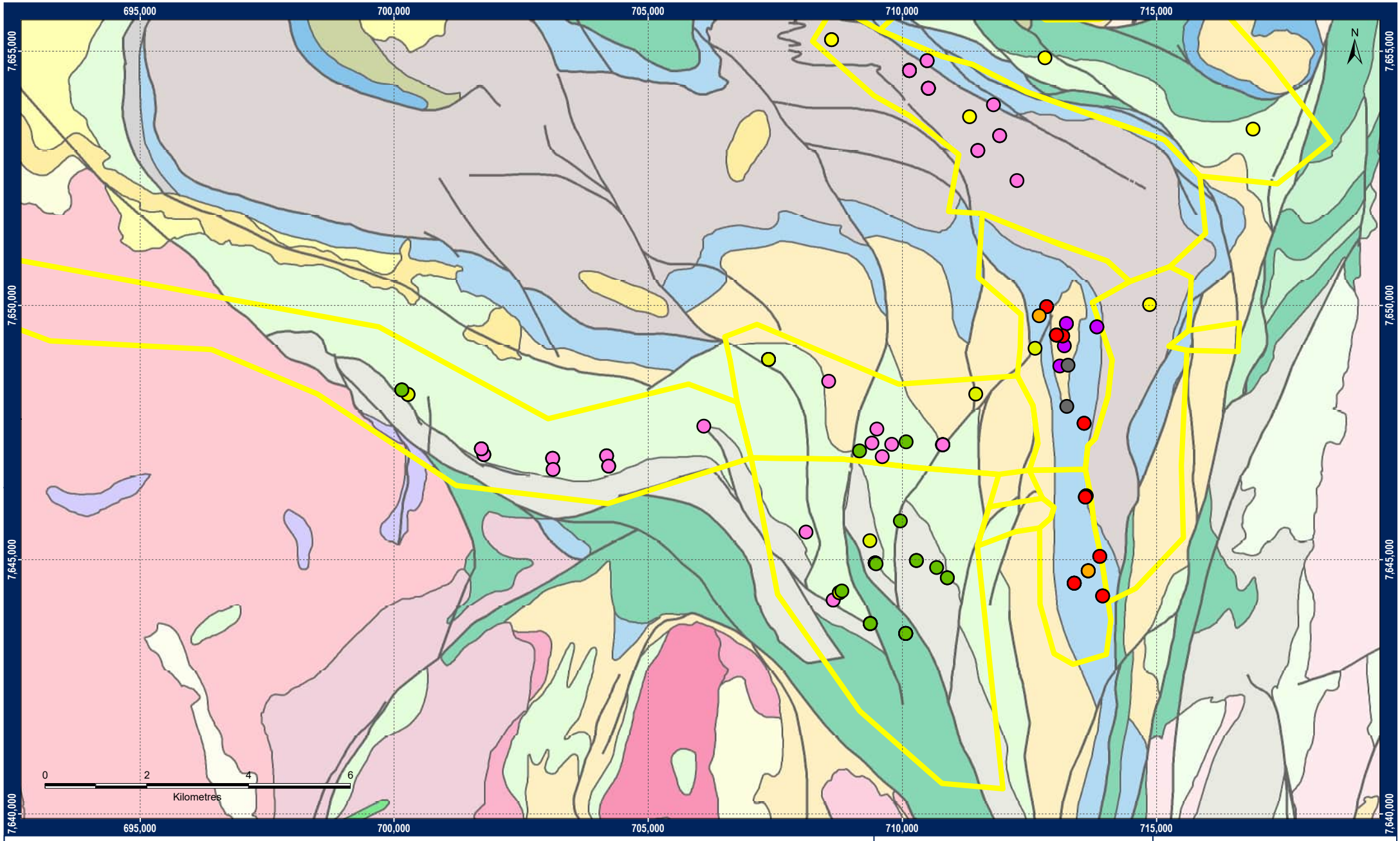
IB Near Mine H3
Hydrogeological Drilling

Fortescue



LEGEND

- Location Reference Areas
- Structure

Testing by Hydrostrat Unit

- Alluvium
- Faulted Bedrock
- Faulted Orebody
- Fresh Bedrock
- Fresh Orebody
- Shale
- Weathered Bedrock
- Weathered Orebody

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:95,605
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map6

Date: 30/05/2023
Size: A4L
Revision: 0
Confidentiality: 1

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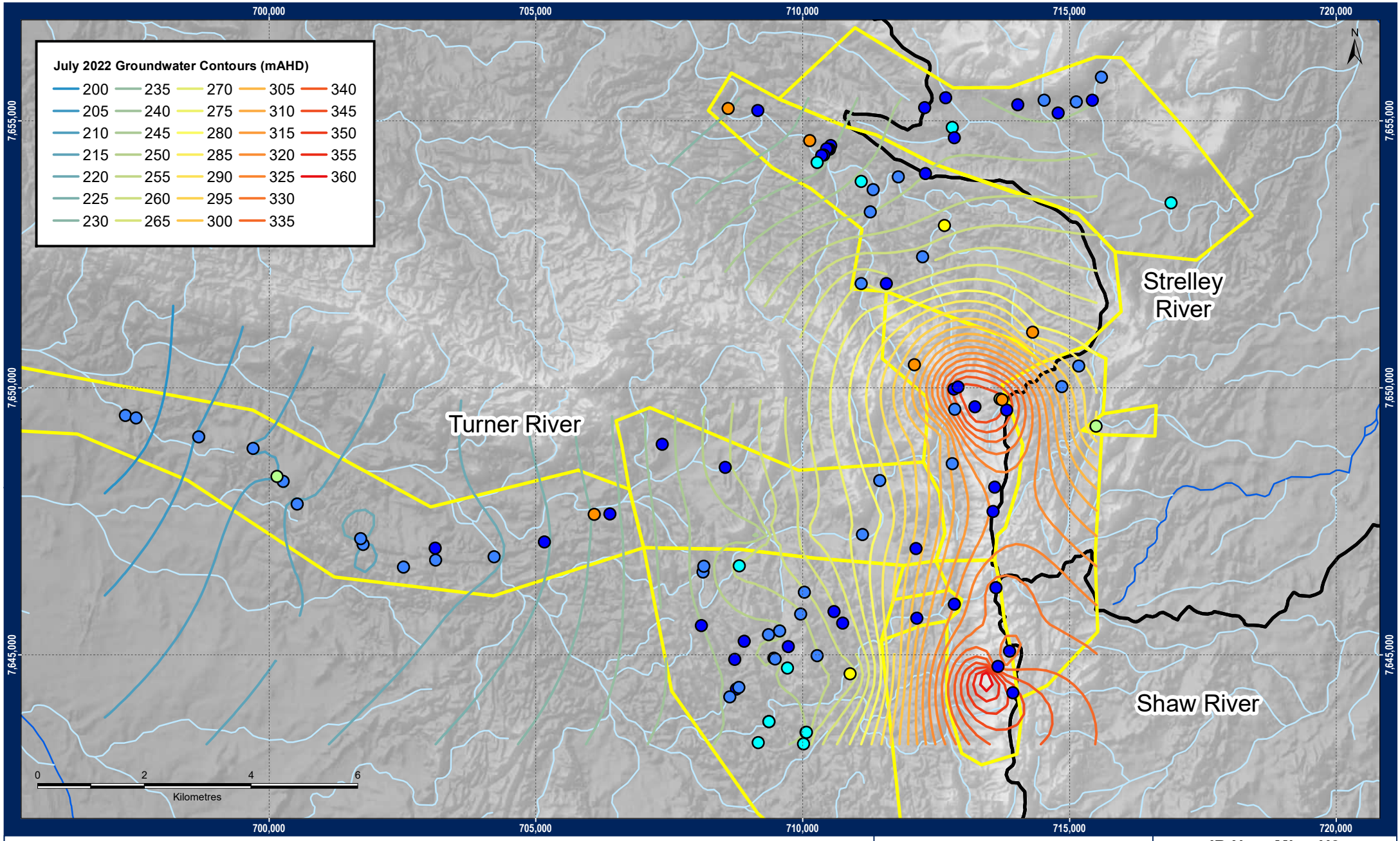
IB Near Mine H3
Hydrogeological Testing

Fortescue



LEGEND

- Location Reference Areas
- **Water_Level_Records (count)**
  - 101 - 120
  - 81 - 100
  - 61 - 80
  - 41 - 60
  - 21 - 40
  - 1 - 20

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:91,231
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map7

Date: 30/05/2023
Size: A4L
Revision: 0
Confidentiality: 1

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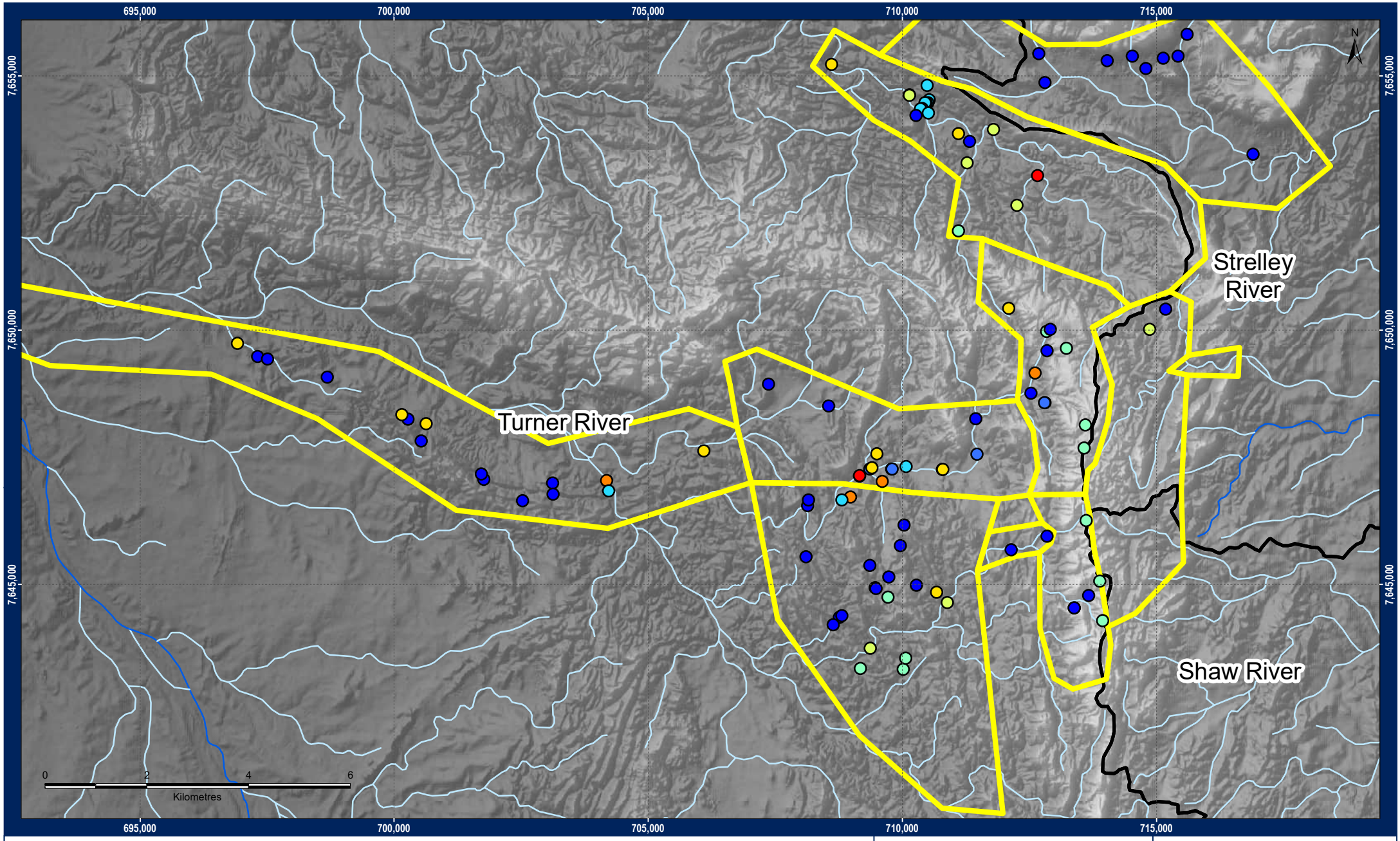
IB Near Mine H3

Hydrological and Hydrogeological Features

Fortescue



LEGEND

- Location Reference Areas

 # Water Quality Samples

- 15 - 16
- 13 - 14
- 11 - 12
- 9 - 10
- 7 - 8
- 5 - 6
- 3 - 4
- 1 - 2

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:95,605
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map8

Date: 30/05/2023
Size: A4L
Revision: 0
Confidentiality: 1

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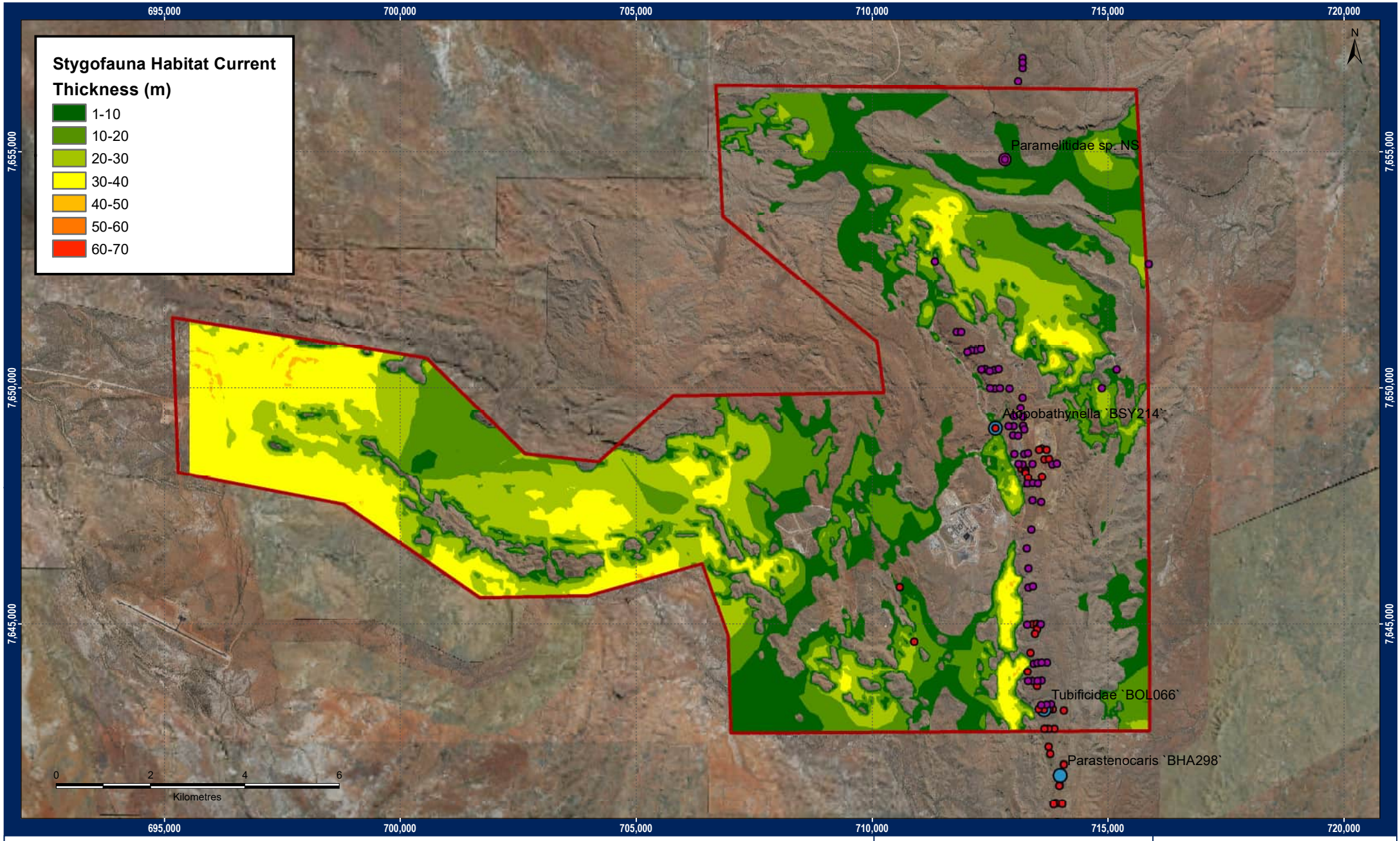
IB Near Mine H3
Groundwater Sampling

Fortescue



LEGEND

SubFauna Survey Locations 2011-12
- Widespread Species
- Limited Range Species

SubFauna Survey Locations 2022-23
- Widespread Species
- Limited Range Species

Habitat Model Extent

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:103,197
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map9

Date: 31/07/2023
Size: A4L
Revision: 0
Confidentiality: 1

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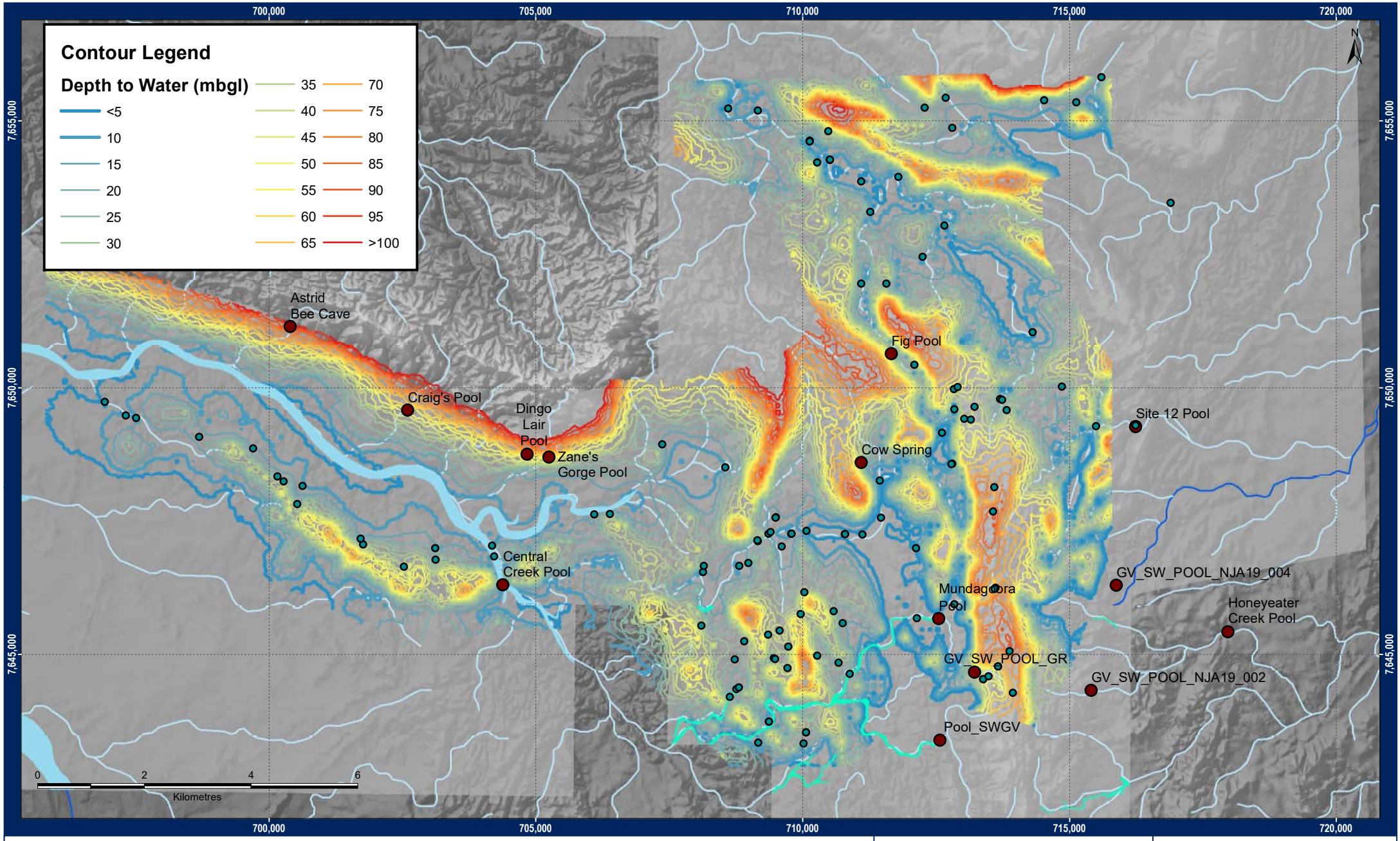
IB Near Mine H3
Current Stygofauna Habitat

Fortescue



LEGEND

- IB_Pools
- EvApTI
- EvAtCC
- Mapping Boundary

250k Drainage

- Major
- Minor
- Depth to Water Data

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:91,231
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map10

Date: 21/08/2023
Size: A4L
Revision: 0
Confidentiality: 1

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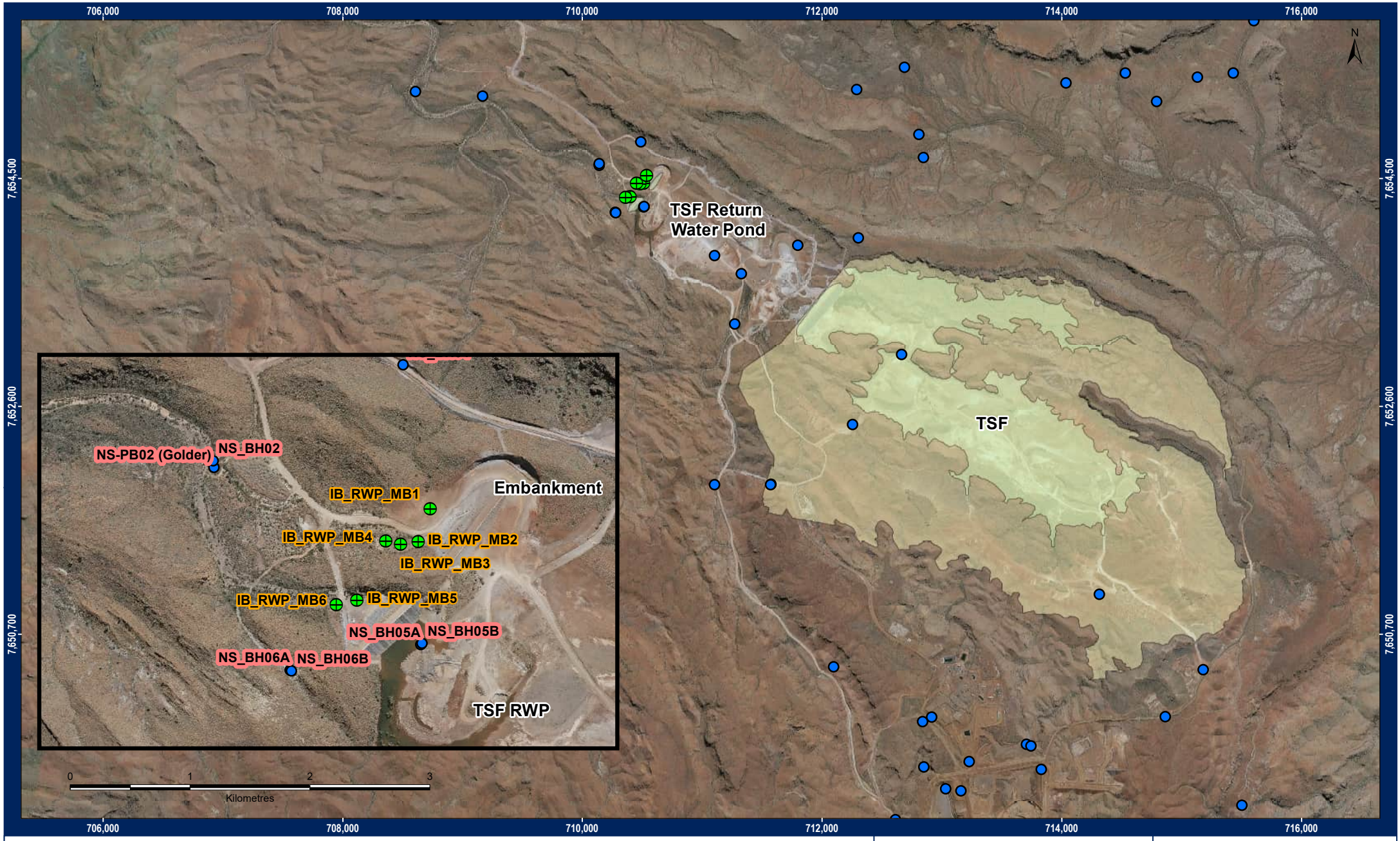
IB Near Mine H3
GW, SW and Vegetation

Fortescue



LEGEND

- Water Management Bore
- TSF Seepage Monitoring & Recovery
- Active TSF Footprint
- Planned TSF Footprint

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:40,623
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map11

Date: 25/07/2023
Size: A4L
Revision: 0
Confidentiality: 1

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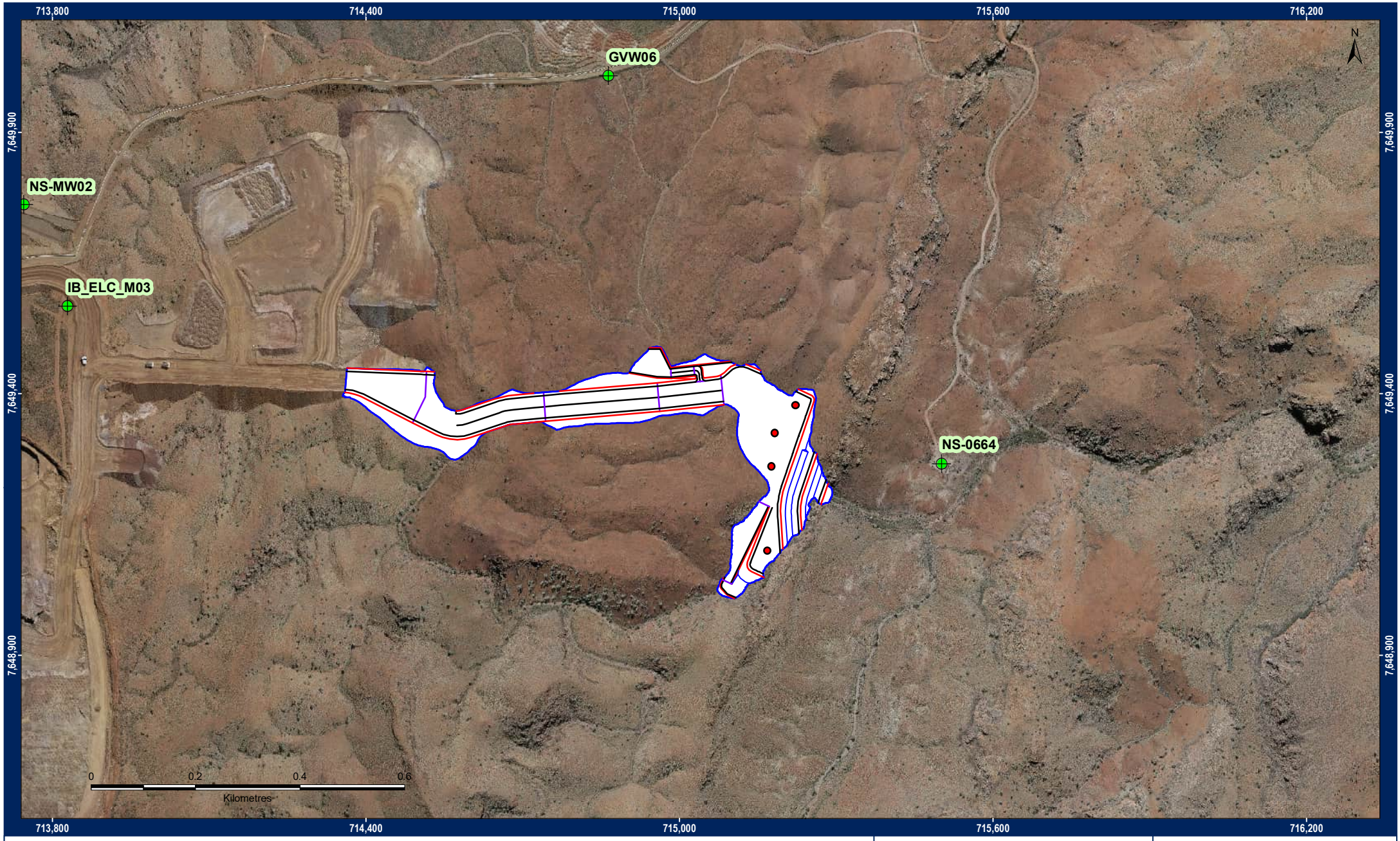
IB Near Mine H3
TSF Seepage Recovery

Fortescue



LEGEND

- Proposed Bore Locations
- **Hydro Drilling**
- **Bore Type**
  - Injection Bore
  - Saline Injection Bore
  - Monitoring Bore
  - Pastoral Bore
  - Abstraction Bore
  - Abstraction Bore (WHPZ)

Requested By: M Carroll
Drawn By: M Carroll
Revised By: f619608
Approved By: M Carroll
Scale: 1:9,317
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map10

Date: 1/06/2023
Size: A4L
Revision: 0
Confidentiality: 1

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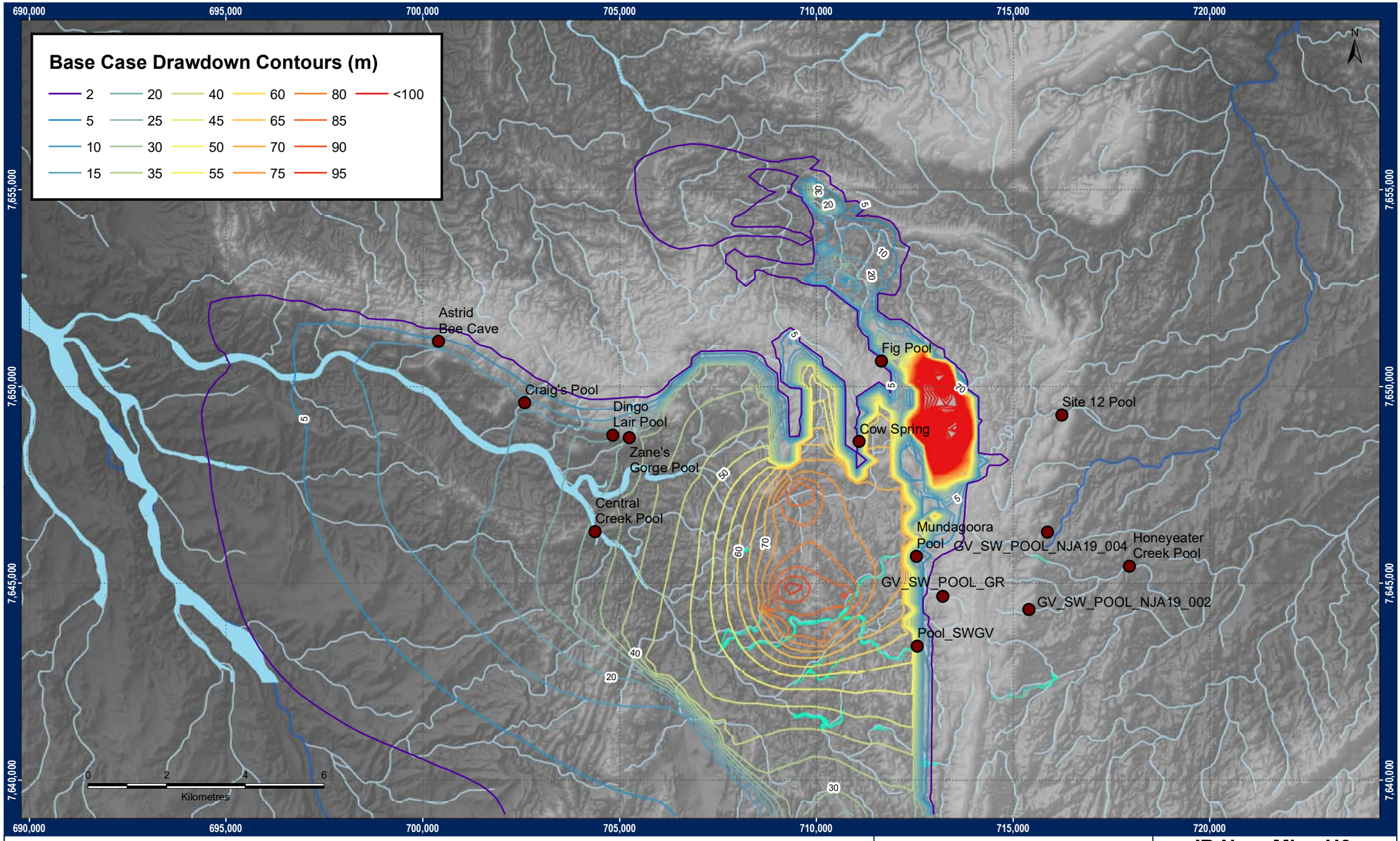
IB Near Mine H3
WRD Monitoring Bores

Fortescue



LEGEND

- IB_Pools
- EvApTI
- EvAtCC

250k Drainage

- Major
- Minor

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:123,735
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map14

Date: 3/08/2023
Size: A4L
Revision: 0
Confidentiality: 1

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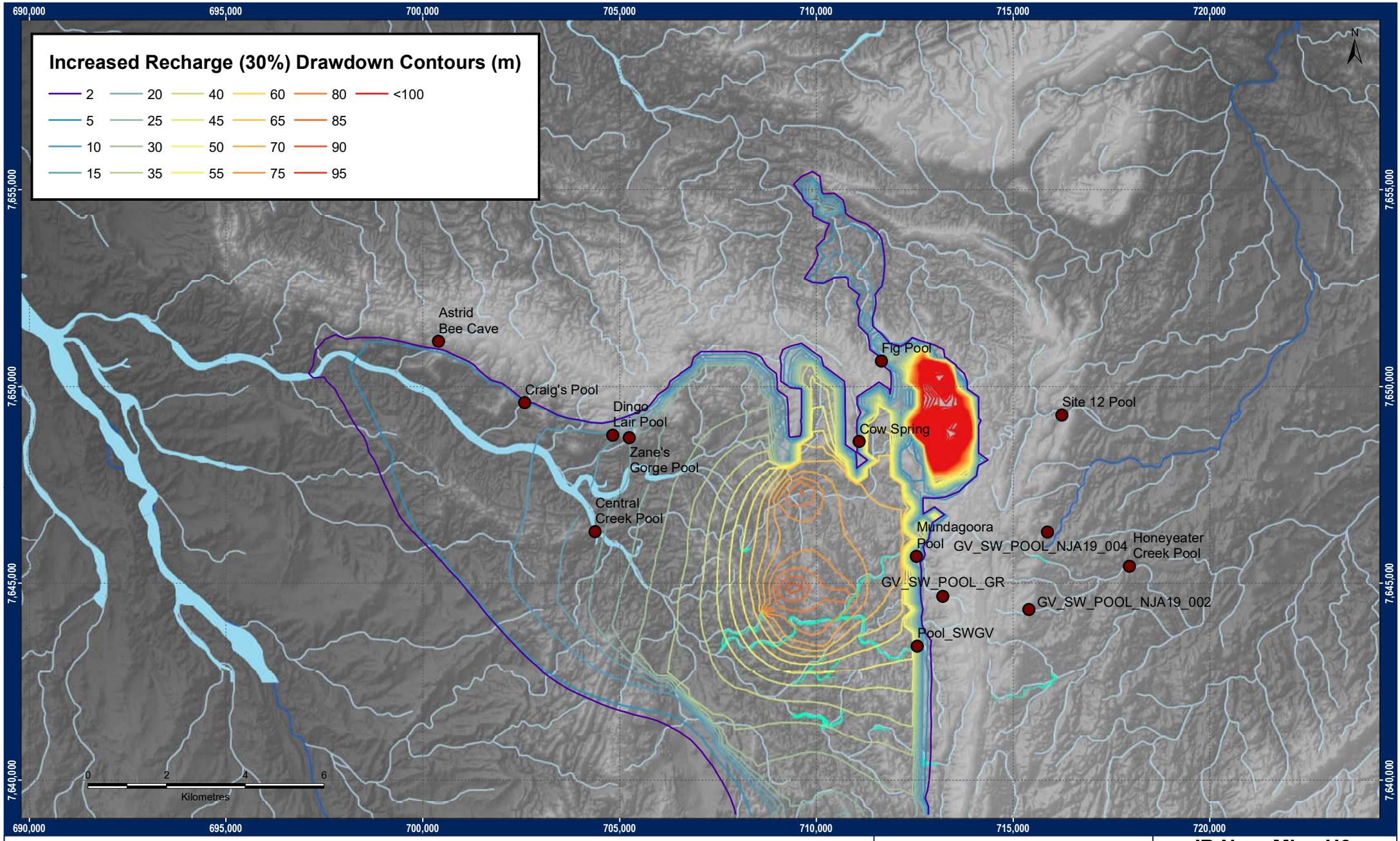
IB Near Mine H3

Predicted Drawdown Base Case

Fortescue



LEGEND

- IB_Pools
- EvApTI
- EvAtCC

250k Drainage

- Major
- Minor

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:123,735
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map14

Date: 3/08/2023
Size: A4L
Revision: 0
Confidentiality: 1

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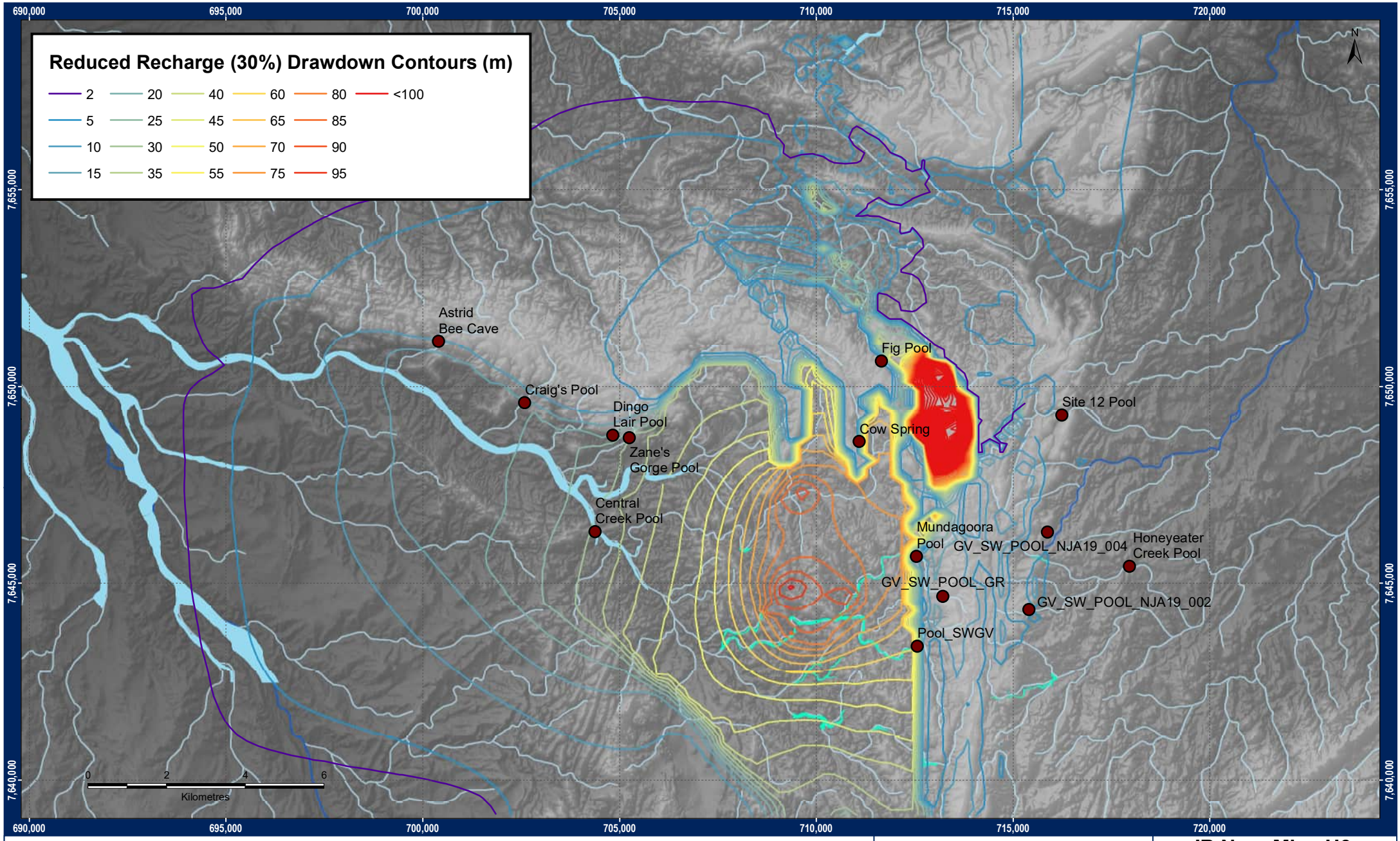
IB Near Mine H3

Predicted Drawdown Increased Recharge

Fortescue



LEGEND

- IB_Pools
- EvApTI
- EvAtCC

250k Drainage

- Major
- Minor

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:123,735
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map14

Date: 3/08/2023
Size: A4L
Revision: 0
Confidentiality: 1

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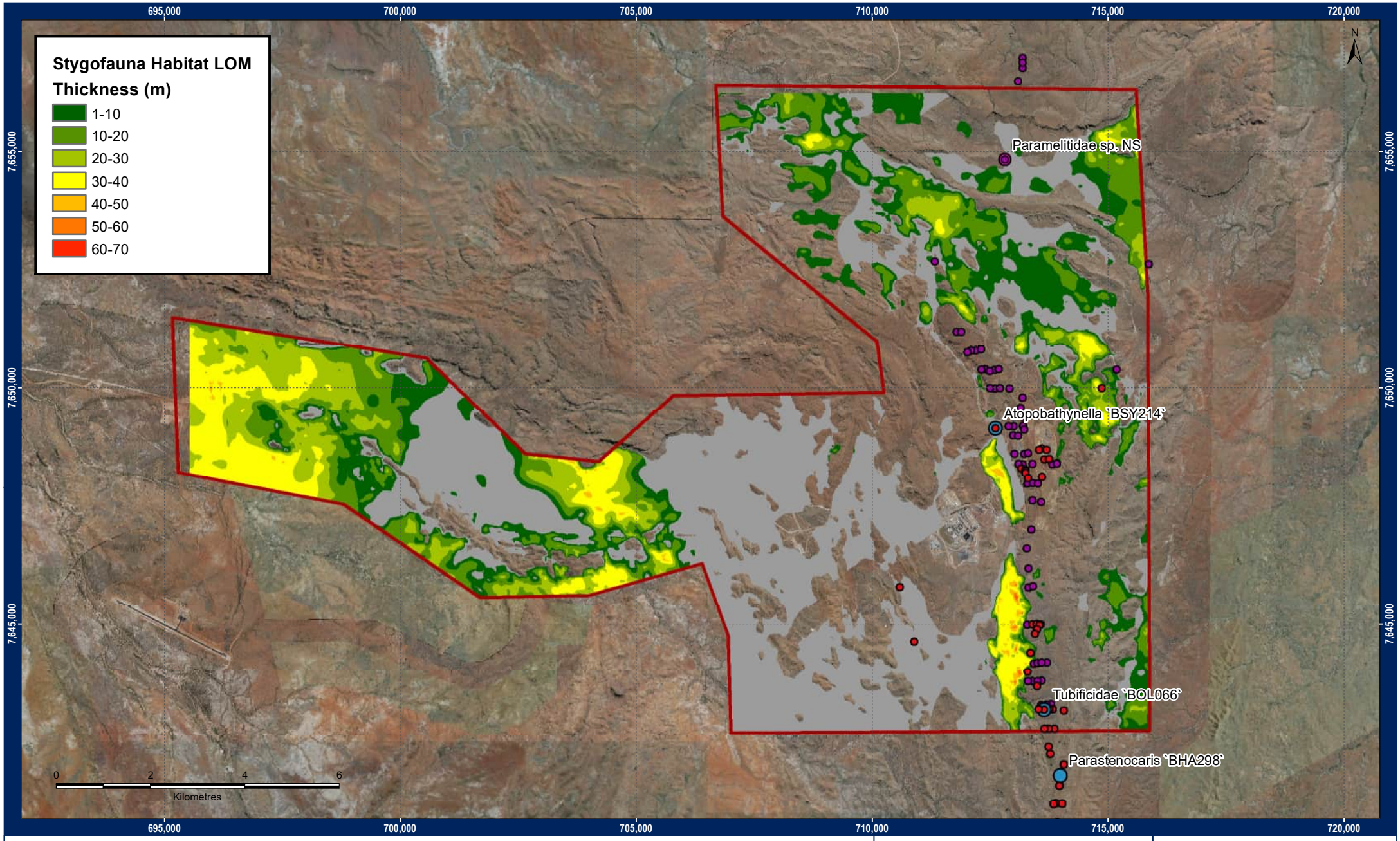
IB Near Mine H3

Predicted Drawdown Reduced Recharge

Fortescue



LEGEND

SubFauna Survey Locations 2011-12
- Widespread Species
- Limited Range Species

SubFauna Survey Locations 2022-23
- Limited Range Species
- Widespread Species

- Habitat Model Extent
- Current Extent of Stygofauna Habitat

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:103,197
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map13

Date: 31/07/2023
Size: A4L
Revision: 0
Confidentiality: 1

GDA94

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IB Near Mine H3
LOM Stygofauna Habitat

Fortescue

Current GWOS Monitoring

- GWOS Abstraction Bores
- GWOS Monitoring Bores
- GWOS Trigger Monitoring Bores
- Other Monitoring Bores

Proposed Monitoring

- Groundwater Monitoring
- Pool Monitoring
- Seepage Monitoring
- Vegetation Monitoring

Requested By: M Carroll
Drawn By: M Carroll
Revised By: mcarroll
Approved By: M Carroll
Scale: 1:86,674
Coordinate System: GDA 1994 MGA Zone 50
Document Name: GIS Data for IB H3_2023_Map15

Date: 31/08/2023
Size: A4L
Revision: 0
Confidentiality: 1

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IB Near Mine H3

Current and Proposed Monitoring

Fortescue

Appendix 1: Groundwater Licence 176289 and 164321 Details

Government of **Western Australia**
Department of **Water and Environmental Regulation**

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Pilbara Water and Power Pty Ltd		
Description of Water Resource	Pilbara Pilbara - Fractured Rock	**Annual Water Entitlement**	2,500,000kL
Location of Water Source	L45/361 M45/1226 M45/1244		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Commissioning and testing of mine processing plant	M45/1226 M45/1244
	Dust suppression for earthworks and construction purposes	L45/361 L45/515 L45/589 M45/1226 M45/1244
	Hydro pressure testing of pipeline	L45/361 L45/515 L45/589 M45/1226 M45/1244
	Mineral ore processing and other mining purposes	M45/1226 M45/1244
	Mining camp purposes	L45/361 L45/515 L45/589 M45/1226 M45/1244
	Mining Care and maintenance purposes	L45/361 L45/515 L45/589

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000.

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

		M45/1226 M45/1244
Duration of Licence	From 16 February 2023 to 22 October 2030	

This Licence is subject to the following terms, conditions and restrictions:

1. The annual water year for water taken under this licence is defined as 1 January to 31 December.

2. The licensee shall comply with the commitments of the operating strategy "Iron Bridge Near Mine Groundwater Supply Scheme, 30 January 2023, 661MI-0000-PL-HY-0001_rev 3", as prepared by FMG and approved by the Department of Water and Environmental Regulation on 16/02/2023 including any modifications to the commitments as approved during the term of the licence.

3. The licensee shall submit abstraction data within the monitoring summary and if due, triennial review that is due on 31 March and 30 April respectively, each year.

4. Every 12 Months the licensee shall provide to the Department of Water and Environmental Regulation a Groundwater Monitoring Summary for the preceding water year. The first report is due 31/03/2024.

5. Every 3 Years the licensee shall provide to the Department of Water and Environmental Regulation a Groundwater Monitoring Review. The first report is due 30/04/2023. A Groundwater Monitoring Summary need not be submitted in a year in which a Groundwater Monitoring Review is due.

End of terms, conditions and restrictions

File No: RF1762-02

Government of Western Australia
Department of Water

Instrument No. GWL164321(3)

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Fortescue Metals Group Ltd		
Description of Water Resource	Pilbara Pilbara - Fractured Rock	**Annual Water Entitlement**	90000 kL
Location of Water Source	M45/1226		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Dust suppression for earthworks and construction purposes	M45/1226
	Exploratory drilling operations	
	General campsite purposes	
	Mineral exploration activities	

Duration of Licence	From 1 September 2014 to 29 August 2024

This Licence is subject to the following terms, conditions and restrictions:

End of terms, conditions and restrictions

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000

Appendix 2: Groundwater Bore Details

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Table A2-0: Drilling and Bore Completion Summary – FY23 Near Mine Water Supply

Bore Name	Start Date	Cased Depth (m bgl)	Casing Material	Casing Diameter (mm)	Easting	Northing	Elevation (mAHD)	Water Level (m bgl)	Stick Up (m)	Screen From	Screen To	pH	EC (uS/cm)	Yield (L/s)
IB_SB_PB03	31/1/2023	268	Steel	300	710,890	7,644,617	270.434	25.4	0.5	30	214	7.87	1306	30
IB_SB_PB04	20/2/2023	216	Steel	300	709,214	7,644,854	272.887	36.1	0.5	42	268	7.81	1256	20

Table A2-1: Drilling and Bore Completion Summary – FY23 Glacier Valley – Mundagoora Pool Program.

Bore Name	Start Date	Cased Depth (m bgl)	Casing Material	Casing Diameter (mm)	Easting	Northing	Elevation (mAHD)	Water Level (m bgl)	Stick Up (m)	Screen From	Screen To
IB_MP_M01	Sep-22	50.49	PVC	50	712846.9	7645936	305.256	12.83	0.7	8.49	50.49
IB_MP_M02	Aug-22	40.15	PVC	50	712143.5	7645669	288.237	7.79	0.67	10.15	40.15

Table A2-2: Drilling and Bore Completion Summary – FY23 Glacier Valley – Stage 2 Orebody Characterisation.

Bore Name	Start Date	Cased Depth (m bgl)	Casing Material	Casing Diameter (mm)	Easting	Northing	Elevation (mAHD)	Water Level (m bgl)	Stick Up (m)	Screen From	Screen To
IB_ELC_M03	May-20	69.5	PVC	50	713829.2	7649567	382.03	40.88	0.39	-0.5	69.5
IB_GVN_M01	Jul-20	160	PVC	50	713627.4	7646253	416.2	88.43	0.5	58	160
IB_GVS_M01	Jul-20	204	PVC	50	713944.8	7644272	421.63	50.61	0.5	54	204
IB_GVS_M02	Jul-20	204	PVC	50	713884	7645048	416.31	54.94	0.45	54	204
IB_NST_M01	Apr-20	0.4	PVC	100	713600.5	7648129	386.435	35.74	0.6		
IB_NST_M02	May-20	198.5	PVC	50	713576.8	7647675	412.882	74.7	0.5	60.5	198.5
IB_NST_M03	May-20	198	PVC	50	712840.6	7649965	386.653	49.23	0.4	60	198
IB_NST_P01	Apr-20	212	PVC	300	713230.5	7649633	386.72	34.89	0.5	48	212

Table A2-3: Drilling and Bore Completion Summary – FY23 Glacier Valley – Stage 2 Near Mine Water Supply Drilling Program.

Bore Name	Start Date	Cased Depth (m bgl)	Casing Material	Casing Diameter (mm)	Easting	Northing	Elevation (mAHD)	Water Level (m bgl)	Stick Up (m)	Screen From	Screen To
IB_NB_P01	Nov-19	200	PVC	300	707375.2	7648931	256.874	8.23	0.38	39.62	195.62
IB_NB_P01	Nov-19	200	PVC	350	707375.2	7648931	256.874	8.23	0.38	39.62	195.62
IB_SB_P01	Feb-20	198	PVC	350	709469.7	7644926	273.571	11.76	0.516	103.85	199.85

IB_SB_P02	Mar-20	212	PVC	350	708764.8	7644344	259.469	9.39	0.5	32	212
IB_TSF_M01	Apr-20	0.4	PVC	100	709169.6	7655183	236.474	3.3	0.28		
IB_TSF_M01	Apr-20	0.4	Steel	200	709169.6	7655183	236.474	3.3	0.28		

Table A2-4: Drilling and Bore Completion Summary – FY23 Glacier Valley – Stage 1 Orebody Characterisation

Bore Name	Start Date	Cased Depth (m bgl)	Casing Material	Casing Diameter (mm)	Easting	Northing	Elevation (mAHD)	Water Level (m bgl)	Stick Up (m)	Screen From	Screen To
GVM01_D	Sep-18	252.5	PVC	50	713386.9	7644525	405.14	49.04	0.48	114.5	252.5
GVM01_S	Sep-18	80.42	PVC	50	713386.9	7644525	405.14	44.38	0.55	68.42	80.42
GVM02_D	Sep-18	252.5	PVC	50	713665.2	7644768	399.32		0.3	132.5	252.5
GVM02_D	Sep-18	252.5	Steel	250	713665.2	7644768	399.32		0.3	132.5	252.5
GVM02_S	Sep-18	49.5	PVC	50	713665.2	7644768	399.32	38.09	0.35	37.5	49.5
GVM02_S	Sep-18	49.5	Steel	250	713665.2	7644768	399.32	38.09	0.35	37.5	49.5
GVP01	Sep-18	322.5	Steel	200	713488.3	7644580	410.38	29.56			
GVP01	Sep-18	322.5	Steel	250	713488.3	7644580	410.38	29.56			
IBM01	Aug-18	143.8	PVC	50	713608.5	7646218	414.93	42.56	0.6	71.8	143.8
IBM01	Aug-18	143.8	Steel	200	713608.5	7646218	414.93	42.56	0.6	71.8	143.8
NSM01	Jul-18	300	PVC	0	713160.3	7649389	385.57	38.18	0.6	42	300
NSM01	Jul-18	300	PVC	50	713160.3	7649389	385.57	38.18	0.6	42	300
NSP01R	Aug-18	299.46	Steel	200	713034.6	7649405	382.7	34.89	0.63	47.46	299.46
NSP01R	Aug-18	299.46	Steel	400	713034.6	7649405	382.7	34.89	0.63	47.46	299.46

Iron Bridge Stage 1 Near Mine Water Supply Borefield Investigation

Table A2-5: Drilling and Bore Completion Summary – Eastern Borefield.

Name	Easting	Northing	Elevation	Tenement	Start Date	Completion Date	Drilling Method	Company	Drilled Diameter (mm)	Total Depth (mbgl)	Casing Material	Casing Diameter (mm)	Slotted Interval (mbgl)	Airlift Yield (L/s)	Water Level (mbgl)
Obs01	714529.994	7655375.488	257.891	M 45/1226-I	11/12/2013	11/12/2013	Reverse circulation drilling	McKay Drilling	140	120	CL 18 PVC	100	6-38	1	17.430
Obs02	714035.18	7655291.061	259.186	M 45/1226-I	11/12/2013	11/12/2013	Reverse circulation drilling	McKay Drilling	140	160	CL 12 PVC	100	70-148	3	20.570
Obs03	715134.204	7655341.243	256.951	M 45/1226-I	13/12/2013	14/12/2013	Reverse circulation drilling	McKay Drilling	140	120	CL 18 PVC	100	6-114	1	17.750

Obs04	715430.601	7655376.43	251.64	M 45/1226-I	12/12/2013	13/12/2013	Reverse circulation drilling	McKay Drilling	140	120	CL 18 PVC	100	10.5-112.5	0	12.330
Obs05	715604.726	7655809.934	256.848	M 45/1226-I	11/12/2013	12/12/2013	Reverse circulation drilling	McKay Drilling	140	120	CL 18 PVC	100	12-78	0.5	16.320
Obs06	714793.436	7655136.494	252.528	M 45/1226-I	14/12/2013	14/12/2013	Reverse circulation drilling	McKay Drilling	140	150	CL 18 PVC	100	6-114	1	13.620
Obs13	708611.57	7655220.449	236.255	M 45/1226-I	5/12/2014	7/12/2014	Conventional air rotary drilling	Easternwell	203	84	CL 18 PVC	100	12-72	2.7	5.048
Obs14	712615.353	7649148.238	306.603	M 45/1226-I	11/03/2014	11/03/2014	Reverse circulation drilling	McKay Drilling	140	120	CL 9 (0-70m)/ CL 18 (70-119.5m) PVC	100	0-119.25	6	5.400
Obs20	711274.536	7653281.692	255.541	M 45/1226-I	10/12/2014	11/12/2014	Conventional air rotary drilling	Easternwell	203	120	CL 18 PVC	100	12-96	1	7.796
Obs26	712688.871	7655424.016	264.242	M 45/1226-I	3/12/2013	4/12/2014	Conventional air rotary drilling	Easternwell	203	50	CL 18 PVC	100	7.5-37.5	0	18.875
Obs27	712852.2	7649586.1	322.912	M 45/1226-I	Nov-13	Nov-13	Reverse circulation drilling	McKay Drilling	140	102	CL 18 PVC	100		5	15.511
Obs28	712810.443	7648564.555	311.965	M 45/1226-I	Nov-13	Nov-13	Reverse circulation drilling	McKay Drilling	140	102	CL 9 (0-54m)/ CL 18 (54-150m) PVC	100		0.5	13.897
Obs29	712099.532	7650421.142	312.787	M 45/1226-I	Nov-13	Nov-13	Reverse circulation drilling	McKay Drilling	140	102	CL 18 PVC	100		1	15.914
Obs14A	712533.087	7648751.62	303.761	M 45/1226-I	16/03/2014	16/03/2014	Reverse circulation drilling	McKay Drilling	140	150	CL 9 (0-47m)/ CL 18 (47-145m) PVC	100	116-158	4	6.712
Obs20A	711106.612	7653852.842	251.273	M 45/1226-I	8/12/2014	9/12/2014	Conventional air rotary drilling	Easternwell	203	186	CL 18 PVC	100	17.5-155.5	1	6.987
Obs28A	712798.048	7648560.421	311.662	M 45/1226-I	18/03/2014	18/03/2014	Reverse circulation drilling	McKay Drilling	140	150	CL 18 PVC	100	36-126	6	11.883
PB02	710143.021	7654606.366	242.191	M 45/1226-I	12/04/2014	14/04/2014	Dual rotary drilling (22-106m open hole)	Easternwell	355	106	CL 18 PVC	200	9-99	11.5	4.687

Table A2-6: Drilling and Bore Completion Summary – Northern Borefield.

Name	Easting	Northing	Elevation	Tenement	Start Date	Completion Date	Drilling Method	Company	Drilled Diameter (mm)	Total Depth (mbgl)	Casing Material	Casing Diameter (mm)	Slotted Interval (mbgl)	Airlift Yield (L/s)	Water Level (mbgl)
Obs09	711105.133	7651942.421	273.955	M 45/1226	29/09/2014	12/10/2014	Conventional air rotary drilling	Easternwell	203	218	CL 9 PVC, CL 18 PVC	100	6-204	2	4.900
Obs15	709364.439	7647257.239	267.905	M 45/1226-I	12/12/2014	13/12/2014	Conventional air rotary drilling	Easternwell	203	108	CL 9 (0-28m)/ CL 18 (28-106m) PVC	100	5-101	9	8.120
PB15	709402.967	7647283.21	268.188	M 45/1226-I	10/01/2014	15/01/2014	Conventional air rotary drilling	Easternwell	304	120	CL 18 PVC	200	6-90	10.9	8.230
EX16	711129.186	7647236.889	279.391	M 45/1226-I	7/03/2014	11/03/2014	Conventional air rotary drilling	Easternwell	203	168					5.040
Obs17	709794.857	7647256.77	271.307	M 45/1226-I	16/01/2014	19/01/2014	Conventional air rotary drilling	Easternwell	203	158	CL 9 (0-30m)/ CL 18 (30-156m) PVC	100	6-144	4	9.660
PB17	709799.951	7647257.029	271.39	M 45/1226-I	19/03/2014	27/03/2014	Conventional air rotary drilling	Easternwell	304	150	CL 18 PVC	200	6-114	17.5	10.460
Obs18	710075.634	7647308.222	272.518	M 45/1226-I	21/03/2014	21/03/2014	Reverse circulation drilling	McKay Drilling	140	168	CL 9 (0-12m)/ CL 18 (12-158m) PVC	100	116-158	7	6.060
Obs19	709164.629	7647117.326	267.199	M 45/1226-I	14/12/2013	5/03/2014	Mud rotary drilling	Easternwell	203	150	CL 9 (0-18m)/ CL 18 (18-42m) PVC	100	18-42	5	9.510
PB19	709162.558	7647131.299	267.529	M 45/1226-I	15/02/2014	28/02/2014	Mud rotary drilling	Easternwell	304	163	CL 18 PVC	200	1.4-157.4	20+	9.800
EX23	711480.307	7647548.229	282.26	M 45/1226-I	12/03/2014	12/03/2014	Conventional air rotary drilling	Easternwell	203	20					
Obs23	711476.656	7647552.13	282.367	M 45/1226-I	12/03/2014	18/03/2014	Mud rotary 6-18m, Air rotary 0-6m & 18-156m	Easternwell	304/203	156	CL 9 (0-56m)/ CL 18 (56-156m) PVC	100	12-50	2	7.240
Obs24	712256.947	7652443.076	271.029	M 45/1226	24/09/2014	26/09/2014	Conventional air rotary drilling	Easternwell	203	164	CL 9 PVC, CL 18 PVC	100	14-152	2.9	9.790
Obs25	711799.969	7653939.289	254.463	M 45/1226	22/09/2014	24/09/2014	Conventional air rotary drilling	Easternwell	203	194	CL 9 PVC, CL 18 PVC	100	14-182	3.6	8.030
PB30	708555.092	7648497.965	259.61	M 45/1226-I	4/04/2014	9/04/2014	Dual rotary drilling (18-146m open hole)	Easternwell	355	146	CL 18 PVC	200	18-140	2	13.860
EX31	709508.257	7647560.555	271.662	M 45/1226-I	29/05/2014	30/05/2014	Conventional air rotary drilling	Easternwell	203	156				3	10.700
PB31	709500.972	7647557.921	271.573	M 45/1226-I	31/05/2014	3/06/2014	Conventional air rotary drilling	Easternwell	355	102	CL 18 PVC	200	5-59 65-83	11.1	10.390
PB32	709611.036	7647017.534	270.222	M 45/1226-I	31/03/2014	2/04/2014	Dual rotary drilling (28-76m open hole)	Easternwell	355	76	CL 18 PVC	200	10-70	6	9.660
Obs33	710795.218	7647248.912	277.618	M 45/1226	14/09/2014	16/09/2014	Conventional air rotary drilling	Easternwell	203	170	CL 9 PVC	100	12-54, 96-102, 144-156,	10+	8.690
PB33	710799.752	7647246.465	277.705	M 45/1226	28/11/2014	1/12/2014	Mud rotary drilling	Easternwell	304	60	CL 18 PVC	200	6-54	16.6	8.940
Obs34	711450.933	7648249.403	287.61	M 45/1226	17/09/2014	19/09/2014	Conventional air rotary drilling	Easternwell	203	158	CL 9 PVC, CL 18 PVC	100	20-56, 74-80, 98-104, 120-146	1.7	9.470
Obs35	712129.488	7646980.848	294.361	M 45/1226	19/09/2014	21/09/2014	Conventional air rotary drilling	Easternwell	203	152	CL 9 PVC	100	18-60	2	13.040

Table A2-7: Drilling and Bore Completion Summary – Western Borefield.

Name	Easting	Northing	Elevation	Tenement	Start Date	Completion Date	Drilling Method	Company	Drilled Diameter (mm)	Total Depth (mbgl)	Casing Material	Casing Diameter (mm)	Slotted Interval (mbgl)	Airlift Yield (L/s)	Water Level (mbgl)
ObsW01	704189.587	7647031.619	223.994	L 45/361	18/08/2014	20/08/2014	Conventional air rotary drilling	Easternwell	203	160	CL 9 PVC	100	10-142	7.8	5.36
ObsW01A	706102.794	7647615.904	241.923	L 45/361	22/10/2014	25/10/2014	Conventional air rotary drilling	Easternwell	203	206	CL 9 PVC, CL 18 PVC	100	20-140	5	12.38
ObsW02	703125.617	7646982.96	230.391	L 45/361	20/08/2014	25/08/2014	Conventional air rotary drilling	Easternwell	203	164	CL 9 PVC	100	11-125	2.5	12.56
ObsW02A	702531.518	7646633.11	241.396	L 45/361	12/11/2014	15/11/2014	Conventional air rotary drilling	Easternwell	203	218	CL 9 PVC	100	56-212	0.25	23.14
ObsW02B	701723.275	7647165.827	231.76	L 45/361	4/11/2014	6/11/2014	Conventional air rotary drilling	Easternwell	203	218	CL 9 PVC	100	38-206	2.9	18.74
ObsW02C	701774.383	7647057.083	236.628	L 45/361	31/08/2014	3/09/2014	Conventional air rotary drilling	Easternwell	203	194	CL 9 PVC	100	20-146	8	13.68
ObsW03	700634.717	7648149.48	223.025	L 45/361	25/08/2014	28/08/2014	Conventional air rotary drilling	Easternwell	203	176	CL 9 PVC	100	12-150	2	10.42
ObsW03A	698694.683	7649066.401	222.801	L 45/361	28/08/2014	31/08/2014	Conventional air rotary drilling	Easternwell	203	140	CL 9 PVC	100	60-126	0.5	17.08
ObsW03B	700536.412	7647811.316	231.38	L 45/361	7/11/2014	9/11/2014	Conventional air rotary drilling	Easternwell	203	218	CL 9 PVC	100	68-206	0.5	14.12
ObsW04	697321.513	7649468.502	204.451	L 45/361	3/09/2014	5/09/2014	Conventional air rotary drilling	Easternwell	203	146	CL 9 PVC	100	20-86	0.75	9.25
ObsW04A	697519.786	7649422.931	205.991	L 45/361	11/09/2014	14/09/2014	Conventional air rotary drilling	Easternwell	203	218	CL 9 PVC, CL 18 PVC	100	32-62, 74-80, 86-104, 116-134, 146-152, 158-164, 170-182, 188-206	3	9.35
ObsW04B	696929.725	7649727.33	201.901	L 45/361	9/09/2014	11/09/2014	Conventional air rotary drilling	Easternwell	203	110	CL 9 PVC	100	44-80	0.05	6.83
EXW05	692705	7650153	183	L 45/361	6/09/2014	7/09/2014	Conventional air rotary drilling	Easternwell	203	104					
ObsW07	699708.763	7648850.971	225.218	L 45/361	13/10/2014	15/10/2014	Conventional air rotary drilling	Easternwell	203	104	CL 9 PVC	100	14-92	0.05	14.15
PBW08	700162.499	7648328.086	232.234	L 45/361	18/11/2014	27/11/2014	Mud rotary drilling	Easternwell	304	218	CL 18 PVC	200	53-83, 131-215	20	15.43
ObsW09	700279.235	7648237.623	232.425	L 45/361	15/11/2014	18/11/2014	Conventional air rotary drilling	Easternwell	203	218	CL 9 PVC	100	68-206	2	15.42
ObsW10	703130.587	7646764.277	234.888	L 45/361	31/10/2014	2/11/2014	Conventional air rotary drilling	Easternwell	203	176	CL 9 PVC	100	20-152	5	16.23
EXW14	705170.741	7647097.665	239.268	L 45/361	22/03/2015	25/03/2015	Conventional air rotary drilling	Easternwell	203	188				10	19.91
EXW15	706392.375	7647626.668	248.624	L 45/361	19/03/2015	22/03/2015	Conventional air rotary drilling	Easternwell	203	320					16.05
ObsW17	704228.318	7646826.738	224.472	L 45/361	2/12/2014	5/12/2014	Conventional air rotary drilling	Easternwell	203	200	CL 9 PVC	100	7.5-121.5, 187.5-193.5	7.5	5.7

Table A2-8: Drilling and Bore Completion Summary – Southern Borefield.

Name	Easting	Northing	Elevation	Tenement	Start Date	Completion Date	Drilling Method	Company	Drilled Diameter (mm)	Total Depth (mbgl)	Casing Material	Casing Diameter (mm)	Slotted Interval (mbgl)	Airlift Yield (L/s)	Water Level (mbgl)
EXS01	710042.234	7646156.235	291.43	M 45/1244	21/01/2015	23/01/2015	Conventional air rotary drilling	Easternwell	204	248				1	30.12
EXS03	710676.811	7644834.783	271.997	M 45/1244	18/01/2015	29/01/2015	Conventional air rotary drilling	Easternwell	204	210				47.1	9.53
EXS04	709573.884	7645436.447	285.482	M 45/1244	5/02/2015	8/02/2015	Conventional air rotary drilling	Easternwell	204	302				1	25.83
ObsS05	709966.535	7645749.207	291.133	M 45/1244	23/01/2015	27/01/2015	Conventional air rotary drilling	Easternwell	204	302	CL 9 PVC, CL 12 PVC	100	186-288	2.5	28.64
ObsS08	709739.923	7645138.961	281.472	M 45/1244	3/02/2015	5/02/2015	Conventional air rotary drilling	Easternwell	204	340	CL 9 PVC	100	0-28	1	19.6
ObsS09	708988.744	7646706.963	268.674	L 45/364	15/10/2014	19/10/2014	Conventional air rotary drilling	Easternwell	204	218	CL 9 PVC	100	26-128	3	35.98
ObsS10	708817.177	7646652.893	264.588	L 45/364	19/10/2014	21/10/2014	Conventional air rotary drilling	Easternwell	204	218	CL 9 PVC, CL 18 PVC	100	8-134, 194-212	1.1	6.28
ObsS12	708138.831	7646536.871	254.749	L 45/364	28/10/2014	30/10/2014	Conventional air rotary drilling	Easternwell	204	188	CL 9 PVC	100	20-146	3	6.98
ObsS13	708158.254	7646648.745	256.235	L 45/364	26/10/2014	28/10/2014	Conventional air rotary drilling	Easternwell	204	122	CL 9 PVC	100	14-104	0.9	8.36
ObsS16	709363.396	7645361.545	280.263	M 45/1244	10/02/2015	14/02/2015	Conventional air rotary drilling	Easternwell	204	278	CL 9 PVC, CL 12 PVC	100	101-269	0.5	20.3
EXS17	709487.838	7644908.837	274.284	M 45/1244	29/01/2015	31/01/2015	Conventional air rotary drilling	Easternwell	204	248				25+	14.98
ObsS18	709725.908	7644741.368	285.865	M 45/1244	31/01/2015	2/02/2015	Conventional air rotary drilling	Easternwell	204	264	CL 9 PVC	100	54-180	0.5	23.16
ObsS19	710279.378	7644971.7	283.749	M 45/1244	15/01/2015	18/01/2015	Conventional air rotary drilling	Easternwell	204	318	CL 9 PVC	100	156-312	5	21.24
EXS21	708107.005	7645532.477	266.736	M 45/1244	17/02/2015	20/02/2015	Conventional air rotary drilling	Easternwell	204	261				2.5	16.7
EXS22	708642.642	7644197.999	258.104	M 45/1244	22/02/2015	25/02/2015	Conventional air rotary drilling	Easternwell	204	260				5	8.72
EXS23	709377.311	7643734.42	256.312	M 45/1245	26/02/2015	28/02/2015	Conventional air rotary drilling	Easternwell	204	206				25	6.16
PBS23	709373.202	7643733.749	256.263	M 45/1246	1/03/2015	3/03/2015	Conventional air rotary drilling	Easternwell	302	194	CL 18 PVC	200	98.5-182.5	13.3	5.52
ObsS25	710066.329	7643536.122	268.942	M 45/1244	7/03/2015	9/03/2015	Conventional air rotary drilling	Easternwell	204	110	CL 9 PVC	100	44-80	9	11.28
PBS25	710073.649	7643534.715	269.147	M 45/1244	10/03/2015	12/03/2015	Conventional air rotary drilling	Easternwell	302	98	CL 18 PVC	200	5-83	42	11.26
EXS26	710024.823	7643322.488	265.701	M 45/1244	25/03/2015	28/03/2015	Conventional air rotary drilling	Easternwell	204	242				0	10.26
ObsS28	710891.66	7644632.851	270.341	M 45/1244	11/01/2015	15/01/2015	Conventional air rotary drilling	Easternwell	204	284	CL 9 PVC, CL 12 PVC	100	79.5-175.5	8.3	7.5
ObsS29	709177.194	7643339.908	253.974	M 45/1244	3/03/2015	6/03/2015	Conventional air rotary drilling	Easternwell	204	224	CL 9 PVC, CL 12 PVC	100	94-184	0	5.69
EXS30	708912.377	7645239.887	274.52	M 45/1244	15/02/2015	17/02/2015	Conventional air rotary drilling	Easternwell	204	218				1	13.41
EXS31	708813.192	7644375.264	260.557	M 45/1244	20/02/2015	22/02/2015	Conventional air rotary drilling	Easternwell	204	270				5	10.74
EXS35	710591.201	7645800.132	284.414	M 45/1244	17/03/2015	19/03/2015	Conventional air rotary drilling	Easternwell	204	92				0	13.56
EXS36	710754.075	7645577.612	281.583	M 45/1244	13/03/2015	17/03/2015	Conventional air rotary drilling	Easternwell	204	278				0	10.69

Appendix 3: Compiled Borelogs

PRODUCTION WELL BORE LOG

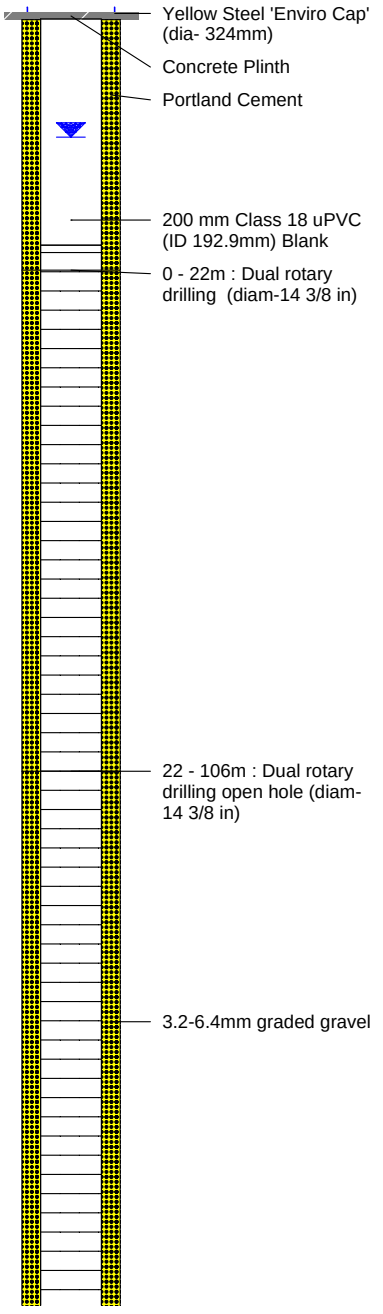
BOREHOLE NUMBER

NS-PB02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Dual rotary drilling (22-106m open hole)**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **710143.02**
NORTHING (m): **7654606.37**
MEAS PT ELEVATION (mAHD): **242.191**
DRILLING DIAMETER(S) (mm): **355**
26D LICENCE #: **CAW178127(1)**
DATE BEGUN: **12/04/2014** DATE COMPLETED: **14/04/2014**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.5**
Drilled Depth (mbgl):	**106**
Cased Depth (mbgl):	**105**
Casing Stick Up (magl):	**0.53**
Development Airlift Yield (l/s):	**11.5**
Water Level (mbgl) & Date:	**4.687** & **31/10/2013**



DEPTH	DESCRIPTION	YIELD (l/s)
0	DETRITUS: Mix of red, black and white, 0-30mm, 50-60% chips and 40-50% fine sand size from 0-2m and silt from 2-4m, rounded to angular, completely weathered chert, shale, calcrete, sandstone and quartzite	
5	SHALE: Moderately weathered and graded, 0-30mm chips, 60-70% brown to red, angular, silicified, medium to hard shale with 0-5mm thick chert banding, 30-40% silt coating chips, trace soft silt/claystone clasts and calcrete, chips become angular from 8m	
10	SHALE: Brown to red, 70-80% moderately graded, 0-30mm chips and 20-30% silt, shale as above, silt/clay is darker with less clay more silt (not as tenacious when dry)	
15	SHALE: As above, 20-30% silt/clay coating	
	SHALE: As above, 10-20% silt/clay coating, chips are well graded 0-20mm with trace chips 20-30mm	
20		6
25	SHALE: 1-20mm, trace chips 20-30mm from 22-24m, well graded 50% brown, medium silicified shale to very fine sandstone, 25% grey medium to hard silicified shale, 25% black, hard shale	
	SHALE: 1-20mm, well graded 30% brown, medium silicified shale to very fine sandstone, 30% grey medium to hard silicified shale, 30% black, hard shale	6
30		
35		6
40		6
45	SANDSTONE/WACKE: 1-20mm, well graded chips, 60% mauve, medium to fine sandstone, 40% grey, medium to fine sandstone, sandstone crumbles under moderate finger pressure	6
50	SANDSTONE/WACKE: 1-20mm, well graded chips, 40% mauve, medium to fine sandstone, 60% grey, medium to fine sandstone, sandstone crumbles under moderate finger pressure	

Comments:

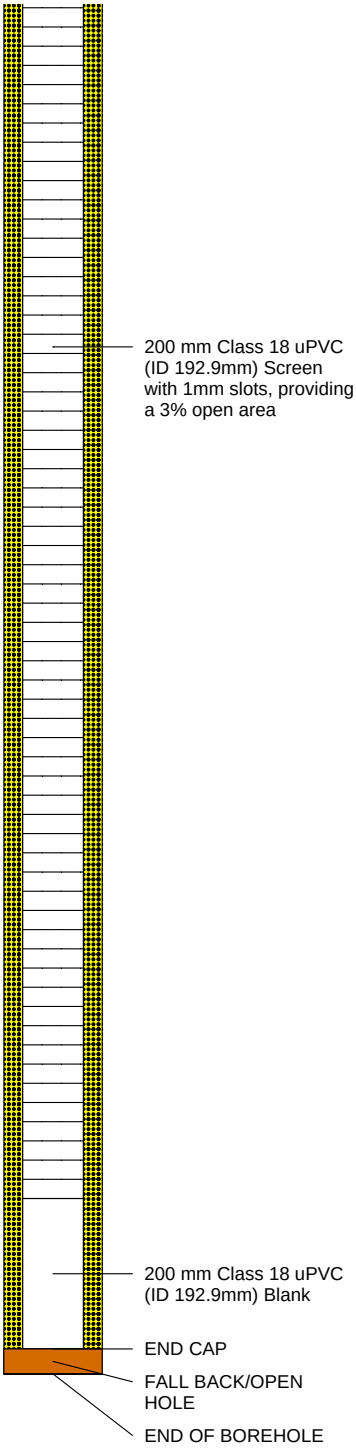
OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	55		SANDSTONE/WACKE: Grey, 1-20mm, well graded, rounded medium to fine sandstone chips, trace hard black shale from 58, slightly more black shale at 58, 60, 68 and 76-80m, driller notes very slow drilling from 96 to 99m	6
	60			9
200 mm Class 18 uPVC (ID 192.9mm) Screen with 1mm slots, providing a 3% open area	65			9
	70			10.5
	75			10.5
	80			11.5
	85			11.5
	90			11.5
	95			11.5
200 mm Class 18 uPVC (ID 192.9mm) Blank	100			11.5
END CAP	105			11.5
FALL BACK/OPEN HOLE				
END OF BOREHOLE				



Comments:

OBSERVATION WELL BORE LOG

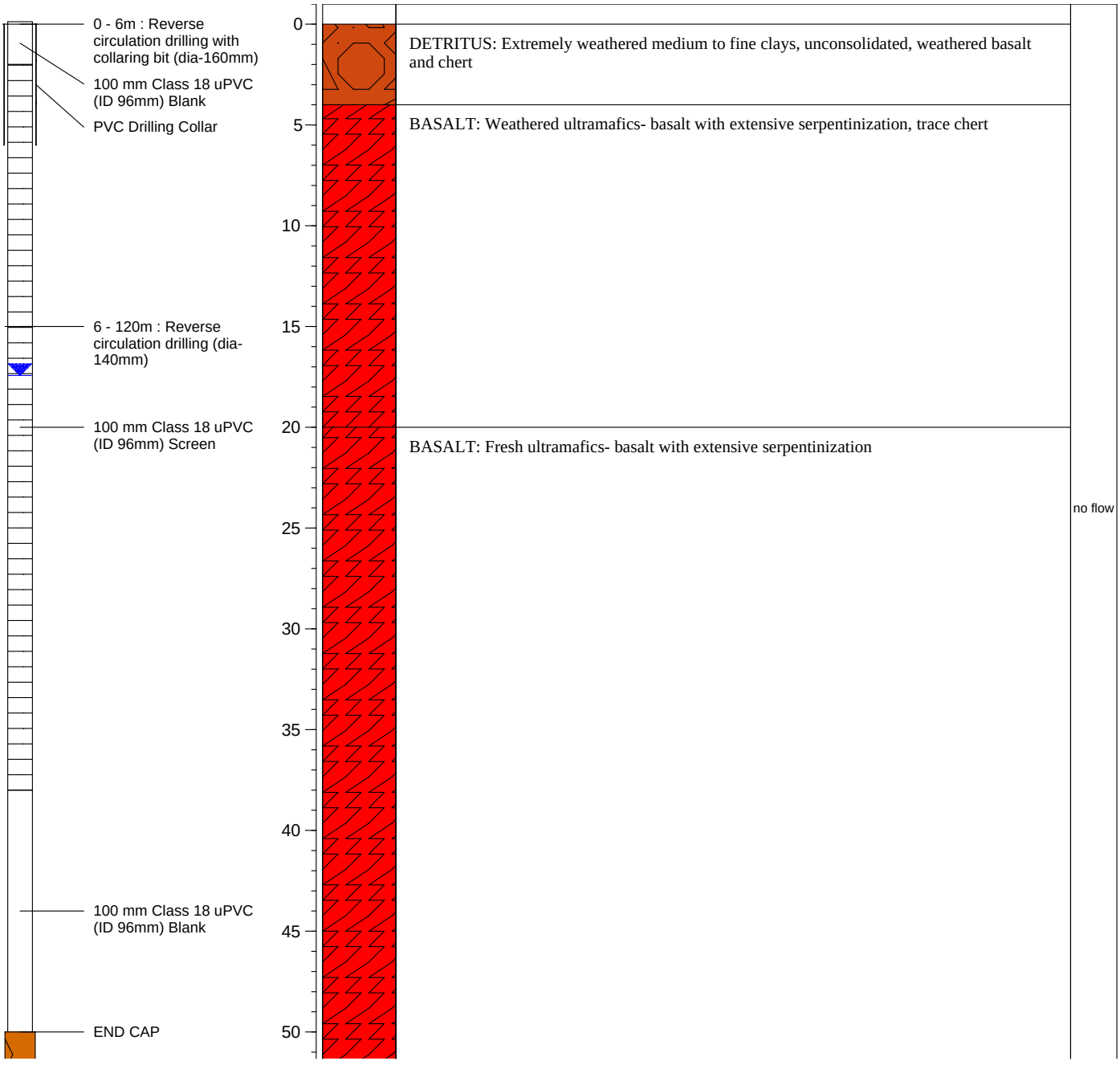
BOREHOLE NUMBER

NS-Obs01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Eastern Borefield FMG- North Star Site**
DRILLING CO:	**Mckay Drilling**
DRILLING METHOD:	**Reverse circulation drilling**
LOGGED BY:	**Deborah Booth**
EASTING (m):	**714529.99**
NORTHING (m):	**7655375.49**
MEAS PT ELEVATION (mAHD):	**257.89**
DRILLING DIAMETER(S) (mm):	**140**
DATE BEGUN: **11/12/2013**	DATE COMPLETED: **11/12/2013**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**120**
Cased Depth (mbgl):	**50**
Casing Stick Up (magl):	**0.123**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**17.43** & **12/12/2013**



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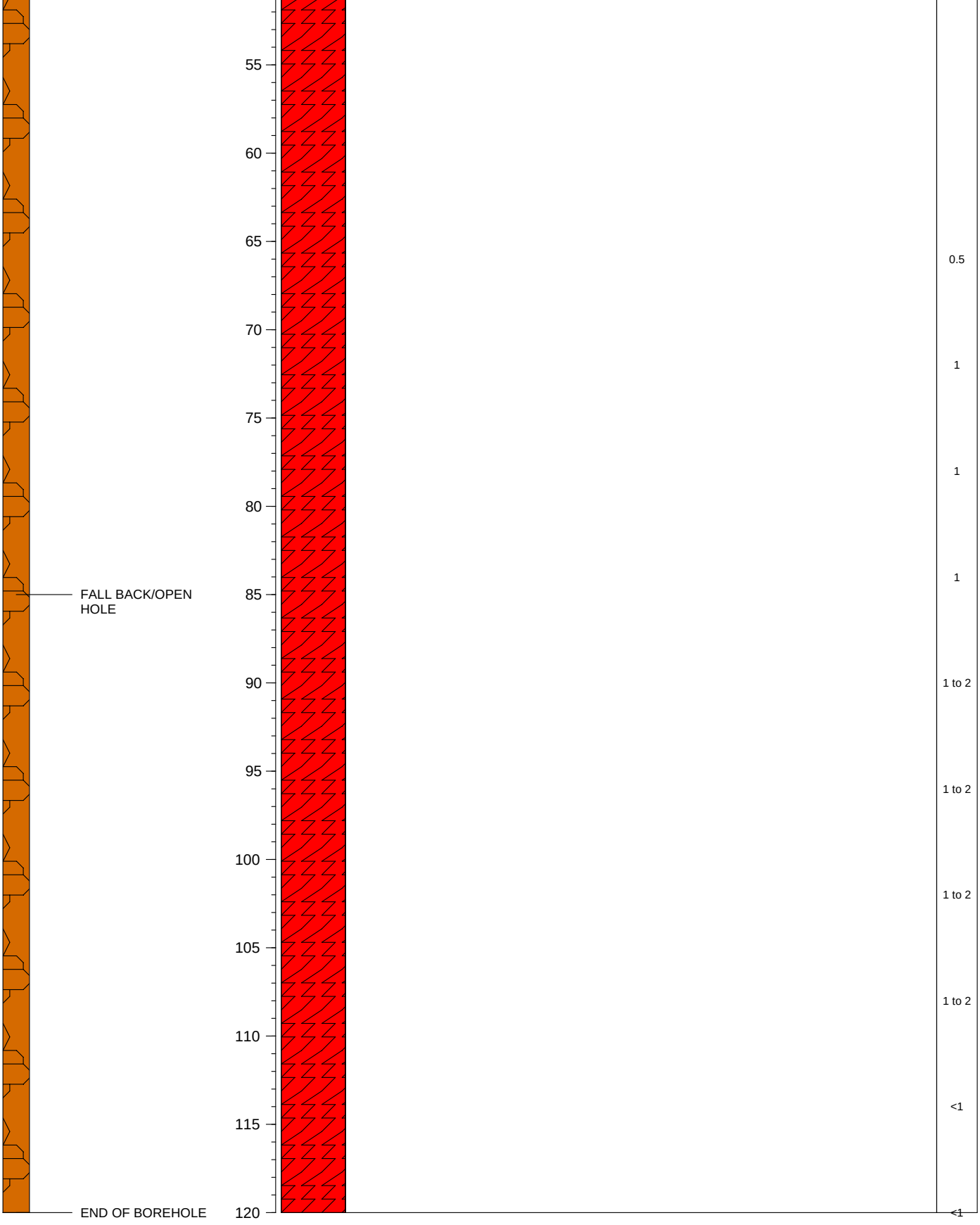

55
60
65
70
75
80
85
90
95
100
105
110
115
120
FALL BACK/OPEN HOLE
END OF BOREHOLE
0.5
1
1
1
1 to 2
1 to 2
1 to 2
1 to 2
<1
<1

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

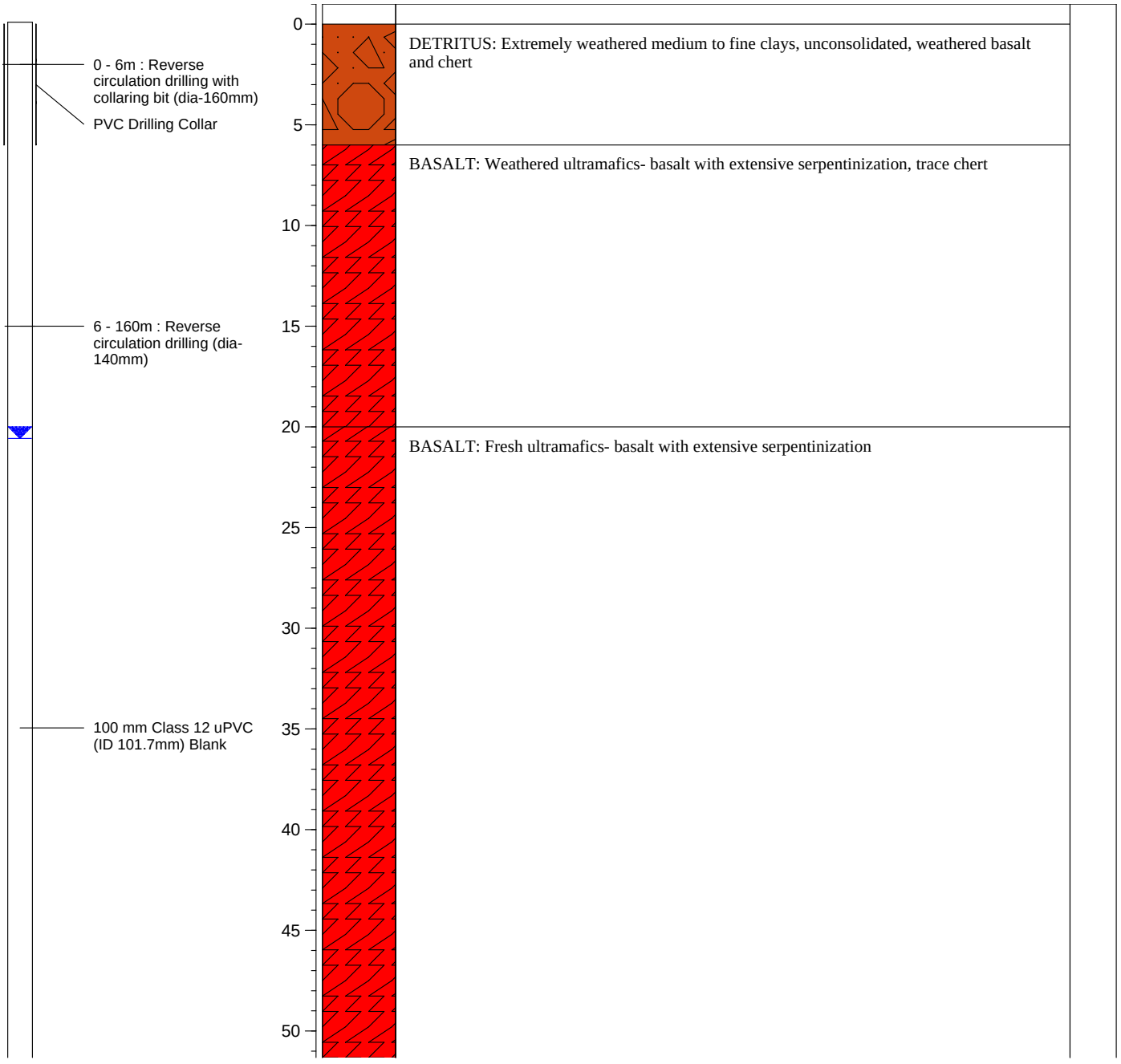
NS-Obs02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Eastern Borefield FMG- North Star Site**
DRILLING CO:	**Mckay Drilling**
DRILLING METHOD:	**Reverse circulation drilling**
LOGGED BY:	**Deborah Booth**
EASTING (m):	**714035.18**
NORTHING (m):	**7655291.06**
MEAS PT ELEVATION (mAHD):	**259.19**
DRILLING DIAMETER(S) (mm):	**140**
DATE BEGUN: **11/12/2013**	DATE COMPLETED: **11/12/2013**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**160**
Cased Depth (mbgl):	**160**
Casing Stick Up (magl):	**0.102**
Development Airlift Yield (l/s):	**3**
Water Level (mbgl) & Date:	**20.57** & **12/12/2013**

BORE CONSTRUCTION | DEPTH | LITHOLOGY | DESCRIPTION | YIELD (L/sec)



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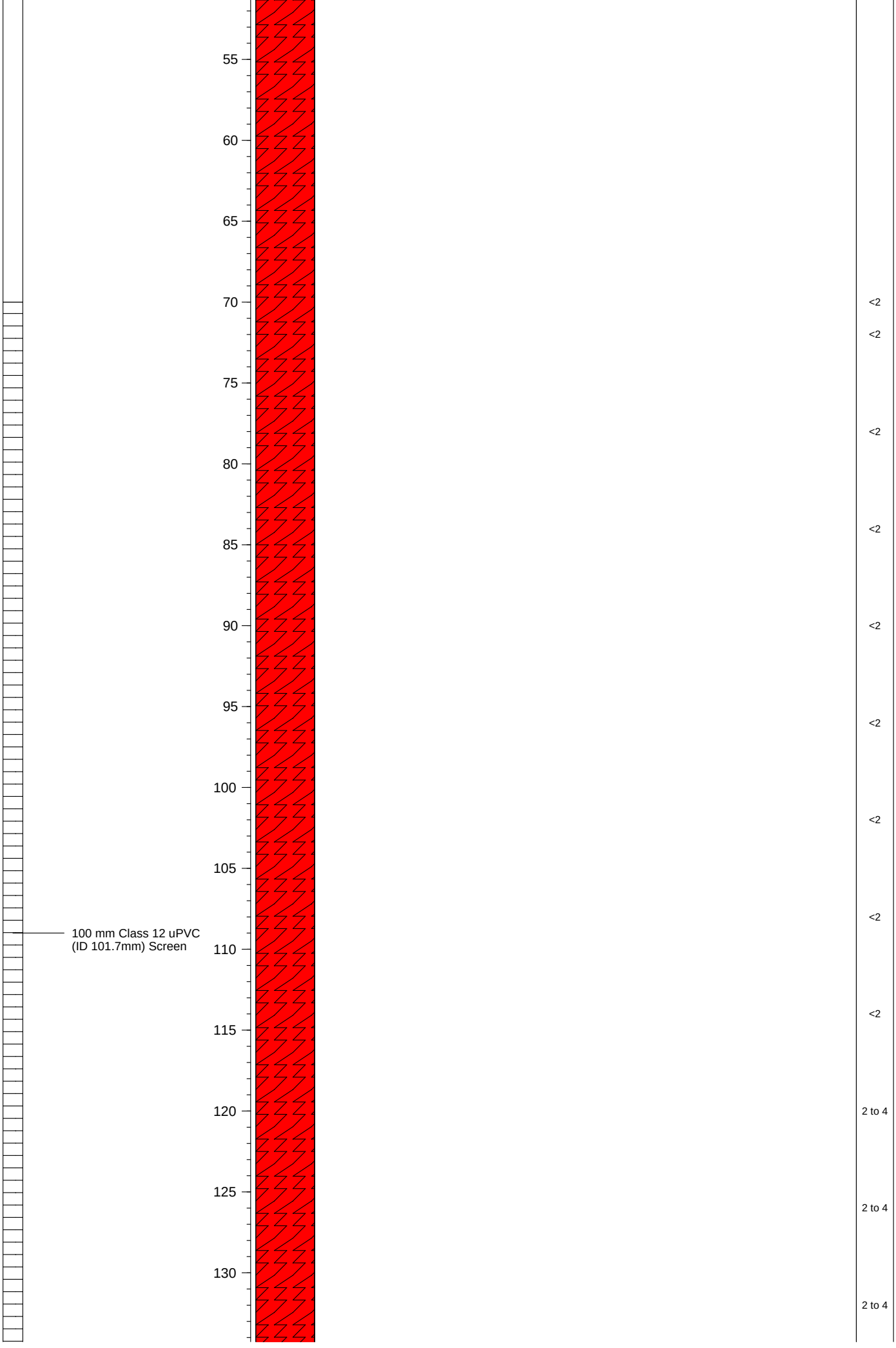
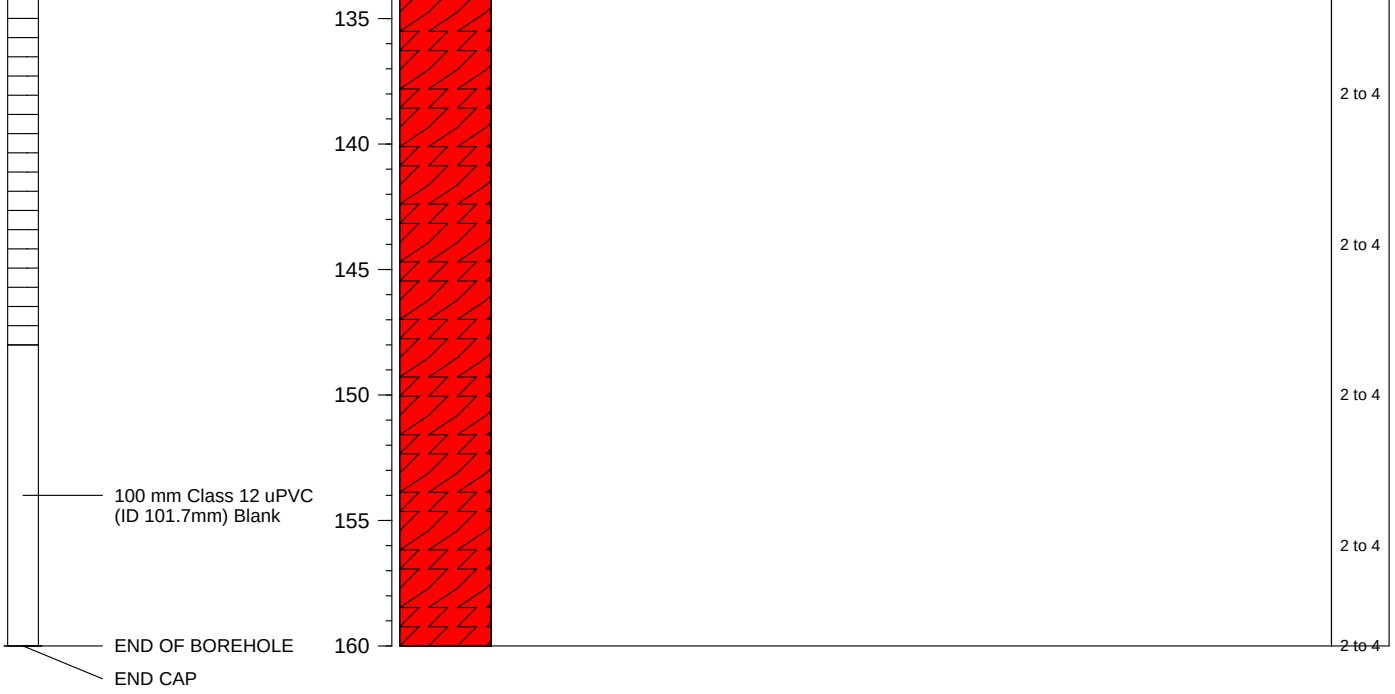

55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
100 mm Class 12 uPVC
(ID 101.7mm) Screen
<2
<2
<2
<2
<2
<2
<2
<2
<2
2 to 4
2 to 4
2 to 4

Comments:


135
140
145
150
155
160
2 to 4
2 to 4
2 to 4
2 to 4
2 to 4
100 mm Class 12 uPVC
(ID 101.7mm) Blank
END OF BOREHOLE
END CAP

OBSERVATION WELL BORE LOG

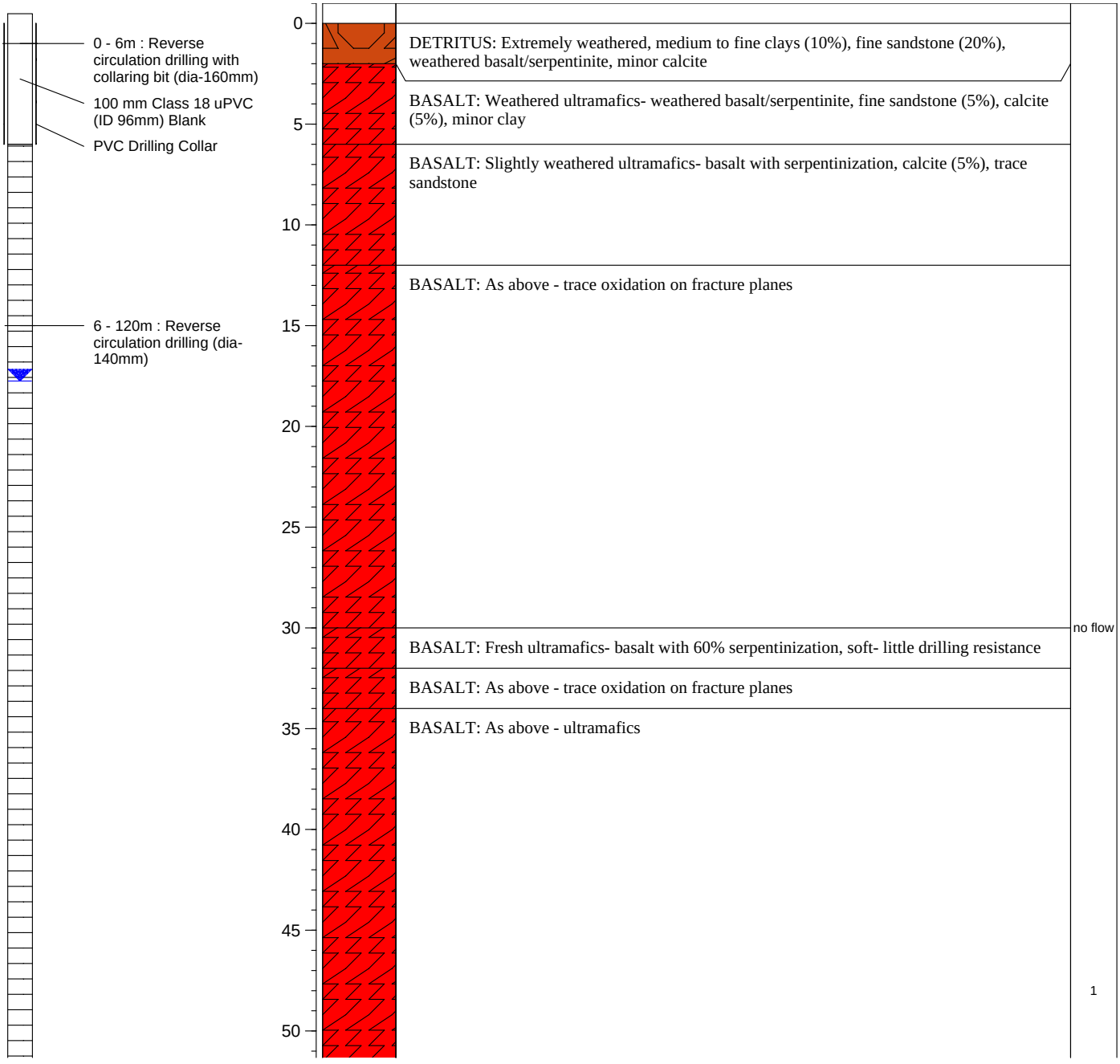
BOREHOLE NUMBER

NS-Obs03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Eastern Borefield FMG- North Star Site**
DRILLING CO:	**Mckay Drilling**
DRILLING METHOD:	**Reverse circulation drilling**
LOGGED BY:	**Deborah Booth**
EASTING (m):	**715134.20**
NORTHING (m):	**7655341.24**
MEAS PT ELEVATION (mAHD):	**256.95**
DRILLING DIAMETER(S) (mm):	**140**
DATE BEGUN: **13/12/2013**	DATE COMPLETED: **14/12/2013**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**120**
Cased Depth (mbgl):	**120**
Casing Stick Up (magl):	**0.485**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**17.75** & **20/12/2013**



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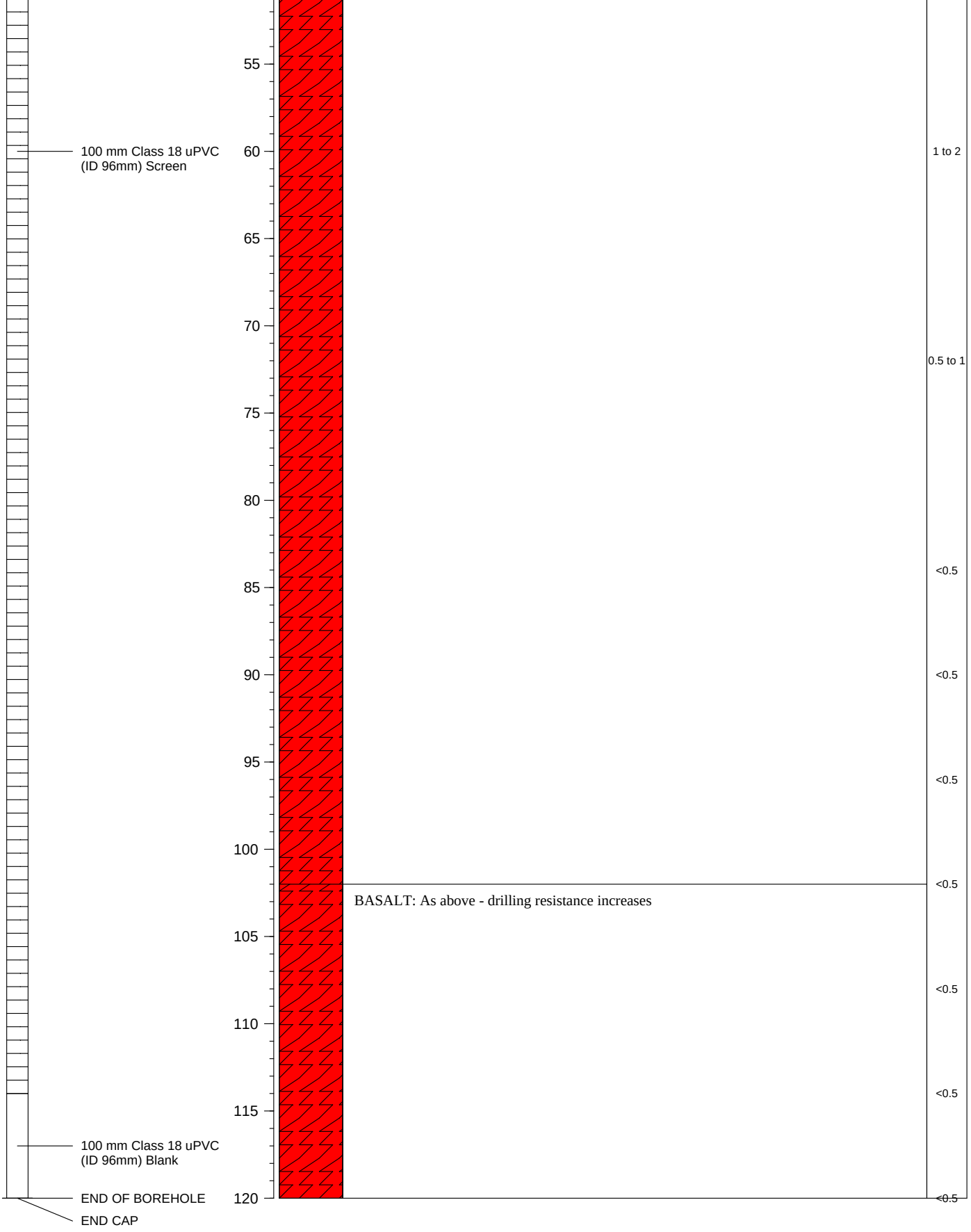

55
60
65
70
75
80
85
90
95
100
105
110
115
120
100 mm Class 18 uPVC
(ID 96mm) Screen
100 mm Class 18 uPVC
(ID 96mm) Blank
END OF BOREHOLE
END CAP
BASALT: As above - drilling resistance increases
1 to 2
0.5 to 1
<0.5
<0.5
<0.5
<0.5
<0.5
<0.5
<0.5

Comments:

OBSERVATION WELL BORE LOG

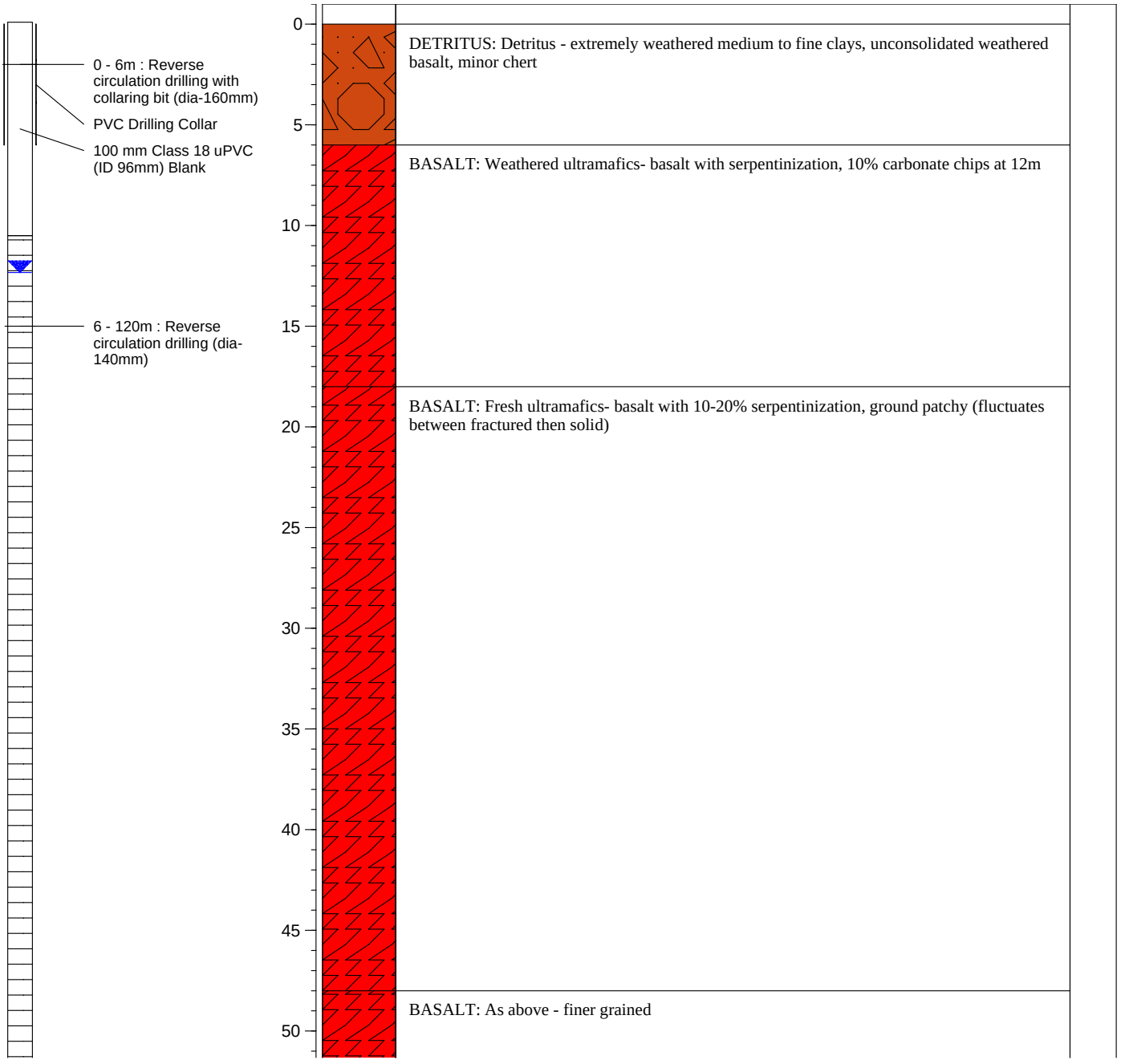
BOREHOLE NUMBER

NS-Obs04

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Eastern Borefield FMG- North Star Site**
DRILLING CO:	**Mckay Drilling**
DRILLING METHOD:	**Reverse circulation drilling**
LOGGED BY:	**Deborah Booth**
EASTING (m):	**715430.60**
NORTHING (m):	**7655376.43**
MEAS PT ELEVATION (mAHD):	**251.64**
DRILLING DIAMETER(S) (mm):	**140**
DATE BEGUN: **12/12/2013**	DATE COMPLETED: **13/12/2013**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**120**
Cased Depth (mbgl):	**118.5**
Casing Stick Up (magl):	**0.097**
Development Airlift Yield (l/s):	**0**
Water Level (mbgl) & Date:	**12.33** & **20/12/2013**



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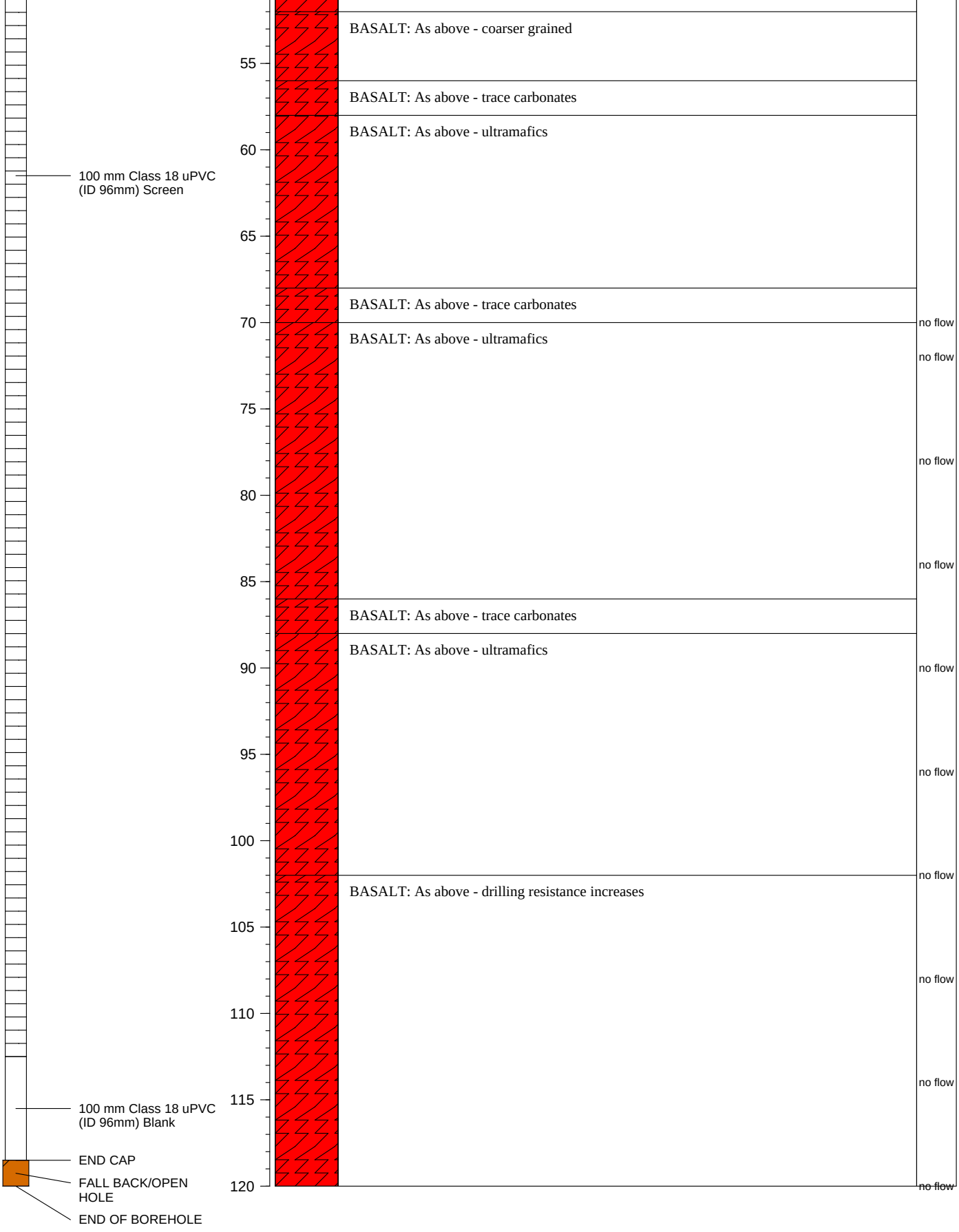

55
60
65
70
75
80
85
90
95
100
105
110
115
120
BASALT: As above - coarser grained
BASALT: As above - trace carbonates
BASALT: As above - ultramafics
BASALT: As above - trace carbonates
BASALT: As above - ultramafics
BASALT: As above - trace carbonates
BASALT: As above - ultramafics
BASALT: As above - drilling resistance increases
100 mm Class 18 uPVC (ID 96mm) Screen
100 mm Class 18 uPVC (ID 96mm) Blank
END CAP
FALL BACK/OPEN HOLE
END OF BOREHOLE
no flow
no flow
no flow
no flow
no flow
no flow
no flow
no flow
no flow

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

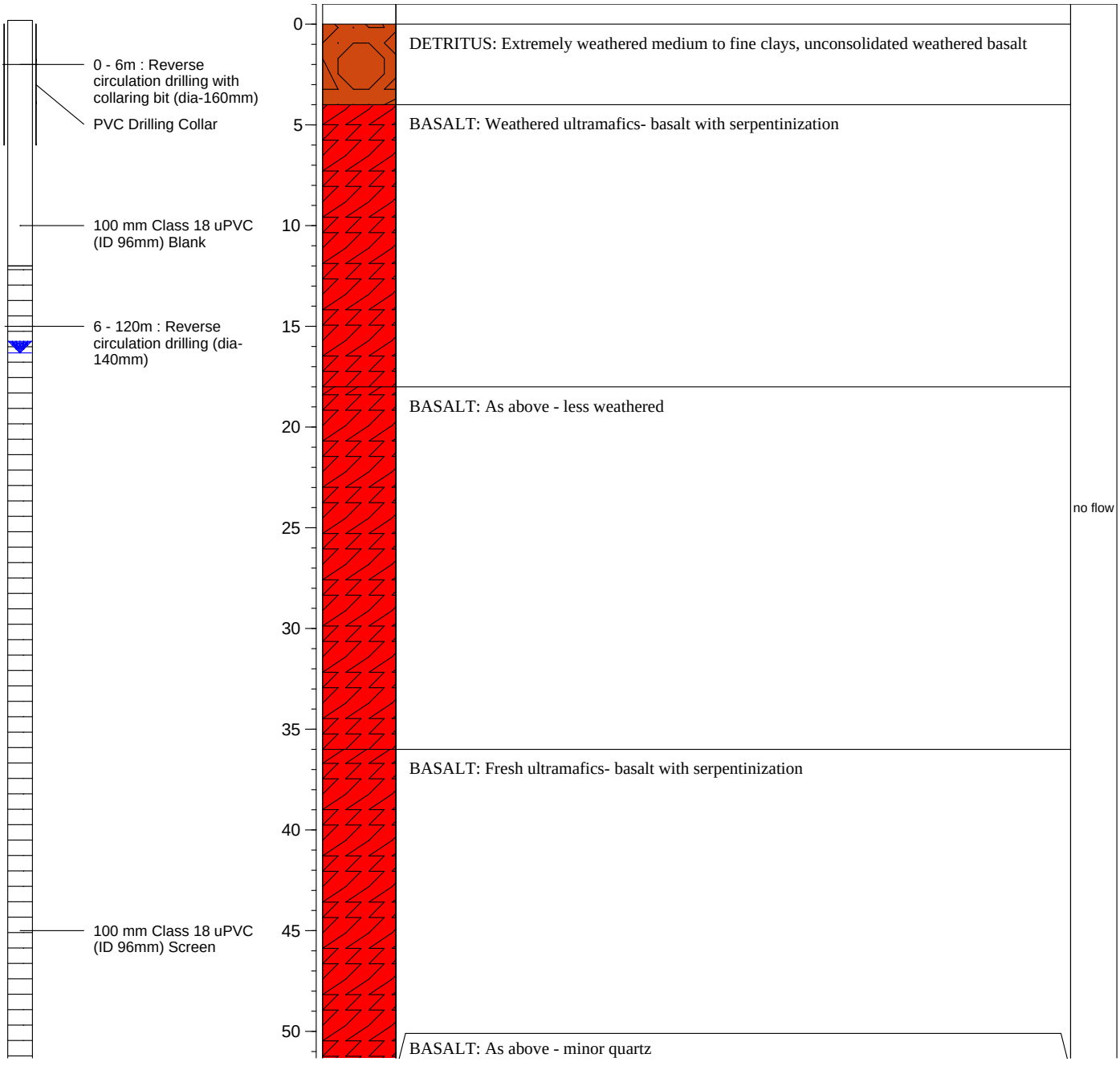
NS-Obs05

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Eastern Borefield FMG- North Star Site**
DRILLING CO:	**Mckay Drilling**
DRILLING METHOD:	**Reverse circulation drilling**
LOGGED BY:	**Deborah Booth**
EASTING (m):	**715604.73**
NORTHING (m):	**7655809.93**
MEAS PT ELEVATION (mAHD):	**256.85**
DRILLING DIAMETER(S) (mm):	**140**
DATE BEGUN: **11/12/2013**	DATE COMPLETED: **12/12/2013**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**120**
Cased Depth (mbgl):	**90**
Casing Stick Up (magl):	**0.185**
Development Airlift Yield (l/s):	**0.5**
Water Level (mbgl) & Date:	**16.32** & **20/12/2013**

BORE CONSTRUCTION | DEPTH | LITHOLOGY | DESCRIPTION | YIELD (L/sec)



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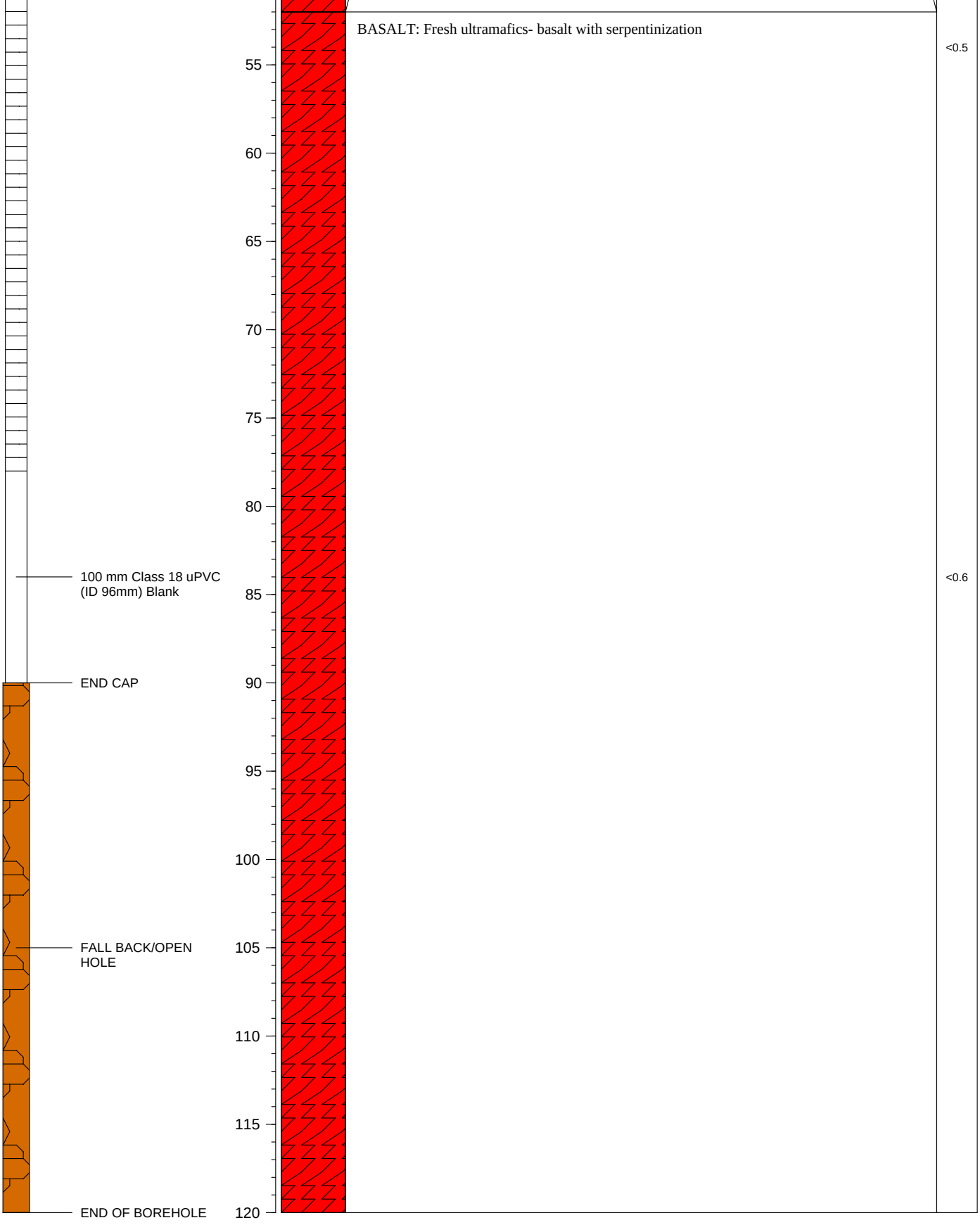

55
60
65
70
75
80
85
90
95
100
105
110
115
120
100 mm Class 18 uPVC
(ID 96mm) Blank
END CAP
FALL BACK/OPEN
HOLE
END OF BOREHOLE
BASALT: Fresh ultramafics- basalt with serpentinization
<0.5
<0.6

Comments:

OBSERVATION WELL BORE LOG

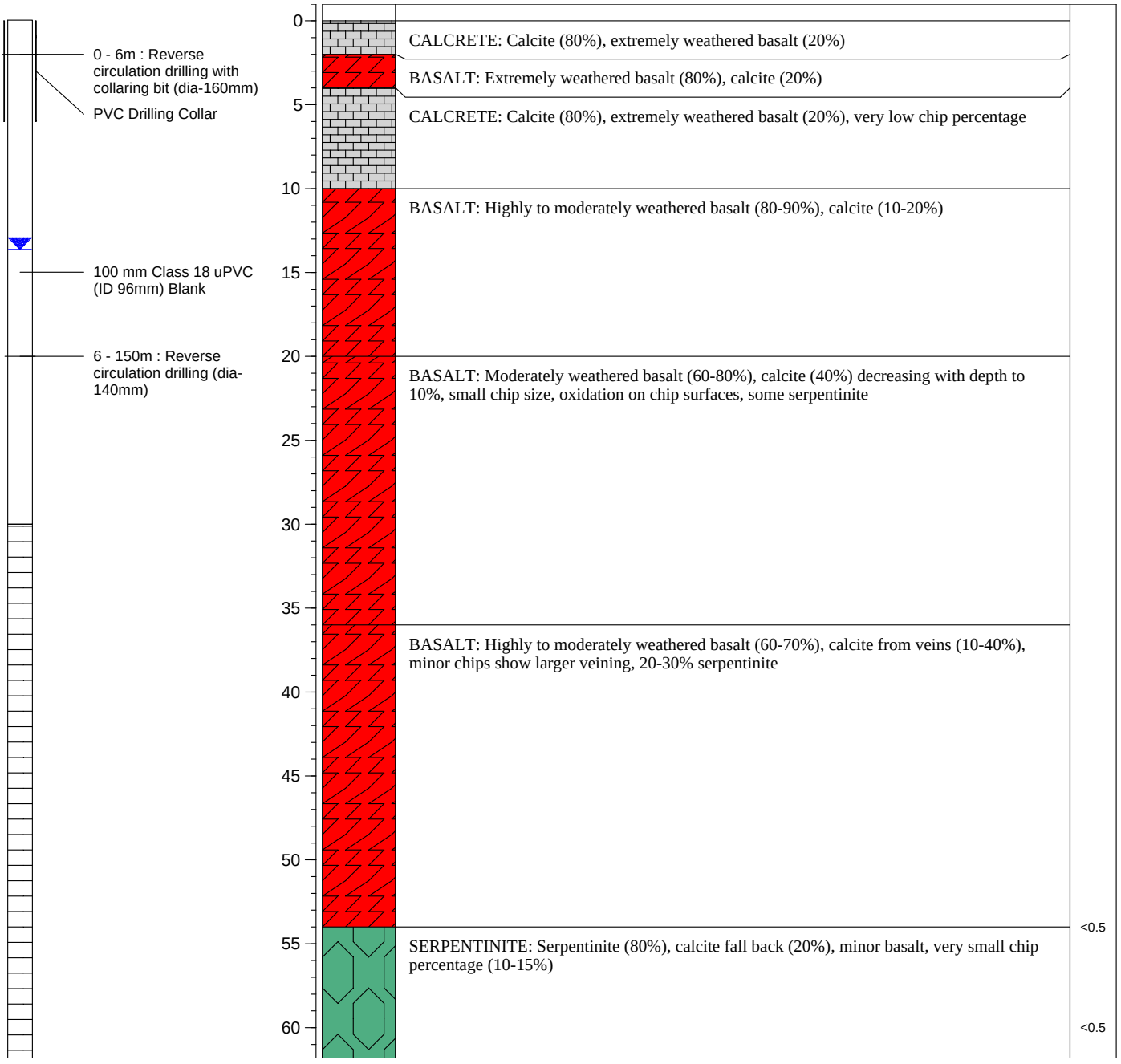
BOREHOLE NUMBER

NS-Obs06

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Mckay Drilling**
DRILLING METHOD: **Reverse circulation drilling**
LOGGED BY: **Deborah Booth**
EASTING (m): **714793.44**
NORTHING (m): **7655136.49**
MEAS PT ELEVATION (mAHD): **252.53**
DRILLING DIAMETER(S) (mm): **140**
DATE BEGUN: **14/12/2013** DATE COMPLETED: **14/12/2013**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**150**
Cased Depth (mbgl):	**150**
Casing Stick Up (magl):	**0.042**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**13.62** & **20/12/2013**



Comments:

65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
BASALT: Fresh ultramafics- basalt (50%) and serpentinite (50%), 20% of which are milky green
SERPENTINITE: Fresh ultramafics - mostly serpentinite
BASALT: Fresh ultramafics- basalt (50%) and serpentinite (50%)
100 mm Class 18 uPVC (ID 96mm) Screen
100 mm Class 18 uPVC (ID 96mm) Blank
END OF BOREHOLE
END CAP
<0.5
<0.5
<0.5
<0.5
<0.5
<0.5
no flow
1
1
>1
no flow
<0.5
no flow

Comments:

OBSERVATION WELL BORE LOG

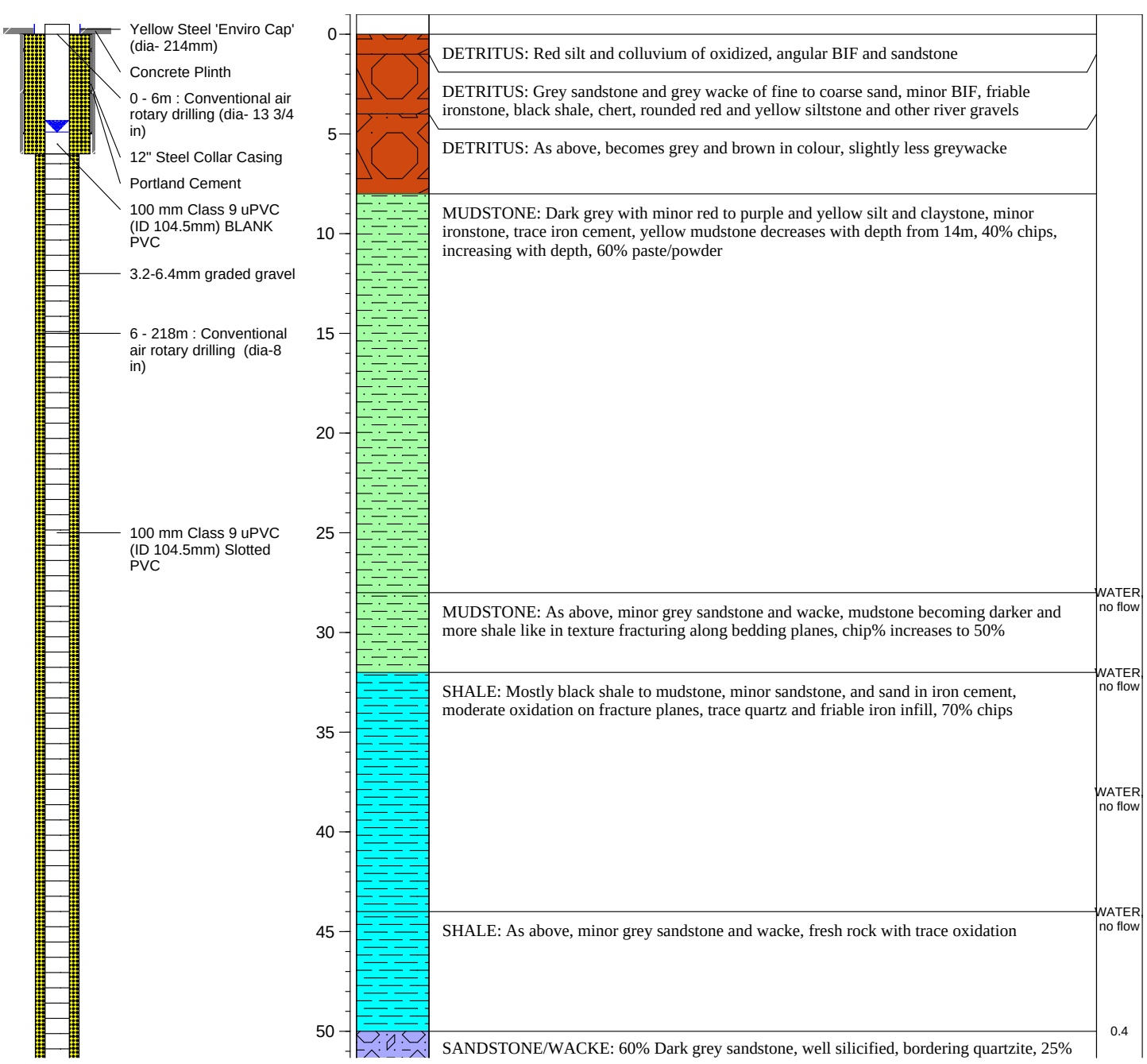
BOREHOLE NUMBER

NS-Obs09

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **711105.13**
NORTHING (m): **7651942.42**
MEAS PT ELEVATION (mAHD): **274.647**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **29/09/2014** DATE COMPLETED: **12/10/2014**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**218**
Cased Depth (mbgl):	**204**
Casing Stick Up (magl):	**0.692**
Completion Stick Up (magl):	**0.75**
Development Airlift Yield (l/s):	**2**
Water Level (mbgl) & Date:	**4.9** & **11/04/2015**



Comments: **Class 9 PVC from 0-132m, Class 18 PVC from 132-204m**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-Obs09

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
			black shale, 15% ironstone and iron cement, moderate oxidation, 90% chips	
	55		SANDSTONE/WACKE: 75% Dark grey sandstone as above, 25% black shale, all well silicified, only trace ironstone and oxidation, sandstone content increases with depth	0.4
	60			0.4
	65			0.4
100 mm Class 9 uPVC (ID 104.5mm) Slotted PVC	70		SANDSTONE/WACKE: Dark grey to black greywacke; angular to rounded 0-2mm clasts of grey quartz and black shale set in a dark grey to black microcrystalline matrix if silicified shale, by 100m some chert/quartz clasts are up to 5mm in diameter	0.4
	75			0.4
	80			0.4
	85			0.4
	90			0.4
	95			0.4
	100			0.4
	105			0.4
	110			0.4
3.2-6.4mm graded gravel	115			0.4

Comments: **Class 9 PVC from 0-132m, Class 18 PVC from 132-204m**

OBSERVATION WELL BORE LOG	BOREHOLE NUMBER
	NS-Obs09

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
100 mm Class 18 uPVC (ID 96mm) Slotted PVC	120 125 130 135 140 145 150 155 160 165 170 175 180			0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4

Comments: **Class 9 PVC from 0-132m, Class 18 PVC from 132-204m**

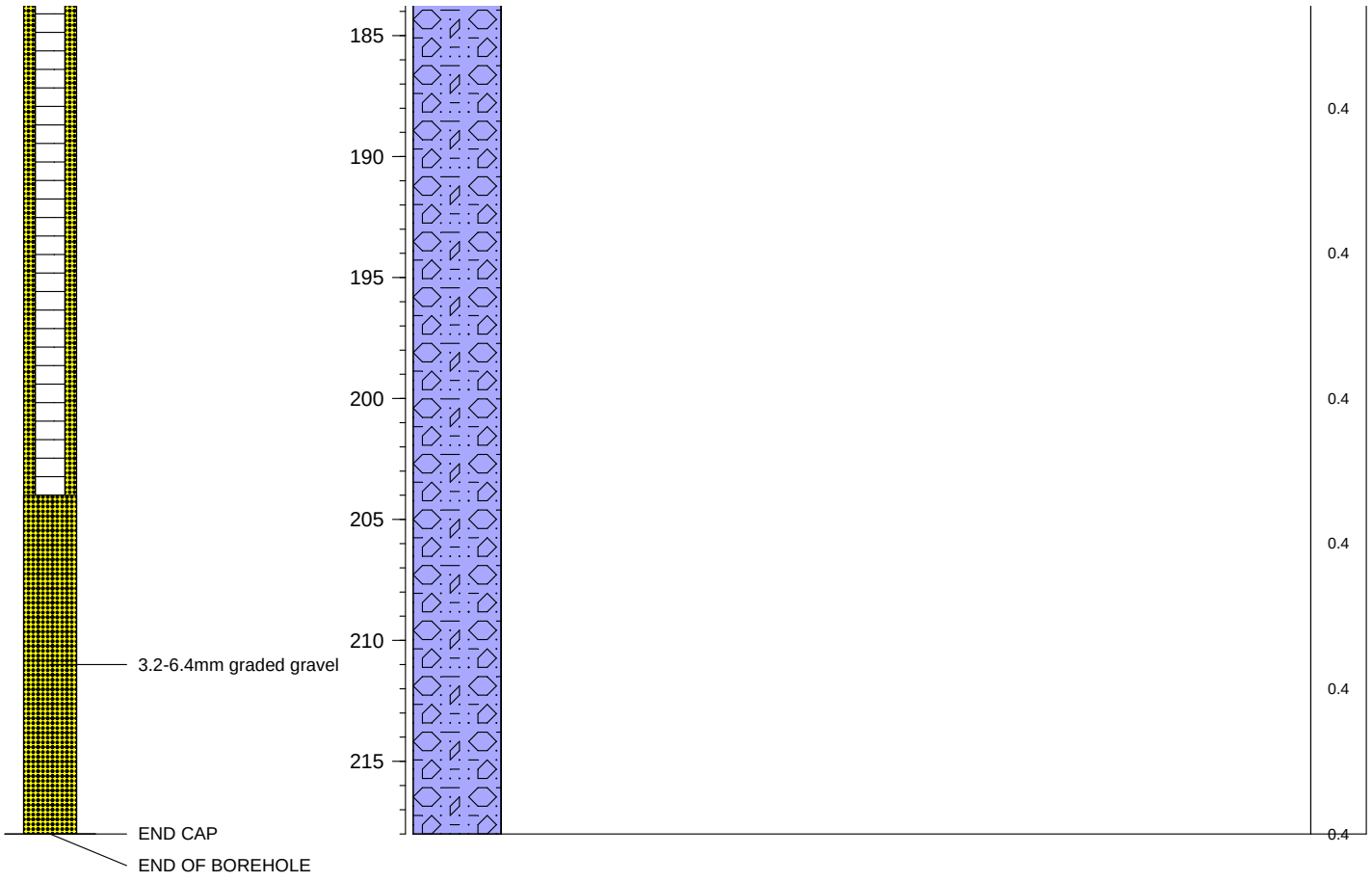
OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-Obs09

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



Comments: **Class 9 PVC from 0-132m, Class 18 PVC from 132-204m**

OBSERVATION WELL BORE LOG

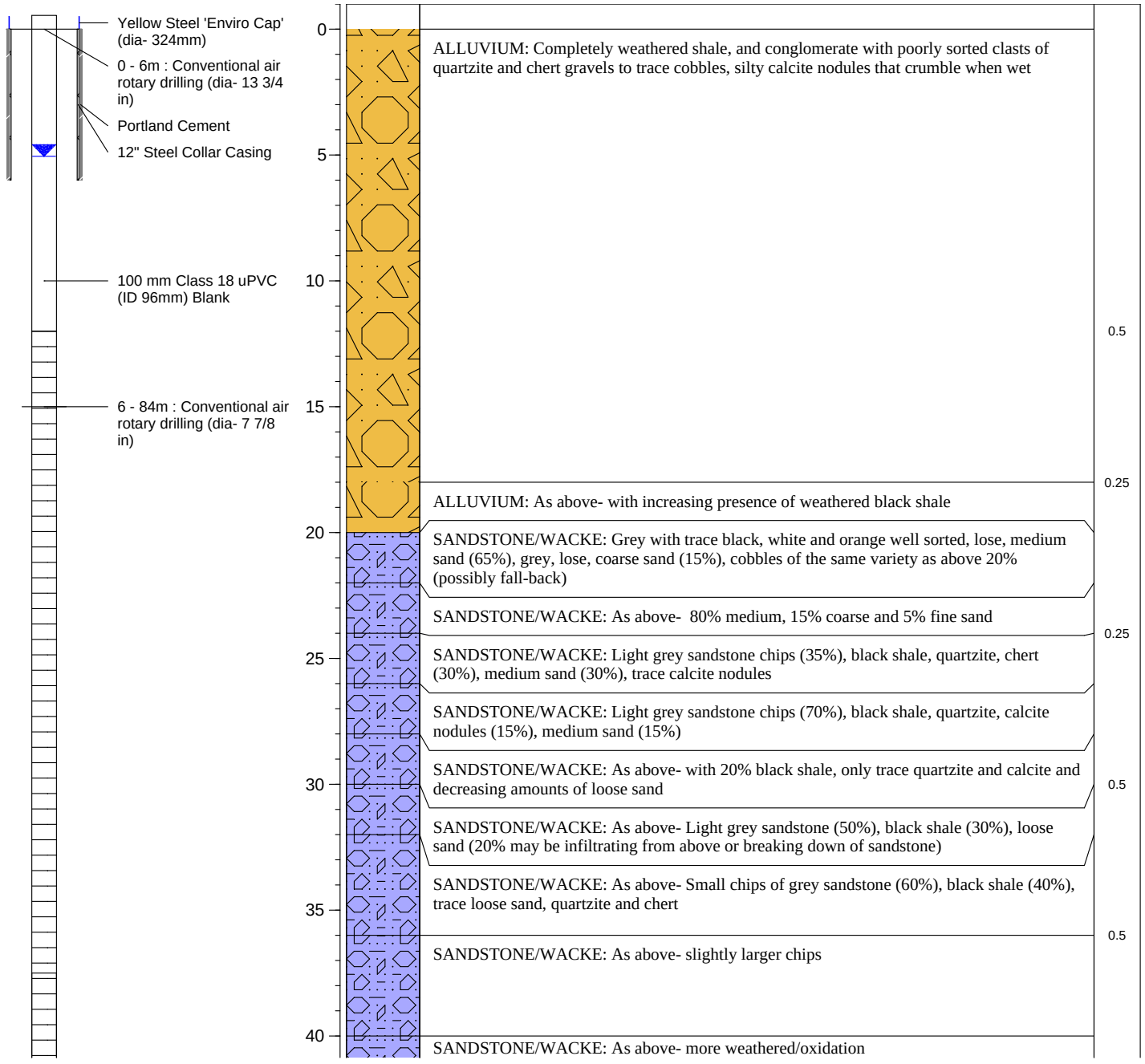
BOREHOLE NUMBER

NS-Obs13

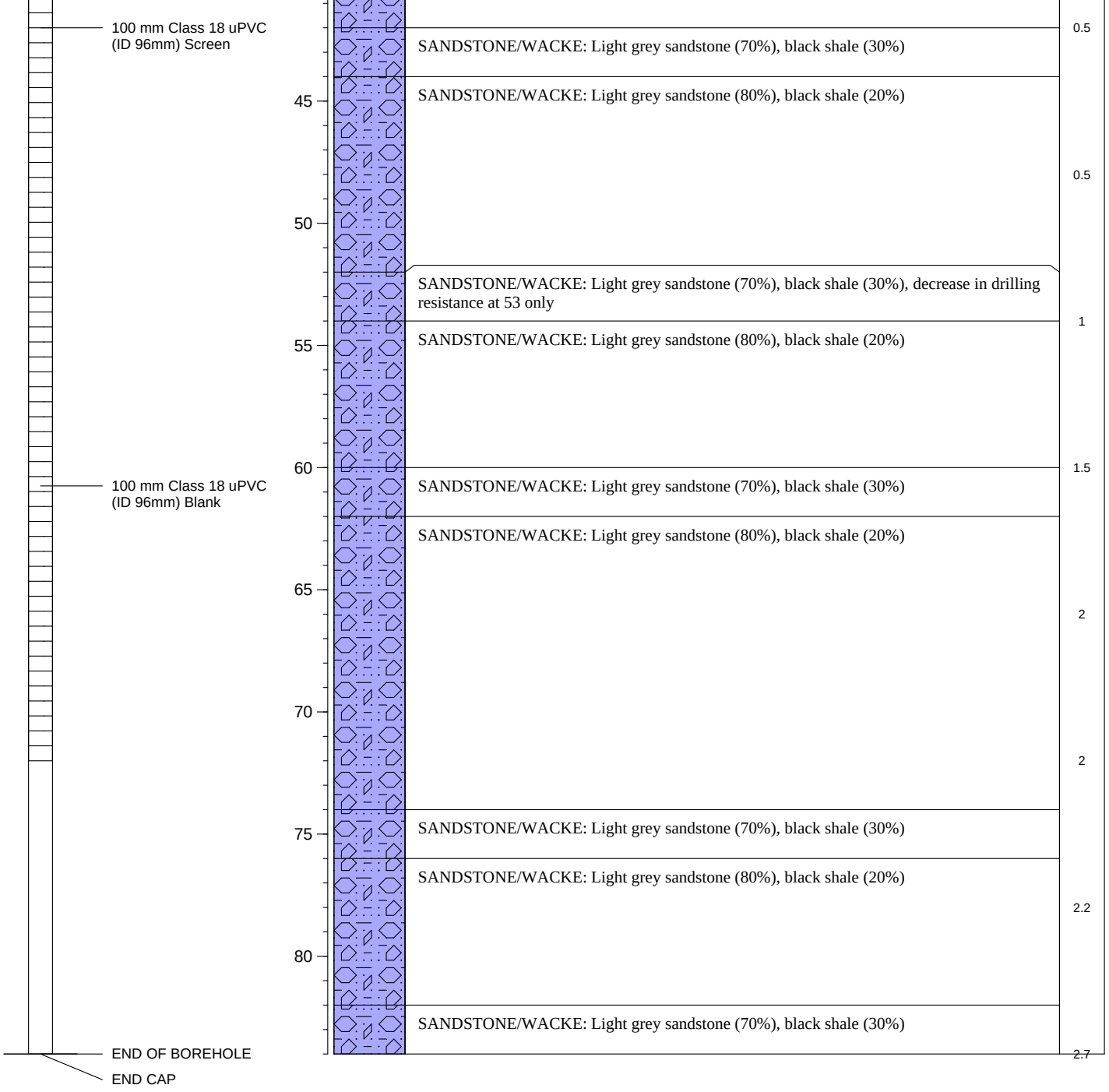
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **708611.57**
NORTHING (m): **7655220.45**
MEAS PT ELEVATION (mAHD): **236.26**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **5/12/2014** DATE COMPLETED: **7/12/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.625**
Drilled Depth (mbgl):	**84**
Cased Depth (mbgl):	**84**
Casing Stick Up (magl):	**0.552**
Development Airlift Yield (l/s):	**2.7**
Water Level (mbgl) & Date:	**5.048** & **8/12/2013**



Comments: **Technical difficulties with development attemp-inefficient to airlift development plans abandoned**



Comments: **Technical difficulties with development attemp-inefficient to airlift development plans abandoned**

OBSERVATION WELL BORE LOG

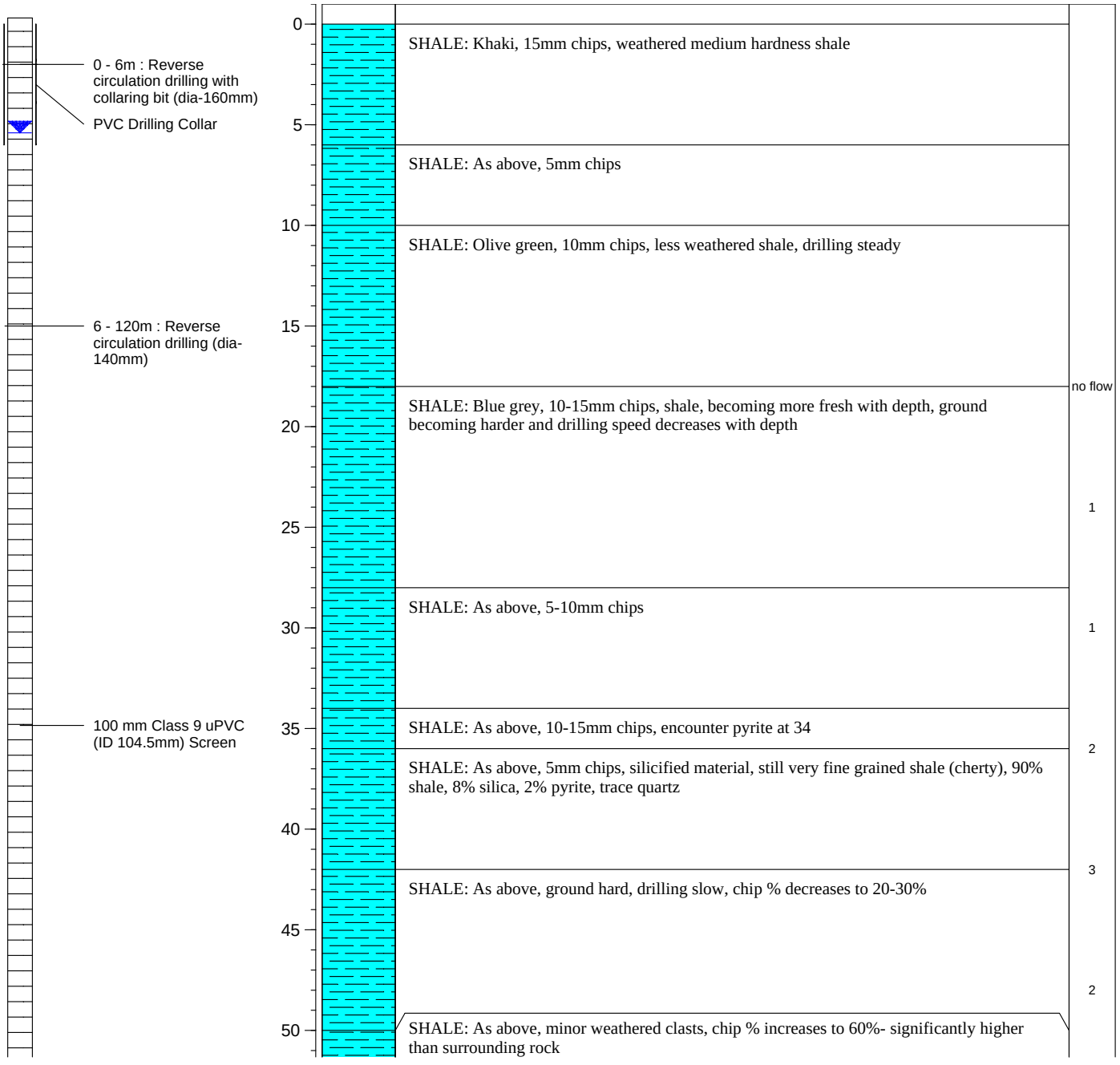
BOREHOLE NUMBER

NS-Obs14

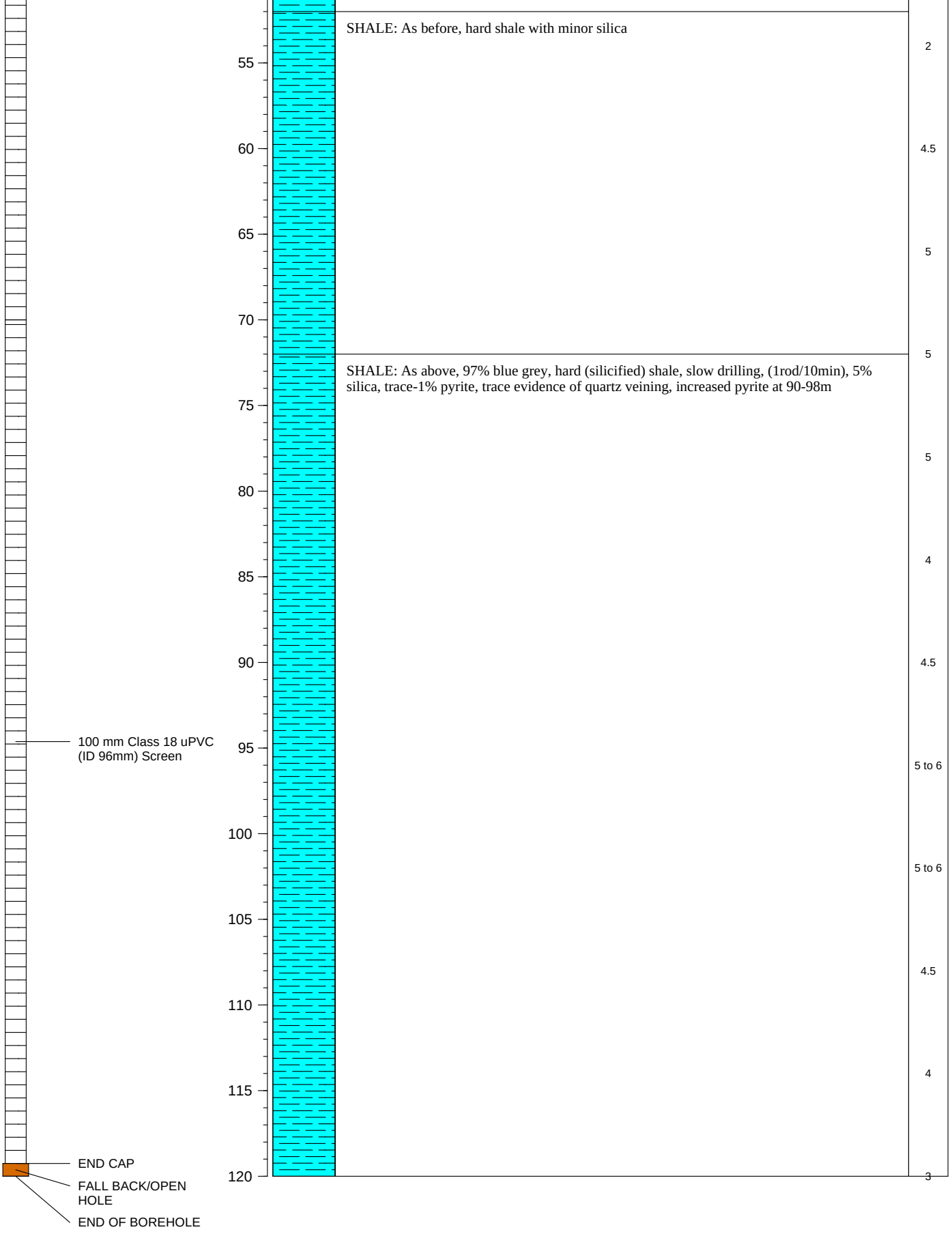
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Mckay Drilling**
DRILLING METHOD: **Reverse circulation drilling**
LOGGED BY: **Deborah Booth**
EASTING (m): **712615.35**
NORTHING (m): **7649148.24**
MEAS PT ELEVATION (mAHD): **306.60**
DRILLING DIAMETER(S) (mm): **140**
DATE BEGUN: **11/03/2014** DATE COMPLETED: **11/03/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**120**
Cased Depth (mbgl):	**119.25**
Casing Stick Up (magl):	**0.311**
Development Airlift Yield (l/s):	**6**
Water Level (mbgl) & Date:	**5.4** & **13/04/2014**



Comments:



SHALE: As before, hard shale with minor silica

SHALE: As above, 97% blue grey, hard (silicified) shale, slow drilling, (1rod/10min), 5% silica, trace-1% pyrite, trace evidence of quartz veining, increased pyrite at 90-98m

2
4.5
5
5
5
4
4.5
5 to 6
5 to 6
4.5
4
3

Comments:

OBSERVATION WELL BORE LOG

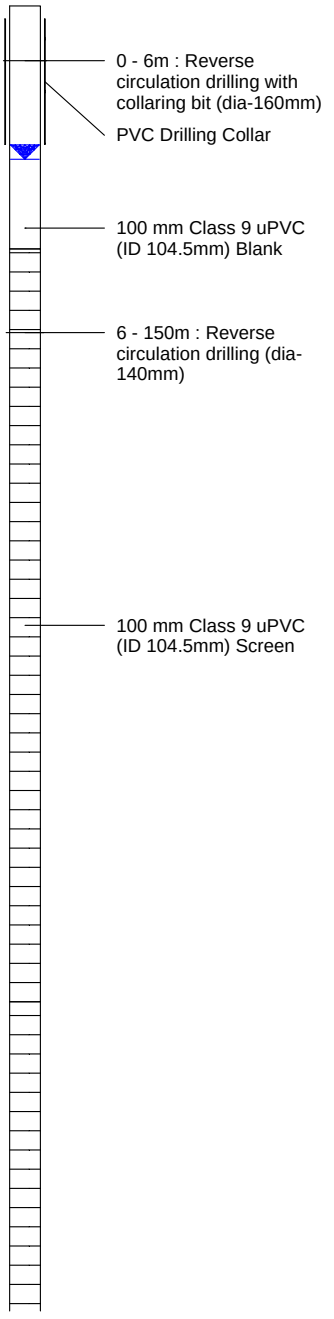
BOREHOLE NUMBER

NS-Obs14A

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

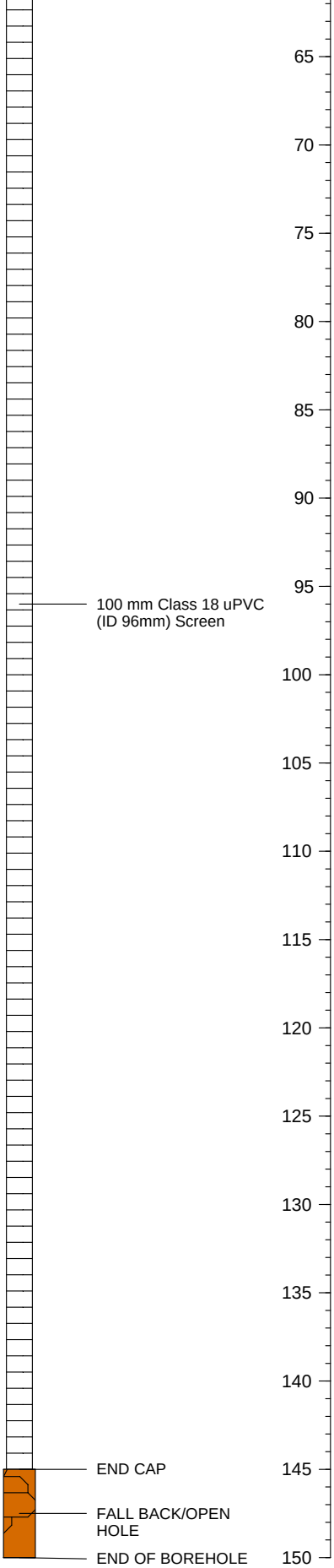
PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Mckay Drilling**
DRILLING METHOD: **Reverse circulation drilling**
LOGGED BY: **Deborah Booth**
EASTING (m): **712533.09**
NORTHING (m): **7648751.62**
MEAS PT ELEVATION (mAHD): **303.76**
DRILLING DIAMETER(S) (mm): **140**
DATE BEGUN: **16/03/2014** DATE COMPLETED: **16/03/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**150**
Cased Depth (mbgl):	**145**
Casing Stick Up (magl):	**0.618**
Development Airlift Yield (l/s):	**4**
Water Level (mbgl) & Date:	**6.712** & **13/04/2014**



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0			
		SHALE: Reddish brown, 5-15mm chips, extremely weathered shale, minor chert, some enrichment of HO/GO	
10		SHALE: Pale yellow brown, 5-10mm chips, highly weathered shale, water between 12-18m	1
20		SHALE: Light grey, 10-18mm chips, moderately weathered shale,	1.5
30		SHALE: Yellowish white, 5-10mm chips, highly weathered shale, chips hold shape, medium hardness, increased 10-20mm chip size at 36-38m	1.5
40		SHALE: Light grey, 5-10mm chips, moderately weathered shale,	1.5
45		SHALE: Light grey, 10-15mm chips, slightly weathered shale, drilling rate steady ground beginning to harden	1.5
55			2
60		SHALE: Medium to dark grey, fresh shale, chips showing silicification, ground hard, drilling slowed, 5% pyrite with significant amounts visible along fracture planes and in massive habit	2

Comments:



65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150

SHALE: Medium to dark grey fresh shale, increasingly silicified, significant pyrite, no quartz/ veining observed, chip size decreasing, ground hard

SHALE: As above, fresh rock, very siliceous, minor banding, minor quartz, some chips show darker green alteration surfaces (102-116), fine to very fine grained with some moderately developed bedding

SHALE: Fracture zone, soft patch in drilling (102-108m), ground hard 15-20min/ rod

SHALE: As before fracture zone, trace pyrite at 130-135

SHALE: Dark grey 5-10mm, occasional 15mm chips, very fine grained, siliceous shale, trace quartz on chip surfaces and pyrite

2
3
3
3
3 to 4
2 to 3
4
3
2
3 to 4
2
3
2
1.5-2
1.5

Comments:

OBSERVATION WELL BORE LOG

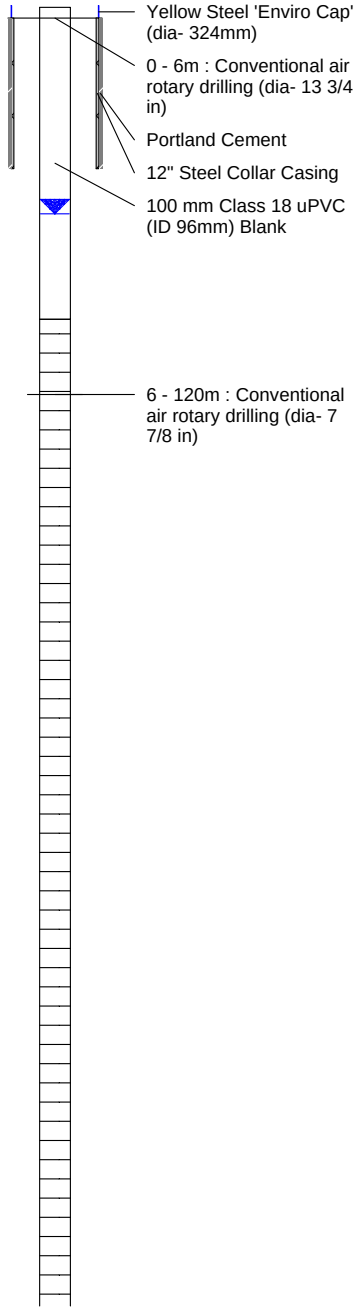
BOREHOLE NUMBER

NS-Obs20

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

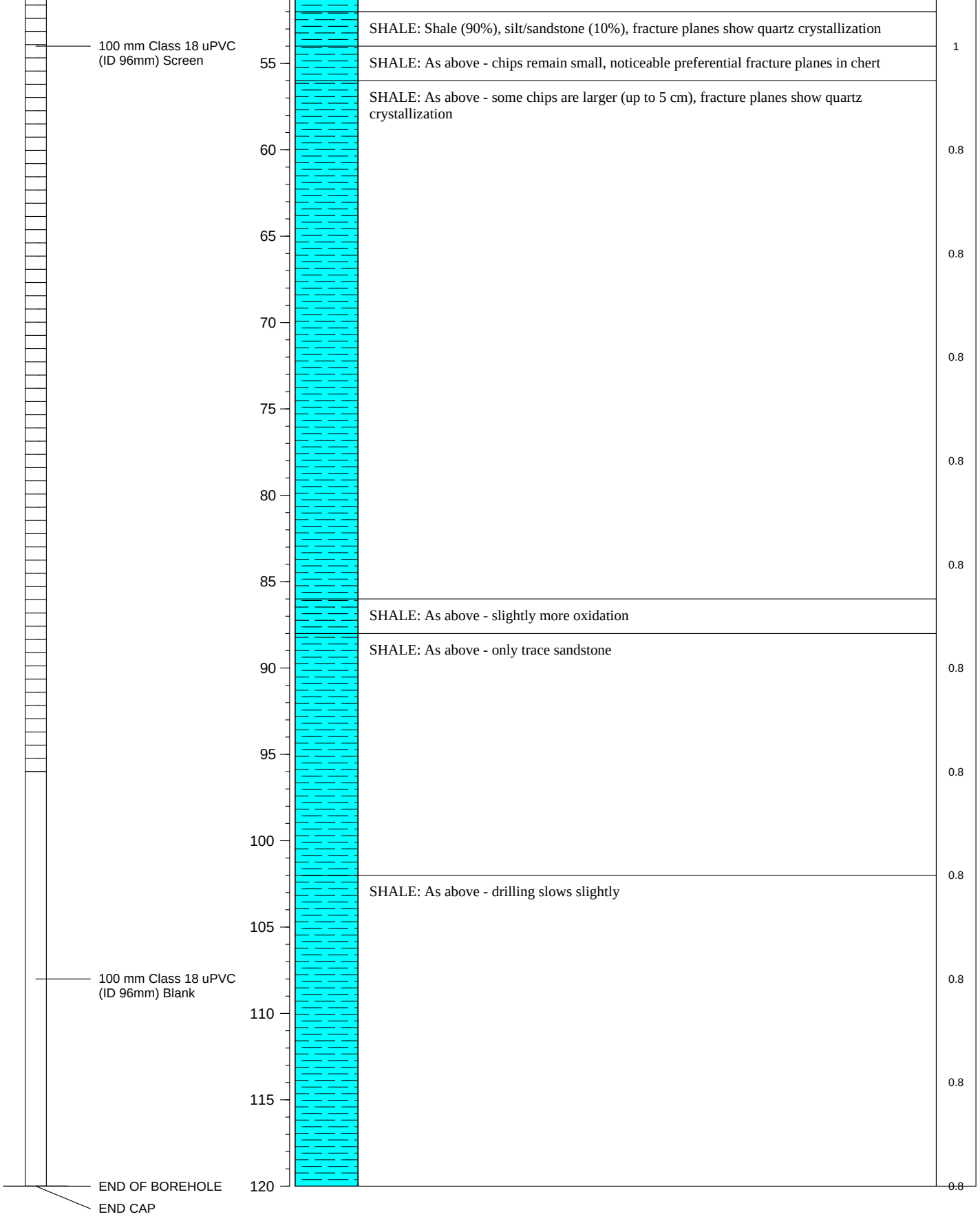
PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **711274.54**
NORTHING (m): **7653281.69**
MEAS PT ELEVATION (mAHD): **255.54**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **10/12/2014** DATE COMPLETED: **11/12/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.569**
Drilled Depth (mbgl):	**120**
Cased Depth (mbgl):	**120**
Casing Stick Up (magl):	**0.434**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**7.796** & **20/12/2013**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Weathered shale, sandstone, chert gravels, silty/clay- clumping from moisture in foam	
5	DETRITUS: Shale, trace calcite, silty/clay- clumping from moisture in foam	
	SILTSTONE: Interbedded/laminated purple mudstone and light grey silt/fine sandstone. Silt/fine sandstone crumbles easily, mudstone is slightly harder, both can be broken by hand resulting in the drill rig bringing up clumps of clay/silt, trace calcite and chert	
10	SHALE: Weathered black shale with oxidized red colouration along fracture planes, breaks easily with hammer (60%), fine grey silt/sandstone (30%), chert and calcite (10%)	
	SHALE: As above - shale (80%), silt/sandstone (20%), trace calcite	
15	SHALE: Shale (90%), silt/sandstone (10%), slightly less weathered	
	SHALE: Shale (95%), silt/sandstone (5%), slightly less weathered	
20	SHALE: As above - with trace sandstone, chert and calcite, somewhat weathered	
25		0.5
30		0.5
35		0.5
	SHALE: As above - slightly more weathered	
40	SHALE: As above - slightly less weathered	0.5
45		0.5
	SHALE: Shale (80%), silt/sandstone (20%)	
50	SHALE: Shale (100%), trace silt/sandstone	

Comments:


100 mm Class 18 uPVC
(ID 96mm) Screen
100 mm Class 18 uPVC
(ID 96mm) Blank
END OF BOREHOLE
END CAP
55
60
65
70
75
80
85
90
95
100
105
110
115
120
SHALE: Shale (90%), silt/sandstone (10%), fracture planes show quartz crystallization
SHALE: As above - chips remain small, noticeable preferential fracture planes in chert
SHALE: As above - some chips are larger (up to 5 cm), fracture planes show quartz crystallization
SHALE: As above - slightly more oxidation
SHALE: As above - only trace sandstone
SHALE: As above - drilling slows slightly
1
0.8
0.8
0.8
0.8
0.8
0.8
0.8
0.8
0.8
0.8

Comments:

OBSERVATION WELL BORE LOG

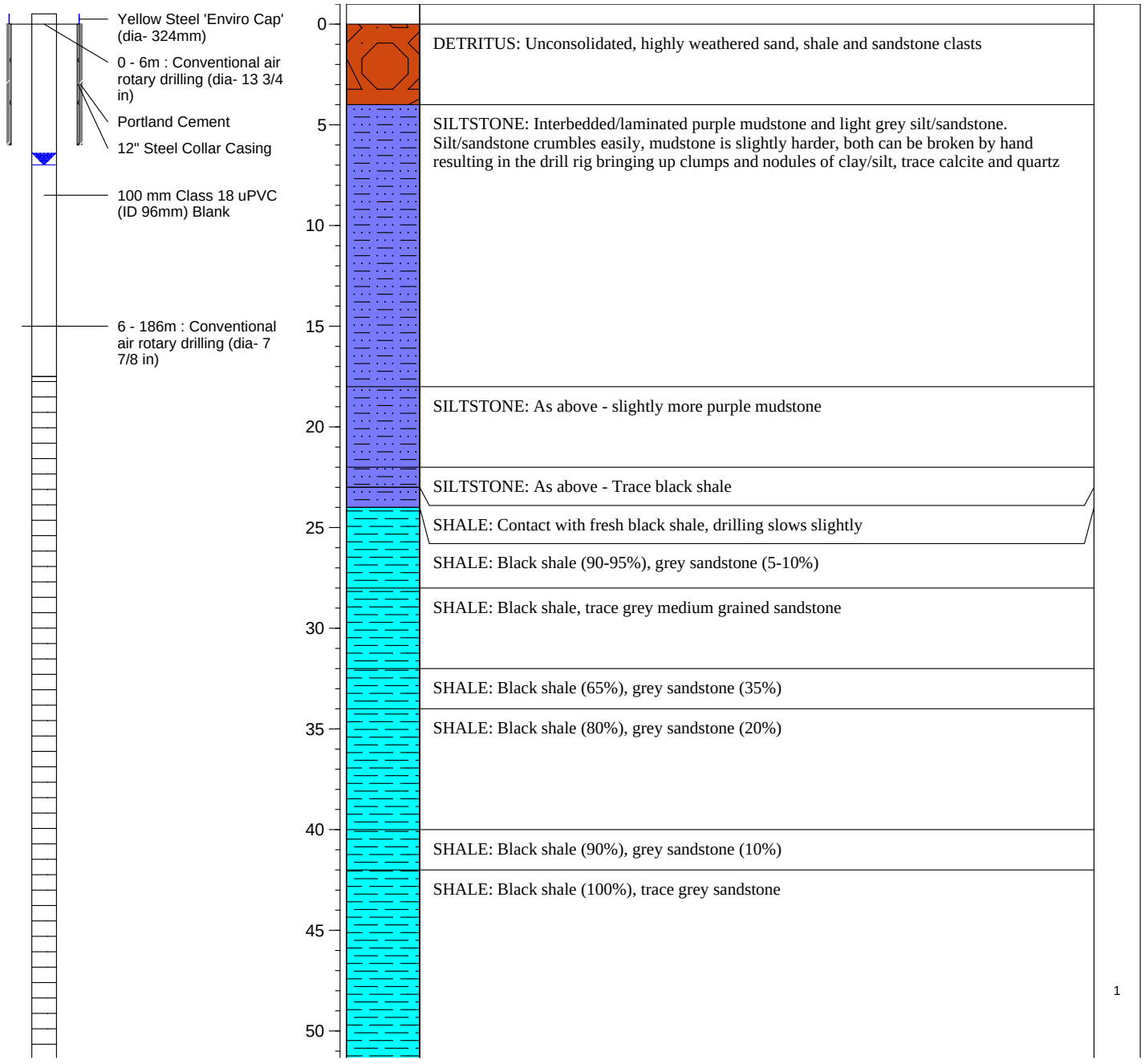
BOREHOLE NUMBER

NS-Obs20A

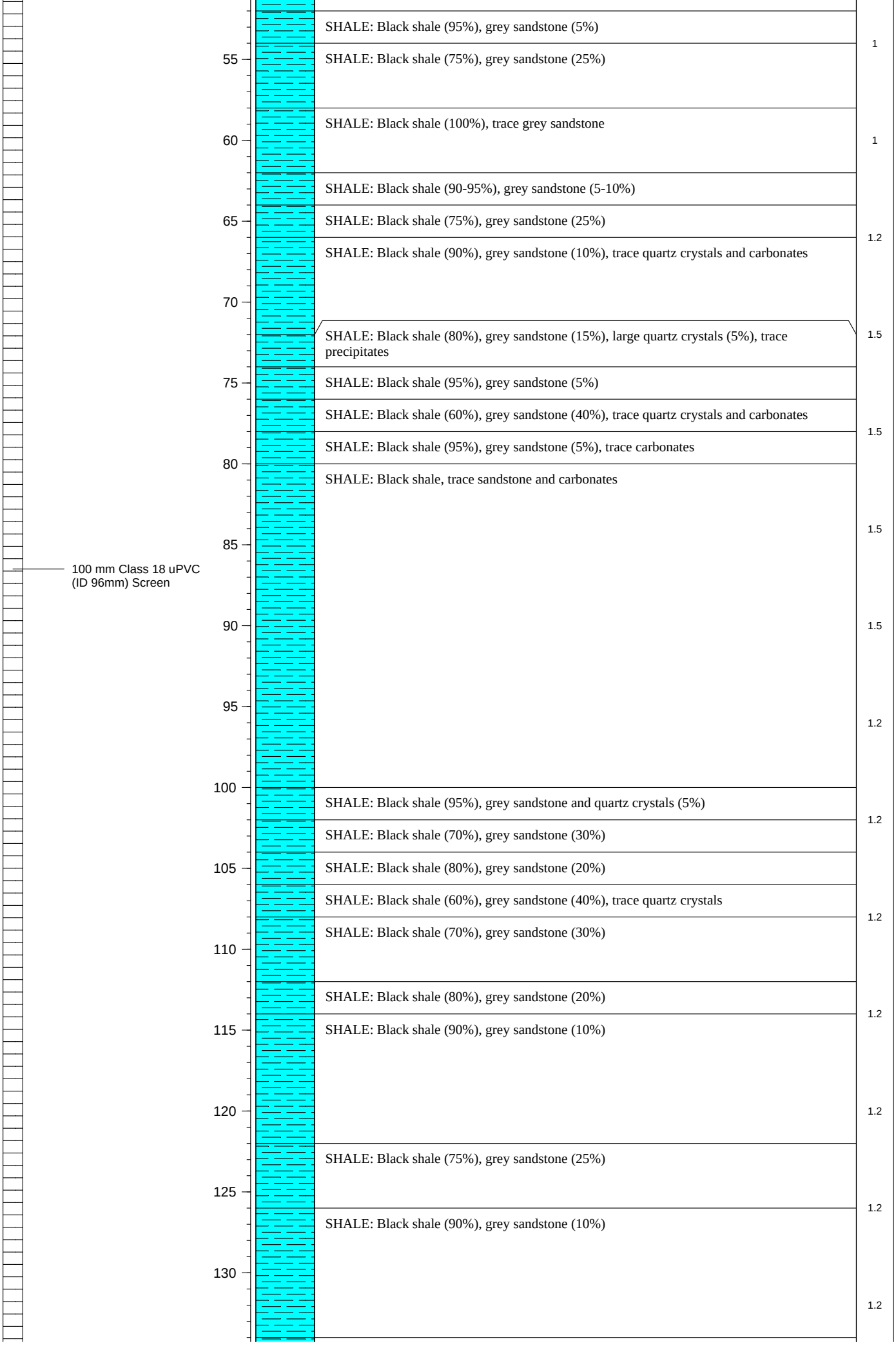
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **711106.61**
NORTHING (m): **7653852.84**
MEAS PT ELEVATION (mAHD): **251.27**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **8/12/2014** DATE COMPLETED: **9/12/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.637**
Drilled Depth (mbgl):	**186**
Cased Depth (mbgl):	**185.5**
Casing Stick Up (magl):	**0.513**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**6.987** & **11/12/2013**



Comments:



SHALE: Black shale (95%), grey sandstone (5%)

SHALE: Black shale (75%), grey sandstone (25%) — 1

SHALE: Black shale (100%), trace grey sandstone — 1

SHALE: Black shale (90-95%), grey sandstone (5-10%)

SHALE: Black shale (75%), grey sandstone (25%)

SHALE: Black shale (90%), grey sandstone (10%), trace quartz crystals and carbonates — 1.2

SHALE: Black shale (80%), grey sandstone (15%), large quartz crystals (5%), trace precipitates — 1.5

SHALE: Black shale (95%), grey sandstone (5%)

SHALE: Black shale (60%), grey sandstone (40%), trace quartz crystals and carbonates

SHALE: Black shale (95%), grey sandstone (5%), trace carbonates — 1.5

SHALE: Black shale, trace sandstone and carbonates — 1.5

1.5

1.2

SHALE: Black shale (95%), grey sandstone and quartz crystals (5%)

SHALE: Black shale (70%), grey sandstone (30%) — 1.2

SHALE: Black shale (80%), grey sandstone (20%)

SHALE: Black shale (60%), grey sandstone (40%), trace quartz crystals

SHALE: Black shale (70%), grey sandstone (30%) — 1.2

SHALE: Black shale (80%), grey sandstone (20%)

SHALE: Black shale (90%), grey sandstone (10%) — 1.2

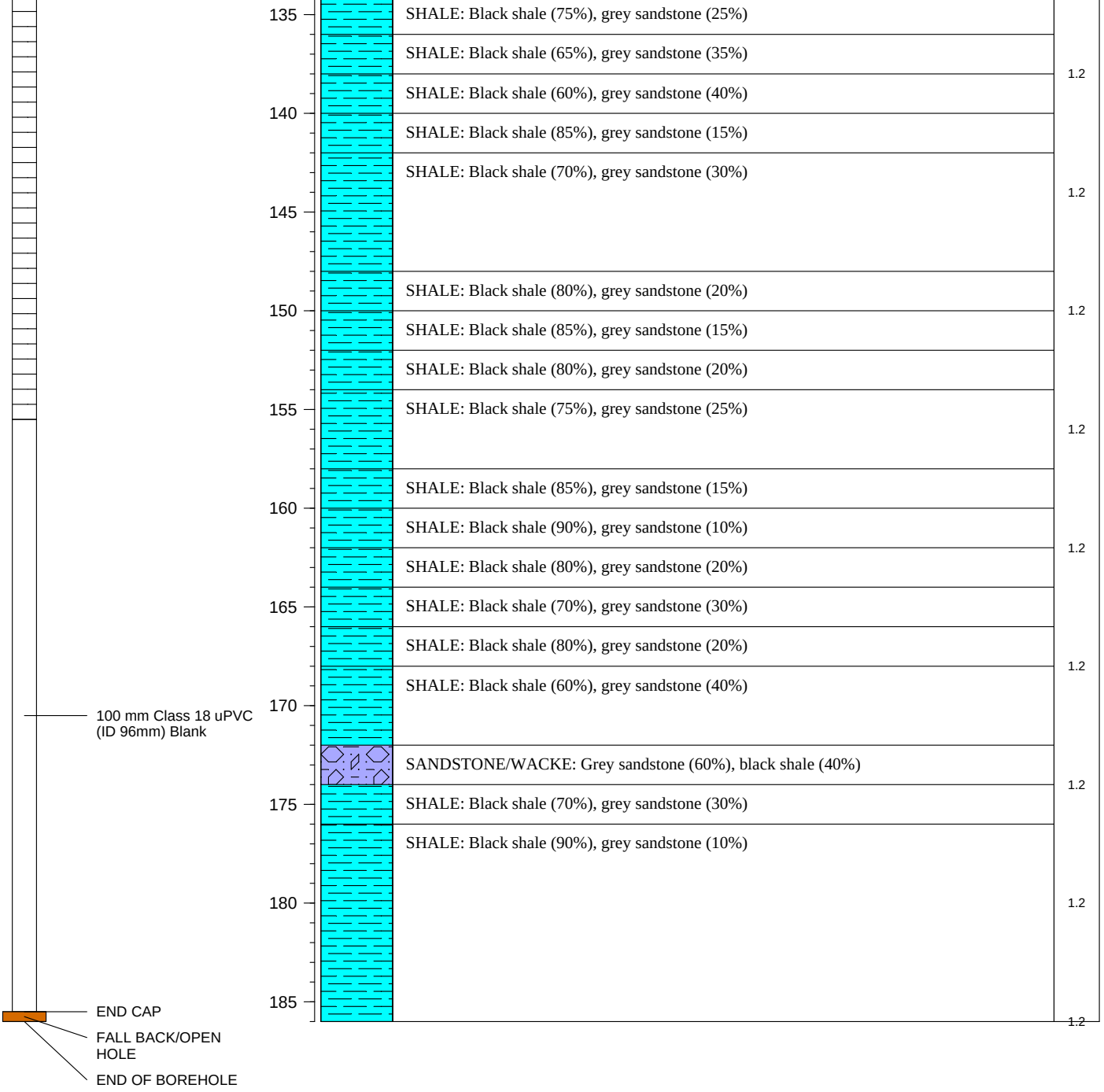
1.2

SHALE: Black shale (75%), grey sandstone (25%)

SHALE: Black shale (90%), grey sandstone (10%) — 1.2

1.2

Comments:


135
140
145
150
155
160
165
170
175
180
185
SHALE: Black shale (75%), grey sandstone (25%)
SHALE: Black shale (65%), grey sandstone (35%)
SHALE: Black shale (60%), grey sandstone (40%)
SHALE: Black shale (85%), grey sandstone (15%)
SHALE: Black shale (70%), grey sandstone (30%)
SHALE: Black shale (80%), grey sandstone (20%)
SHALE: Black shale (85%), grey sandstone (15%)
SHALE: Black shale (80%), grey sandstone (20%)
SHALE: Black shale (75%), grey sandstone (25%)
SHALE: Black shale (85%), grey sandstone (15%)
SHALE: Black shale (90%), grey sandstone (10%)
SHALE: Black shale (80%), grey sandstone (20%)
SHALE: Black shale (70%), grey sandstone (30%)
SHALE: Black shale (80%), grey sandstone (20%)
SHALE: Black shale (60%), grey sandstone (40%)
SANDSTONE/WACKE: Grey sandstone (60%), black shale (40%)
SHALE: Black shale (70%), grey sandstone (30%)
SHALE: Black shale (90%), grey sandstone (10%)
1.2
100 mm Class 18 uPVC (ID 96mm) Blank
END CAP
FALL BACK/OPEN HOLE
END OF BOREHOLE

Comments:

OBSERVATION WELL BORE LOG

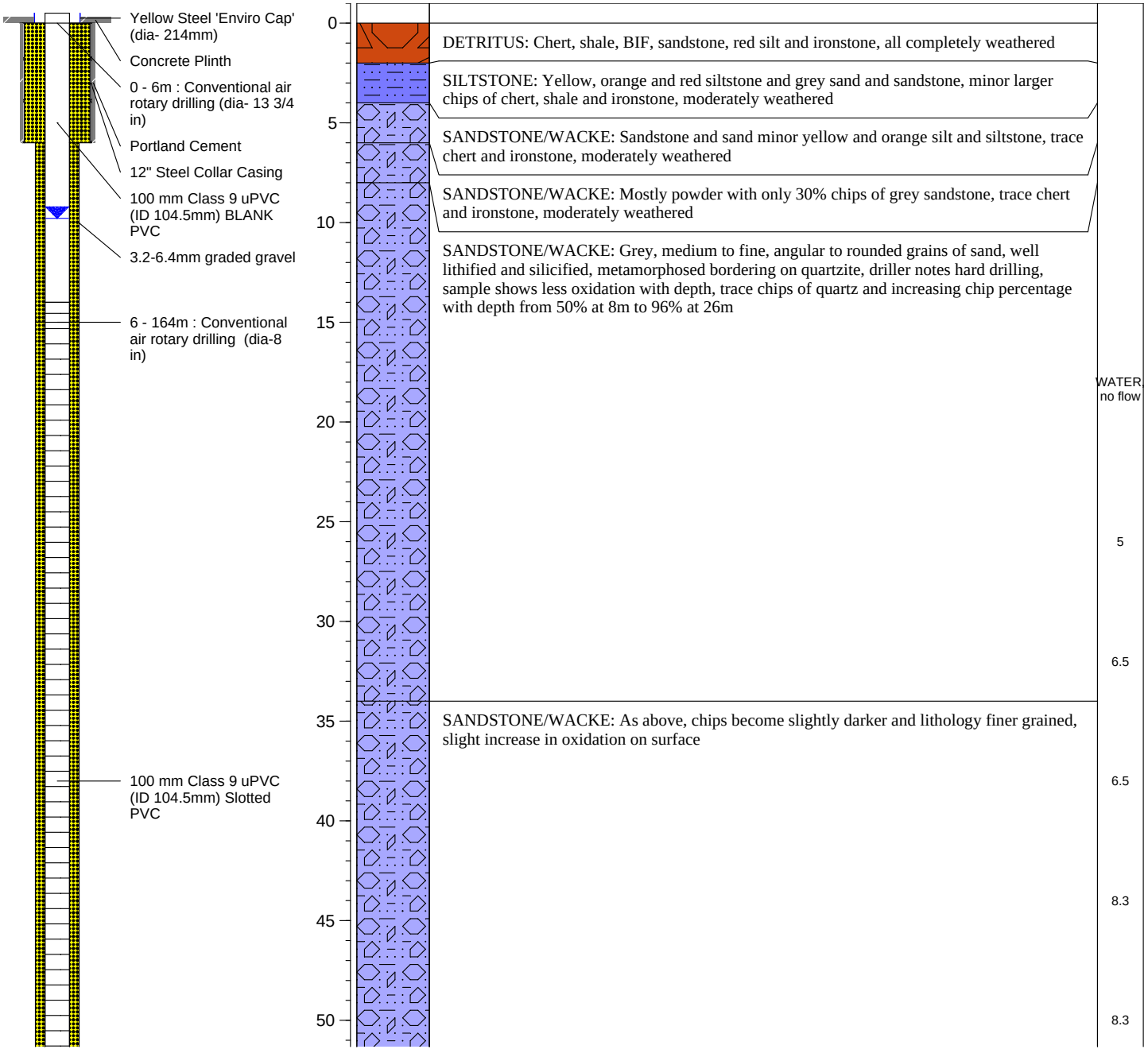
BOREHOLE NUMBER

NS-Obs24

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **712256.95**
NORTHING (m): **7652443.08**
MEAS PT ELEVATION (mAHD): **271.346**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **24/09/2014** DATE COMPLETED: **26/09/2014**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**164**
Cased Depth (mbgl):	**164**
Casing Stick Up (magl):	**0.317**
Completion Stick Up (magl):	**0.716**
Development Airlift Yield (l/s):	**2.9**
Water Level (mbgl) & Date:	**9.79** & **11/04/2015**



Comments: **Class 18 PVC from 62-152m, all else Class 9 PVC**

OBSERVATION WELL BORE LOG	BOREHOLE NUMBER
	NS-Obs24

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	55		SANDSTONE/WACKE: Dark grey sandstone as above, minor to trace black shale	8.3
	60		SANDSTONE/WACKE: Dark grey sandstone, grains are barely visible border lining silicified siltstone to shale	8.3
	65			8.3
	70		SANDSTONE/WACKE: Dark grey sandstone grains are easily distinguished, sample from 138-140m is ground to mostly sand with trace black shale, likely contact point	8.3
	75			8.3
	80			8.3
3.2-6.4mm graded gravel	85			8.3
	90			8.3
	95			8.3
	100			8.3
100 mm Class 18 uPVC (ID 96mm) Slotted PVC	105			8.3
	110			8.3
	115			8.3

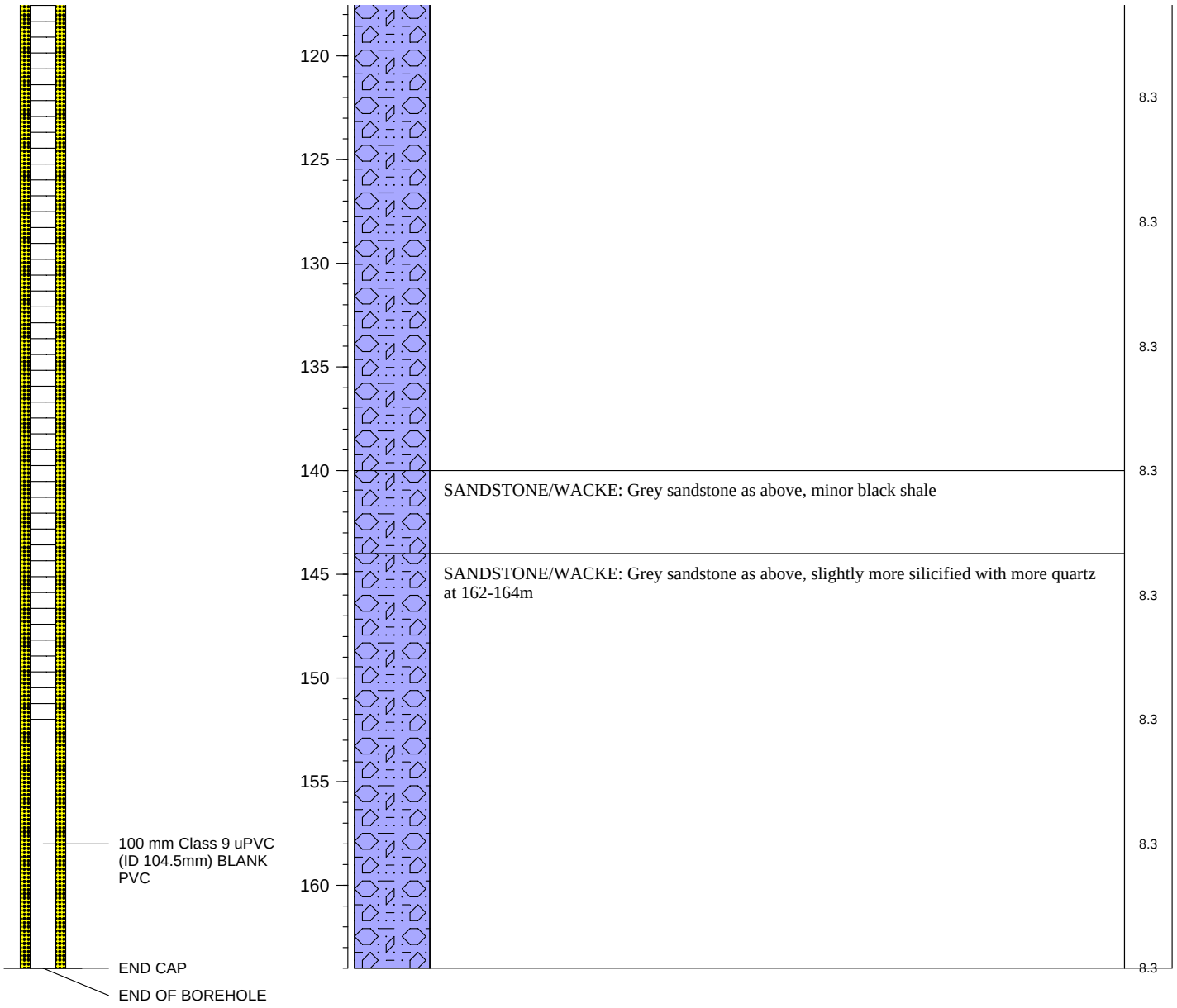
Comments: **Class 18 PVC from 62-152m, all else Class 9 PVC**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-Obs24

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments: **Class 18 PVC from 62-152m, all else Class 9 PVC**

OBSERVATION WELL BORE LOG

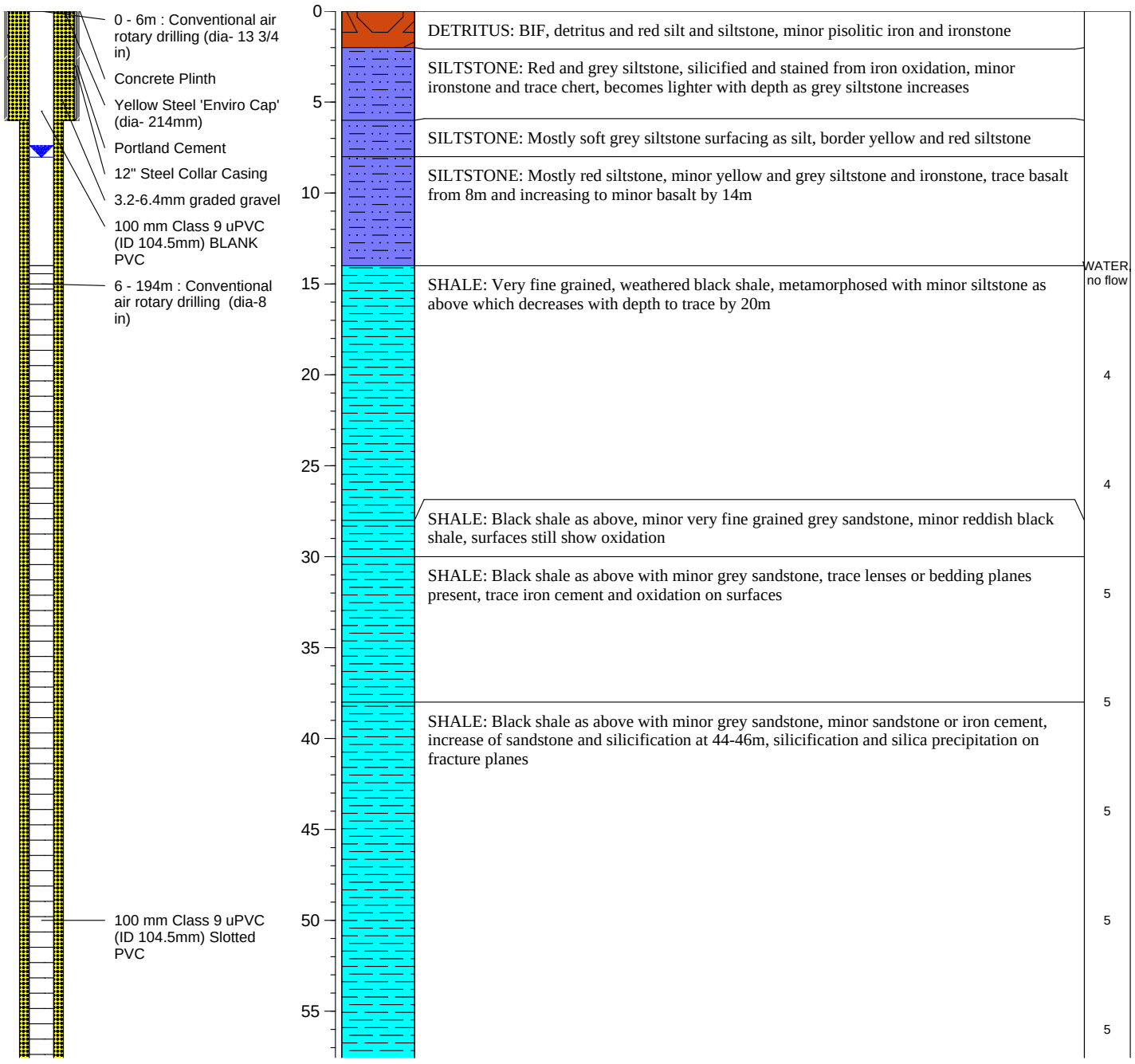
BOREHOLE NUMBER

NS-Obs25

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **711799.97**
NORTHING (m): **7653939.29**
MEAS PT ELEVATION (mAHD): **254.848**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **22/09/2014** DATE COMPLETED: **24/09/2014**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**194**
Cased Depth (mbgl):	**194**
Casing Stick Up (magl):	**0.385**
Completion Stick Up (magl):	**0.605**
Development Airlift Yield (l/s):	**3.6**
Water Level (mbgl) & Date:	**8.03** & **15/04/2015**



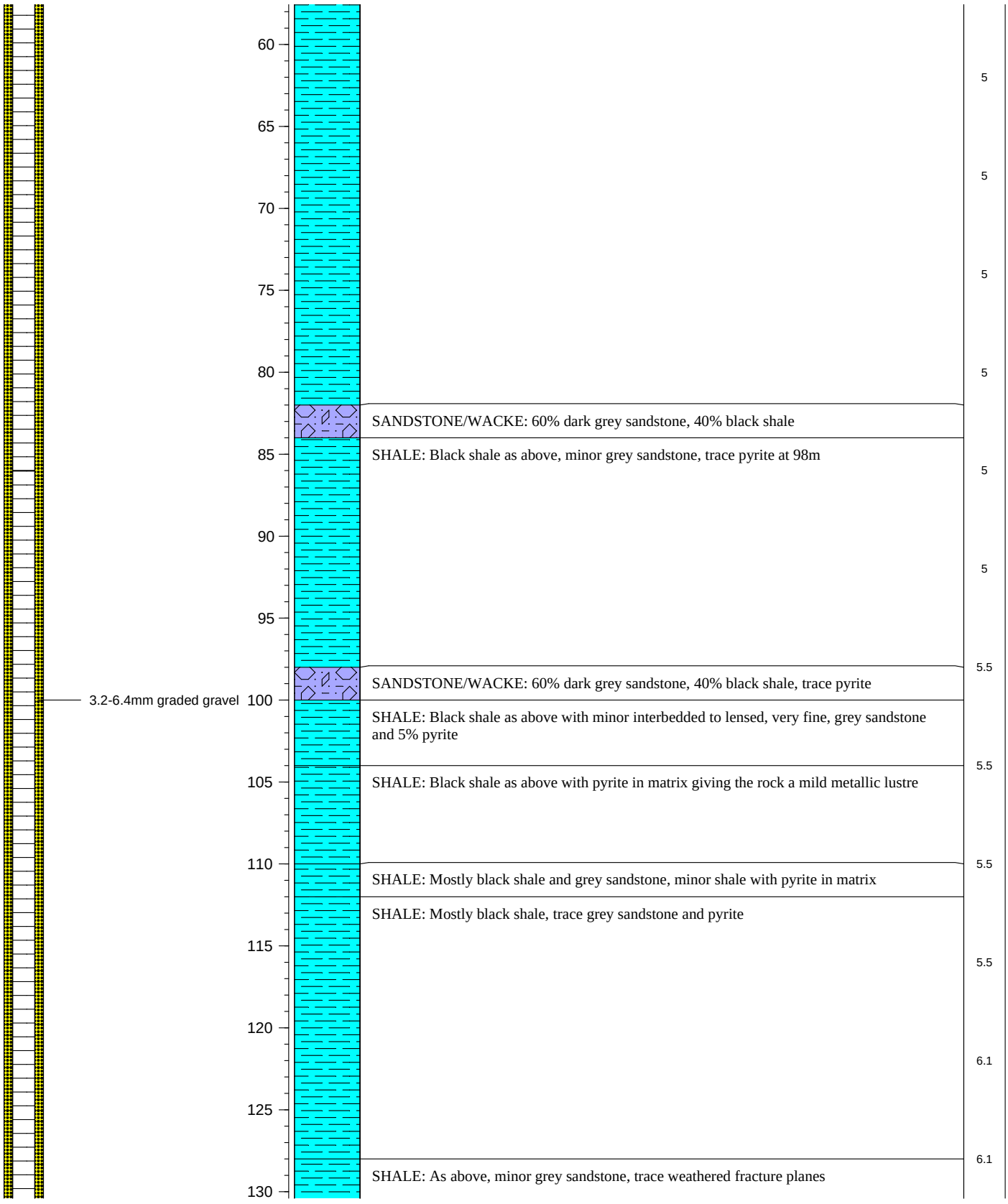
Comments: **Class 18 PVC from 86-182m, all else Class 9 PVC**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-Obs25

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



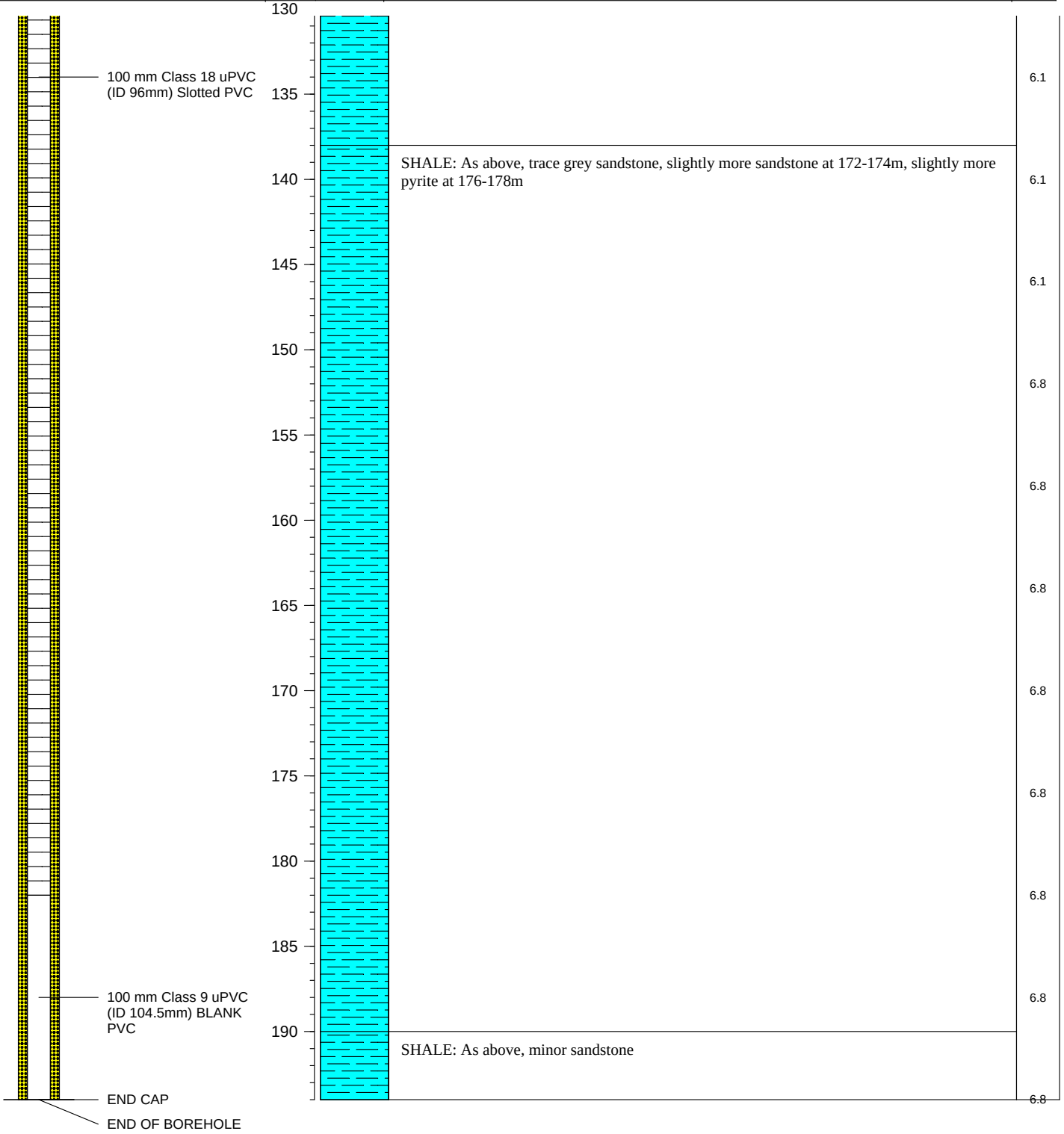
Comments: **Class 18 PVC from 86-182m, all else Class 9 PVC**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-Obs25

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments: **Class 18 PVC from 86-182m, all else Class 9 PVC**

OBSERVATION WELL BORE LOG

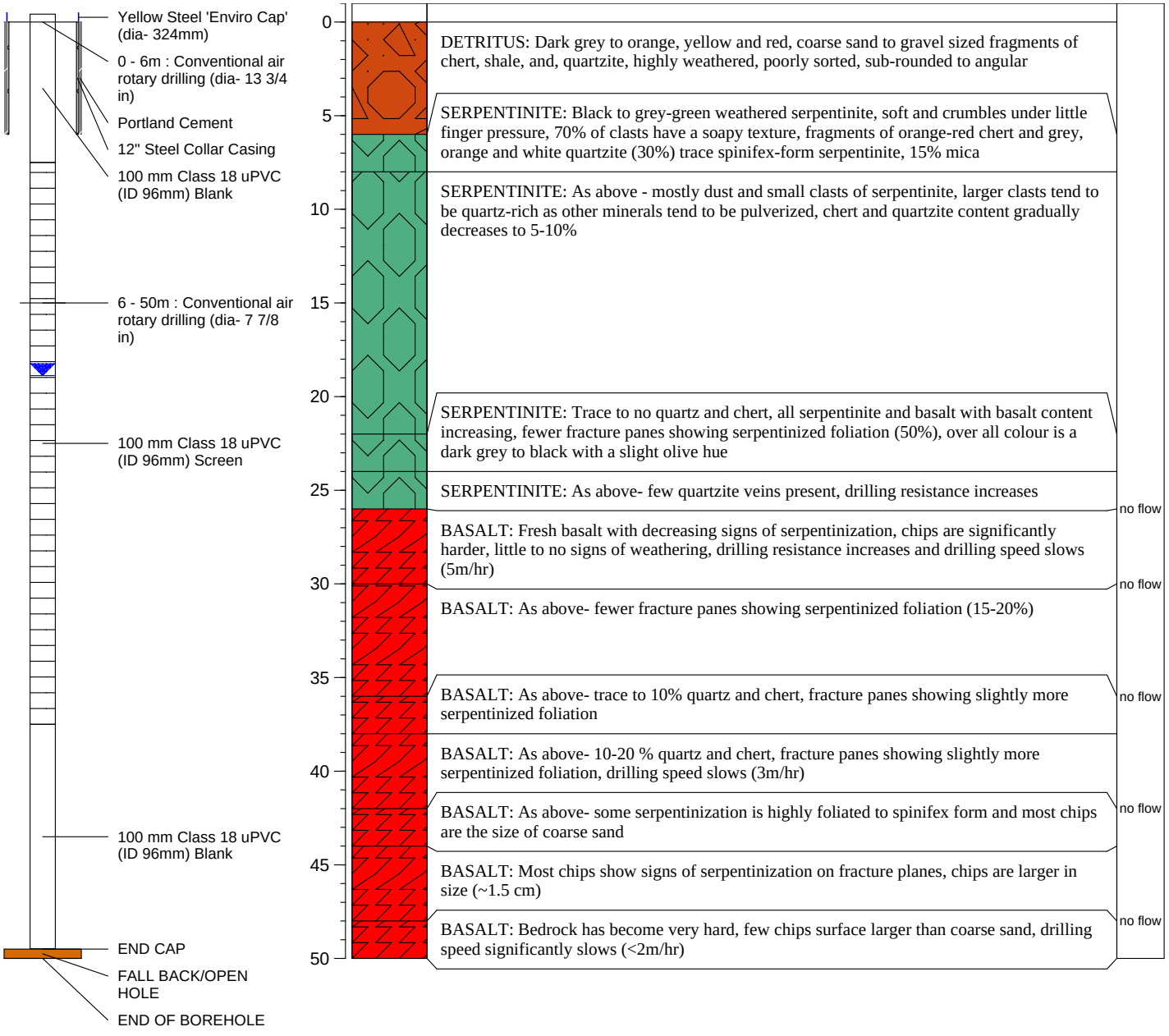
BOREHOLE NUMBER

NS-Obs26

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Eastern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**712688.87**
NORTHING (m):	**7655424.02**
MEAS PT ELEVATION (mAHD):	**264.24**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **3/12/2013**	DATE COMPLETED: **4/12/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.527**
Drilled Depth (mbgl):	**49.5**
Cased Depth (mbgl):	**50**
Casing Stick Up (magl):	**0.425**
Development Airlift Yield (l/s):	**0**
Water Level (mbgl) & Date:	**18.875** & **12/12/2013**



Comments:

OBSERVATION WELL BORE LOG

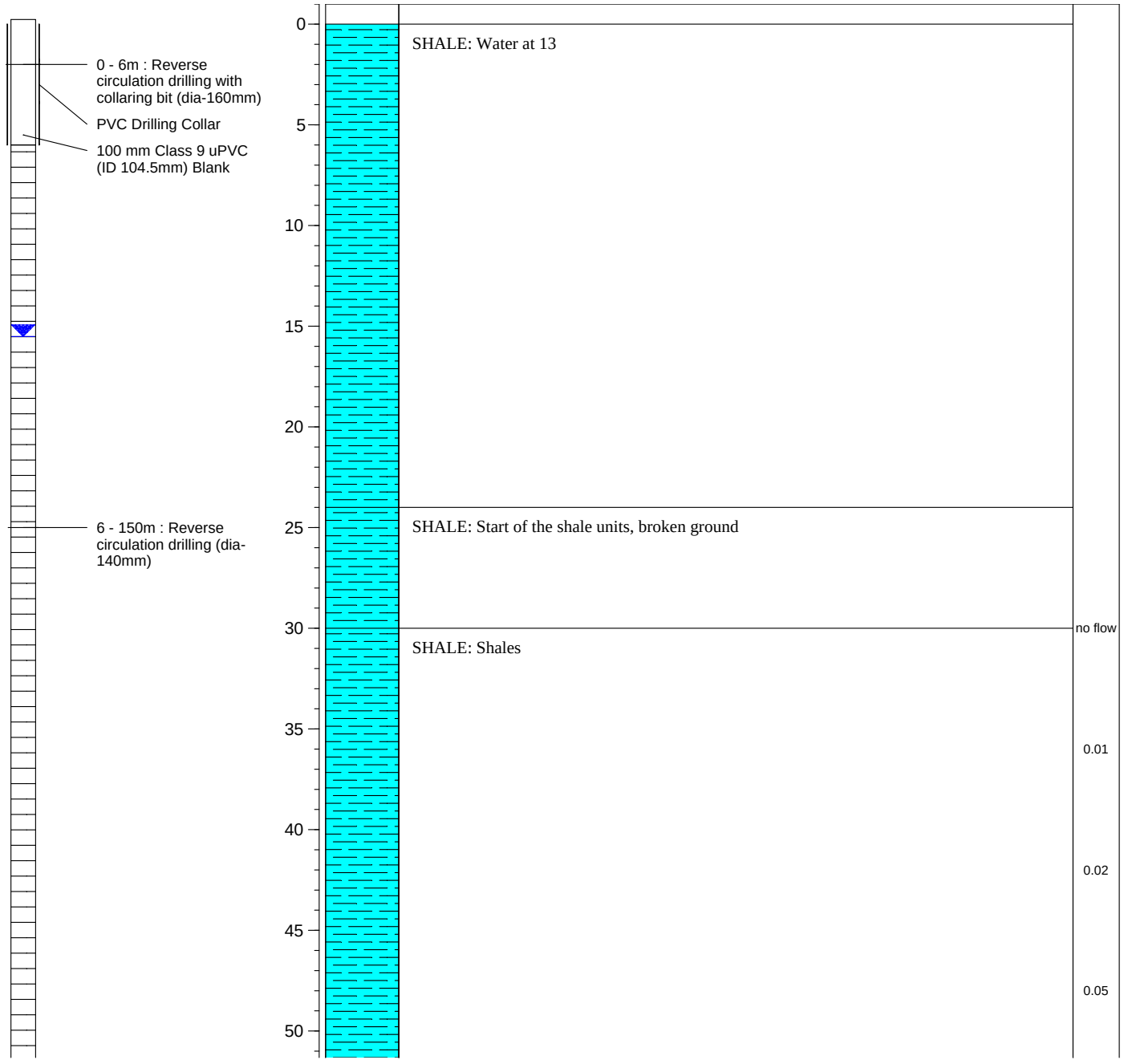
BOREHOLE NUMBER

NS-Obs27

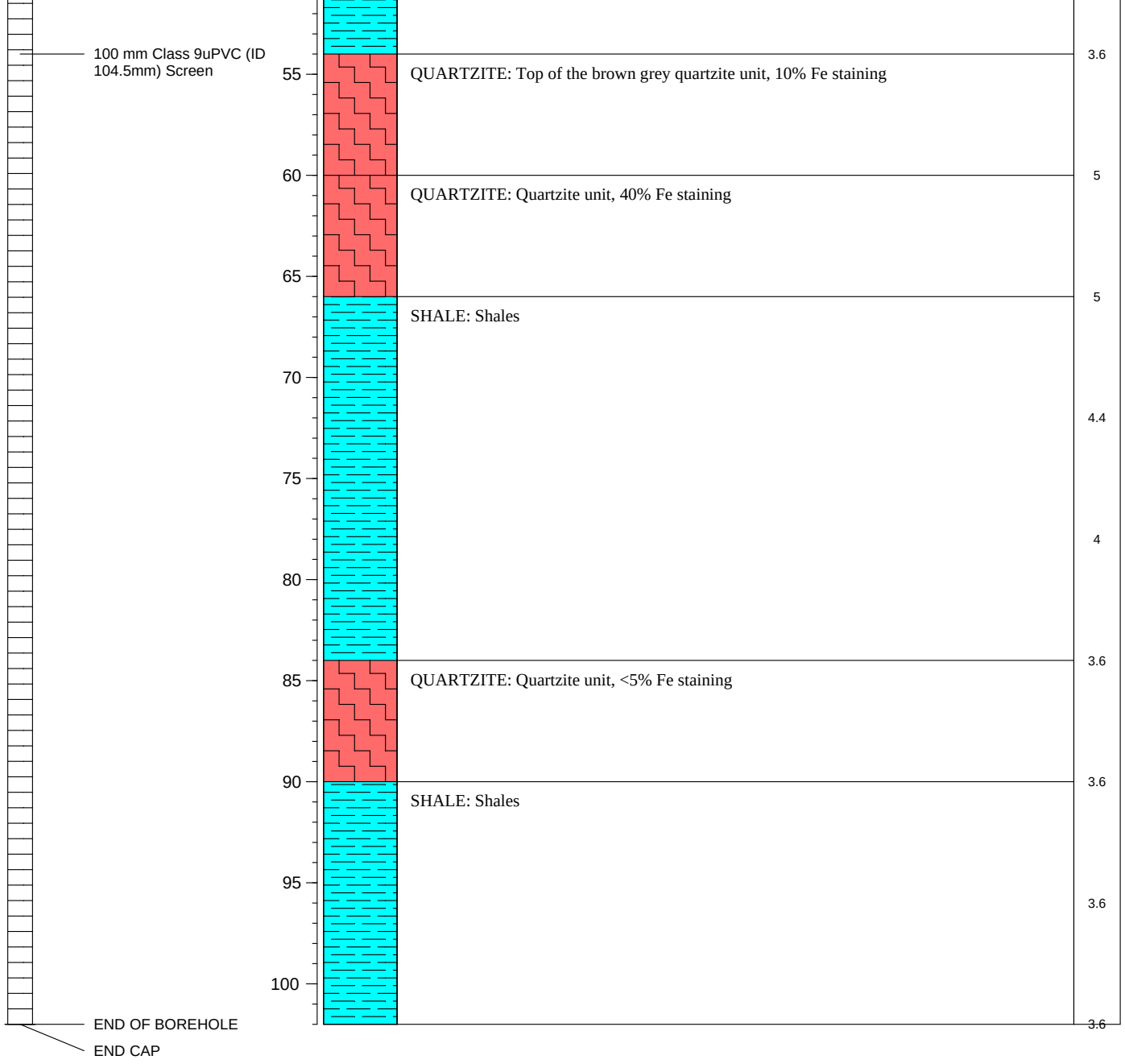
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Mckay Drilling**
DRILLING METHOD: **Reverse circulation drilling**
LOGGED BY: **Daniel Woolford**
EASTING (m): **712852.20**
NORTHING (m): **7649586.10**
MEAS PT ELEVATION (mAHD): **322.91**
DRILLING DIAMETER(S) (mm): **140**
DATE BEGUN: **1/11/2013** DATE COMPLETED: **1/11/2013**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**102**
Cased Depth (mbgl):	**Not Documented**
Casing Stick Up (magl):	**0.186**
Development Airlift Yield (l/s):	**5**
Water Level (mbgl) & Date:	**15.511**& **24/11/2013**



Comments:


100 mm Class 9uPVC (ID 104.5mm) Screen
END OF BOREHOLE
END CAP
55
60
65
70
75
80
85
90
95
100
QUARTZITE: Top of the brown grey quartzite unit, 10% Fe staining
QUARTZITE: Quartzite unit, 40% Fe staining
SHALE: Shales
QUARTZITE: Quartzite unit, <5% Fe staining
SHALE: Shales
3.6
5
5
4.4
4
3.6
3.6
3.6
3.6

Comments:

OBSERVATION WELL BORE LOG

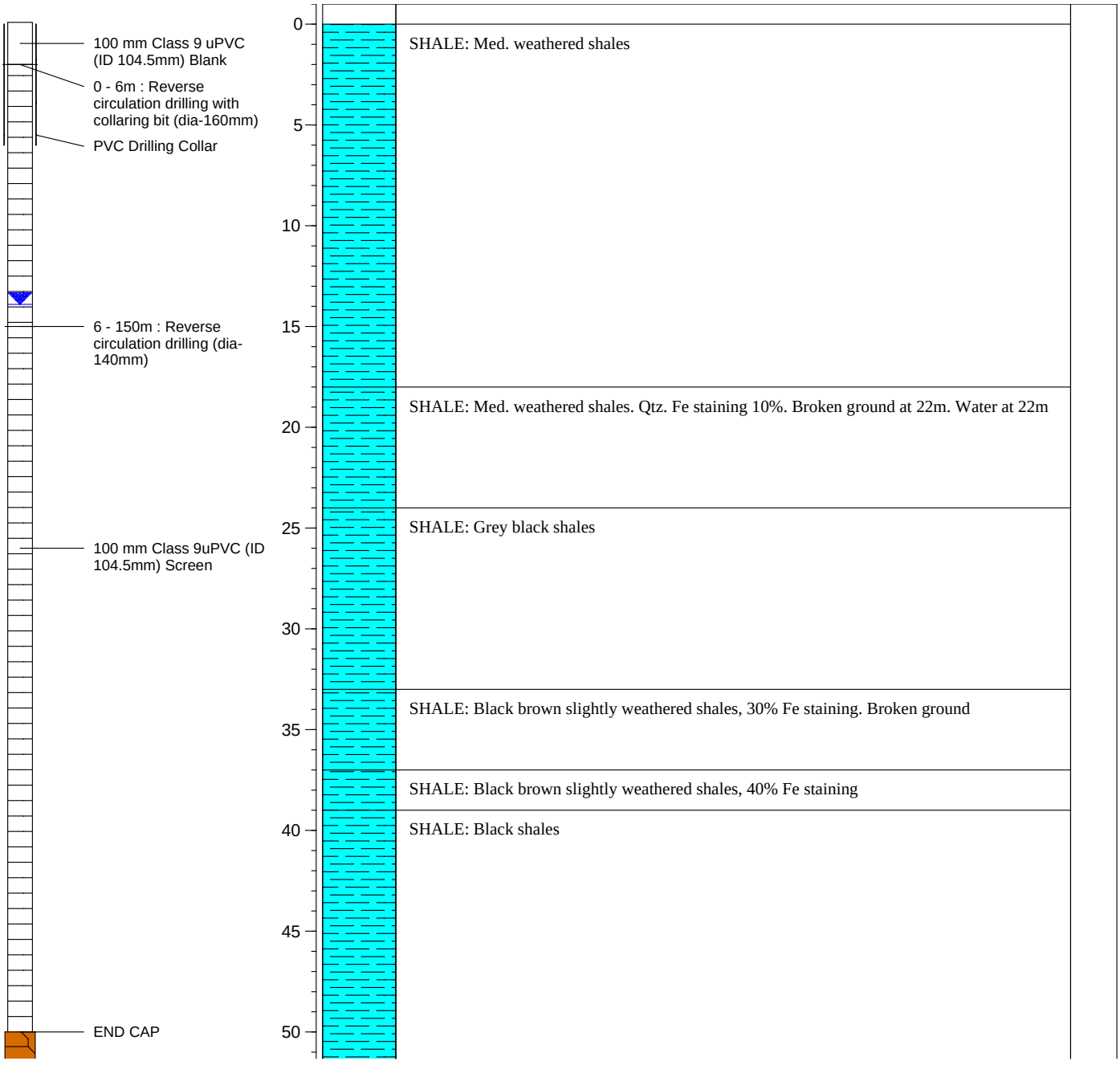
BOREHOLE NUMBER

NS-Obs28

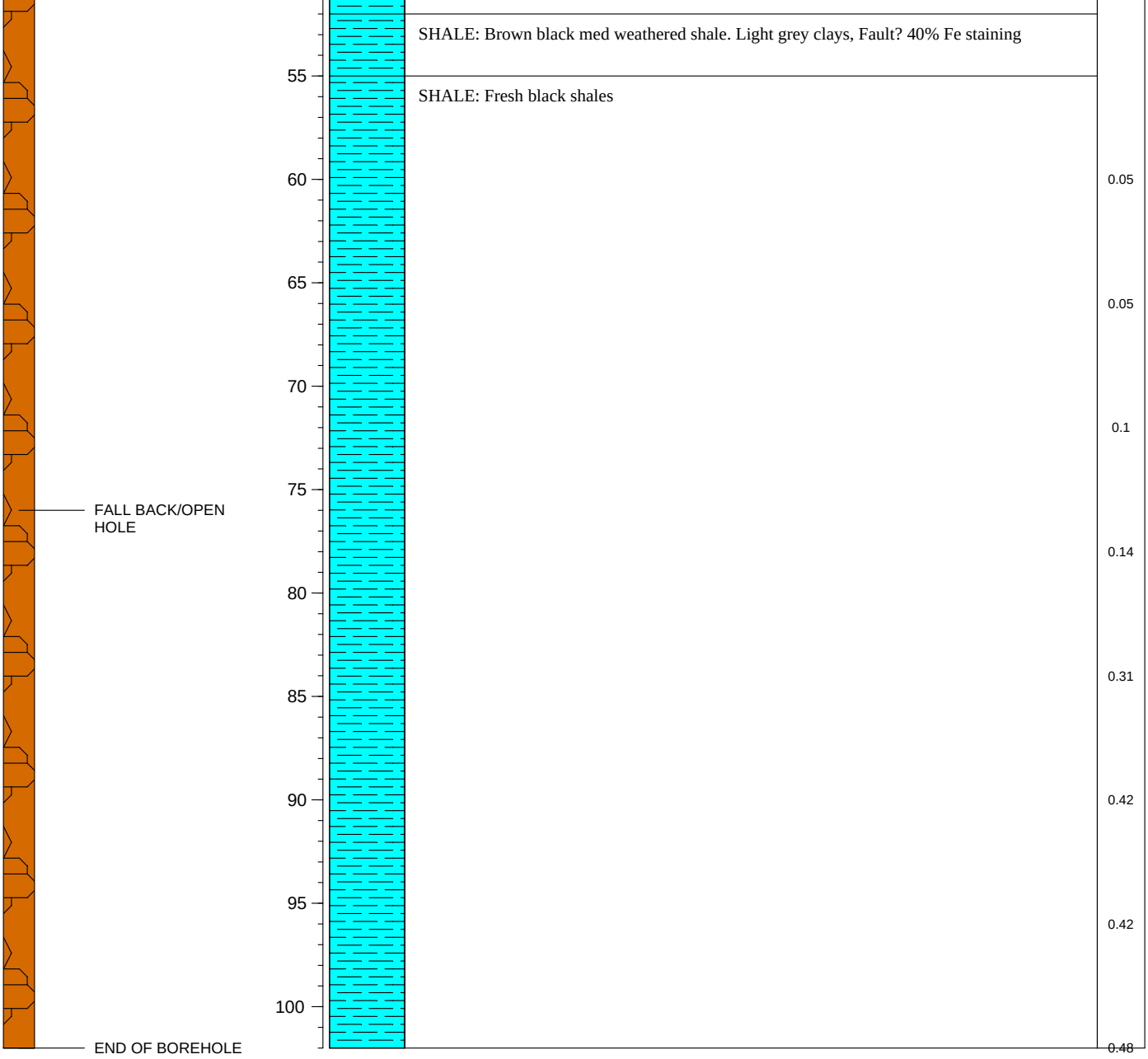
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Eastern Borefield FMG- North Star Site**
DRILLING CO:	**Mckay Drilling**
DRILLING METHOD:	**Reverse circulation drilling**
LOGGED BY:	**Daniel Woolford**
EASTING (m):	**712810.44**
NORTHING (m):	**7648564.56**
MEAS PT ELEVATION (mAHD):	**311.97**
DRILLING DIAMETER(S) (mm):	**140**
DATE BEGUN: **1/11/2013**	DATE COMPLETED: **1/11/2013**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**102**
Cased Depth (mbgl):	**Not Documented**
Casing Stick Up (magl):	**0.093**
Development Airlift Yield (l/s):	**0.5**
Water Level (mbgl) & Date:	**13.897** & **24/11/2013**



Comments:


SHALE: Brown black med weathered shale. Light grey clays, Fault? 40% Fe staining
SHALE: Fresh black shales
55
60
65
70
75
80
85
90
95
100
FALL BACK/OPEN HOLE
END OF BOREHOLE
0.05
0.05
0.1
0.14
0.31
0.42
0.42
0.48

Comments:

OBSERVATION WELL BORE LOG

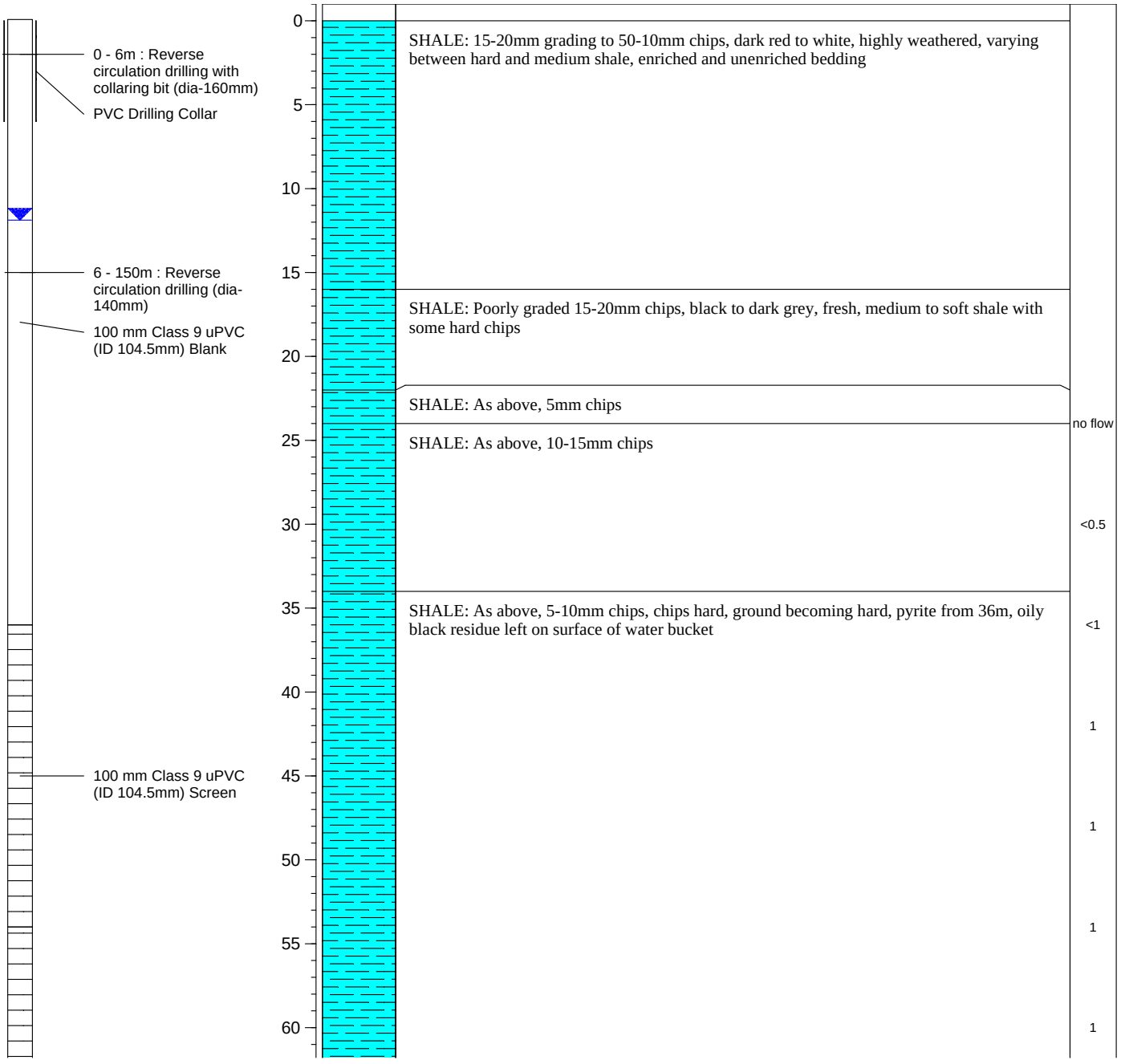
BOREHOLE NUMBER

NS-Obs28A

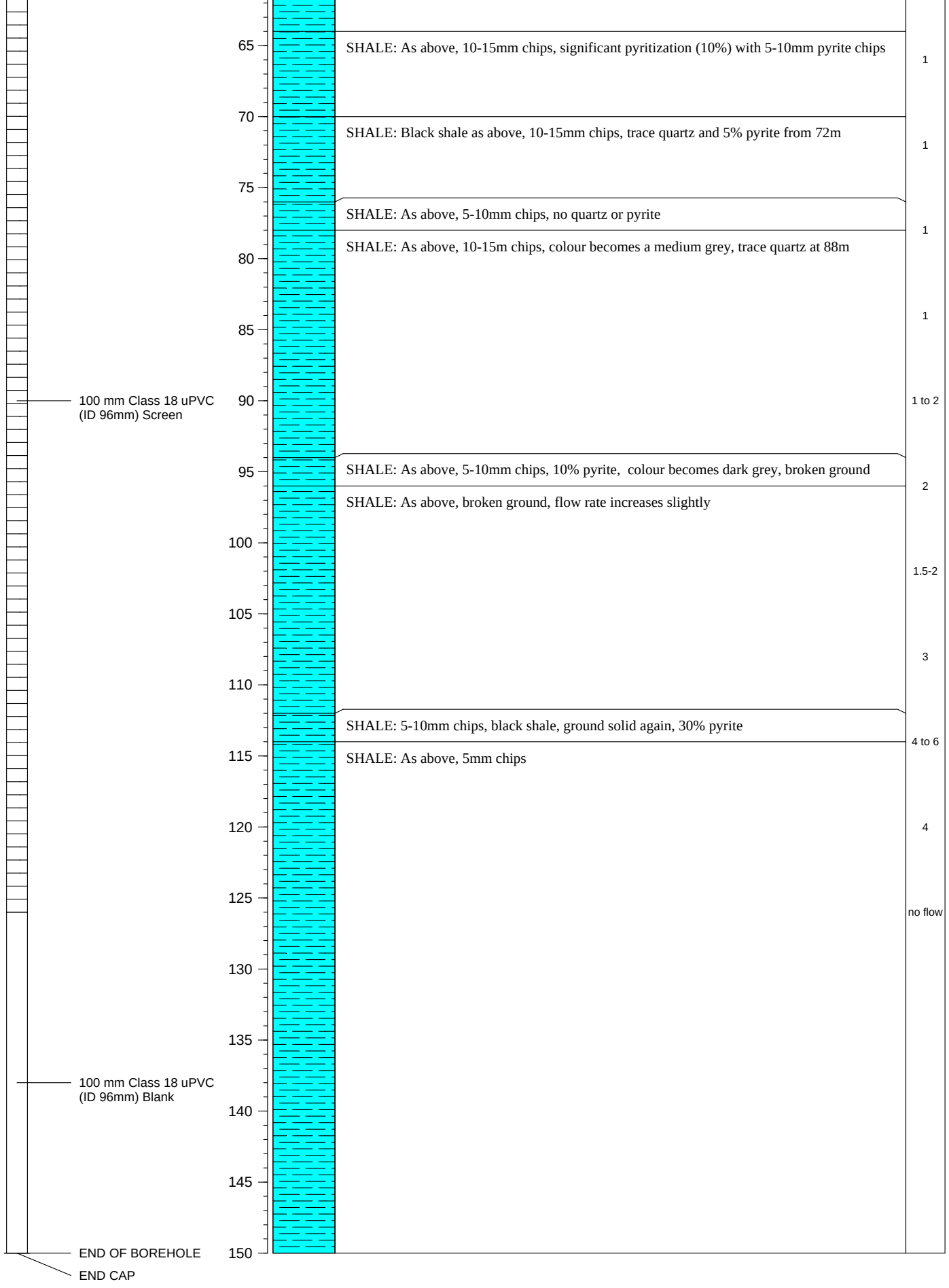
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Mckay Drilling**
DRILLING METHOD: **Reverse circulation drilling**
LOGGED BY: **Deborah Booth**
EASTING (m): **712798.05**
NORTHING (m): **7648560.42**
MEAS PT ELEVATION (mAHD): **311.66**
DRILLING DIAMETER(S) (mm): **140**
DATE BEGUN: **18/03/2014** DATE COMPLETED: **18/03/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**150**
Cased Depth (mbgl):	**150**
Casing Stick Up (magl):	**0.077**
Development Airlift Yield (l/s):	**6**
Water Level (mbgl) & Date:	**11.883** & **13/04/2014**



Comments:


65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
SHALE: As above, 10-15mm chips, significant pyritization (10%) with 5-10mm pyrite chips
SHALE: Black shale as above, 10-15mm chips, trace quartz and 5% pyrite from 72m
SHALE: As above, 5-10mm chips, no quartz or pyrite
SHALE: As above, 10-15m chips, colour becomes a medium grey, trace quartz at 88m
SHALE: As above, 5-10mm chips, 10% pyrite, colour becomes dark grey, broken ground
SHALE: As above, broken ground, flow rate increases slightly
SHALE: 5-10mm chips, black shale, ground solid again, 30% pyrite
SHALE: As above, 5mm chips
1
1
1
1
1 to 2
2
1.5-2
3
4 to 6
4
no flow
100 mm Class 18 uPVC (ID 96mm) Screen
100 mm Class 18 uPVC (ID 96mm) Blank
END OF BOREHOLE
END CAP

Comments:

OBSERVATION WELL BORE LOG

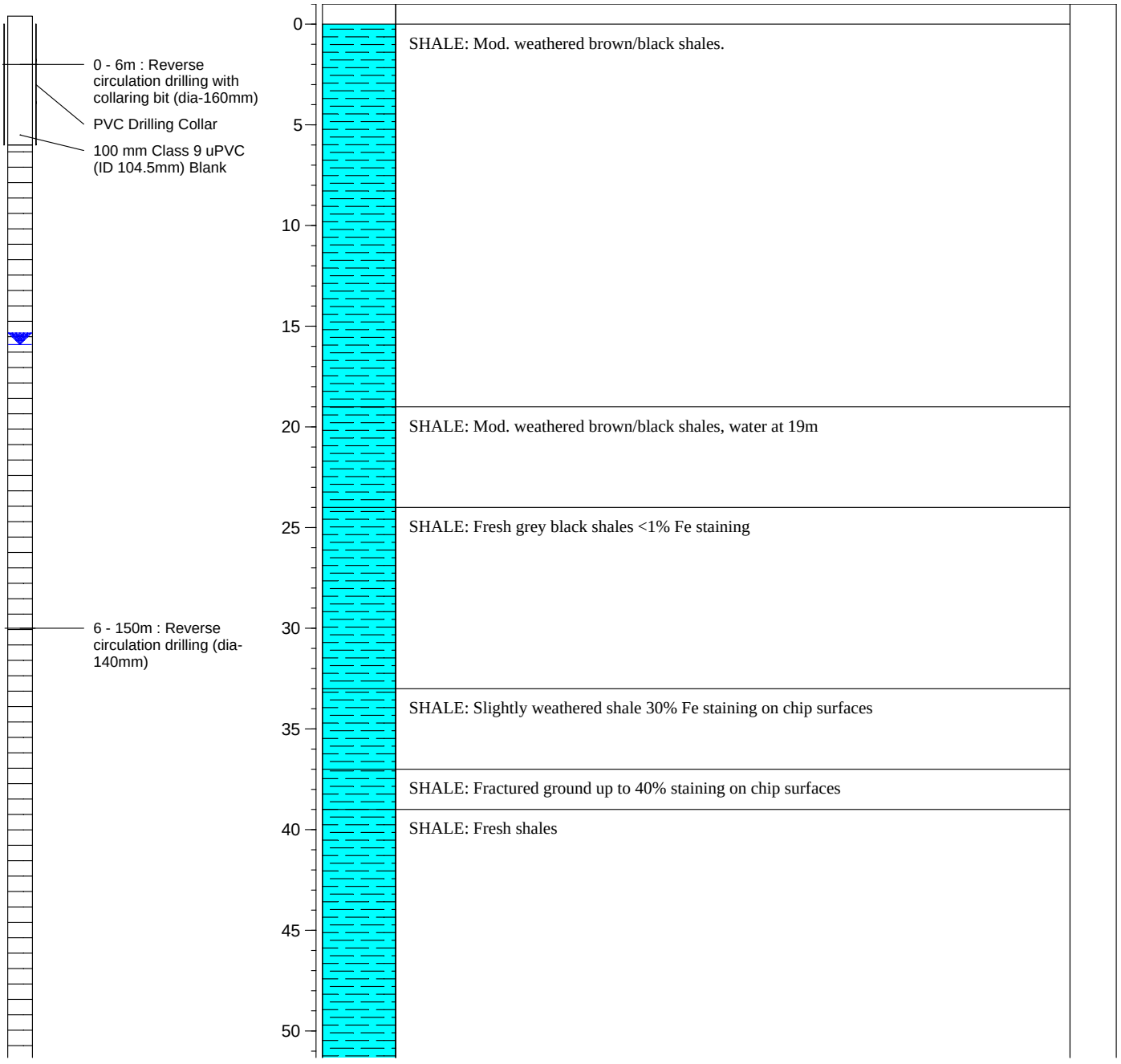
BOREHOLE NUMBER

NS-Obs29

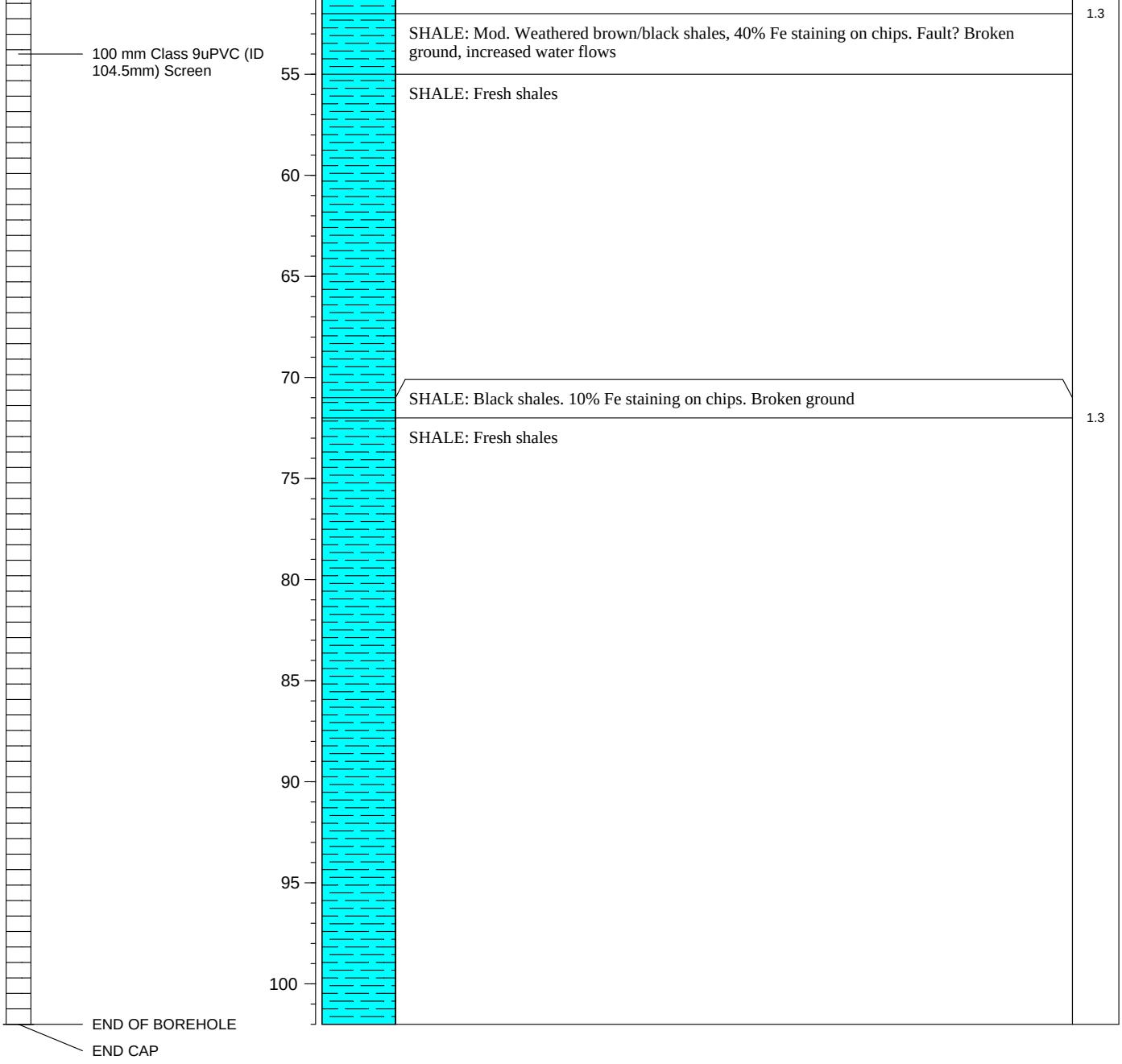
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Eastern Borefield FMG- North Star Site**
DRILLING CO: **Mckay Drilling**
DRILLING METHOD: **Reverse circulation drilling**
LOGGED BY: **Daniel Woolford**
EASTING (m): **712099.53**
NORTHING (m): **7650421.14**
MEAS PT ELEVATION (mAHD): **312.79**
DRILLING DIAMETER(S) (mm): **140**
DATE BEGUN: **1/11/2013** DATE COMPLETED: **1/11/2013**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**102**
Cased Depth (mbgl):	**Not Documented**
Casing Stick Up (magl):	**0.396**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**15.914** & **24/11/2013**



Comments:


100 mm Class 9uPVC (ID 104.5mm) Screen
END OF BOREHOLE
END CAP
55
60
65
70
75
80
85
90
95
100
SHALE: Mod. Weathered brown/black shales, 40% Fe staining on chips. Fault? Broken ground, increased water flows
1.3
SHALE: Fresh shales
SHALE: Black shales. 10% Fe staining on chips. Broken ground
1.3
SHALE: Fresh shales

Comments:

EXPLORATION BORE LOG

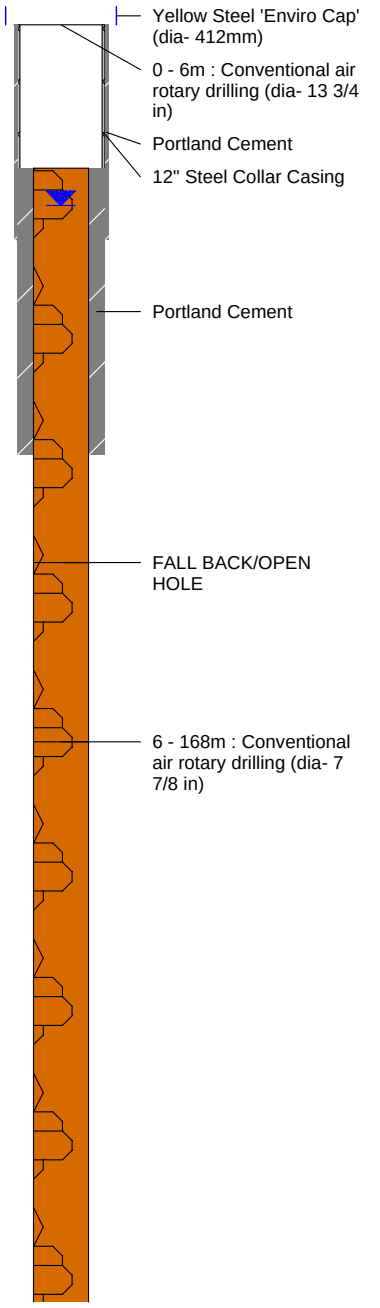
BOREHOLE NUMBER

NS-EX16

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Northern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**711129.19**
NORTHING (m):	**7647236.89**
MEAS PT ELEVATION (mAHD):	**280.06**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **7/03/2014**	DATE COMPLETED: **11/03/2014**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**168**
Completion Stick Up (magl):	**0.669**
Development Airlift Yield (l/s):	**NA**
Water Level (mbgl) & Date:	**5.04** & **15/04/2015**



DEPTH	DESCRIPTION
0	DETRITUS: Unconsolidated and completely weathered, 1-30mm, well graded chips, 50% red, orange, grey, black and white, banded to massive chert, 30% black-brown-red, 1-4mm iron concretions, 20% orang-red-white, soft, fine sand to siltstone with trace calcrete
	DETRITUS: Chips as above, 40% chert as above, 40% black, weathered, magnetic basalt, with metallic lustre on grains, 10% green to black serpentinite/ultramafics, 5% light grey-white, soft siltstone (1-3mm), 5% dark grey to white quartz (2-2.5mm) and trace calcrete
5	BASALT: 1-30mm, well graded chips, 60% black basalt as above, only 10% show oxidation, 30% green-black ultramafics, 10% red-orange chert as above, trace aragonite and calcrete
	BASALT: 1-40mm, well graded chips, 60% black basalt as above, 60% show oxidation, 30% completely weathered, yellow-orange and black chert and quartz, 10% green-black ultramafics
10	BASALT: 1-20mm, well graded chips, 85% black basalt, 5-10% show oxidation, 20% surfaces showing serpentinization-often with a soapy texture, 10% green-black ultramafics, 5% 0-5mm red chert and oxidized iron, trace calcrete
	BASALT: As above, slightly less chert and more serpentinite
15	BASALT: 1-60mm, well graded chips, 95% black to olive serpentinized basalt, 50-60% of surfaces show serpentinization, more glassy than soapy, some Fe staining, trace to 5% red chert and trace calcrete/aragonite
	BASALT: As above, fewer large gravels
20	BASALT: 1-30mm, well graded chips, 95-100% black with green hue basalt as above, serpentinization on 30-40% of surfaces, 10% show oxidation/Fe staining, still slightly magnetic, trace-5% aragonite and soft serpentinite pieces
	BASALT: 1-15mm, well graded chips, 95-100% black with green hue basalt as above, serpentinization on 10-20% of surfaces, 5% show oxidation/Fe staining, trace-5% aragonite
25	BASALT: As above, serpentinization on 10% of surfaces, trace oxidation/Fe staining, 5% aragonite, 5% soft serpentinite
30	BASALT: As above, slightly smaller chips (1-10mm), slightly more aragonite and serpentinite with trace larger chips
	BASALT: 1-15mm, well graded chips, 95-100% black, mafic to ultramafic basalt with 10% of surfaces showing soapy green serpentinization, trace oxidation/Fe staining and moderate magnetism, trace to 5% white colourless to orange aragonite crystals and platy chips
35	

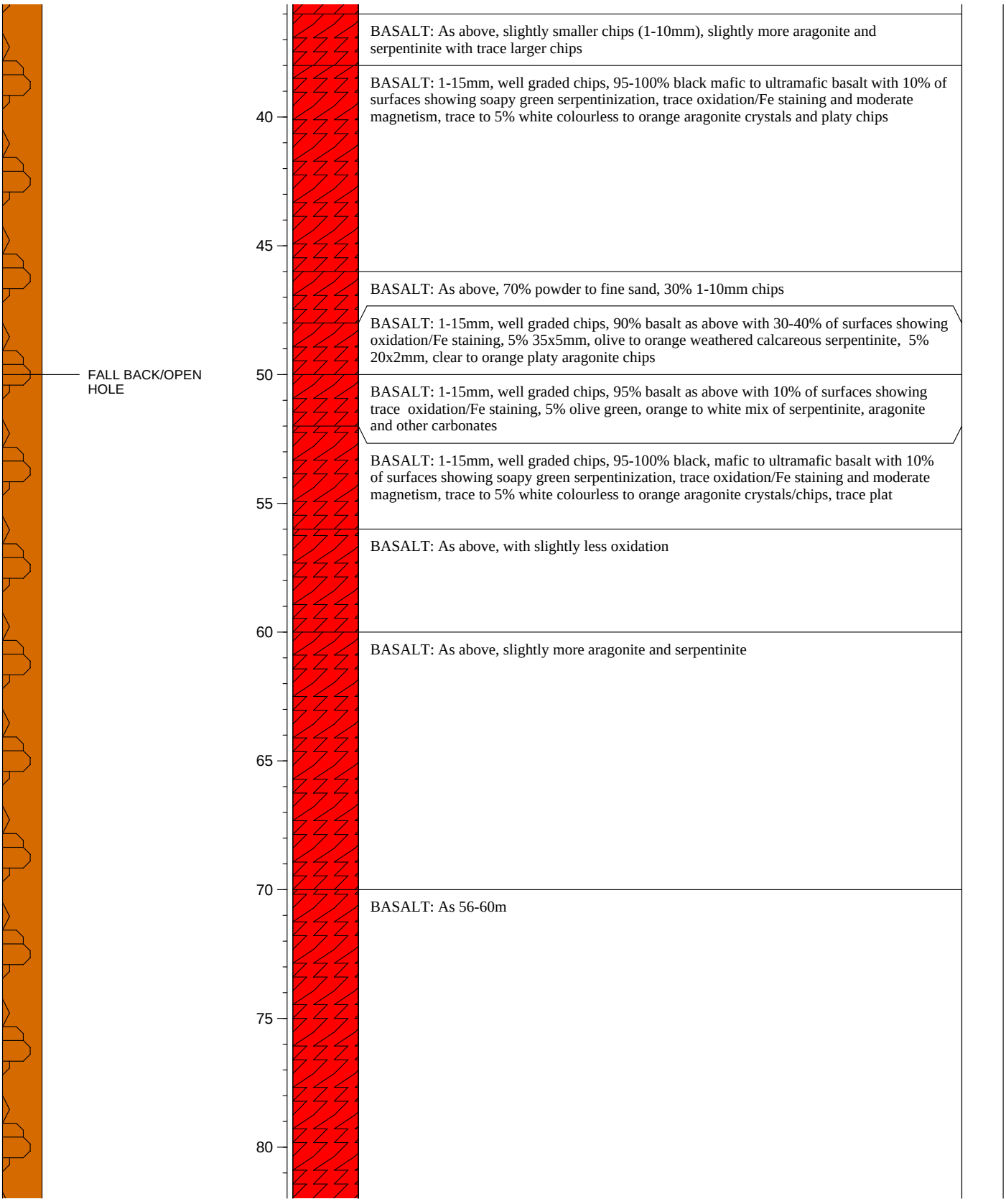
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EX16

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments:

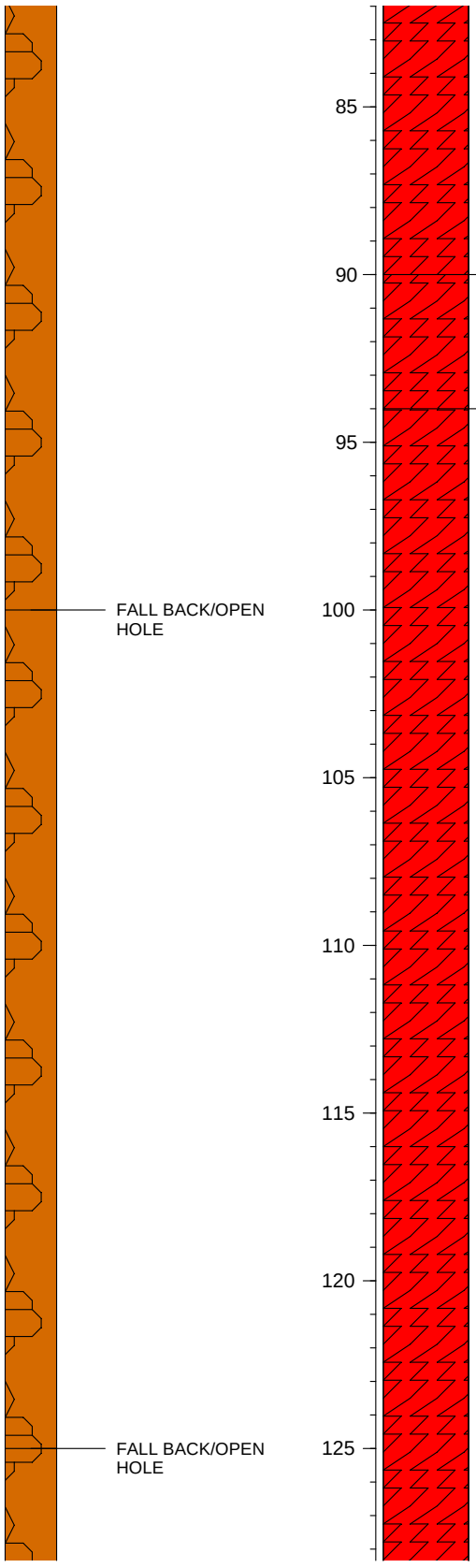
OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EX16

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



BASALT: 1-25mm, well graded chips, 70% black to orange hue basalt, larger, more platy chips with 60-80% of surfaces showing oxidation/Fe staining, 30% olive to orange weathered carbonates, aragonite, mixed with minor serpentinite

BASALT: As 56-60m

Comments:

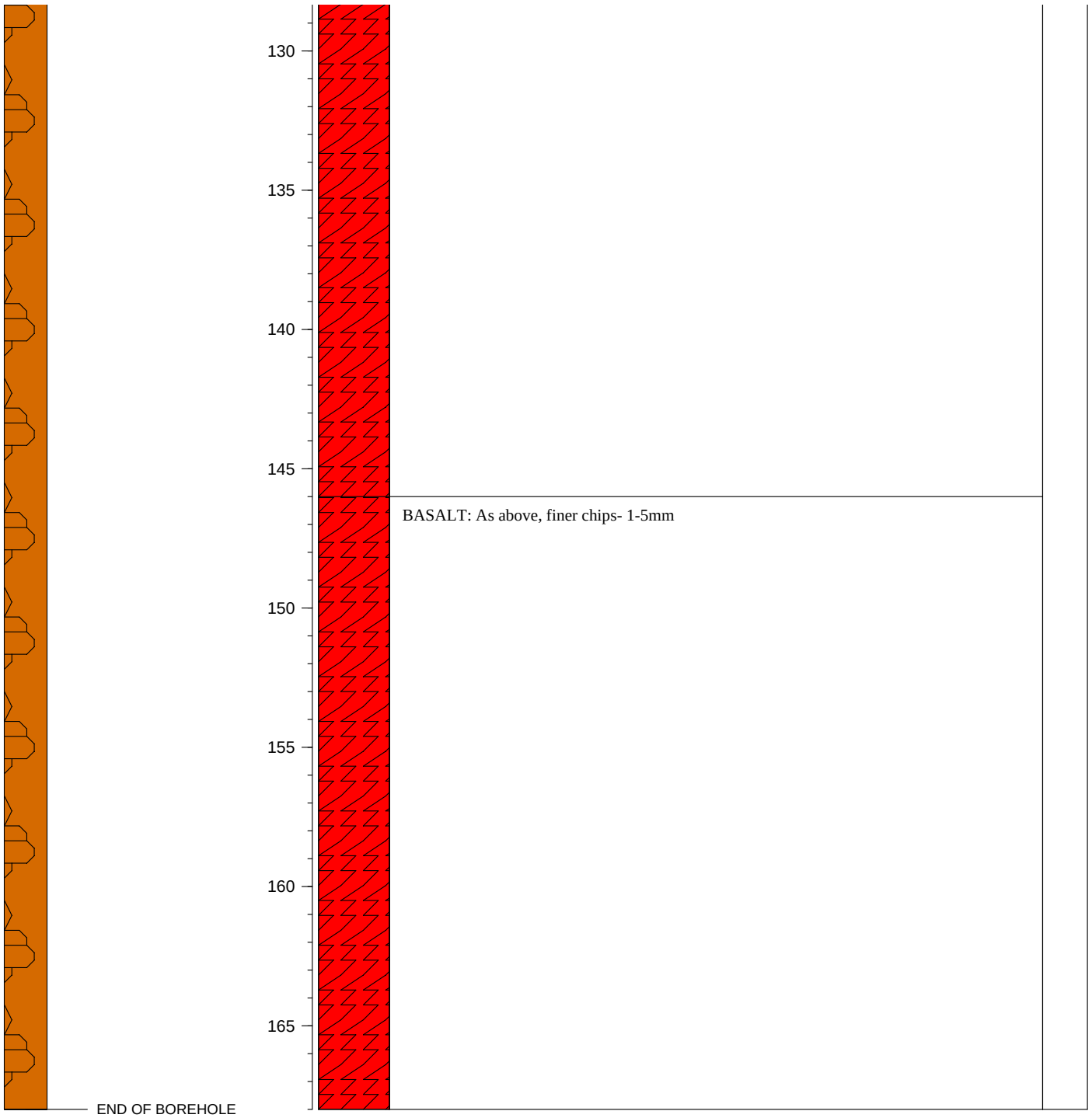
OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EX16

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



BASALT: As above, finer chips- 1-5mm

Comments:

EXPLORATION BORE LOG

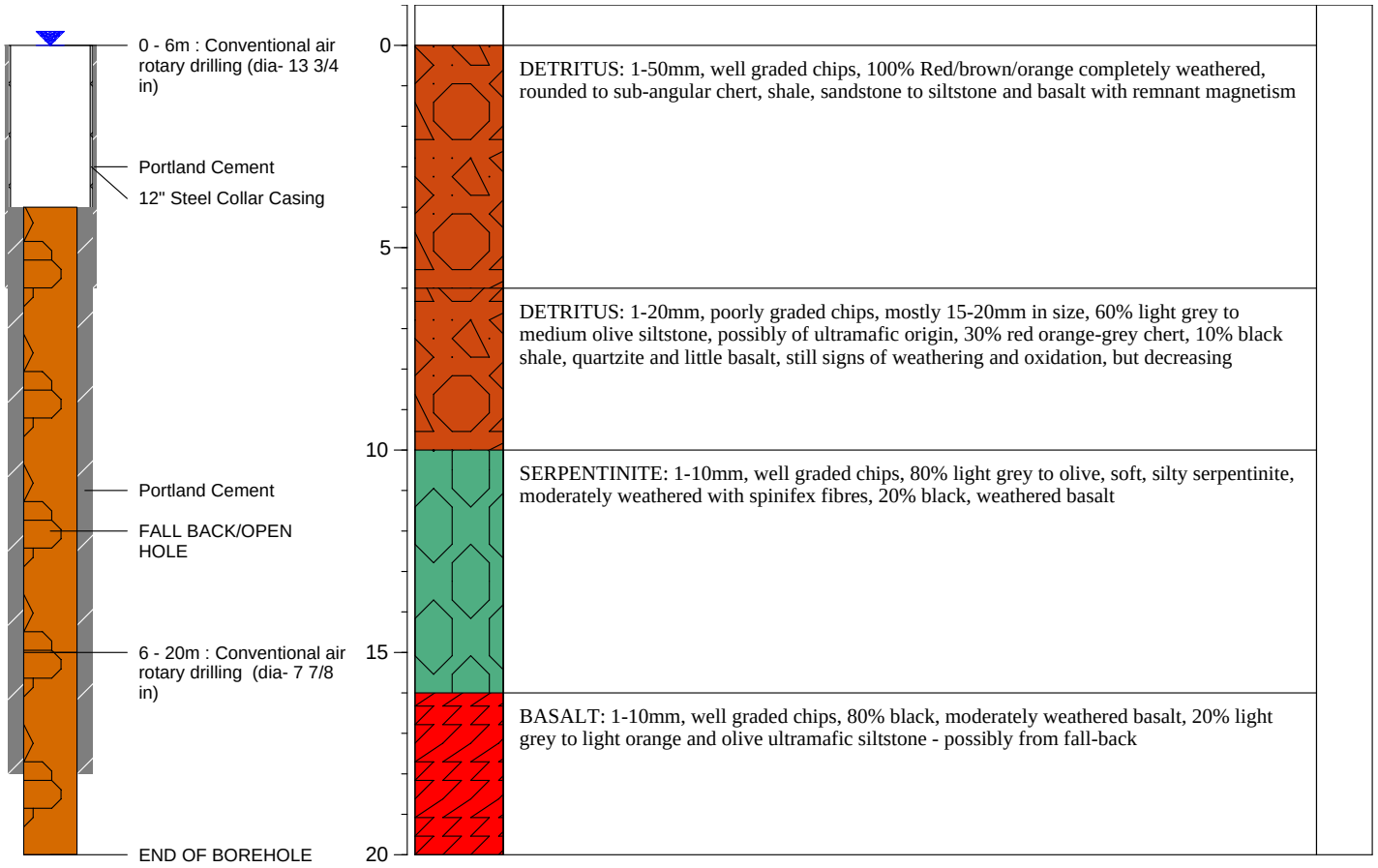
BOREHOLE NUMBER

NS-EX23

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **711480.31**
NORTHING (m): **7647548.23**
MEAS PT ELEVATION (mAHD): **282.442**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **12/03/2014** DATE COMPLETED: **12/03/2014**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**20**
Completion Stick Up (magl):	**NA**
Development Airlift Yield (l/s):	**NA**
Water Level (mbgl) & Date:	**NA** &



Comments: **BORE HOLE W/STEEL CASING ONLY NO WELL/PVC**

EXPLORATION BORE LOG

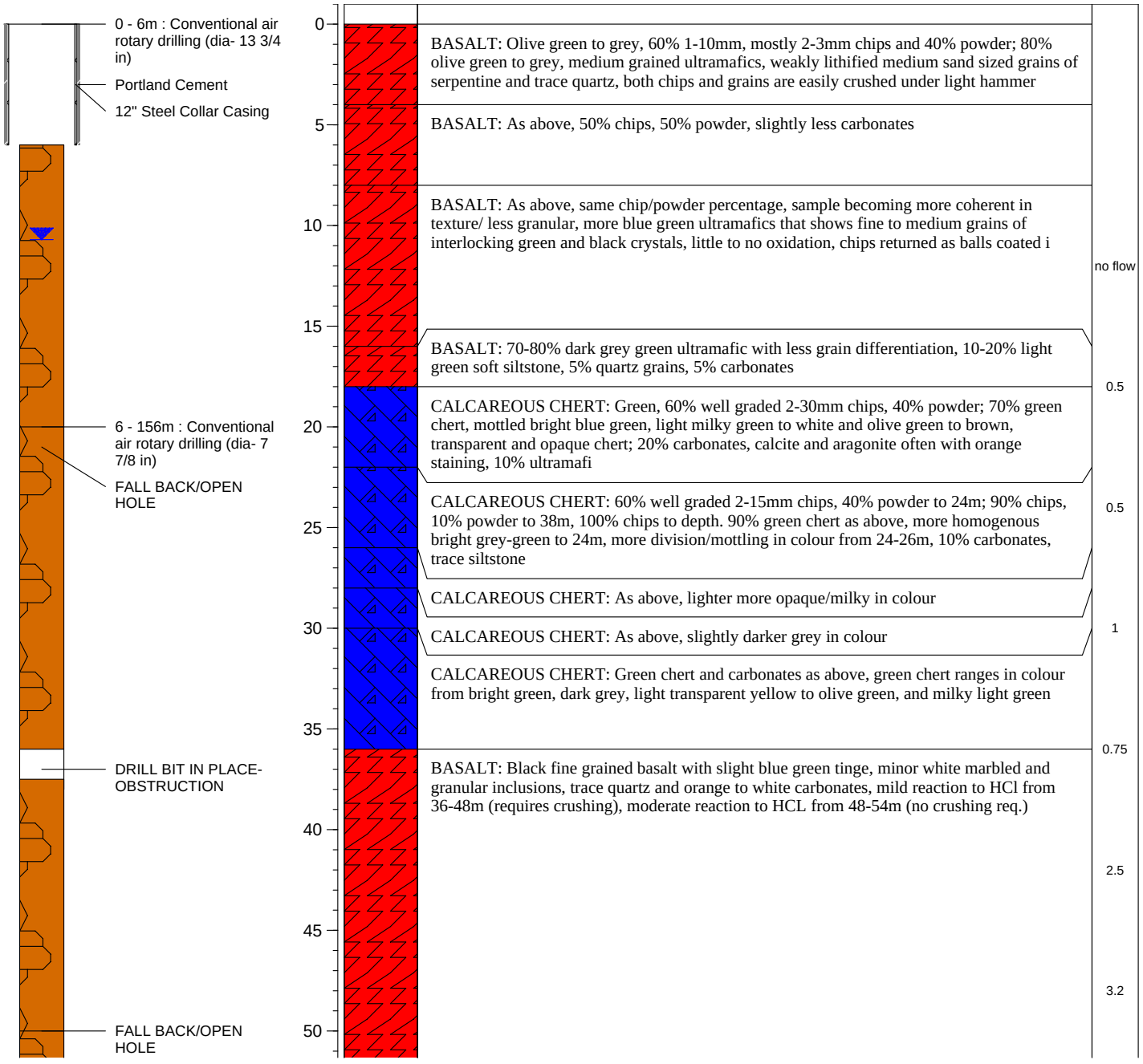
BOREHOLE NUMBER

NS-EX31

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Northern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**709508.26**
NORTHING (m):	**7647560.56**
MEAS PT ELEVATION (mAHD):	**272.318**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **29/05/2014**	DATE COMPLETED: **30/05/2014**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**156**
Completion Stick Up (magl):	**0.656**
Development Airlift Yield (l/s):	**3**
Water Level (mbgl) & Date:	**10.7** & **15/04/2015**



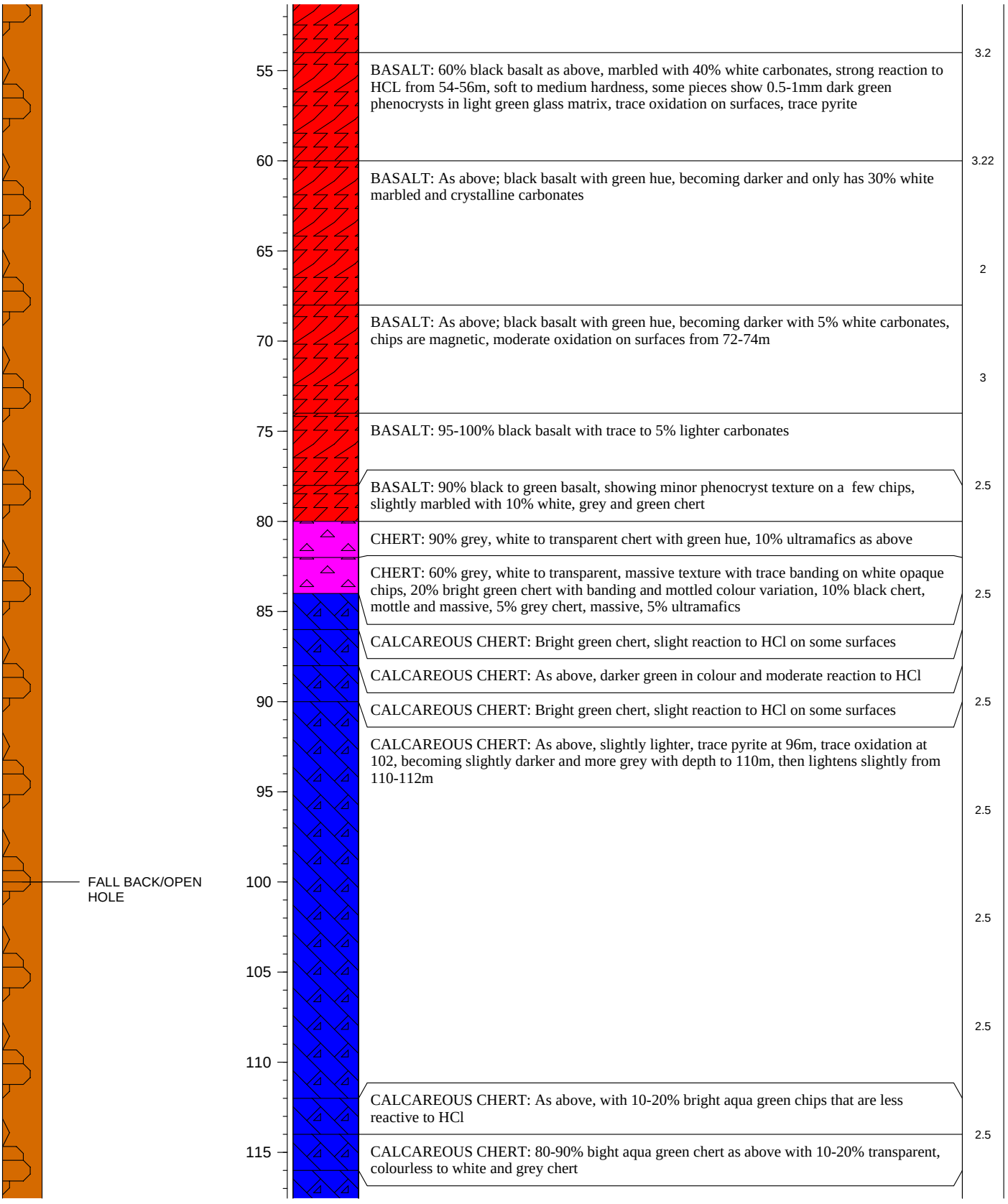
Comments: **BORE HOLE W/STEEL CASING ONLY NO WELL/PVC**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EX31

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



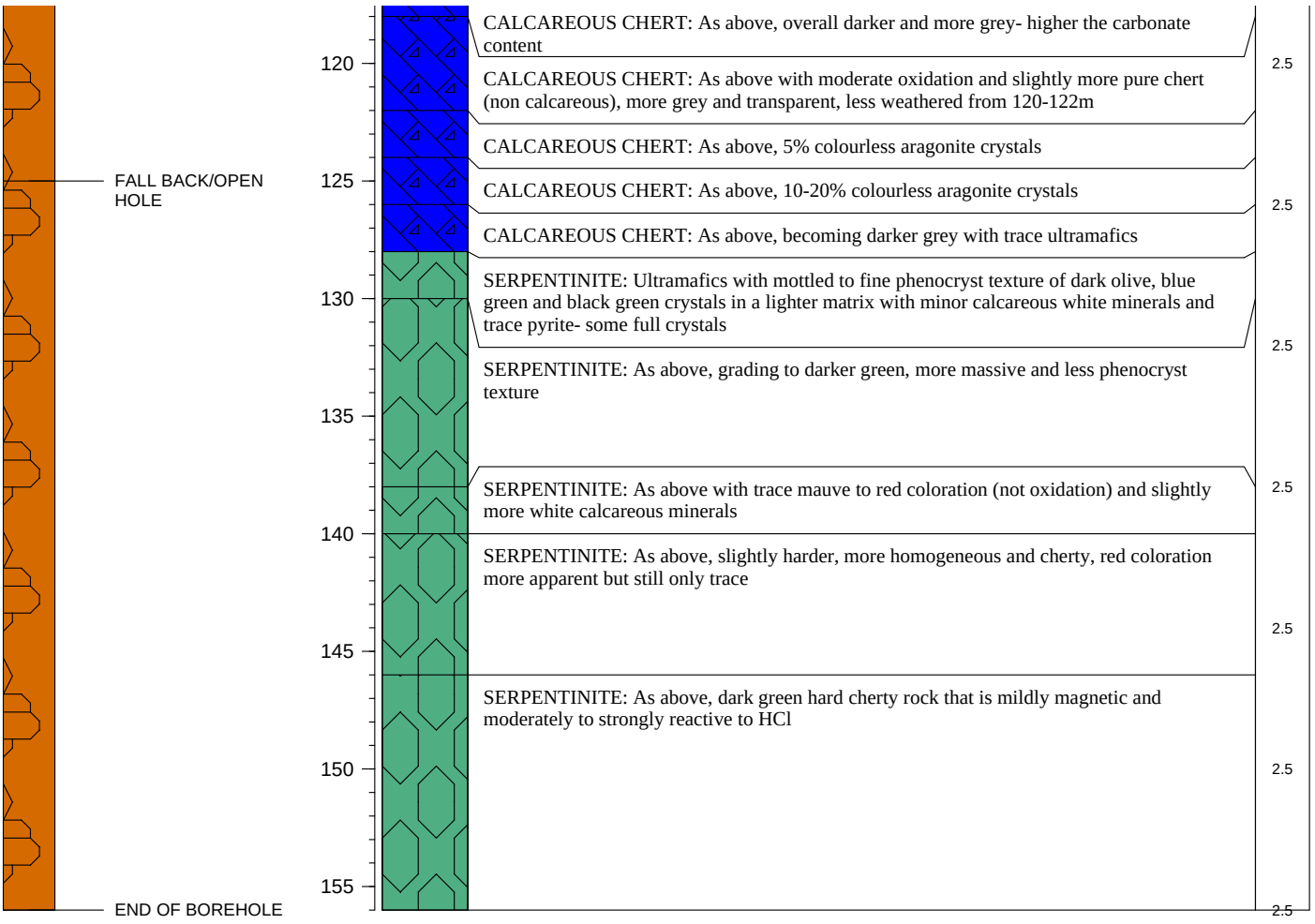
Comments: **BORE HOLE W/STEEL CASING ONLY NO WELL/PVC**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EX31

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments: **BORE HOLE W/STEEL CASING ONLY NO WELL/PVC**

OBSERVATION WELL BORE LOG

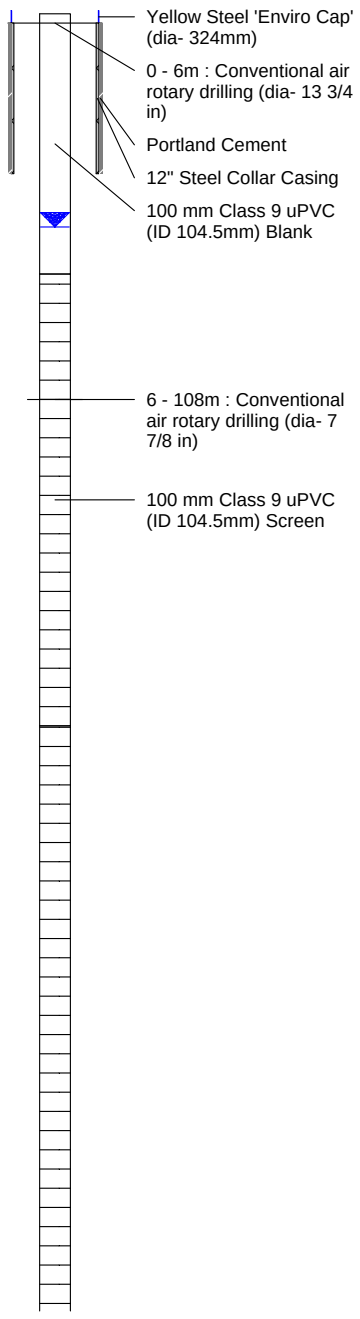
BOREHOLE NUMBER

NS-Obs15

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

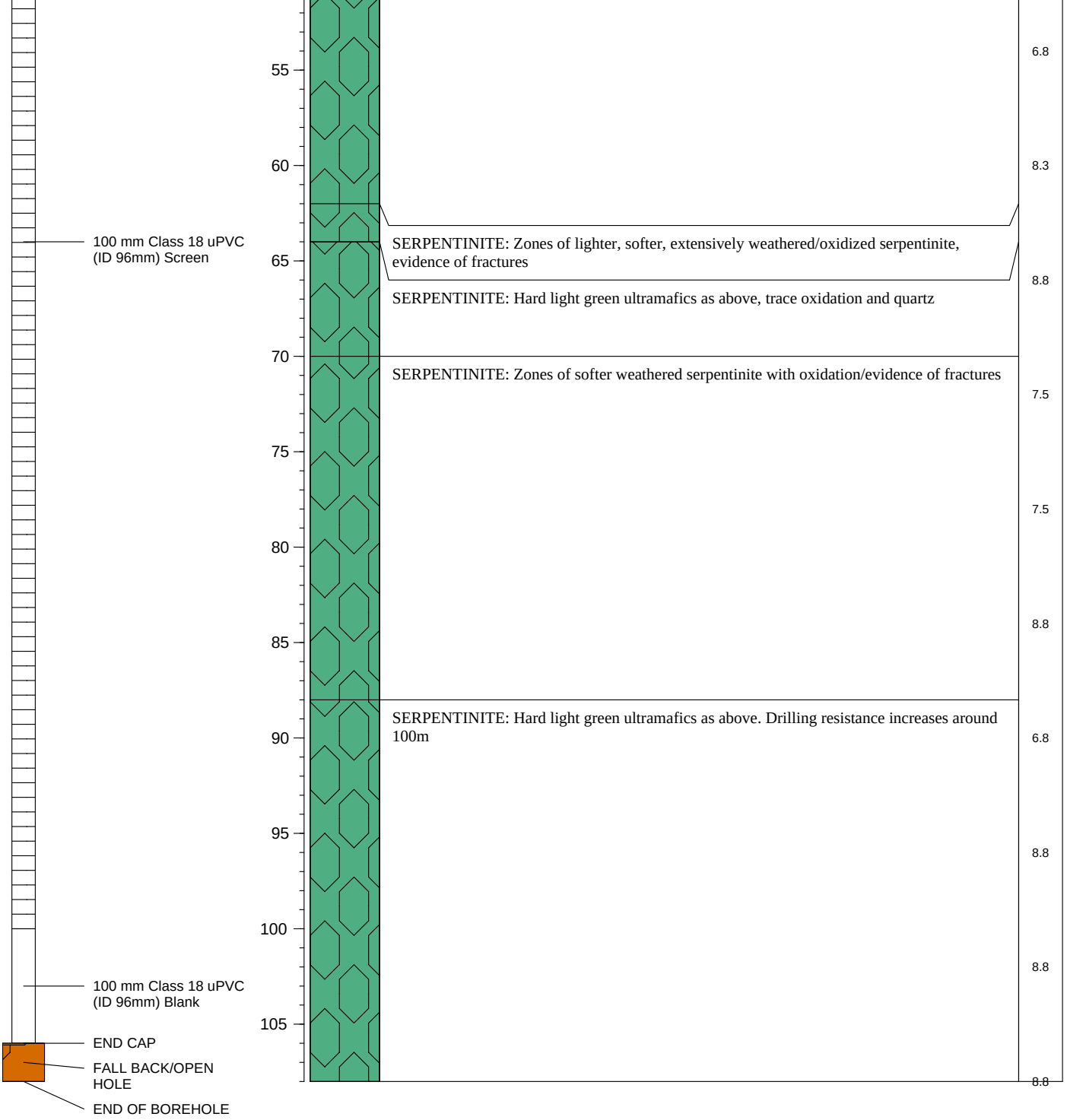
PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Northern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**709364.44**
NORTHING (m):	**7647257.24**
MEAS PT ELEVATION (mAHD):	**267.90**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **12/12/2014**	DATE COMPLETED: **13/12/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.484**
Drilled Depth (mbgl):	**108**
Cased Depth (mbgl):	**106**
Casing Stick Up (magl):	**0.373**
Development Airlift Yield (l/s):	**9**
Water Level (mbgl) & Date:	**8.12** & **15/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Detritus, unconsolidated/weathered serpentinite, sandstone, basalt, shale, calcrete and chert	
5	SERPENTINITE: Angular to sub-angular clasts of medium olive grey to light green serpentine with a very fine grained matrix, medium to fine grained dark grey to black inclusions, minor black and white marbling with high carbonate content, little basalt	no flow
	SERPENTINITE: Mostly sub-rounded gravels of chert and angular to sub-angular serpentinite, little basalt and trace rounded sandstone, quartz and calcrete	
10	SERPENTINITE: Mostly ultramafics as above- serpentinite and little meta-basalt, trace carbonates and chert	1
15		3.3
20		3.5
25		
30		4
35		6
40	SERPENTINITE: Zones of softer weathered serpentinite with oxidation, evidence of fractures	6
45	SERPENTINITE: Hard light green ultramafics as above	
	SERPENTINITE: As above, colour slightly darker, less oxidation but still signs of weathering	6
50		

Comments:


55
60
65
70
75
80
85
90
95
100
105
100 mm Class 18 uPVC (ID 96mm) Screen
100 mm Class 18 uPVC (ID 96mm) Blank
END CAP
FALL BACK/OPEN HOLE
END OF BOREHOLE
SERPENTINITE: Zones of lighter, softer, extensively weathered/oxidized serpentinite, evidence of fractures
SERPENTINITE: Hard light green ultramafics as above, trace oxidation and quartz
SERPENTINITE: Zones of softer weathered serpentinite with oxidation/evidence of fractures
SERPENTINITE: Hard light green ultramafics as above. Drilling resistance increases around 100m
6.8
8.3
8.8
7.5
7.5
8.8
6.8
8.8
8.8
8.8

Comments:

OBSERVATION WELL BORE LOG

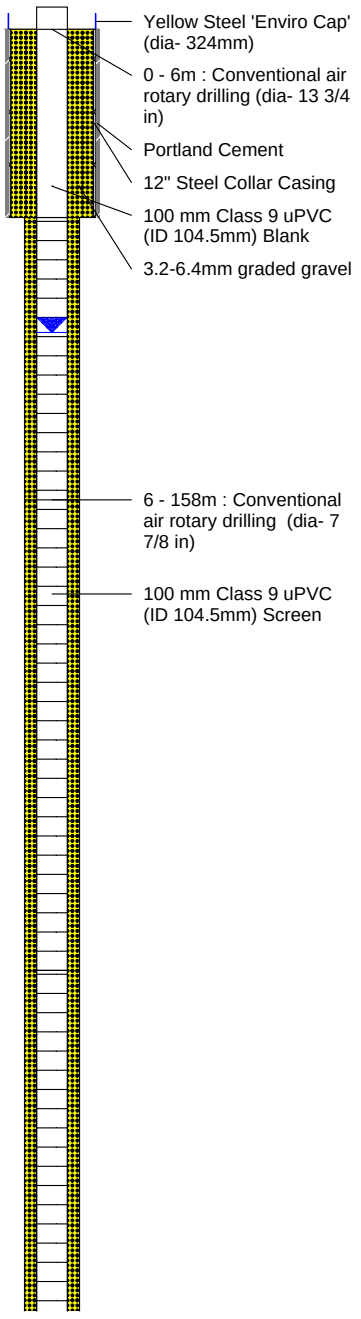
BOREHOLE NUMBER

NS-Obs17

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

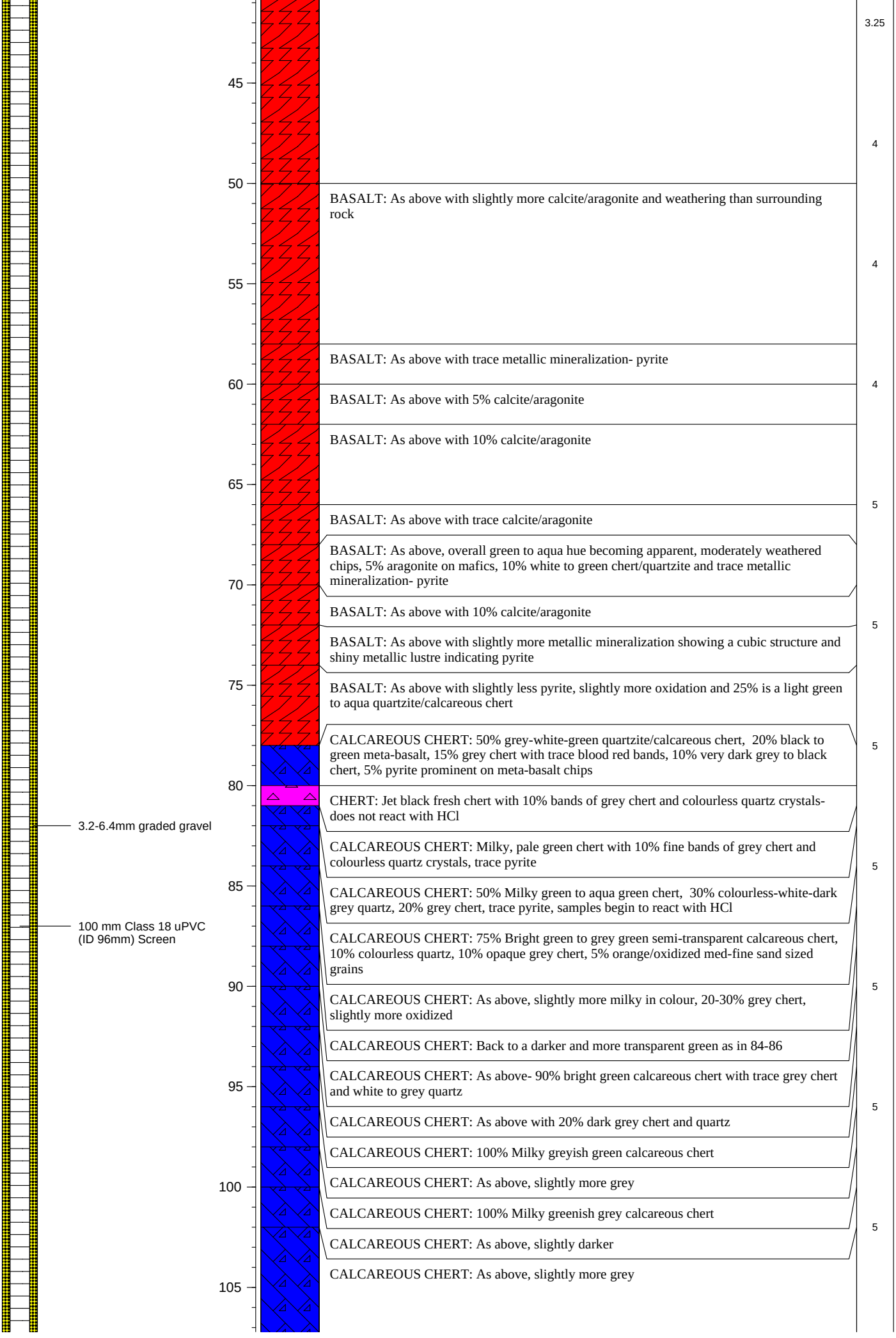
PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709794.86**
NORTHING (m): **7647256.77**
MEAS PT ELEVATION (mAHD): **271.31**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **16/01/2014** DATE COMPLETED: **19/01/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.6612**
Drilled Depth (mbgl):	**158**
Cased Depth (mbgl):	**156**
Casing Stick Up (magl):	**0.0267**
Development Airlift Yield (l/s):	**4**
Water Level (mbgl) & Date:	**9.66** & **15/04/2015**

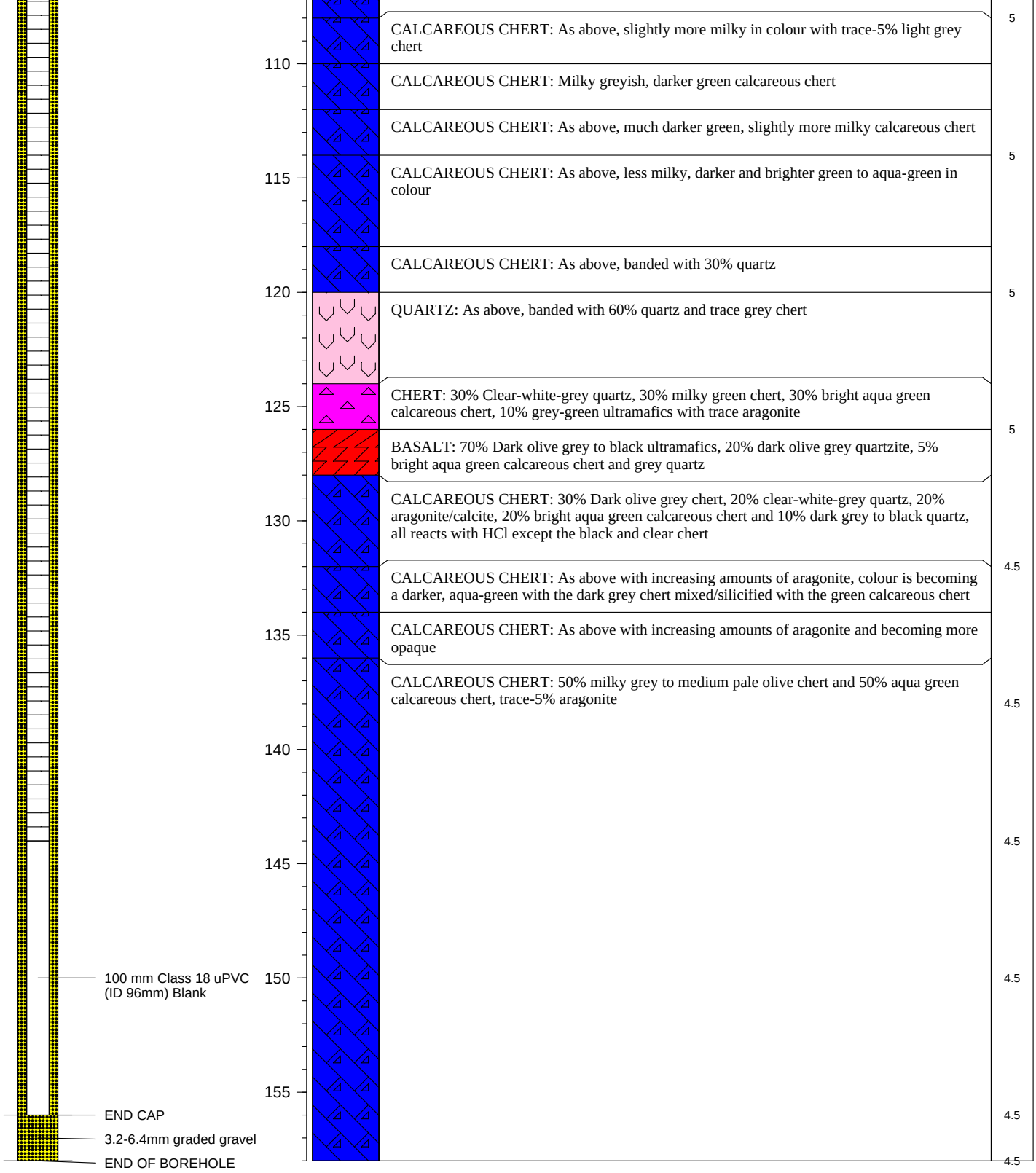


DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Red/brown/orange completely weathered well graded 25mm basalt chips with 30 % calcrete and a dark fine shale to chert	
	CALCRETE: 75% weathered and pulverized light olive green to light brown calcareous silt returned as powder and coating other chips, 20% fractured and weathered basalt, calcite and a dark fine shale to chert	
5	BASALT: 75% grading to 85% fractured and weathered red/orange to brownish black basalt with slight greenish hue, 20% grading to 10% weathered light brownish grey silty calcareous serpentinite pulverized and coating chips, 5% red/orange to white weathered calcite	NA
10	BASALT: Fractured and slightly weathered very dark grey to black basalt with green serpentinized hue, samples react with HCl, trace calcite	0.1
15	BASALT: As above, with 5% calcite and calcite crystals/aragonite with a slightly greenish hue in some	2.25
20	BASALT: As above with trace calcite/aragonite	
25	BASALT: As above with 5% calcite/aragonite, slightly more weathered than surrounding rock	2.25
	BASALT: As above with 5% calcite/aragonite	
30	BASALT: As above with trace calcite/aragonite	3.25
	BASALT: As above with 5% calcite/aragonite, slightly more weathered than surrounding rock	
35	BASALT: As above with 5-10% calcite/aragonite, slightly more weathered than surrounding rock	3.25
	BASALT: As above with 5% calcite/aragonite	
40	BASALT: As above with trace calcite/aragonite only trace signs of weathering	

Comments:


45
50
55
60
65
70
75
80
85
90
95
100
105
3.25
4
4
4
5
5
5
5
5
5
5
5
3.2-6.4mm graded gravel
100 mm Class 18 uPVC (ID 96mm) Screen
BASALT: As above with slightly more calcite/aragonite and weathering than surrounding rock
BASALT: As above with trace metallic mineralization- pyrite
BASALT: As above with 5% calcite/aragonite
BASALT: As above with 10% calcite/aragonite
BASALT: As above with trace calcite/aragonite
BASALT: As above, overall green to aqua hue becoming apparent, moderately weathered chips, 5% aragonite on mafics, 10% white to green chert/quartzite and trace metallic mineralization- pyrite
BASALT: As above with 10% calcite/aragonite
BASALT: As above with slightly more metallic mineralization showing a cubic structure and shiny metallic lustre indicating pyrite
BASALT: As above with slightly less pyrite, slightly more oxidation and 25% is a light green to aqua quartzite/calcareous chert
CALCAREOUS CHERT: 50% grey-white-green quartzite/calcareous chert, 20% black to green meta-basalt, 15% grey chert with trace blood red bands, 10% very dark grey to black chert, 5% pyrite prominent on meta-basalt chips
CHERT: Jet black fresh chert with 10% bands of grey chert and colourless quartz crystals- does not react with HCl
CALCAREOUS CHERT: Milky, pale green chert with 10% fine bands of grey chert and colourless quartz crystals, trace pyrite
CALCAREOUS CHERT: 50% Milky green to aqua green chert, 30% colourless-white-dark grey quartz, 20% grey chert, trace pyrite, samples begin to react with HCl
CALCAREOUS CHERT: 75% Bright green to grey green semi-transparent calcareous chert, 10% colourless quartz, 10% opaque grey chert, 5% orange/oxidized med-fine sand sized grains
CALCAREOUS CHERT: As above, slightly more milky in colour, 20-30% grey chert, slightly more oxidized
CALCAREOUS CHERT: Back to a darker and more transparent green as in 84-86
CALCAREOUS CHERT: As above- 90% bright green calcareous chert with trace grey chert and white to grey quartz
CALCAREOUS CHERT: As above with 20% dark grey chert and quartz
CALCAREOUS CHERT: 100% Milky greyish green calcareous chert
CALCAREOUS CHERT: As above, slightly more grey
CALCAREOUS CHERT: 100% Milky greenish grey calcareous chert
CALCAREOUS CHERT: As above, slightly darker
CALCAREOUS CHERT: As above, slightly more grey

Comments:


110
115
120
125
130
135
140
145
150
155
100 mm Class 18 uPVC (ID 96mm) Blank
END CAP
3.2-6.4mm graded gravel
END OF BOREHOLE
CALCAREOUS CHERT: As above, slightly more milky in colour with trace-5% light grey chert
CALCAREOUS CHERT: Milky greyish, darker green calcareous chert
CALCAREOUS CHERT: As above, much darker green, slightly more milky calcareous chert
CALCAREOUS CHERT: As above, less milky, darker and brighter green to aqua-green in colour
CALCAREOUS CHERT: As above, banded with 30% quartz
QUARTZ: As above, banded with 60% quartz and trace grey chert
CHERT: 30% Clear-white-grey quartz, 30% milky green chert, 30% bright aqua green calcareous chert, 10% grey-green ultramafics with trace aragonite
BASALT: 70% Dark olive grey to black ultramafics, 20% dark olive grey quartzite, 5% bright aqua green calcareous chert and grey quartz
CALCAREOUS CHERT: 30% Dark olive grey chert, 20% clear-white-grey quartz, 20% aragonite/calcite, 20% bright aqua green calcareous chert and 10% dark grey to black quartz, all reacts with HCl except the black and clear chert
CALCAREOUS CHERT: As above with increasing amounts of aragonite, colour is becoming a darker, aqua-green with the dark grey chert mixed/silicified with the green calcareous chert
CALCAREOUS CHERT: As above with increasing amounts of aragonite and becoming more opaque
CALCAREOUS CHERT: 50% milky grey to medium pale olive chert and 50% aqua green calcareous chert, trace-5% aragonite
5
5
5
5
5
4.5
4.5
4.5
4.5
4.5
4.5

Comments:

OBSERVATION WELL BORE LOG

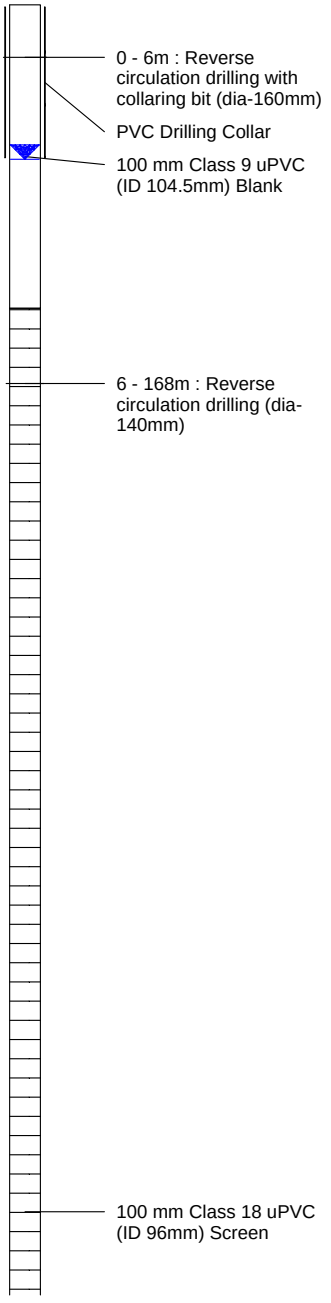
BOREHOLE NUMBER

NS-Obs18

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

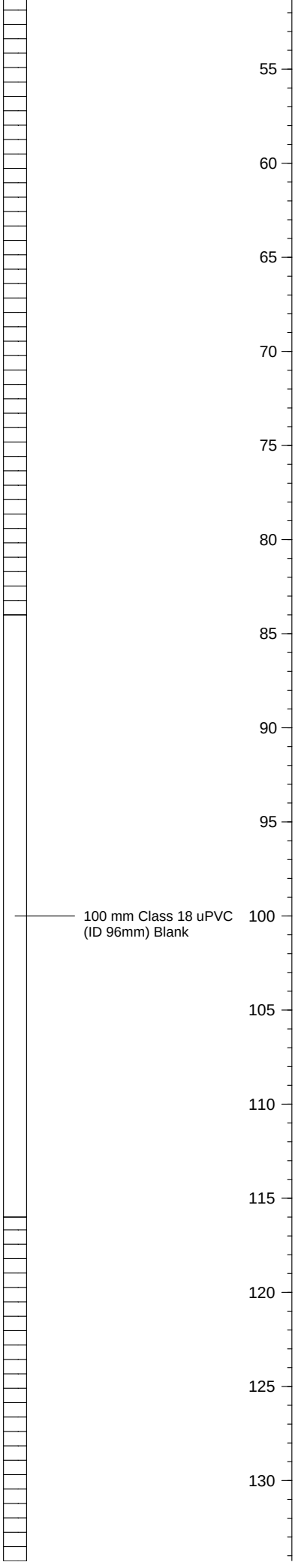
PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Northern Borefield FMG- North Star Site**
DRILLING CO:	**Mckay Drilling**
DRILLING METHOD:	**Reverse circulation drilling**
LOGGED BY:	**Deborah Booth**
EASTING (m):	**710075.63**
NORTHING (m):	**7647308.22**
MEAS PT ELEVATION (mAHD):	**272.52**
DRILLING DIAMETER(S) (mm):	**140**
DATE BEGUN: **21/03/2014**	DATE COMPLETED: **21/03/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**NA**
Drilled Depth (mbgl):	**168**
Cased Depth (mbgl):	**158**
Casing Stick Up (magl):	**0.091**
Development Airlift Yield (l/s):	**7**
Water Level (mbgl) & Date:	**6.06** & **15/04/2015**



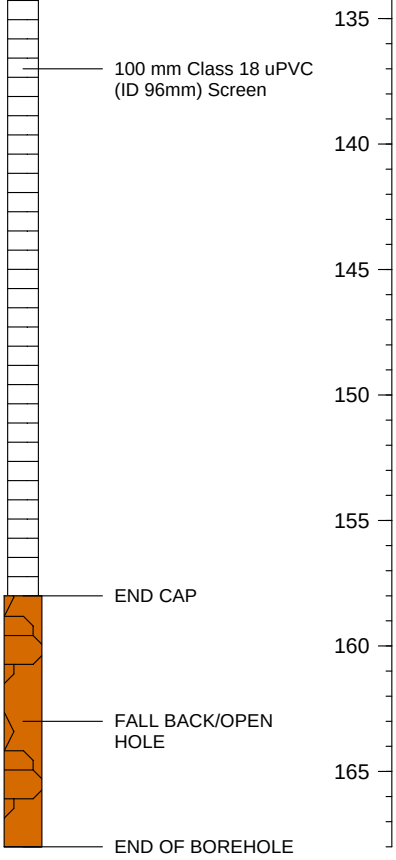
DEPTH	DESCRIPTION	YIELD (L/sec)
0	BASALT: 10-15 mm chips, dark green, fine to medium grained weathered basalt, some alteration surfaces visible on chips	
5	BASALT: As above 15-20 mm chips	
	BASALT: 15-20 mm, dark green, fine to medium grained weathered basalt, some alteration surfaces visible on chips	
10	BASALT: As above, 5-10mm chips, water at 12m	<0.5
15	BASALT: As above, 5mm chips, ground very hard, low chip percentage	
	BASALT: As above, medium to dark green, 5-10mm chips	<0.5
20	BASALT: As above, 5mm chips	1-1.5
25		
	BASALT: As above, broken ground, larger chips size and higher chip %, 5-10mm chips	
30	BASALT: As above, 15-20mm chips	1
	BASALT: As above, 10-15mm chips	
35	BASALT: As above, 5-10mm chips	2 to 3
40		2
45	BASALT: As above, end of broken ground	
	BASALT: As above, 15-20mm chips	2
50	BASALT: As above, minor serpentinite alteration on chip surfaces	

Comments:



55	BASALT: As above, 10-15mm chips	2
60	BASALT: As above, 15-20mm chips, chip percentage is 40-60%	2
65	BASALT: As above, 10-15mm chips	2
70	BASALT: As above, driller reports broken ground at 70m, serpentinite alteration on chip surfaces, oxidation on chip surfaces at 70m and 76m	2
75		2
80	BASALT: As above, 5-10mm chips	2
	BASALT: As above, 15-20mm chips	
85	BASALT: As above, 15-20mm chips	4
90		4
95	BASALT: As above, chip fracture surfaces are smooth, broken ground	4
100	BASALT: As above, smaller chips, rough surfaces on chip faces	5
105		5
110	BASALT: As above, 5-10mm, very hard ground, minor quartz in-fill on chips	5
115		5
120		5
125		5
130	BASALT: As above, ground hard	5

Comments:



135		
	QUARTZ: Fracture zone, 70% quartz in sample, 30% as above	7
	BASALT: As above, 40% quartz in sample	
140	BASALT: Basalt as above 136m, ground very hard	2 to 5
145	BASALT: As above, 10-15mm chips	
	BASALT: As above, driller reports minor fracture zones (~2in) at 152m, minor alteration on chips, does not affect flow rate	0
150	BASALT: As above, 5-10mm chips, drop in chip percentage from 50% to 20%	
155		
160		
165	BASALT: hard ground, no further fractures	

Comments:

OBSERVATION WELL BORE LOG

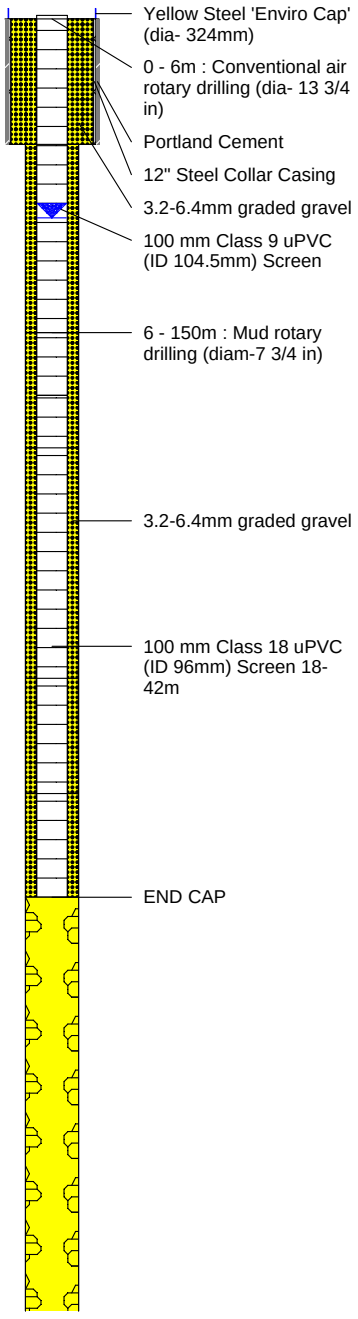
BOREHOLE NUMBER

NS-Obs19

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

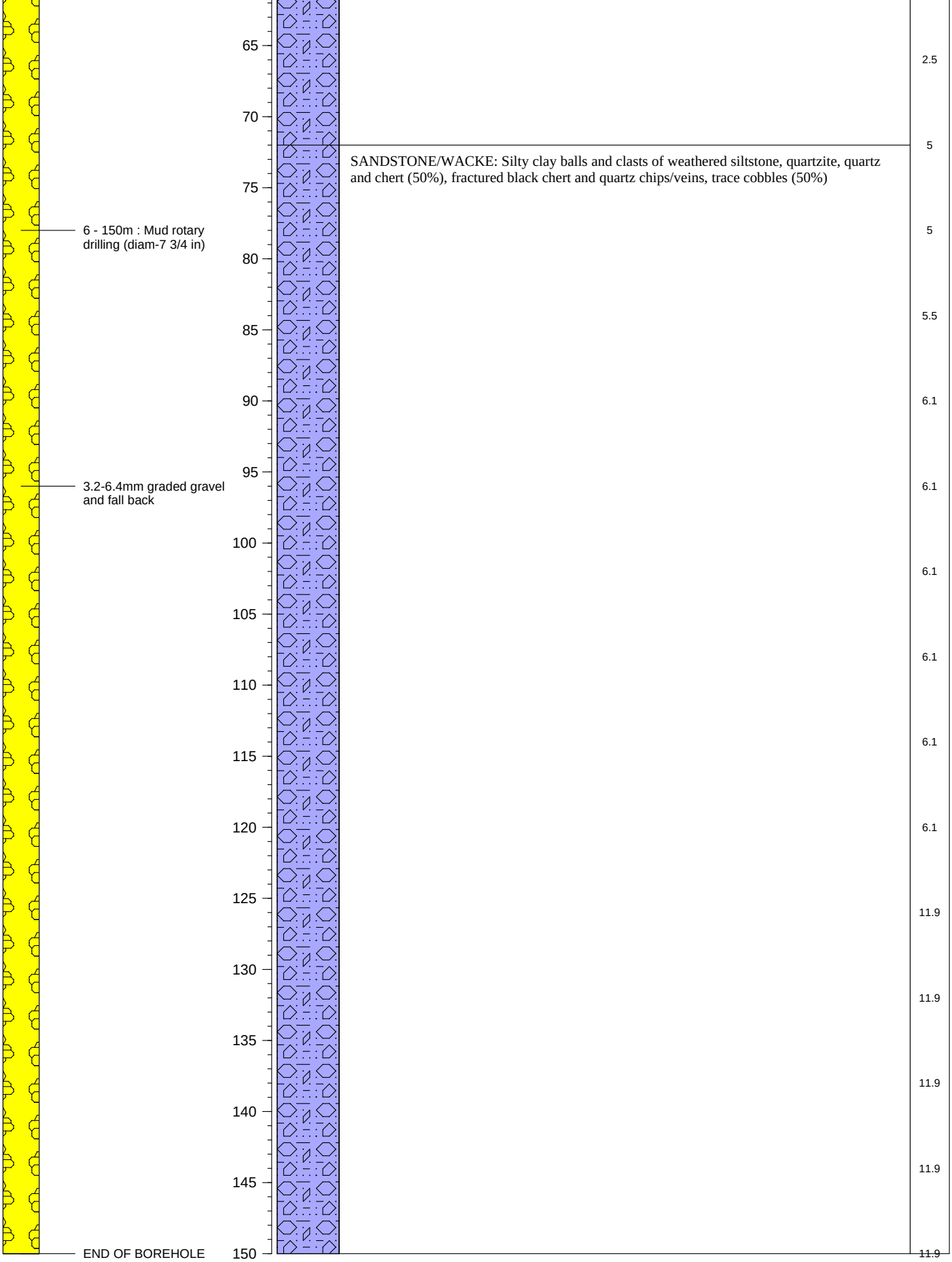
PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Mud rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709164.63**
NORTHING (m): **7647117.33**
MEAS PT ELEVATION (mAHD): **267.20**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **14/12/2013** DATE COMPLETED: **5/03/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.775**
Drilled Depth (mbgl):	**150**
Cased Depth (mbgl):	**42**
Casing Stick Up (magl):	**0.505**
Development Airlift Yield (l/s):	**5**
Water Level (mbgl) & Date:	**9.51** & **15/04/2015**



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		CALCRETE: Completely weathered light grey-orange clay and calcrete matrix with trace shale, chert and quartz	
5		CALCRETE: Moderately weathered light grey-orange clay and calcrete matrix with trace shale, chert and quartz	
10		MUDSTONE: Mostly white to orangey grey clay (pulverized soft silt/clay, calcrete and foam) with 20% chips of chert, weathered quartzite and harder calcrete	
15		MUDSTONE: Cuttings surface as clay balls with a light outer and dark brown inner coating of silty clay surrounding small chips of weathered and fractured chert, brown to grey quartzite/sandstone and quartz crystals. Little reaction to HCl-probably from fall-back	
20		MUDSTONE: Mostly white to orangey grey clay (pulverized soft silt/clay and foam) with minor chert, weathered quartzite and harder calcrete - the little reaction to HCl probably from fall-back	
25		MUDSTONE: Mostly weathered, light orange silt, 5-15% medium sand sized chips of weathered black chert, quartzite, quartz and other chert, little reaction to HCl probably from fall-back	
30		MUDSTONE: Mostly silty clay, little to no reaction to HCl, slightly less weathered (more light grey in colour) and slightly more black chert	no flow
		MUDSTONE: As above - slightly more weathered (more light orange in colour)	
		MUDSTONE: As above - slightly less weathered (more light grey in colour)	no flow
35		MUDSTONE: As above - mostly light grey silty-clay, 5-15% medium sand sized chips of weathered black chert, quartzite, quartz and other chert with 10% gravel sized chips of weathered, fractured black chert, black chert content increasing with depth	
40		CHERT: Well graded medium sand to gravel sized chips of weathered, fractured black chert (50%), greywacke- quartzite, siltstone, other chert and quartz (50%)	0.5
45		CHERT: As above - with larger gravel clasts of fractured black chert containing grey, fine grained phenocrysts	1
50		CHERT: Fresh black chert, trace cobble sized clasts highly fractured with quartz veins, 30% greywacke as above	1.7
55		SANDSTONE/WACKE: Medium sand sized chips of quartz/silicified sandstone (50%), with quartzite, siltstone and chert (20%), and fractured black chert (30%)	
60		SANDSTONE/WACKE: Silty clay balls and clasts of weathered siltstone, quartzite, trace chert clasts (70%), fractured black chert and quartz chips/veins, trace cobbles (30%)	2.2
		SANDSTONE/WACKE: Silty clay balls and clasts of weathered siltstone, quartzite, quartz and chert (60%), fractured black chert and quartz chips/veins, trace cobbles (40%)	2.2

Comments: **Drilled with air, redrilled with mud, could not case past 42m, gravel continued past 42m and backfilled hole**



Comments: **Drilled with air, redrilled with mud, could not case past 42m, gravel continued past 42m and backfilled hole**

OBSERVATION WELL BORE LOG

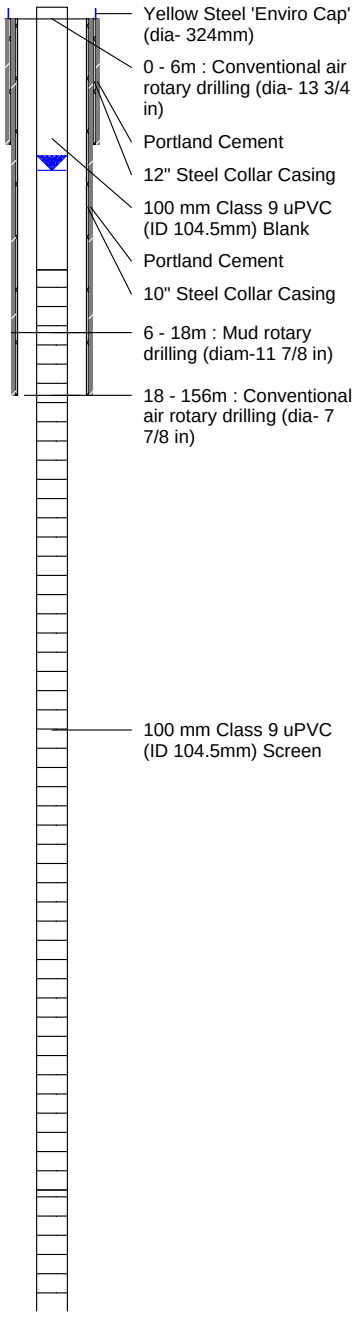
BOREHOLE NUMBER

NS-Obs23

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

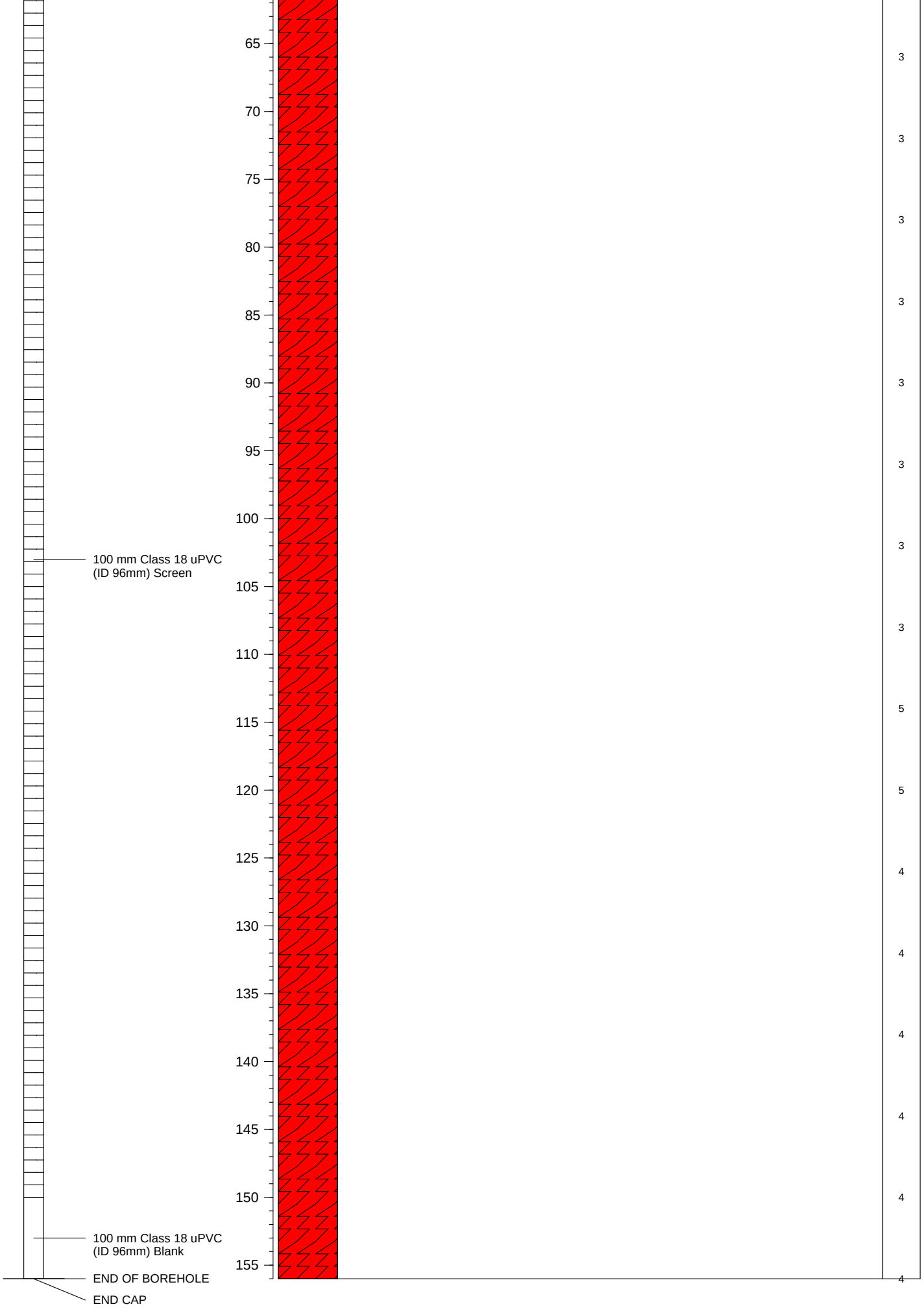
PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Mud rotary 6-18m, Air rotary 0-6m & 18-156m**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **711476.66**
NORTHING (m): **7647552.13**
MEAS PT ELEVATION (mAHD): **282.37**
DRILLING DIAMETER(S) (mm): **304/203**
DATE BEGUN: **12/03/2014** DATE COMPLETED: **18/03/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.604**
Drilled Depth (mbgl):	**156**
Cased Depth (mbgl):	**156**
Casing Stick Up (magl):	**0.555**
Development Airlift Yield (l/s):	**2**
Water Level (mbgl) & Date:	**7.24** & **15/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: 1-50mm, well graded chips, 100% Red/brown/orange completely weathered, rounded to sub-angular chert, shale, sandstone to siltstone and basalt with remnant magnetism	
5	DETRITUS: 1-35mm, well graded chips, 65% red-orange, 20% black, 15% white-light orange, detritus as above, less weathered, rock types are more easily distinguished, higher amounts of light siltstone	
10	DETRITUS: 1-20mm chips, mostly 15-20mm, 60% light grey to medium olive siltstone/ultramafic, 30% red orange to grey chert and quartzite, 10% black basalt, still signs of weathering and oxidation, but decreasing	
15	SERPENTINITE: 1-10mm, well graded chips, 80% light grey to olive, 20% black, soft silty serpentinite, moderately weathered with signs of spinifex form fibres and weathered basalt	
17	BASALT: 1-10mm, well graded chips, 80% black, 20% light grey to light orange and olive, moderately weathered basalt with little siltstone and ultramafics- possibly from fall-back	1
20	BASALT: 50% powder, 50% 1-10mm, well graded chips, 95-100% black, strongly magnetic basalt with soapy texture on large fracture planes, slight greenish hue and fibrous texture only noticeable upon very close inspection, 5%-trace light grey-orange-green serpentini	1
25		1
30		1
35		2.5
40		2.5
45		2.5
50	BASALT: As above, 1-20mm, well graded chips, slightly more serpentinized siltstone from 50-52m and 66-68m, trace - 5% perfect aragonite crystals at 112 and 120. Drillers note: gypsum-like sectile layer with higher water yield at 112m	2.5
55		2.5
60		2.5

Comments:


65
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105
110
115
120
125
130
135
140
145
150
155
3
3
3
3
3
3
3
3
3
5
5
4
4
4
4
4
4
100 mm Class 18 uPVC
(ID 96mm) Screen
100 mm Class 18 uPVC
(ID 96mm) Blank
END OF BOREHOLE
END CAP

Comments:

OBSERVATION WELL BORE LOG

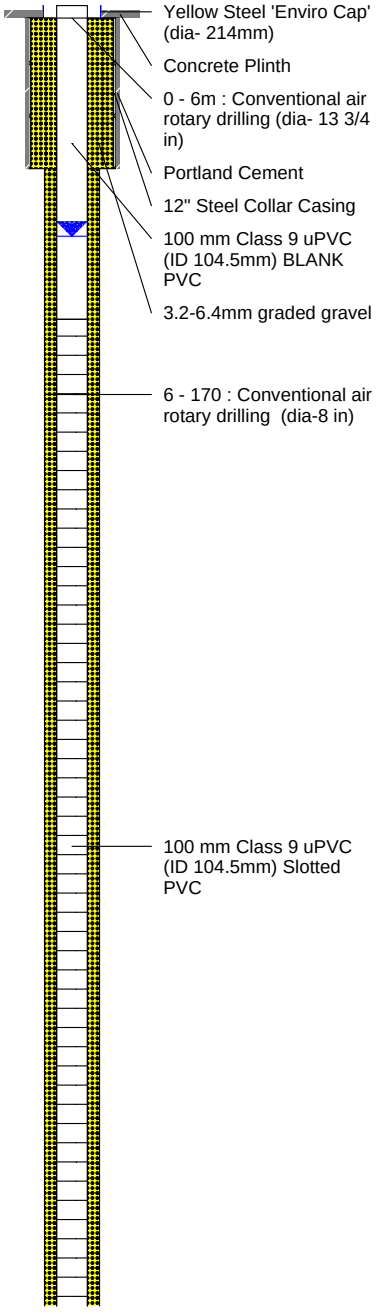
BOREHOLE NUMBER

NS-Obs33

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **710795.22**
NORTHING (m): **7647248.91**
MEAS PT ELEVATION (mAHD): **277.855**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **14/09/2014** DATE COMPLETED: **16/09/2014**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**170**
Cased Depth (mbgl):	**168**
Casing Stick Up (magl):	**0.237**
Completion Stick Up (magl):	**0.635**
Development Airlift Yield (l/s):	**10+**
Water Level (mbgl) & Date:	**8.69** & **15/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Fine red silt and sand with angular chips of red BIF, chert basalt and shale, all completely weathered	
5	DETRITUS: Brown and grey completely weathered basalt, minor detritus	
10	BASALT: Brownish grey weathered and metamorphosed and mildly porphyritic to spinifex textured basalt with a dark grey to blue green matrix, 1mm black grains/ phenocrysts, minor lighter aragonite as phenocrysts and in hairline fracture in-fills	
15	BASALT: Dark grey moderately weathered basalt as above, water at 12m	1.4
20	BASALT: Basalt as above with large 50-60mm weathered chips, driller notes lose ground at 18m	10
25	BASALT: As above, trace large chips that decrease in quantity with depth, chips are mild to moderately weathered	17
30	BASALT: Medium grey basalt as above, chips are lighter in colour, phenocrysts are just visible, only trace aragonite at 30 – 38m, 10% is a soft siltstone like rock that crumbles easily- steatite, trace aragonite/ carbonates, ground becomes harder at 38m still mildly to moderately weathered showing oxidation on fracture planes	20
35	BASALT: As above trace to no oxidation, trace to no aragonite, soft silty rock increases to 25% by 38m	20
40	BASALT: As above soft rock % decreases to 10% and overall rock appears to be more serpentinized on fracture planes and silicified, still mild granular texture is visible on some chips	20
45	BASALT: Medium to dark grey, fresh basalt as above, no soft chips/steatite, not as metamorphosed (no serpentinization on fracture planes)	
50		17.5

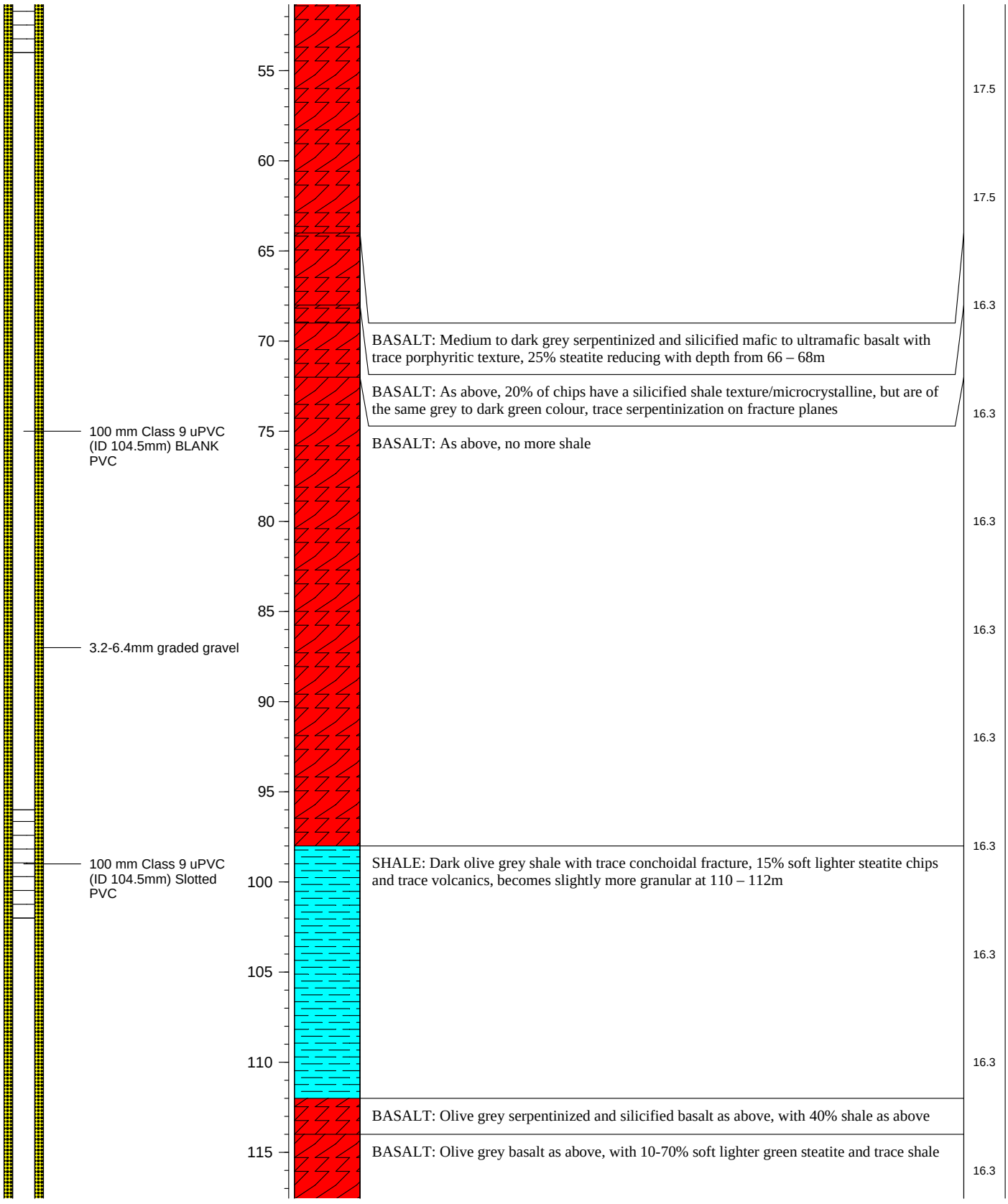
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-Obs33

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



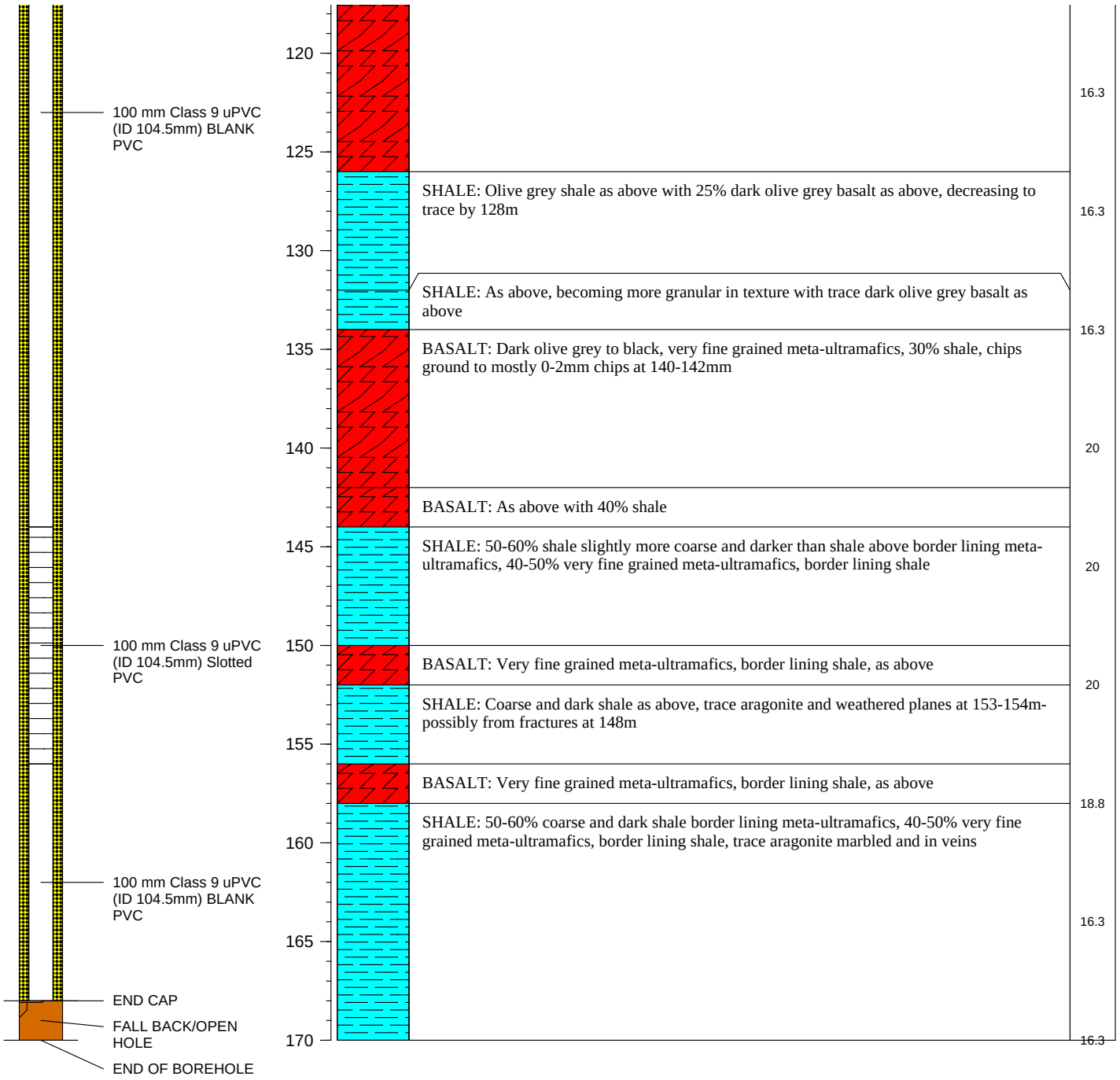
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-Obs33

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments:

OBSERVATION WELL BORE LOG

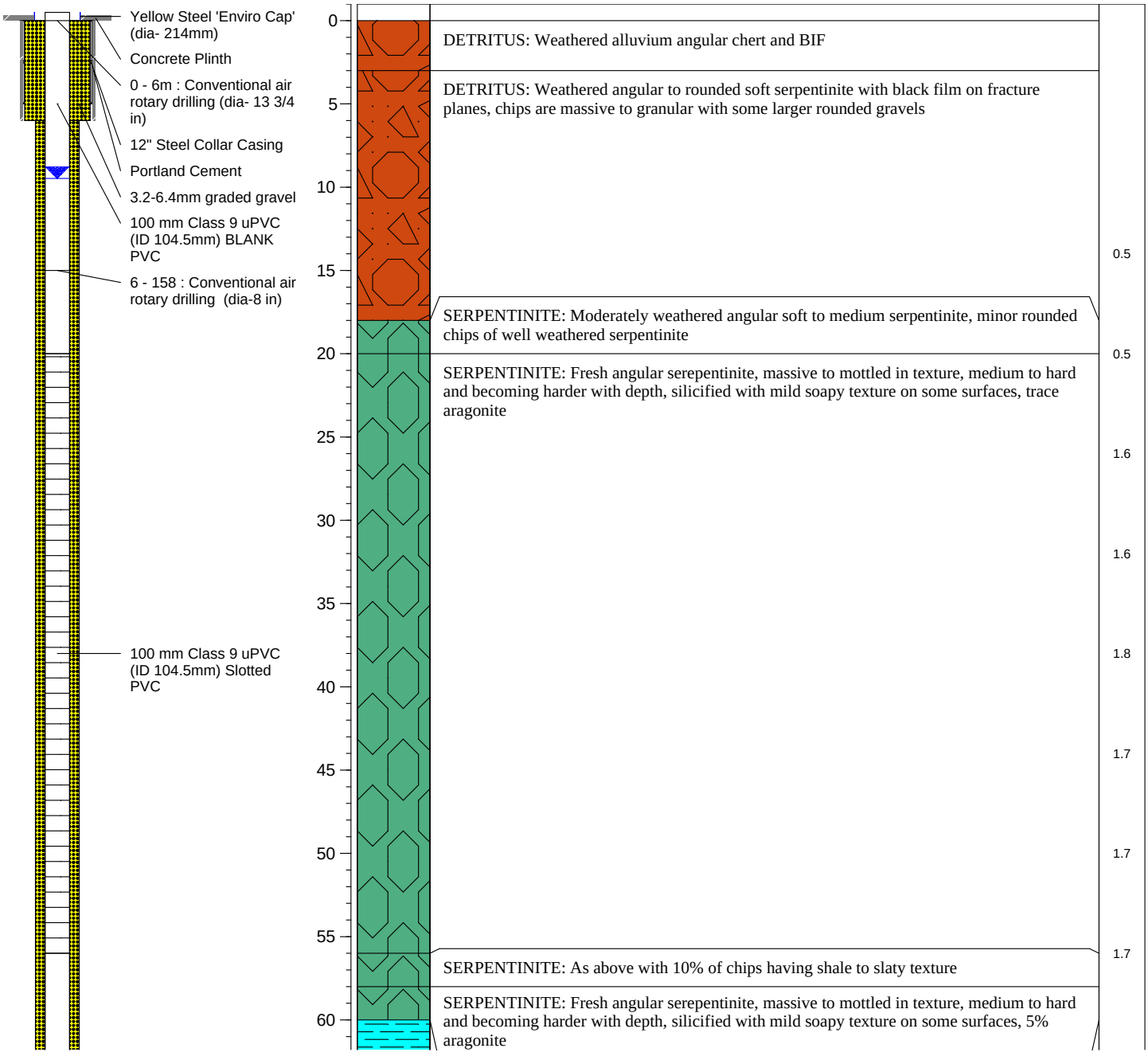
BOREHOLE NUMBER

NS-Obs34

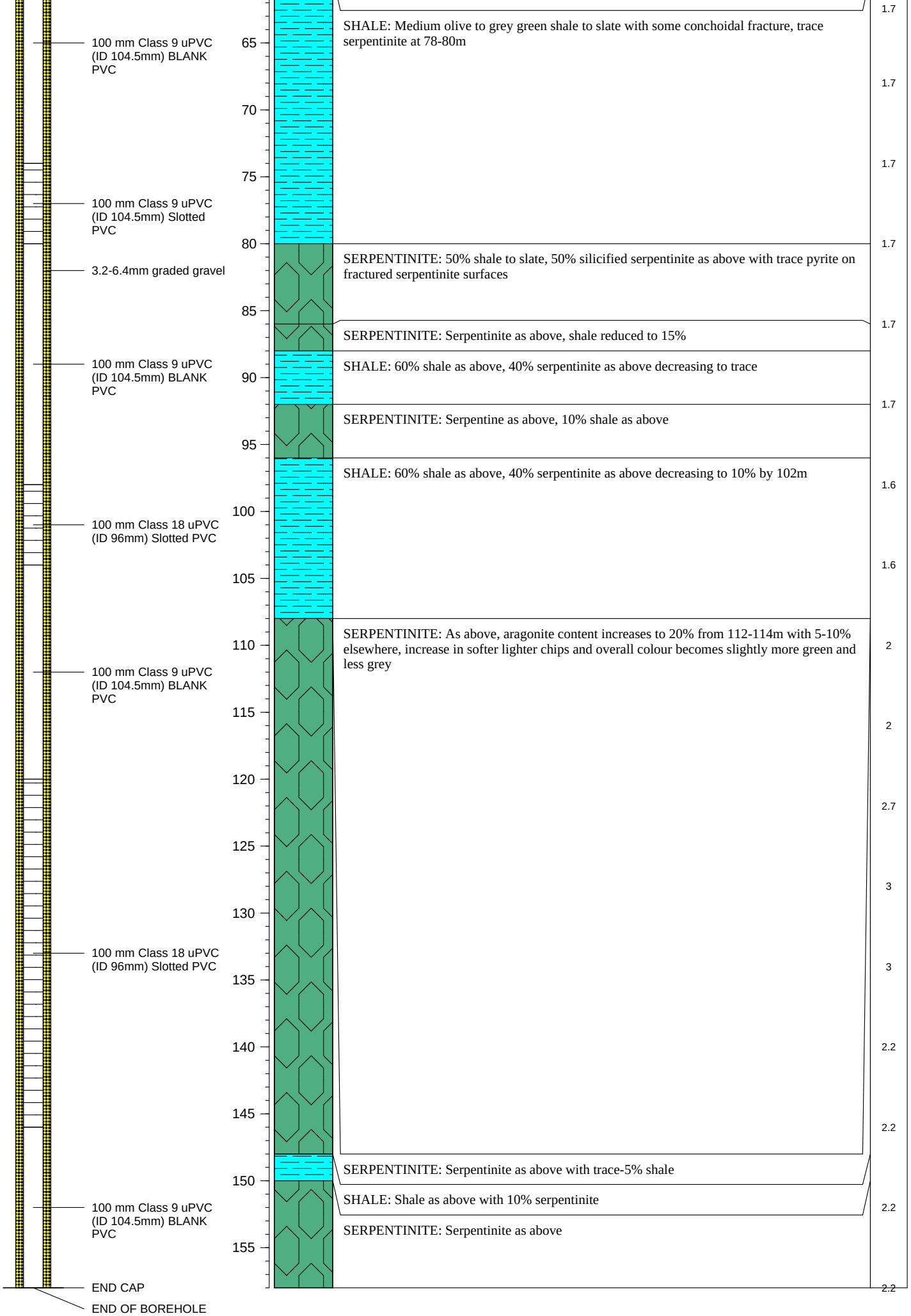
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Northern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**711450.93**
NORTHING (m):	**7648249.40**
MEAS PT ELEVATION (mAHD):	**287.61**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **17/09/2014**	DATE COMPLETED: **19/09/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.732**
Drilled Depth (mbgl):	**158**
Cased Depth (mbgl):	**158**
Casing Stick Up (magl):	**0.52**
Development Airlift Yield (l/s):	**1.7**
Water Level (mbgl) & Date:	**9.47** & **11/04/2015**



Comments: **Class 18 PVC from 98-104m & 120-146m, all else Class 9 PVC**



Comments: **Class 18 PVC from 98-104m & 120-146m, all else Class 9 PVC**

OBSERVATION WELL BORE LOG

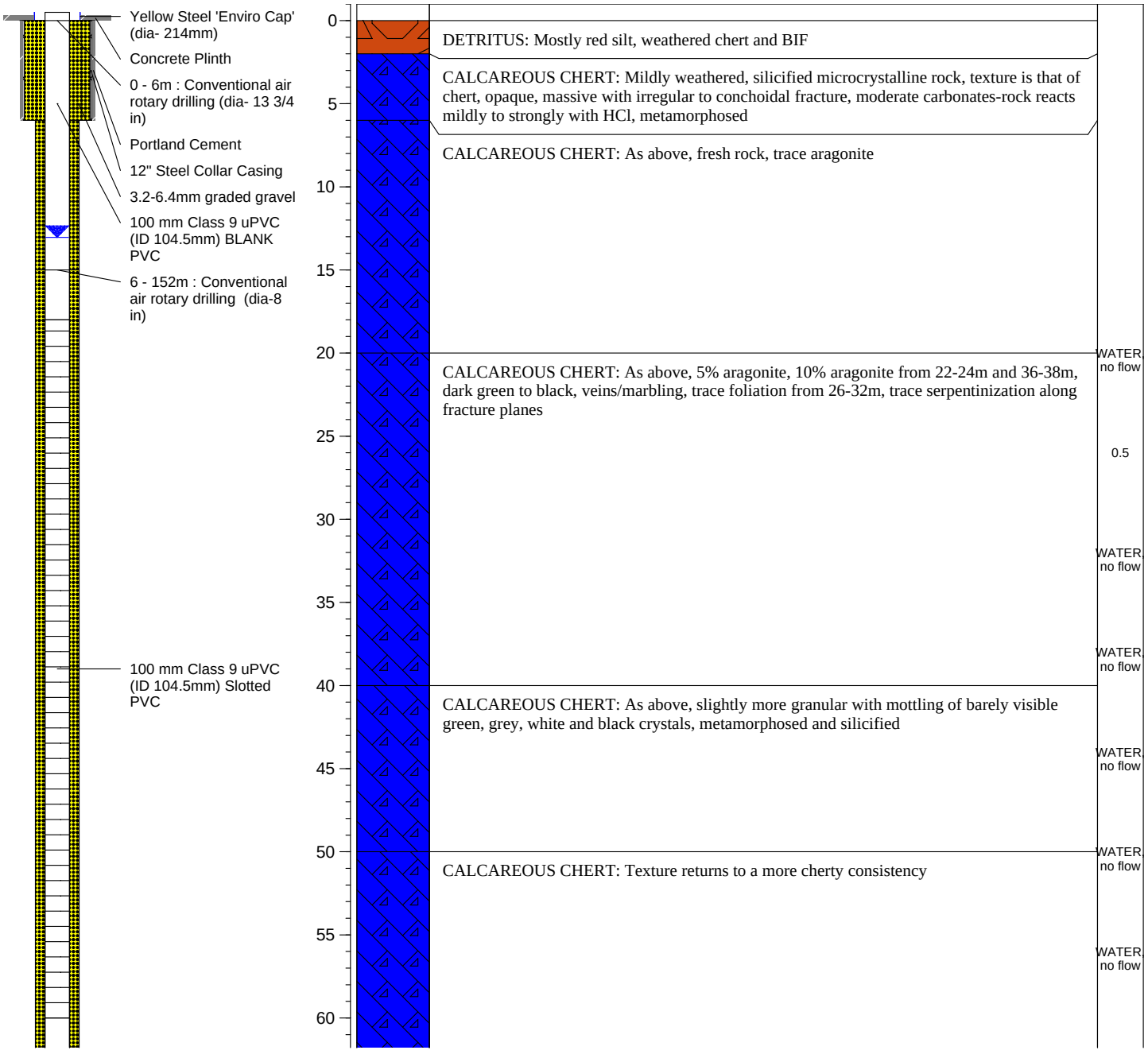
BOREHOLE NUMBER

NS-Obs35

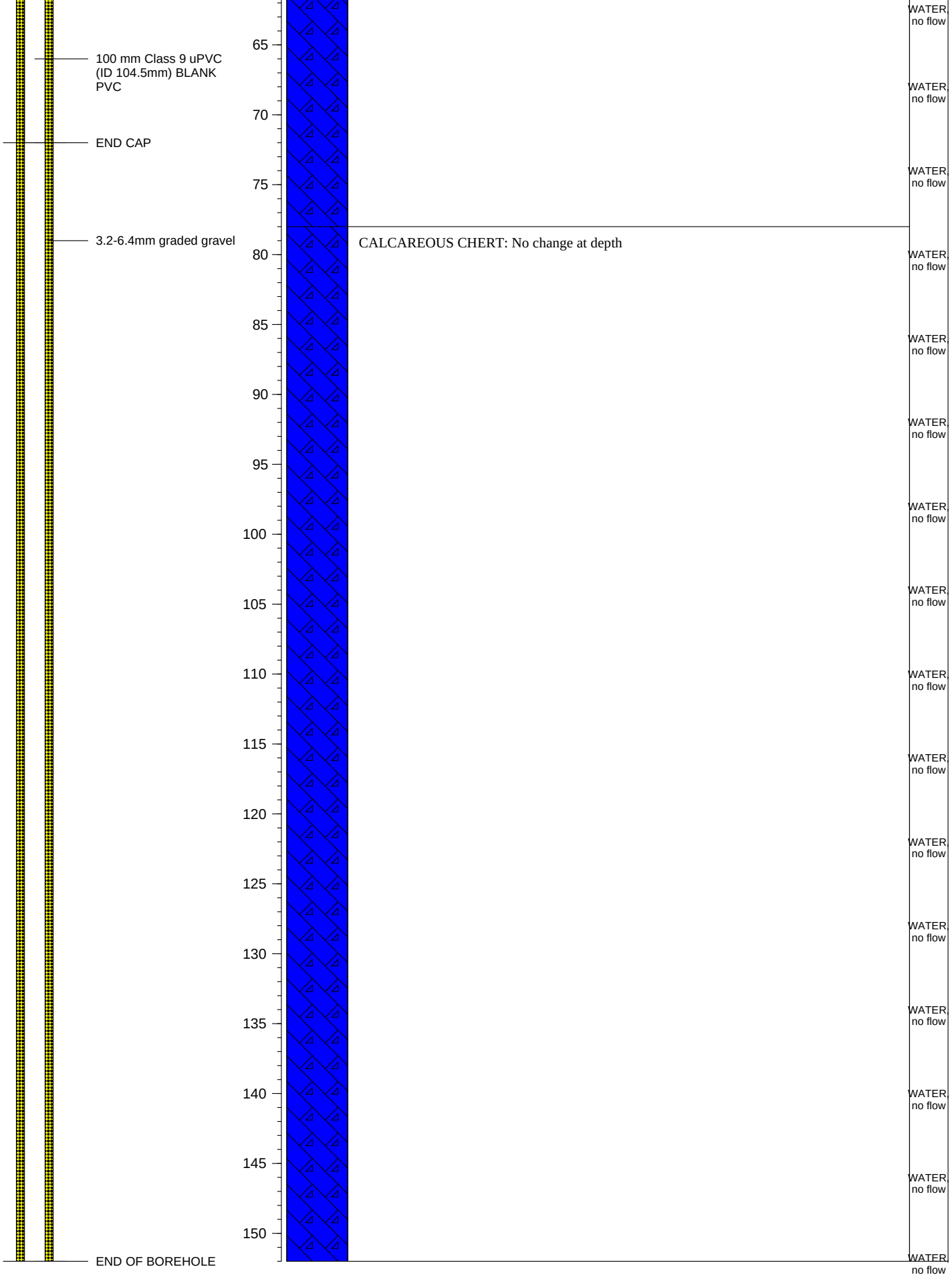
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **712129.49**
NORTHING (m): **7646980.85**
MEAS PT ELEVATION (mAHD): **294.36**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **19/09/2014** DATE COMPLETED: **21/09/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.722**
Drilled Depth (mbgl):	**152**
Cased Depth (mbgl):	**72**
Casing Stick Up (magl):	**0.499**
Development Airlift Yield (l/s):	**NA**
Water Level (mbgl) & Date:	**13.04** & **11/04/2015**



Comments:


100 mm Class 9 uPVC (ID 104.5mm) BLANK PVC
END CAP
3.2-6.4mm graded gravel
END OF BOREHOLE
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
CALCAREOUS CHERT: No change at depth
WATER no flow

Comments:

PRODUCTION WELL BORE LOG

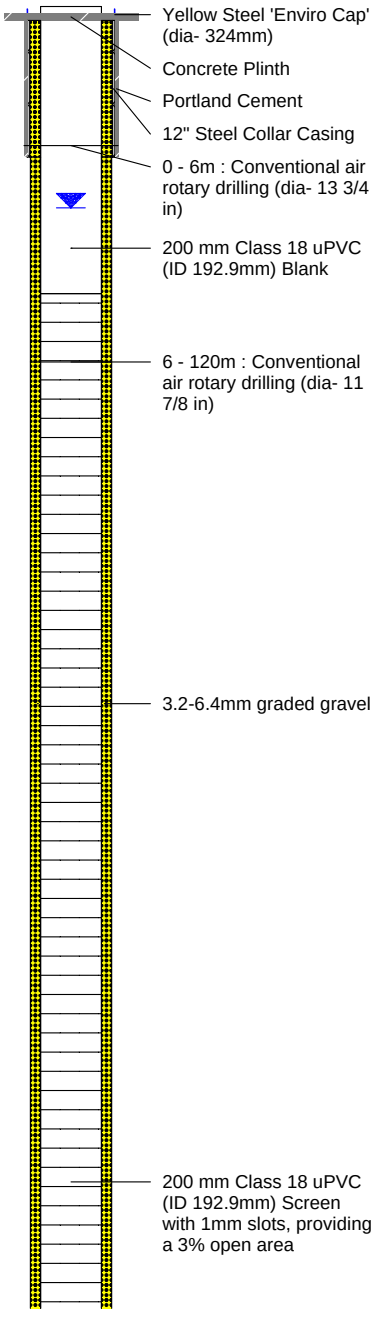
BOREHOLE NUMBER

NS-PB15

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709402.97**
NORTHING (m): **7647283.21**
MEAS PT ELEVATION (mAHD): **268.794**
DRILLING DIAMETER(S) (mm): **304**
26D LICENCE #: **CAW178127(1)**
DATE BEGUN: **10/01/2014** DATE COMPLETED: **15/01/2014**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.623**
Drilled Depth (mbgl):	**120**
Cased Depth (mbgl):	**120**
Casing Stick Up (magl):	**0.606**
Development Airlift Yield (l/s):	**10.9**
Water Level (mbgl) & Date:	**8.23** & **15/04/2015**



DEPTH	DESCRIPTION	YIELD (l/s)
0	DETRITUS: Weathered, light olive grey ultramafics with 30% weathered calcrete	
	SERPENTINITE: Weathered, light olive grey ultramafics with 10% weathered calcrete	
5	SERPENTINITE: Weathered, light olive grey ultramafics, mostly larger 2" clasts, trace weathered calcrete	1
	SERPENTINITE: Weathered, light olive grey ultramafics, well graded 2" clasts to medium sand sized, 20% weathered orange calcrete	
10	SERPENTINITE: Weathered, light olive grey ultramafics, well graded but with fewer 2" clasts grading to medium sand sized, 5% weathered orange calcrete	1
15	SERPENTINITE: Light to medium olive grey ultramafics with trace dark grey to black basalt, signs of weathering along 10% of fracture planes, trace orange calcrete, all well sorted medium to coarse sand sized with 5-10% being 1" chips	
	SERPENTINITE: As above, slightly more grey in over all colour, 5% light olive grey calcareous serpentinite siltstone, trace quartz along basalt fractures	1.5
20		
	SERPENTINITE: As above, slightly more grey in over all colour, 10% light olive grey calcareous serpentinite siltstone	2
25	SERPENTINITE: As above, 70% of planes show oxidation, trace calcrete	
	SERPENTINITE: As above, 25% of planes show oxidation	
30	SERPENTINITE: 80% ultramafics, 10% light calcareous serpentinite siltstone, 10% quartz, 70% of planes show oxidation	3
	SERPENTINITE: 70% light olive grey ultramafics with 30% white-orange calcrete and calcareous serpentinite, 70% of planes show oxidation,	
35	SERPENTINITE: 80% ultramafics, 10% light calcareous serpentinite siltstone, 10% quartz, 70% of planes show oxidation	3.5
40	SERPENTINITE: Light to medium olive grey ultramafics with 10% aragonite and trace lighter olive grey calcareous serpentinite siltstone, signs of weathering along 10% of fracture planes	3.3
45	SERPENTINITE: As above, trace oxidation/signs of weathering	
	SERPENTINITE: As above, with 5% aragonite and basalt	3.3
	SERPENTINITE: As above, with trace aragonite and basalt	
50	SERPENTINITE: As above, with 5-10% aragonite, basalt and lighter olive grey calcareous serpentinite siltstone	
	SERPENTINITE: As above, with 5% aragonite, basalt and lighter olive grey calcareous serpentinite siltstone	4.3
55		

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB15

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	60		SERPENTINITE: As above, with trace aragonite, basalt and lighter olive grey calcareous serpentinite siltstone	
			SERPENTINITE: As above, with 5% basalt and trace aragonite and lighter olive grey calcareous serpentinite siltstone	4.3
3.2-6.4mm graded gravel	65			5.5
	70		SERPENTINITE: As above, with 5% aragonite and trace basalt and lighter olive grey calcareous serpentinite siltstone	
			SERPENTINITE: As above, with trace aragonite, basalt and lighter olive grey calcareous serpentinite siltstone	5.9
	75		SERPENTINITE: As above, with 5% aragonite and trace basalt and lighter olive grey calcareous serpentinite siltstone	6.8
	80			
	85		SERPENTINITE: As above, with 5% basalt and trace aragonite and lighter olive grey calcareous serpentinite siltstone	7.5
			SERPENTINITE: As above, with trace aragonite, basalt and lighter olive grey calcareous serpentinite siltstone	
	90		SERPENTINITE: As above, with 10% lighter olive grey calcareous serpentinite siltstone and trace basalt and aragonite	6.1
	95			6.1
	100			5.5
200 mm Class 18 uPVC (ID 192.9mm) Blank	105			4.3
	110			
	115			4.3
END OF BOREHOLE	120			4.9
END CAP				

Comments:

PRODUCTION WELL BORE LOG

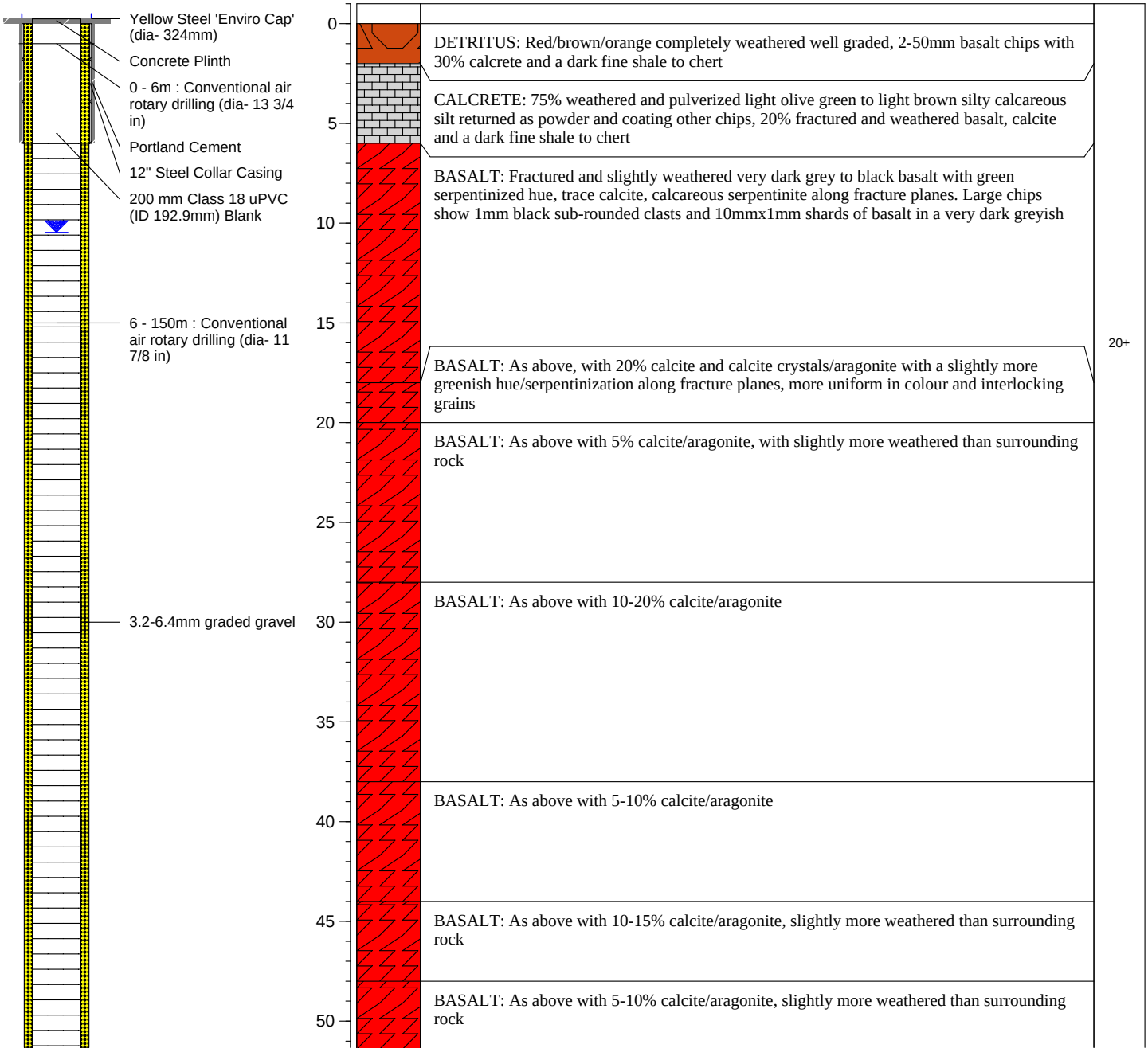
BOREHOLE NUMBER

NS-PB17

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709799.95**
NORTHING (m): **7647257.03**
MEAS PT ELEVATION (mAHD): **272.134**
DRILLING DIAMETER(S) (mm): **304**
26D LICENCE #: **CAW178127(1)**
DATE BEGUN: **19/03/2014** DATE COMPLETED: **27/03/2014**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.744**
Drilled Depth (mbgl):	**150**
Cased Depth (mbgl):	**150**
Casing Stick Up (magl):	**NA**
Development Airlift Yield (l/s):	**17.5**
Water Level (mbgl) & Date:	**10.46** & **15/04/2015**



Comments:

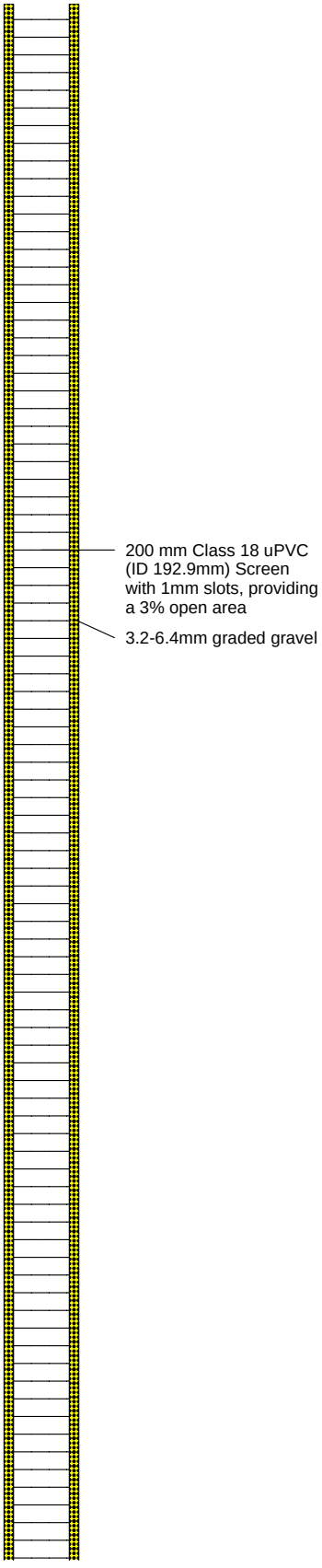
OBSERVATION WELL BORE LOG

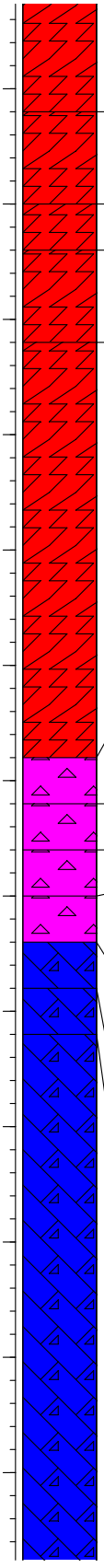
BOREHOLE NUMBER

NS-PB17

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)





BASALT: As above with 20% calcite/aragonite, slightly greyer in colour

BASALT: As above with trace metallic mineralization- pyrite

BASALT: As above with 5-10% calcite/aragonite and trace metallic mineralization- pyrite

BASALT: As above with 5% calcite/aragonite and trace metallic mineralization- pyrite, lighter and slightly more green in colour

CHERT: 50% grey-white-green quartzite/calcareous chert and very dark grey to black chert, 50% black to green meta-basalt, trace pyrite prominent on meta-basalt chips

CHERT: Fresh black, grey, white to transparent chert

CHERT: 90-80% as above, 10-20% milky, pale green chert, trace pyrite

CHERT: 30% Milky green to aqua green calcareous chert, 50% colourless-white-dark grey chert, 20% grey chert, trace pyrite

CALCAREOUS CHERT: 50% Bright green to grey green semitransparent chalcedony/chert/quartzite (calcareous chert), 50% colourless-white-dark grey chert, trace pyrite

CALCAREOUS CHERT: 80% milky green to grey green semitransparent calcareous chert, 20% colourless-white-dark grey chert, trace pyrite

CALCAREOUS CHERT: 100% greenish grey calcareous chert

Comments:

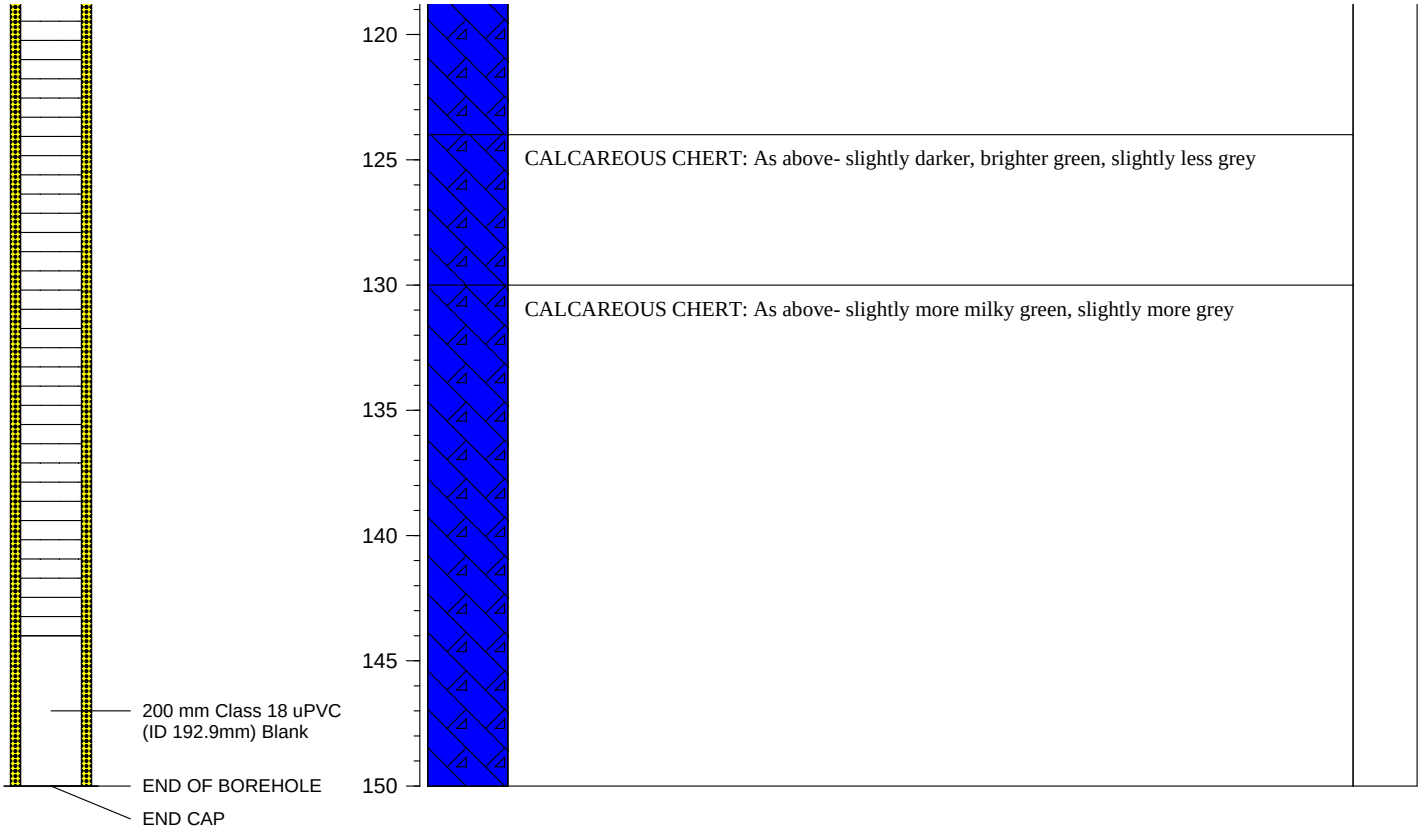
OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB17

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



CALCAREOUS CHERT: As above- slightly darker, brighter green, slightly less grey

CALCAREOUS CHERT: As above- slightly more milky green, slightly more grey

Comments:

PRODUCTION WELL BORE LOG

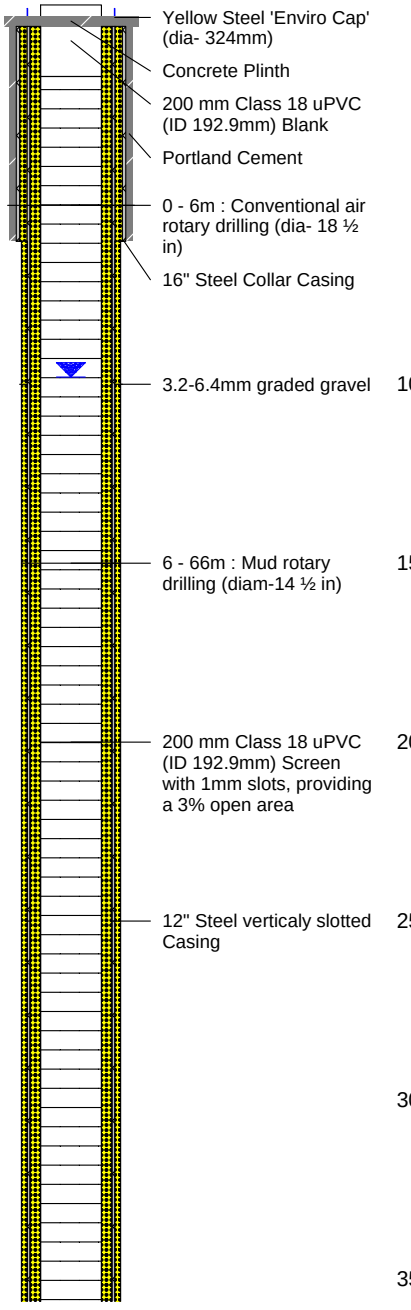
BOREHOLE NUMBER

NS-PB19

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Mud rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709162.56**
NORTHING (m): **7647131.30**
MEAS PT ELEVATION (mAHD): **268.072**
DRILLING DIAMETER(S) (mm): **304**
26D LICENCE #: **CAW178127(1)**
DATE BEGUN: **15/02/2014** DATE COMPLETED: **28/02/2014**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.515**
Drilled Depth (mbgl):	**163**
Cased Depth (mbgl):	**157.4**
Casing Stick Up (magl):	**0.543**
Development Airlift Yield (l/s):	**20+**
Water Level (mbgl) & Date:	**9.8** & **15/04/2015**



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (l/s)
0		CALCRETE: Orange to white/grey, completely weathered calcrete and soft siltstone from 3cm sized chips to pulverize silt, trace medium to coarse sand sized chert	
5		CALCRETE: 50% Orange to white/grey, moderately weathered calcrete, quartz crystals, quartzite, and precipitated carbonates, 50% moderately weathered black chert * there is a prominent 6" black chert dike through the calcrete/silt formation ~10m from bore hole	
		MUDSTONE: 80% Orange to white/grey, moderately weathered calcrete and soft silt/claystone, quartz crystals, quartzite, and chert, 20% moderately weathered black chert, reaction to HCl probably from calcrete fall-back	
10		MUDSTONE: 90% Light calcrete-clay/silt as above to fine silicified sandstone, 10% black chert as above, less reaction to HCl- presence of calcrete probably from fall-back	
		MUDSTONE: 95% Light clay/silt to fine silicified sandstone as above, 5% black chert as above, little to no reaction to HCl	
15		MUDSTONE: As above, slightly more weathered/oxidized, black chert content increasing from 5-10% at 14m to 30-40% at 22m- orange/yellow siltstone decreases from 30% to 15%	
20		CHERT: 80% Fractured black chert, 20% light siltstone to silicified sandstone	
25		CHERT: 60% Fractured black chert, 20% colourless to white quartz crystals, 10% light grey to brown quartzite/silicified sandstone and chert, 10% orange to white siltstone mix	
		CHERT: 75% Fractured black chert, 10% colourless to white quartz crystals, 5% light grey to brown quartzite/silicified sandstone and chert, 5% orange to white siltstone	
30		CHERT: 80% Fractured black chert, 20% colourless to white quartz crystals, light grey to brown quartzite/silicified sandstone, chert and white silt	
		CHERT: 70% Fractured black chert, 20% light grey to white silt - no longer reacts to HCl, 10% silicified sandstone (colourless to white quartz crystals, light grey to brown quartzite/silicified sandstone, and grey chert with very fine black veins)	
35		SANDSTONE/WACKE: 50% Fractured black chert, 30% grey silicified sandstone, 20% light	

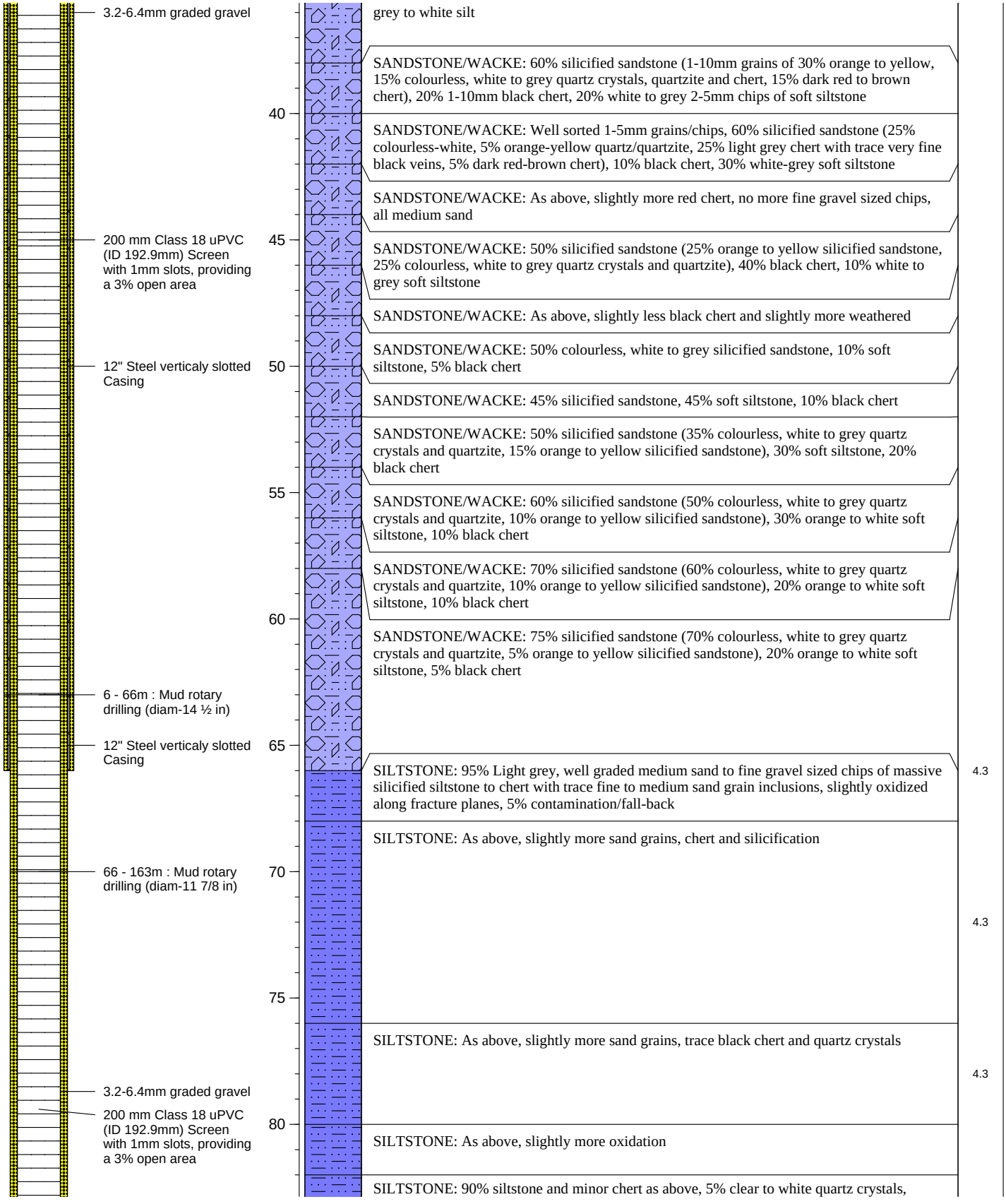
Comments: **Drilling sequence: 0-6m 18 ½" air, 6-66m 12 ¼" mud, 6-66 14 ½ mud, 66-162m 11 7/8" air, 66-163m 11 7/8" mud**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB19

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



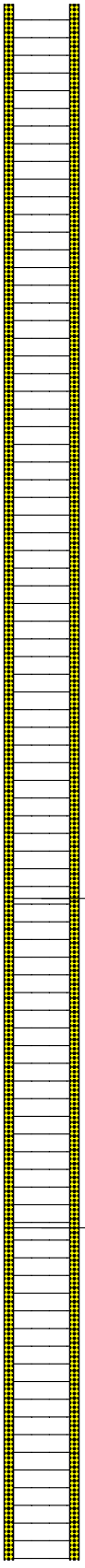
Comments: **Drilling sequence: 0-6m 18 ½" air, 6-66m 12 ¼" mud, 6-66 14 ½ mud, 66-162m 11 7/8" air, 66-163m 11 7/8" mud**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB19

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
		silicified sandstone, 5% black chert	
85		SILTSTONE: 90% light grey siltstone and minor chert as above, 5% orange to brown silicified sandstone, 5% clear to white quartz crystals, trace black chert	4.9
		SILTSTONE: 60% light grey siltstone and minor chert as above, 30% orange to brown silicified very fine grained siltstone, 10% clear to white quartz crystals and black chert	
90		SILTSTONE: 60% orange to light brown silicified, very fine grained siltstone as above, 20% light grey siltstone and minor chert as above, 15% black chert, 5% clear to white quartz crystals	5.2
		SILTSTONE: 80% light grey to orange slightly silicified, very fine grained siltstone, softer than above, 20% black chert, trace quartz	
		SILTSTONE: 90% light grey to orange, slightly silicified, very fine grained siltstone, softer than above, 10% black chert and trace quartz	
95		SILTSTONE: As above, only trace black chert	6.8
100		SILTSTONE: 65% orange to light brown very fine siltstone, 30% black chert, 5% clear to white quartz crystals	
		SILTSTONE: 90% orange to light brown very fine siltstone, 10% black chert and trace quartz	8
105		SILTSTONE: 95% orange to light brown very fine siltstone, 5% quartz, trace black chert	
		SILTSTONE: 100-95% orange to light brown very fine siltstone, 5% to trace quartz and black chert, chips are larger	
		SILTSTONE: 90% orange to light brown very fine siltstone, 10% black chert and trace quartz	8.3
110		SILTSTONE: 100-95% orange to light brown very fine siltstone, 5% to trace quartz and black chert, chips are larger, up to fine gravel in size	
		SILTSTONE: 90% orange to light brown very fine siltstone, 10% black chert and trace quartz, chips are smaller, back to medium to coarse sand sized, mostly medium sand at 120m	9
115			
120			9.1
125			9.1
		SILTSTONE: 60% orange to light brown very fine siltstone, 30% black chert, 10% light grey soft siltstone	
		CHERT: 70% black chert, 20% orange to light brown chert to siltstone, 10% light grey soft siltstone	
130			

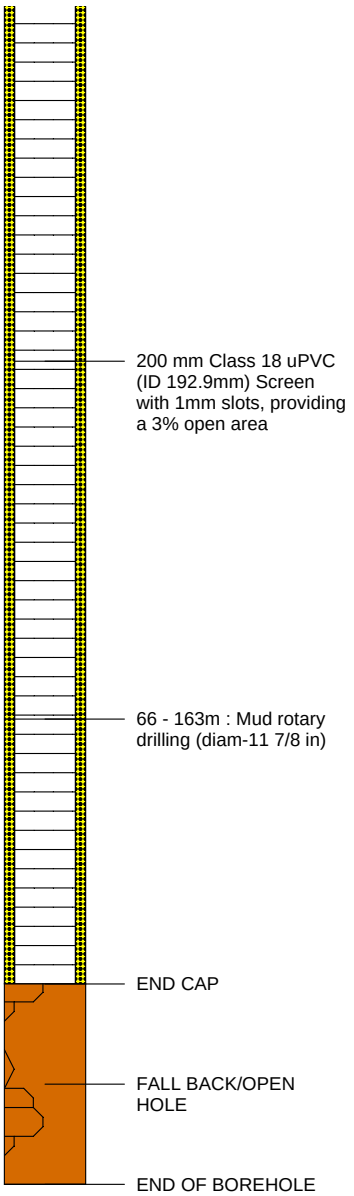
Comments: **Drilling sequence: 0-6m 18 ½" air, 6-66m 12 ¼" mud, 6-66 14 ½ mud, 66-162m 11 7/8" air, 66-163m 11 7/8" mud**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB19

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
130		CHERT: 50% black chert, 40% orange to light brown chert to siltstone, 10% light grey soft siltstone, trace silicified sandstone	
		SANDSTONE/WACKE: 40% black chert, 30% orange to light brown chert to siltstone, 10% light grey soft siltstone, 10% silicified sandstone, 10% quartz crystals	11.9
135		CHERT: 60% black chert, 20% orange to light brown silicified sandstone, 20% quartz, 5% light grey to orange siltstone	
		CHERT: 50% black chert, 30% orange to light brown silicified sandstone, 15% quartz, 5% light grey to orange siltstone	
		SANDSTONE/WACKE: 50% orange to light brown silicified sandstone, 40% black chert, 10% quartz	12.3
140		SANDSTONE/WACKE: 50% orange to light brown silicified sandstone, 20% black chert, 20% quartz, 10% light grey soft siltstone	
			13.1
145		SANDSTONE/WACKE: 80% orange to light brown silicified sandstone,15% quartz, 5% black chert	
		SILICEOUS REPLACEMENT: 75% orange vuggy/craggy quartz intrusion and silicified sandstone, 20% quartz crystals, 5% black chert, all very well oxidized	
150		SILICEOUS REPLACEMENT: 70% orange vuggy/craggy quartz intrusion, 10% silicified sandstone, 10% quartz crystals, 10% black chert, all very well oxidized	13.5
		SILICEOUS REPLACEMENT: 60% orange vuggy/craggy quartz intrusion, 20% quartz crystals, 20% black chert, trace silicified sandstone, all very well oxidized	
155		SILICEOUS REPLACEMENT: 55% orange, white to clear quartz crystals, 30% black chert, 15% orange vuggy/craggy quartz intrusion, all very well oxidized	
		SILICEOUS REPLACEMENT: 60% orange vuggy/craggy quartz intrusion, 20% black chert, 15% quartz crystals, 5% light grey soft siltstone, all very well oxidized	60+
160		SILICEOUS REPLACEMENT: 50% orange vuggy/craggy quartz intrusion, 25% black chert, 15% quartz crystals, 10% light grey soft siltstone, all very well oxidized	
		CHERT: 50% black chert, 25% clear to white quartz crystals, 20% orange to light brown silicified sandstone, all very well oxidized	

Comments: **Drilling sequence: 0-6m 18 ½" air, 6-66m 12 ¼" mud, 6-66 14 ½ mud, 66-162m 11 7/8" air, 66-163m 11 7/8" mud**

PRODUCTION WELL BORE LOG

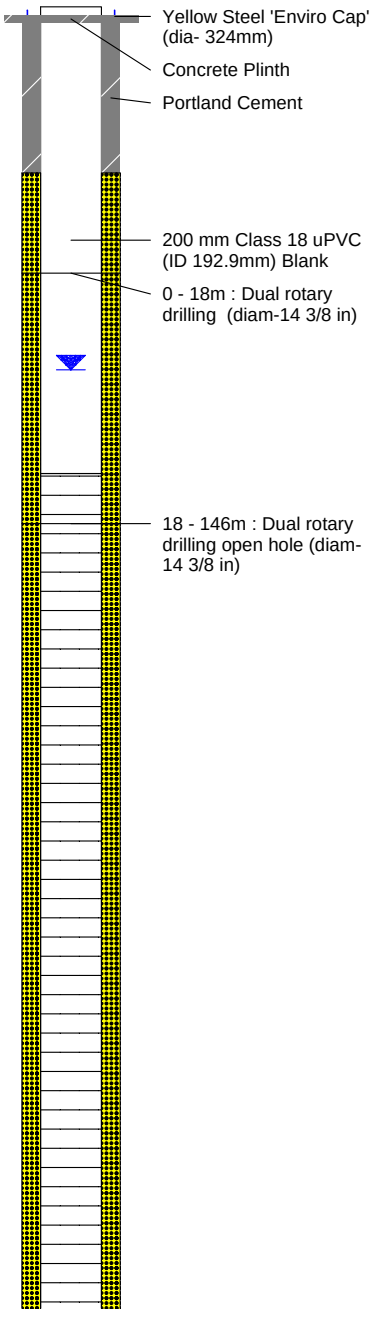
BOREHOLE NUMBER

NS-PB30

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Dual rotary drilling (18-146m open hole)**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **708555.09**
NORTHING (m): **7648497.97**
MEAS PT ELEVATION (mAHD): **260.24**
DRILLING DIAMETER(S) (mm): **355**
26D LICENCE #: **CAW178127(1)**
DATE BEGUN: **4/04/2014** DATE COMPLETED: **9/04/2014**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.5**
Drilled Depth (mbgl):	**146**
Cased Depth (mbgl):	**146**
Casing Stick Up (magl):	**0.63**
Development Airlift Yield (l/s):	**2**
Water Level (mbgl) & Date:	**13.86** & **13/04/2014**



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (l/s)
0		BASALT: Moderately graded 10-50mm (most are graded 10-40mm) with chips over 15mm sub-rounded to rounded, 95% medium olive grey, moderately weathered, mostly hard ultramafics with few soft crumbly clasts of ultramafic siltstone, trace-5% white, poorly graded 10mm	
5		BASALT: Well graded 10-40mm ultramafic chips as above, 90% medium olive grey, 5-10% white calcrete/aragonite as above, trace-5% black and red chert, silty clay coating all chips	
10		BASALT: 85% ultramafics as above, 10-15% calcrete/aragonite as above, trace-5% chert as above, thick silty clay paste coating all chips	
		BASALT: 90% ultramafics as above, 10% calcrete/aragonite as above	
15		BASALT: 90% ultramafics as above, 5% calcrete/aragonite as above, ground becomes slightly harder at 10m, still lose and large gravels continue to bog down rod, black bacterial-like slimy film on surfaces of softer chips- scrapes off easily with nail	
20		BASALT: Well graded 1-15mm angular chips, 95-100% dark olive green to black, fresh ultramafics/ serpentinized basalt, darker in colour than above- higher basalt content with minor olive grey silty serpentinite possibly from above, trace calcrete/aragonite	
		BASALT: As above, no calcrete/aragonite	1.5
25			1.5
30			
35			2
40		BASALT: 70% dark olive grey, well graded 1-15mm angular chips, hard ultramafics/ meta-basalt, 30% medium to soft black striated to foliated meta-basalt alteration contact at roughly 40m with the black and olive green rock, trace basalt	2.2
45			2.2
50			

Comments:

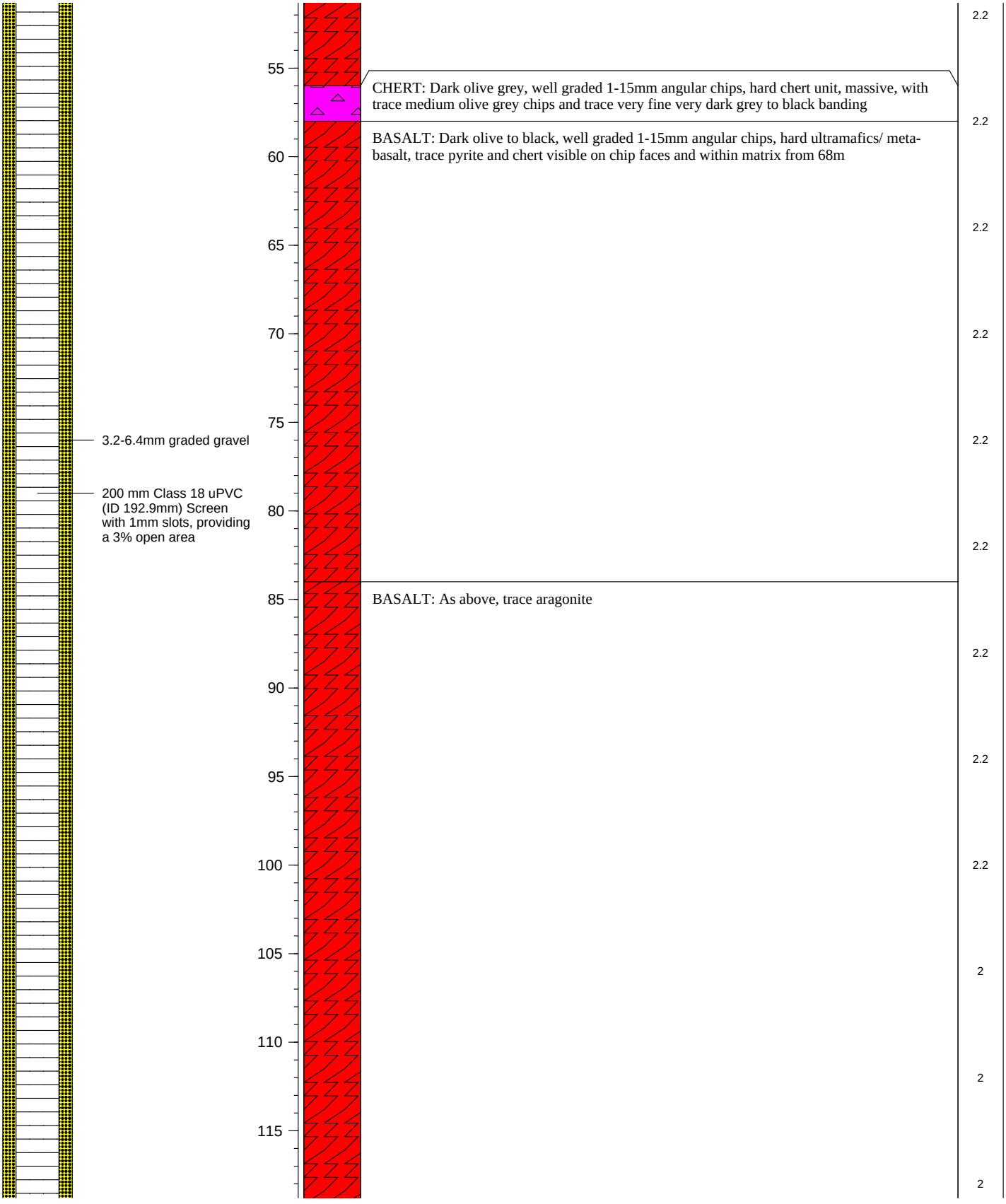
OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB30

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



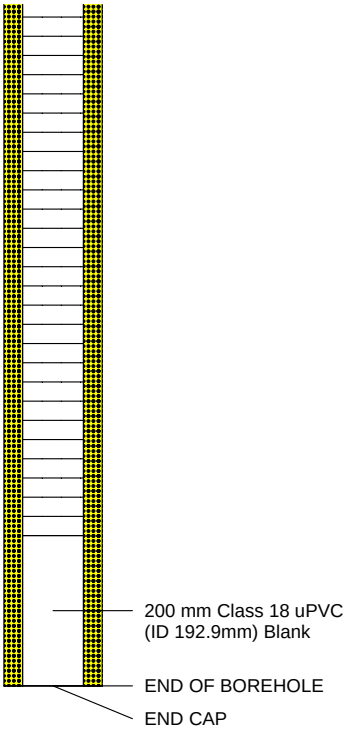
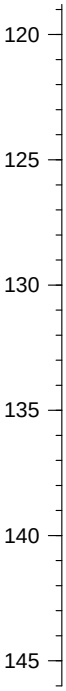
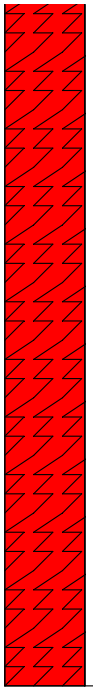
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB30

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
				

Comments:

PRODUCTION WELL BORE LOG

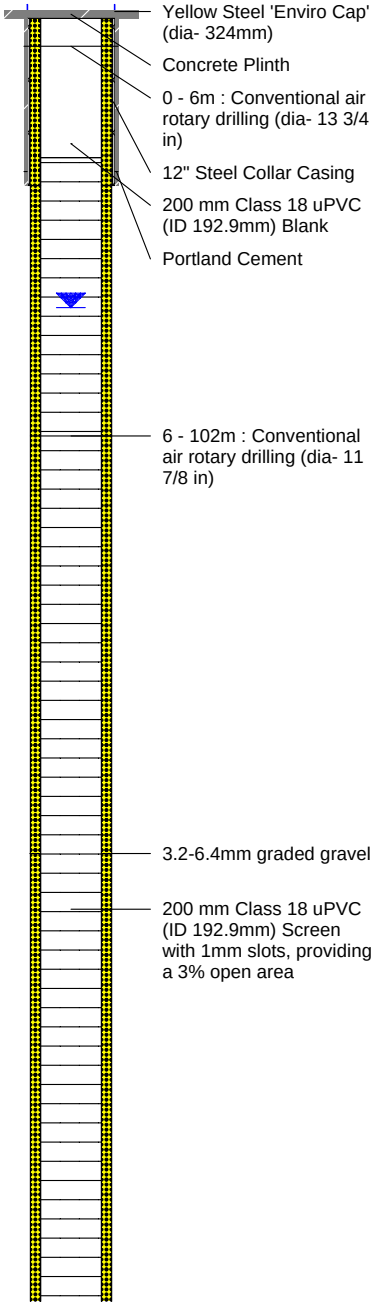
BOREHOLE NUMBER

NS-PB31

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709500.97**
NORTHING (m): **7647557.92**
MEAS PT ELEVATION (mAHD): **272.035**
DRILLING DIAMETER(S) (mm): **355**
26D LICENCE #: **CAW178127(1)**
DATE BEGUN: **31/05/2014** DATE COMPLETED: **3/06/2014**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.453**
Drilled Depth (mbgl):	**102**
Cased Depth (mbgl):	**101**
Casing Stick Up (magl):	**0.462**
Development Airlift Yield (l/s):	**11.1**
Water Level (mbgl) & Date:	**10.39** & **15/04/2015**



DEPTH	DESCRIPTION	YIELD (l/s)
0	BASALT: Highly weathered, 70% is 2-50mm well graded chips, 30% return as powder; 70% dark olive green, fine to medium grained ultramafics, with a medium olive, fine grained to glassy matrix with black inclusions; 30% detritus including angular chips of grey to tr	
5	BASALT: As above, moderately weathered; 80% doleritic basalt; 20% detritus	
	BASALT: As above, mildly weathered; 90% doleritic basalt; 10% detritus	
10	SHALE: Mildly weathered medium to hard olive green shale, 2-50mm platy, angular chips, 1-10mm thick, oxidation and black dendritic formations along foliation planes. Driller notes fractures from 8-14m	
	SHALE: Medium olive grey, well graded 1-20mm chips with larger plates of shale, 60% shale as above, slightly more silicified, border-lining slate, 40% doleritic basalt as above, both rock types are slightly lighter/more milky green than above and moderately oxid	1
15	BASALT: 60% doleritic basalt as above, 40% silicified shale/slate as above	
	BASALT: Medium olive grey, moderately oxidized, well graded 2-50mm, 50% doleritic basalt to serpentinite, softer and more silty in texture than basalt above, 20% medium to soft siltstone, lighter in colour, 20% milky to transparent chert, 10% shale as above, tra	5
20	CALCAREOUS CHERT: Medium olive grey, well graded 2-20mm chips with trace gravels, 80% mildly oxidized chert with irregular fracture planes, black elongated inclusions and trace tiny yellow-lined vesicle like inclusions, 20% mix of shale, white quartz, doleritic basalt and	
	CALCAREOUS CHERT: Medium olive grey, well graded 2-20mm chips, 90% calcareous chert as above with trace lighter calcareous marbling, still mildly oxidized, 10% light soft siltstone (only 1-3mm rounded chips), trace quartz and aragonite	8
25	CALCAREOUS CHERT: Subrounded to subangular, well graded 2-20mm chips, 70% mottled bright olive to blue green and white calcareous chert, 30% colourless to white chert/quartz, trace shale and doleritic basalt	
30	CALCAREOUS CHERT: Subrounded to subangular, well graded 2-20mm chips, 85% chert as above, darker and brighter green in colour, trace oxidation, 15% grey to white chert/quartz	10
	CALCAREOUS CHERT: Chips as above with consistent size and shape through end of borehole. Mottled green calcareous chert: 50% milky light green with moderate oxidation and 20% dark, bright green, 20% dark olive grey calcareous chert; 10% white to transparent non-calcareous	
35	CALCAREOUS CHERT: Mottled calcareous chert: mostly milky green with patches of white and dark green, minor white to transparent siliceous chert/quartz, light soft siltstone and aragonite, trace oxidation, drilling begins to slow slightly at 40m	10.5
40	CALCAREOUS CHERT: 70% light milky green calcareous chert as above, 30% dark blue green to grey calcareous chert as above, trace dolomitic basalt and aragonite, trace oxidation	
	CALCAREOUS CHERT: 85% dark blue green to grey calcareous chert as above, 10% light milky green soft siltstone, 5% white aragonite, trace oxidation	11
45	CALCAREOUS CHERT: 60% dark green calcareous chert as above, 20% dark green fine to	

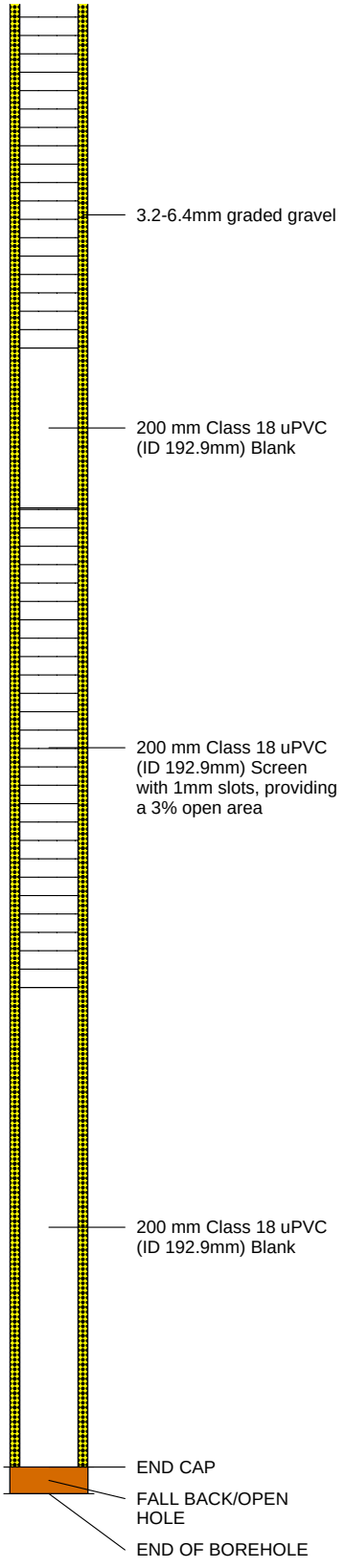
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB31

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
50		medium grained basalt, 10% light green siltstone, 10% white to transparent aragonite and quartz, moderate oxidation	11
		CALCAREOUS CHERT: 80% dark to medium green calcareous chert as above, slightly lighter in colour, 20% light green to white soft siltstone, aragonite and quartz, trace oxidation	
		CALCAREOUS CHERT: As above, slightly lighter and brighter green and one gravel sized clast of aragonite with a vain of embedded sediments	
55		CALCAREOUS CHERT: As above, slightly darker and trace doleritic basalt	11.5
		BASALT: 80% dark green to black medium to fine grained, medium to soft meta-basalt marbled with 20% light green to white carbonates, trace pyrite	
60			11.5
		BASALT: 70% decreasing to 60% metamorphosed ultramafics- doleritic basalt as above, 30% increasing to 40% carbonates with increase in oxidation and trace shale (62-64m possibly contaminated)	
65			11.5
		CALCAREOUS CHERT: Marbled grey white green and colourless calcareous chert with 20% altered ultramafics, texture is highly variable with mottling, marbling and medium grained inclusions, in a glass matrix. Carbonate content decreased as pure siliceous chert content increas	
70		CALCAREOUS CHERT: 90% mottled light green calcareous chert with mild oxidation and 10% colourless quartz/chert, driller notes harder ground at 71m	16.5
		CHERT: Moderately weathered chips, 85% colourless to white and grey quartz/chert, 5% black quartz/chert, 10% marbled white and green calcareous chert	
75		CHERT: Trace to mildly weathered chips, 60% colourless to white and grey quartz/chert, 20% black chert, 20% marbled white and green chert with only trace carbonates	
		CHERT: 80% milky green chert with trace orange to red coloration (not oxidation), 20% colourless to white and grey chert with trace, more glassy chert, sample slightly more reactive to HCl	16.5
80		CHERT: 90% milky green as above, still only trace carbonates/reaction to HCl, trace to 10% colourless to white and grey glassy chert; driller notes formation becomes harder at 82m, drilling slows significantly at 82m	
85			16.5
90			16.5
95			16.5
100			16.5

Comments:

PRODUCTION WELL BORE LOG

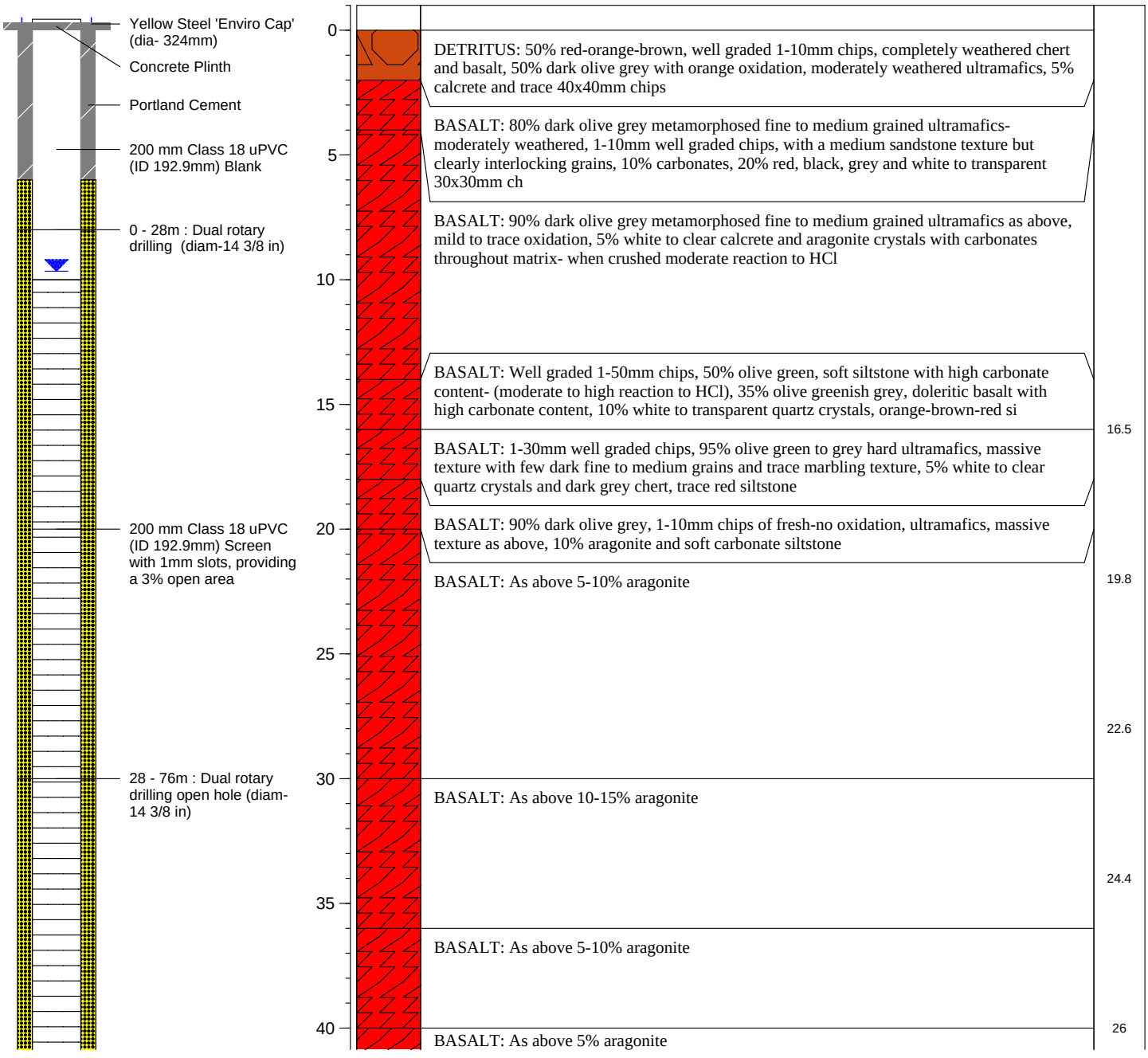
BOREHOLE NUMBER

NS-PB32

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Dual rotary drilling (28-76m open hole)**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709611.04**
NORTHING (m): **7647017.53**
MEAS PT ELEVATION (mAHD): **270.666**
DRILLING DIAMETER(S) (mm): **355**
26D LICENCE #: **CAW178127(1)**
DATE BEGUN: **31/03/2014** DATE COMPLETED: **2/04/2014**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.457**
Drilled Depth (mbgl):	**76**
Cased Depth (mbgl):	**76**
Casing Stick Up (magl):	**0.444**
Development Airlift Yield (l/s):	**6**
Water Level (mbgl) & Date:	**9.66** & **15/04/2015**



Comments: **Devolping Yield: 6L/S, Low yield due to using 6 5/8 rodsi n 8" installation.**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PB32

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
3.2-6.4mm graded gravel	45		BASALT: As above 5-10% aragonite	26
	50			26
	55		BASALT: As above trace-5% aragonite	26
200 mm Class 18 uPVC (ID 192.9mm) Screen with 1mm slots, providing a 3% open area	60			26
	65			26
	70			26
200 mm Class 18 uPVC (ID 192.9mm) Blank	75			26
END OF BOREHOLE				
END CAP				

Comments: **Devolping Yield: 6L/S, Low yield due to using 6 5/8 rodsi n 8" installation.**

PRODUCTION WELL BORE LOG

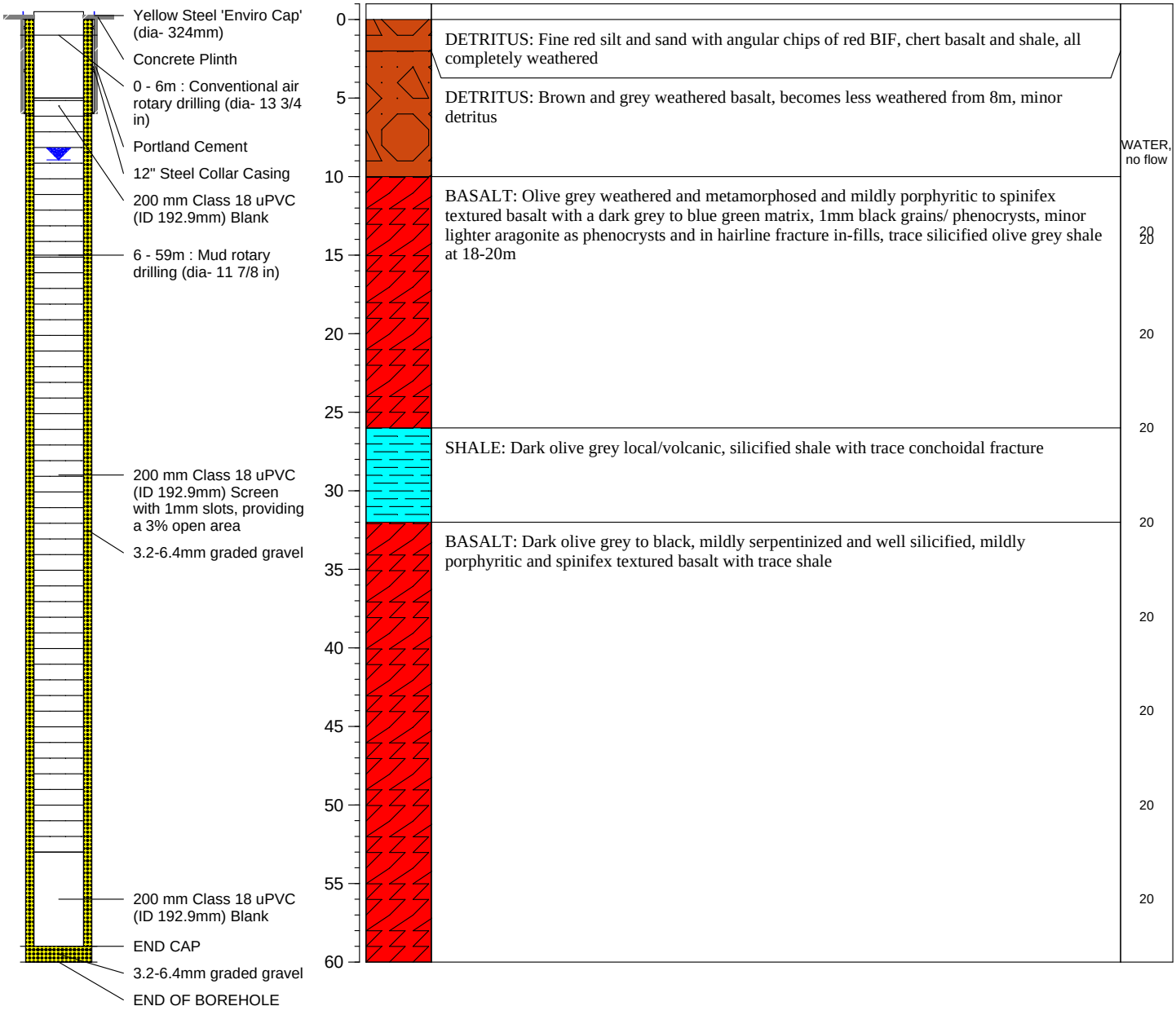
BOREHOLE NUMBER

NS-PB33

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Northern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Mud rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **710799.75**
NORTHING (m): **7647246.47**
MEAS PT ELEVATION (mAHD): **278.262**
DRILLING DIAMETER(S) (mm): **304**
26D LICENCE #:
DATE BEGUN: **28/11/2014** DATE COMPLETED: **1/12/2014**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.4662**
Drilled Depth (mbgl):	**60**
Cased Depth (mbgl):	**59**
Casing Stick Up (magl):	**0.557**
Development Airlift Yield (l/s):	**16.6**
Water Level (mbgl) & Date:	**8.94** & **15/04/2015**



Comments:

REPORT OF BOREHOLE: BH01

Golder Associates

CLIENT: Fortescue Metals Group Limited
PROJECT: North Star Magnetite Project
LOCATION: Pilbara Region
JOB NO: 117645032

POSITION:
COORDS: 710491.0 m E 7654795.0 m N MGA94 56
SURFACE RL: 266.00 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 142 mm HOLE DEPTH: 30.00 m

SHEET: 1 OF 1
DRILL RIG:
CONTRACTOR: McKAY
LOGGED: RF DATE: 11/12/11
CHECKED: GM DATE: 22/11/11

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
RC	11/12/11	0	266.00				SANDSTONE, fine grained, red brown colour, medium/high strength		Backfill
			3.00						Bentonite Seal (Wetted)
			263.00				Interbedded SANDSTONE, fine grained, red brown, high strength and SILTSTONE pale grey, medium strength		
		5							
		10							Gravel Pack
		15							Solid Casing 100mm
		20							Bentonite Seal (Wetted)
		25							Gravel Pack
			27.00						Slotted Casing 100mm
			239.00				Interbedded SANDSTONE, fine grained, pale grey, high strength and SILTSTONE pale gray, medium strength		
		30	30.00						
			236.00				END OF BOREHOLE @ 30.00 m		

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F05 RL3

GAP 8_07.2 LIB.GLB Log GAP WELL 117645032 - BOREHOLES NEW.GPJ <<DrawingFile>> 03/02/2012 17:57 8.2.856

REPORT OF BOREHOLE: BH02

Golder Associates

CLIENT: Fortescue Metals Group Limited
PROJECT: North Star Magnetite Project
LOCATION: Pilbara Region
JOB NO: 117645032

POSITION:
COORDS: 710144.0 m E 7654616.0 m N MGA94 56
SURFACE RL: 241.00 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 142 mm HOLE DEPTH: 30.00 m

SHEET: 1 OF 1
DRILL RIG:
CONTRACTOR: McKAY
LOGGED: RF DATE: 12/12/11
CHECKED: GM DATE: 22/11/11

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
RC	12/12/11	0	241.00				GP - Poorly graded Sandy GRAVEL. Medium size grained. Grey white and red brown colour, with some fine to coarse sand, traces of low plasticity fines.		Bentonite Seal (Wetted)
									Gravel Pack
		5							Bentonite Seal (Wetted)
			8.00 / 233.00				Interbedded SANDSTONE, medium to fine grained, yellow and grey colour, high strength and SILTSTONE pale grey colour, medium strength.		
		10	11.00 / 230.00				SILTSTONE. Red brown colour. Low/medium strength.		
			13.00 / 228.00				Interbedded SANDSTONE, fine grained, grey colour, high strength and SILTSTONE grey colour, medium strength		
		15							Solid casing 100mm
									Material collapsed
			18.00 / 223.00				Interbedded SANDSTONE, fine grained, red brown and yellow colour, high strength and SILTSTONE pale grey and red brown colour, medium strength		
		20							
		25							Slotted casing 100mm
		30	30.00 / 211.00				END OF BOREHOLE @ 30.00 m		

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F05 RL3

GAP 8_07.2 LIB.GLB Log GAP WELL 117645032 - BOREHOLES NEW.GPJ <<DrawingFile>> 03/02/2012 17:57 8.2.856

REPORT OF BOREHOLE: BH05 A

Golder Associates

CLIENT: Fortescue Metals Group Limited
PROJECT: North Star Magnetite Project
LOCATION: Pilbara Region
JOB NO: 117645032

POSITION:
COORDS: 710512.0 m E 7654257.0 m N MGA94 56
SURFACE RL: 245.00 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 142 mm HOLE DEPTH: 30.00 m

SHEET: 1 OF 1
DRILL RIG:
CONTRACTOR: McKAY
LOGGED: RF DATE: 12/12/11
CHECKED: GM DATE: 22/11/11

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
RC	12/12/11	0	245.00				GP - Poorly graded Sandy GRAVEL. Medium size grained. Grey white and red brown, with some fine to coarse sand, traces of low placity fines.		Backfill
			1.00 244.00				SILTSTONE pale grey colour, medium strength.		
		5							Bentonite Seal
			8.00 237.00				SANDSTONE, medium to fine grained, pale grey colour, high strength.		Gravel Pack
		10							
		15							Solid Casing 100mm
									Material collapsed
		20							
		25							Slotted casing 100mm
									Material collapsed
		30	30.00 215.00				END OF BOREHOLE @ 30.00 m		

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F05 RL3

GAP 8_07.2 LIB.GLB Log GAP WELL 117645032 - BOREHOLES NEW.GPJ <<DrawingFile>> 03/02/2012 17:57 8.2.856

REPORT OF BOREHOLE: BH05 B

CLIENT: Fortescue Metals Group Limited
PROJECT: North Star Magnetite Project
LOCATION: Pilbara Region
JOB NO: 117645032

POSITION:
COORDS: 710512.0 m E 7654257.0 m N MGA94 56
SURFACE RL: 245.00 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 190 mm HOLE DEPTH: 8.20 m

SHEET: 1 OF 1
DRILL RIG:
CONTRACTOR: McKAY
LOGGED: RF DATE: 12/12/11
CHECKED: GM DATE: 22/11/11

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
RC	12/12/11	0	245.00				GP - Poorly graded Sandy GRAVEL. Medium size grained. Grey white and red brown, with some fine to coarse sand, traces of low placity fines.		Backfill
			1.00						Bentonite Seal (Wetted)
		1	244.00				SILTSTONE pale grey colour, medium strength.		Solid Casing 100mm
		2							
		3							
		4							Gravel Pack
		5							Slotted Casing 100mm
		6							
		7							Material Collapsed
		8	8.20						
			236.80				END OF BOREHOLE @ 8.20 m		
		9							

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GAP gINT FN. F05 RL3

GAP 8_07.2 LIB.GLB Log GAP WELL 117645032 - BOREHOLES NEW.GPJ <<DrawingFile>> 03/02/2012 17:57 8.2.856

REPORT OF BOREHOLE: BH06 A

CLIENT: Fortescue Metals Group Limited
PROJECT: North Star Magnetite Project
LOCATION: Pilbara Region
JOB NO: 117645032

POSITION:
COORDS: 710279.0 m E 7654206.0 m N MGA94 56
SURFACE RL: 272.50 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 142 mm HOLE DEPTH: 72.00 m

SHEET: 1 OF 1
DRILL RIG:
CONTRACTOR: McKAY
LOGGED: RF DATE: 11/12/11
CHECKED: GM DATE: 22/11/11

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
RC	11/12/11	0	272.50				Interbedded SANDSTONE, fine grained, red brown, low strength and SILTSTONE pale grey, low strength		
			6.00 266.50				SANDSTONE, medium to fine grained, red brown and pale grey colour, low to medium strength.		Backfill
		10	14.00 258.50				SANDSTONE, medium grained, red brown and pale grey colour, medium strength.		Bentonite Seal (Wetted)
		20							Gravel Pack
		30	33.00 239.50				SANDSTONE, medium grained, pale grey colour, medium to high strength.		
		40							Solid Casing 100mm
		50							Material collapsed
		60							
		70	72.00 200.50				END OF BOREHOLE @ 72.00 m		Slotted Casing 100mm

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F05
RL3

GAP 8_07.2 LIB.GLB Log GAP WELL 117645032 - BOREHOLES NEW.GPJ <<DrawingFile>> 03/02/2012 17:57 8.2.856

REPORT OF BOREHOLE: BH06 B

CLIENT: Fortescue Metals Group Limited
PROJECT: North Star Magnetite Project
LOCATION: Pilbara Region
JOB NO: 117645032

POSITION:
COORDS: 710279.0 m E 7654206.0 m N MGA94 56
SURFACE RL: 272.50 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 190 mm HOLE DEPTH: 6.50 m

SHEET: 1 OF 1
DRILL RIG:
CONTRACTOR: McKAY
LOGGED: RF DATE: 11/12/11
CHECKED: GM DATE: 22/11/11

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
RC		0	272.50				Interbedded SANDSTONE, fine grained, red brown, low strength and SILTSTONE pale grey, low strength		Solid Casing 100mm Backfill
		1							Bentonite Seal (Wetted)
		2							
		3							Slotted Casing 100mm
		4							Gravel Pack
		5							
		6	6.00 266.50				SANDSTONE, medium to fine grained, red brown and pale grey colour, low to medium strength.		
			6.50 266.00				END OF BOREHOLE @ 6.50 m		
		7							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F05
RL3

GAP 8_07.2 LIB.GLB Log GAP WELL 117645032 - BOREHOLES NEW.GPJ <<DrawingFile>> 03/02/2012 17:57 8.2.856

EXPLORATION BORE LOG

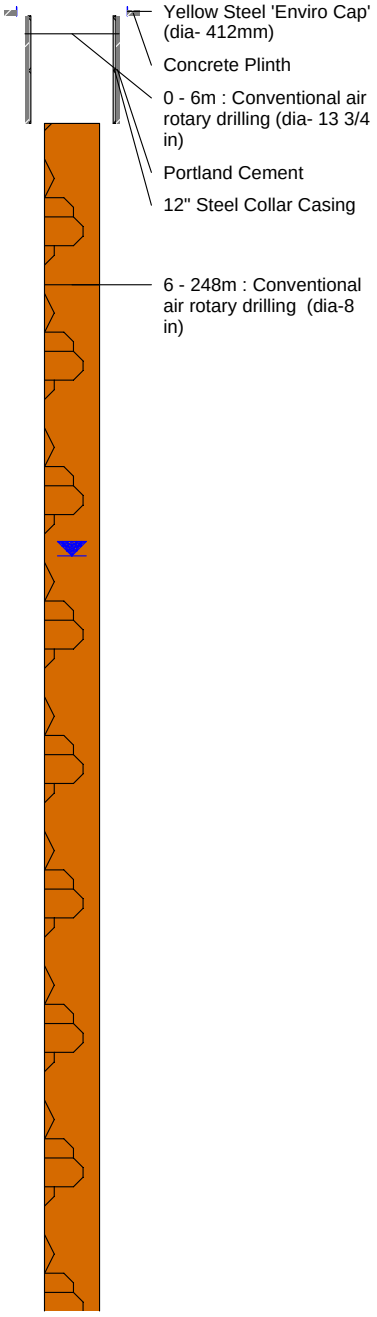
BOREHOLE NUMBER

NS-EXS01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**710042.23**
NORTHING (m):	**7646156.24**
MEAS PT ELEVATION (mAHD):	**292.133**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **21/01/2015**	DATE COMPLETED: **23/01/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**248**
Completion Stick Up (magl):	**0.703**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**30.12** & **11/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Black and grey chert, red and brown silt, brown to white fine soft schist, minor calcrete	
5	SCHIST: Well weathered, soft, white, brown and black schist, mottled to massive in texture, crumbles easily, minor chert, 50% powder, 50% chips, trace carbonates from 2-6m, increase in dark chert from 10-12m	
10		
15	CHERT: Weathered, angular chips of chert ranging from milky to transparent, colourless, and grey to black, oxidized on 30% of fracture planes, trace to minor schist as above, increased oxidation from 20-22m	
20	CHERT: Pale milky green with minor grey, black and colourless chert as above with colourless quartz veinlets, well weathered with oxidised surfaces	
25	CHERT: As above, chips become brighter green with massive to brecciated inclusions in a microcrystalline quartz matrix	
30	SCHIST: Very soft pale green schist, breaks up into fine silt powder, 80% powder, 20% chips, minor green grey black and colourless chert as above	
35	CHERT: Pale milky to slightly brighter green chert, minor dark grey and colourless chert, minor soft schist, all well oxidized with 30-50% of surfaces weathered to an orange brown, increased oxidation and colourless quartz to 50% from 38-40m	WATER no flow
40	CHERT: Milky microcrystalline chert matrix to cement with white, colourless and grey brecciated inclusions up to 1 mm in diameter, minor colourless angular quartz, trace oxidation increasing at 42-44m	6.5
45	CHERT: Colourless to milky white, angular to subrounded quartz chips	6.5
50	CHERT: Mostly colourless with minor white and grey quartz as above, minor green chert as above, trace weathering, minor soft green mottled schist increasing with depth to 60% by 52m, then decreasing to 40% by 54m	6.5
55	CHERT: Bright green, semi-transparent, angular quartz, mottled with lighter green schist and colourless quartz, textures continue to be mottled to brecciated in a microcrystalline matrix or massive with quartz veinlets, metamorphosed	6.5
60	CHERT: As above, minor orange to brown inclusions and veinlets, increased oxidation from 62m, colour becomes darker olive green with trace mafic schist from 64-68m	6.5
65		6.5
70		

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	75			5.5
	80		CHERT: As above, chips are more silicified, less pale green schist and decreasing with depth to trace by 80m, increase in bright green to aqua and darker olive grey colouration, chips show brecciated, massive and mottled textures with veinlets of colourless, orange to brown quartz, mild to moderate oxidation, minor colourless quartz chips from larger quartz veins, trace ironstone, minor weathered iron rich inclusions, trace green schist, at 92-94m	5.5
	85			5.5
	90			5.5
	95		CHERT: As above, overall colour becomes more pale olive to brown and texture becomes more massive, colour darkening with depth, minor mafic schist	5.5
	100			5.5
	105			5.5
	110		BASALT: Medium to dark olive green to grey basalt, high carbonate content, massive with a silty mottled texture, minor marbling with carbonate minerals, minor aragonite, minor quartz	5.5
	115			5.5
	120			5.5
	125			5.5
OPEN HOLE	130		BASALT: As above, trace mineralisation in veins with quarts, increased quartz and carbonates at 132m	5.5
	135		BASALT: As above, slightly more silicified, with a more quartzite texture, white carbonates marbled in or confined to fracture planes	5.5
	140			5.5
	145			5.5
	150			5.5
	155			5.5
	160			5.5
	165			5.5

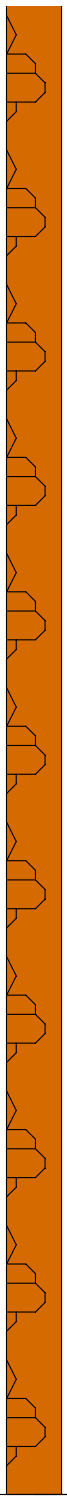
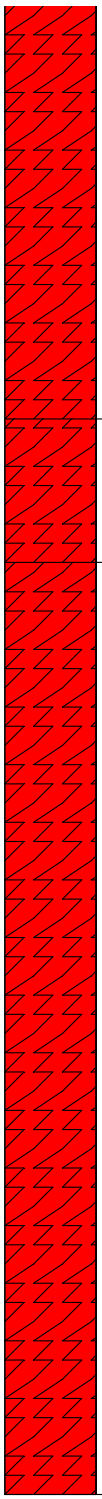
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245		BASALT: As above with minor colourless quartz and minor chips of darker olive green to black (less grey), with a more granular texture, grains are distinguishable, minor pyrite, moderate carbonates, trace oxidation, darker green to black chips from 194-196m BASALT: Olive grey basalt, high carbonate content, granular in texture, with minor visible darker and lighter grains under 1mm and mottled with white carbonates, 10% dark olive green to black basalt chips, trace pyrite, trace mineralization	5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5

END OF BOREHOLE

Comments:

EXPLORATION BORE LOG

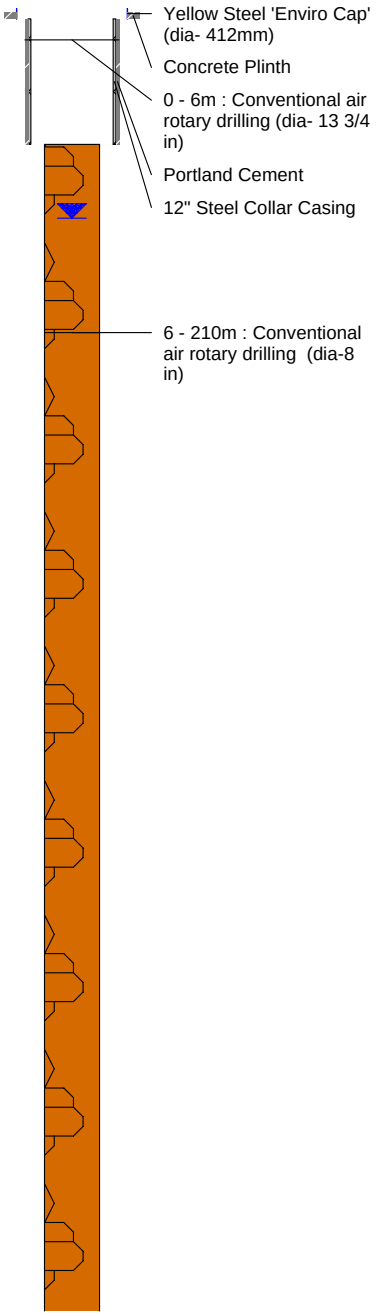
BOREHOLE NUMBER

NS-EXS03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **710676.81**
NORTHING (m): **7644834.78**
MEAS PT ELEVATION (mAHD): **271.997**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **18/01/2015** DATE COMPLETED: **29/01/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**210**
Completion Stick Up (magl):	**0.472**
Development Airlift Yield (l/s):	**47.1**
Water Level (mbgl) & Date:	**9.53** & **11/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	SANDSTONE/WACKE: Red orange, pink and purple, weathered, fine grained meta wacke with minor grains of 0-1mm quartz sand 60% powder, 40% 1-10mm chips, mostly under 5mm	
10	SANDSTONE/WACKE: White to grey fine grained sand in a white to yellow matrix, silicified, weathered and metamorphosed, crumbles easily, 80% powder, 20% chips	
15	SANDSTONE/WACKE: 90% pale red to orange fine silt powder with minor 0-1mm sand grains and chips of sand in a yellow to white and pale red to orange matrix, trace chips over 10mm	
20		WATER no flow
25	SANDSTONE/WACKE: As above, pale orange to white	0.4
30	SANDSTONE/WACKE: As above, red to purple, minor iron stone	0.4
35	SANDSTONE/WACKE: As above, white to light grey	0.4
40	SANDSTONE/WACKE: As above, 70% powder, 30% chips, moderate oxidation, with minor purple and red chips, minor ironstone, grains are less distinguishable, more mottling with metamorphosed to quartzite texture, still very high matrix quantities, over all soft to medium in hardness and crumples easily	0.4
45	SANDSTONE/WACKE: As above, only trace oxidation and orange to yellow colouration	1
50		1
55		
60		

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	65			1
	70		SANDSTONE/WACKE: As above, over all more silicified, with less soft white matrix which has become more of a cement and nearly impossible to distinguish, minor pink colouration in chips from 76-80m, 60% chips, 40% powder	2
	75			2
	80		SANDSTONE/WACKE: Pale olive grey wacke with increased (60%) matrix, quartz grains becoming easily distinguished in milky olive grey matrix, minor pink colouration, minor elongated grains not in any preferential orientation, most chips are under 1mm with 60% powder, 40% chips	2
	85			2
	90		SANDSTONE/WACKE: Pale green wacke with a reduced matrix of 10-15% mostly as a cement, mottled texture and harder overall with less soft matrix, becoming darker green with depth	2.5
	95			
	100		SANDSTONE/WACKE: Medium grey green quartz grains in a 50% medium to pale milky green silica matrix, grains are angular to subrounded with many elongated to blade like grains not preferentially oriented, chip percentage begins to increase and reaches 70% chips by 98m, driller notes harder drilling from 98-108m, grains become less distinguishable with a more mottled quartzite texture from 104-110	3
	105			3
OPEN HOLE	110		SANDSTONE/WACKE: As above, matrix is not silicified but silty and softer in hardness, chip percentage begins to decrease to 60% by 118m	3
	115			3
	120		SANDSTONE/WACKE: Medium grey green and pale to bright green quartz grains in a white to pale green matrix, some chips have a softer matrix that is easily scratched, others are well silicified, texture is mottled to granular, minor angular colourless transparent quartz chips, 70% chips 30% fine sand to powder	3
	125			3
	130		SANDSTONE/WACKE: As above, brighter green in colour, minor pink to red colouration or grains and over all chip size decreases to 1-3mm, texture is less granular and the grains are less distinguishable from 126-128m	3
	135			3
	140		SANDSTONE/WACKE: As above, brighter green in colour, minor pink to red colouration or grains and over all chip size decreases to 1-3mm, texture is less granular and the grains are less distinguishable from 126-128m	3
			SANDSTONE/WACKE: As above, dull grey in colour with minor pale orange inclusions or	

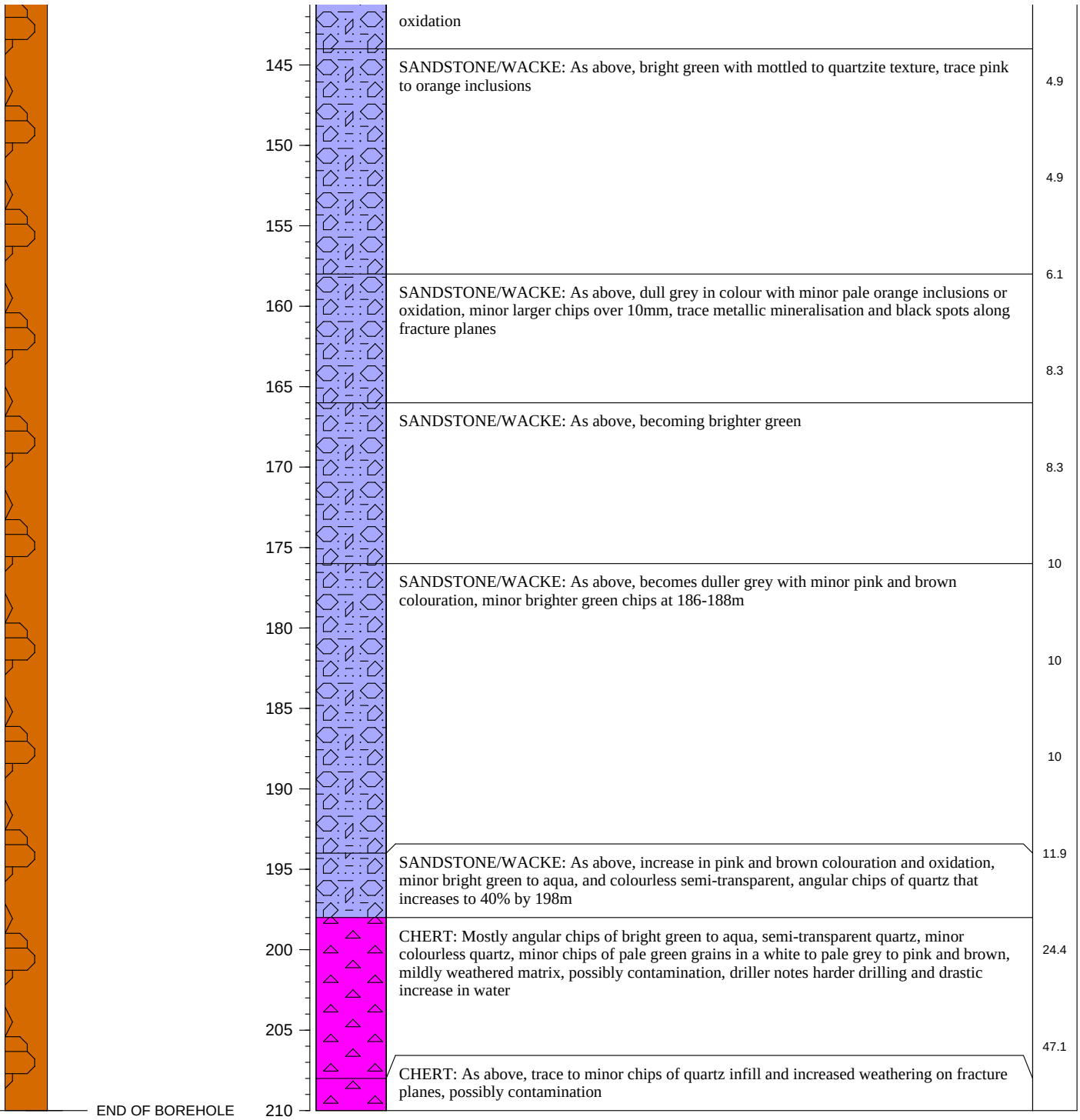
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	145		oxidation	
	150		SANDSTONE/WACKE: As above, bright green with mottled to quartzite texture, trace pink to orange inclusions	4.9
	155			4.9
	160		SANDSTONE/WACKE: As above, dull grey in colour with minor pale orange inclusions or oxidation, minor larger chips over 10mm, trace metallic mineralisation and black spots along fracture planes	6.1
	165			8.3
	170		SANDSTONE/WACKE: As above, becoming brighter green	8.3
	175			10
	180		SANDSTONE/WACKE: As above, becomes duller grey with minor pink and brown colouration, minor brighter green chips at 186-188m	10
	185			10
	190			10
	195		SANDSTONE/WACKE: As above, increase in pink and brown colouration and oxidation, minor bright green to aqua, and colourless semi-transparent, angular chips of quartz that increases to 40% by 198m	11.9
	200		CHERT: Mostly angular chips of bright green to aqua, semi-transparent quartz, minor colourless quartz, minor chips of pale green grains in a white to pale grey to pink and brown, mildly weathered matrix, possibly contamination, driller notes harder drilling and drastic increase in water	24.4
	205			47.1
END OF BOREHOLE	210		CHERT: As above, trace to minor chips of quartz infill and increased weathering on fracture planes, possibly contamination	

Comments:

EXPLORATION BORE LOG

BOREHOLE NUMBER

NS-EXS04

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**709573.88**
NORTHING (m):	**7645436.45**
MEAS PT ELEVATION (mAHD):	**286.127**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **5/02/2015**	DATE COMPLETED: **8/02/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**302**
Completion Stick Up (magl):	**0.645**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**25.83** & **13/04/2015**

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
Yellow Steel 'Enviro Cap' (dia- 412mm) Concrete Plinth 0 - 6m : Conventional air rotary drilling (dia- 13 3/4 in) Portland Cement 12" Steel Collar Casing 6 - 302m : Conventional air rotary drilling (dia-8 in)	0 5 10 15 20 25 30 35 40 45 50 55 60 65		DETRITUS: Completely weathered red silt and angular clasts of schist and chert, 80% 1-50mm chips, 20% silt SCHIST: As above, 30% chips, 70% silt SCHIST: Moderately weathered angular chips of medium to soft olive grey with minor pale white to orange schist to completely weathered metabasalt, minor angular grey chert, 50% 1-10mm chips, 50% pale grey to brown silt SCHIST: Pale grey schist to saprolitic basalt, 95-100% powder, trace to 5% 1-5mm chips SCHIST: As above, minor pink to orange schist with minor iron cement and chert SCHIST: Pale grey schist to saprolitic basalt, 95-100% powder, trace to 5% 1-5mm chips SCHIST: As above, minor pink to orange colouration with minor iron cement and chert BASALT: Weathered, soft, olive green to pale brown schist to saprolitic metabasalt, moderate oxidation on fracture planes, reducing with depth to trace by 38m, 40% 2-5mm chips with few over 15mm, texture is mottled to mildly granular, however when scratched all crumbles easily and evenly, soapy texture and pearly lustre BASALT: Olive grey metamorphosed basalt as above, granular texture can be observed	

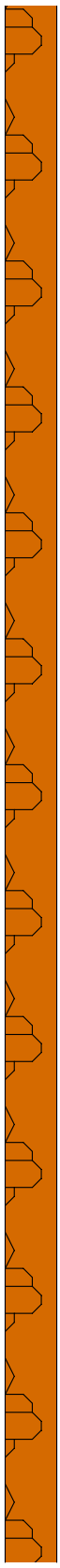
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS04

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
70			
75			WATER, no flow
80			WATER, no flow
85			WATER, no flow
90			WATER, no flow
95			WATER, no flow
100			0.2
105			0.2
110		BASALT: As above, small sample return from 108-110, high silt/clay content, sample becomes less granular, trace pyrite at 118m, trace darker schist at 122-124m	0.2
115			0.2
120			0.2
125			0.2
130			0.2
135		BASALT: Metabasalt as above, minor darker silicified serpentinite to chert	0.2
140		BASALT: Metabasalt as above	0.2
145			0.2
150		BASALT: As above, texture becomes less granular, increased pink and red oxidation, minor colourless to white quartz	0.2

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS04

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
OPEN HOLE	155		BASALT: As above, becoming more silicified, 25-30% white quartz	0.2
	160		BASALT: Metabasalt, less pink and red oxidation and continues to become more silicified with depth, 5-15% white quartz	0.2
	165		BASALT: Quartzite like mottled colouration, chips are much harder and overall calcareous	0.2
	170		BASALT: Massive to mottled, medium grey calcareous, metamorphosed basalt with minor, very hard pale brown chert from 168-170m	1
	175			1
	180		BASALT: Olive green, very hard massive quartz/chert with conchoidal fracture and minor olive green to grey slightly softer calcareous chert marbled with and containing lighter carbonates in matrix, possibly a minor silicified flow top	1
	185		BASALT: Olive green speckled to mottled medium grained metamorphosed calcareous doleritic basalt of medium hardness, darker and lighter grains are visible but mottled and interlocking, moderately to well silicified, reacts strongly with HCl	1
	190			1
	195			1
	200		BASALT: As above, harder, more silicified with little to no reaction to HCl, texture is more soapy, minor, massive, slightly paler olive green quartz chert from 198-200m	1
	205			1
	210			1
	215			1
	220			1
	225		BASALT: As above, colour becomes slightly paler green, increased carbonate content mostly in concentrated regions of marbled or veined white carbonates, texture is still soapy with only trace speckled to mottled colouration	1
	230			1
	235			1

Comments:

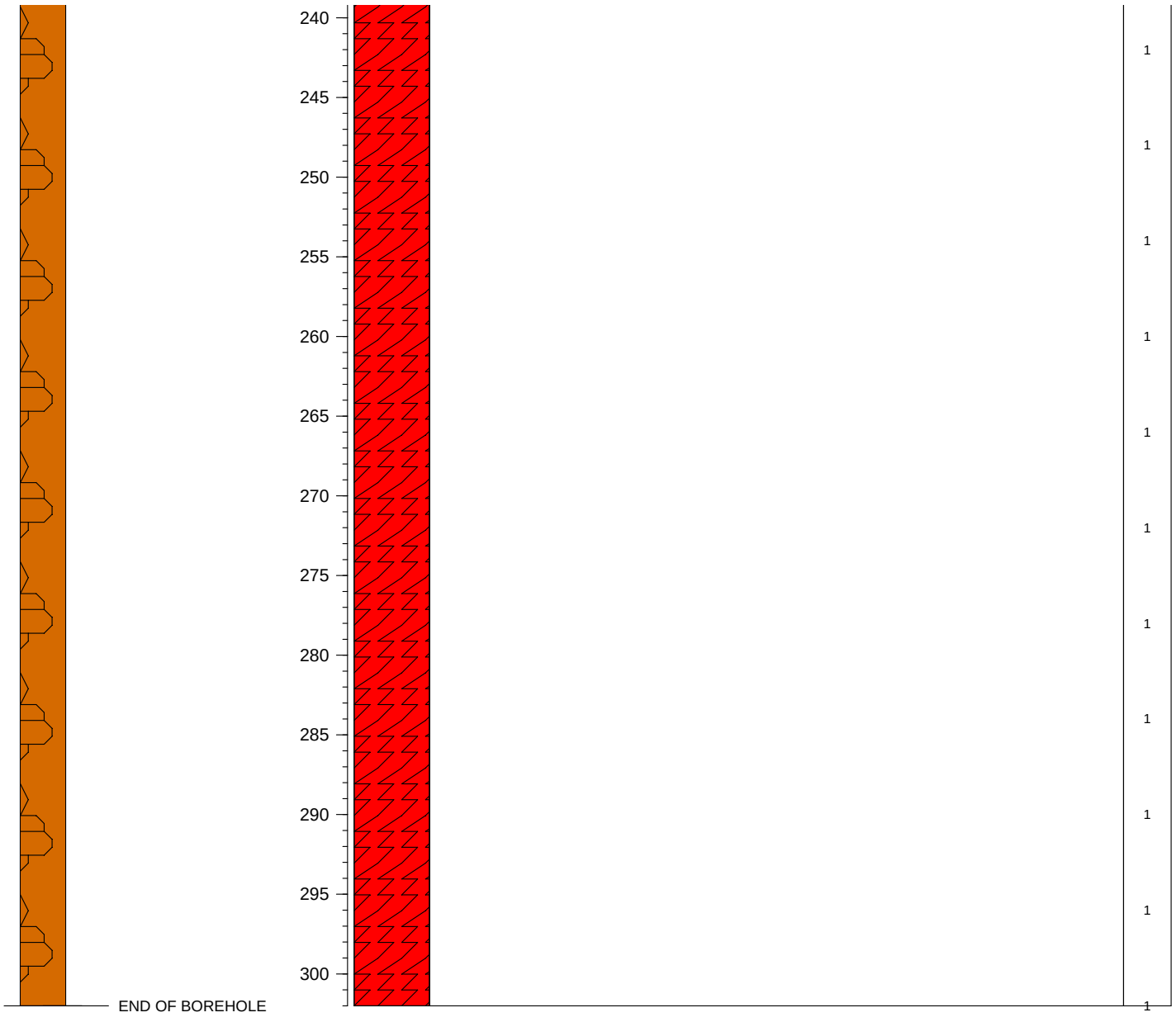
OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS04

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



Comments:

OBSERVATION WELL BORE LOG

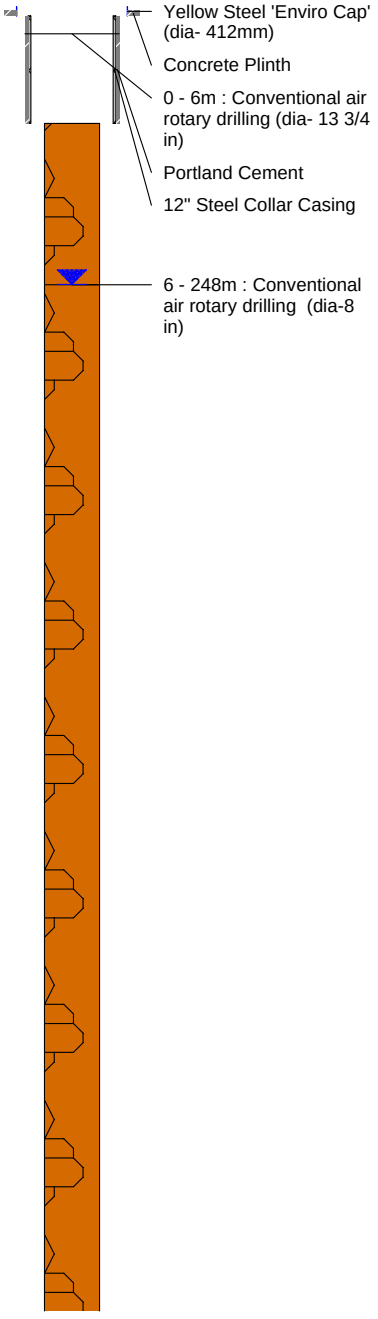
BOREHOLE NUMBER

NS-EXS17

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

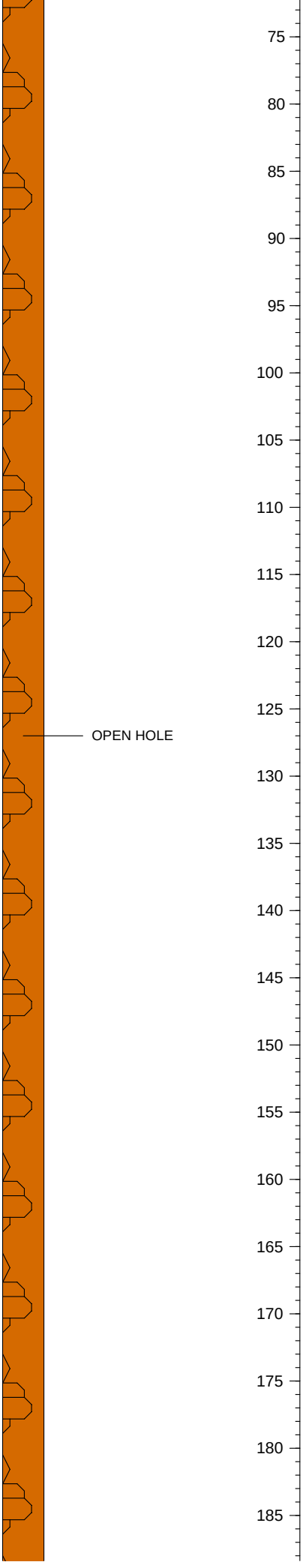
PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**709487.84**
NORTHING (m):	**7644908.84**
MEAS PT ELEVATION (mAHD):	**274.28**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **29/01/2015**	DATE COMPLETED: **31/01/2015**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.559**
Drilled Depth (mbgl):	**248**
Cased Depth (mbgl):	**NA**
Casing Stick Up (magl):	**NA**
Development Airlift Yield (l/s):	**25+**
Water Level (mbgl) & Date:	**14.98 & 11/04/2015**



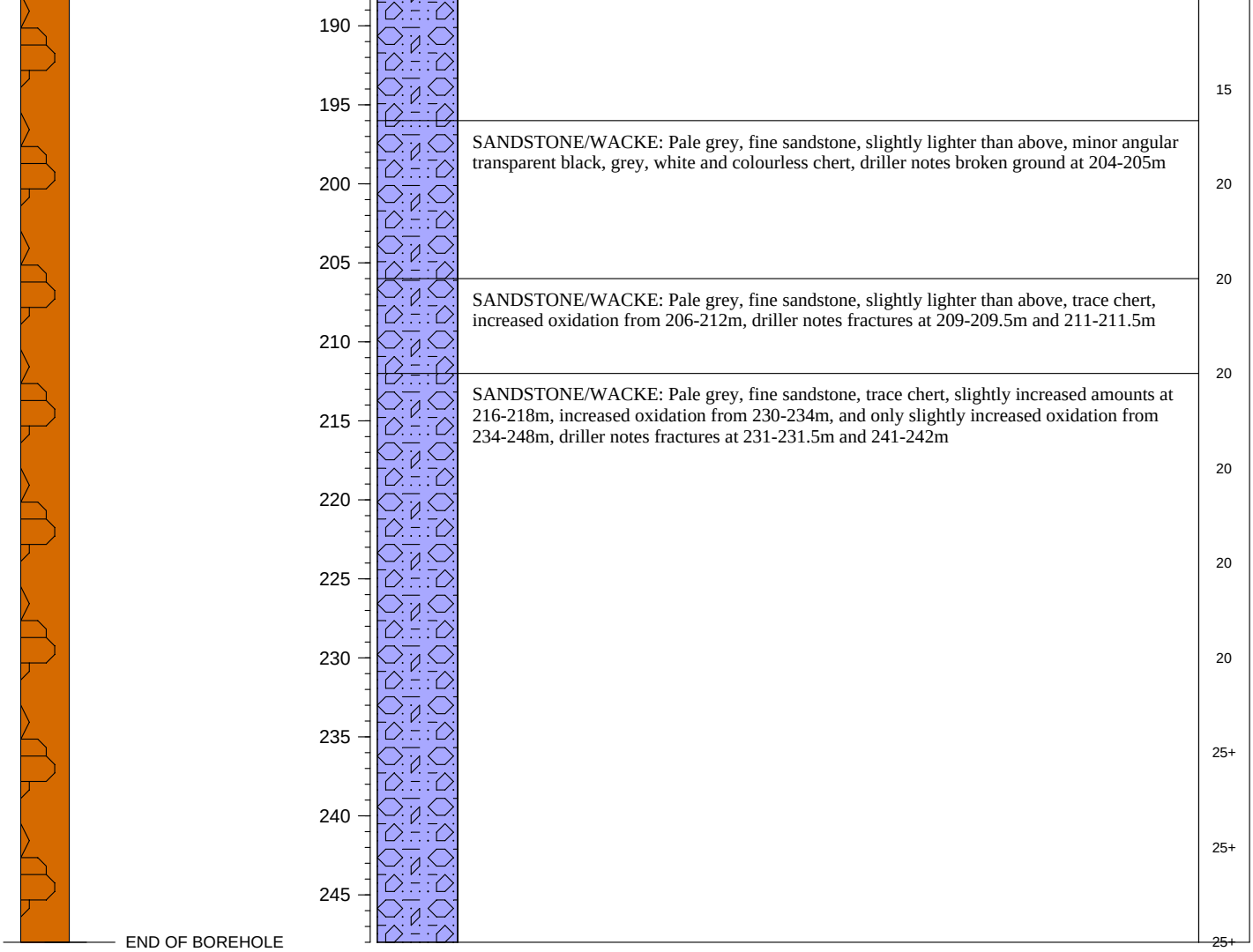
DEPTH	DESCRIPTION	YIELD (L/sec)
0	MUDSTONE: Orange to pale grey sandy mudstone, well weathered with more than half of fracture planes stained orange, sand is very fine grained, crumbles easily	
5	MUDSTONE: Pale grey with minor pink to purple sandy mudstone, moderately weathered, sand is very fine grained, crumbles easily	
10	MUDSTONE: Pale grey with minor pink to purple sandy mudstone, moderately weathered, sand is very fine grained, crumbles easily, minor angular transparent black chert	
15	MUDSTONE: Pale grey and pink to purple sandy mudstone, moderately weathered, sand is very fine grained, crumbles easily, minor weathered iron cement, trace angular transparent black chert	
20	MUDSTONE: Pale grey with minor pink to purple sandy mudstone interbedded or veined with chert, mildly weathered, medium hardness, minor quartz veinlets, minor angular transparent black, grey, white and colourless chert, with increased chert up to 50% at 12-18, 24-26, 28-34m, becoming sandier with depth	0.5
25		1
30		1
35	SANDSTONE/WACKE: Pale grey with trace pink to purple sandstone to wacke with chert veins, fine to medium grey sand in a pale grey to white cement to matrix, mildly weathered showing orange oxidation on 5-15% of fracture planes, medium hardness, minor quartz veinlets, minor angular transparent black, grey, white and colourless chert, trace secondary quartz infill, becoming overall slightly darker with depth	2
40		2.5
45		
50	SANDSTONE/WACKE: As above, driller notes fractures at 51.5-52m, increased quartz content at 54-56m and 58-62m	2.5
55		2.5
60		3
65	SANDSTONE/WACKE: As above, chert content increased to 20-30%, driller notes broken ground at 82-84m	3
70		

Comments:



75		3
80		3
85		3.5
90	SANDSTONE/WACKE: Pale grey sandstone as above, only minor chert, increased pink and purple colouration at 90-94m, increased chert content at 100-102m, and 108-110m, increased oxidation and pink colouration at 110-112m	3.5
95		3.5
100		3.5
105		4
110	SANDSTONE/WACKE: Pale grey sand stone as above, more strongly lithified and slightly darker, increased chert content at 114-116m, driller notes fractures at 116-116.5m	4
115	SANDSTONE/WACKE: Pale grey sandstone as above, weakly lithified, trace vuggy texture, trace large chips of secondary quartz in-fill, driller notes soft ground at 118-120m	6.5
120	SANDSTONE/WACKE: Grey sand stone as above, more strongly lithified and slightly darker, increased chert content at 120-122m and 130-132m, driller notes fractures at 123-123.5m and 126-127m	9
125		9
130	SANDSTONE/WACKE: Pale grey sandstone as above, weakly lithified, trace vuggy texture	11
135	SANDSTONE/WACKE: Grey sand stone as above, more strongly lithified and slightly darker, trace vuggy texture, larger (50mm) gravels of angular clasts of brecciated chert in a fine white silicified silt matrix from 146-150, metamorphosed, driller notes fractures at 145-146m, 147-148m, 150-151m and 158-160m, trace pyrite observed from 156m	13
140		13
145		15
150		15
155	SANDSTONE/WACKE: Grey, fine sandstone, slightly darker than above, trace chert, fresh rock, driller notes fracture at 165-165.5m and the ground becoming harder at 165.5m	15
160		15
165		15
170		15
175	SANDSTONE/WACKE: Pale grey, fine sandstone, slightly lighter than above, trace chert	15
180		15
185		

Comments:



		15
	SANDSTONE/WACKE: Pale grey, fine sandstone, slightly lighter than above, minor angular transparent black, grey, white and colourless chert, driller notes broken ground at 204-205m	20
	SANDSTONE/WACKE: Pale grey, fine sandstone, slightly lighter than above, trace chert, increased oxidation from 206-212m, driller notes fractures at 209-209.5m and 211-211.5m	20
	SANDSTONE/WACKE: Pale grey, fine sandstone, trace chert, slightly increased amounts at 216-218m, increased oxidation from 230-234m, and only slightly increased oxidation from 234-248m, driller notes fractures at 231-231.5m and 241-242m	20
		20
		20
		20
		25+
		25+
		25+

Comments:

EXPLORATION BORE LOG

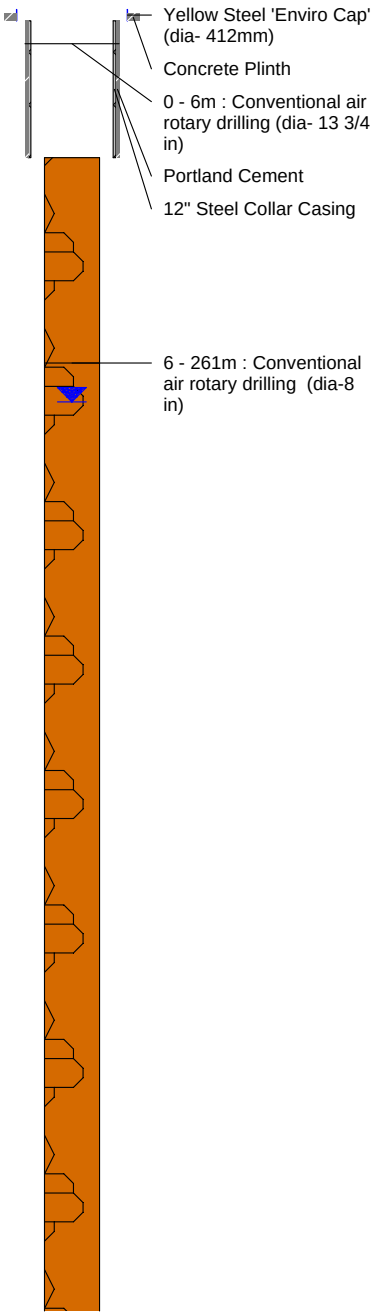
BOREHOLE NUMBER

NS-EXS21

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **708107.01**
NORTHING (m): **7645532.48**
MEAS PT ELEVATION (mAHD): **267.444**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **17/02/2015** DATE COMPLETED: **20/02/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**261**
Completion Stick Up (magl):	**0.708**
Development Airlift Yield (l/s):	**2.5**
Water Level (mbgl) & Date:	**16.7** & **11/04/2015**



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		CALCRETE: Weathered white to orange and red calcrete and silcrete, minor black chert, red sand and other detritus cemented bi calcrete	
5		SILTSTONE: Pale grey to white siltstone, mostly silt clumps, maybe 10% chips, minor carbonates, minor chert	
		CHERT: Black chert, moderately oxidized, minor white siltstone as above	
10		SILTSTONE: White siltstone, minor black chert as above and decreasing with depth, trace to minor carbonates/mild reaction to HCl	
		SILTSTONE: White siltstone, minor pink and purple colouration, trace black and colourless chert, trace to minor carbonates/mild reaction to HCl	
15		SILTSTONE: White siltstone, minor pink and purple colouration, trace to minor carbonates/mild reaction to HCl	
20		SILTSTONE: White siltstone, minor pink and purple colouration, trace black and colourless chert, trace to minor carbonates/mild reaction to HCl	
		CHERT: Black chert, moderately oxidized, trace white siltstone as above	
25		CHERT: Black chert, moderately oxidized, minor white siltstone as above	5
		CHERT: Black chert, moderately oxidized, trace white siltstone as above	
30		SILTSTONE: White siltstone, minor pink and purple colouration, trace black and colourless chert	5
35		SILTSTONE: White and pink siltstone, 30% black and colourless chert, increasing orange staining, trace ironstone	
		SILTSTONE: Orange and pink siltstone, trace black and colourless chert increasing to minor by 38m, increased orange staining from 34-36, trace ironstone	5
40		SILTSTONE: Pale white with minor orange siltstone, trace black and colourless chert	
		SILTSTONE: Pale white with minor orange siltstone, minor black and colourless chert	
45		SILTSTONE: Pale white with minor orange siltstone, becoming more granular with depth with grains visible from 44, trace black and colourless chert	5
		SILTSTONE: Pale grey sandy siltstone, 30% black and colourless chert, moderately oxidized	
50		CHERT: Pale grey, very fine, well lithified sandy, silicified chert to shale, trace oxidation, trace black and colourless chert and quartz veinlets	5
55			5

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS21

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
60		CHERT: Pale grey chert as above, with 40% white to colourless quartz	
		CHERT: Pale grey chert as above, with minor white to colourless quartz	5
65		CHERT: Pale grey, silicified shale to chert, trace oxidation, trace black and colourless chert and quartz veinlets, becoming more fine grained, silicified and metamorphosed, bordering chert	5
70			5
75			5
80			5
85			5
90			5
95		CHERT: As above, minor black, metamorphosed streamers, veinlets and melted textures, trace pyrite	5
100		CHERT: Pale grey, silicified chert to shale as above	5
105		CHERT: As above, minor black, metamorphosed streamers, veinlets and melted textures, trace pyrite	
110		CHERT: Pale grey, silicified chert to shale as above with 40% black and white chert	5
115		CHERT: Pale grey, silicified chert to shale as above with minor black and white chert and trace pyrite	5
120		CHERT: Pale grey, silicified chert to shale as above with trace black and white chert and trace pyrite	5
125			5

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS21

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
OPEN HOLE	130			
	135		CHERT: Pale grey, silicified chert to shale as above with minor black and white chert and trace pyrite	5
	140		CHERT: Pale grey, silicified chert to shale as above with trace black and white chert and trace pyrite	5
	145			5
	150			5
	155			5
	160		CHERT: Black chert, minor pale grey silicified chert to shale as above, trace oxidation, trace pyrite	5
	165		CHERT: Pale grey silicified chert to shale as above, minor black chert decreasing with depth to trace by 166m, trace pyrite	
	170		CHERT: Black chert, trace pale grey silicified chert to shale as above increasing to minor by 170m	7
			CHERT: Pale grey silicified chert to shale as above, trace black chert	
	175		CHERT: Black chert, minor pale grey silicified chert to shale as above, trace pyrite	7
	180		CHERT: Pale chert, minor black chert, trace pyrite	7
	185		CHERT: Black chert, minor grey and colourless chert, trace pyrite	7
	190			7
	195			7
	200			7

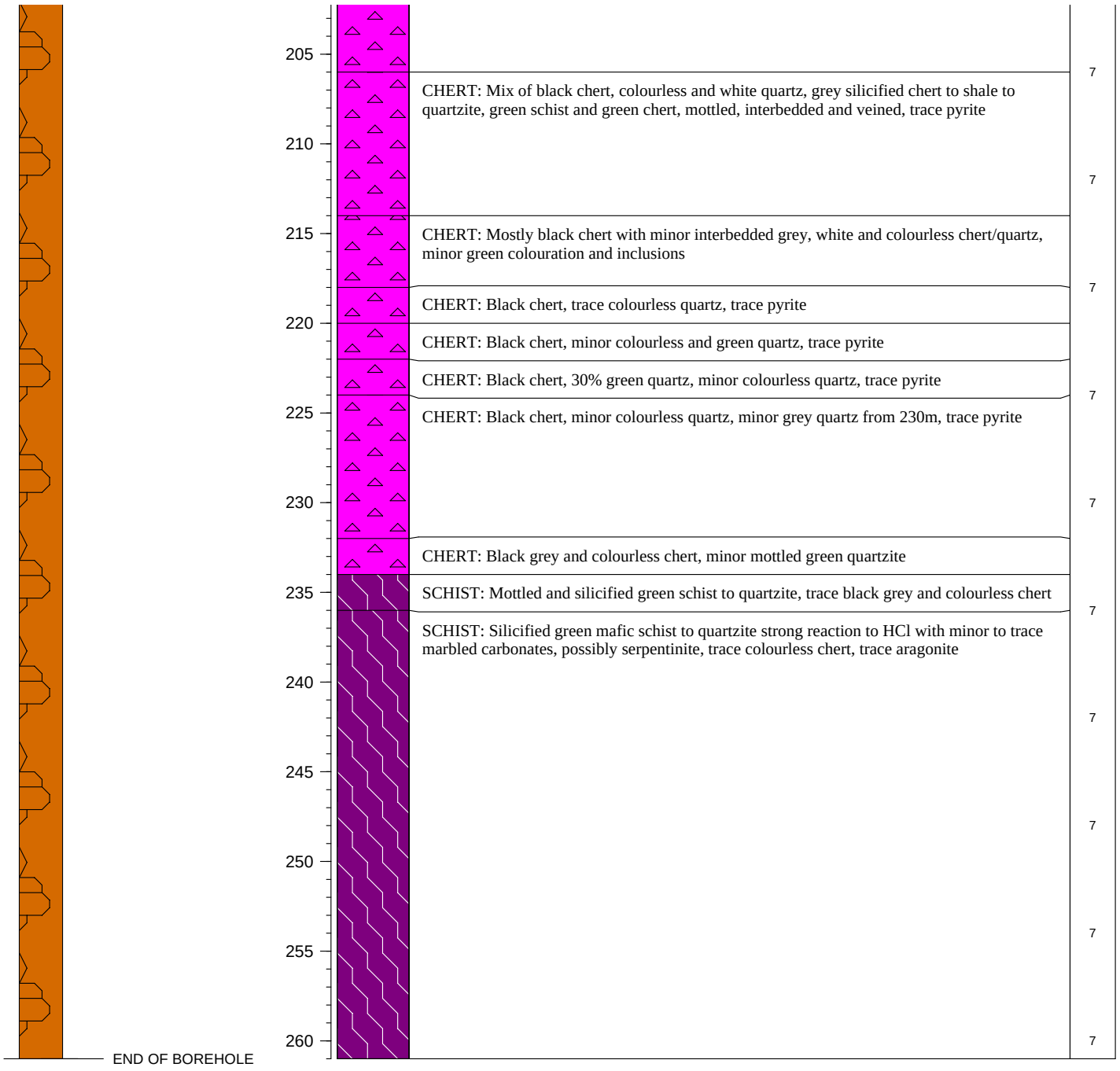
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS21

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DESCRIPTION	YIELD (L/sec)
CHERT: Mix of black chert, colourless and white quartz, grey silicified chert to shale to quartzite, green schist and green chert, mottled, interbedded and veined, trace pyrite	7
CHERT: Mostly black chert with minor interbedded grey, white and colourless chert/quartz, minor green colouration and inclusions	7
CHERT: Black chert, trace colourless quartz, trace pyrite	7
CHERT: Black chert, minor colourless and green quartz, trace pyrite	
CHERT: Black chert, 30% green quartz, minor colourless quartz, trace pyrite	
CHERT: Black chert, minor colourless quartz, minor grey quartz from 230m, trace pyrite	7
CHERT: Black grey and colourless chert, minor mottled green quartzite	7
SCHIST: Mottled and silicified green schist to quartzite, trace black grey and colourless chert	7
SCHIST: Silicified green mafic schist to quartzite strong reaction to HCl with minor to trace marbled carbonates, possibly serpentinite, trace colourless chert, trace aragonite	7
	7
	7
	7
	7

Comments:

EXPLORATION BORE LOG

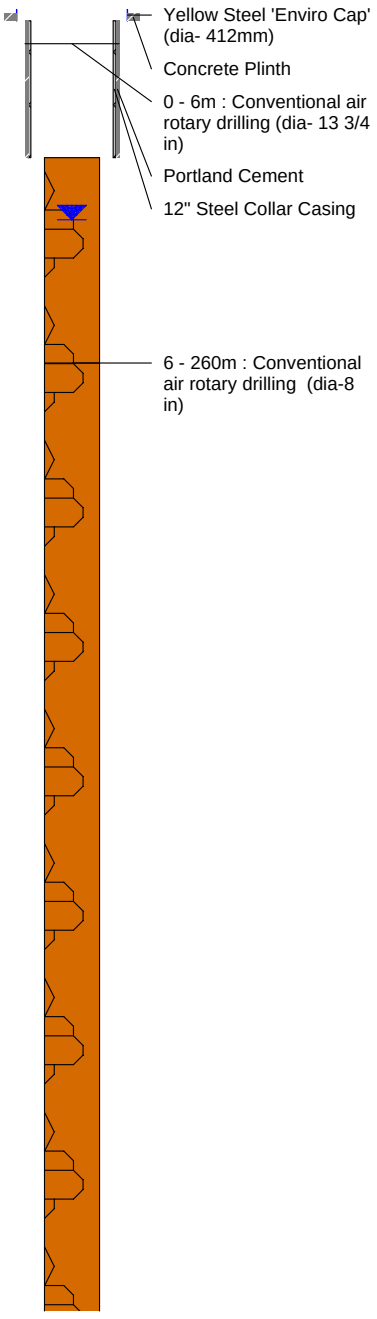
BOREHOLE NUMBER

NS-EXS22

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **708642.64**
NORTHING (m): **7644198.00**
MEAS PT ELEVATION (mAHD): **258.834**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **22/02/2015** DATE COMPLETED: **25/02/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**260**
Completion Stick Up (magl):	**0.73**
Development Airlift Yield (l/s):	**5**
Water Level (mbgl) & Date:	**8.72** & **13/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Red to orange, well weathered detritus of white to beige calcrete and silcrete, grey chert, and red silt, minor organics, 50% 1-20mm chips, 50% silt	
5	SILTSTONE: White with minor orange, moderately weathered sandy silcrete and calcrete with minor quartz veinlets, chip size is 1-10mm, same chip percentage	
	SANDSTONE/WACKE: As above with angular black and colourless to white quartz /chert, 30% 1-25mm chips, 70% powder	
10	SANDSTONE/WACKE: Medium grey fine sand in a silica and carbonate matrix, metamorphosed, many grains are blended in to the silica matrix, minor pink to purple colouration minor silica and carbonate veinlets, minor colourless to white quartz, minor weathering, 90% chips, 10% silt	1.5
15	SANDSTONE/WACKE: As above, no pink and purple colouration, 95% 1-15mm chips, with trace over 15mm, 5% powder	
20		4
25	SANDSTONE/WACKE: As above, only trace weathering	5
30		6
35		
40	SANDSTONE/WACKE: As above, trace pyrite	6.5
45		6.5
50	SANDSTONE/WACKE: As above, no pyrite, becoming more fine grained, border lining quartzite	6.5
	MARBLE: White to pale grey very fine grained calcareous, silica rich, marble, minor grey sandstone to quartzite as above	
55	MARBLE: As above, only trace grey sandstone	6.5

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS22

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
60		MARBLE: As above, minor grey quartzite/sandstone as above	6.5
65		SANDSTONE/WACKE: Pale grey, fine grained, calcareous sandstone as in 14-24m, increase in colourless to white chert/quartz, at 72m, slightly less reactive to HCl	6.5
70			6.5
75			6.5
80			6.5
85		SANDSTONE/WACKE: As above, trace black chert, with oxidation	6.5
		SANDSTONE/WACKE: As above, trace orange sandstone to quartzite, trace black chert	
90		SANDSTONE/WACKE: As above, minor orange sandstone to quartzite, trace black chert, veined and well metamorphosed	6.5
		CHERT: Mostly grey chert to quartzite, only minor reaction to HCl, trace black chert	
95		SANDSTONE/WACKE: Orange, pink, red and black calcareous silt to fine sandstone, well silicified and metamorphosed, minor grey quartzite to chert, from 92-94m and 96-100m, minor black chert to shale from 94-96 and increasing with depth to 104m, then becoming more sandy and granular, well weathered and oxidized throughout, orange colouration within the silicified matrix- possibly oxidized then re-silicified	6.5
100			8
105		SANDSTONE/WACKE: Very fine grained red sandstone, to quartzite, with 40-50% black shale to chert, trace banding visible, only mild oxidation	8
110		SANDSTONE/WACKE: Orange, oxidized, fine, weathered sandstone	8
115		SANDSTONE/WACKE: Grey to green, fine sandstone to quartzite, minor black chert	8
		SANDSTONE/WACKE: As above, becoming more green, only trace chert, continues to react with HCl, trace pyrite, minor orange stained sandstone at 118m	
120		CHERT: Chert composed of medium to fine grained subrounded to angular- mostly brecciated black green, colourless and white sand in a silica matrix with conchoidal fracture cutting through grains, trace pyrite	8
125		CHERT: As above, with 40% grey to black shale/chert	8
		CHERT: Chert as 120-124m with increased inclusions of brecciated black chert up to 1mm	
		SHALE: Well to moderately weathered and oxidized black sandy shale, minor white to grey	8

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS22

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
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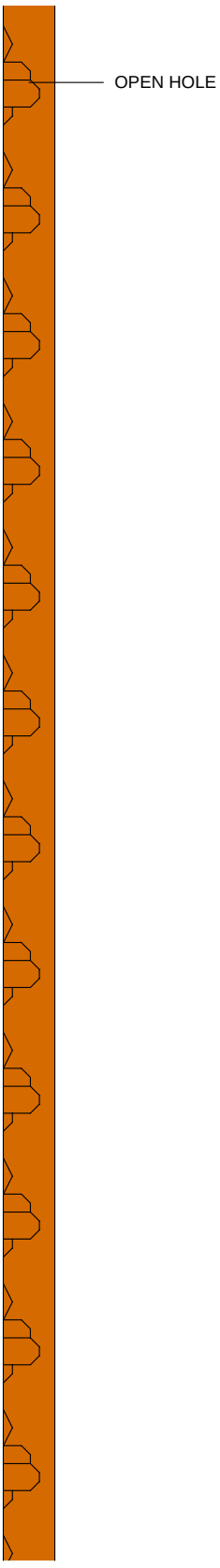

DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
130		speckled chert as above, non calcareous	
		SHALE: Well to moderately weathered and oxidized black sandy shale, trace pyrite	
135		SHALE: Mildly weathered black shale to chert, trace pyrite, some fine grey sand banding-often oxidized	8
140		SHALE: Well weathered black shale with extensive orange staining and oxidation on fracture planes and veinlets	8
145		SHALE: Mildly weathered black shale to chert	8
150		CHERT: As above, minor grey to green quartzite from fine sandstone	
		CHERT: Pale grey and green quartzite from fine sandstone, trace black shale, mildly reactive to HCl	8
155		CHERT: Medium grey and green chert to quartzite, mild conchoidal fracture, mild oxidation, minor black chert, trace pyrite, black chert increases and green chert decreases with depth, trace reaction with HCl	8
160		CHERT: Black shale to chert, trace conchoidal fracture, minor to trace oxidation	
165		CHERT: As above, minor speckled green, white and black chert	8
		CHERT: Banded black and grey chert from silicified sandstone and shale	
170		CHERT: Speckled, banded and black chert mix, mild oxidation	8
		CHERT: Black shale to chert, minor conchoidal fracture, trace fine sand texture	
175		CHERT: Black white and green speckled sandstone to quartzite, minor black to grey chert from 172-174m, 178-180m, 184-186m, 188-190m	8
180			8
185			8
190		CHERT: Black and grey chert with minor speckled sandstone	
		CHERT: Speckled quartzite to sandstone with minor black and grey chert, minor oxidation	9
195		CHERT: Pale grey to green and colourless quartzite with minor black chert to shale, grains are only distinguishable from 196-200m, many veinlets, mild oxidation decreasing to trace by 200m, mildly reactive to HCl, many black melted streamers evident after 200m, metamorphosed	
200			9

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS22

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
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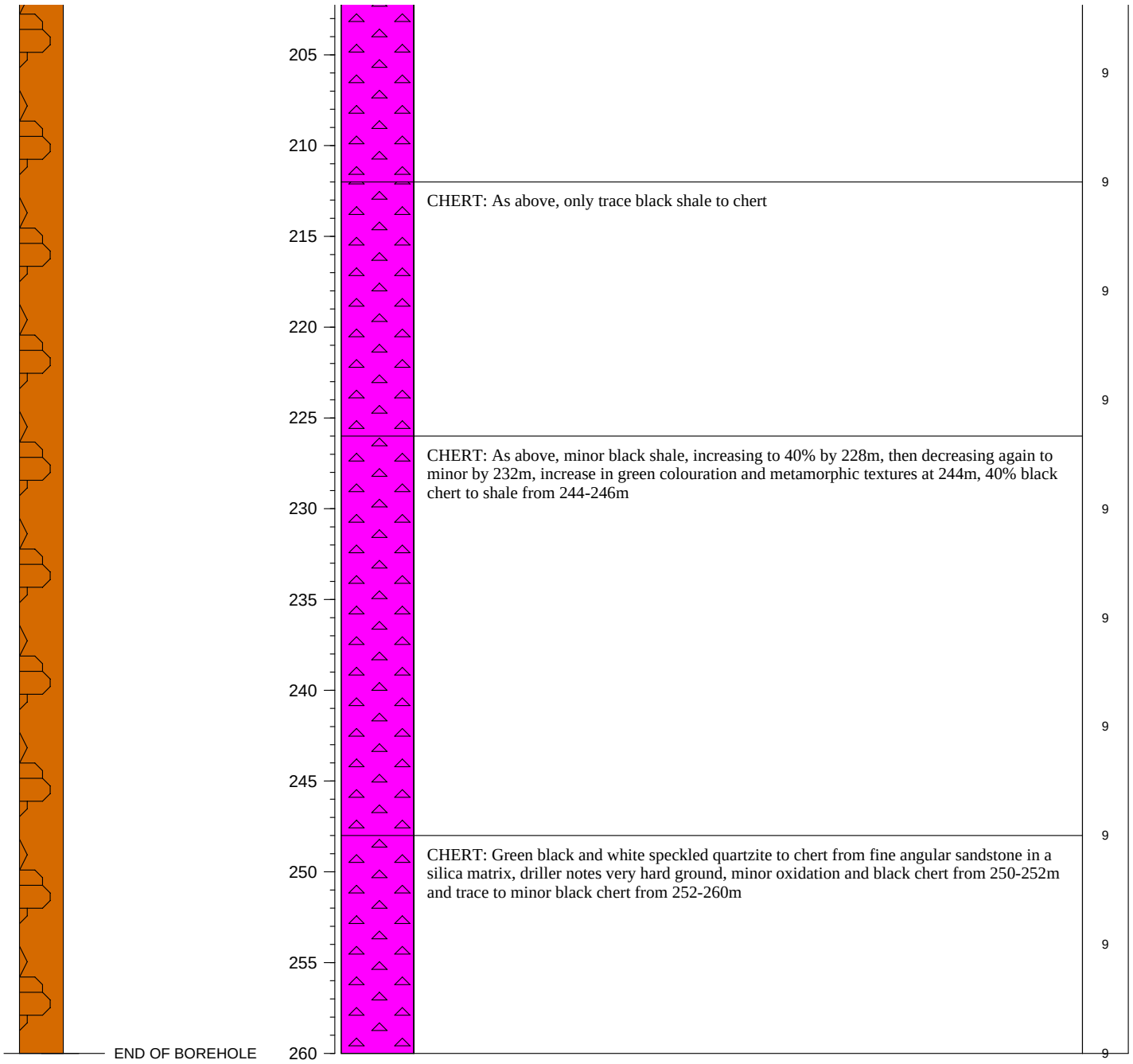


Comments:

EXPLORATION BORE LOG

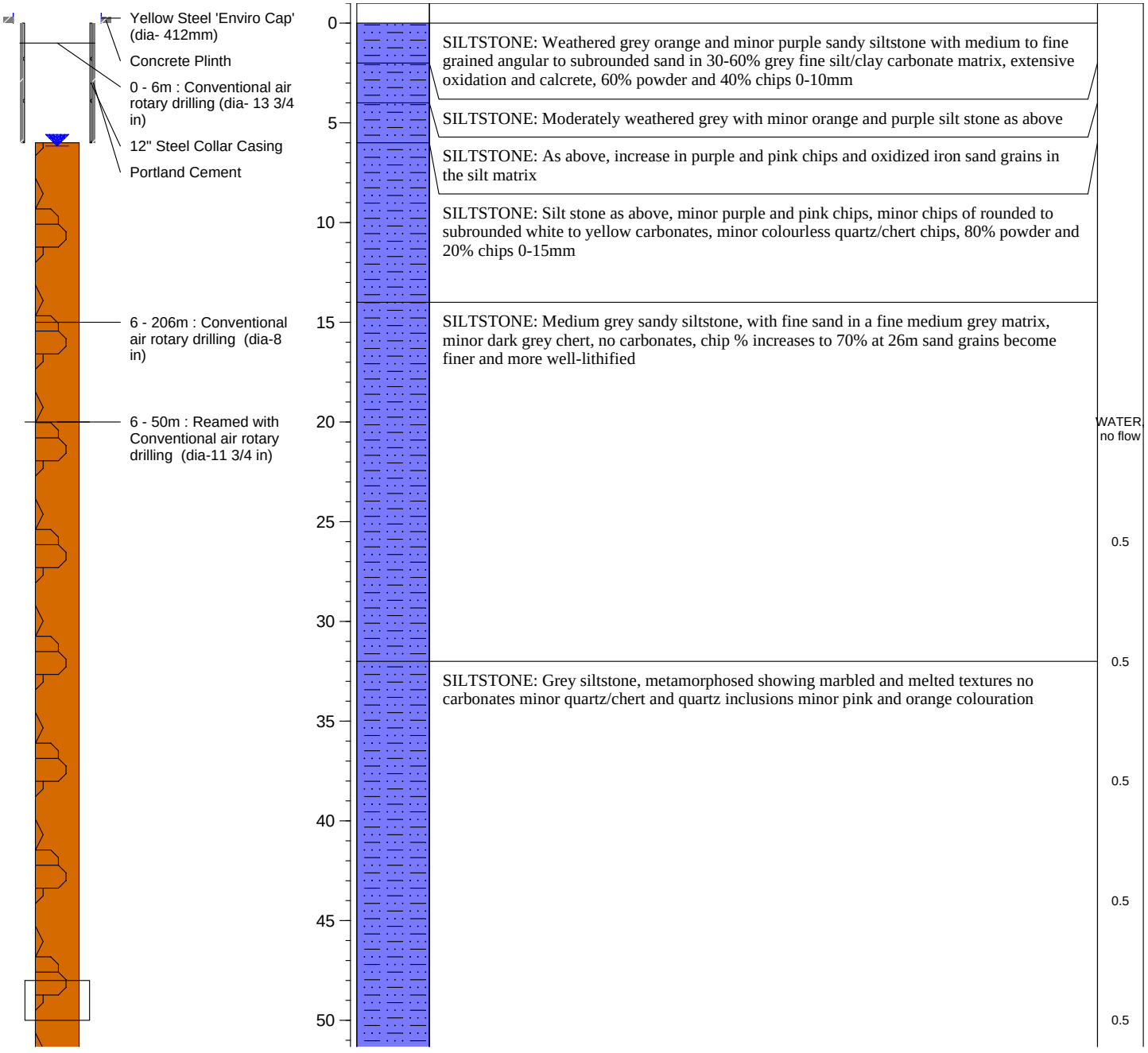
BOREHOLE NUMBER

NS-EXS23

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709377.31**
NORTHING (m): **7643734.42**
MEAS PT ELEVATION (mAHD): **256.984**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **26/02/2015** DATE COMPLETED: **28/02/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**206**
Completion Stick Up (magl):	**0.672**
Development Airlift Yield (l/s):	**25**
Water Level (mbgl) & Date:	**6.16** & **13/04/2015**



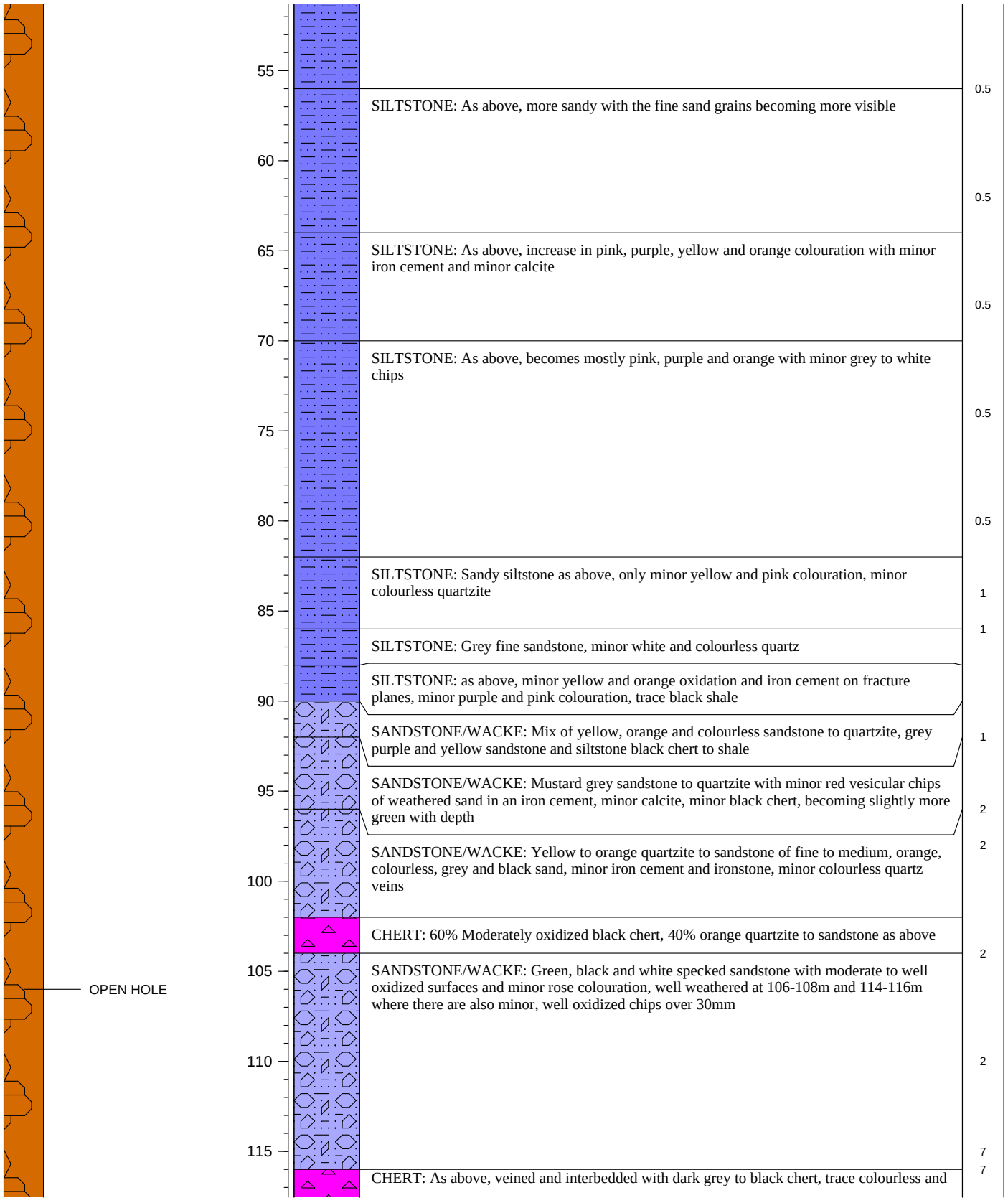
Comments: **DRILL BIT IN PLACE AT 50m**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS23

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments: **DRILL BIT IN PLACE AT 50m**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS23

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
120		white chert from 118m	
		CHERT: Fresh white chert/quartz, minor black chert and green sandstone	10
125		CHERT: 50% mildly oxidised white chert, 25% black chert, 25% green sandstone	
		CHERT: Oxidized white chert, minor black chert and green sandstone	
		SANDSTONE/WACKE: Green sandstone to quartzite, minor grey to black chert, and white sandstone, quartzite and chert, moderate iron oxidation	10
130		SILTSTONE: Well oxidized orange sandy siltstone minor grey white and green chert to quartzite	
		CHERT: Grey and green with minor white quartzite, minor orange siltstone, moderately oxidized	10
135		SILTSTONE: Orange, well oxidized siltstone, minor colourless and green quartzite and green schist, minor red iron cement, minor vesicular chips of weathered sandstone of sand in an iron cement	
		SANDSTONE/WACKE: As above with an increase in green quartzite	12
140		SANDSTONE/WACKE: Green quartzite to sandstone, colouration is an even/non speckled, pale green, minor orange siltstone and sand in a weathered iron cement, minor pale brown to green sandstone, all metamorphosed with moderate oxidation	
		SANDSTONE/WACKE: Orange, well oxidized mix of green chert/quartzite, green schist, oxidized and stained quartz infill with vuggy texture, minor orange siltstone, metamorphosed, larger chips (over 50mm) from 144	15
145		SANDSTONE/WACKE: Mostly red chips of sandstone with sand in an iron rich, oxidised cement, most chips have a craggy and vuggy texture, minor green stone, minor colourless quartz, all well oxidized	
		SANDSTONE/WACKE: Orange, well oxidized mix of green chert/quartzite, green schist, oxidized and stained quartz infill with vuggy texture, minor orange siltstone, minor secondary carbonate precipitate and increase in green schist at 152-154m	18.2
150		SANDSTONE/WACKE: Green sandstone to quartzite, even green colour, minor colourless to white quartz and secondary quartz infill, minor green schist, all moderately weathered	
		SANDSTONE/WACKE: As above with 40% fresh white quartz and an increase in green schist	18.2
155		SCHIST: Olive green to grey schist, soft crumbles in to fine silt, possibly talc, mild foliated texture with some chips still having granular appearance but also crumbles into a silt, moderately weathered, 20-30% colourless to white quartz veins and infill, many larger (10-30mm) irregular chips and trace chips over 30mm, trace ironstone, and minor dark blue green mafics from 170m	
		BASALT: As above, slight increase in blue-green metamorphosed mafics, with mild reaction to HCl, minor aragonite and calcite from 196 increase in calcite and aragonite and dark metamorphosed mafics with depth, driller notes high contamination	25
160			
			25
165			
			25
170			
			25
175			
			25
180			

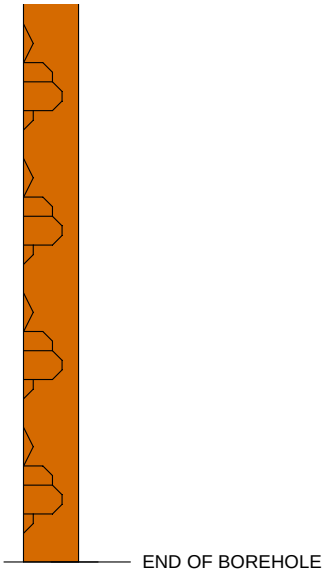
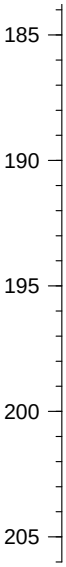
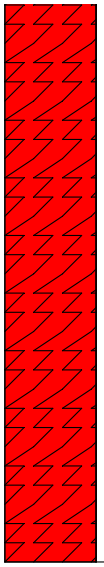
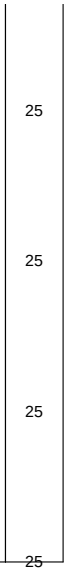
Comments: **DRILL BIT IN PLACE AT 50m**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS23

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
				

Comments: **DRILL BIT IN PLACE AT 50m**

EXPLORATION BORE LOG

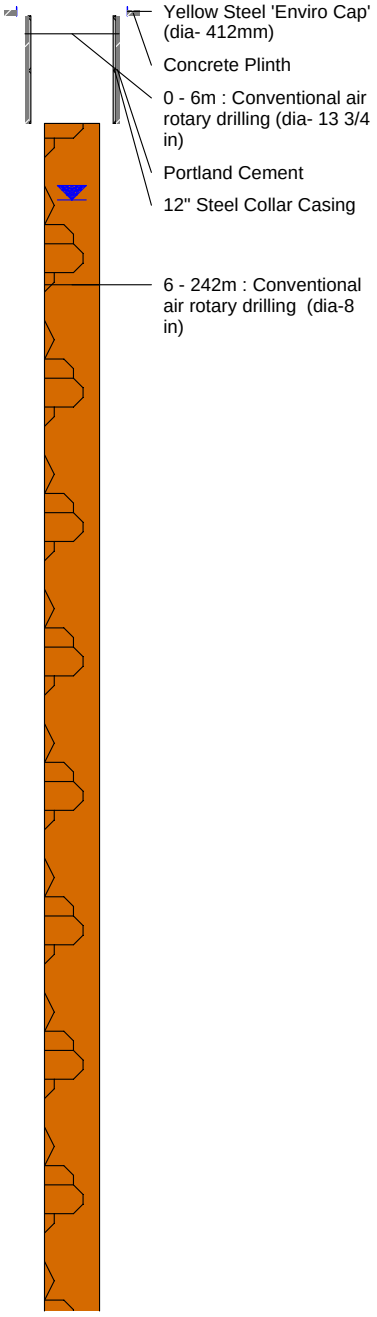
BOREHOLE NUMBER

NS-EXS26

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **710024.82**
NORTHING (m): **7643322.49**
MEAS PT ELEVATION (mAHD): **266.381**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **25/03/2015** DATE COMPLETED: **28/03/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**242**
Completion Stick Up (magl):	**0.68**
Development Airlift Yield (l/s):	**0**
Water Level (mbgl) & Date:	**10.26** & **13/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Olive grey to orange well weathered mafic schist, orange discolouration and oxidation on most fracture planes and surfaces minor orange to white silt and siltstone, minor white to orange calcrete, minor ironstone, 70% chips 1-20mm,340% powder	
5	SCHIST: Olive to brown moderately oxidized mafic schist, medium to soft and scratches into a pale brown silt to talc, soapy texture, minor foliated textures, moderately oxidized, chip percent decreases to 60%	
10	SCHIST: As above, much softer and mostly broken up into silt, the chips that remain are darker olive grey to green, 20% chips 1-5mm, with 80% paler brown powder	
15	SCHIST: Black to very dark green mafic schist, medium to soft and scratches into a pale olive silt to talc, soapy texture, minor foliated textures, mild oxidation and decreasing to trace by 24m, chip percent increases to 80 then 90% by 22m, driller notes ground is slightly harder from 26-40m, minor fractures at 40-41m and broken ground from 41-42m, after which it becomes softer	0.1
20		0.1
25		0.1
30		0.2
35		0.2
40		0.2
45		0.2
50	SCHIST: As above, trace reaction to HCl	0.2
55		0.2
60	SCHIST: As above, moderate reaction to HCl, trace aragonite chips	0.1
65	SCHIST: As above, very mild coloration change to chips of the original black to dark green decreasing with depth and an increase of a slightly paler olive green, and a greyish brown to olive mix, strong reaction to HCl, minor aragonite chips	
70		

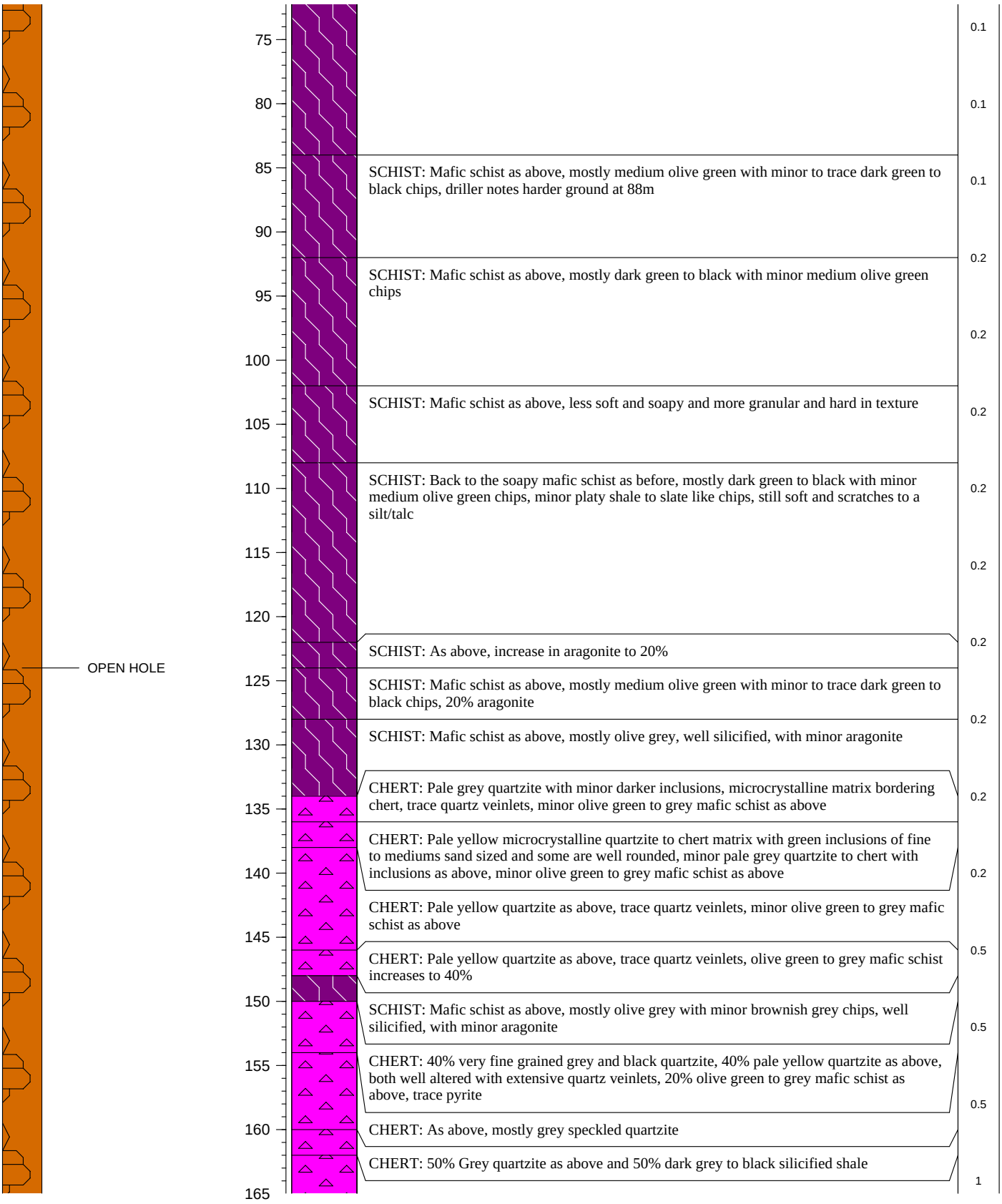
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS26

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS26

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

Comments:

EXPLORATION BORE LOG

BOREHOLE NUMBER

NS-EXS30

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **708912.38**
NORTHING (m): **7645239.89**
MEAS PT ELEVATION (mAHD): **275.22**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **15/02/2015** DATE COMPLETED: **17/02/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**218**
Completion Stick Up (magl):	**0.7**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**13.41** & **13/04/2015**

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
Yellow Steel 'Enviro Cap' (dia- 412mm) Concrete Plinth 0 - 6m : Conventional air rotary drilling (dia- 13 3/4 in) Portland Cement 12" Steel Collar Casing 6 - 218m : Conventional air rotary drilling (dia-8 in)	0 5 10 15 20 25 30 35 40 45 50 55 60		DETRITUS: Weathered brown and red silt and angular clasts of chert, weathered basalt and organic soil, 50% 1-50mm chips, 50% silt SCHIST: Pale olive green to grey, well weathered talc-chlorite schist, trace oxidation, chip percentage decreases to 30% by 6m and 10% with 90% powder by 8m BASALT: Olive green to grey, altered and serpentinized, mildly granular basalt, trace spinifex texture, 50% 1-15mm chips, minor aragonite and carbonates, no oxidation BASALT: Basalt as above, minor chips with a more glassy chert like texture at 26m, pale olive grey, microcrystalline matrix and dark, 0-1mm inclusions, 60% powder and 40% chips BASALT: Mix of olive green basalt, pale olive green microcrystalline rock with dark olive green inclusions and minor dark green to black basalt with trace magnetism, all textures and colours are mottled and sometimes blend together, trace aragonite, trace quartz chips	0.1 0.1 0.1 0.1

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS30

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	65			0.1
	70			0.2
	75			0.2
	80			0.2
	85			0.2
	90			0.5
	95		BASALT: As above, trace pyrite from 94m	0.5
	100			0.5
	105		BASALT: As above, slight increase in aragonite at 102-106m, 116-120m, and 142-144m with 30% aragonite from 144-146, slight increase in aragonite at 156-160m and 166-168m	0.5
OPEN HOLE	110			0.5
	115			3
	120			3
	125			3
	130			3
	135			3
	140			3

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS30

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	145			3
	150			3
	155			3
	160			3
	165			3
	170			3
	175			3
	180			3
	185		BASALT: Basalt as above, increase in pale olive green microcrystalline matrix with dark olive green inclusions	3
	190			3
	195			3
	200			3
	205			3
	210		BASALT: Basalt as above, slight increase in aragonite and white to colourless quartz	3
	215			3
END OF BOREHOLE				

Comments:

EXPLORATION BORE LOG

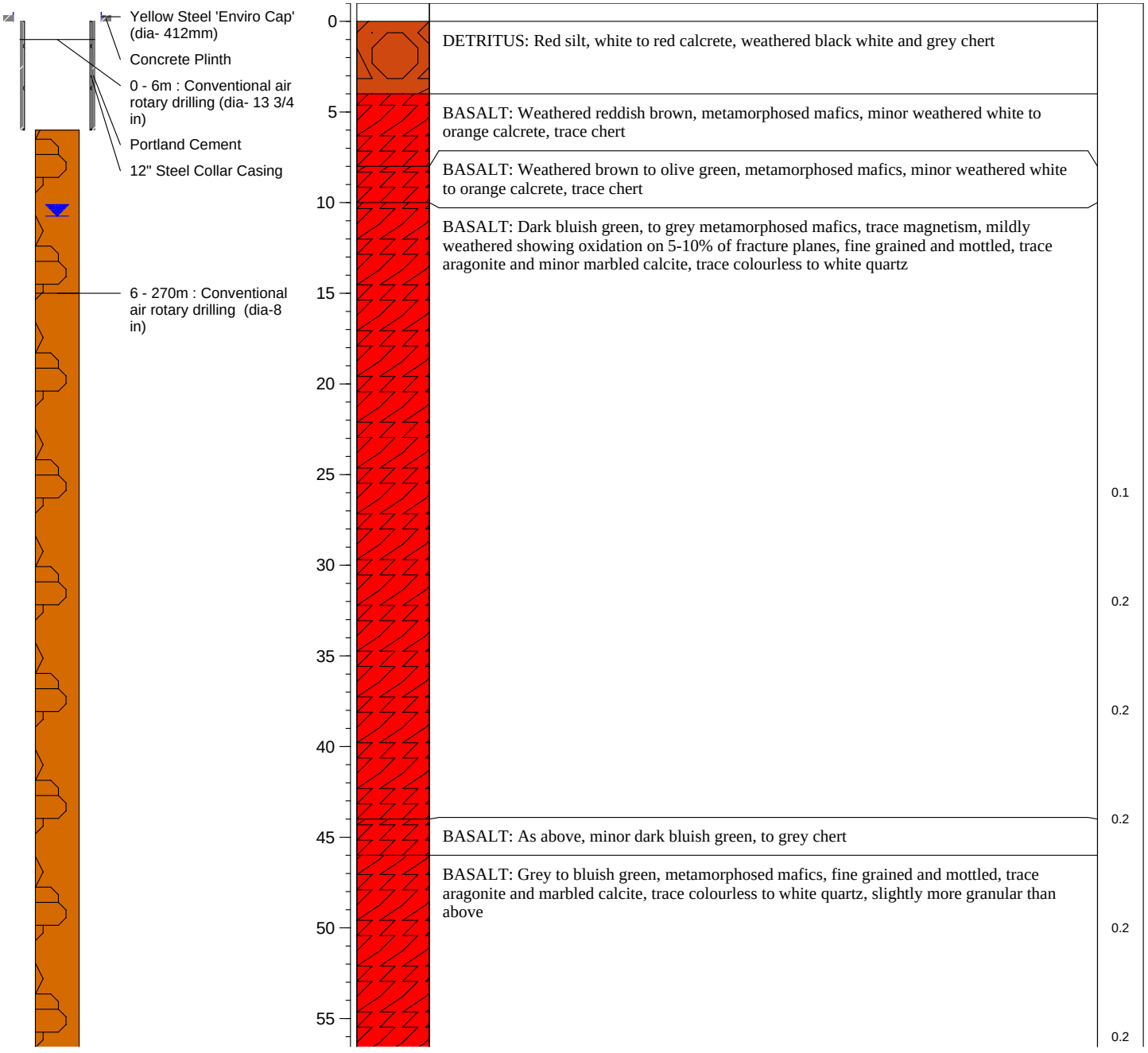
BOREHOLE NUMBER

NS-EXS31

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **708813.19**
NORTHING (m): **7644375.26**
MEAS PT ELEVATION (mAHD): **261.231**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **20/02/2015** DATE COMPLETED: **22/02/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**270**
Completion Stick Up (magl):	**0.674**
Development Airlift Yield (l/s):	**5**
Water Level (mbgl) & Date:	**10.74** & **13/04/2015**



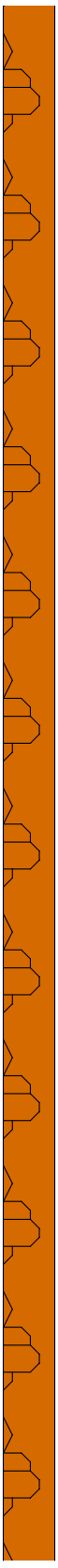
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS31

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
60			0.2
65			0.2
70			
75		BASALT: As above, minor weathered and soft brown to olive green metamorphosed mafics, only some grains are visible	0.2
		BASALT: Weathered, soft brown to olive green metamorphosed mafics, crumbles easily into silt, some grains are visible, minor grey and bluish green basalt as above	
80			0.3
		BASALT: Weathered, medium to hard brown to olive green metamorphosed mafics, some chips are harder and slightly more silicified, mottled with some grains visible, only trace bluish green basalt, minor basalt from 98-100m, and 122-124m, trace iron cement and trace chips with schist texture	
85			0.3
90			0.5
95			
100			0.5
105			0.5
110			0.5
115			2
120			2
125			
		BASALT: Bluish green, metamorphosed mafics, fine grained and mottled, trace aragonite and marbled calcite, minor colourless to white quartz and quartz veinlets, trace pyrite	2

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS31

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
OPEN HOLE	130		CHERT: White, grey and black quartz, minor silicified basalt	
	135		CHERT: Mostly black with minor grey and white quartz and minor silicified basalt, increase in oxidation	2
			CHERT: Well oxidized mostly black with minor grey and white quartz, minor iron cement	
	140		CHERT: As above, increase in white to colourless quarts and grey quartzite	2
	145			2
	150			2
	155			2
	160		CHERT: Mostly black with minor grey and white quartz, decreased in oxidation	2.5
	165		CHERT: Mostly white to colourless quarts and grey quartzite, minor black quartz, trace pyrite, trace iron cement, moderate oxidation, many chips over 20mm	6
	170			6.5
	175			6.5
	180		BASALT: Grey to bluish green, metamorphosed mafics, fine grained and mottled, trace aragonite and marbled calcite, minor colourless to white quartz and quartz veinlets, trace pyrite	6.5
	185			
	190		BASALT: Weathered, medium to hard brown to olive green metamorphosed mafics, some chips are softer and crumble easily, mottled with some grains visible, minor bluish green basalt, trace iron cement and trace chips with schist texture, trace colourless quartz	11
	195			
	200			11

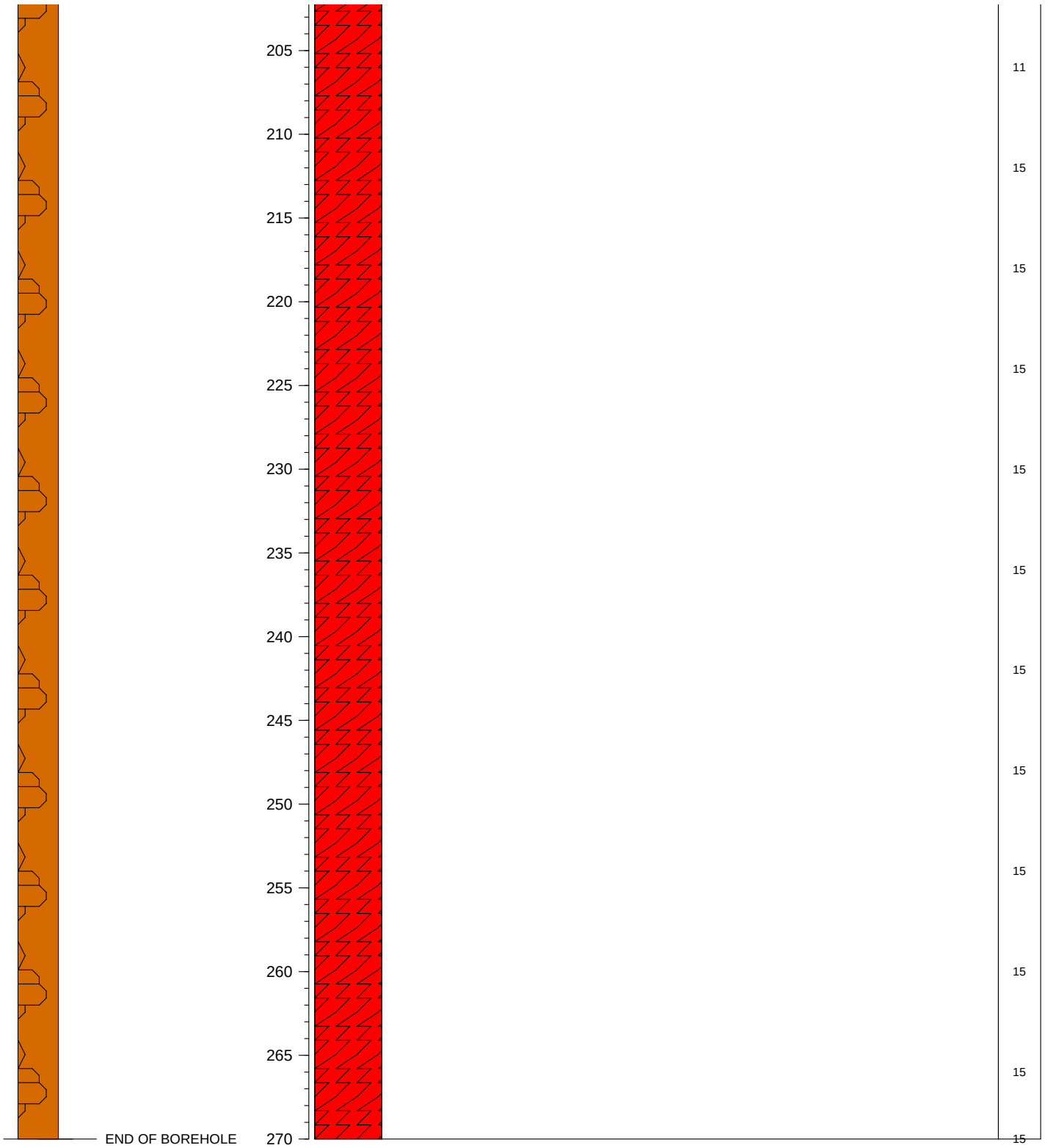
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS31

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments:

EXPLORATION BORE LOG

BOREHOLE NUMBER

NS-EXS35

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**710591.20**
NORTHING (m):	**7645800.13**
MEAS PT ELEVATION (mAHD):	**285.16**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **17/03/2015**	DATE COMPLETED: **19/03/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**92**
Completion Stick Up (magl):	**0.746**
Development Airlift Yield (l/s):	**0**
Water Level (mbgl) & Date:	**13.56** & **11/04/2015**

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
Yellow Steel 'Enviro Cap' (dia- 412mm) Concrete Plinth 0 - 6m : Conventional air rotary drilling (dia- 13 3/4 in) Portland Cement 12" Steel Collar Casing 6 - 92m : Conventional air rotary drilling (dia-8 in) OPEN HOLE	0 5 10 15 20 25 30 35 40 45 50		BASALT: Orange, completely weathered basalt, minor olive green chips between 1mm-30mm, 80% chips, 20% powder BASALT: Olive green to grey, moderately weathered, metamorphosed, fine grained basalt, with massive to mottled texture, 1mm-30mm, 80% chips, 20% powder BASALT: As above, chip percentage down to 20% with 80% powder, chips are 1-5mm BASALT: Olive green to grey, moderately weathered, metamorphosed, fine grained basalt, trace aragonite and calcite, chips become harder with depth, possibly silicified, 1-20mm, with most 1-10mm, 80% chips, 20% powder, mild reaction to HCl increasing to strong by 50m BASALT: As above, chips are hard, trace to minor chips of darker grey basalt, trace pyrite BASALT: Olive green, slightly less grey in colour, all else as above	No water No water No water No water No water

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS35

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	55			No water
	60			No water
	65			No water
	70			No water
	75			No water
	80			No water
	85		BASALT: As above, slightly lighter in colour	No water
END OF BOREHOLE	90			No water

EXPLORATION BORE LOG

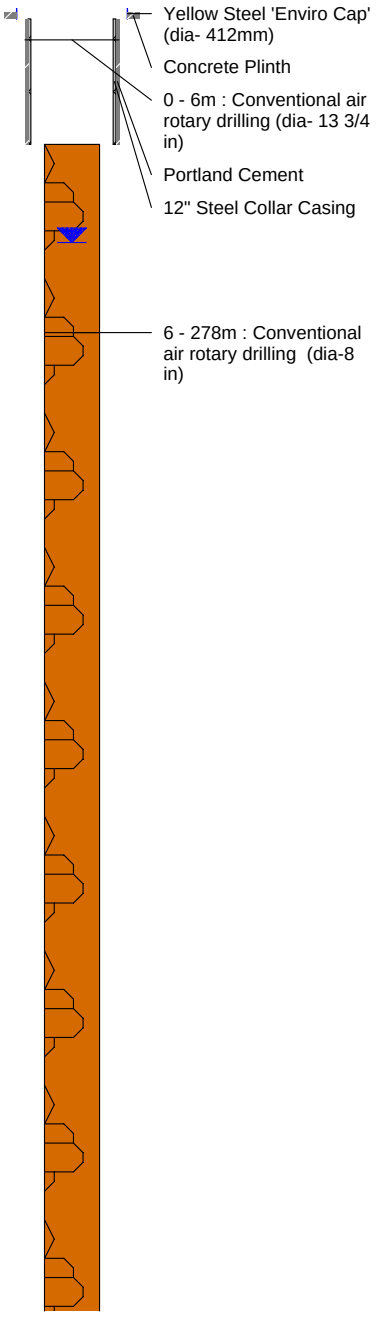
BOREHOLE NUMBER

NS-EXS36

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**710754.08**
NORTHING (m):	**7645577.61**
MEAS PT ELEVATION (mAHD):	**282.176**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **13/03/2015**	DATE COMPLETED: **17/03/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**278**
Completion Stick Up (magl):	**0.593**
Development Airlift Yield (l/s):	**0**
Water Level (mbgl) & Date:	**10.69** & **11/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	BASALT: Orange, completely weathered basalt, minor olive green chips between 1mm-30mm, 80% chips, 20% powder	
5	BASALT: Olive green to orange moderately weathered basalt, 1mm-30mm, 80% chips, 20% powder	
10	BASALT: Olive green to grey, moderately weathered, metamorphosed, fine grained basalt, with massive to mottled texture, 1mm-30mm, 80% chips, 20% powder	
	BASALT: As above, chip percentage down to 20% with 80% powder, chips are 1-20mm	
15	BASALT: Olive green to grey, moderately weathered, metamorphosed, fine grained basalt, trace aragonite and calcite, chips become harder with depth, possibly silicified, 1mm-20mm, with most 1-10mm, 80% chips, 20% powder, mild reaction to HCl increasing to strong b	
20		
25	BASALT: As above, chips are hard, trace to minor chips of darker grey basalt, trace pyrite from 34m	Water no flow
30		Water no flow
35		
40		Water no flow
45		Water no flow
50	BASALT: Olive green, slightly less grey in colour, all else as above	Water no flow 0.5
55		0.5
60		

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS36

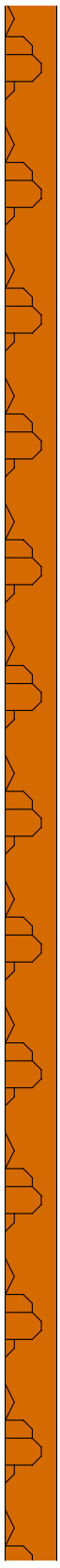
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	65			0.5
	70			0.5
	75			0.5
	80		BASALT: As above, texture is more speckled, with 1mm grains of dark to light olive green, with angular to mottled edges	0.5
	85		BASALT: Olive green basalt as above, return to more fine grained and mottled texture as before 76m	0.5
	90			0.5
	95			0.5
	100			0.5
	105			0.5
	110			0.5
	115			0.5
	120			0.5
	125			0.5
	130			0.5
	135			0.5
OPEN HOLE	140		BASALT: As above, slightly lighter in colour	0.5

Comments:

OBSERVATION WELL BORE LOG	BOREHOLE NUMBER
	NS-EXS36

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
145			0.5
150			0.5
155			0.5
160		BASALT: Light olive green basalt as above, minor dark greenish blue to black softer mafic schist	0.5
165			
170			0.5
175			0.5
180			0.5
185			
190		BASALT: Light olive green basalt as above only, none to trace dark greenish blue to black softer mafic schist	
195			
200		BASALT: Light olive green basalt as above, minor dark greenish blue to black softer mafic schist	
205			
210			
215			
220			

Comments:

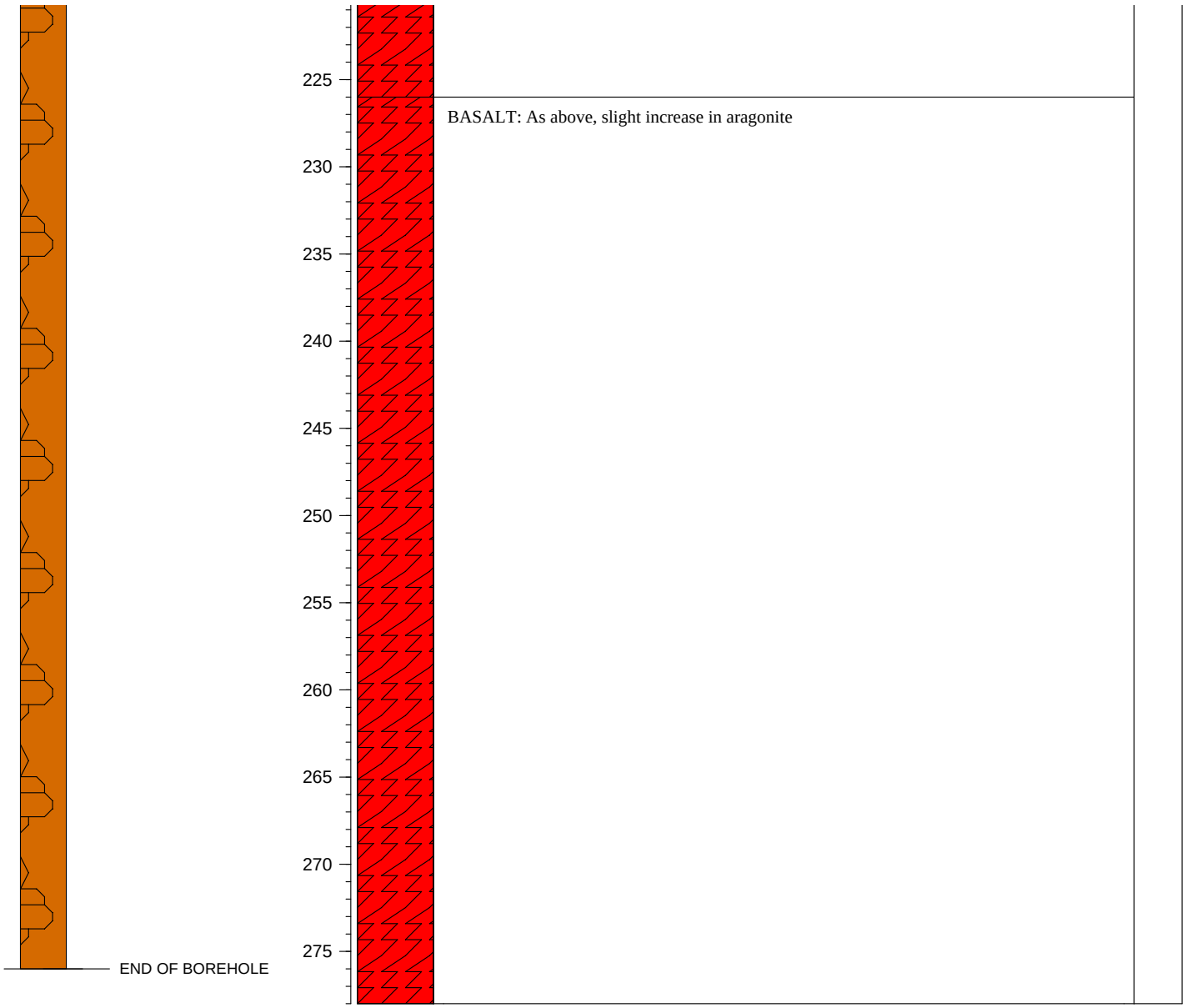
OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXS36

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



BASALT: As above, slight increase in aragonite

Comments:

OBSERVATION WELL BORE LOG

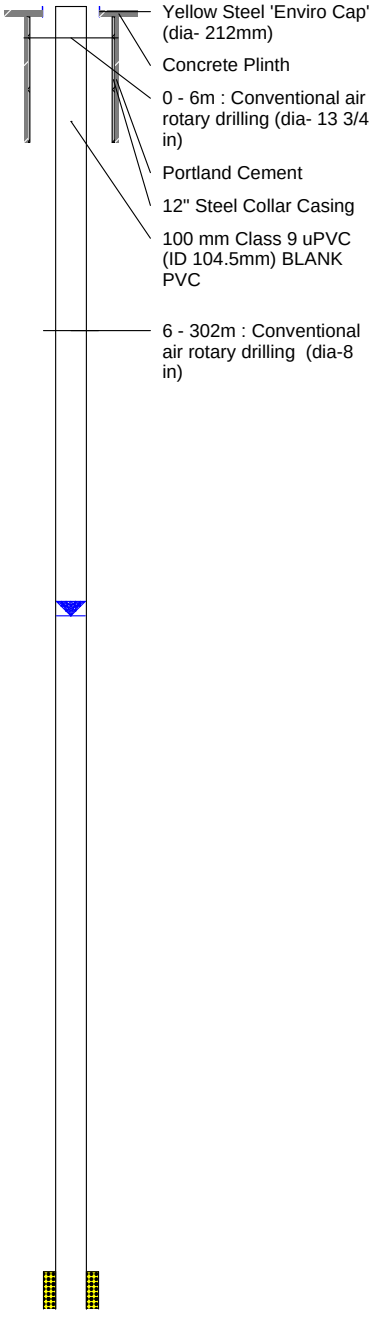
BOREHOLE NUMBER

NS-ObsS05

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

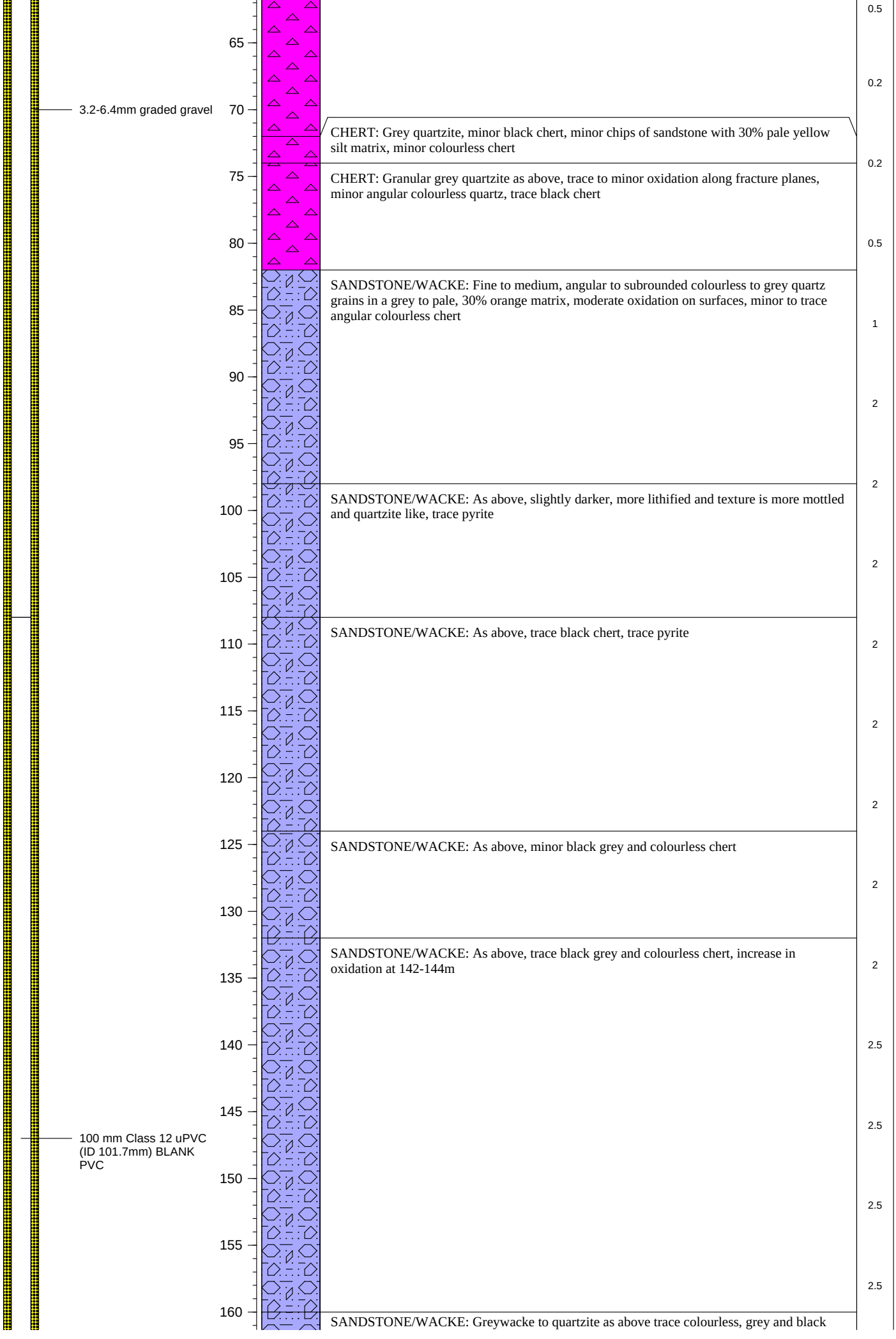
PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**709966.54**
NORTHING (m):	**7645749.21**
MEAS PT ELEVATION (mAHD):	**291.13**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **23/01/2015**	DATE COMPLETED: **27/01/2015**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.703**
Drilled Depth (mbgl):	**302**
Cased Depth (mbgl):	**300**
Casing Stick Up (magl):	**0.374**
Development Airlift Yield (l/s):	**2.5**
Water Level (mbgl) & Date:	**28.64** & **11/04/2015**



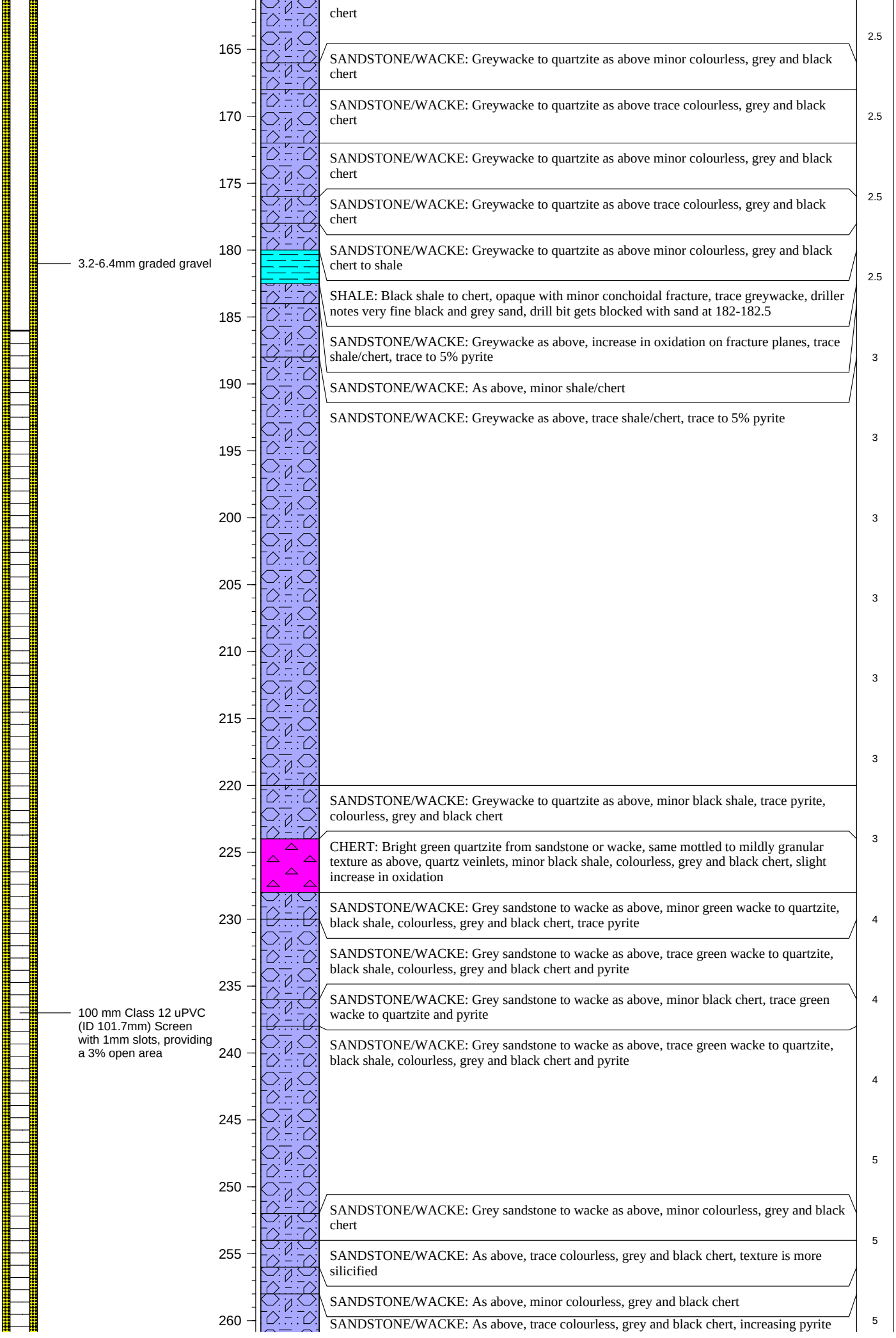
DEPTH	DESCRIPTION	YIELD (L/sec)
0	SANDSTONE/WACKE: Medium grey to orange, well weathered/well oxidized sandstone, fine to very fine, subrounded grains of colourless to grey and minor orange quartz grains, trace angular, opaque black shale to chert	
5	SANDSTONE/WACKE: Weathered sandstone as above, 30% black shale to chert,	
10	SANDSTONE/WACKE: Sandstone as above with minor to moderate weathering to orange along fracture planes, and minor sandstone with a pink silt matrix from 6-8m, 30% black chert,	
15	SANDSTONE/WACKE: 60% Black chert, 30% grey sandstone, minor colourless and grey chert	
	SANDSTONE/WACKE: 70% Grey sandstone, 30% black chert	
20	SANDSTONE/WACKE: Grey sandstone, trace black chert	
	SANDSTONE/WACKE: 70% Grey sandstone, 30% black chert	
25	SANDSTONE/WACKE: Grey sandstone, becomes more lithified and silicified with depth, bordering quartzite	
30	CHERT: Grey quartzite, mild granular texture, trace to minor black chert, trace colourless quartz	WATER no flow
35	CHERT: Grey quartzite, minor black chert	0.5
40	CHERT: Grey quartzite, trace black chert	0.5
45		
50	CHERT: Grey quartzite, minor black chert, minor chips of sandstone with 30% pale yellow silt matrix, minor colourless chert	0.5
55	CHERT: Grey quartzite, trace black chert	0.5
60		

Comments:



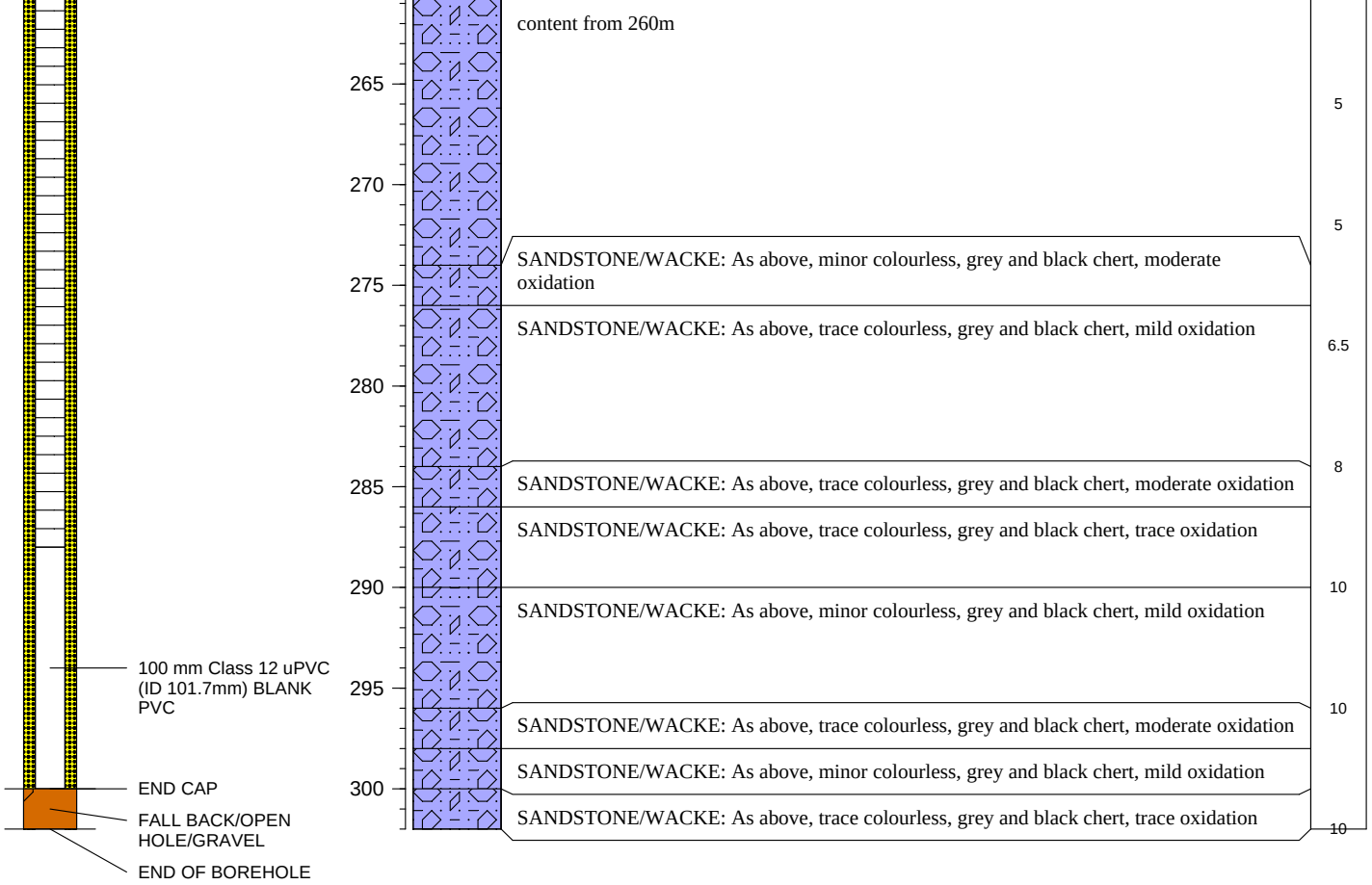
65		0.5
70		0.2
75	CHERT: Grey quartzite, minor black chert, minor chips of sandstone with 30% pale yellow silt matrix, minor colourless chert	0.2
80	CHERT: Granular grey quartzite as above, trace to minor oxidation along fracture planes, minor angular colourless quartz, trace black chert	0.5
85	SANDSTONE/WACKE: Fine to medium, angular to subrounded colourless to grey quartz grains in a grey to pale, 30% orange matrix, moderate oxidation on surfaces, minor to trace angular colourless chert	1
90		2
95		2
100	SANDSTONE/WACKE: As above, slightly darker, more lithified and texture is more mottled and quartzite like, trace pyrite	2
105		2
110	SANDSTONE/WACKE: As above, trace black chert, trace pyrite	2
115		2
120		2
125	SANDSTONE/WACKE: As above, minor black grey and colourless chert	2
130		2
135	SANDSTONE/WACKE: As above, trace black grey and colourless chert, increase in oxidation at 142-144m	2.5
140		2.5
145		2.5
150		2.5
155		2.5
160	SANDSTONE/WACKE: Greywacke to quartzite as above trace colourless, grey and black	

Comments:



	chert	
165	SANDSTONE/WACKE: Greywacke to quartzite as above minor colourless, grey and black chert	2.5
170	SANDSTONE/WACKE: Greywacke to quartzite as above trace colourless, grey and black chert	2.5
	SANDSTONE/WACKE: Greywacke to quartzite as above minor colourless, grey and black chert	
175	SANDSTONE/WACKE: Greywacke to quartzite as above trace colourless, grey and black chert	2.5
180	SANDSTONE/WACKE: Greywacke to quartzite as above minor colourless, grey and black chert to shale	2.5
	SHALE: Black shale to chert, opaque with minor conchoidal fracture, trace greywacke, driller notes very fine black and grey sand, drill bit gets blocked with sand at 182-182.5	
185	SANDSTONE/WACKE: Greywacke as above, increase in oxidation on fracture planes, trace shale/chert, trace to 5% pyrite	3
190	SANDSTONE/WACKE: As above, minor shale/chert	
	SANDSTONE/WACKE: Greywacke as above, trace shale/chert, trace to 5% pyrite	3
195		
200		3
205		3
210		3
215		3
220	SANDSTONE/WACKE: Greywacke to quartzite as above, minor black shale, trace pyrite, colourless, grey and black chert	
225	CHERT: Bright green quartzite from sandstone or wacke, same mottled to mildly granular texture as above, quartz veinlets, minor black shale, colourless, grey and black chert, slight increase in oxidation	3
230	SANDSTONE/WACKE: Grey sandstone to wacke as above, minor green wacke to quartzite, black shale, colourless, grey and black chert, trace pyrite	4
	SANDSTONE/WACKE: Grey sandstone to wacke as above, trace green wacke to quartzite, black shale, colourless, grey and black chert and pyrite	
235	SANDSTONE/WACKE: Grey sandstone to wacke as above, minor black chert, trace green wacke to quartzite and pyrite	4
240	SANDSTONE/WACKE: Grey sandstone to wacke as above, trace green wacke to quartzite, black shale, colourless, grey and black chert and pyrite	4
245		5
250	SANDSTONE/WACKE: Grey sandstone to wacke as above, minor colourless, grey and black chert	
255	SANDSTONE/WACKE: As above, trace colourless, grey and black chert, texture is more silicified	5
	SANDSTONE/WACKE: As above, minor colourless, grey and black chert	
260	SANDSTONE/WACKE: As above, trace colourless, grey and black chert, increasing pyrite	5

Comments:


content from 260m
265
270
275
280
285
290
295
300
SANDSTONE/WACKE: As above, minor colourless, grey and black chert, moderate oxidation
SANDSTONE/WACKE: As above, trace colourless, grey and black chert, mild oxidation
SANDSTONE/WACKE: As above, trace colourless, grey and black chert, moderate oxidation
SANDSTONE/WACKE: As above, trace colourless, grey and black chert, trace oxidation
SANDSTONE/WACKE: As above, minor colourless, grey and black chert, mild oxidation
SANDSTONE/WACKE: As above, trace colourless, grey and black chert, moderate oxidation
SANDSTONE/WACKE: As above, minor colourless, grey and black chert, mild oxidation
SANDSTONE/WACKE: As above, trace colourless, grey and black chert, trace oxidation
5
5
6.5
8
10
10
10
100 mm Class 12 uPVC (ID 101.7mm) BLANK PVC
END CAP
FALL BACK/OPEN HOLE/GRAVEL
END OF BOREHOLE

OBSERVATION WELL BORE LOG

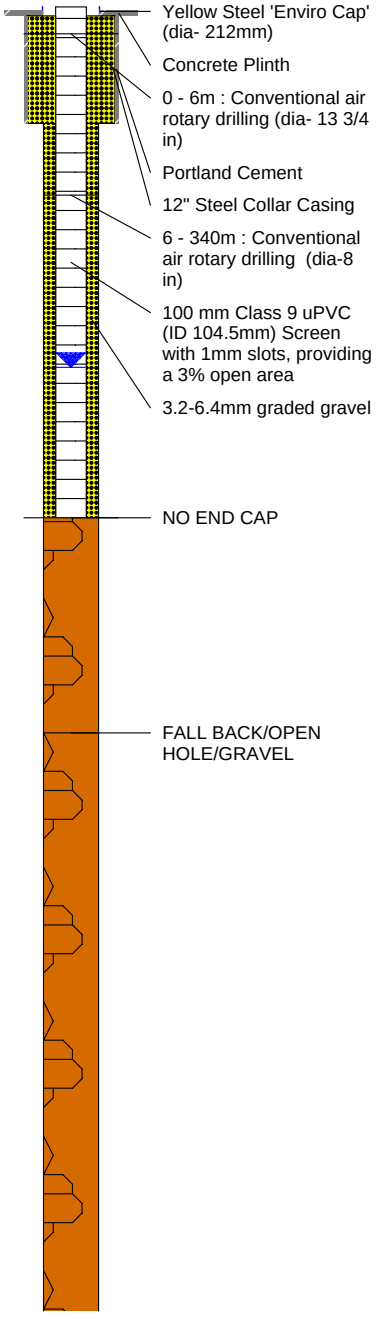
BOREHOLE NUMBER

NS-ObsS08

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

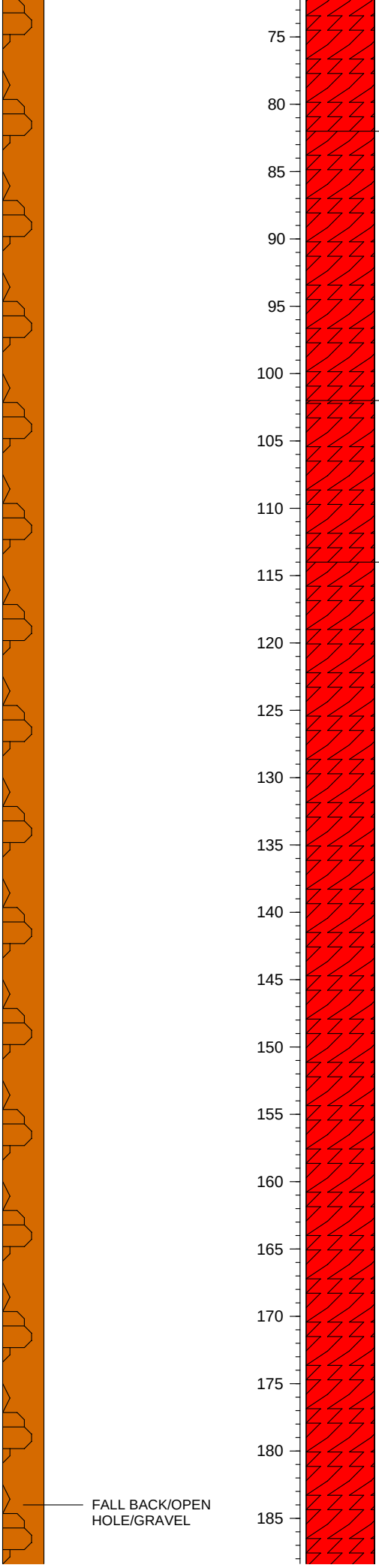
PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**709739.92**
NORTHING (m):	**7645138.96**
MEAS PT ELEVATION (mAHD):	**281.47**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **3/02/2015**	DATE COMPLETED: **5/02/2015**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.63**
Drilled Depth (mbgl):	**340**
Cased Depth (mbgl):	**28**
Casing Stick Up (magl):	**0.308**
Development Airlift Yield (l/s):	**1**
Water Level (mbgl) & Date:	**19.6 & 11/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Red silt, white to red calcrete, completely weathered green to grey metamorphosed mafics, less calcrete and more mafics with depth	
5	BASALT: Weathered greenish grey metamorphosed mafics, medium to soft, soapy with some friable pieces, crumbles with a mild granular texture, trace schist foliation, moderately weathered showing oxidation on 20-30% of fracture planes, trace red friable ironstone/iron cement chips, all highly altered and weathered	
10		
15		
20	BASALT: Weathered greenish grey metamorphosed mafics as above, increased oxidation, minor chips of white to colourless quartz in-fill	
25	BASALT: Weathered greenish grey metamorphosed mafics as above, increased oxidation, trace chips of white to colourless quartz in-fill, increased mafic schist content, overall rock becomes softer and more friable crumbling into a soapy talk	
30	BASALT: Weathered, greenish grey metamorphosed mafics as above, 30% colourless to white quartz chips and quartz in-fill	
35	BASALT: Weathered greenish grey metamorphosed mafics as above, increased oxidation	
40	BASALT: Weathered, greenish grey metamorphosed mafics as above, 30% colourless to white quartz chips	
45	BASALT: Black to grey mafic talc-schist, scratches easily but medium hardness, mixed with minor greenish grey metamorphosed mafics as above, minor colourless to white quartz chips and quartz in-fill, minor orange oxidation and iron staining	
50	BASALT: Pale grey siltstone talc, very soft, soapy, friable, chips expand and foliate when re-hydrated, trace to minor oxidation on chip surfaces, chips are 0-5mm rounded to subrounded from drilling action	
55	BASALT: Grey siltstone talc, soft, soapy, friable, trace to minor oxidation on chip surfaces, chips are 0-5mm subrounded from drilling action, becoming slightly harder and darker	
60	BASALT: As above, becoming more green in colour and granular when broken, chips are mostly 1-2mm rounded and vuggy, still very friable, trace iron cement, trace quartz chips	
65		WATER no flow
70		WATER no flow

Comments:



WATER no flow

WATER no flow

BASALT: As above, chips are 0-30mm, minor black vuggy metabasalt, oxidized 1mm voids, possibly from oxidized iron inclusions, still relatively soft, trace iron cement, soapy serpentinization on some fracture planes, darker overall with a soapy talc feel

WATER no flow

WATER no flow

WATER no flow

1

BASALT: As above, increased oxidized iron chips, chips are mostly 1-2mm rounded granular and vuggy, still very friable, trace iron cement, trace quartz chips, soapy talc feel

1

1

4

BASALT: As above, mix of granular, massive siltstone and schistose texture, minor oxidized iron and iron cement, trace to minor quartz in-fill and chips, soapy talc feel, still friable

4

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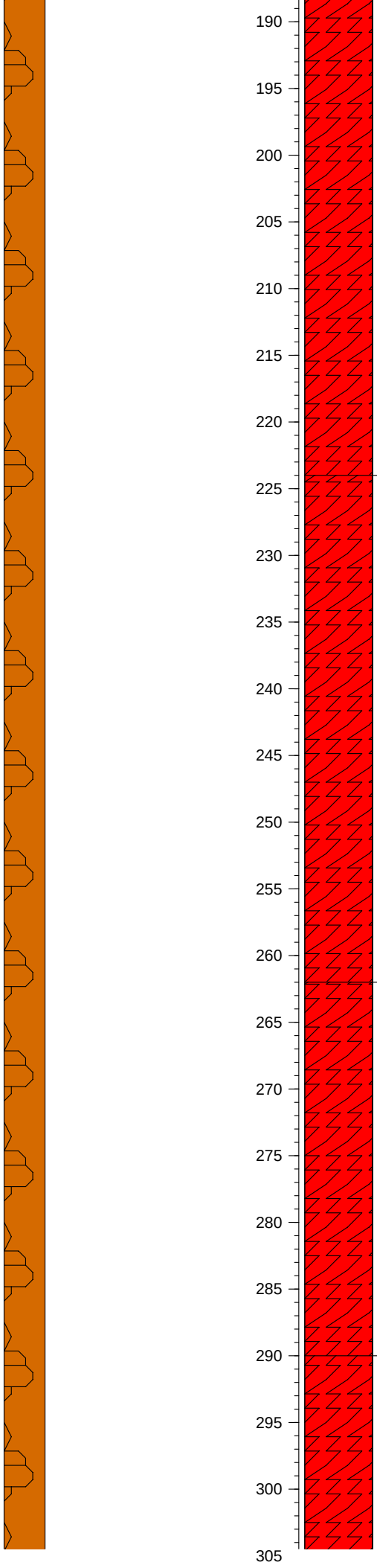
4

Comments:



BASALT: As above, driller notes hard ground, Higher quartz content from 230 to 262m

BASALT: As above, increased percent of black silicified basalt

BASALT: As above, back to a mix of medium hardness metabasalt, talc, serpentinite, and minor quartz in-fill, driller notes hard drilling at 304-319m, hard and soft beds from 319-334m and hard drilling at 334-340

4
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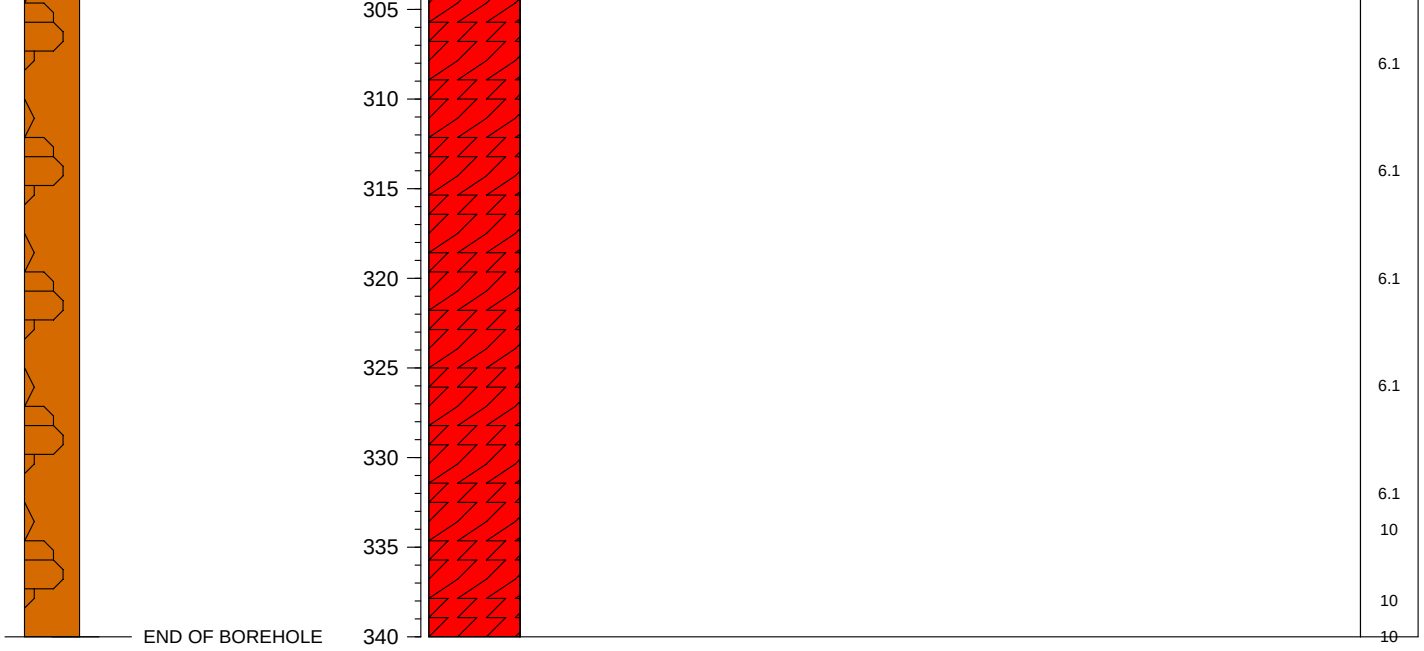
6.1
6.1
6.1
6.1
6.1
7.5
6.1
6.1

Comments:


305
310
315
320
325
330
335
340
END OF BOREHOLE
6.1
6.1
6.1
6.1
6.1
10
10
10

Comments:

OBSERVATION WELL BORE LOG

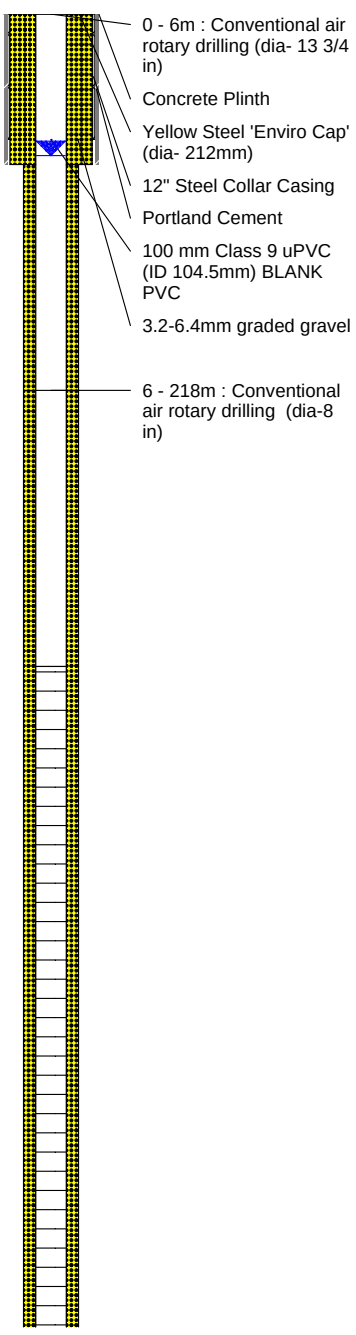
BOREHOLE NUMBER

NS-ObsS09

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **708988.74**
NORTHING (m): **7646706.96**
MEAS PT ELEVATION (mAHD): **269.501**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **15/10/2014** DATE COMPLETED: **19/10/2014**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**218**
Cased Depth (mbgl):	**140**
Casing Stick Up (magl):	**0.827**
Completion Stick Up (magl):	**0.691**
Development Airlift Yield (l/s):	**3**
Water Level (mbgl) & Date:	**5.64** & **14/11/2014**



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		DETRITUS: Red silt, well weathered calcrete, minor weathered mudstone, trace organics, chips are 0-50mm, mostly gravel sized/25mm or larger	
5		CALCRETE: Grey, moderately to well weathered calcrete and mudstone, sample mostly powder with 30% chips between 0-20mm, trace chips over 10mm	
10		MUDSTONE: Grey, moderately weathered mudstone with minor calcrete, trace quarts and quartz infill, sample mostly powder with 25% chips between 0-10mm, trace chips over 10mm	
15		MUDSTONE: Grey with orange oxidation, moderately weathered mudstone with trace quartz, sample mostly powder with 5% chips between 0-5mm, trace chips over 5mm	
20			
25		MUDSTONE: Grey, mildly weathered mudstone with trace pink from iron staining, sample is 50% powder, 50% chips between 0-10mm, trace chips over 10mm	WATER no flow
30		SANDSTONE/WACKE: Grey mudstone to wacke, pinkish grey sandy mudstone, fractured, veined, moderately oxidized with significant quartz infill, trace black to red friable iron, sample is 50% paste, 50% chips between 0-10mm, trace chips over 10mm	WATER no flow
35			WATER no flow
40			
45			WATER no flow
		SANDSTONE/WACKE: Grey and red, orange and brown, sandy mudstone with minor ironstone and quartz infill, moderately to well oxidized, sample is 50% paste, 50% chips between 0-10mm, trace chips over 10mm	
50		SANDSTONE/WACKE: As above, increase in ironstone and red colouration, trace grey chert and silicified shale, sample is 50% paste, 50% chips between 0-10mm, trace chips over	WATER no flow

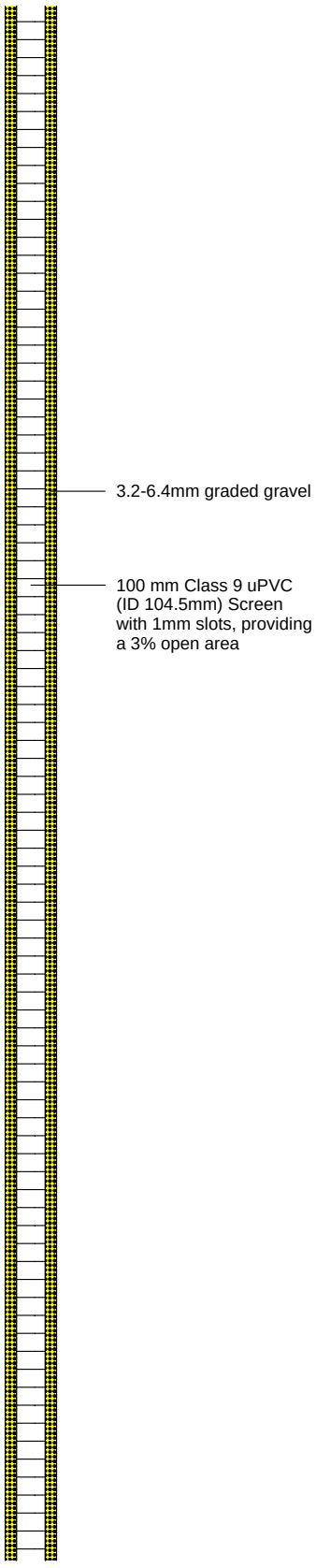
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-ObsS09

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
55		10mm	0.5
60		SANDSTONE/WACKE: As above, ironstone continues to increase, mudstone is predominately pink orange and red with minor grey, increase in colourless chert/quartz to 30% by 64m, 30% paste, 70% chips 0-20mm, trace chips over 20 mm	0.5
65			0.5
70		SANDSTONE/WACKE: 40% colourless to white chert/quartz, 30% weathered ironstone and iron cement and 30% red, orange and grey sandy mudstone, extensive oxidation, 90% chips 0-10mm, trace chips greater than 10mm	0.5
75		SANDSTONE/WACKE: 30% white to yellow sandy mudstone, 30% quartz, 20% red, orange and grey sandy mudstone, 20% ironstone, extensive oxidation, 90% chips 0-10mm, trace chips greater than 10mm	1.75
80		SANDSTONE/WACKE: Even mix of red, orange and grey wacke, ironstone and colourless to white quartz, extensive oxidation, wacke is completely orange by 88m, 100% chips 0-10mm, trace chips greater than 10 mm	1.75
85			1.75
90		CHERT: Black chert, completely weathered and fractured with iron and quartz infill, ironstone, quartz and minor wacke, weathering/oxidation decreases with depth	1.75
95		CHERT: White to colourless, grey, black and green chert, well weathered, minor ironstone driller notes hard drilling from 92-98m	5
		CHERT: Black and green, trace white and grey chert, fresh rock	
		CHERT: Black chert, angular with conchoidal fracture, fresh rock	
100		CHERT: Alternating layers of black with blue green to grey green chert, angular with conchoidal fracture, fresh rock	5
105			5
110			5
115		CHERT: As above minor silicified grey wacke also angular with conchoidal fracture	5

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-ObsS09

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East Perth, WA 6004
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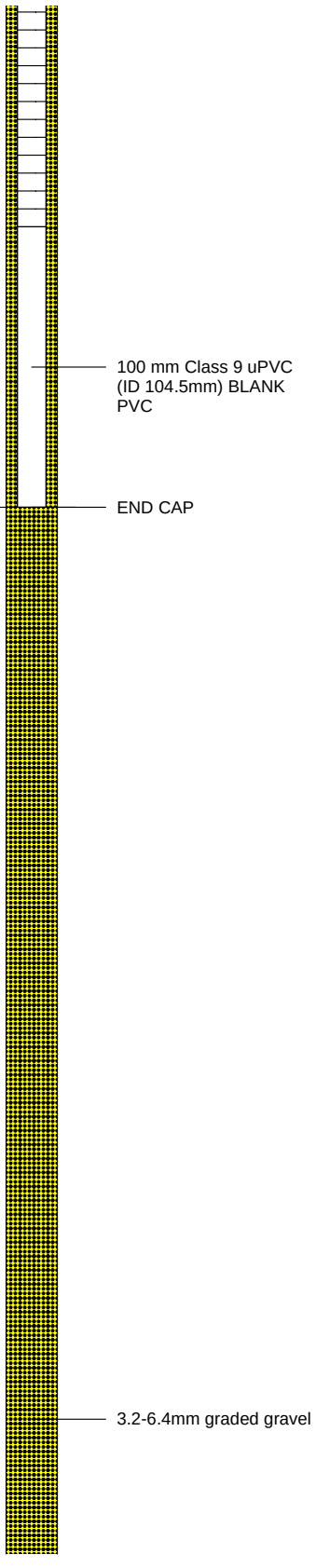


DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
120		CHERT: Black chert, minor green and grey chert and silicified grey wacke-possibly contamination	5
125			
		SHALE: Black silicified shale banded with minor to trace grey shale to sandy siltstone, some visible grains, only trace signs of conchoidal fracture, trace pyrite	5
130		SHALE: Grey silicified shale, some grains visible, interbedded with minor back silicified shale, trace pyrite	
		SHALE: Black and grey silicified shale as above, white to colourless quarts, minor green and black chert, quartz infill and pink, red to orange ferruginous sandstone and weathered quartzite	4
135		CHERT: Black to dark grey chert border lining shale, clearly becoming chert with conchoidal fracture at 138m	
140			4
		CHERT: Green to grey chert with minor black, grey and colourless chert	
145		CHERT: Chert composed of brecciated chert fragments 0-5mm in diameter, some chips appear to have wacke consistency in a silica matrix, other have more graded inclusions, all inclusion are angular to sub angular, black, white, grey green, and colourless, all comp	4
		CHERT: Mottled green and grey chert, black chert, trace colourless chert, mild to moderate oxidation	
150		CHERT: Mottled green and grey green with minor colourless and black chert, mild to moderate oxidation	4
155		CHERT: As above, increase in green chert, minor chips of bright green to aqua, softer green chert border lining serpentinite or green schist, some chip have trace yellow specks/vesicles, mild to moderate weathering, black chert band at 158m	4
160		CHERT: Mostly mottled green to grey chert, minor black, colourless, and bright green chert, mild to moderate weathering, black chert band at 170m	
165			4
170			4
175		CHERT: As above, increased oxidation, increased black and grey chert to shale bands	4
		CHERT: Mostly mottled green to grey chert, minor black, colourless, and bright green chert, mild to moderate weathering	
180			4
		CHERT: As above, increased weathering at 182-183m with a black chert band at 185-186m	
185			

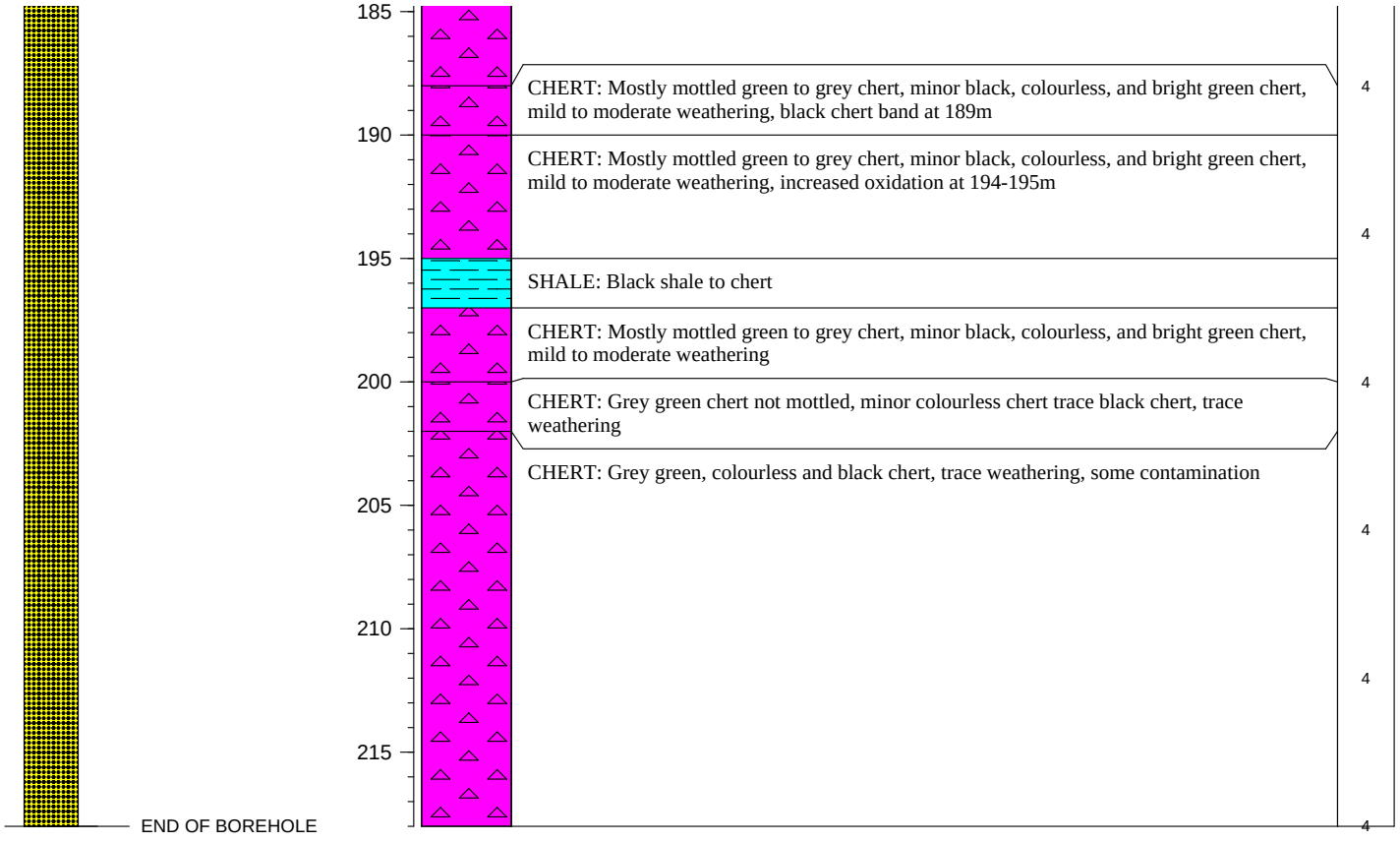
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-ObsS09

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments:

OBSERVATION WELL BORE LOG

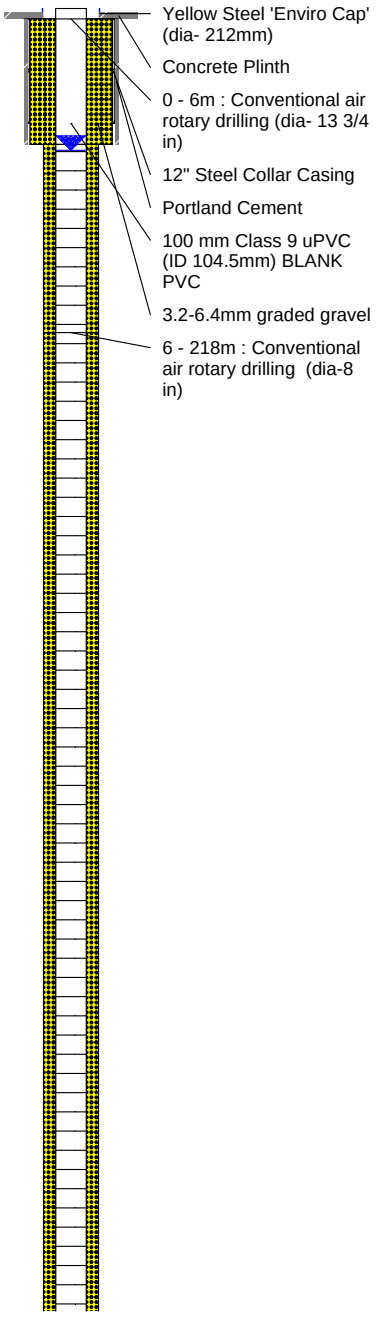
BOREHOLE NUMBER

NS-ObsS10

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

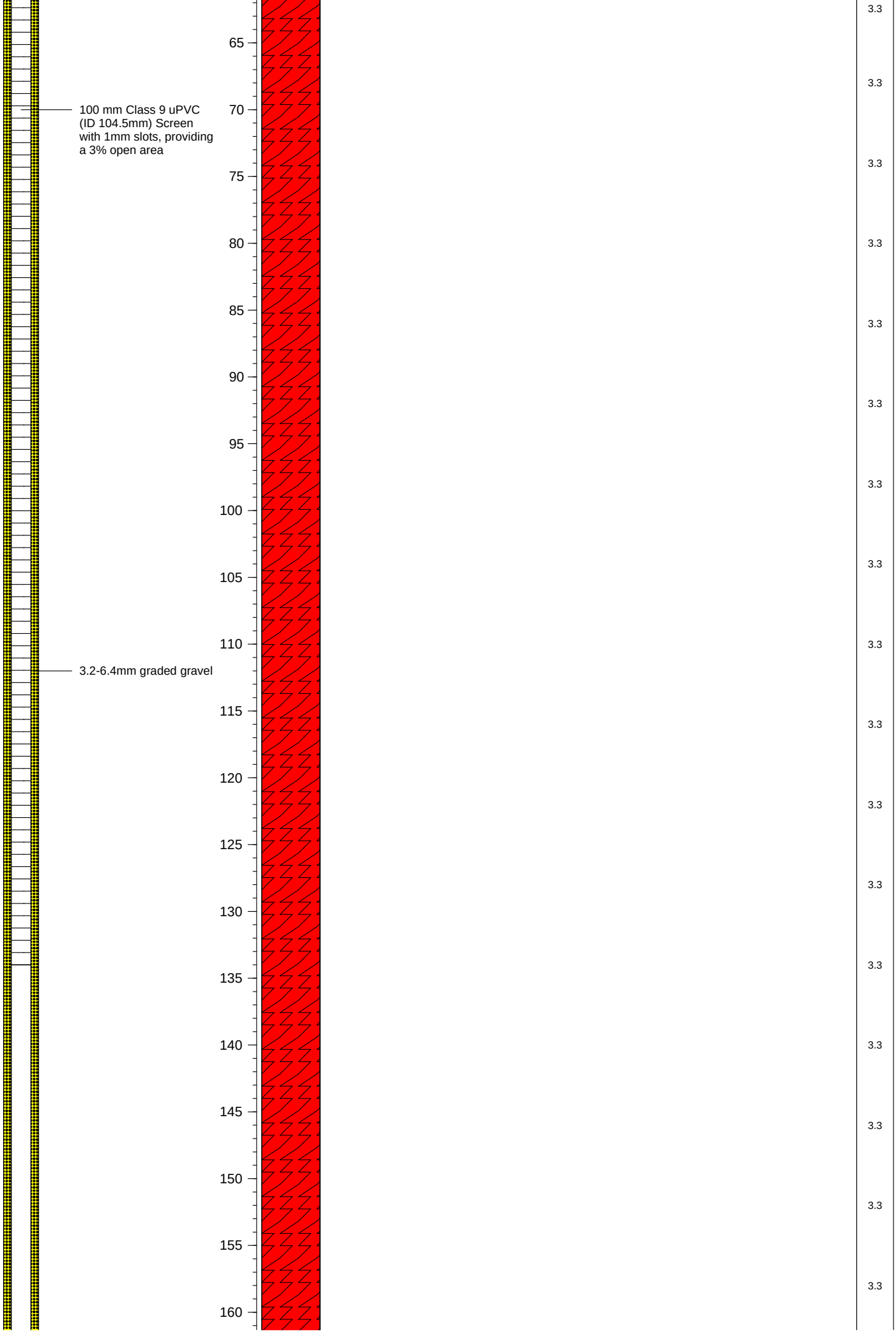
PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**708817.18**
NORTHING (m):	**7646652.89**
MEAS PT ELEVATION (mAHD):	**264.59**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **19/10/2014**	DATE COMPLETED: **21/10/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.709**
Drilled Depth (mbgl):	**218**
Cased Depth (mbgl):	**218**
Casing Stick Up (magl):	**0.335**
Development Airlift Yield (l/s):	**1.1**
Water Level (mbgl) & Date:	**6.28** & **11/04/2015**

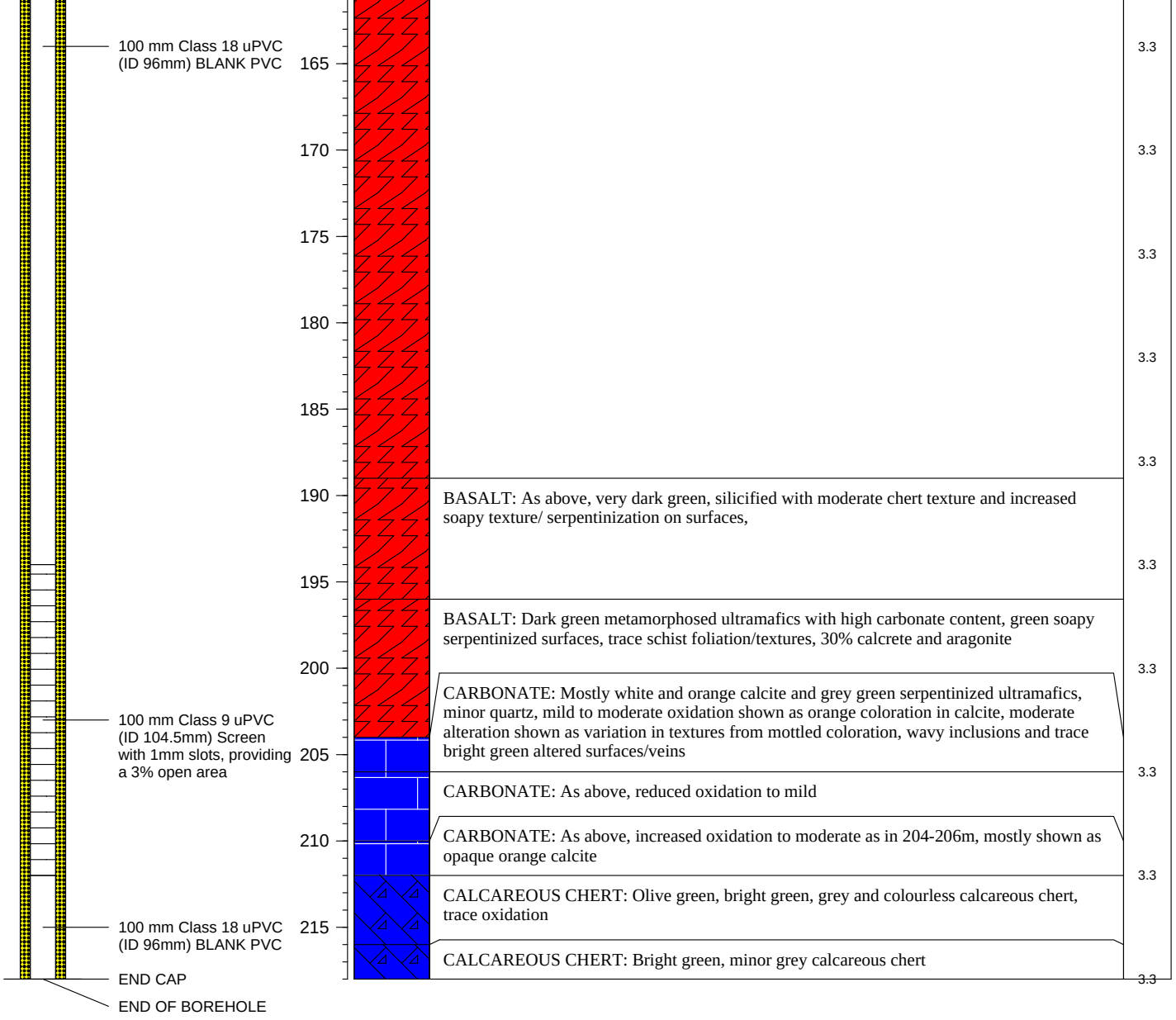


DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		DETRITUS: Red silt, white to red calcrete, completely weathered basalt, trace organics, less calcrete and more basalt with depth	
5		BASALT: Weathered green to black metamorphosed ultramafics, minor schist foliation textures, trace spinifex texture, minor to trace calcrete and aragonite, soapy surfaces prevalent	
10		BASALT: Very dark green to black metamorphosed ultramafics, green soapy serpentinized surfaces, trace schist foliation, trace aragonite	WATER, no flow
15			3.3
20			3.3
25			3.3
30			3.3
35			3.3
40			3.3
45			3.3
50			3.3
55		BASALT: As above, silicified with moderate chert texture	
60		BASALT: Very dark green to black metamorphosed ultramafics, green soapy serpentinized surfaces, trace schist foliation/textures, trace aragonite	3.3

Comments:


100 mm Class 9 uPVC (ID 104.5mm) Screen with 1mm slots, providing a 3% open area
3.2-6.4mm graded gravel
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
3.3

Comments:


100 mm Class 18 uPVC
(ID 96mm) BLANK PVC
100 mm Class 9 uPVC
(ID 104.5mm) Screen
with 1mm slots, providing
a 3% open area
100 mm Class 18 uPVC
(ID 96mm) BLANK PVC
END CAP
END OF BOREHOLE
165
170
175
180
185
190
195
200
205
210
215
BASALT: As above, very dark green, silicified with moderate chert texture and increased soapy texture/ serpentinization on surfaces,
BASALT: Dark green metamorphosed ultramafics with high carbonate content, green soapy serpentinized surfaces, trace schist foliation/textures, 30% calcrete and aragonite
CARBONATE: Mostly white and orange calcite and grey green serpentinized ultramafics, minor quartz, mild to moderate oxidation shown as orange coloration in calcite, moderate alteration shown as variation in textures from mottled coloration, wavy inclusions and trace bright green altered surfaces/veins
CARBONATE: As above, reduced oxidation to mild
CARBONATE: As above, increased oxidation to moderate as in 204-206m, mostly shown as opaque orange calcite
CALCAREOUS CHERT: Olive green, bright green, grey and colourless calcareous chert, trace oxidation
CALCAREOUS CHERT: Bright green, minor grey calcareous chert
3.3
3.3
3.3
3.3
3.3
3.3
3.3
3.3
3.3
3.3

Comments:

OBSERVATION WELL BORE LOG

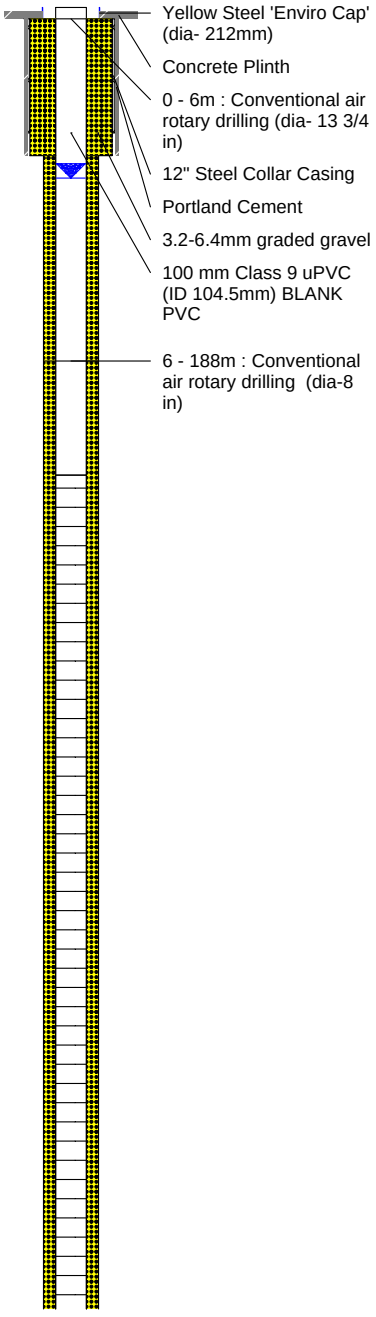
BOREHOLE NUMBER

NS-ObsS12

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

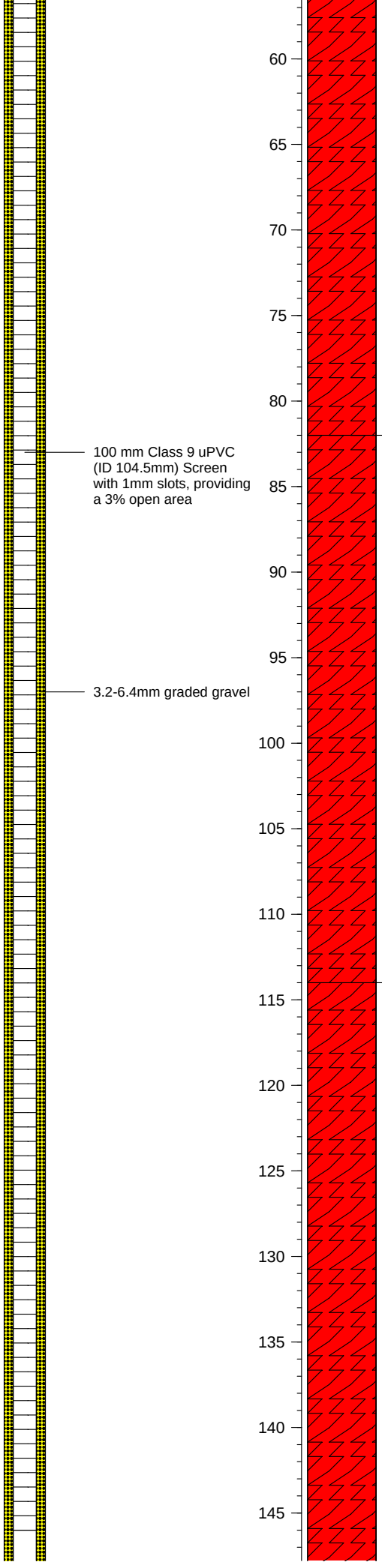
PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **708138.83**
NORTHING (m): **7646536.87**
MEAS PT ELEVATION (mAHD): **254.75**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **28/10/2014** DATE COMPLETED: **30/10/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.655**
Drilled Depth (mbgl):	**188**
Cased Depth (mbgl):	**188**
Casing Stick Up (magl):	**0.416**
Development Airlift Yield (l/s):	**3**
Water Level (mbgl) & Date:	**6.98** & **13/04/2015**



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		DETRITUS: Red to orange silt and oxidized chips of metamorphosed ultramafics, minor calcrete	
5		CALCRETE: Mostly white and orange calcite and grey green serpentinized ultramafics	
10		BASALT: Olive to grey green metamorphosed ultramafics, minor calcrete, all well weathered	
15		BASALT: Grey green to black metamorphosed ultramafics and trace calcrete, minor weathering	1
20			1
25			1
30			3.8
35			3.5
40			3.5
45			3.5
50		BASALT: Olive to blue green metamorphosed ultramafics, trace aragonite and calcite, trace to no weathering, texture is mostly mottled green grey with lighter carbonates	3.5
55			3.5

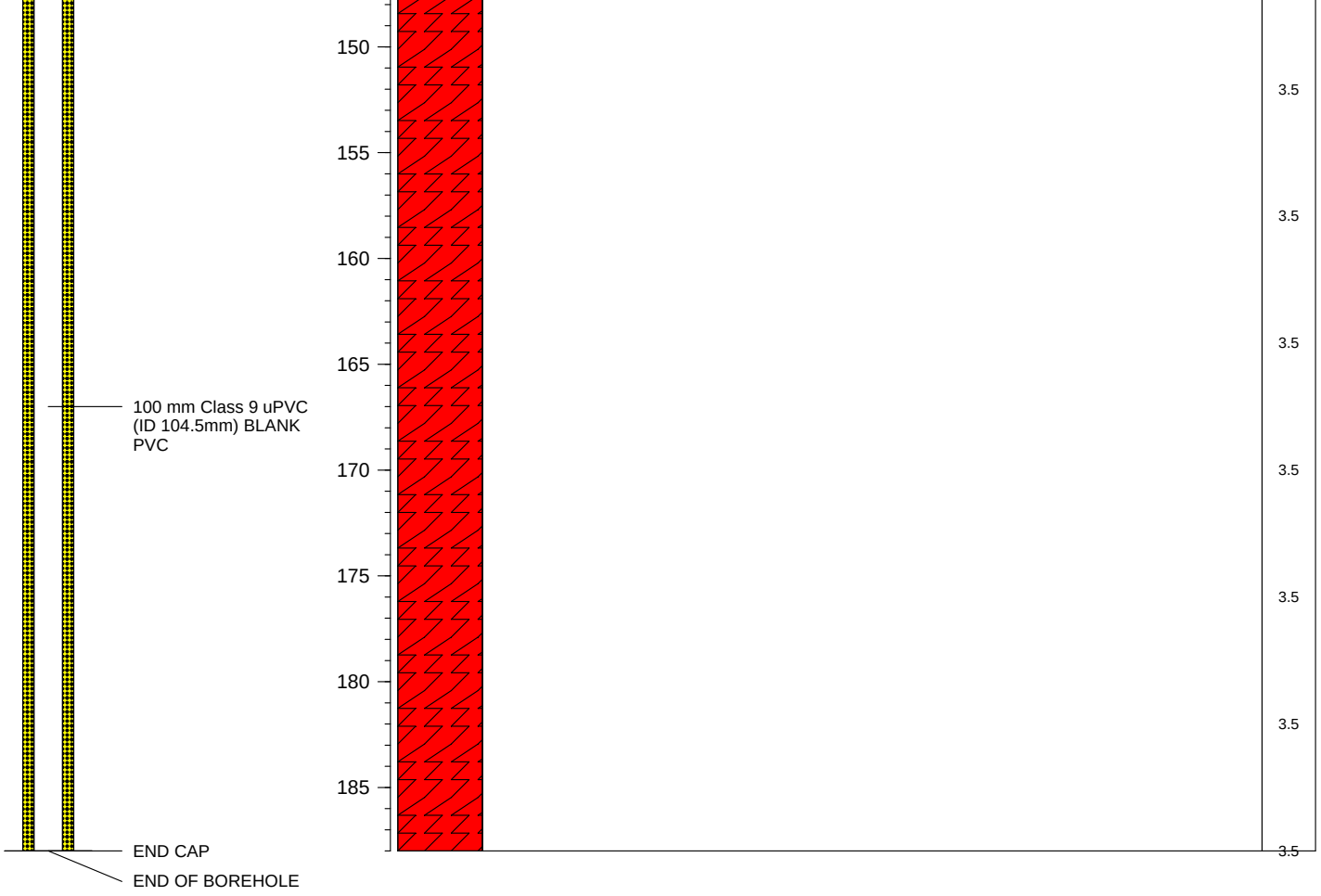
Comments:



BASALT: As above with minor fibrous to spinifex texture

BASALT: Olive to blue green metamorphosed ultramafics, trace aragonite and calcite, trace to no weathering, texture is mostly mottled green grey with lighter carbonates

3.5


150
155
160
165
170
175
180
185
3.5
3.5
3.5
3.5
3.5
3.5
3.5
100 mm Class 9 uPVC (ID 104.5mm) BLANK PVC
END CAP
END OF BOREHOLE

Comments:

OBSERVATION WELL BORE LOG

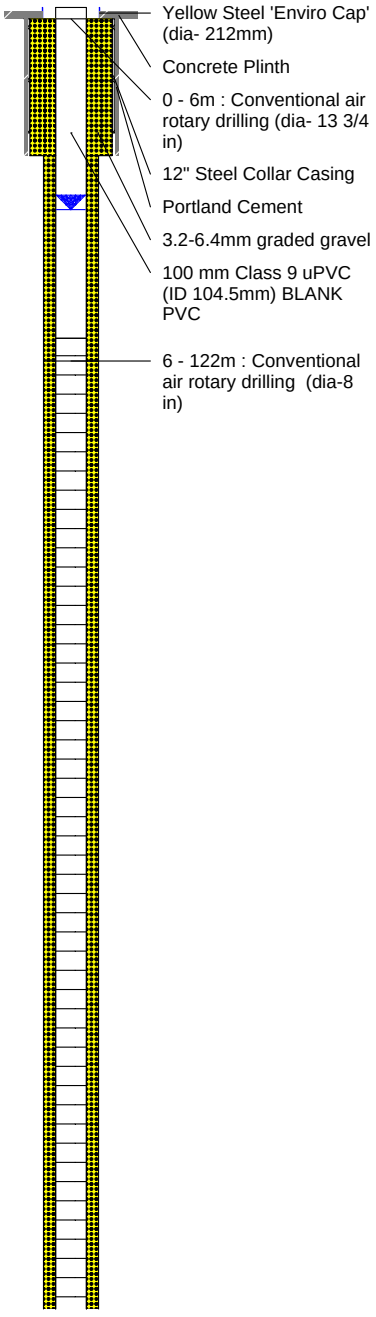
BOREHOLE NUMBER

NS-ObsS13

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

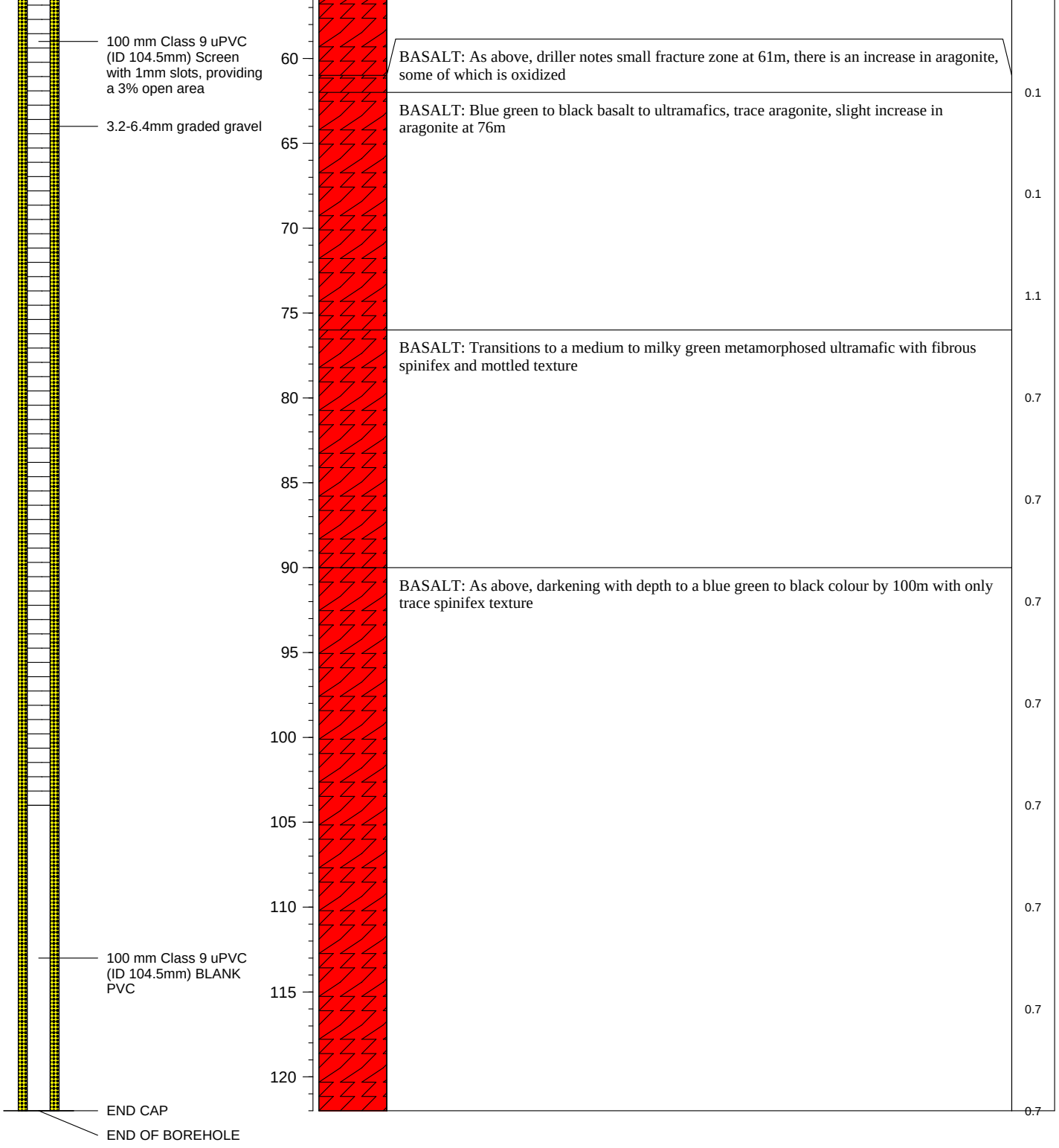
PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **708158.25**
NORTHING (m): **7646648.75**
MEAS PT ELEVATION (mAHD): **256.24**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **26/10/2014** DATE COMPLETED: **28/10/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.681**
Drilled Depth (mbgl):	**122**
Cased Depth (mbgl):	**122**
Casing Stick Up (magl):	**0.681**
Development Airlift Yield (l/s):	**0.9**
Water Level (mbgl) & Date:	**8.36** & **13/04/2015**



DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Red silt and chips 0mm to large gravels of completely weathered mafic schist and metamorphosed ultramafics minor calcrete	
5	BASALT: Olive to blue green metamorphosed ultramafics, minor calcrete, all well weathered, chips are 0-30mm with 50% powder	
	BASALT: Olive to blue green metamorphosed ultramafics and trace calcrete, minor weathering, chips are 0-20mm with 25% powder	0.1
10	BASALT: Olive to blue green metamorphosed ultramafics, trace aragonite and calcite, trace to no weathering, chips are 0-20mm with 10% powder, decreasing with depth	
15		0.1
20		0.1
25		0.1
30		0.1
35		0.1
40	BASALT: As above, 50% of chips are slightly lighter green and show a fibrous spinifex texture	
45	BASALT: Olive to blue green metamorphosed ultramafics, trace aragonite and calcite, trace spinifex texture as above	0.1
50	BASALT: As above, chips are more silicified and marbled in a milky, lighter green microcrystalline siliceous rock with darker fibrous inclusions and trace conchoidal fracture, this lighter green rock increase with depth to 50% by 54m	0.1
55		0.1

Comments:


100 mm Class 9 uPVC (ID 104.5mm) Screen with 1mm slots, providing a 3% open area
3.2-6.4mm graded gravel
100 mm Class 9 uPVC (ID 104.5mm) BLANK PVC
END CAP
END OF BOREHOLE
60
65
70
75
80
85
90
95
100
105
110
115
120
BASALT: As above, driller notes small fracture zone at 61m, there is an increase in aragonite, some of which is oxidized
BASALT: Blue green to black basalt to ultramafics, trace aragonite, slight increase in aragonite at 76m
BASALT: Transitions to a medium to milky green metamorphosed ultramafic with fibrous spinifex and mottled texture
BASALT: As above, darkening with depth to a blue green to black colour by 100m with only trace spinifex texture
0.1
0.1
1.1
0.7
0.7
0.7
0.7
0.7
0.7
0.7
0.7

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-ObsS16

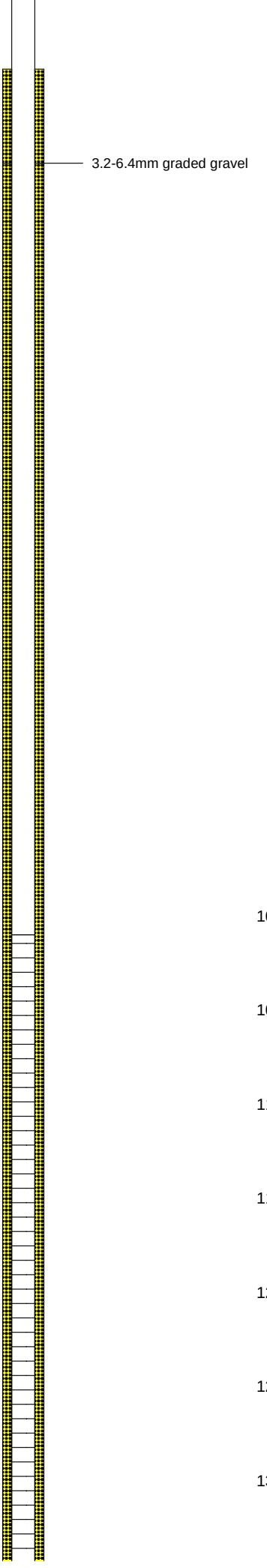
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**709363.40**
NORTHING (m):	**7645361.55**
MEAS PT ELEVATION (mAHD):	**280.26**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **10/02/2015**	DATE COMPLETED: **14/02/2015**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.71**
Drilled Depth (mbgl):	**278**
Cased Depth (mbgl):	**275**
Casing Stick Up (magl):	**0.504**
Development Airlift Yield (l/s):	**0.5**
Water Level (mbgl) & Date:	**20.3** & **11/04/2015**

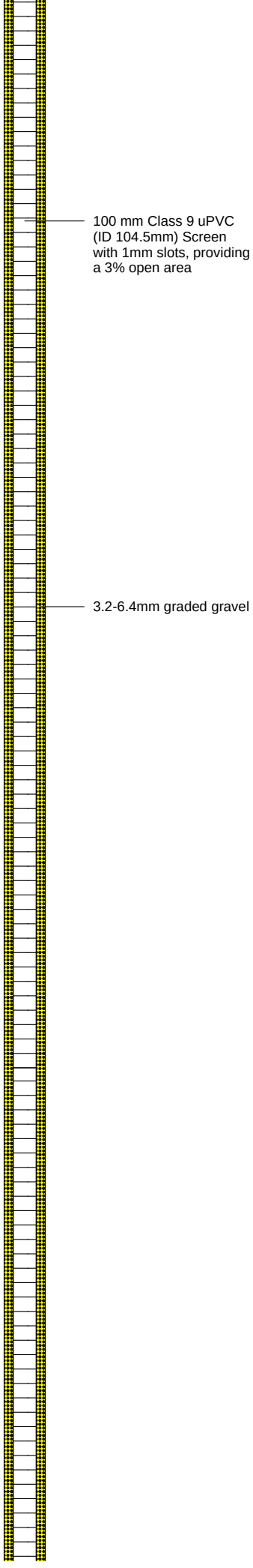
BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
Yellow Steel 'Enviro Cap' (dia- 212mm) Concrete Plinth 0 - 6m : Conventional air rotary drilling (dia- 13 3/4 in) 12" Steel Collar Casing Portland Cement	0		SCHIST: Pale orange to white felsic schist, very soft 30% chips of angular chert, 70% silt powder from felsic schist, trace calcrete and ironstone	
	5		SCHIST: 90% Yellow to orange silty powder, 10% chips of soft schist to weathered siltstone	
	10		SCHIST: 90-95% Reddish brown silty powder, 5-10% chips of completely weathered ironstone and siltstone	
6 - 278m : Conventional air rotary drilling (dia-8 in)	15			
	20			
	25			
	30			
	35		SCHIST: 70% Reddish brown completely weathered ironstone, with red to orange streak, trace magnetism, 30% powder, trace chert	0.1
	40		SCHIST: Pale grey siltstone to schist, minor ironstone, minor chert, 80% chips, 20% powder	0.2
	45		SANDSTONE/WACKE: Grey sand stone to wacke and quartzite, minor siltstone, minor chert, trace ironstone, 80% chips, 20% powder	0.2
100 mm Class 9 uPVC (ID 104.5mm) Blank	50		SANDSTONE/WACKE: Mostly pale grey, grey and beige siltstone, minor quartzite, cut by	0.2

Comments:



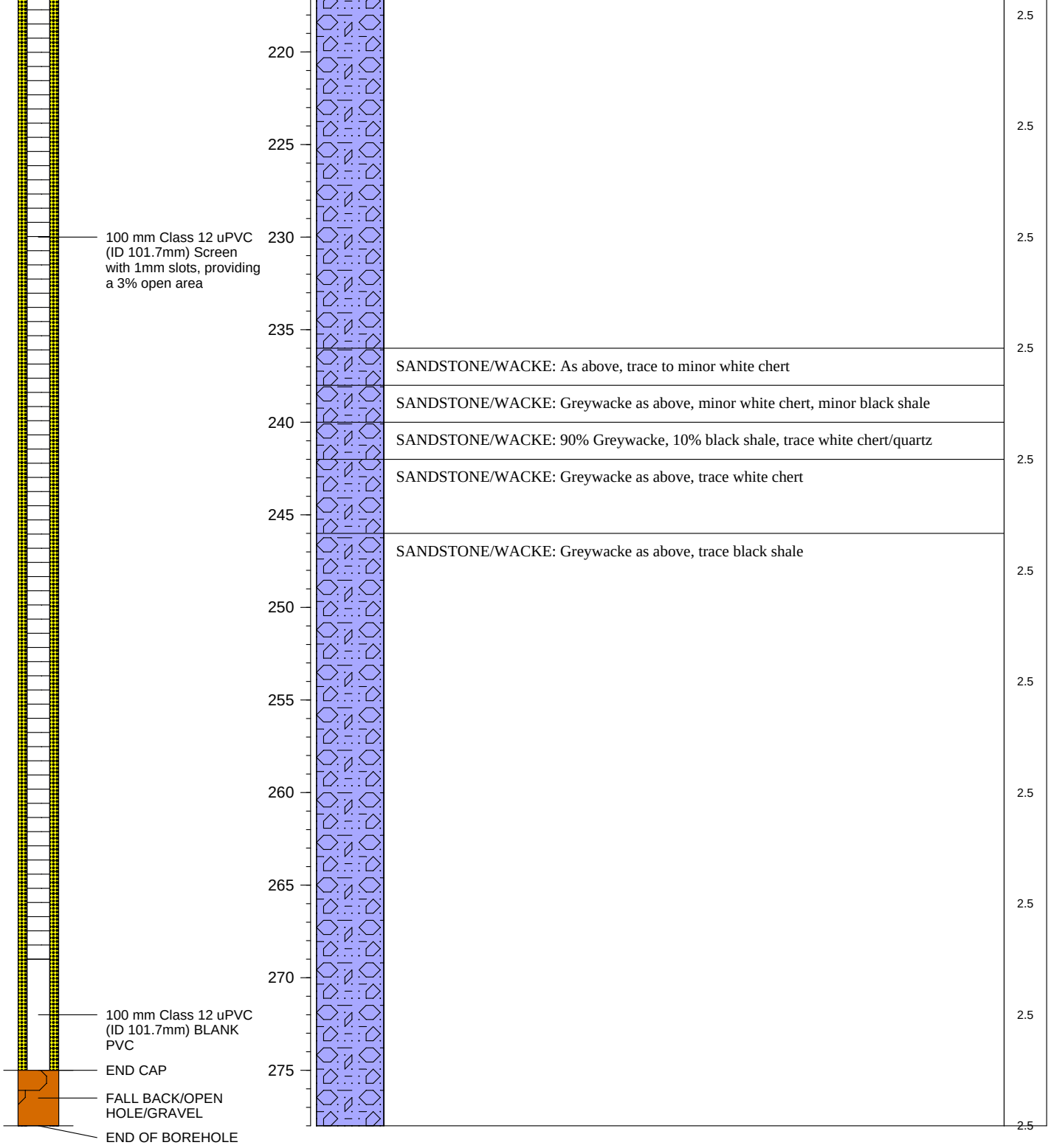
	quartz veins and silicified, all metamorphosed, trace ironstone, increase in dark grey quartz and quartzite from 52m	
55	SHALE: Black shale and grey silicified siltstone and quartzite, all cut by quartz veinlets, minor ironstone, and oxidation	0.3
	SHALE: Black silicified shale to chert, minor red ironstone, minor colourless and grey chert	
60	IRONSTONE: Red oxidized ironstone with trace magnetism, minor black shale to chert, trace colourless and grey chert, 80% chips, 20% powder	
	IRONSTONE: Black and red ironstone, minor black shale to chert, not as oxidized as above	0.5
65	SHALE: Mostly grey and beige siltstone, fine grained sandstone and quartzite, 30% black shale to chert, minor ironstone	
	CHERT: Dark grey to black, white and colourless quartzite and chert with minor pale grey to pale orange quartzite to sandstone or wacke	0.5
70	SHALE: 50% Black shale to chert, 40% silicified greywacke to quartzite, 10% white to colourless chert or quartz veins, trace ironstone, mild oxidation	
	SANDSTONE/WACKE: 50% Silicified greywacke to quartzite, 40% black shale to chert, 10% white to colourless chert or quartz veins, trace ironstone, mild oxidation	0.5
75	SHALE: 50% Black shale to chert, 40% silicified greywacke to quartzite, 10% white to colourless chert or quartz veins, trace ironstone, mild oxidation and an increase at 78m, minor chips of brecciated rock in silica and iron cement, more craggy textures, minor milky green chips at 82-84m	
80		1.25
85	SANDSTONE/WACKE: 70% Medium grained grey quartz to sandstone/wacke, with a pale grey to white matrix, 30% black silicified shale, trace orange oxidation, and ironstone,	1.25
	SHALE: 50% Black shale as above, 50% greywacke as above	
90	SANDSTONE/WACKE: 70% Medium grained grey quartz to sandstone/wacke, with a pale grey to white matrix, 30% black silicified shale, trace orange oxidation, and ironstone,	1.25
95	SHALE: 50% Black shale as above, 50% greywacke as above, grains are more blended with a more quartzite texture	
	SANDSTONE/WACKE: 80% Quartzite to wacke, 20% black shale to chert	1.25
100	SANDSTONE/WACKE: 70% Quartzite to wacke as above, 30% black shale as above	
105	SANDSTONE/WACKE: 80% Grey wacke more granular with a faint green hue, 20% black shale as above	1.25
	SHALE: 80% Black shale as above, 20% wacke as above	
110	SHALE: 95-100% Black shale as above, trace to 5% wacke as above	1.25
115	SHALE: 60% Black shale, 40% greywacke	
	SANDSTONE/WACKE: 70% Greywacke, 30% black shale	1.25
120	SANDSTONE/WACKE: 50% Greywacke, 50% black shale	
	SANDSTONE/WACKE: 70% Greywacke, 30% black shale	
125	SANDSTONE/WACKE: 90% Greywacke, 10% black shale	1.5
130	SANDSTONE/WACKE: 70% Greywacke, 30% black shale	1.5
	SHALE: 80% Black shale, 20% greywacke	1.5

Comments:



135	SANDSTONE/WACKE: 60% Greywacke, 40% black shale	
140	SHALE: 70% Black shale, 30% greywacke	1.5
	SANDSTONE/WACKE: 70% Greywacke, 30% black shale	
145	SANDSTONE/WACKE: 90% Greywacke, 10% black shale	
	SANDSTONE/WACKE: 70% Greywacke, 30% black shale	1.5
	SHALE: 80% Black shale, 20% greywacke	
150	SANDSTONE/WACKE: 80% Greywacke, 20% black shale	
	SANDSTONE/WACKE: 90% Greywacke, 10% black shale	1.5
155	SANDSTONE/WACKE: 60% Greywacke, 40% black shale	
	SHALE: 60% Black shale, 40% greywacke	1.5
160	SHALE: 80% Black shale, 20% greywacke, trace brecciated black shale in white quartz cement	
	SANDSTONE/WACKE: 70% Greywacke, 30% black shale	1.5
165	SANDSTONE/WACKE: Greywacke, trace black shale	
170		1.5
175		
	SANDSTONE/WACKE: Greywacke, trace black shale, increase in larger 1-2mm grains of angular black shale within the greywacke matrix, overall appearance is more mottled	1.5
180		
	SANDSTONE/WACKE: 80% Greywacke, 20% black shale	1.5
185	SANDSTONE/WACKE: Greywacke, trace black shale	
		1.5
190	SANDSTONE/WACKE: 90% Greywacke, 10% black shale	
		1.5
195	SANDSTONE/WACKE: Greywacke, trace black shale	
200	SANDSTONE/WACKE: As above with a harder, darker more lithified quartzite texture than the granular sandstone as above, still mottled dark and light grey, trace black inclusions	2
205		2
210		
	SHALE: 90% Black shale, 10% greywacke	2
215	SANDSTONE/WACKE: 90% Greywacke, 10% black shale	

Comments:


220
225
230
235
240
245
250
255
260
265
270
275
100 mm Class 12 uPVC (ID 101.7mm) Screen with 1mm slots, providing a 3% open area
100 mm Class 12 uPVC (ID 101.7mm) BLANK PVC
END CAP
FALL BACK/OPEN HOLE/GRAVEL
END OF BOREHOLE
SANDSTONE/WACKE: As above, trace to minor white chert
SANDSTONE/WACKE: Greywacke as above, minor white chert, minor black shale
SANDSTONE/WACKE: 90% Greywacke, 10% black shale, trace white chert/quartz
SANDSTONE/WACKE: Greywacke as above, trace white chert
SANDSTONE/WACKE: Greywacke as above, trace black shale
2.5
2.5
2.5
2.5
2.5
2.5
2.5
2.5
2.5
2.5
2.5
2.5
2.5

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

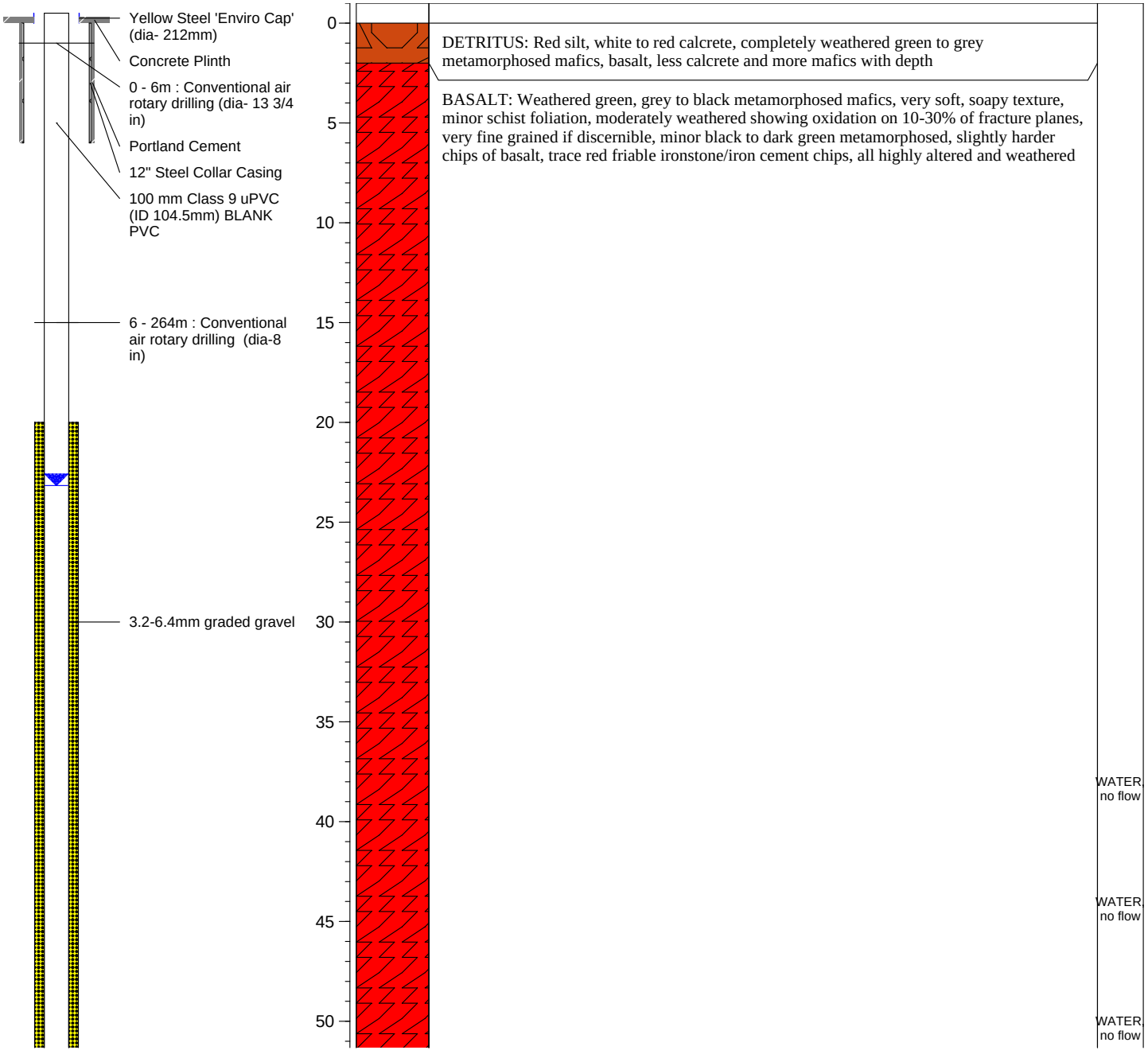
NS-ObsS18

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

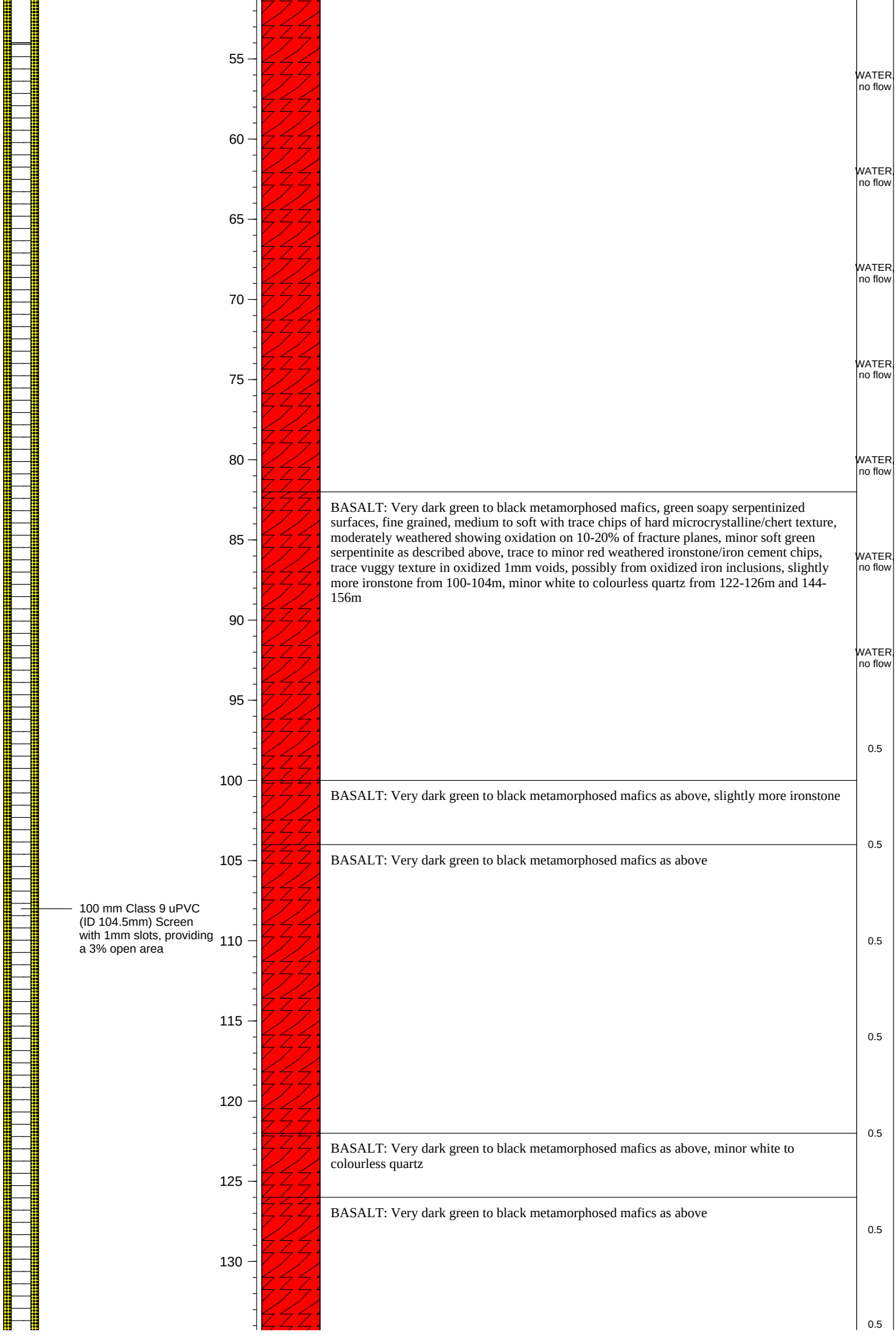
PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709725.91**
NORTHING (m): **7644741.37**
MEAS PT ELEVATION (mAHD): **285.87**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **31/01/2015** DATE COMPLETED: **2/02/2015**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.643**
Drilled Depth (mbgl):	**264**
Cased Depth (mbgl):	**180**
Casing Stick Up (magl):	**0.167**
Development Airlift Yield (l/s):	**0.5**
Water Level (mbgl) & Date:	**23.16** & **11/04/2015**

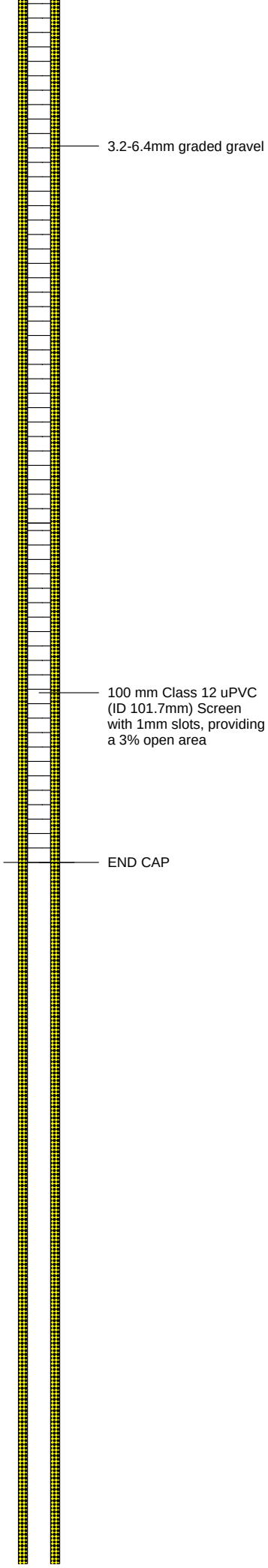
BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



Comments:

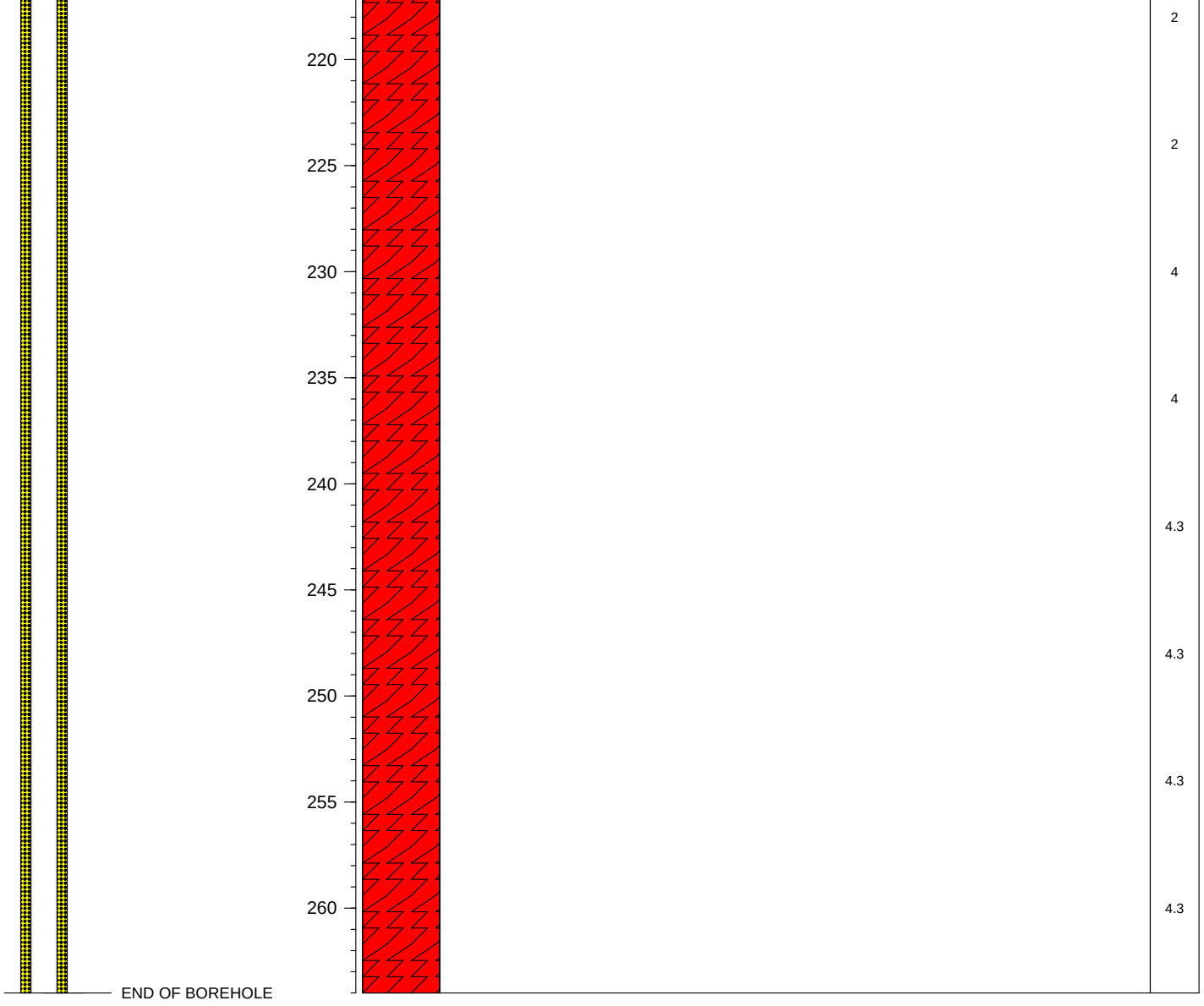

55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
100 mm Class 9 uPVC (ID 104.5mm) Screen with 1mm slots, providing a 3% open area
WATER no flow
WATER no flow
WATER no flow
WATER no flow
WATER no flow
WATER no flow
BASALT: Very dark green to black metamorphosed mafics, green soapy serpentinized surfaces, fine grained, medium to soft with trace chips of hard microcrystalline/chert texture, moderately weathered showing oxidation on 10-20% of fracture planes, minor soft green serpentinite as described above, trace to minor red weathered ironstone/iron cement chips, trace vuggy texture in oxidized 1mm voids, possibly from oxidized iron inclusions, slightly more ironstone from 100-104m, minor white to colourless quartz from 122-126m and 144-156m
BASALT: Very dark green to black metamorphosed mafics as above, slightly more ironstone
BASALT: Very dark green to black metamorphosed mafics as above
BASALT: Very dark green to black metamorphosed mafics as above, minor white to colourless quartz
BASALT: Very dark green to black metamorphosed mafics as above
0.5
0.5
0.5
0.5
0.5
0.5
0.5

Comments:



135		
140		0.5
145	BASALT: Very dark green to black metamorphosed mafics as above, minor white to colourless quartz	0.5
150		0.5
155	BASALT: Very dark green to black metamorphosed mafics as above	0.5
160		
	BASALT: Very dark green to black metamorphosed mafics as above, slightly less altered	0.5
165	BASALT: Very dark green to black metamorphosed mafics as above	
170		0.5
175		0.5
180		0.5
185		0.5
190		0.5
195		0.5
200		0.5
205	BASALT: Very dark green to black metamorphosed mafics as above, increased vuggy texture in oxidized 1mm voids, possibly from oxidized iron inclusions	4
210		2
215		

Comments:


220
225
230
235
240
245
250
255
260
END OF BOREHOLE
2
2
4
4
4.3
4.3
4.3
4.3

Comments:

OBSERVATION WELL BORE LOG

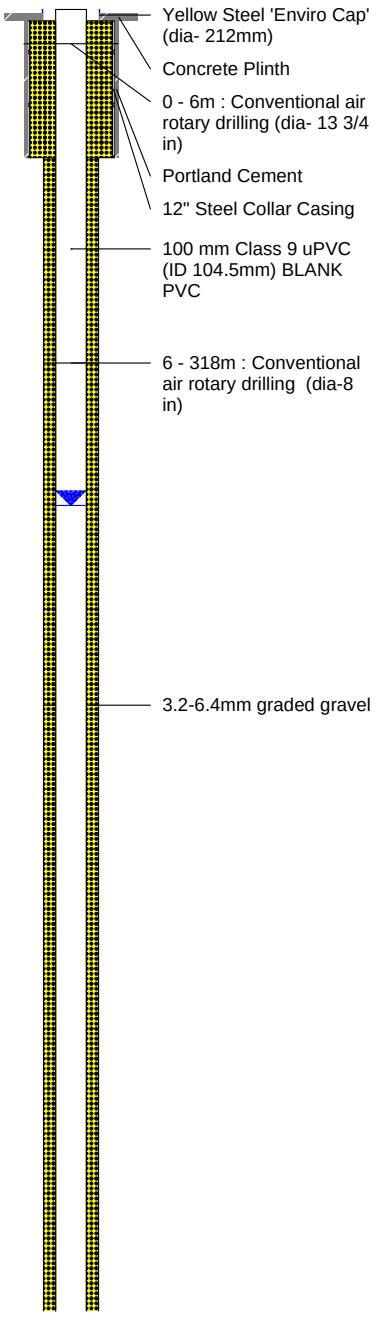
BOREHOLE NUMBER

NS-ObsS19

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

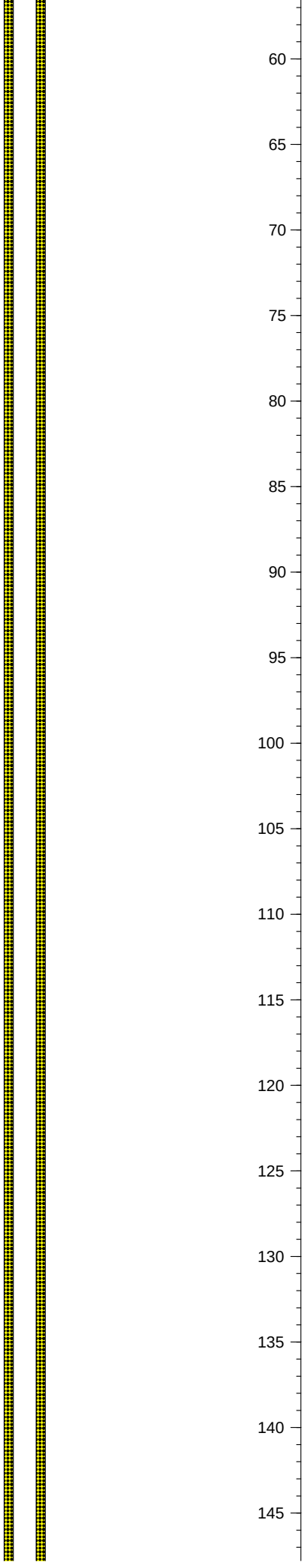
PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **710279.38**
NORTHING (m): **7644971.70**
MEAS PT ELEVATION (mAHD): **283.75**
DRILLING DIAMETER(S) (mm): **204**
DATE BEGUN: **15/01/2015** DATE COMPLETED: **18/01/2015**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.624**
Drilled Depth (mbgl):	**318**
Cased Depth (mbgl):	**318**
Casing Stick Up (magl):	**0.341**
Development Airlift Yield (l/s):	**5**
Water Level (mbgl) & Date:	**21.24** & **11/04/2015**



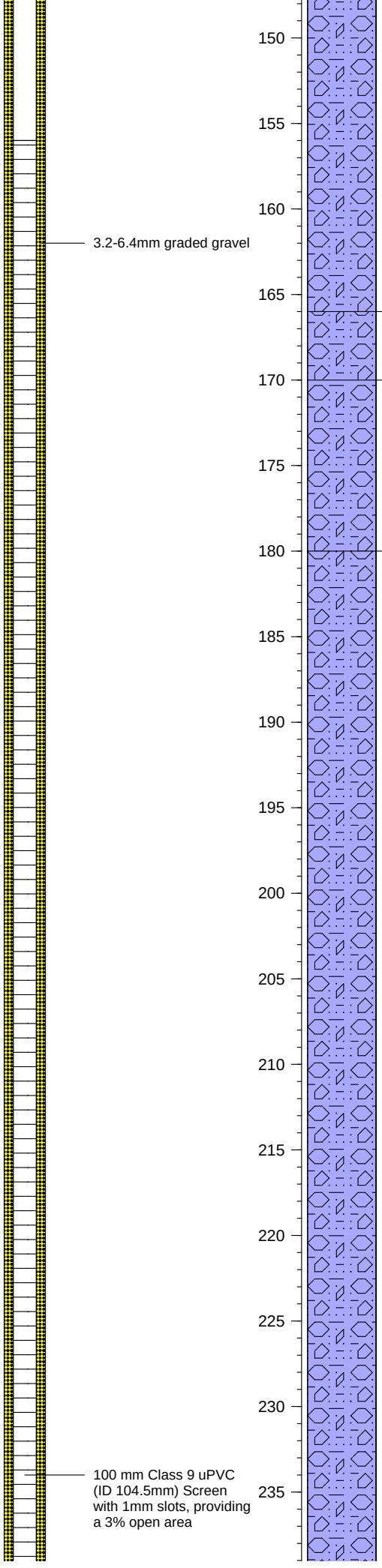
DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		DETRITUS: Light orange with minor white detritus, well oxidized mix of red silt, 0-10mm chips of white mudstone, surfaces showing light pink and purple discolouration and black dendric formations, minor orange stained transparent quartz/chert chips, 40% chips 0-, 6	
5		MUDSTONE: Light orange to white mudstone as above with minor orange stained to colourless 0-5mm transparent quartz chips, trace grey to green chips, chips are mostly 0-5mm	
10		MUDSTONE: White mudstone, light grey to green silicified mudstone, with mottled to schistose texture, minor embedded pale green to colourless and white angular to subrounded quartz crystals with 25% chips of 0-5mm quartz, chip percent reduces to 20% at 8m with 80%	
15		MUDSTONE: As above, slight increase in quartz mostly in individual chips with less green colouration, most of sample is pulverized mudstone, with some white mudstone chips showing more pink and purple and less grey to green colouration	
20		MUDSTONE: As above, increase in light grey/green colouration, trace chips of grey/green silicified sandstone and trace sandstone embedded in white mudstone	
25		MUDSTONE: Mudstone has become overall more grey/green and rich in fine sand, sample continues to surface as 80% powder and 20% chips	
30		MUDSTONE: Mudstone is more white to light purple and pink with fewer fine sand embedded in mudstone, but an increase in larger 1-5mm colourless quartz crystals	
35		MUDSTONE: Mudstone has become overall more grey/green and rich in fine sand, sample continues to surface as 80% powder and 20% chips	
40		MUDSTONE: Olive grey chips of very fine quartz sand in a very fine matrix, trace-5% chips of angular colourless quartz over 5mm, sample is still 80% powder, 20% chips	WATER no flow
45			
50			
55			

Comments:



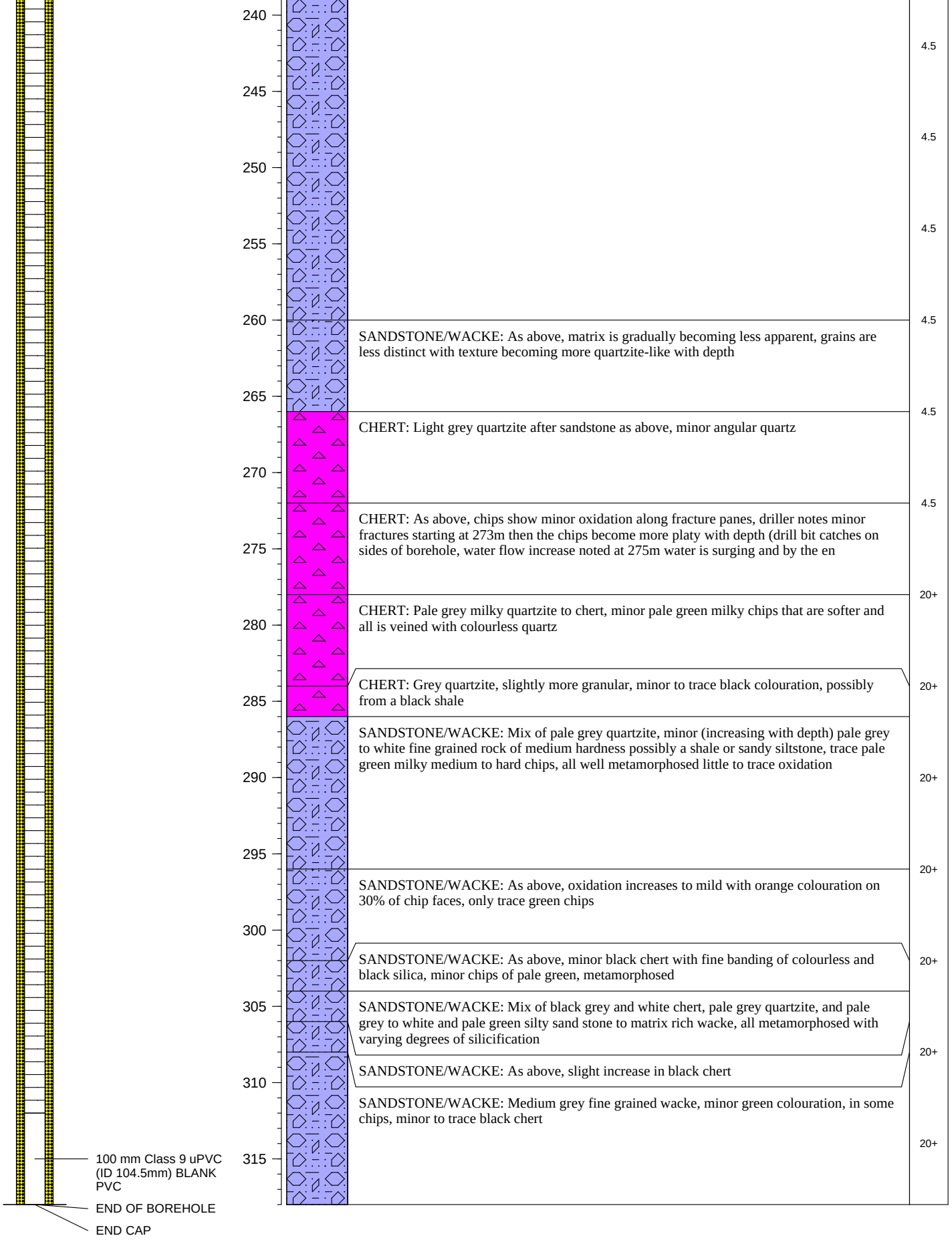
MUDSTONE: As above, chip percentage increases to 60% with 40% powder, 30-40% is colourless angular quartz chips over 1mm with higher quantities over 10mm	
MUDSTONE: Olive grey chips of very fine quartz sand in a very fine matrix, trace-5% chips of angular colourless quartz over 5mm, 60% chips, 40% powder	1
MUDSTONE: Grey to green mudstone as above, with 25% of sample is pale pink to white mudstone (as 10-22m), trace to 5% large quartz chips, 60% chips, 40% powder	
MUDSTONE: Grey to green mudstone as above, with 15% of sample is pale pink to white mudstone (as 10-22m), trace to 5% large quartz chips, 60% chips, 40% powder	2.5
MUDSTONE: Olive grey chips of very fine quartz sand in a very fine matrix, trace-5% chips of angular colourless quartz over 5mm, trace metallic mineralization on fracture planes, 60% chips, 40% powder	
MUDSTONE: As above, trace metallic mineralisation on fracture planes	2.5
	2.5
CHERT: As above, increased quartz to 60%, increased percent of larger chips of angular quartz over 10mm, minor iron cement, trace oxidation	
MUDSTONE: Olive grey chips of very fine quartz sand in a very fine matrix, trace-5% chips of angular colourless quartz over 5mm, slight increase in colourless, quartz chips 5-10mm in diameter from 90-92m and 94-96m	3.8
	3.8
	3.8
MUDSTONE: As above, slightly lighter with 30% quartz chips	3.8
CHERT: Mostly angular quartz chips, minor chips of fine to medium sand in a matrix of pale yellow to white and pink silt, minor olive green wacke chips, mildly oxidized	
SANDSTONE/WACKE: 80% olive green wacke chips, 20% colourless quartz, mild iron staining/oxidation	3.8
SANDSTONE/WACKE: As above with increased oxidation and larger quartz chips	
CHERT: Mostly angular quartz chips, minor pale yellow and minor olive green wacke, mildly oxidized	
SANDSTONE/WACKE: Mix of 40% olive green wacke, 30% pale yellow wacke, with minor iron staining and oxidation, and 30% colourless quartz	3.8
SANDSTONE/WACKE: Olive green wacke, 30% to 60% colourless quartz, chip percentage increase to 60% by 120m, 30% colourless quartz chips at 118-120m increased to 60% at 128-130m, 138-140m, and 144-146m, slightly lighter at 164m	3.8
	3.8
	3.8
	3.8
	3.8
	3.8

Comments:



150		3.8
155		3.8
160		3.8
165		3.8
170	SANDSTONE/WACKE: As above becoming lighter grey and more granular	3.8
175	SANDSTONE/WACKE: Light grey sandstone with well sorted 1mm subrounded to subangular grains of quartz in a white cement, trace 5mm chips of angular transparent colourless quartz, chip percent increase to 80%	3.8
180	SANDSTONE/WACKE: As above, chips become slightly larger in size 5-10mm from 180m and chip percent increases to 90%, minor 5mm chips of colourless quartz, from 204-210m, 226-228 and 252-254m	3.8
185		4.5
190		4.5
195		4.5
200		4.5
205		4.5
210		4.5
215		4.5
220		4.5
225		4.5
230		4.5
235		4.5

Comments:



240		4.5
245		4.5
250		4.5
255		
260	SANDSTONE/WACKE: As above, matrix is gradually becoming less apparent, grains are less distinct with texture becoming more quartzite-like with depth	4.5
265	CHERT: Light grey quartzite after sandstone as above, minor angular quartz	4.5
270		4.5
275	CHERT: As above, chips show minor oxidation along fracture panes, driller notes minor fractures starting at 273m then the chips become more platy with depth (drill bit catches on sides of borehole, water flow increase noted at 275m water is surging and by the en	20+
280	CHERT: Pale grey milky quartzite to chert, minor pale green milky chips that are softer and all is veined with colourless quartz	
285	CHERT: Grey quartzite, slightly more granular, minor to trace black colouration, possibly from a black shale	20+
290	SANDSTONE/WACKE: Mix of pale grey quartzite, minor (increasing with depth) pale grey to white fine grained rock of medium hardness possibly a shale or sandy siltstone, trace pale green milky medium to hard chips, all well metamorphosed little to trace oxidation	20+
295		20+
300	SANDSTONE/WACKE: As above, oxidation increases to mild with orange colouration on 30% of chip faces, only trace green chips	
305	SANDSTONE/WACKE: As above, minor black chert with fine banding of colourless and black silica, minor chips of pale green, metamorphosed	20+
310	SANDSTONE/WACKE: Mix of black grey and white chert, pale grey quartzite, and pale grey to white and pale green silty sand stone to matrix rich wacke, all metamorphosed with varying degrees of silicification	20+
315	SANDSTONE/WACKE: As above, slight increase in black chert	
	SANDSTONE/WACKE: Medium grey fine grained wacke, minor green colouration, in some chips, minor to trace black chert	20+

Comments:

OBSERVATION WELL BORE LOG

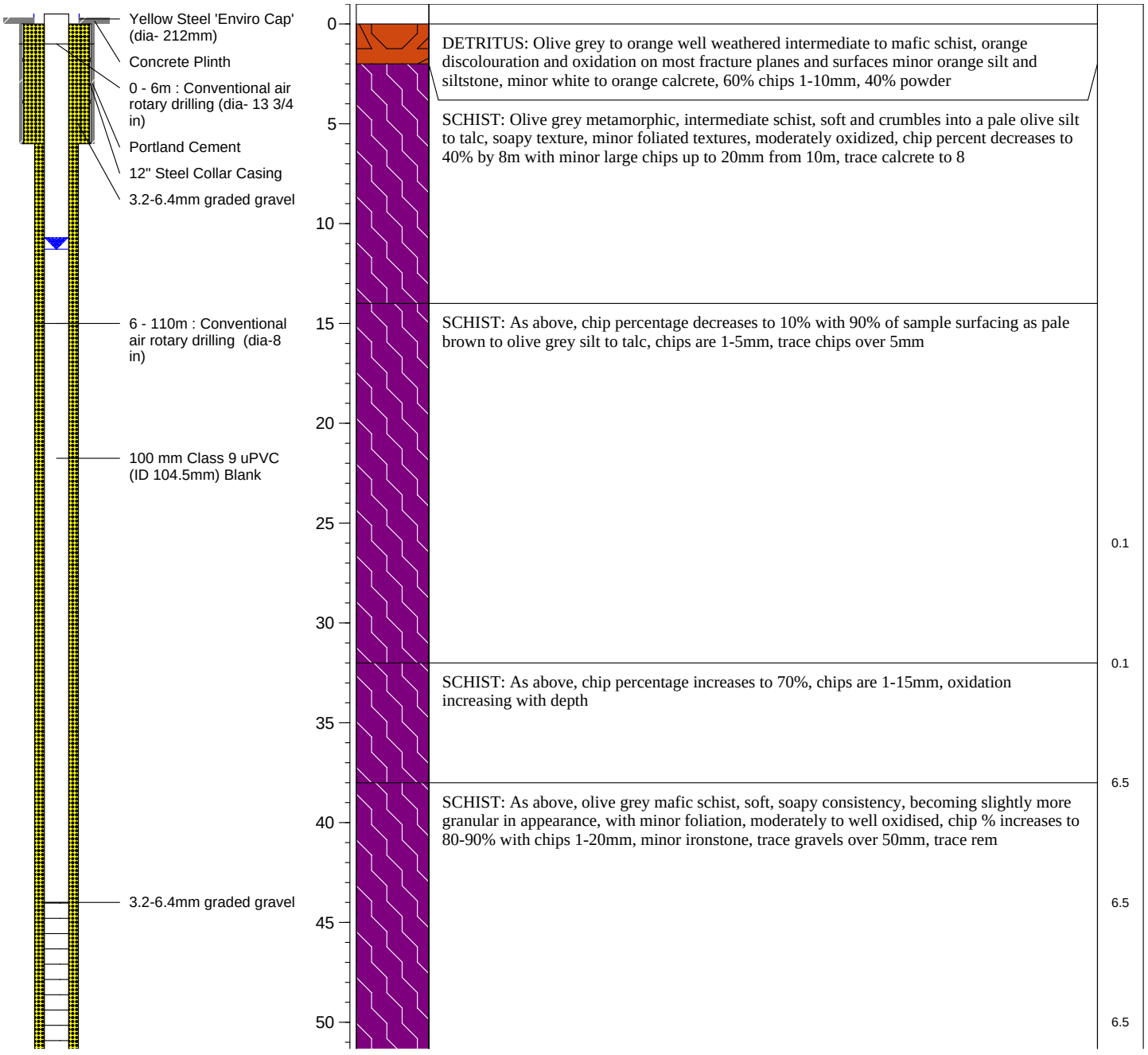
BOREHOLE NUMBER

NS-ObsS25

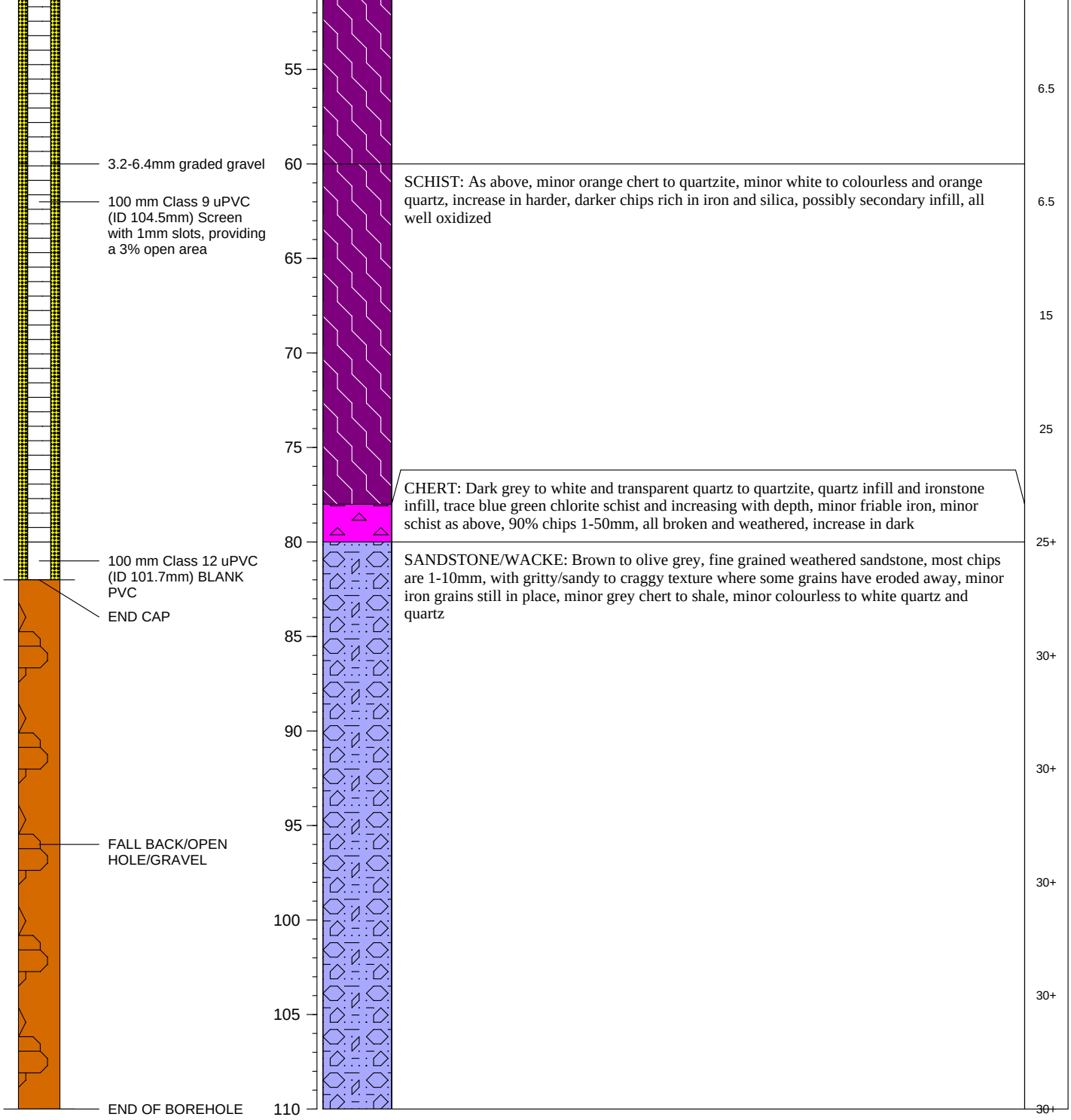
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**710066.33**
NORTHING (m):	**7643536.12**
MEAS PT ELEVATION (mAHD):	**268.94**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **7/03/2015**	DATE COMPLETED: **9/03/2015**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.554**
Drilled Depth (mbgl):	**110**
Cased Depth (mbgl):	**82**
Casing Stick Up (magl):	**0.523**
Development Airlift Yield (l/s):	**9**
Water Level (mbgl) & Date:	**11.28** & **13/04/2015**



Comments:


55
60
65
70
75
80
85
90
95
100
105
110
3.2-6.4mm graded gravel
100 mm Class 9 uPVC (ID 104.5mm) Screen with 1mm slots, providing a 3% open area
100 mm Class 12 uPVC (ID 101.7mm) BLANK PVC
END CAP
FALL BACK/OPEN HOLE/GRAVEL
END OF BOREHOLE
SCHIST: As above, minor orange chert to quartzite, minor white to colourless and orange quartz, increase in harder, darker chips rich in iron and silica, possibly secondary infill, all well oxidized
CHERT: Dark grey to white and transparent quartz to quartzite, quartz infill and ironstone infill, trace blue green chlorite schist and increasing with depth, minor friable iron, minor schist as above, 90% chips 1-50mm, all broken and weathered, increase in dark
SANDSTONE/WACKE: Brown to olive grey, fine grained weathered sandstone, most chips are 1-10mm, with gritty/sandy to craggy texture where some grains have eroded away, minor iron grains still in place, minor grey chert to shale, minor colourless to white quartz and quartz
6.5
6.5
15
25
25+
30+
30+
30+
30+
30+

Comments:

OBSERVATION WELL BORE LOG

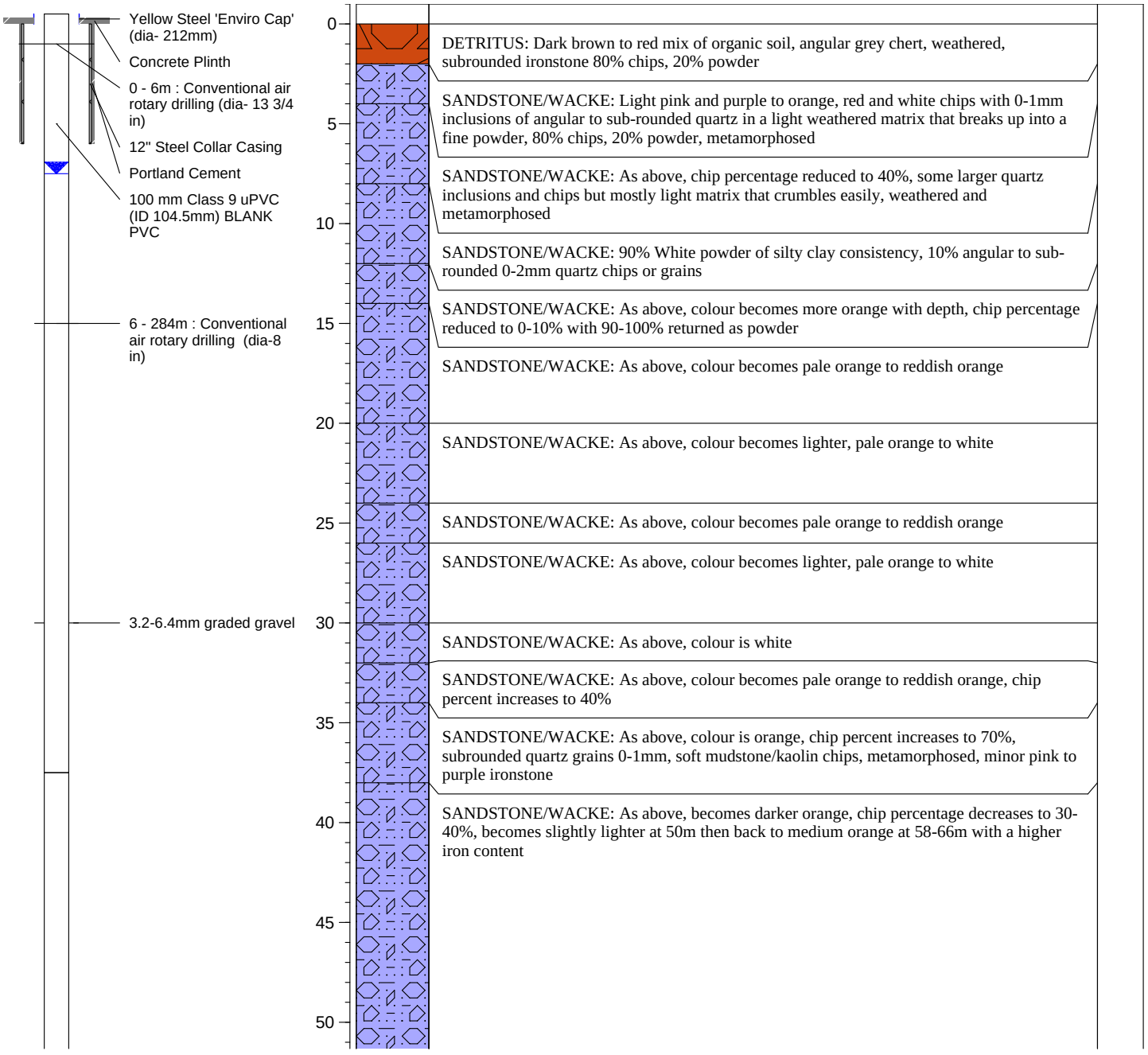
BOREHOLE NUMBER

NS-ObsS28

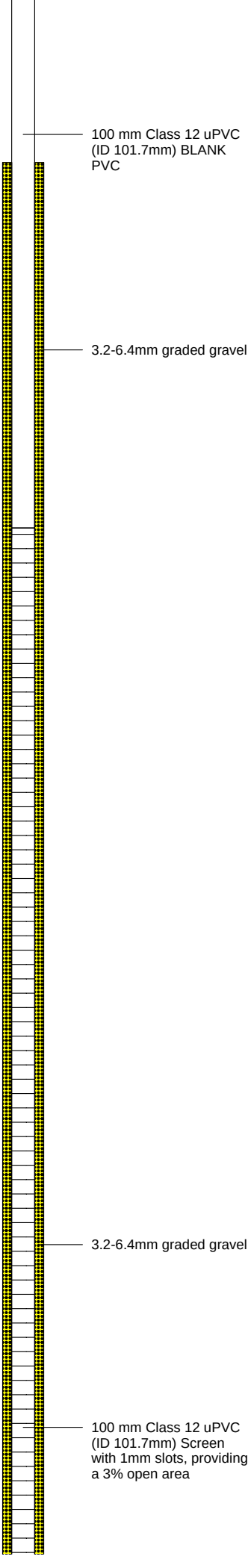
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**710891.66**
NORTHING (m):	**7644632.85**
MEAS PT ELEVATION (mAHD):	**270.34**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **11/01/2015**	DATE COMPLETED: **15/01/2015**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.678**
Drilled Depth (mbgl):	**284**
Cased Depth (mbgl):	**175.5**
Casing Stick Up (magl):	**0.181**
Development Airlift Yield (l/s):	**8.3**
Water Level (mbgl) & Date:	**7.5** & **11/04/2015**

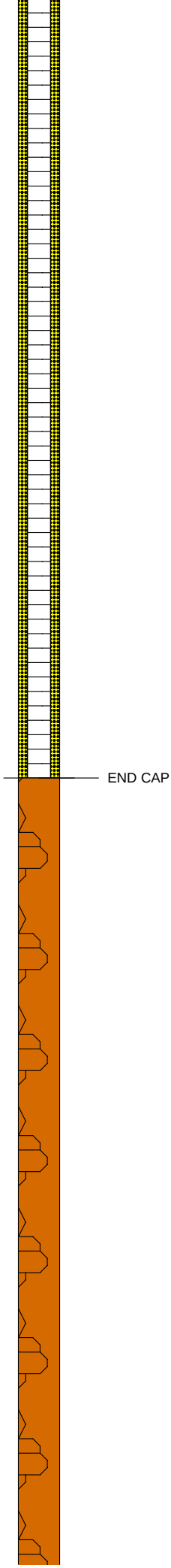


Comments:



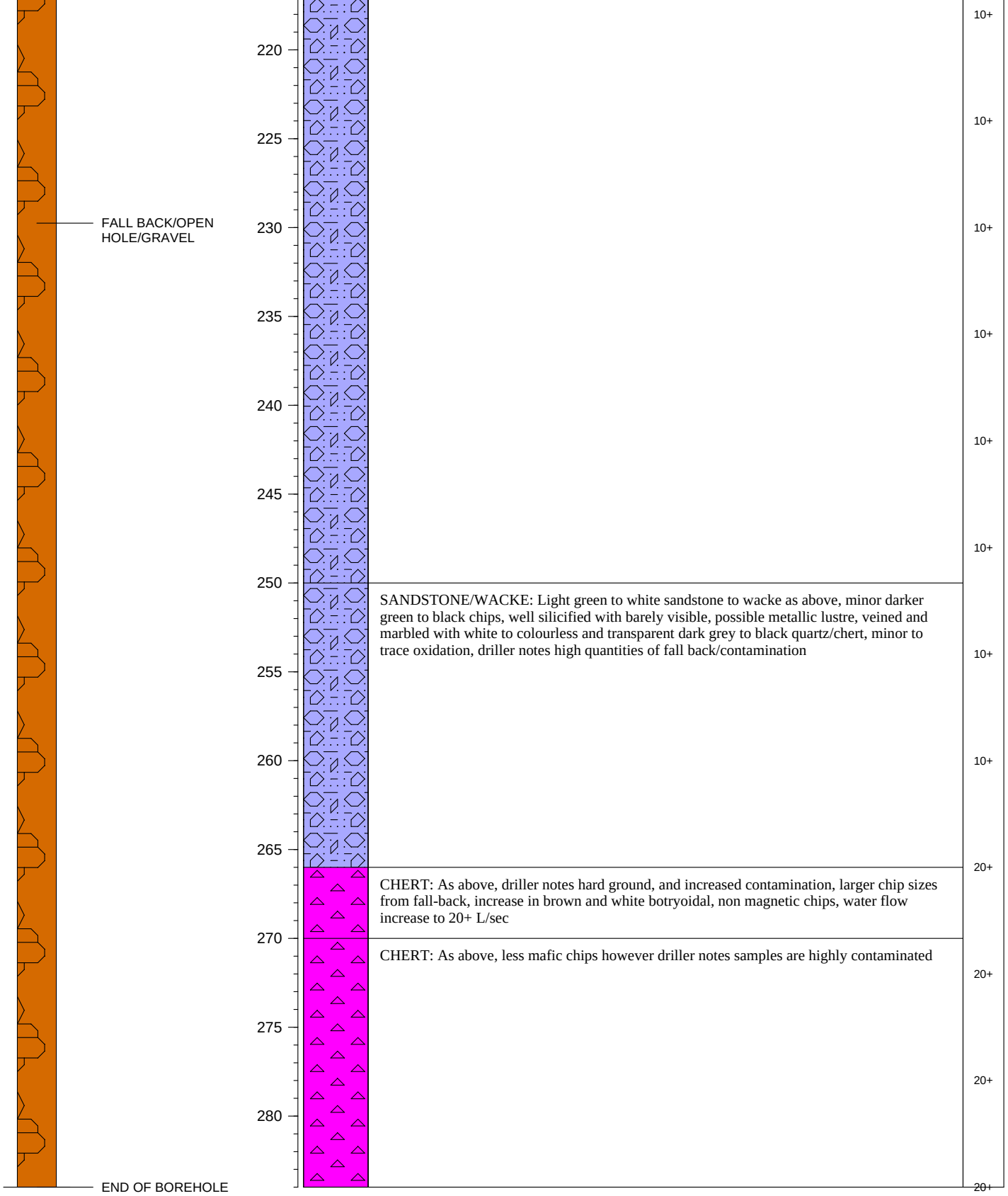
55			
60			
65		WATER, no flow	
70	SANDSTONE/WACKE: As above, medium orange, chip percent increases to 60%	WATER, no flow	
75	SANDSTONE/WACKE: As above, medium orange, weathered, subrounded to sub angular well sorted 0-1mm grains of colourless quartz, some darker grey quartz to chert, minor orange oxidized iron, some larger chips show the above described in a fine, lighter matrix to cement, chip percent is at 75%, colour lightens with depth, minor to trace pink and purple iron cement and quartz veins with oxidation on chip surfaces	WATER, no flow	
80			1
85	SANDSTONE/WACKE: As above, trace larger chips of secondary silicification infill growth in cavities/fractures		1
90	SANDSTONE/WACKE: As above, trace gravel of light pink and white hematite and quartz precipitate, craggy in texture		
95	SANDSTONE/WACKE: Sandstone to wacke as above with quartz veining and minor pink and purple iron cement, trace chips of green ultramafics/serepentinite or komatiite at 95m, two large gravels, green, massive with minor trace quartz inclusions and spinifex texture- likely contamination		1
100	SANDSTONE/WACKE: As above, probable contamination- trace gravel of grey angular chert with banding and tiny <1, dark grey to black inclusions, trace sulphide inclusions with metallic lustre, trace serpentinite gravel as above		1
105	SANDSTONE/WACKE: As above, trace to minor translucent to opaques black chert, minor iron cement and ironstone, trace gravel of serpentinite as described above, trace gravel of hematite at 98-100m as described above, trace gravel of banded chert at 100-102m as described above,		1
110	SANDSTONE/WACKE: As above, trace black chert, trace gravel of pink craggy secondary hematite and quartz silicification at 102-104m		1
115	SANDSTONE/WACKE: As above, becoming slightly greener in colour, possibly chlorite or sand from a more intermediate magma		1
120	SANDSTONE/WACKE: As above, slightly darker with slightly more black chert, quartz grains ae slightly darker grey/green, trace ironstone and cement		1
125			1
130	SANDSTONE/WACKE: As above, slightly lighter white to pale green quartz grains and trace ironstone and oxidation, trace quartz infill and gravels of iron cement at 132-138		1
			1

Comments:



135		
140		1
145	SANDSTONE/WACKE: As above, becomes whiter, slight increase in iron and oxidation	1
150	SANDSTONE/WACKE: As above, slightly more grey green with an increase in iron and oxidation at 152-154m and 164-168m	1
155		1
160		1
165		1
170	SANDSTONE/WACKE: As above, larger chips 1-30mm with angular to craggily texture and an increased matrix percentage which is less silicified and crumbles easily	1
175	SANDSTONE/WACKE: As above, larger chips 3-40mm of white to very pale green and colourless quartz, larger quartz crystals and infill, soft white chips that crumble easily with many voids, both have a vuggy consistency, little to trace iron oxidation, driller notes fractures at 174-175, water flow increase to 11 L/sec	10+
180	SANDSTONE/WACKE: Sandstone to wacke as above, return to 0-5mm chips of white to light green sandstone to wacke in a fine of white to light green matrix to cement, trace yellow to orange iron oxidation, matrix percent varies from 10-40% with some chips showing a more quartzite like texture where matrix is more of a cement if present, some chips are a soft white matrix of 40% with the quartz grains often absent leaving voids, minor transparent grey chert/quartz chips, trace chips of botryoidal brown and white precipitate, trace pink to orange hematite- quartz precipitate	10+
185		10+
190		10+
195		10+
200		10+
205		10+
210		10+
215		

Comments:


220
225
230
235
240
245
250
255
260
265
270
275
280
FALL BACK/OPEN HOLE/GRAVEL
END OF BOREHOLE
SANDSTONE/WACKE: Light green to white sandstone to wacke as above, minor darker green to black chips, well silicified with barely visible, possible metallic lustre, veined and marbled with white to colourless and transparent dark grey to black quartz/chert, minor to trace oxidation, driller notes high quantities of fall back/contamination
CHERT: As above, driller notes hard ground, and increased contamination, larger chip sizes from fall-back, increase in brown and white botryoidal, non magnetic chips, water flow increase to 20+ L/sec
CHERT: As above, less mafic chips however driller notes samples are highly contaminated
10+
10+
10+
10+
10+
10+
10+
20+
20+
20+
20+

Comments:

OBSERVATION WELL BORE LOG

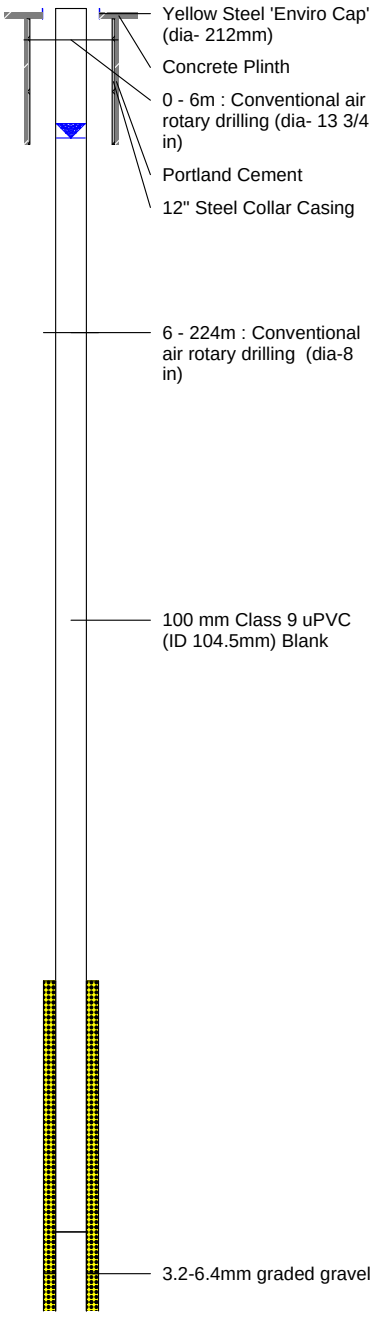
BOREHOLE NUMBER

NS-ObsS29

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

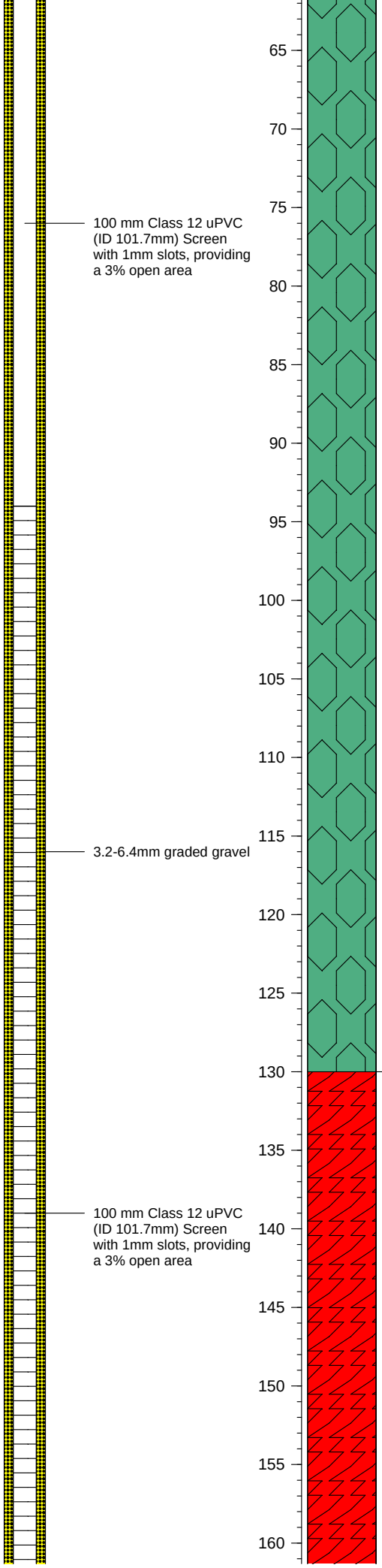
PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Southern Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**709177.19**
NORTHING (m):	**7643339.91**
MEAS PT ELEVATION (mAHD):	**253.97**
DRILLING DIAMETER(S) (mm):	**204**
DATE BEGUN: **3/03/2015**	DATE COMPLETED: **6/03/2015**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.659**
Drilled Depth (mbgl):	**224**
Cased Depth (mbgl):	**186**
Casing Stick Up (magl):	**0.448**
Development Airlift Yield (l/s):	**0**
Water Level (mbgl) & Date:	**5.69** & **13/04/2015**



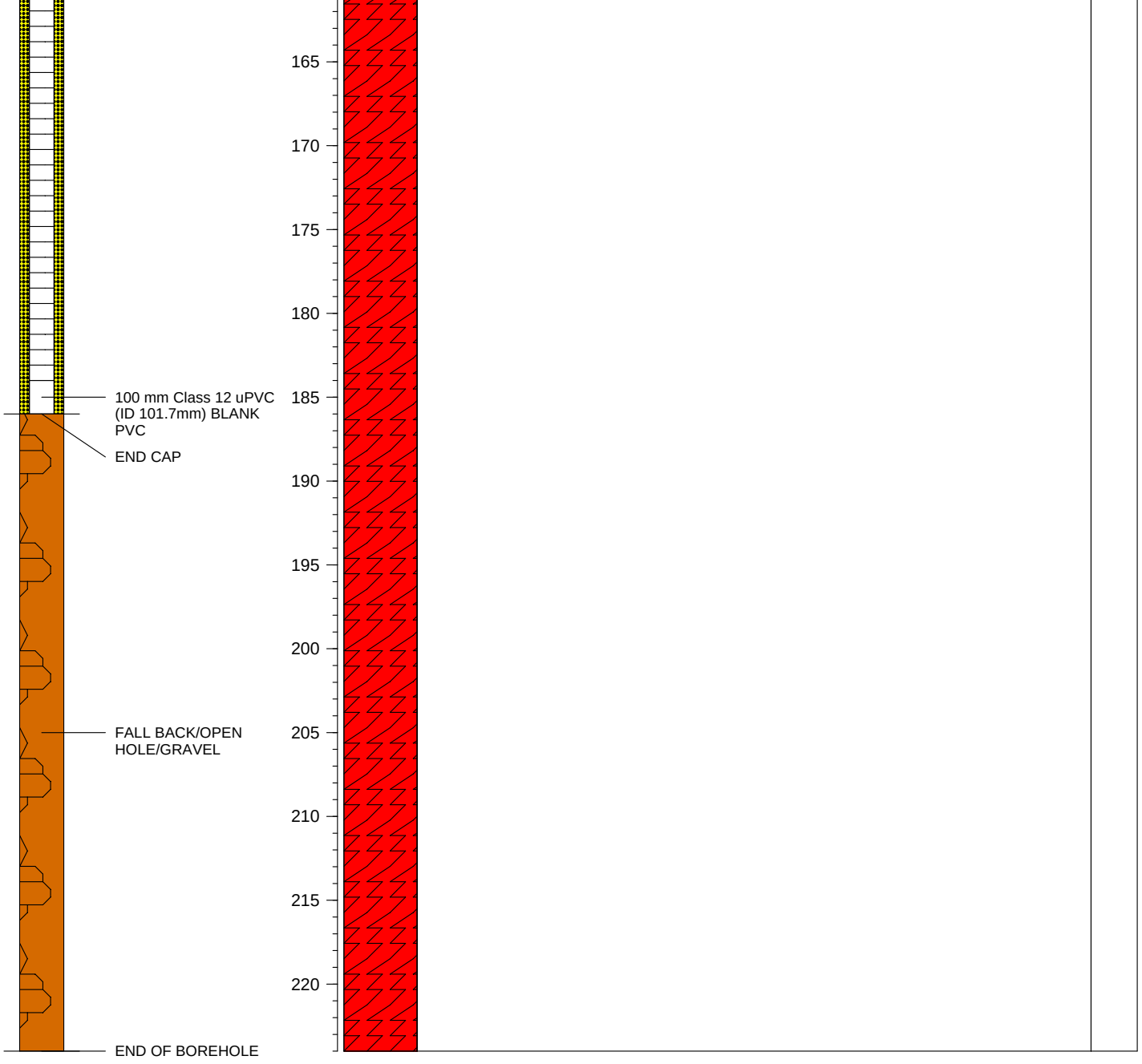
DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Weathered, red silt, black and grey chert, colourless quartz, calcrete and organic soil	
5	SERPENTINITE: Olive green serpentinized mafics to schist, with a mild foliated texture, soft and scratches with finger nail, soapy textured surfaces, trace mottled to granular textures still present, minor aragonite and calcite along trace fracture planes, 50% chips of diam 1-50mm, increasing to 70% chips by 16m with mostly 5-15mm chips, minor chips over 20mm	
10		0.5
15		0.5
20	SERPENTINITE: As above, increase in darker metamorphosed nearly blue black mafics from 24-38m, with minor amounts from 38m to 130m, 70% 1-30mm subrounded chips, 30% powder	0.5
25		0.5
30		0.5
35		0.5
40		0.5
45		0.5
50		0.5
55		
60		

Comments:



BASALT: Bluish black to very dark green metamorphosed mafics, soapy texture, soft and scratches with finger nail, minor schist texture, pearly lustre, minor aragonite and olive green serpentinite, 70% 1-30mm subrounded chips, 30% powder, slight increase in olive green serpentinite from 208m

Comments:


165
170
175
180
185
190
195
200
205
210
215
220
100 mm Class 12 uPVC (ID 101.7mm) BLANK PVC
END CAP
FALL BACK/OPEN HOLE/GRAVEL
END OF BOREHOLE

Comments:

PRODUCTION WELL BORE LOG

BOREHOLE NUMBER

NS-PBS23

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **709373.20**
NORTHING (m): **7643733.75**
MEAS PT ELEVATION (mAHD): **256.228**
DRILLING DIAMETER(S) (mm): **302**
26D LICENCE #:
DATE BEGUN: **1/03/2015** DATE COMPLETED: **3/03/2015**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.68**
Drilled Depth (mbgl):	**194**
Cased Depth (mbgl):	**188.5**
Casing Stick Up (magl):	**-0.035**
Development Airlift Yield (l/s):	**13.3**
Water Level (mbgl) & Date:	**5.52** & **15/04/2015**

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (l/s)
Yellow Steel 'Enviro Cap' (dia- 412mm) Concrete Plinth 0 - 6m : Conventional air rotary drilling (dia- 13 3/4 in) 12" Steel Collar Casing Portland Cement 3.2-6.4mm graded gravel 200 mm Class 18 uPVC (ID 192.9mm) Blank 6 - 194m : Conventional air rotary drilling (dia-11 3/4 in)	0 5 10 15 20 25 30 35 40 45 50 55		SILTSTONE: Weathered grey orange and minor purple sandy siltstone with medium to fine grained angular to subrounded sand in 30-60% grey fine silt/clay and carbonate matrix, extensive oxidation and calcrete, 60% powder and 40% chips 0-10mm SILTSTONE: Moderately weathered pale grey with minor orange and purple silt stone as above, chip percentage decreases to 10% at 4m with an increase in fine white to grey silt SILTSTONE: As above, more purple and pink chips SILTSTONE: Mostly purple and pink sandy siltstone with minor grey chips, minor oxidized iron cement and grains in the silt matrix, trace dark quartz/chert, chip percentage increases to 40% by 10m, becoming slightly more grey at 18m SILTSTONE: Very fine pale grey to white silt to clay stone, grains are almost undistinguishable, minor purple, pink and orange chips and surfaces, minor oxidized iron cement and brecciated quartz grains in the silt matrix, minor colourless quartz/chert chips and veinlets, 10% powder and 80% chips 0-20mm SILTSTONE: Medium grey sandy siltstone, with fine sand in a fine medium grey matrix, no carbonates, at 50m there is less sand and grains become finer and more well-lithified	1 1 1 1 1 1 1

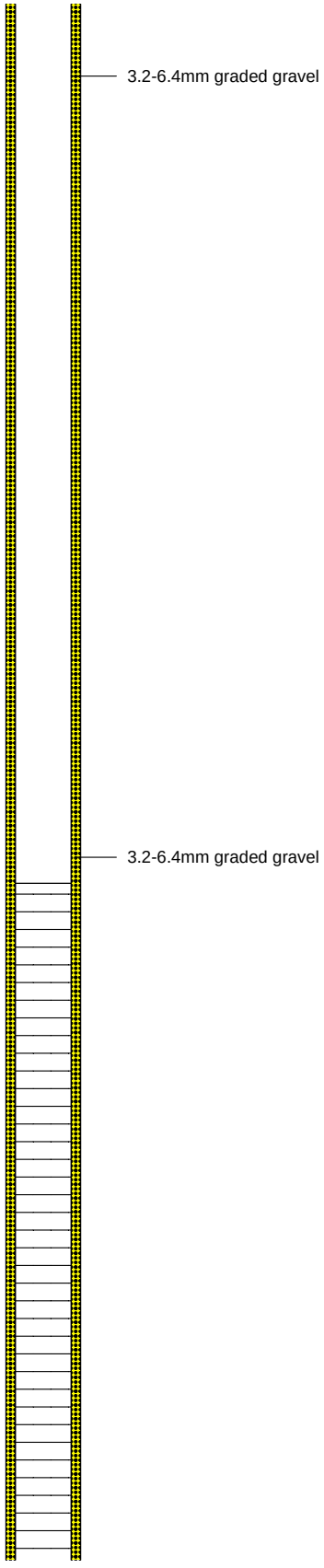
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PBS23

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
60		SILTSTONE: As above, more sandy with the fine sand grains becoming more visible, minor pink and purple colouration and trace iron cement	
		SILTSTONE: As above, minor ironstone and red, iron stained and iron rich sandstone	1
65		SILTSTONE: Medium to pale grey sandy siltstone as above, trace ironstone and red, iron stained and iron rich sandstone	
		SILTSTONE: As above, colour becomes slightly more orange and yellow and more granular to a silty sandstone	1
70			
75		SANDSTONE/WACKE: Pale grey silty sandstone, minor ironstone and red, iron stained and iron rich sandstone	1
80			1
85		SANDSTONE/WACKE: Medium greenish grey silty sandstone as above, minor ironstone and yellow and red, iron stained and iron rich sandstone	1.8
90			2
95			
100			2
105		SANDSTONE/WACKE: As above, minor black chert, minor yellow to orange quartzite to sandstone of fine to medium sand	2
		CHERT: 60% Moderately oxidized black chert, 30% orange quartzite to sandstone as above, 10% green quartzite to sandstone	
110		SANDSTONE/WACKE: Green, black and white specked sandstone with moderate to well oxidized surfaces and minor rose colouration, well weathered with well oxidized chips over 30mm, minor black chert, driller notes fractures from 115-116m	2.5
115			10.5
		SANDSTONE/WACKE: As above, veined and interbedded with dark grey to black chert, trace colourless and white chert all stained orange with oxidation	
120			10.5
125		CHERT: Mostly black chert with green white and colourless quartzite as above	
		CHERT: Mostly orange stained white to colourless quartz, trace black and green chert/quartzite, driller notes broken ground from 129-130m	11.9
130			

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PBS23

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	135		SANDSTONE/WACKE: Green quartzite to sandstone, colouration is an even/non speckled, pale green, minor orange siltstone and sand in a weathered iron cement, minor pale brown to green sandstone, all metamorphosed with moderate oxidation	11.9
			SANDSTONE/WACKE: Orange, well oxidized mix of green chert/quartzite, green schist, oxidized and stained quartz infill with vuggy texture, minor orange siltstone, metamorphosed, larger chips (over 50mm) from 134, driller notes broken ground from 134-156m	
200 mm Class 18 uPVC (ID 192.9mm) Screen with 1mm slots, providing a 3% open area	140			11.9
	145			11.9
	150		SANDSTONE/WACKE: Mostly red chips of sandstone with sand in an iron rich, oxidised cement, most chips have a craggy and vuggy texture, minor green stone, minor colourless quartz, all well oxidized	16.3
	155		SANDSTONE/WACKE: Orange, well oxidized mix of green chert/quartzite, green schist, oxidized and stained quartz infill with vuggy texture, minor orange siltstone, metamorphosed	
			SANDSTONE/WACKE: Green sandstone to quartzite, even green colour, minor colourless to white quartz and secondary quartz infill, minor green schist, trace olive green to grey mafics from 158m, all moderately weathered	21.5
	160		SANDSTONE/WACKE: As above with 40% fresh white quartz and an increase in green schist	
	165		SCHIST: Olive green to grey metamorphic mafics/ schist, some chips are soft and crumble easily, mild foliated texture with some chips still having granular to vuggy texture, moderately weathered, trace ironstone, increased white quartz from 170-172m and 182-184m	21.5
	170			21.5
	175			22.9
	180			26
200 mm Class 18 uPVC (ID 192.9mm) Blank	185		BASALT: Harder, less weathered, more silicified, slightly darker blue-green metamorphosed mafics, with mild reaction to HCl, minor aragonite and calcite, driller notes hard ground rom 185m	26
END CAP				
FALL BACK/OPEN HOLE/GRAVEL	190		BASALT: Very hard well silicified dark blue-green metamorphosed mafics marbled with white quartz, minor aragonite and calcite, driller notes very hard ground from 190m	
END OF BOREHOLE				26

Comments:

PRODUCTION WELL BORE LOG

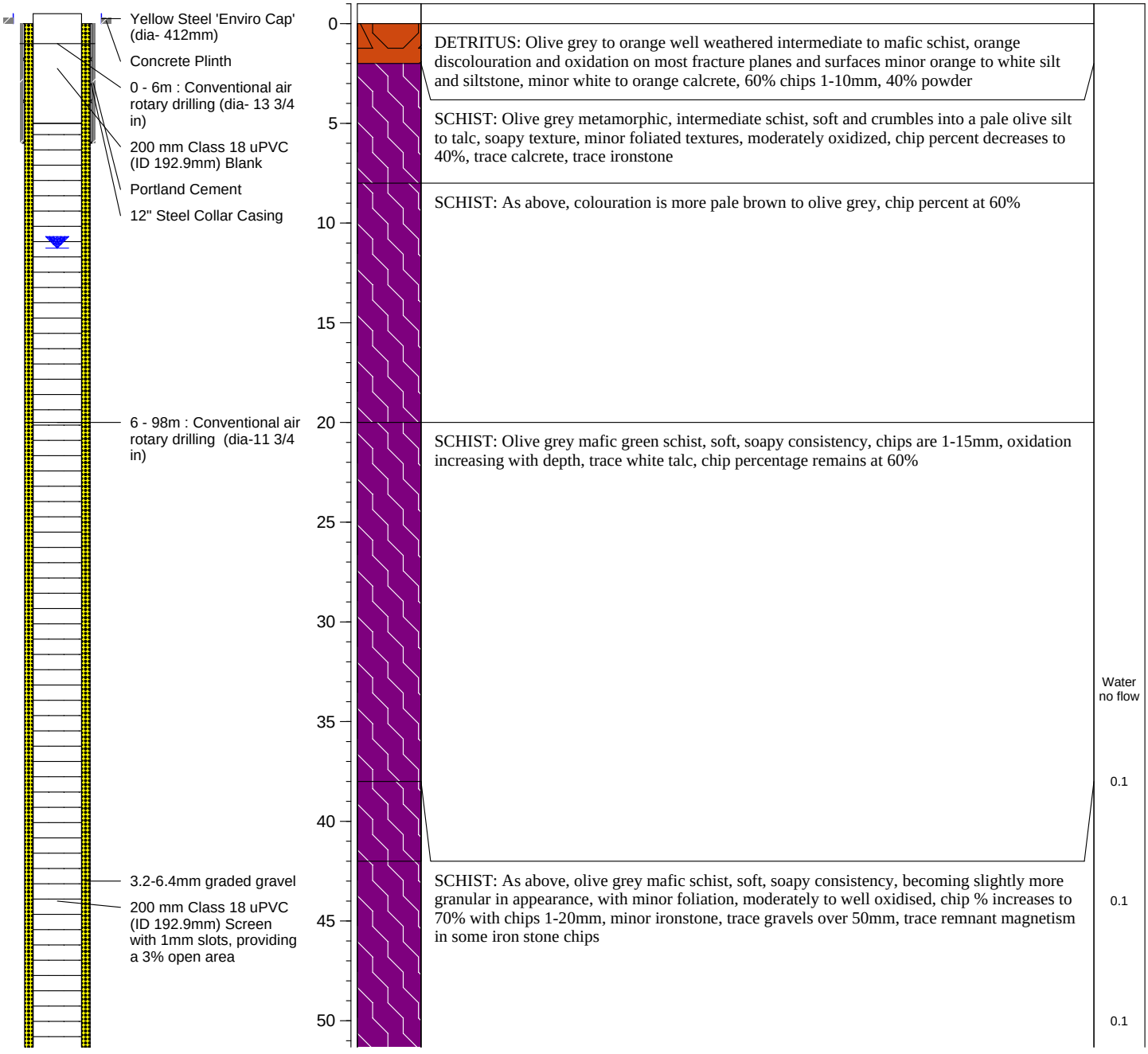
BOREHOLE NUMBER

NS-PBS25

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Southern Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **710073.65**
NORTHING (m): **7643534.72**
MEAS PT ELEVATION (mAHD): **269.447**
DRILLING DIAMETER(S) (mm): **302**
26D LICENCE #:
DATE BEGUN: **10/03/2015** DATE COMPLETED: **12/03/2015**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.693**
Drilled Depth (mbgl):	**98**
Cased Depth (mbgl):	**86**
Casing Stick Up (magl):	**0.3**
Development Airlift Yield (l/s):	**42**
Water Level (mbgl) & Date:	**11.26** & **13/04/2015**



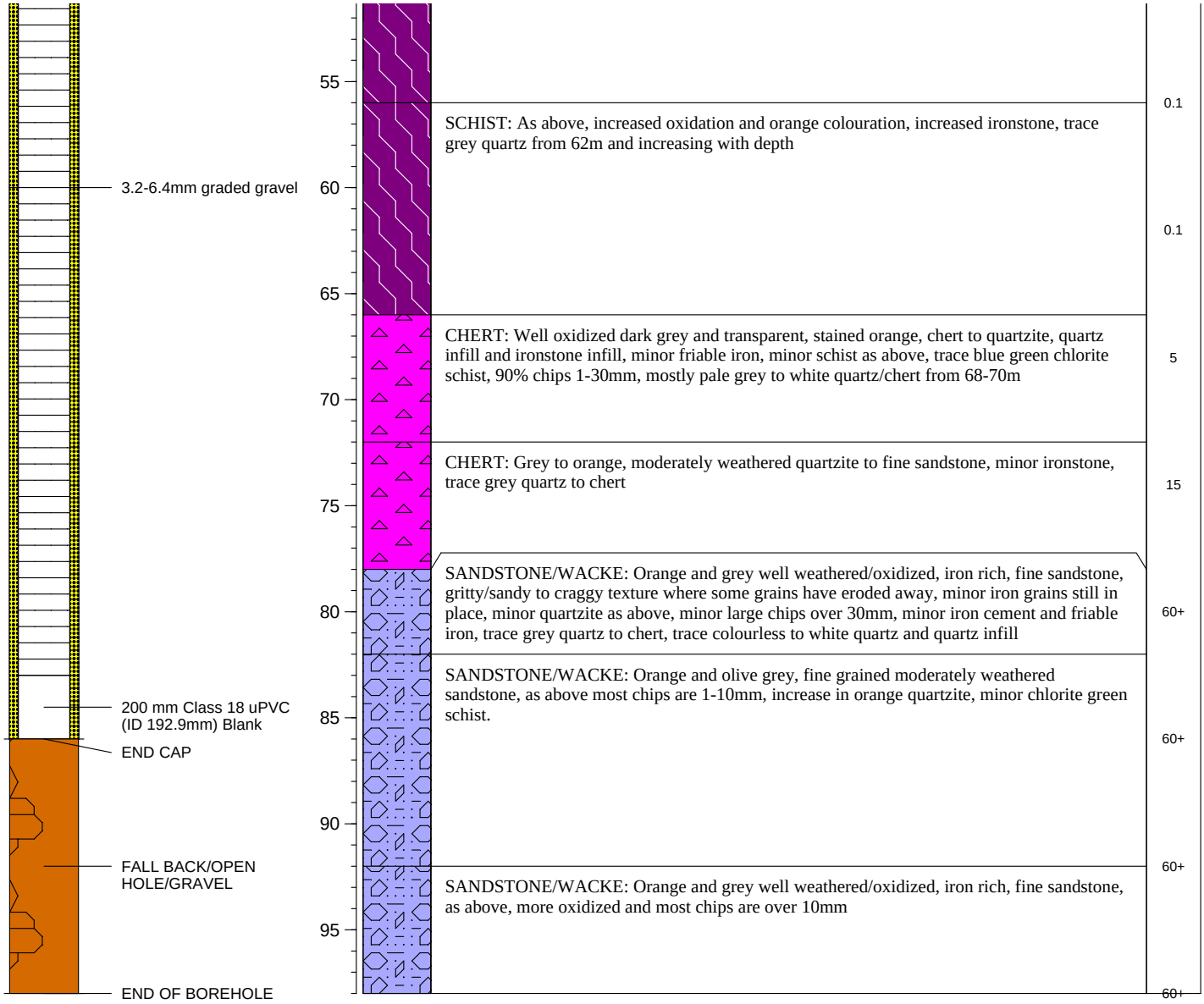
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PBS25

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments:

EXPLORATION BORE LOG

BOREHOLE NUMBER

NS-EXW05

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **692705.00**
NORTHING (m): **7650153.00**
MEAS PT ELEVATION (mAHD):
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **6/09/2014** DATE COMPLETED: **7/09/2014**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**104**
Completion Stick Up (magl):	**NA**
Development Airlift Yield (l/s):	**NA**
Water Level (mbgl) & Date:	**NA** &

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0 - 6m : Conventional air rotary drilling (dia- 13 3/4 in) 12" Steel Collar Casing 6 - 104m : Conventional air rotary drilling (dia-8 in) Backfilled	0 5 10 15 20 25 30 35 40 45 50		DETRITUS: Weathered granite with pisolitic and friable iron, granite stained from iron oxidation GRANITE: Moderately weathered granite, stained orange from iron oxidation, minor to trace pisolitic iron GRANITE: Mildly weathered granite, metamorphosed, oxidation still present GRANITE: Granite, metamorphosed, mottled salt and pepper texture GRANITE: Muscovite and white quartz of mostly medium sand sized, only trace other minerals GRANITE: Granite as above, trace oxidation, increased white quartz at 70-72m and grains become more prominent with depth	

Comments: **Borehole destroyed soon after drilling, no marker**

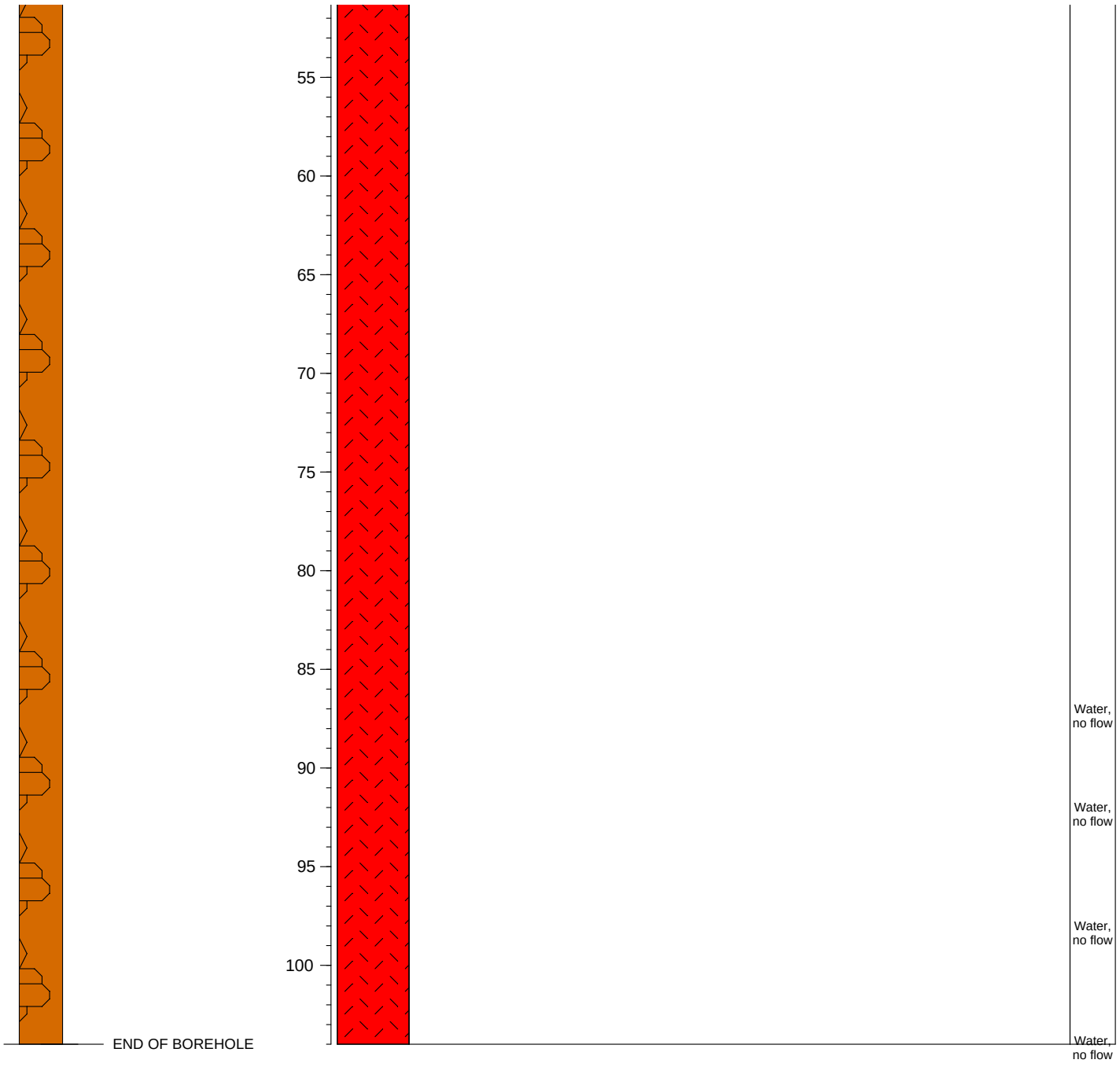
OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXW05

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



Comments: **Borehole destroyed soon after drilling, no marker**

EXPLORATION BORE LOG

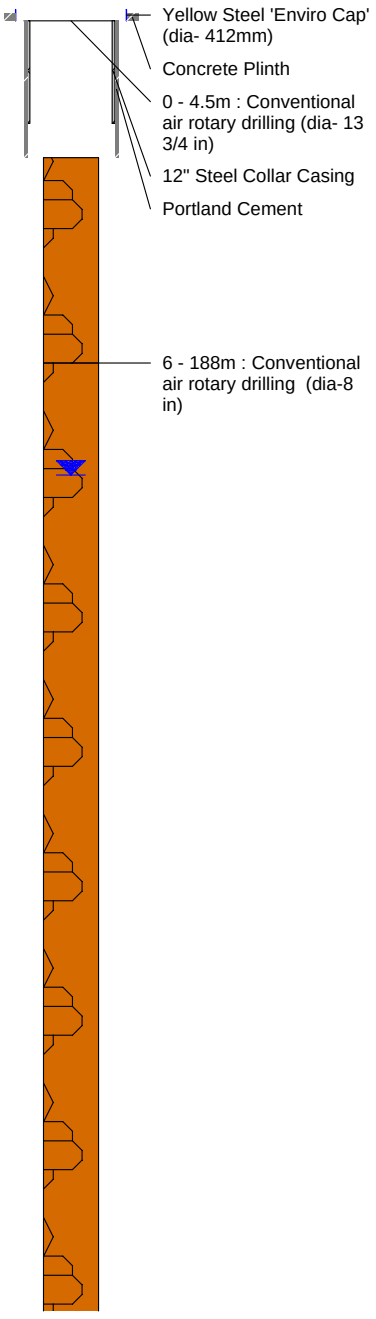
BOREHOLE NUMBER

NS-EXW14

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Western Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**705170.74**
NORTHING (m):	**7647097.67**
MEAS PT ELEVATION (mAHD):	**239.987**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **22/03/2015**	DATE COMPLETED: **25/03/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**188**
Completion Stick Up (magl):	**0.719**
Development Airlift Yield (l/s):	**10**
Water Level (mbgl) & Date:	**19.91** & **10/04/2015**



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		METAPELITE: Red, pink and minor white, well weathered, oxidized siltstone, 80% chips 1-30mm	
5		METAPELITE: Pale grey to white with minor pink and orange moderateley oxidized siltstone, 50% chips 1-5mm	
		METAPELITE: White with minor pale pink and purple mildly weathered siltstone, trace white quartz, chip percentage down to 10% with chips 1-5mm	
10		METAPELITE: White with trace pale pink and purple siltstone, trace white quartz, 10% chips 1-5mm	
15			
20		METAPELITE: Pale grey to white with minor orange sandy siltstone, trace black and colourless quartz, 30% chips 1-5mm	
25			Water, no flow
30		METAPELITE: As above, becoming slightly more sandy, increased black and colourless quartz from 30-32m, 36-38m, and minor black shale and quartz from 42-44m, 80% chips 1-10mm	0.5
35			0.5
40			5
45		METAPELITE: Sandy siltstone as above, increased oxidation, more orange overall with minor iron inclusions, minor black shale from 54m	
50			5
55		METAPELITE: Grey sandy siltstone, sand is colourless and fine grained set in a pale grey to white silt matrix, minor black shale, minor colourless to white quartz, 90% chips 1-10mm,	5

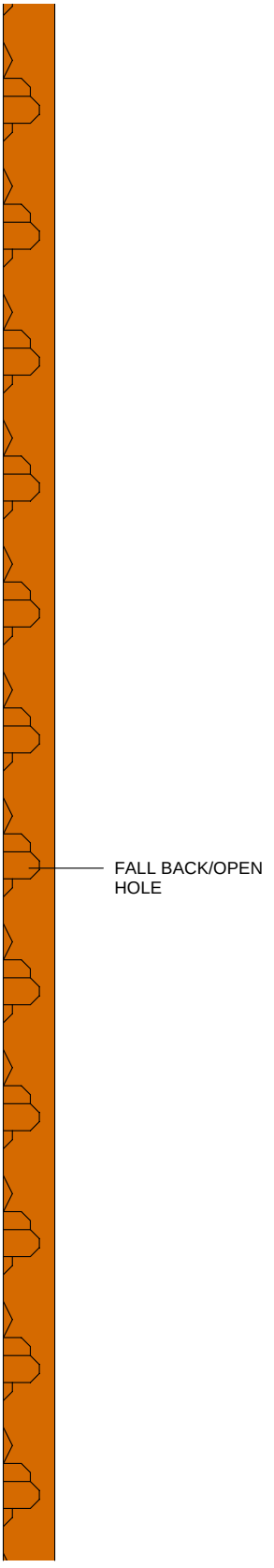
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXW14

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	DESCRIPTION	YIELD (L/sec)
	trace chips over 10mm	
60	SANDSTONE/WACKE: Pale brown to grey silty sandstone, sand is still fine grained and dificult to distinguish, trace orange oxidised sandstone	
	SANDSTONE/WACKE: White to pale grey silty sandstone, sand is still fine grained and dificult to distinguish, minor orange stained chips	5
65	SANDSTONE/WACKE: White to pale grey silty sandstone, sand is still fine grained and dificult to distinguish, minor orange stained chips, minor black shale	
	SANDSTONE/WACKE: Medium grey silty sandstone, sand is still fine grained and dificult to distinguish, minor orange stained chips, minor black shale	5
70	SANDSTONE/WACKE: Pale brown to grey silty sandstone, sand is still fine grained however grains are more easily distinguished with trace to minonr medium grains from 76m trace orange oxidised sandstone, trace white quartz and quartz infill	
75		5
80	SANDSTONE/WACKE: Medium grey silty sandstone, sand is still fine grained with minor medium grains, trace to minor oxidation	6
	SANDSTONE/WACKE: Mostly medium grey silty sandstone as above, with 30-40% black and white chert and increased oxidation on fracture planes	
85	SANDSTONE/WACKE: Mostly medium grey silty sandstone as above, with 30% black chert, black chert/shale band at 87-88m, trace to mild oxidation	6.8
90	SANDSTONE/WACKE: Medium grey silty sandstone, sand is fine grained with minor medium grains, mild orange colouration and oxidation, trace black chert to shale	6.8
95		7.5
100	SANDSTONE/WACKE: Medium grey sandstone, grainsize becomes slightly larger from 102-106m, metomorphosed and wekk silicified with some grains partialy melted and contacts blured, trave to no oxidation	7.5
105	SANDSTONE/WACKE: Medium grey silty sandstone as above, more weathered, sand is fine grained with minor medium grains, moderate orange colouration and oxidation, trace black chert to shale from 106-108m	
110		8.3
	SANDSTONE/WACKE: As above, becoming slightly less weathered and more silicified	
115	SHALE: Small black shale band, increase in oxidation	8.3
	CHERT: Pale grey chert with colourless quartz veinlets, interbedded with trace to minor black shale to chert	
120		10
125	CHERT: 50% Pale grey chert as above, 40% black shale, 10% white quartz	
	CHERT: 60% black shale, 30% dark grey to black chert, 10% white quartz	10
	CHERT: Pale grey chert with colourless black and white quartz veinlets, minor black shale to	

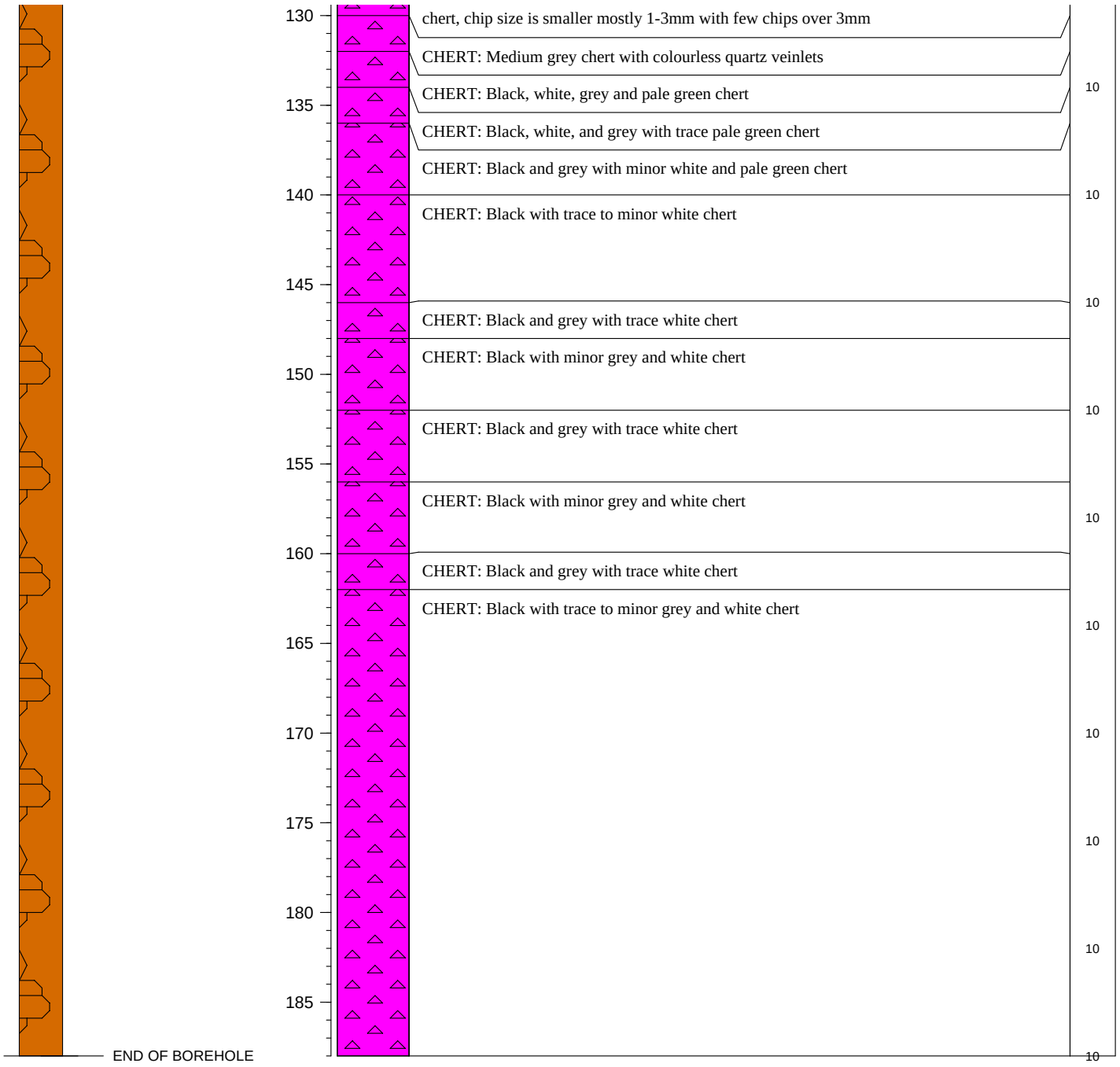
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXW14

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
	130		chert, chip size is smaller mostly 1-3mm with few chips over 3mm	
			CHERT: Medium grey chert with colourless quartz veinlets	
	135		CHERT: Black, white, grey and pale green chert	10
			CHERT: Black, white, and grey with trace pale green chert	
			CHERT: Black and grey with minor white and pale green chert	
	140		CHERT: Black with trace to minor white chert	10
	145		CHERT: Black and grey with trace white chert	10
			CHERT: Black with minor grey and white chert	
	150		CHERT: Black and grey with trace white chert	10
	155		CHERT: Black with minor grey and white chert	10
	160		CHERT: Black and grey with trace white chert	
			CHERT: Black with trace to minor grey and white chert	10
	165			
	170			10
	175			10
	180			10
	185			10
END OF BOREHOLE				

Comments:

EXPLORATION BORE LOG

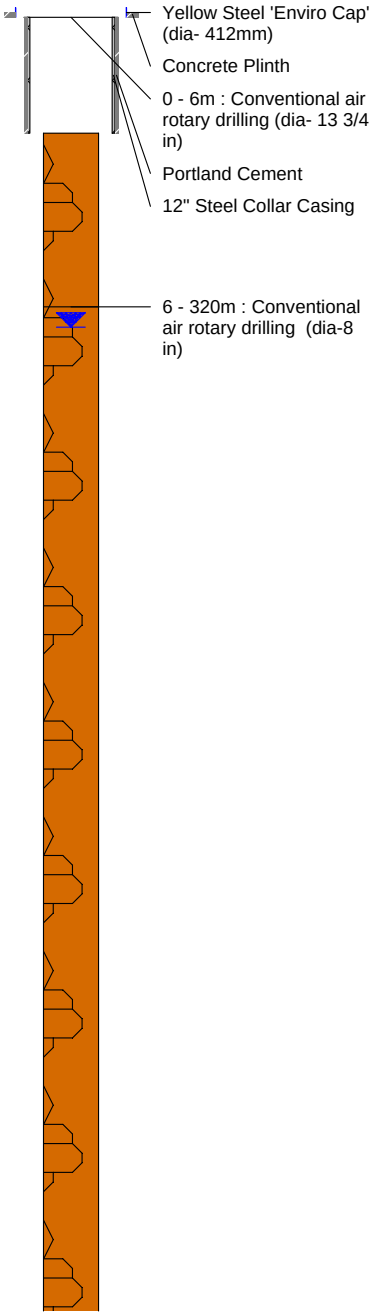
BOREHOLE NUMBER

NS-EXW15

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **706392.38**
NORTHING (m): **7647626.67**
MEAS PT ELEVATION (mAHD): **249.301**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **19/03/2015** DATE COMPLETED: **22/03/2015**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	**320**
Completion Stick Up (magl):	**0.677**
Development Airlift Yield (l/s):	**NA**
Water Level (mbgl) & Date:	**16.05** & **10/04/2015**



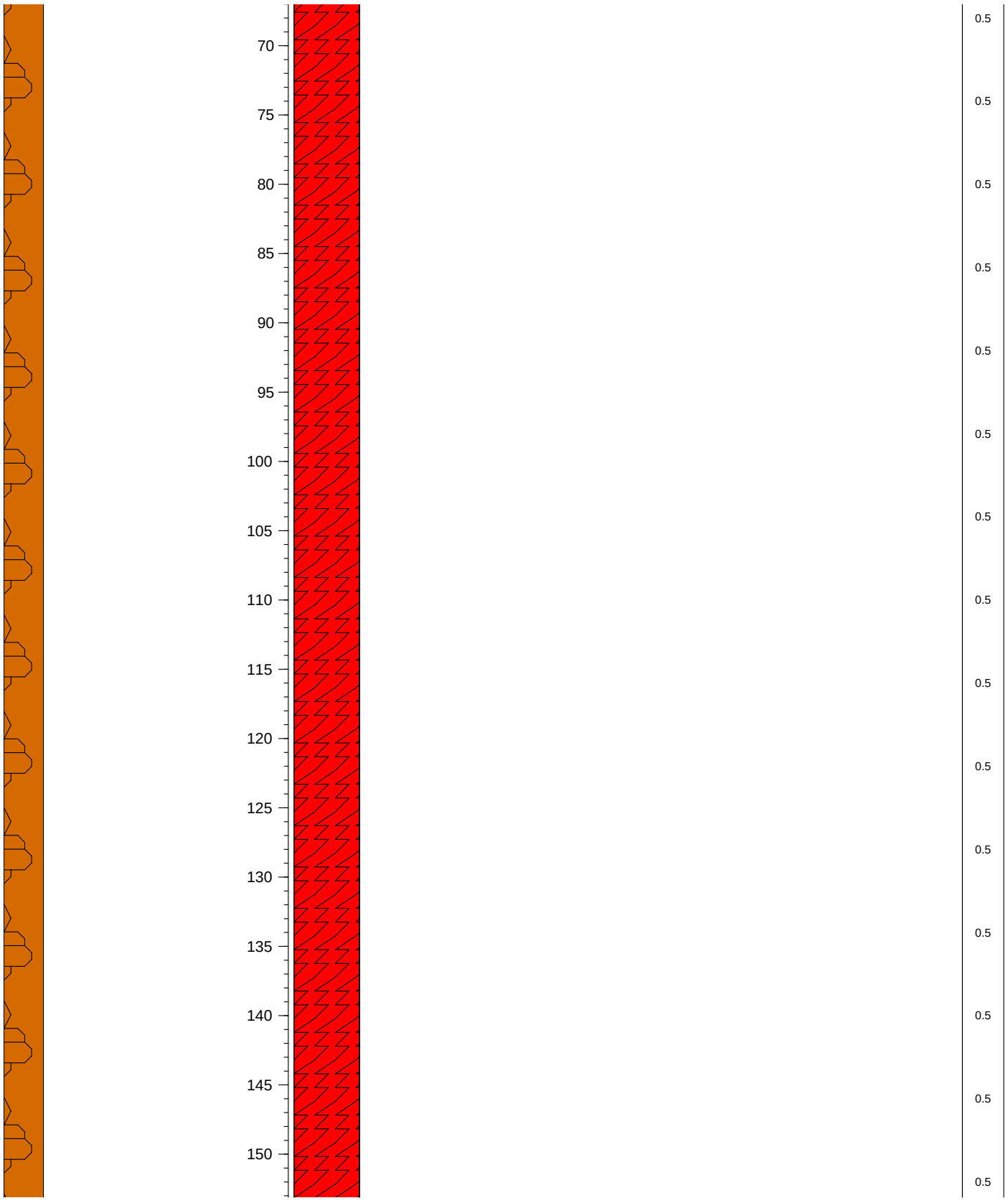
DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Fine light orange silt, carbonates and orange stained metamorphosed mudstone	
5	METAPELITE: Pale grey to white with pale pink, purple and orange streamers and zones, fine, very soft metamorphosed mudstone to sericite, breaks up into a fine silt, colour becomes light yellow to white 14-16m, chips are 1-10mm with lower chip percentage at 4-6m, 8-10m, and 14-16m	
10		
15		
20		
25	METAPELITE: Pale grey sandy metapelite, minor colourless quartz and ironstone	Water, no flow
30		0.5
35		0.5
40	METAPELITE: Pale grey sandy metapelite, silicified and becoming harder with an increase of quartz and iron sand grains in the matrix with depth, mild oxidation	0.5
45		0.5
50	BASALT: Medium grey, metamorphosed, fine grained mafics, well silicified borderline quartzite, possibly metomorphosed volcanic sand, however grains seem to be interlocking, mild oxidation from 50-60m, trace colourless quartz and aragonite, high carbonate content / highly reactive to HCl	0.5
55		0.5
60		0.5
65		

Comments:

OBSERVATION WELL BORE LOG	BOREHOLE NUMBER
	NS-EXW15

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)



Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXW15

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
FALL BACK/OPEN HOLE	155			0.5
	160			0.5
	165			0.5
	170			0.5
	175			0.5
	180			0.5
	185		BASALT: Olive grey calcareous altered mafics as above, more green in colour	0.5
	190			0.5
	195			0.5
	200			0.5
	205		BASALT: As above, back to the medium grey colour, mafics becoming slightly more soapy and talc like in texture with an increase in aragonite with depth	0.5
	210		BASALT: Dark grey altered, microcrystalline to very fine grained, soapy talc textured bordering mafic schist, mild reaction to HCl	0.5
	215			0.5
	220			0.5
	225			0.5
	230			0.5
	235			0.5

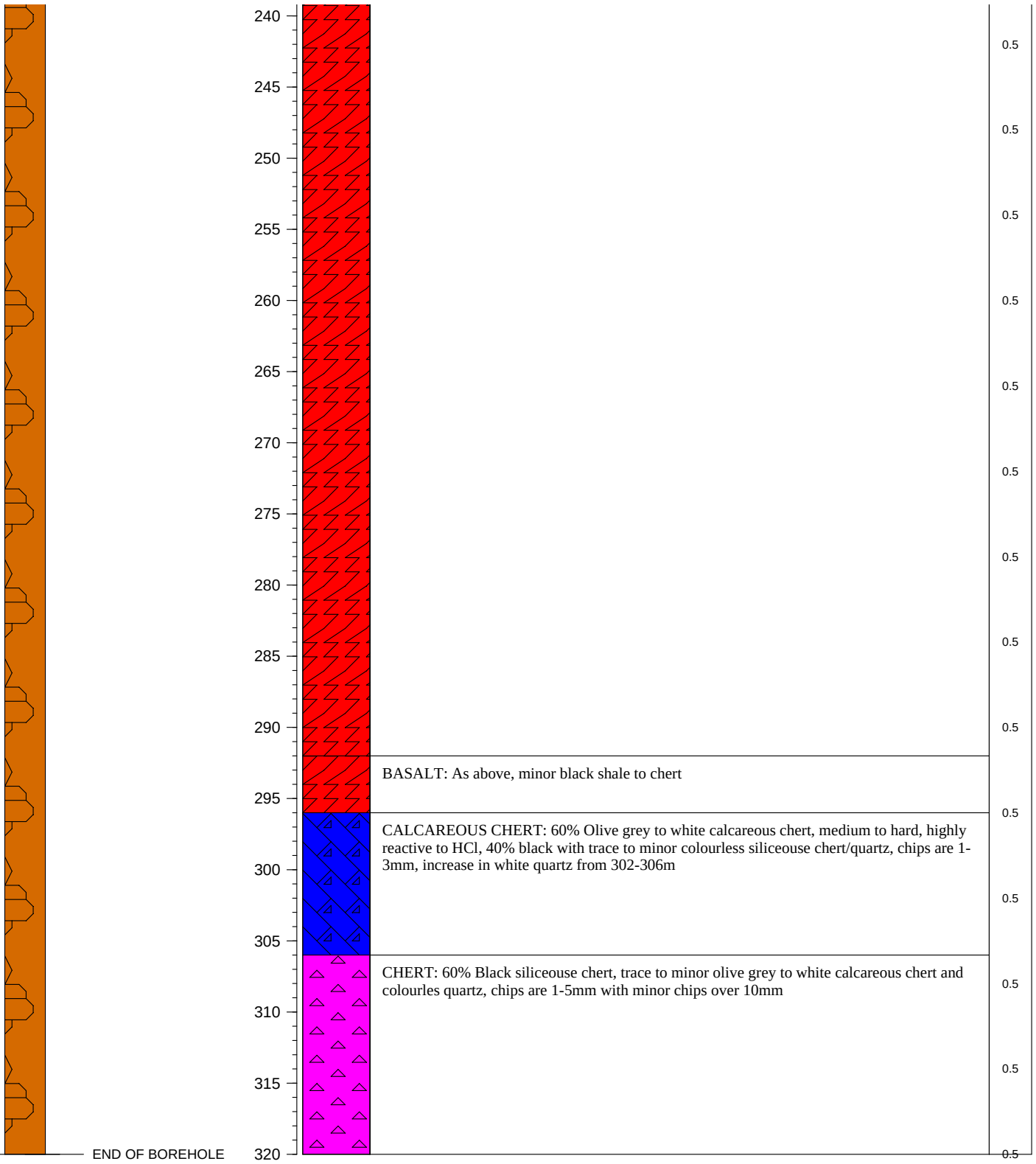
Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-EXW15

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments:

OBSERVATION WELL BORE LOG

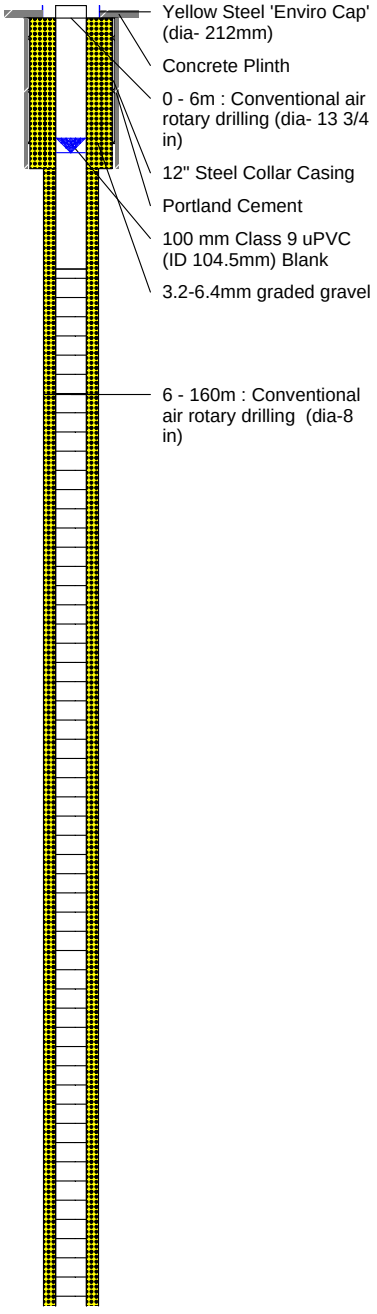
BOREHOLE NUMBER

NS-ObsW01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

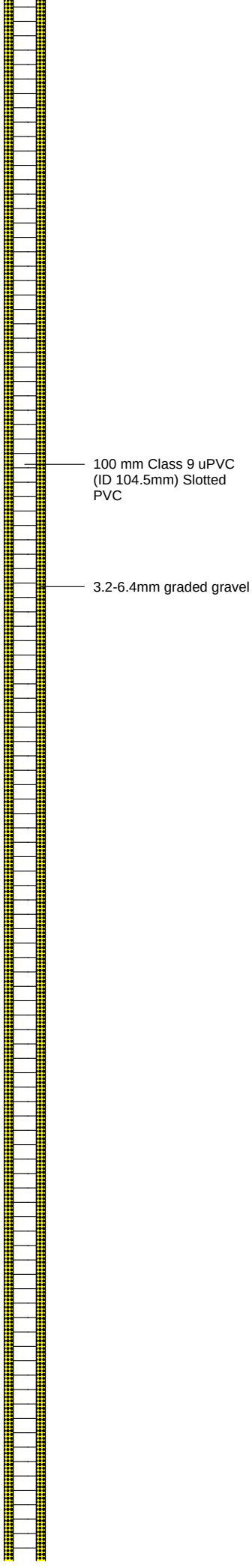
PROJECT NAME: **North Star Stage 1**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **704189.59**
NORTHING (m): **7647031.62**
MEAS PT ELEVATION (mAHD): **223.99**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **18/08/2014** DATE COMPLETED: **20/08/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.466**
Drilled Depth (mbgl):	**160**
Cased Depth (mbgl):	**159**
Casing Stick Up (magl):	**-0.185**
Development Airlift Yield (l/s):	**7.8**
Water Level (mbgl) & Date:	**5.36** & **10/04/2015**



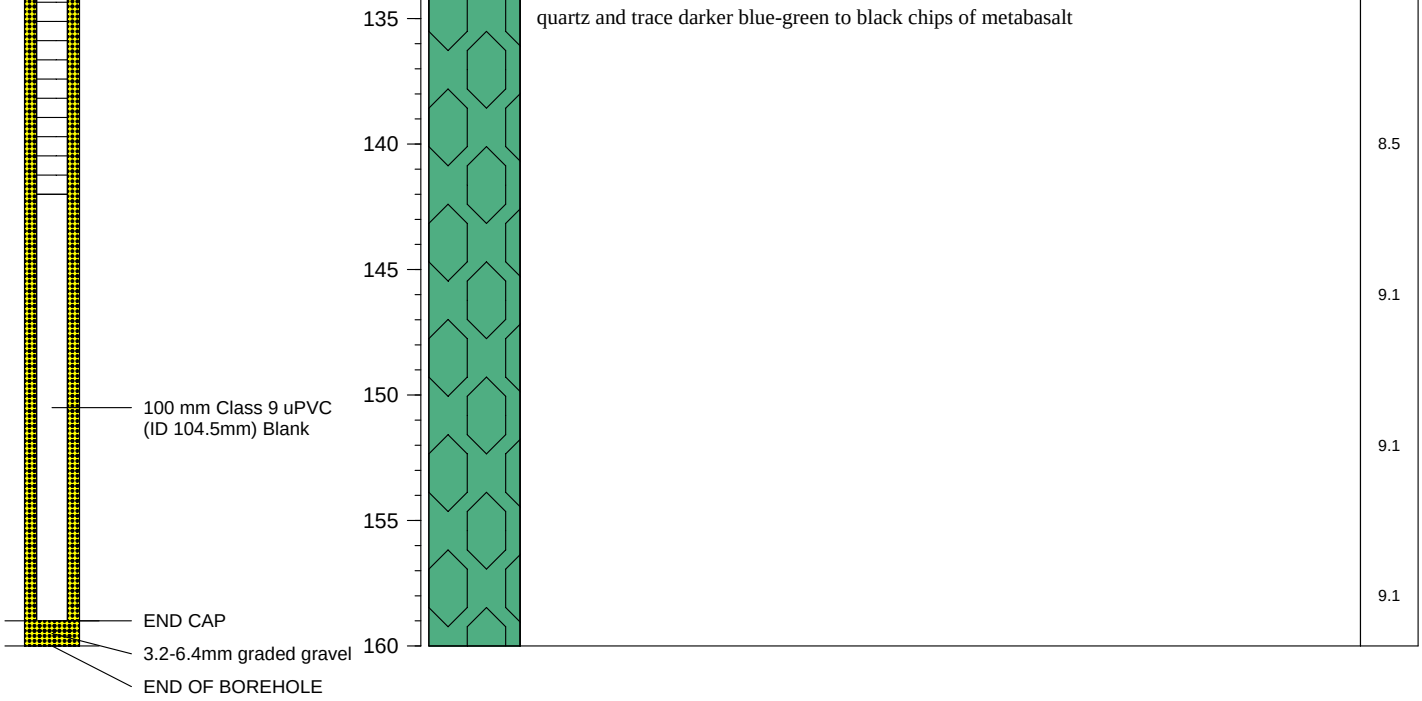
DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		ALLUVIUM: Reddish orange to brown silt, colluvium and top soil, 0-20mm chips, mostly very fine silt with minor angular, coarse sand and fine gravel of serpentinite, chert and quartz, minor organics	
5		ALLUVIUM: Silt, colluvium and top soil-0-20mm reddish orange to brown chips, 50% very fine silt, 30% river bed deposits-rounded sand and fine gravels of chert, shale, and quartz, 20% colluvium: angular, coarse sand and fine gravel of bif, serpentinite, chert, shale	
10		SERPENTINITE: Pale, milky olive green, 1-30mm chips of hard, soapy to resinous metamorphosed ultramafics with minor black flecks and veins in light, massive to schistose textured matrix, moderately weathered/oxidized with 30% reddish orange to brown alluvium as above	
		SERPENTINITE: Pale, milky olive green, 1-30mm chips of serpentinite as above, mildly weathered, 15% returned as powder/paste coating chips	
15		SERPENTINITE: As above, 10% returned as powder/paste coating chips, slightly less oxidation, trace quartz and aragonite and trace blue-green to black chips of meta-basalt-same pale green when crushed and slightly softer than its green counterpart, water at 17m	Water, no flow
20			0.75
25		SERPENTINITE: 1-15mm chips, no powder/paste to depth 50% very soft, pale olive green chips that crumble into silt under little finger pressure and 50% medium olive green, medium to hard chips as above with massive to schistose texture with few dark green to black fine	0.75
30		SERPENTINITE: 90% very soft, pale olive green silt like chips as above and 10% medium olive green chips as above, strong increase in oxidized fracture planes indicating moderate weathering along fracture zones	0.75
35		SERPENTINITE: Mildly weathered serpentinite of medium hardness, medium olive green, ranging from uniform in colour to having tiny dark green to black flecks/phenocryst texture or mild mottling, massive to schistose texture with no mica, mildly soapy to resinous, 5%-tra	
		SERPENTINITE: As above, slight increase in aragonite and darker chips of metabasalt, some chips show black dendritic crystallization on their surfaces	1
40		SERPENTINITE: Mildly weathered serpentinite of medium hardness, medium olive green as above, 5%-trace aragonite, trace quartz and trace darker blue-green to black chips of metabasalt	
45		SERPENTINITE: As above with a more noticeable division between the medium and pale green chips, 10% darker blue-green to black chips of metabasalt, 10% aragonite, 5%-trace quartz, slight increase in weathered surfaces	4.8
50		SERPENTINITE: As above, medium olive green, mildly weathered serpentinite of medium hardness, 15% aragonite, 5% quartz and 15% darker blue-green to black chips of metabasalt	6.8

Comments:



55	SERPENTINITE: As above, trace aragonite and darker blue-green to black chips of metabasalt	7.5
60		8.2
65		8.2
70	SERPENTINITE: 80% serpentinite as above, 20% aragonite and trace quartz	
75	SERPENTINITE: Fresh serpentinite of medium hardness, medium olive green with minor softer lighter olive green chips as above, 5%-trace aragonite, trace quartz and trace darker blue-green to black chips of metabasalt, ground becomes slightly harder at 90m	10
80		10
85		
90		
95		10
100	SERPENTINITE: Fresh serpentinite of medium hardness, medium olive green with a slight increase in softer lighter olive green 1mm chips as described above, slight increase in aragonite	10
105	SERPENTINITE: Fresh serpentinite of medium hardness, medium olive green with a slight decrease in softer lighter olive green chips as described above, overall more mottled in colouration with dark green to black and white calcareous zones	
110		10
115		10
120	SERPENTINITE: Mildly weathered serpentinite of medium hardness, medium olive green with minor softer lighter olive green chips as above, increase in aragonite and quartz, fracture zone implied from increased weathering	10
125	SERPENTINITE: Fresh serpentinite of medium hardness, medium olive green with minor softer lighter olive green chips as above, 5%-trace aragonite, trace quartz and trace darker blue-green to black chips of metabasalt. Shale to chert texture becomes apparent with a unifo	7.7
130	SERPENTINITE: Fresh serpentinite of medium hardness, medium olive green with minor softer lighter olive green chips as above, slight increases in aragonite, trace quartz and trace darker blue-green to black chips of metabasalt	
	SERPENTINITE: Fresh serpentinite of medium hardness, medium olive green with minor softer lighter olive green chips as above, slight increases in aragonite at 148-150m, trace	7.7

Comments:



quartz and trace darker blue-green to black chips of metabasalt

8.5

9.1

9.1

9.1

Comments:

OBSERVATION WELL BORE LOG

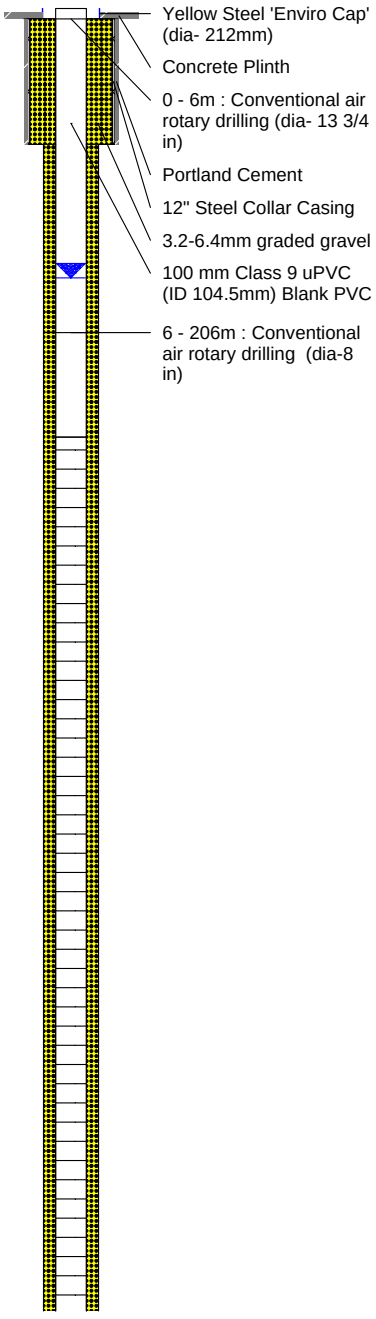
BOREHOLE NUMBER

NS-ObsW01A

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

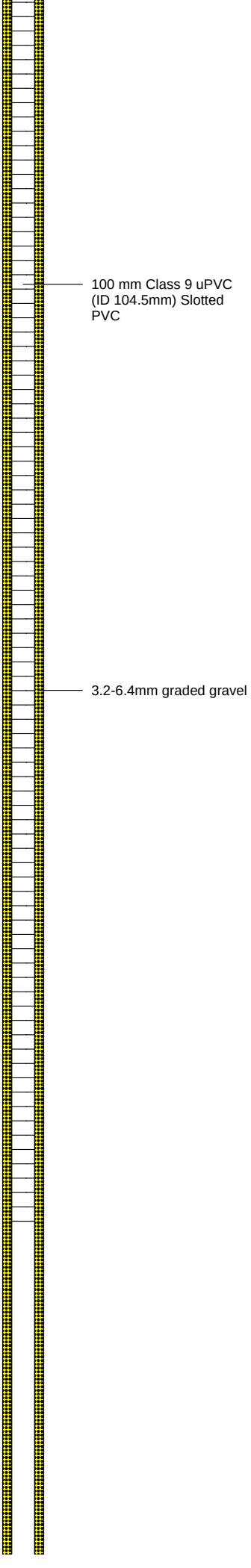
PROJECT NAME: **North Star Stage 2**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **706102.79**
NORTHING (m): **7647615.90**
MEAS PT ELEVATION (mAHD): **241.92**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **22/10/2014** DATE COMPLETED: **25/10/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.691**
Drilled Depth (mbgl):	**206**
Cased Depth (mbgl):	**206**
Casing Stick Up (magl):	**0.507**
Development Airlift Yield (l/s):	**5**
Water Level (mbgl) & Date:	**12.38** & **10/04/2015**



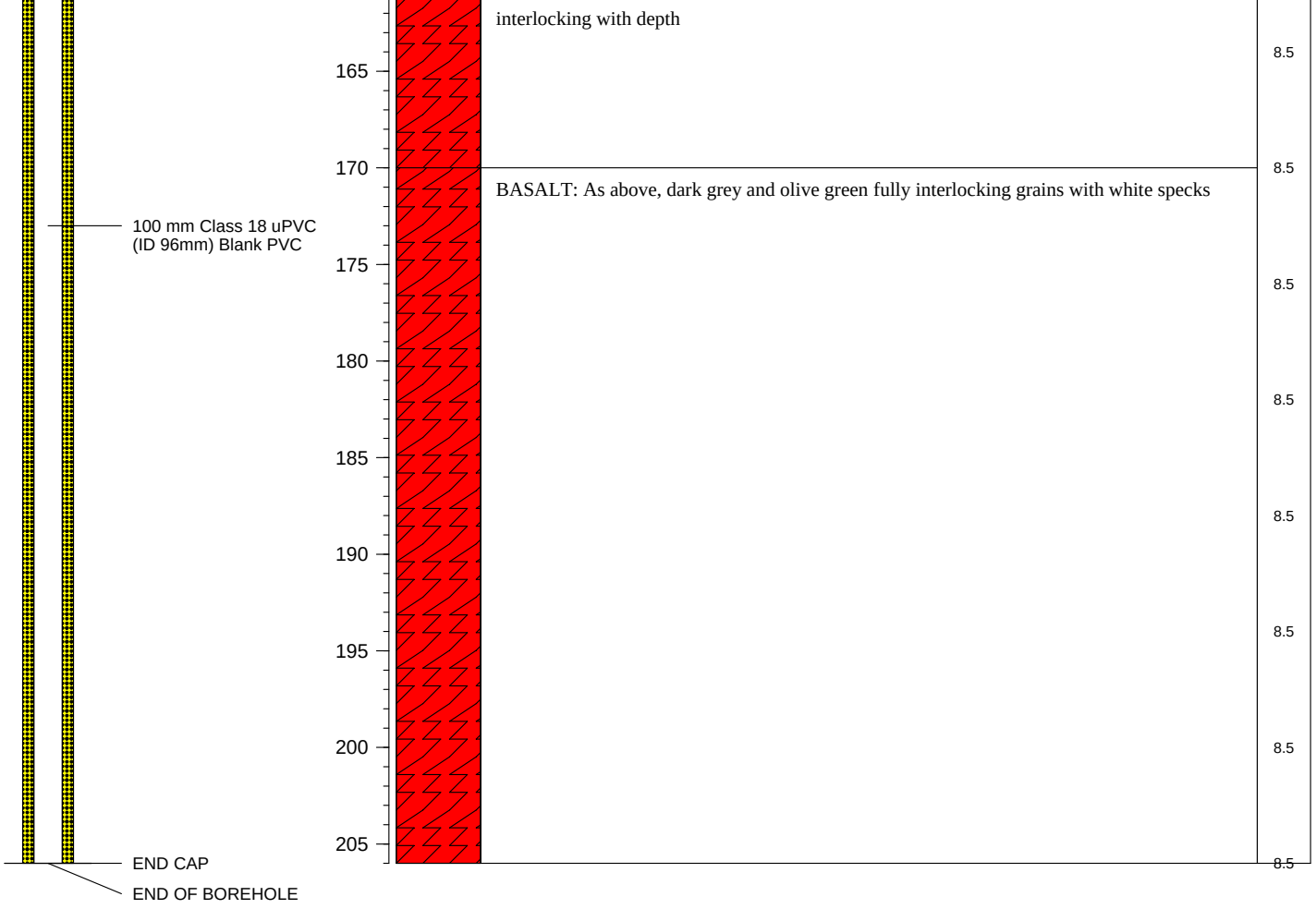
DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Light brown to red silt, olive grey carbonate rock, likely altered mafics and calcrete, all well weathered and oxidized orange on much of the surfaces, high carbonate content / highly reactive to HCl	
5	CARBONATE: Olive grey to white medium to hard silty carbonate, likely altered mafics with quartz veins and minor inclusions under 1mm, minor white calcrete, mildly oxidized, high carbonate content / highly reactive to HCl	
10	CARBONATE: As above, less calcrete	
	CARBONATE: As above, trace aragonite chips, trace calcrete, trace quartz, increase in oxidation and overall more orange in colour	
15	BASALT: Olive grey calcareous rock, becoming darker with depth, likely altered mafics, high carbonate content / highly reactive to HCl	
20		0.1
25	BASALT: As above, slight increase in oxidation and evidence of weathering along fracture planes	1.2
30	BASALT: Olive grey with minor orange/oxidized mafics as above, trace to minor quartz, reduced reaction to HCl,	4.4
35		5.4
40		
45		5.4
50		5.4
55	BASALT: Olive grey, fresh altered basalt, bordering andesite, silicified, highly reactive to HCl, trace to no oxidation	5.4
60		

Comments:



65	BASALT: As above, increase in oxidation along fracture planes, minor gravel sized clasts, increase in colourless quartz chips and chips of softer lighter green rock	8
70	CALCAREOUS CHERT: Olive grey to white and colourless calcareous chert, medium hardness, highly altered with wavy gneissic, marbled, schist foliation and massive chert textures, continues to be highly reactive to HCl	8
75		8
80		
85		
90	CALCAREOUS CHERT: As above, trace yellow-green colouration from 88-92m, and bright blue green colouration from 96-98	
95	CALCAREOUS CHERT: Olive grey to white and colourless calcareous chert, as above, trace bright blue green colouration, increase in silica/quartz chips	6
100	CALCAREOUS CHERT: Olive grey hard calcareous chert, transparent to opaque with conchoidal fracture	6
105	CALCAREOUS CHERT: Pale olive grey opaque calcareous chert cut by colourless veinlets	
	CALCAREOUS CHERT: As above, texture becomes more granular and colour becomes more grey	6
110	CALCAREOUS CHERT: Grey with a slight olive colour,fine black and white barely visible grains, still highly reactive to HCl, trace pyrite	
	CALCAREOUS CHERT: Pale, slightly olive grey opaque calcareous chert, texture is more marbled than previous chert	6.2
115	BASALT: Grey with a slight olive colour, granular to mottled texture with trace black and white barely visible grains, still highly reactive to HCl, trace pyrite	
120	BASALT: Silicified altered mafics with a very fine grained to microcrystalline grey matrix and black and white inclusions under 1mm in diameter, still high carbonate content and trace pyrite	7.8
125		8
130		
135	BASALT: As above, olive grey with minor white, well silicified and slightly more olive in colour, trace pyrite	8
140		8.5
145	BASALT: Olive grey, minor colourless and white interlocking grains, metamorphosed, trace black chert 144-146m	8.5
150	BASALT: As above, increase in quartz and aragonite chips	8.5
155	BASALT: As above, quartz and aragonite content increased to 30% and colour becomes darker grey with depth	8.5
160	BASALT: As above, reduction in quartz and aragonite to 10-20% grains become more clearly	

Comments:


100 mm Class 18 uPVC
(ID 96mm) Blank PVC
END CAP
END OF BOREHOLE
165
170
175
180
185
190
195
200
205
interlocking with depth
BASALT: As above, dark grey and olive green fully interlocking grains with white specks
8.5
8.5
8.5
8.5
8.5
8.5
8.5
8.5

OBSERVATION WELL BORE LOG

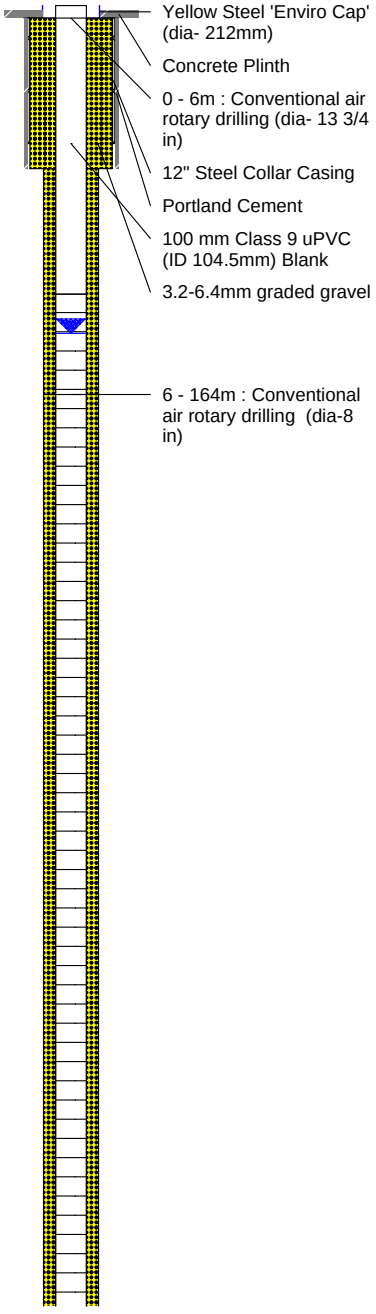
BOREHOLE NUMBER

NS-ObsW02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

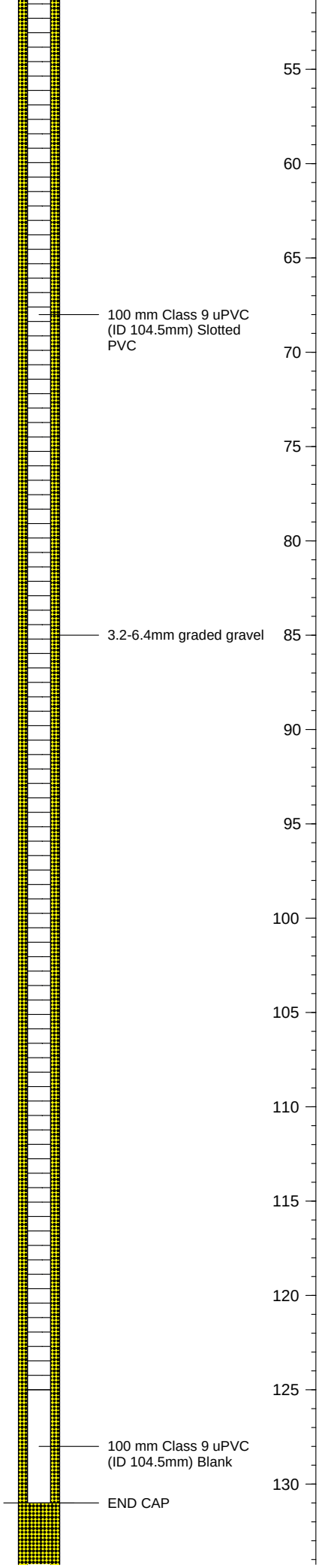
PROJECT NAME: **North Star Stage 1**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **703125.62**
NORTHING (m): **7646982.96**
MEAS PT ELEVATION (mAHD): **230.39**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **20/08/2014** DATE COMPLETED: **25/08/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.721**
Drilled Depth (mbgl):	**164**
Cased Depth (mbgl):	**131**
Casing Stick Up (magl):	**0.42**
Development Airlift Yield (l/s):	**2.5**
Water Level (mbgl) & Date:	**12.56** & **10/04/2015**



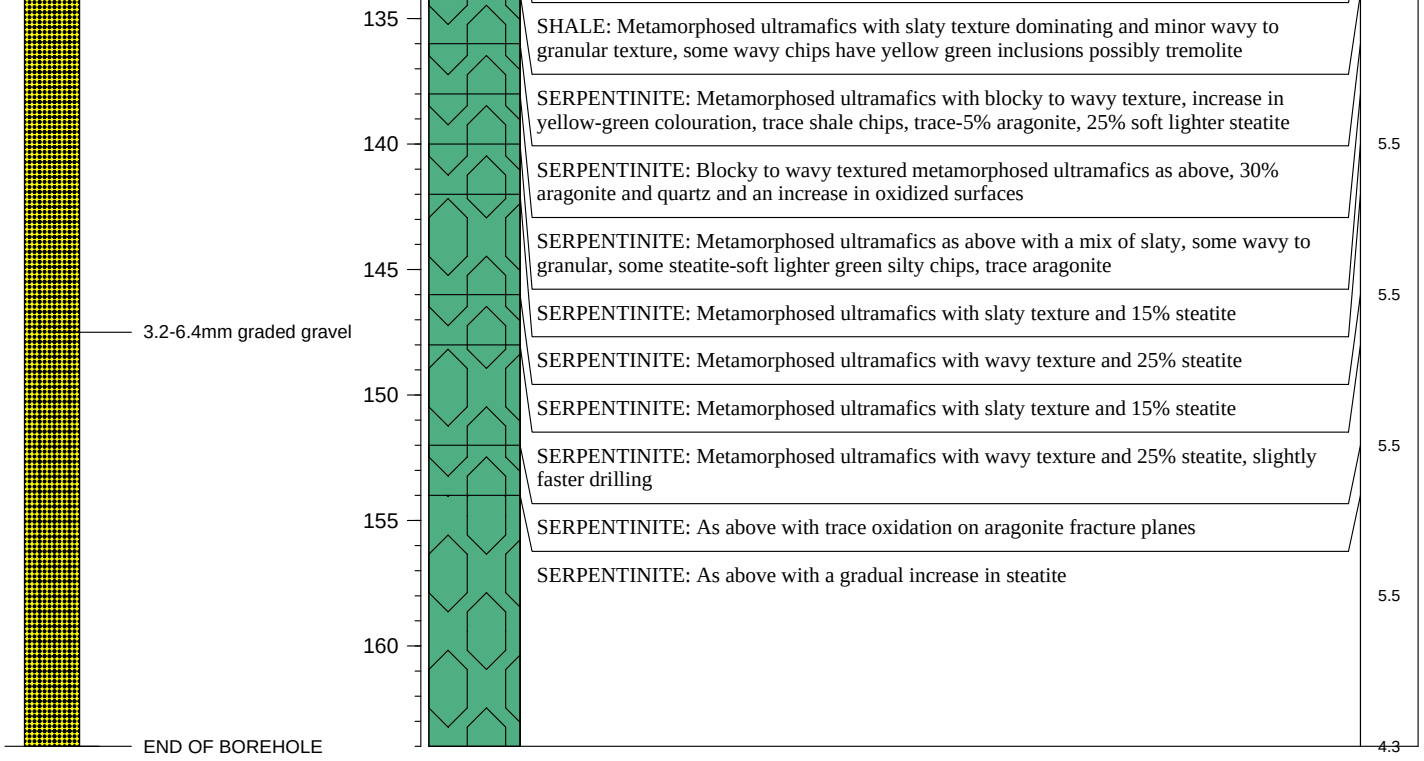
DEPTH	DESCRIPTION	YIELD (L/sec)
0	SERPENTINITE: Lose, moderately weathered metamorphosed ultramafics, pale to milky olive green serpentinite with dark specks, minor quartz, trace grey to black chert, possibly infill from pad clearing, chips are 1-50mm	
5	SERPENTINITE: Highly weathered pale olive green and brown metamorphosed ultramafics with minor, weathered angular chips of grey to black chert and quartz, cobbles present, chips are 1-100mm	
	SERPENTINITE: Moderately weathered pale olive green metamorphosed ultramafics as above with trace grey to black and rose chert and quartz, chips are 1-50mm	
10	SERPENTINITE: Mildly weathered ultramafics as above, mostly a medium olive green with mottled darker and lighter coloration, minor steatite-soft light milky olive green rock of silty texture, minor dark grey to green shale from 6-8m reduced to trace from 8-14m, trace to 5% quartz throughout, trace aragonite starting at 10m	
15	SERPENTINITE: Ultramafics as above, increasing amounts of weathered aragonite and quartz from 14-18m, water at 18m, 10% aragonite and quartz at 18-20m with few large chips up to 20mm	
20	SERPENTINITE: Ultramafics as above with 25% steatite-soft light milky olive green ultramafic of silty texture, 5% quartz and aragonite	2.3
	SERPENTINITE: Ultramafics as above with 40% steatite, trace quartz and aragonite, faster drilling/softer ground 20-26m	
25	SERPENTINITE: 75% medium olive green ultramafics as above of medium hardness, 25% steatite, trace quartz and aragonite, some quartz show brown dendric formation	2.3
30		3.3
35	SERPENTINITE: As above, slightly harder and more uniform/less mottled in coloration, with 5-10% chips of darker almost black coloured mafics/ultramafics, trace aragonite and quartz with brown dendrites, carbonates throughout-mild reaction to HCl throughout	3.3
40	SERPENTINITE: Ultramafics as above-dark olive green ultramafics with mottled darker and lighter coloration, slightly darker than above, minor steatite, minor dark green to black mafic chips, 5% quartz and aragonite, slightly more quartz from 40-42m, 52-54m, 66-68m, slightly more soft lighters chips and aragonite from 72-80m	3.3
45		3.3
50		3.3

Comments:



55		3.3
60		3.3
65		3.3
70		3.3
75		3.3
80		3.3
		4.3
85	SERPENTINITE: Ultramafics as above significant increase in weathered surfaces and aragonite, 25% aragonite and quartz with large 20-40mm chips of aragonite surfacing, driller notes quick drilling at 90m-fracture zone	
90	SERPENTINITE: Ultramafics as above slight increase in quartz and aragonite from 92-94	
95		
	SHALE: Ultramafics as above with very fine foliated flaky shale texture, same olive colour but uniform and microcrystalline	6.1
100	SHALE: Metamorphosed ultramafics with foliated shale texture, 20% aragonite and minor quartz	
		5.5
105	SHALE: As above with trace-5% aragonite and trace quartz	
	SERPENTINITE: As above becoming more blocky to wavy in texture with little to no shale texture, trace quartz an aragonite	
110		5.5
115		5.5
	SHALE: Metamorphosed ultramafics with flaky shale texture and increased aragonite	
	SERPENTINITE: Metamorphosed ultramafics with blocky to wavy texture with minor slaty chips and steatite-soft lighter green silty chips	
120		5.5
	SHALE: Metamorphosed ultramafics with flaky shale texture with trace to no aragonite	
125	SERPENTINITE: Metamorphosed ultramafics with blocky to wavy texture with 5-10% aragonite and steatite	
	SERPENTINITE: As above with only trace-5% aragonite and slightly more yellow in colour trace green to yellow crystals possibly tremolite	5.5
130	SERPENTINITE: Metamorphosed ultramafics as above returned to the original olive colour	
	SERPENTINITE: Metamorphosed ultramafics as above with some slaty and some wavy to granular textured chips, 25% lighter soft silty steatite	5.5

Comments:


135
140
145
150
155
160
3.2-6.4mm graded gravel
END OF BOREHOLE
SHALE: Metamorphosed ultramafics with slaty texture dominating and minor wavy to granular texture, some wavy chips have yellow green inclusions possibly tremolite
SERPENTINITE: Metamorphosed ultramafics with blocky to wavy texture, increase in yellow-green colouration, trace shale chips, trace-5% aragonite, 25% soft lighter steatite
SERPENTINITE: Blocky to wavy textured metamorphosed ultramafics as above, 30% aragonite and quartz and an increase in oxidized surfaces
SERPENTINITE: Metamorphosed ultramafics as above with a mix of slaty, some wavy to granular, some steatite-soft lighter green silty chips, trace aragonite
SERPENTINITE: Metamorphosed ultramafics with slaty texture and 15% steatite
SERPENTINITE: Metamorphosed ultramafics with wavy texture and 25% steatite
SERPENTINITE: Metamorphosed ultramafics with slaty texture and 15% steatite
SERPENTINITE: Metamorphosed ultramafics with wavy texture and 25% steatite, slightly faster drilling
SERPENTINITE: As above with trace oxidation on aragonite fracture planes
SERPENTINITE: As above with a gradual increase in steatite
5.5
5.5
5.5
5.5
4.3

Comments:

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

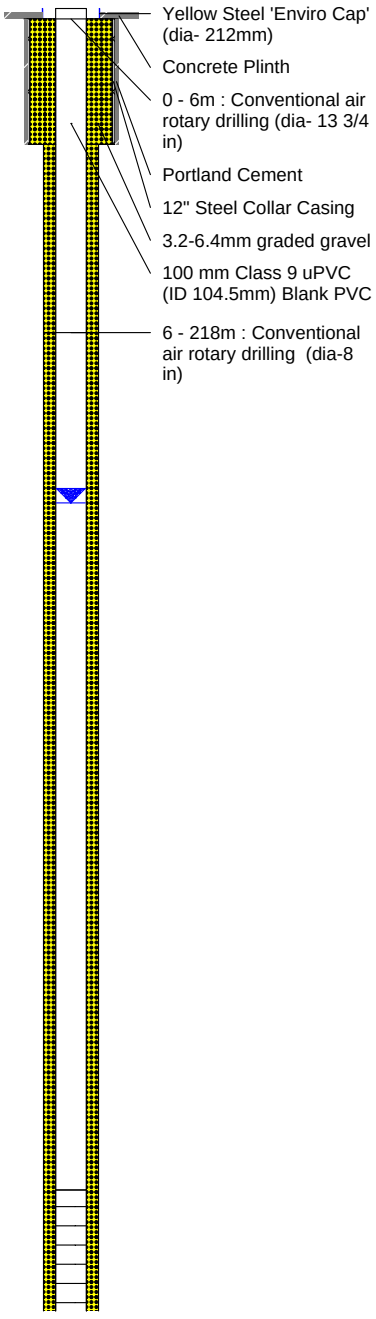
NS-ObsW02A

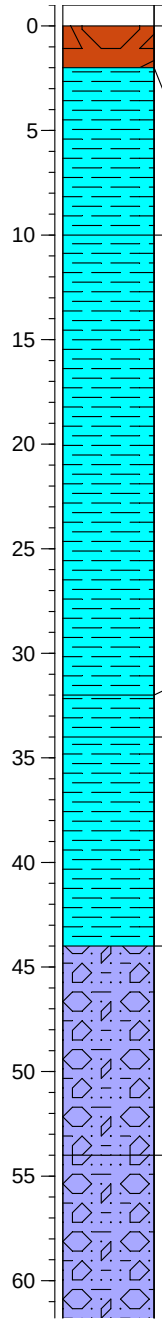
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **702531.52**
NORTHING (m): **7646633.11**
MEAS PT ELEVATION (mAHD): **241.40**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **12/11/2014** DATE COMPLETED: **15/11/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.688**
Drilled Depth (mbgl):	**218**
Cased Depth (mbgl):	**218**
Casing Stick Up (magl):	**0.593**
Development Airlift Yield (l/s):	**0.25**
Water Level (mbgl) & Date:	**23.14** & **10/04/2015**

BORE CONSTRUCTION	DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)





DETRITUS: Orange to grey, well oxidized chips of light grey greywacke, shale, chert, calcrete and fine silt

SHALE: Medium olive grey to orange from oxidation, shale to mudstone, most of sample is silt to clay with minor to trace grains of colourless to orange and pink stained, very fine grained quartz and friable iron

SHALE: As above, 70-95% of sample continues to surface as silt and clay and has become slightly more brown or orange tinged from oxidation

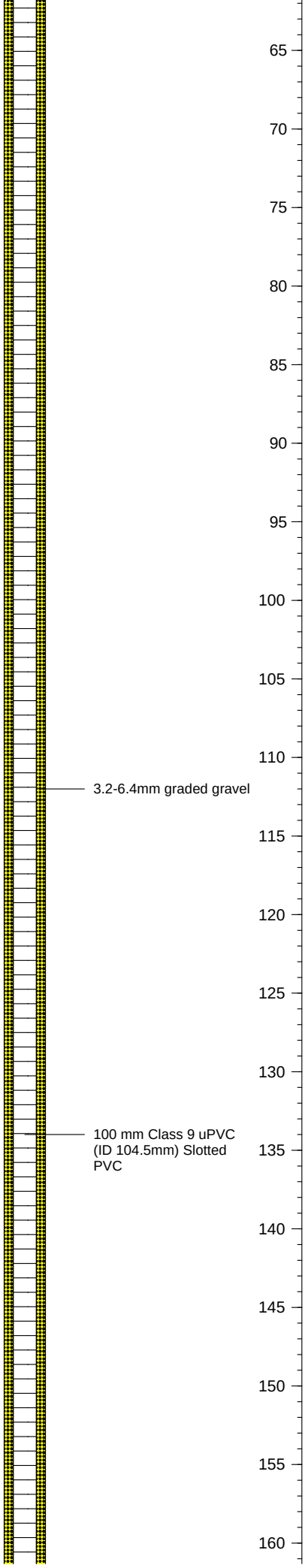
SHALE: As above, sample has become slightly more olive green

SHALE: As above, chip percentage begins to increase and reaches 30% by 36m, chips show an increase in fine quartz sand grains and trace friable iron

SANDSTONE/WACKE: Medium olive to grey mudstone matrix of silt and clay with minor grains of colourless to orange and pink stained, very fine to fine grained quartz that range from subrounded to angular, minor friable iron and iron cement in matrix, moderately weathered, chip percentage gradually increases from 50% at 50m to 95% at 74m, trace chips of secondary quartz encrustation/ intrusion, chip surfaces are speckled with light yellow encrustation possibly from the oxidation of iron grains in the rock

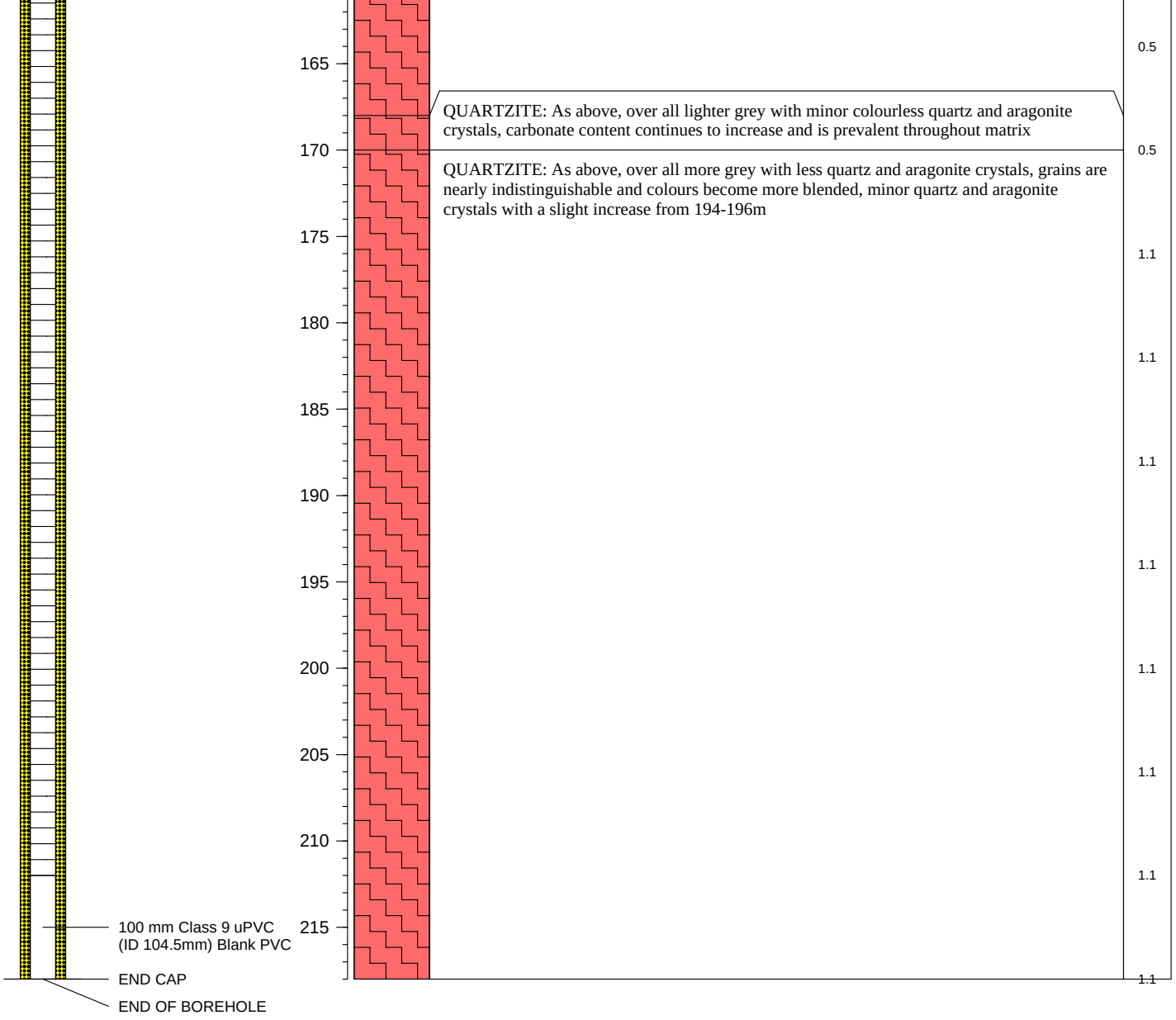
SANDSTONE/WACKE: As above, slight increase in oxidation and chips of friable iron and quartz intrusion and grains

Comments:



65		0.1
70		
75		
80		0.1
85	SANDSTONE/WACKE: As above, drastic increase in oxidation and chips of friable iron, colour becomes more orange and there is a reduction in chip percentage with silt and clay mud increasing and becoming lighter with depth	0.1
90	SANDSTONE/WACKE: Light grey lithic wacke with grains of white to colourless quartz and purple to red friable iron in a lighter silt to clay matrix, increased quartz content and mild metamorphism resulting in a more quartzite texture, trace green chlorite hue	0.1
95	SANDSTONE/WACKE: As above, reduction in purple to red friable iron to trace, colour becomes a light green to white, increase in white silt to clay from 88-92m, then increasing quantities of quartz and silicification from 92m, trace pyrite	0.1
100		0.1
105		0.1
110		0.1
115	CHERT: Solid colourless quartz dominates mix with only minor light green to white lithic arenite as described above, trace pyrite	0.1
120	QUARTZITE: Quartzite from lithic wacke-metamorphosed light green to white and colourless lithic arenite with interlocking grains and minor chips of pure colourless quartz, trace pyrite, minor reaction to HCl	0.3
125		0.3
130	QUARTZITE: As above, over all more grey with minor green and trace pink colouration	0.5
135		0.5
140		0.5
145		0.5
150		0.5
155	QUARTZITE: As above, over all lighter grey with minor colourless quartz and aragonite crystals, formation becoming more reactive to HCl-increase in carbonates with depth	0.5
160	QUARTZITE: As above, over all more grey with less quartz and aragonite, carbonate content continues to increase and is prevalent throughout matrix	

Comments:


165
170
175
180
185
190
195
200
205
210
215
100 mm Class 9 uPVC
(ID 104.5mm) Blank PVC
END CAP
END OF BOREHOLE
QUARTZITE: As above, over all lighter grey with minor colourless quartz and aragonite crystals, carbonate content continues to increase and is prevalent throughout matrix
QUARTZITE: As above, over all more grey with less quartz and aragonite crystals, grains are nearly indistinguishable and colours become more blended, minor quartz and aragonite crystals with a slight increase from 194-196m
0.5
0.5
1.1
1.1
1.1
1.1
1.1
1.1
1.1
1.1
1.1

Comments:

OBSERVATION WELL BORE LOG

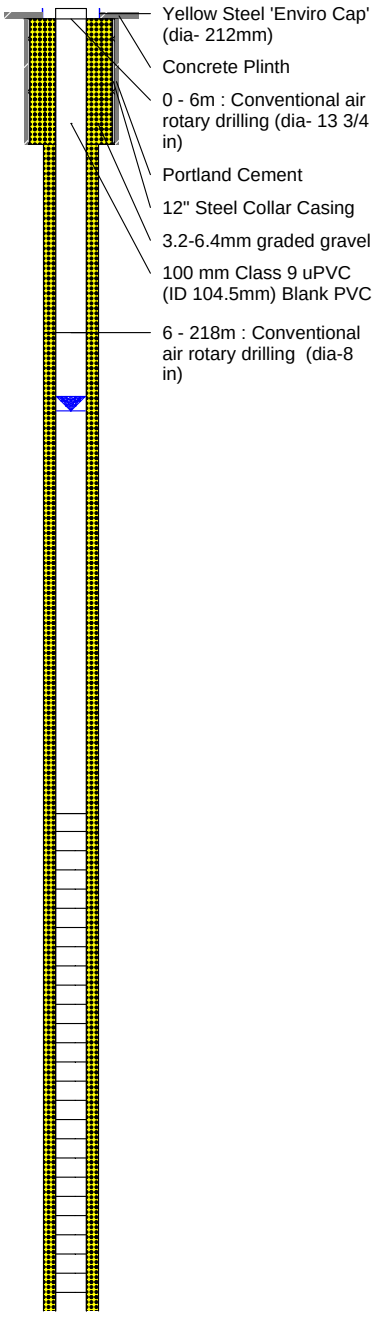
BOREHOLE NUMBER

NS-ObsW02B

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

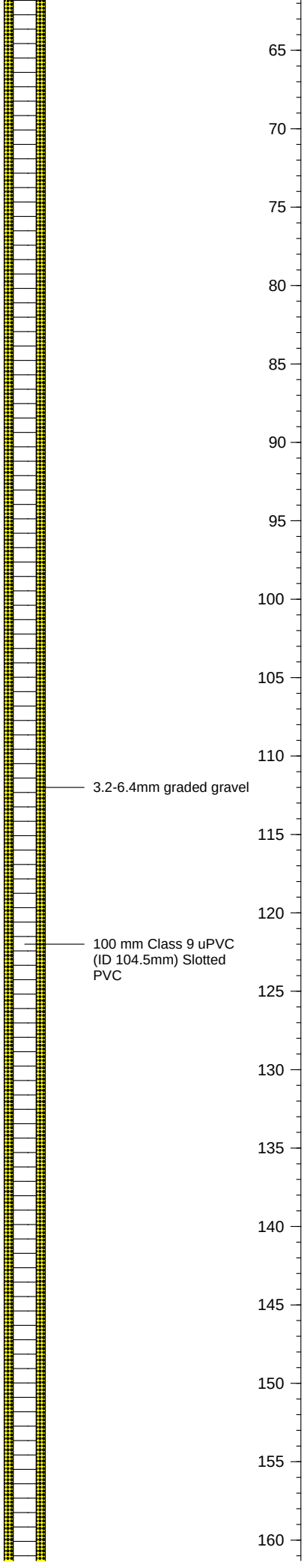
PROJECT NAME: **North Star Stage 2**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **701723.28**
NORTHING (m): **7647165.83**
MEAS PT ELEVATION (mAHD): **231.76**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **4/11/2014** DATE COMPLETED: **6/11/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.554**
Drilled Depth (mbgl):	**218**
Cased Depth (mbgl):	**218**
Casing Stick Up (magl):	**0.478**
Development Airlift Yield (l/s):	**2.9**
Water Level (mbgl) & Date:	**18.74** & **10/04/2015**



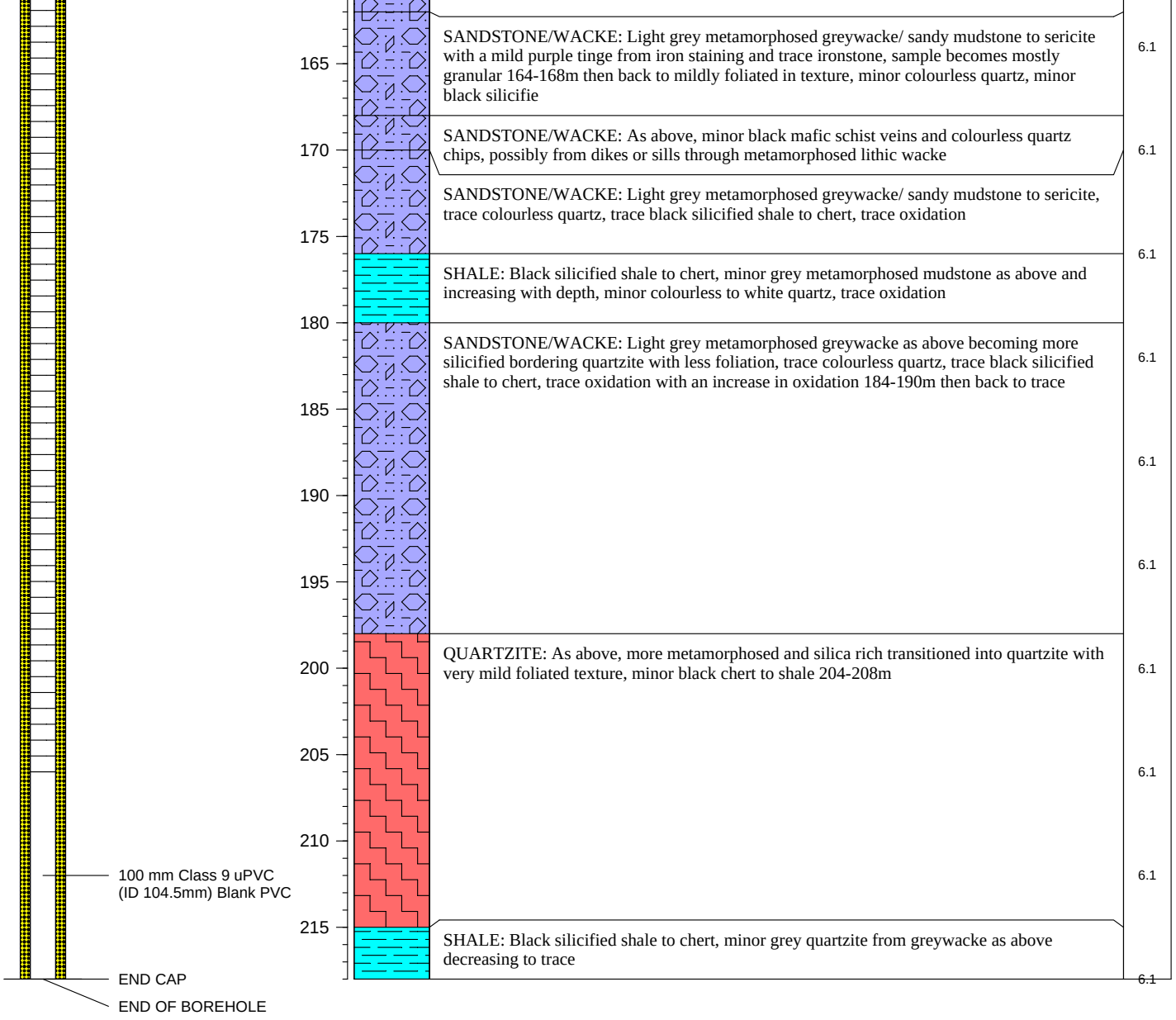
DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Fine orange silt, weathered black, grey to colourless chert colluvium and white to orange calcrete, well oxidized	
5	METAPELITE: Medium light grey mudstone to sericite, massive to foliated texture becoming more foliated with depth, 50% of sample is powder/silt and clay coating chips in round balls, minor colluvium as above and decreasing with depth, trace iron cement, well oxidized	
10	METAPELITE: Sample is mostly silt and clay powder coating chips of light orange to yellow sericite to mudstone with minor grey to black silicified shale to chert, increase in black, silicified shale to chert at 10-12m and 24-26m, well oxidized	
15	METAPELITE: Orange to white talc sericite to mudstone with some chips showing clear fibrous to foliated texture, mild to trace oxidation	
	METAPELITE: Orange to white talc sericite to mudstone with some chips showing clear fibrous to foliated texture with interbedded black silicified shale to chert, mild oxidation	
20	METAPELITE: White with trace orange talc sericite to mudstone with some chips showing clear fibrous to foliated texture, minor colourless quartz, mild to trace oxidation	
25	METAPELITE: White with trace orange talc sericite to mudstone with some chips showing clear fibrous to foliated texture with interbedded black silicified shale to chert, minor colourless quartz, mild to trace oxidation	
	CHERT: Colourless to white quartz, minor talc sericite and black shale, trace oxidation	
30	SHALE: Very black fine silicified shale to chert with colourless quartz, minor light orange sericite as above and trace iron cement, well oxidised	Water, no flow
35	SHALE: Black silicified shale to chert, minor talc sericite and colourless to white quartz, trace oxidation	Water, no flow
40		1
45		1
50		1
55		
60		

Comments:



METAPELITE: White with trace orange talc sericite to mudstone with some chips showing clear fibrous to foliated texture, minor colourless quartz, minor to trace black silicified shale to chert, trace oxidation	2.2
SHALE: Black silicified shale to chert, minor talc sericite and colourless to white quartz, trace oxidation	2.2
METAPELITE: White with trace orange talc sericite to mudstone as above, with minor interbedded black silicified shale to chert decreasing with depth, minor colourless quartz, trace oxidation	2.2
SHALE: Black silicified shale to chert with minor interbedded white talc sericite to mudstone as above, minor colourless quartz increasing with depth, mild to trace oxidation	
CHERT: Colourless to white quartz, minor talc sericite and black shale, trace oxidation	2.2
METAPELITE: Off white sericite to mudstone with some chips showing clear fibrous to foliated texture becoming slightly darker and grey in colour with depth, minor colourless quartz, minor black silicified shale to chert, trace oxidation	2.5
METAPELITE: Light grey sericite to sandy mudstone with fibrous to foliated texture and becoming more silica rich, minor colourless quartz, trace black silicified shale to chert, trace oxidation, trace pyrite to depth	2.9 2.9 2.9 2.9
METAPELITE: Light grey sericite to sandy mudstone as above becoming slightly more granular to foliated texture, minor colourless quartz, trace black silicified shale to chert, trace oxidation	4.2 4.2 3.8
METAPELITE: As above with mild oxidation and an increase in black shale as above	3.4
SHALE: Black silicified shale to chert, minor grey metamorphosed mudstone as above and increasing with depth, minor colourless to white quartz, mild oxidation	3.4
SANDSTONE/WACKE: Light grey metamorphosed greywacke/ sandy mudstone to sericite becoming slightly more granular with depth yet still showing foliated texture, minor colourless quartz, trace black silicified shale to chert, trace oxidation	3.4 3.4 3.4
SANDSTONE/WACKE: As above with increased black silicified shale	3.4
SANDSTONE/WACKE: As above with trace black silicified shale	

Comments:



SANDSTONE/WACKE: Light grey metamorphosed greywacke/ sandy mudstone to sericite with a mild purple tinge from iron staining and trace ironstone, sample becomes mostly granular 164-168m then back to mildly foliated in texture, minor colourless quartz, minor black silicifie — 6.1

SANDSTONE/WACKE: As above, minor black mafic schist veins and colourless quartz chips, possibly from dikes or sills through metamorphosed lithic wacke — 6.1

SANDSTONE/WACKE: Light grey metamorphosed greywacke/ sandy mudstone to sericite, trace colourless quartz, trace black silicified shale to chert, trace oxidation — 6.1

SHALE: Black silicified shale to chert, minor grey metamorphosed mudstone as above and increasing with depth, minor colourless to white quartz, trace oxidation — 6.1

SANDSTONE/WACKE: Light grey metamorphosed greywacke as above becoming more silicified bordering quartzite with less foliation, trace colourless quartz, trace black silicified shale to chert, trace oxidation with an increase in oxidation 184-190m then back to trace — 6.1 — 6.1 — 6.1

QUARTZITE: As above, more metamorphosed and silica rich transitioned into quartzite with very mild foliated texture, minor black chert to shale 204-208m — 6.1 — 6.1 — 6.1

SHALE: Black silicified shale to chert, minor grey quartzite from greywacke as above decreasing to trace — 6.1

Comments:

OBSERVATION WELL BORE LOG

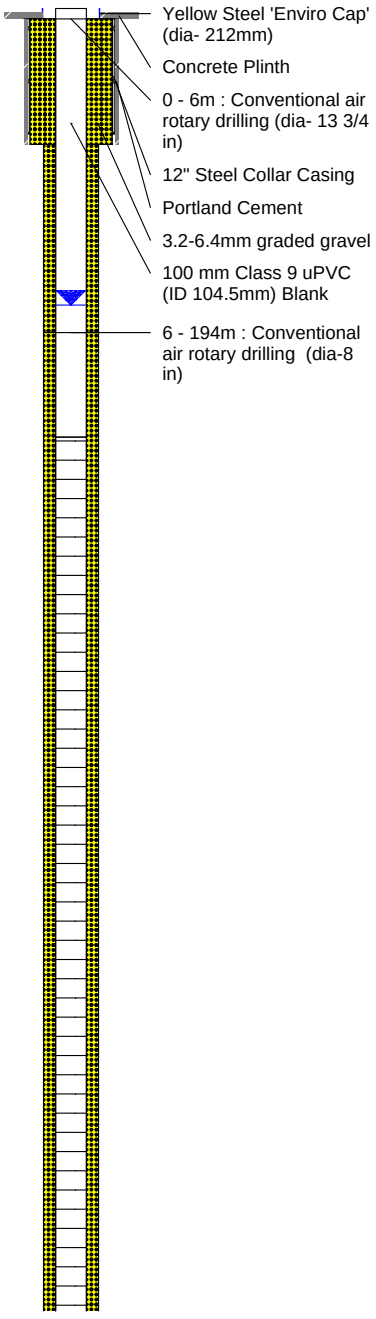
BOREHOLE NUMBER

NS-ObsW02C

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

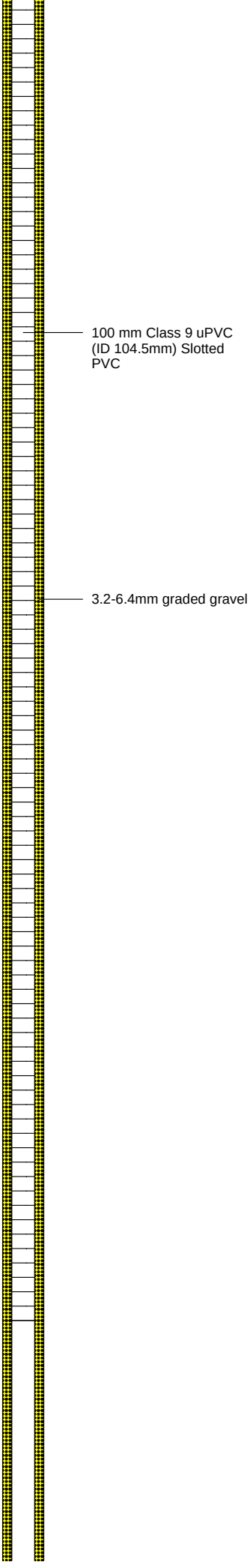
PROJECT NAME: **North Star Stage 1**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **701774.38**
NORTHING (m): **7647057.08**
MEAS PT ELEVATION (mAHD): **236.63**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **31/08/2014** DATE COMPLETED: **3/09/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.738**
Drilled Depth (mbgl):	**194**
Cased Depth (mbgl):	**194**
Casing Stick Up (magl):	**0.642**
Development Airlift Yield (l/s):	**8**
Water Level (mbgl) & Date:	**13.68** & **10/04/2015**



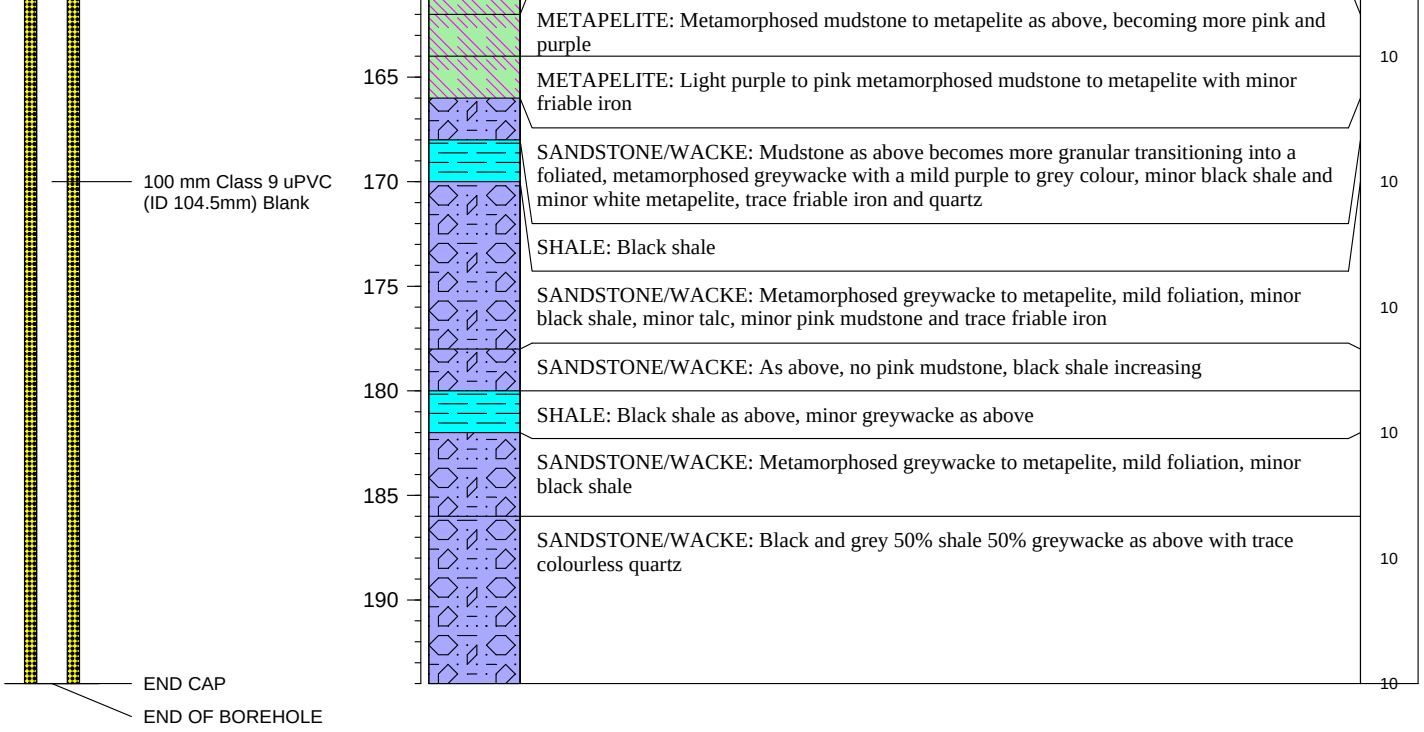
DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Fine red sand and silt, weathered black, grey to colourless chert colluvium and white to orange calcrete	
5	METAPELITE: Medium to hard, light grey mudstone, massive texture, 30 to 50% of sample surfaces as silt and clay coating chips into round balls, minor colluvium as above and decreasing with depth	
10	METAPELITE: Returned as mud with small chips of soft mudstone, trace silicified shale to chert	
	SHALE: Mostly brownish red soft mudstone and mud very dark grey to black fine silicified shale	
15	METAPELITE: Mudstone as above with minor light brown to white mudstone, some chips show banding and some fracture planes show dendric formations	
20	METAPELITE: Light brown, light grey and brownish red mudstone, minor dark grey to black chert, trace fine mafic mica schist with large chips showing oxidation and signs of weathering	0.2
25	SHALE: Moderately weathered, massive and silicified shale to chert with no foliation and some conchoidal fracture, minor mudstone	1
	METAPELITE: Moderately weathered mudstone, silicified mudstone and mud, red/ brown, light brown and grey with 30-40% black and grey silicified shale to chert often in large 50mm chips-possible contamination	
30	SHALE: Moderately weathered, massive and silicified shale to chert with no foliation and some conchoidal fracture, minor mudstone, trace weathered iron cement in friable chips	4
35	METAPELITE: Light grey, metamorphosed mudstone to metapelite, fine sand in a fine matrix of silt to clay, nearly quartzite with mild foliation, minor brown mudstone, minor black shale	5
40	METAPELITE: Light grey metamorphosed mudstone to metapelite as above, slightly more sandy, possibly a metamorphosed greywacke, trace brown mudstone and black shale as above	
	METAPELITE: As 34-36m	5.5
45	METAPELITE: Brown metamorphosed mudstone with minor grey sand and black shale	
	SHALE: Black silicified shale	
50	METAPELITE: Grey sandy mudstone with minor brown mudstone and black shale	5.5
	METAPELITE: Light brown mudstone with minor grey sandy mudstone and black chert	
55	METAPELITE: As above with slightly more black shale	
	SHALE: Black shale with minor grey and brown mudstone	5.5
60	METAPELITE: Grey sandy metamorphosed mudstone to metapelite, becoming foliated with depth, minor black shale from 54-56m	

Comments:



65	METAPELITE: Interbedded black shale and grey foliated metamorphosed mudstone to metapelite, slightly more mudstone	5.5
	SHALE: Shale as above	
70	METAPELITE: Grey foliated metamorphosed mudstone to metapelite	5.5
	SHALE: Interbedded black shale and grey metamorphosed mudstone to metapelite, slightly more black shale	
75	METAPELITE: Light grey foliated metamorphosed sandy mudstone to metapelite as above, chips shows fine sand in a fine matrix of silt to clay, metamorphosed, nearly quartzite, minor brown mudstone, minor black shale	5.5
80	SHALE: Moderately weathered, massive and silicified shale to chert with no foliation and some conchoidal fracture, minor mudstone, drilling continues to be continuous and steady with no difficulty	5.5
85	METAPELITE: Light grey foliated metamorphosed sandy mudstone to metapelite, chips shows fine sand in a fine matrix of silt to clay, metamorphosed, trace brown mudstone, trace black shale	5.5
90	METAPELITE: Interbedded black shale and grey metamorphosed mudstone to metapelite, minor colourless quartz crystals	5.5
95	METAPELITE: Light grey foliated metamorphosed sandy mudstone to metapelite, chips shows fine sand in a fine matrix of silt to clay, metamorphosed, trace brown mudstone, trace black shale	5.5
100		5.5
105		5.5
110		5.5
115		6.5
120		6.5
125	METAPELITE: As above with an increase in black shale and foliation	6.5
130	METAPELITE: Light grey foliated metamorphosed sandy mudstone to metapelite as above with minor quartz	8
135		
140	METAPELITE: As above with minor black shale	10
	METAPELITE: As above, trace black shale	
145	METAPELITE: As above with minor shale	10
	SHALE: Moderately weathered, massive and silicified shale to chert with no foliation and some conchoidal fracture, minor mudstone	
150	METAPELITE: Grey foliated metamorphosed sandy mudstone to metapelite as above	10
155	METAPELITE: Light pink and grey foliated metamorphosed sandy mudstone to metapelite as above, some mudstone is pink and grey with minor friable iron cement and trace black shale, pink colour and friable iron content and decreases from 150-152	
	METAPELITE: 50% black shale, 50% grey mudstone to metapelite as above	
160	METAPELITE: Metamorphosed mudstone to metapelite, trace friable iron and black shale	10

Comments:


100 mm Class 9 uPVC
(ID 104.5mm) Blank
END CAP
END OF BOREHOLE
165
170
175
180
185
190
METAPELITE: Metamorphosed mudstone to metapelite as above, becoming more pink and purple
METAPELITE: Light purple to pink metamorphosed mudstone to metapelite with minor friable iron
SANDSTONE/WACKE: Mudstone as above becomes more granular transitioning into a foliated, metamorphosed greywacke with a mild purple to grey colour, minor black shale and minor white metapelite, trace friable iron and quartz
SHALE: Black shale
SANDSTONE/WACKE: Metamorphosed greywacke to metapelite, mild foliation, minor black shale, minor talc, minor pink mudstone and trace friable iron
SANDSTONE/WACKE: As above, no pink mudstone, black shale increasing
SHALE: Black shale as above, minor greywacke as above
SANDSTONE/WACKE: Metamorphosed greywacke to metapelite, mild foliation, minor black shale
SANDSTONE/WACKE: Black and grey 50% shale 50% greywacke as above with trace colourless quartz
10
10
10
10
10
10
10

Comments:

OBSERVATION WELL BORE LOG

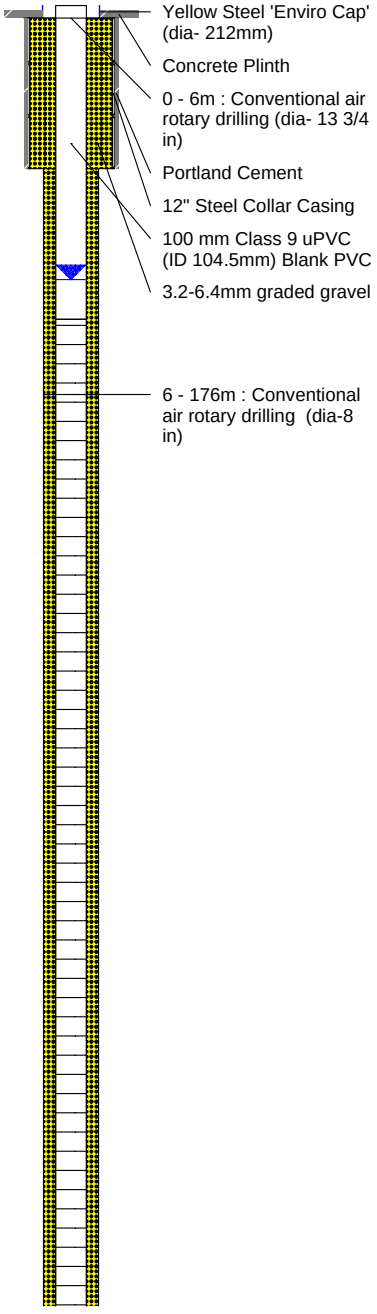
BOREHOLE NUMBER

NS-ObsW03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

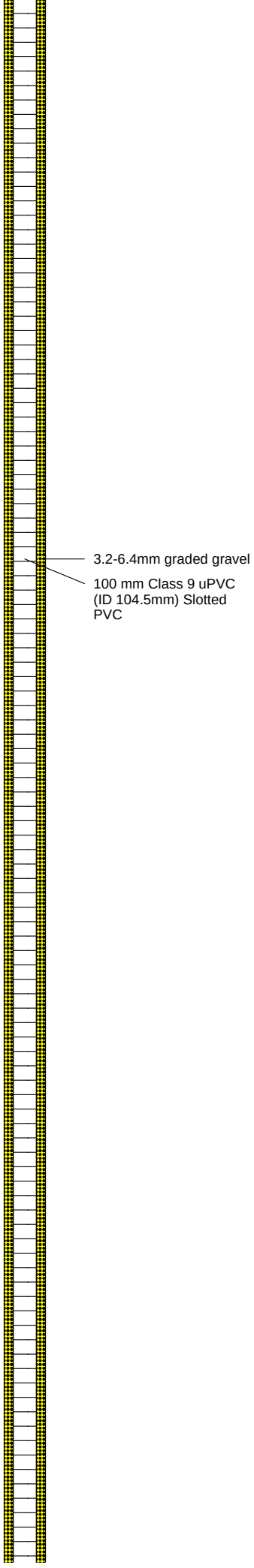
PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Western Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**700634.72**
NORTHING (m):	**7648149.48**
MEAS PT ELEVATION (mAHD):	**223.03**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **25/08/2014**	DATE COMPLETED: **28/08/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.707**
Drilled Depth (mbgl):	**176**
Cased Depth (mbgl):	**156**
Casing Stick Up (magl):	**0.466**
Development Airlift Yield (l/s):	**2**
Water Level (mbgl) & Date:	**10.42** & **10/04/2015**



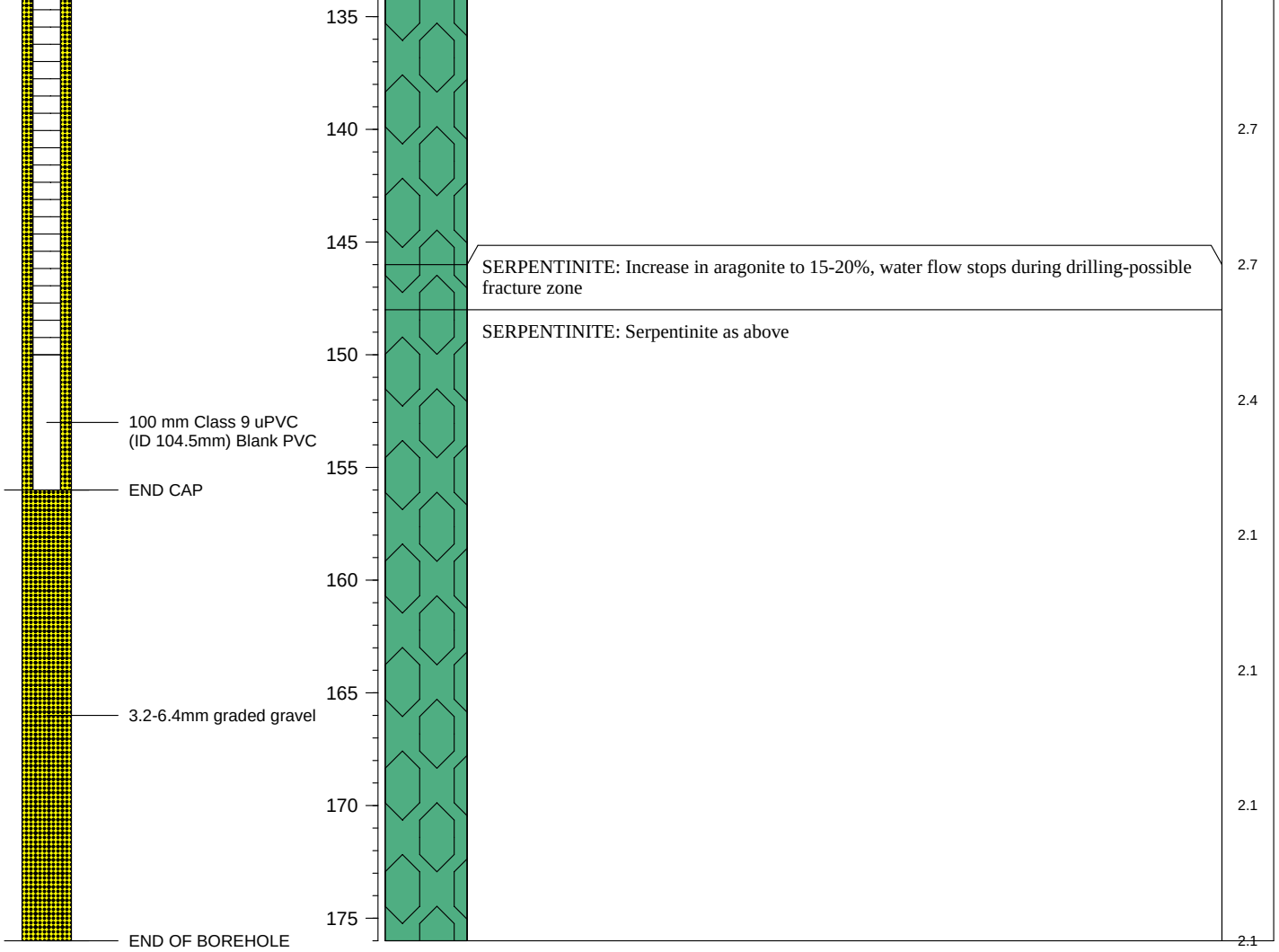
DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Half fine red silt, half angular well weathered serpentinite, chert and calcrete	
	DETRITUS: As above less red silt, more pale green silt from weathered serpentinite	
5	SERPENTINITE: Mostly soft green schist to serpentine silt that surfaces as a thick paste to foam, minor angular chips of weathered serpentinite showing schistose to bladed texture or massive soft siltstone texture, soapy to greasy surfaces and ranging from a dark green to black to a pale olive green, minor orange to brown aragonite and calcrete, trace quartz and chert, all very well weathered	
10	SERPENTINITE: Mostly silt as described above becoming a light, frothy foam only trace to minor chips as above	
	SERPENTINITE: As above, chip percentage increases to 50% and foam becomes more paste like	
15	SERPENTINITE: As above with minor brown clay pods from 14-18m and only trace pods by 20m, chip percentage increases to 80% and brown to orange aragonite and calcrete increases to 20%	
20	SERPENTINITE: Serpentinite as above with large, well graded chips of 10-50mm surfacing, 25% orange to brown carbonates	1.1
	SERPENTINITE: As above with only 5% carbonates and 60% chips, silt content increases, driller notes soft ground at 24m	
25	SERPENTINITE: As above, slightly fewer chips and more silt, slightly less carbonates	1.1
	SERPENTINITE: As above, chip percentage back up to 90% with 20% orange, brown to white carbonates	
30		1.1
35		
		1.7
40	SERPENTINITE: Fresh serpentinite as above, darker green, harder, smaller chips only trace 5% carbonates, trace weathering	
		1.4
45		
	SERPENTINITE: Chip size becomes larger and there is an increase in softer light serpentinite	
50	SERPENTINITE: Weathered serpentinite with most fracture planes showing oxidation, 30-	1.6

Comments:



55	40% orange, brown and white aragonite and minor quartz	
	SERPENTINITE: As above, moderately weathered, 15% carbonates and trace quartz	
	SERPENTINITE: Fresh serpentinite, trace weathering, 15% white to colourless aragonite	1.6
60	SERPENTINITE: As above serpentinite gets darker and carbonates reduced to 5% showing more brown and orange oxidation/ signs of weathering	1.9
65	SERPENTINITE: Serpentinite as above trace-5% aragonite trace oxidation, chips are smaller but increase in size at 70m to 10mm	2.2
70	SERPENTINITE: Serpentinite as above with 20% white to colourless aragonite, trace oxidation	2.2
75	SERPENTINITE: As above, 5% aragonite	2.2
80	SERPENTINITE: Serpentinite as above with 5-10% colourless orange to brown aragonite, oxidation slightly increases with depth to 80m then decreases to trace	2.2
85		2.2
90		2.2
95		2.2
100		2.2
105		2.2
110		2.2
115	SERPENTINITE: Slight increase in aragonite at 116m	2.2
120		2.7
125	SERPENTINITE: Moderate increase in oxidation and orange to brown aragonite at 122-124m with trace larger chips up to 20mm	2.7
130		2.7

Comments:


135
140
145
150
155
160
165
170
175
100 mm Class 9 uPVC
(ID 104.5mm) Blank PVC
END CAP
3.2-6.4mm graded gravel
END OF BOREHOLE
SERPENTINITE: Increase in aragonite to 15-20%, water flow stops during drilling-possible fracture zone
SERPENTINITE: Serpentinite as above
2.7
2.7
2.4
2.1
2.1
2.1
2.1

OBSERVATION WELL BORE LOG

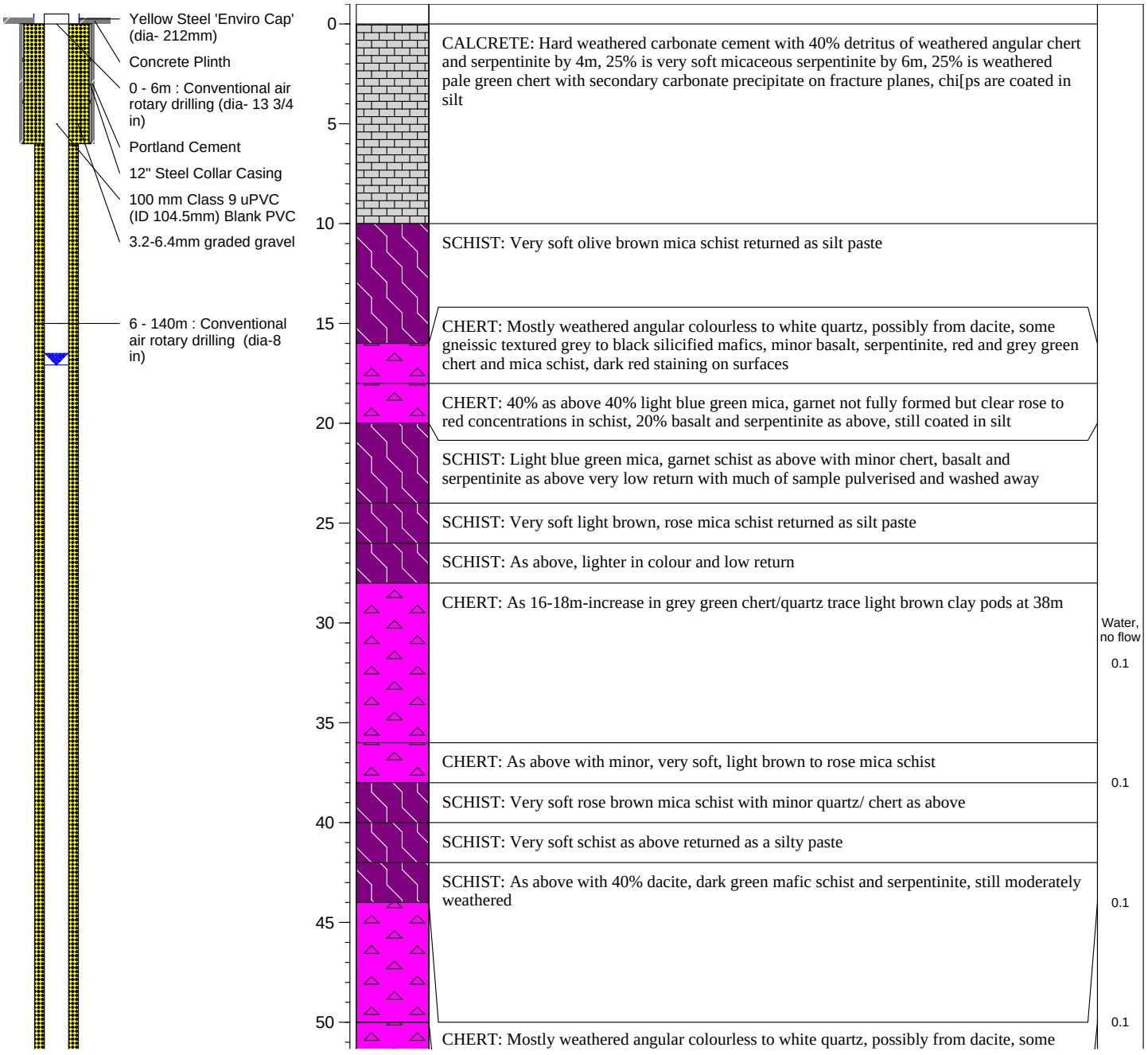
BOREHOLE NUMBER

NS-ObsW03A

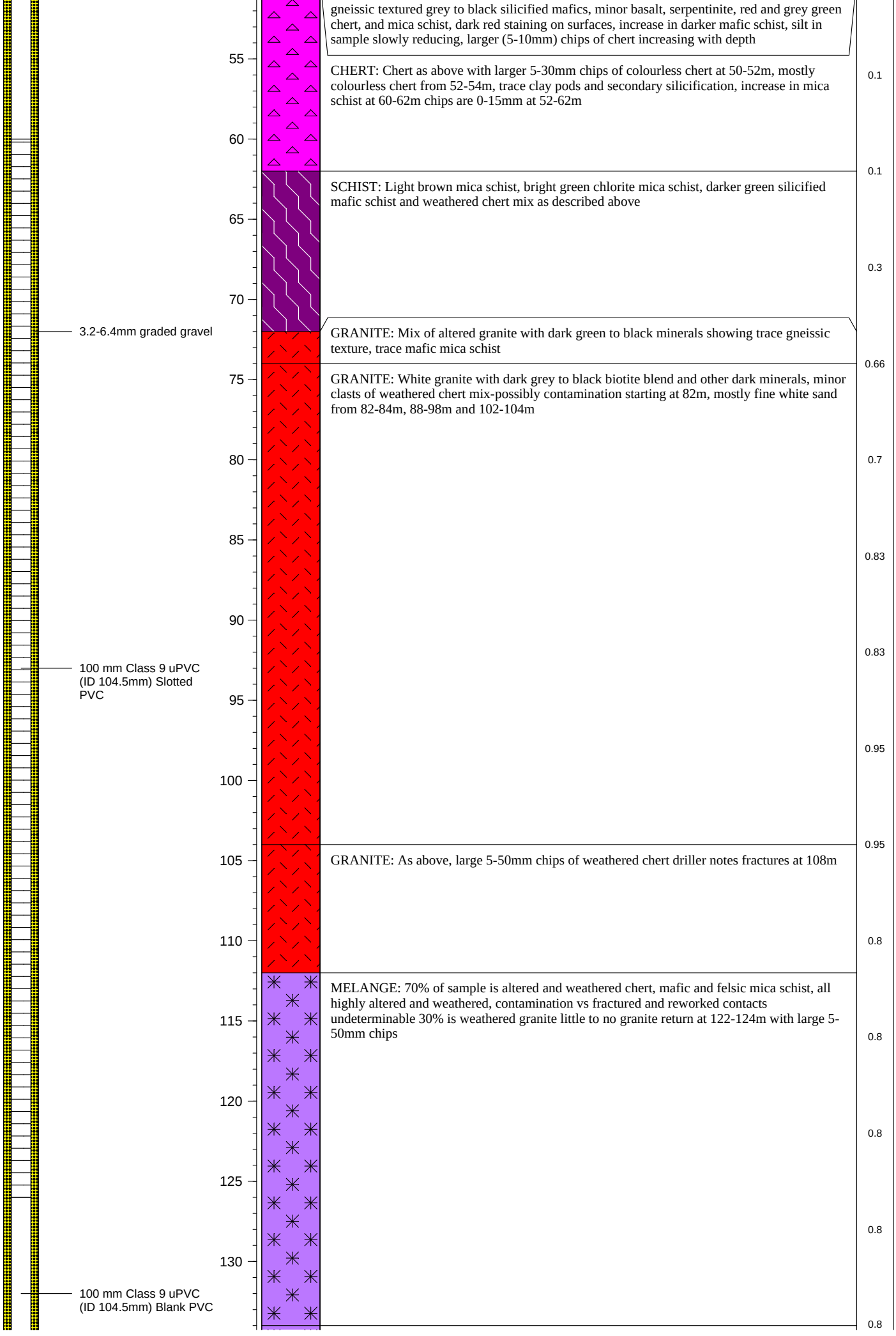
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Western Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**698694.68**
NORTHING (m):	**7649066.40**
MEAS PT ELEVATION (mAHD):	**222.80**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **28/08/2014**	DATE COMPLETED: **31/08/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.666**
Drilled Depth (mbgl):	**140**
Cased Depth (mbgl):	**138**
Casing Stick Up (magl):	**0.551**
Development Airlift Yield (l/s):	**0.5**
Water Level (mbgl) & Date:	**17.08** & **10/04/2015**



Comments:



gneissic textured grey to black silicified mafics, minor basalt, serpentinite, red and grey green chert, and mica schist, dark red staining on surfaces, increase in darker mafic schist, silt in sample slowly reducing, larger (5-10mm) chips of chert increasing with depth

CHERT: Chert as above with larger 5-30mm chips of colourless chert at 50-52m, mostly colourless chert from 52-54m, trace clay pods and secondary silicification, increase in mica schist at 60-62m chips are 0-15mm at 52-62m

SCHIST: Light brown mica schist, bright green chlorite mica schist, darker green silicified mafic schist and weathered chert mix as described above

GRANITE: Mix of altered granite with dark green to black minerals showing trace gneissic texture, trace mafic mica schist

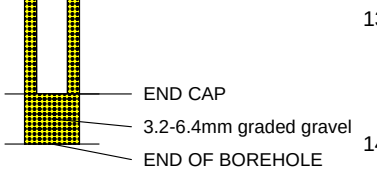
GRANITE: White granite with dark grey to black biotite blend and other dark minerals, minor clasts of weathered chert mix-possibly contamination starting at 82m, mostly fine white sand from 82-84m, 88-98m and 102-104m

GRANITE: As above, large 5-50mm chips of weathered chert driller notes fractures at 108m

MELANGE: 70% of sample is altered and weathered chert, mafic and felsic mica schist, all highly altered and weathered, contamination vs fractured and reworked contacts undeterminable 30% is weathered granite little to no granite return at 122-124m with large 5-50mm chips

0.1
0.1
0.3
0.66
0.7
0.83
0.83
0.95
0.95
0.8
0.8
0.8
0.8
0.8

Comments:



135

140

MELANGE: As above, chips are smaller, mostly medium sand sized with an increase of mica schist, red oxidized ironstone and cement, driller notes red silt in sample from 132-134m

0.8

Comments:

OBSERVATION WELL BORE LOG

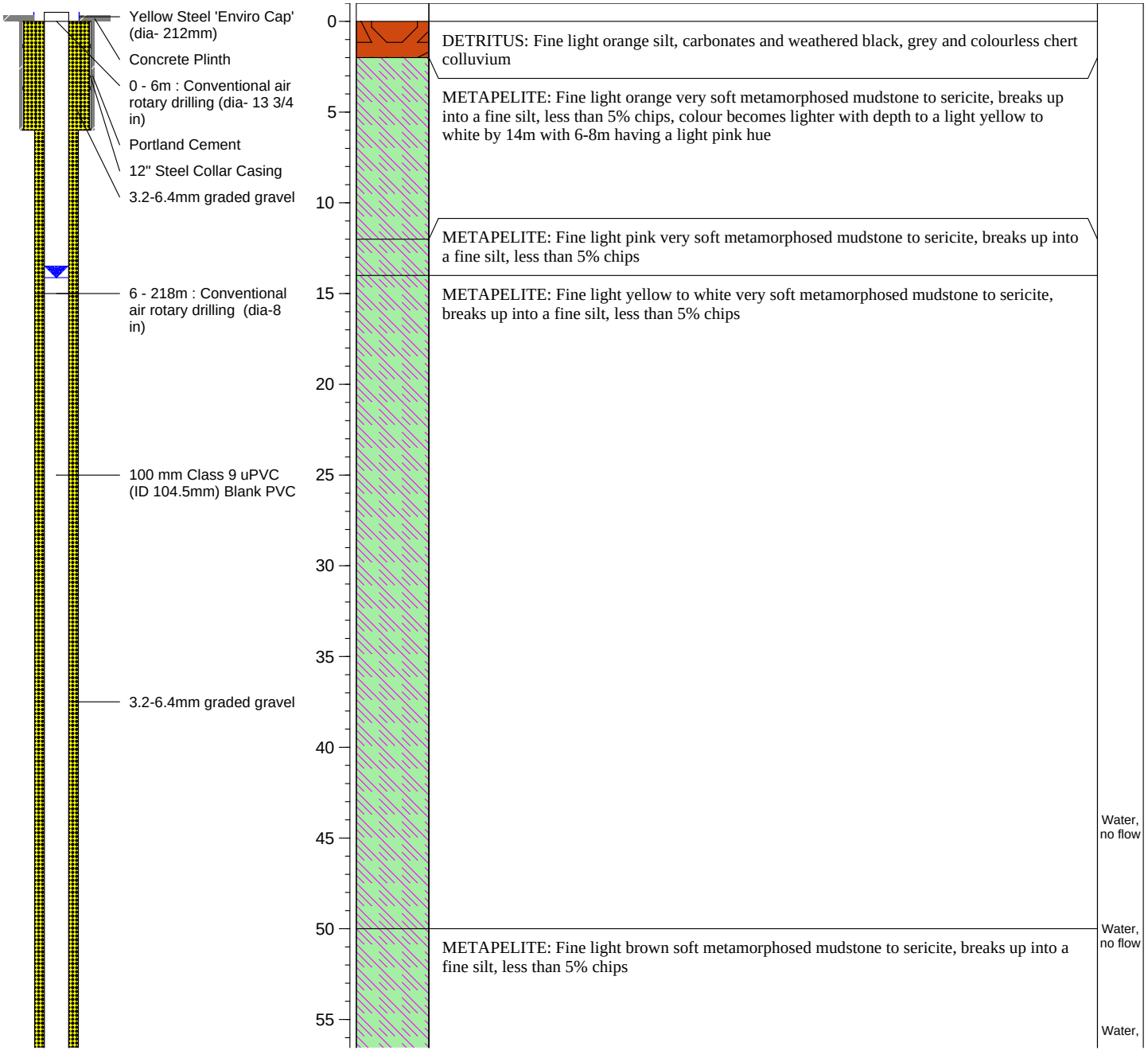
BOREHOLE NUMBER

NS-ObsW03B

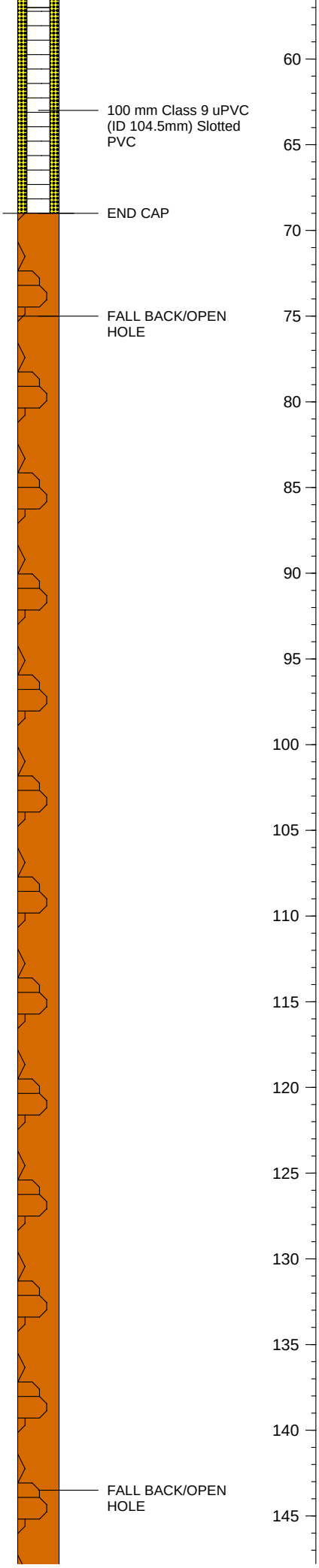
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **700536.41**
NORTHING (m): **7647811.32**
MEAS PT ELEVATION (mAHD): **231.38**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **7/11/2014** DATE COMPLETED: **9/11/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.675**
Drilled Depth (mbgl):	**218**
Cased Depth (mbgl):	**218**
Casing Stick Up (magl):	**0.071**
Development Airlift Yield (l/s):	**0.5**
Water Level (mbgl) & Date:	**14.12** & **10/04/2015**

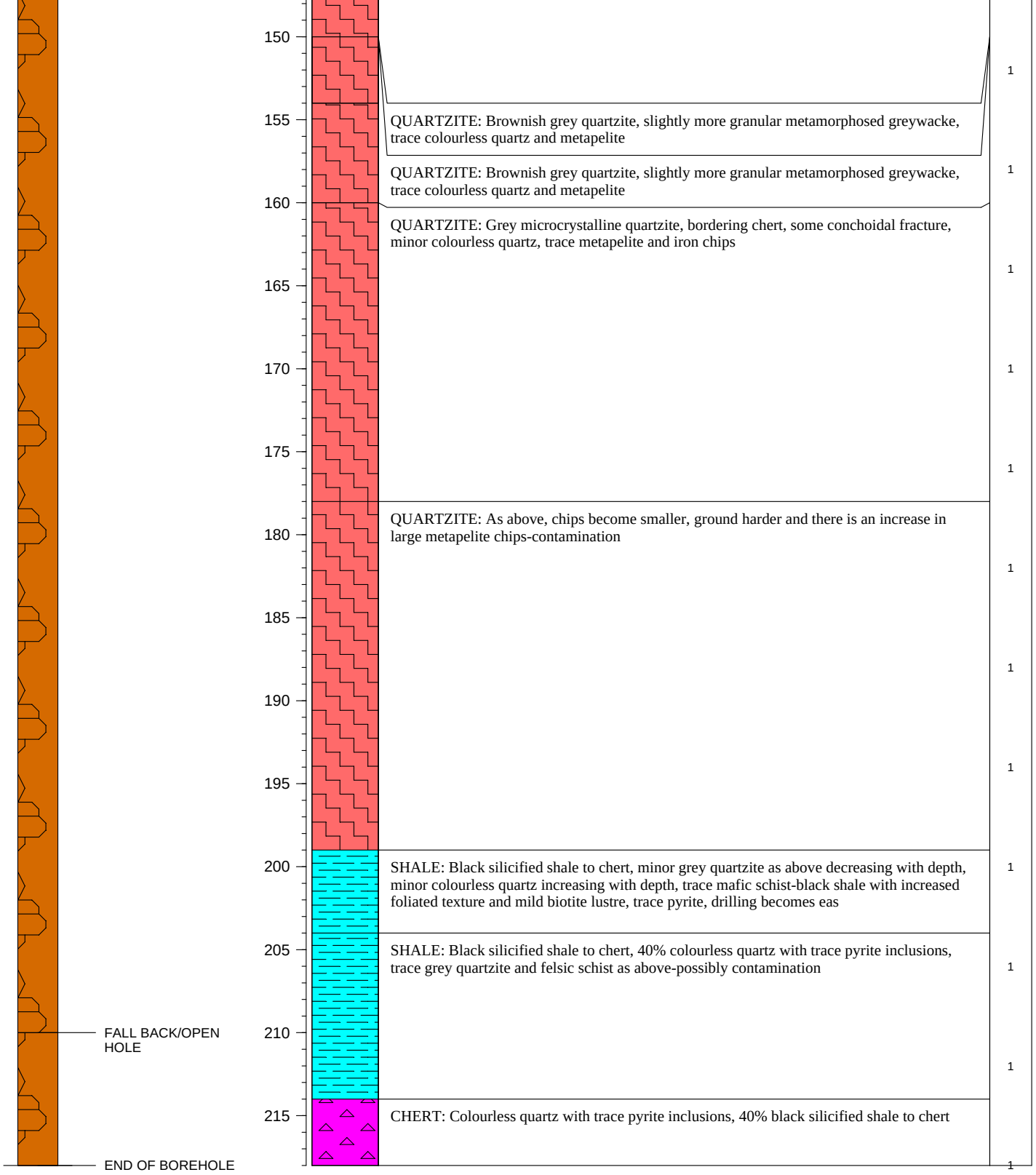


Comments:



60			no flow
65			Water, no flow
70		METAPELITE: Fine pink to purple, light brown to orange and white foliated metamorphosed mudstone to sericite, colourless quartz and minor purple to reddish black friable ironstone and iron cement, sample surfaces as mostly silt however chip percentage increases with	Water, no flow
75		METAPELITE: Light yellowish grey and trace pink to purple foliated to massive, metamorphosed silt to mudstone, minor to trace colourless quartz and trace purple to reddish black friable ironstone and iron cement	1
80			1
85			1
90			1
95		METAPELITE: Metamorphosed mudstone to sericite, as above, becoming more silicified, increasing colourless quartz chips with depth	1
100		METAPELITE: Mostly colourless quartz with minor metapelite and sericite as above	1
105		METAPELITE: Light grey metapelite, silicified and becoming harder and more quartz rich with depth, trace quartz and chert	1
110			1
115			1
120			1
125			1
130		SANDSTONE/WACKE: Light grey silicified, metamorphosed, greywacke, mostly fine grained, nearly quartzite, minor schist as above	1
135		QUARTZITE: Brownish grey quartzite, fine grained, metamorphosed greywacke, trace colourless quartz, chips are larger, mostly 5-30mm, trace pyrite, minor large chips of schist-contamination	1
140			1
145		QUARTZITE: Greenish quartzite as above, trace colourless quartz, trace pyrite, increase in colourless quarts at 148-150m, increase in schist chips at 152-154m,	1

Comments:



QUARTZITE: Brownish grey quartzite, slightly more granular metamorphosed greywacke, trace colourless quartz and metapelite

QUARTZITE: Brownish grey quartzite, slightly more granular metamorphosed greywacke, trace colourless quartz and metapelite

QUARTZITE: Grey microcrystalline quartzite, bordering chert, some conchoidal fracture, minor colourless quartz, trace metapelite and iron chips

QUARTZITE: As above, chips become smaller, ground harder and there is an increase in large metapelite chips-contamination

SHALE: Black silicified shale to chert, minor grey quartzite as above decreasing with depth, minor colourless quartz increasing with depth, trace mafic schist-black shale with increased foliated texture and mild biotite lustre, trace pyrite, drilling becomes eas

SHALE: Black silicified shale to chert, 40% colourless quartz with trace pyrite inclusions, trace grey quartzite and felsic schist as above-possibly contamination

CHERT: Colourless quartz with trace pyrite inclusions, 40% black silicified shale to chert

Comments:

OBSERVATION WELL BORE LOG

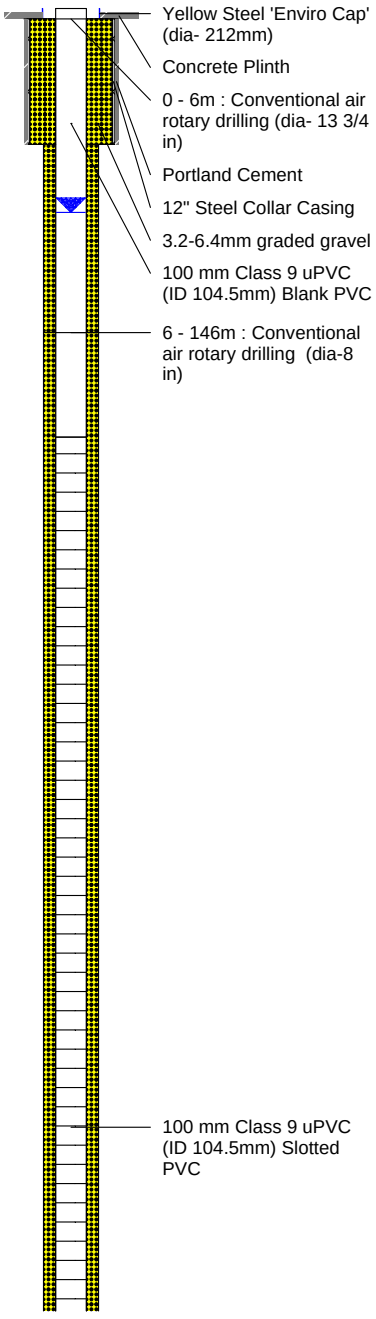
BOREHOLE NUMBER

NS-ObsW04

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

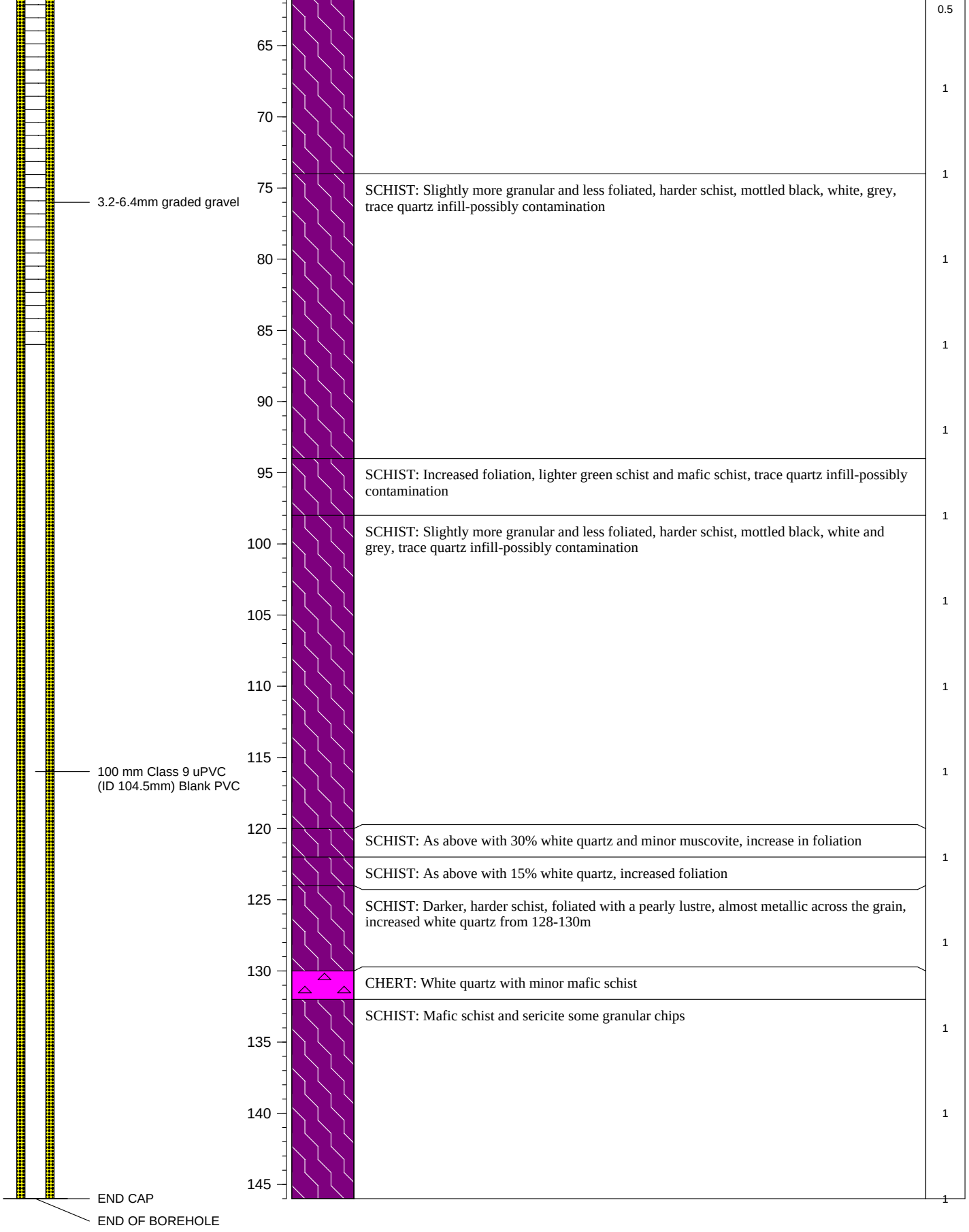
PROJECT NAME:	**North Star Stage 1**
LOCATION:	**Western Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**697321.51**
NORTHING (m):	**7649468.50**
MEAS PT ELEVATION (mAHD):	**204.45**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **3/09/2014**	DATE COMPLETED: **5/09/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.719**
Drilled Depth (mbgl):	**146**
Cased Depth (mbgl):	**146**
Casing Stick Up (magl):	**0.482**
Development Airlift Yield (l/s):	**0.75**
Water Level (mbgl) & Date:	**9.25** & **10/04/2015**



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		CALCRETE: Weathered calcrete and detritus of mica schist and quartz	
5		DETRITUS: Weathered calcrete, red silt, pisolitic and friable iron, mica schist, quartz and sericite	
		DETRITUS: As above less iron and more mafic schist	
10		SCHIST: Mildly weathered mafic schist	
15			
20		SCHIST: Mafic schist and green schist, serpentinite increasing with depth	
25		CHERT: Silicified, fine grained to microcrystalline mafics to glassy and transparent chert trace banding, uneven to conchoidal fracture, minor to trace serpentinite-possibly contamination, trace pyrite	0.25
30		SCHIST: Mafic schist with minor marbled aragonite and quartz, trace pyrite and increasing dark grey chert	0.25
35		CHERT: Chert with minor mafic schist as above	
		SCHIST: Mafic schist as above with minor dark grey chert	0.25
40		SCHIST: Lighter, softer grey green mica schist/ chlorite schist becoming more granular and less foliated at 42m	
45		SCHIST: Slightly more granular and less foliated, harder schist, mottled black, white, grey	0.5
50			0.5
55			0.5
60		SCHIST: Darker, harder schist, foliated with a pearly lustre, almost metallic across the grain	

Comments:


65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
3.2-6.4mm graded gravel
100 mm Class 9 uPVC
(ID 104.5mm) Blank PVC
END CAP
END OF BOREHOLE
SCHIST: Slightly more granular and less foliated, harder schist, mottled black, white, grey, trace quartz infill-possibly contamination
SCHIST: Increased foliation, lighter green schist and mafic schist, trace quartz infill-possibly contamination
SCHIST: Slightly more granular and less foliated, harder schist, mottled black, white and grey, trace quartz infill-possibly contamination
SCHIST: As above with 30% white quartz and minor muscovite, increase in foliation
SCHIST: As above with 15% white quartz, increased foliation
SCHIST: Darker, harder schist, foliated with a pearly lustre, almost metallic across the grain, increased white quartz from 128-130m
CHERT: White quartz with minor mafic schist
SCHIST: Mafic schist and sericite some granular chips
0.5
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1

Comments:

OBSERVATION WELL BORE LOG

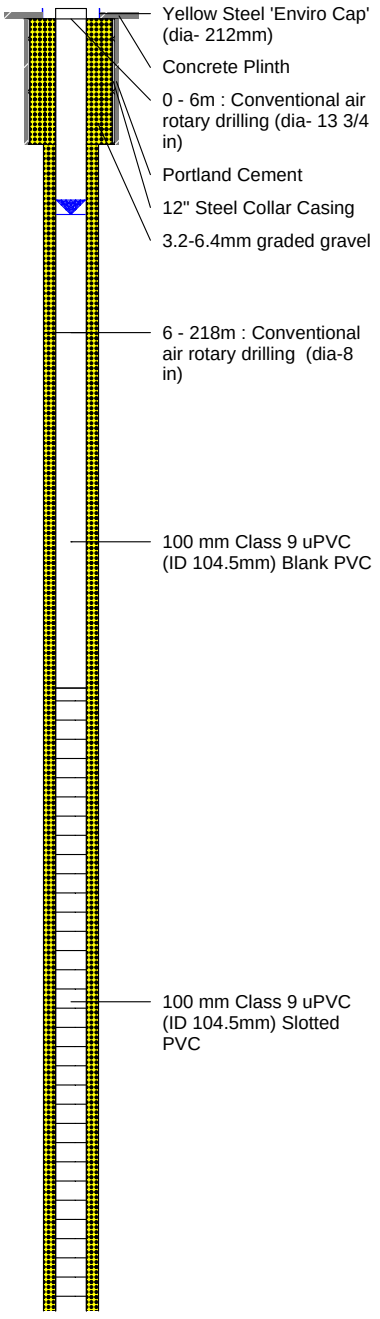
BOREHOLE NUMBER

NS-ObsW04A

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

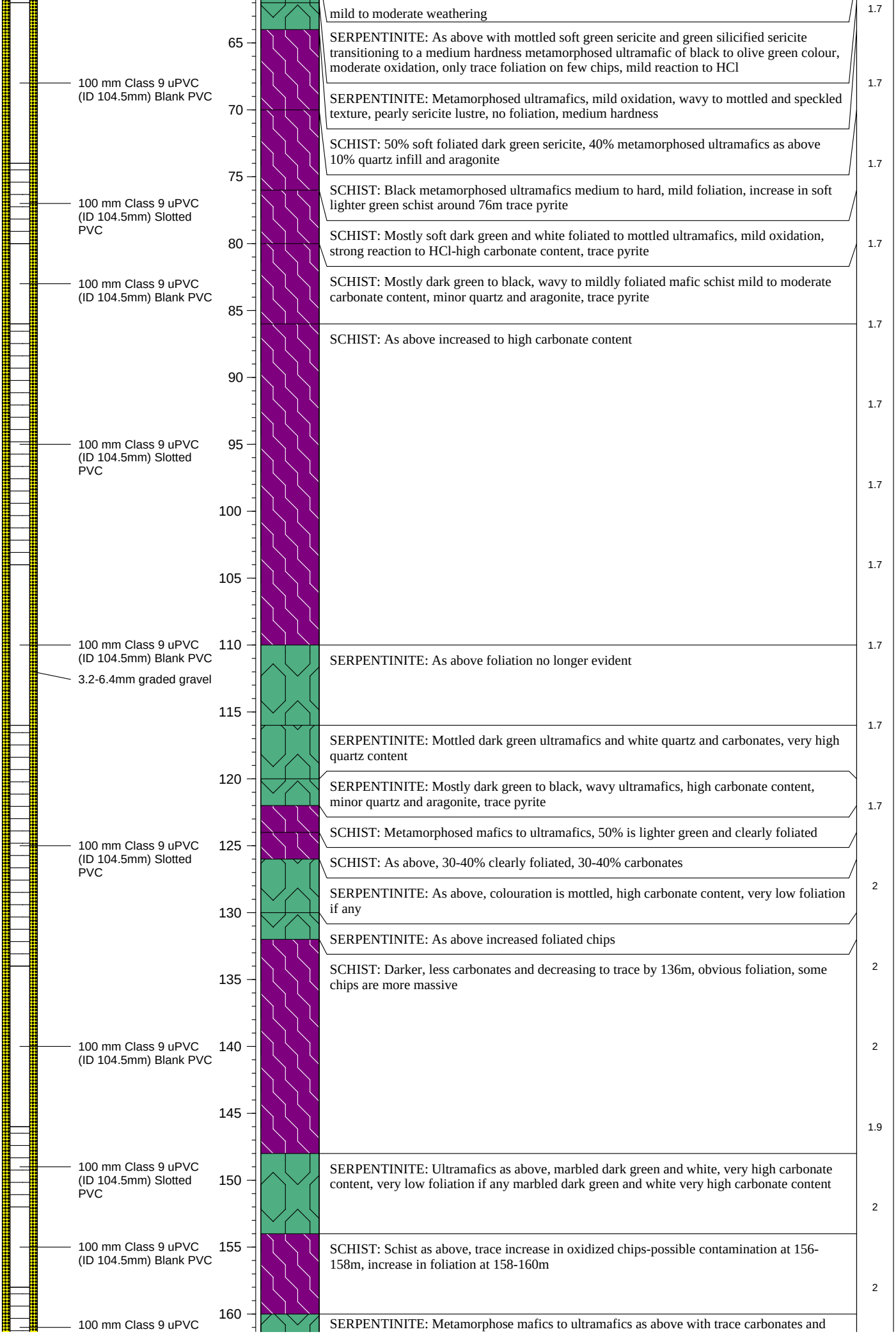
PROJECT NAME: **North Star Stage 1**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **697519.79**
NORTHING (m): **7649422.93**
MEAS PT ELEVATION (mAHD): **205.99**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **11/09/2014** DATE COMPLETED: **14/09/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.647**
Drilled Depth (mbgl):	**218**
Cased Depth (mbgl):	**218**
Casing Stick Up (magl):	**0.355**
Development Airlift Yield (l/s):	**3**
Water Level (mbgl) & Date:	**9.35** & **10/04/2015**

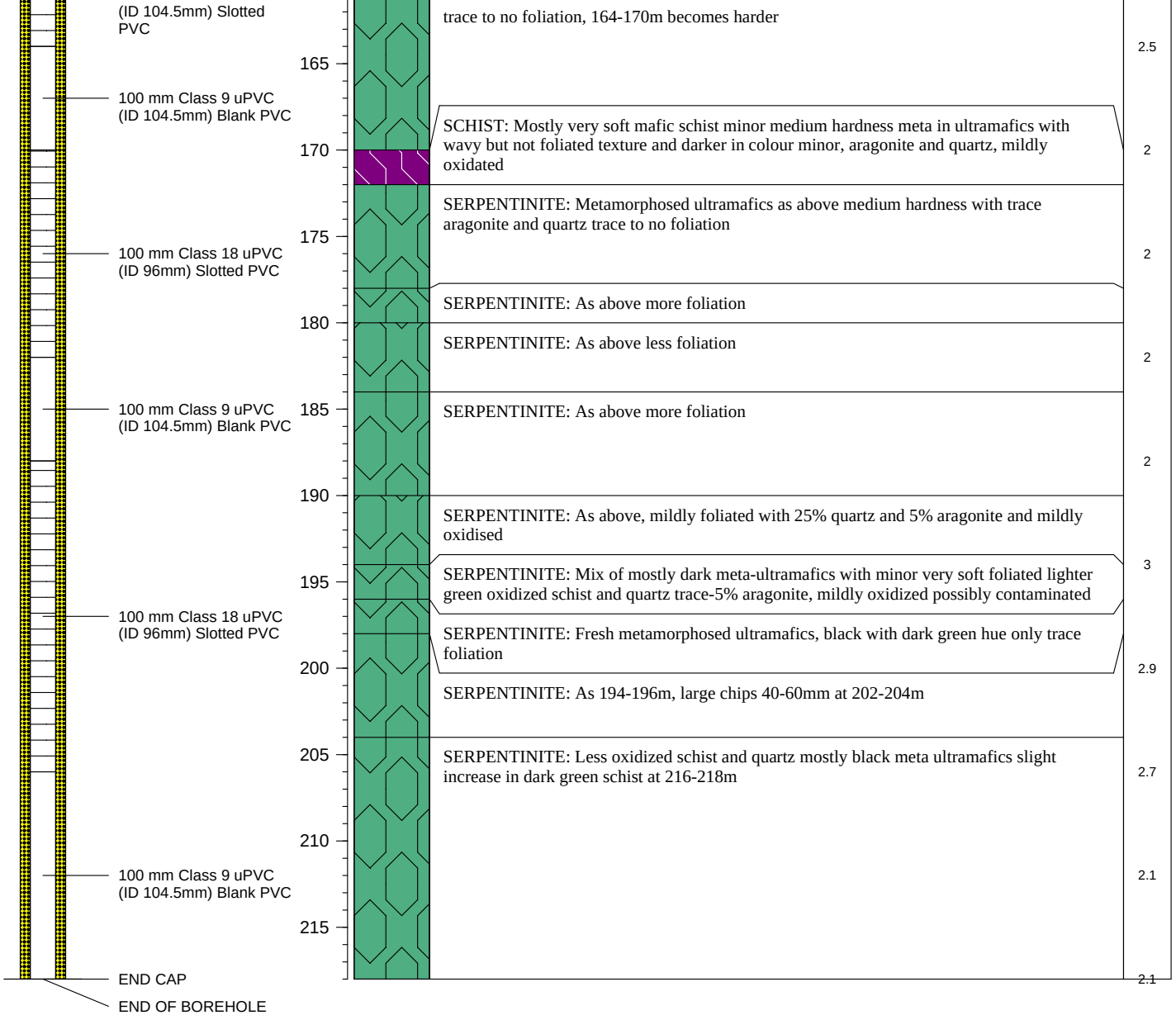


DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0		DETRITUS: Mostly red silt with 40% white to brown quartz and silicified sericite in foliated and angular chips	
5		CHERT: Angular quartz and foliated and silicified sericite, metamorphosed, weathered	
		SHALE: Mostly weathered angular, silicified black shale, minor quartz and sericite as above, banded in the shale, more quartz and sericite than black shale from 6-8m, more black shale from 8-10,	
10		METAPELITE: Mostly white to pale yellow and brown sericite banded with quartz and pulverised to a fine silt, trace black shale	
15		METAPELITE: As above slightly darker in colour and an increasing in black shale with depth, trace pale green silicified sericite	
		METAPELITE: As above, pale green and brown silicified sericite dominates interval, bedded to banded with pale quartz and black silicified shale	1
20			
25		METAPELITE: As above, pale green, pale brown and grey sericite and pale quartz, trace red to orange stained quartz and ironstone	1
30		METAPELITE: Soft white to dark grey sericite not silicified as above and pulverised to a clay minor colourless to white angular quartz	1
		METAPELITE: As above, strong oxidation/ weathering	
35		METAPELITE: As above, moderate oxidation and decreasing with depth, driller notes fractures at 36m, quartz content also decreasing with depth	1
40			
45			1
50			1.7
55		CHERT: 60% Colourless to white quartz with black inclusions and 40% grey sericite as above, trace oxidation	
		METAPELITE: Pale green to dark grey silicified sericite, trace orange stained oxidized quartz, driller notes fractures at 58m	1.7
60		METAPELITE: 60% dark grey, hard, silicified sericite to basalt, metamorphosed, 20% grey green soft mottled sericite, 10% green silicified sericite, 10% orange stained oxidised quartz	

Comments:


mild to moderate weathering
1.7
SERPENTINITE: As above with mottled soft green sericite and green silicified sericite transitioning to a medium hardness metamorphosed ultramafic of black to olive green colour, moderate oxidation, only trace foliation on few chips, mild reaction to HCl
1.7
SERPENTINITE: Metamorphosed ultramafics, mild oxidation, wavy to mottled and speckled texture, pearly sericite lustre, no foliation, medium hardness
SCHIST: 50% soft foliated dark green sericite, 40% metamorphosed ultramafics as above 10% quartz infill and aragonite
1.7
SCHIST: Black metamorphosed ultramafics medium to hard, mild foliation, increase in soft lighter green schist around 76m trace pyrite
SCHIST: Mostly soft dark green and white foliated to mottled ultramafics, mild oxidation, strong reaction to HCl-high carbonate content, trace pyrite
1.7
SCHIST: Mostly dark green to black, wavy to mildly foliated mafic schist mild to moderate carbonate content, minor quartz and aragonite, trace pyrite
SCHIST: As above increased to high carbonate content
1.7
1.7
1.7
1.7
SERPENTINITE: As above foliation no longer evident
1.7
SERPENTINITE: Mottled dark green ultramafics and white quartz and carbonates, very high quartz content
SERPENTINITE: Mostly dark green to black, wavy ultramafics, high carbonate content, minor quartz and aragonite, trace pyrite
1.7
SCHIST: Metamorphosed mafics to ultramafics, 50% is lighter green and clearly foliated
SCHIST: As above, 30-40% clearly foliated, 30-40% carbonates
SERPENTINITE: As above, colouration is mottled, high carbonate content, very low foliation if any
2
SERPENTINITE: As above increased foliated chips
SCHIST: Darker, less carbonates and decreasing to trace by 136m, obvious foliation, some chips are more massive
2
2
1.9
SERPENTINITE: Ultramafics as above, marbled dark green and white, very high carbonate content, very low foliation if any marbled dark green and white very high carbonate content
2
SCHIST: Schist as above, trace increase in oxidized chips-possible contamination at 156-158m, increase in foliation at 158-160m
2
SERPENTINITE: Metamorphose mafics to ultramafics as above with trace carbonates and
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
100 mm Class 9 uPVC (ID 104.5mm) Slotted PVC
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
100 mm Class 9 uPVC (ID 104.5mm) Slotted PVC
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
3.2-6.4mm graded gravel
100 mm Class 9 uPVC (ID 104.5mm) Slotted PVC
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
100 mm Class 9 uPVC (ID 104.5mm) Slotted PVC
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
100 mm Class 9 uPVC

Comments:


(ID 104.5mm) Slotted PVC
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
100 mm Class 18 uPVC (ID 96mm) Slotted PVC
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
100 mm Class 18 uPVC (ID 96mm) Slotted PVC
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
END CAP
END OF BOREHOLE
165
170
175
180
185
190
195
200
205
210
215
trace to no foliation, 164-170m becomes harder
SCHIST: Mostly very soft mafic schist minor medium hardness meta in ultramafics with wavy but not foliated texture and darker in colour minor, aragonite and quartz, mildly oxidated
SERPENTINITE: Metamorphosed ultramafics as above medium hardness with trace aragonite and quartz trace to no foliation
SERPENTINITE: As above more foliation
SERPENTINITE: As above less foliation
SERPENTINITE: As above more foliation
SERPENTINITE: As above, mildly foliated with 25% quartz and 5% aragonite and mildly oxidised
SERPENTINITE: Mix of mostly dark meta-ultramafics with minor very soft foliated lighter green oxidized schist and quartz trace-5% aragonite, mildly oxidized possibly contaminated
SERPENTINITE: Fresh metamorphosed ultramafics, black with dark green hue only trace foliation
SERPENTINITE: As 194-196m, large chips 40-60mm at 202-204m
SERPENTINITE: Less oxidized schist and quartz mostly black meta ultramafics slight increase in dark green schist at 216-218m
2.5
2
2
2
2
2
3
2.9
2.7
2.1
2.1

Comments:

OBSERVATION WELL BORE LOG

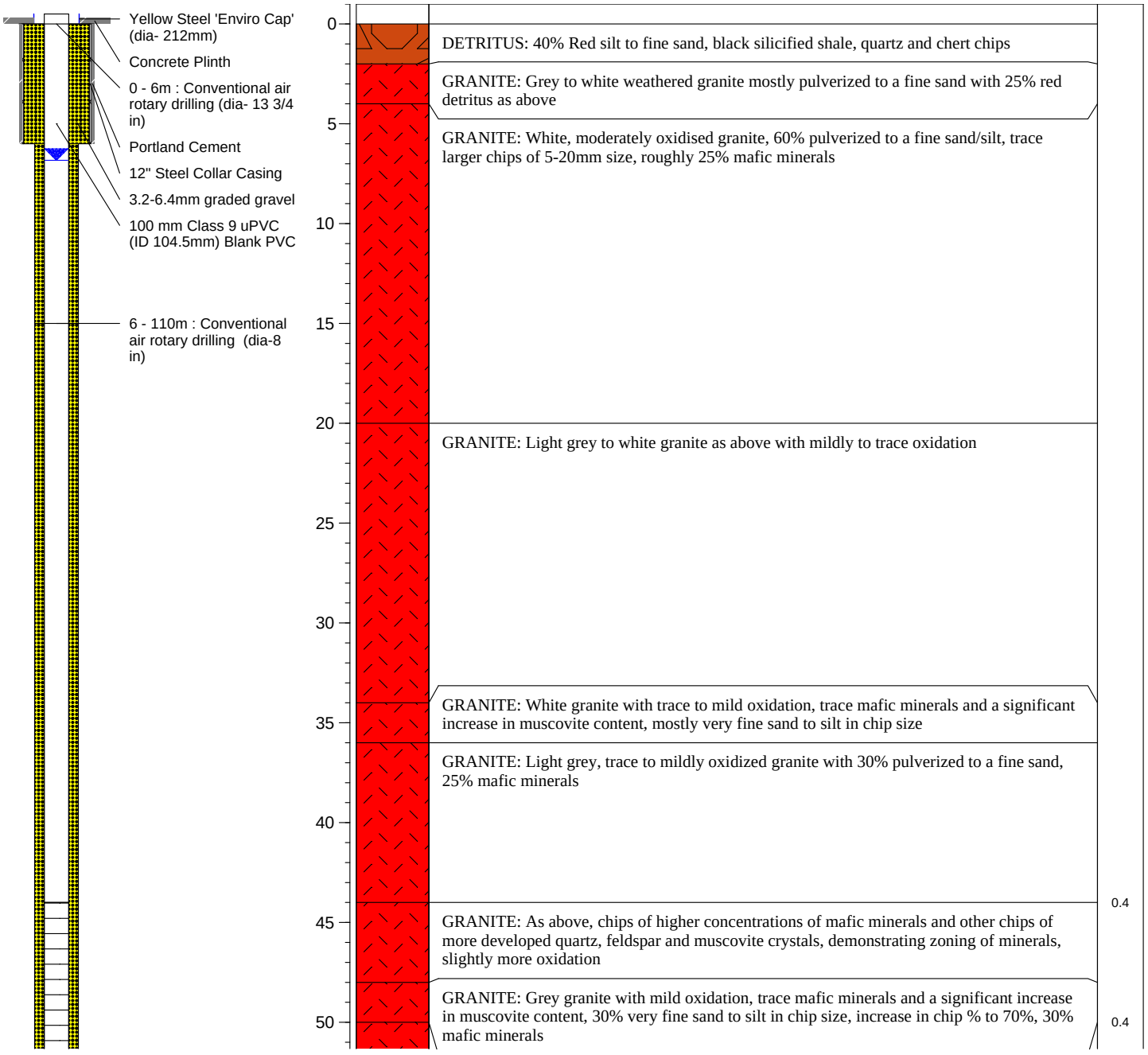
BOREHOLE NUMBER

NS-ObsW04B

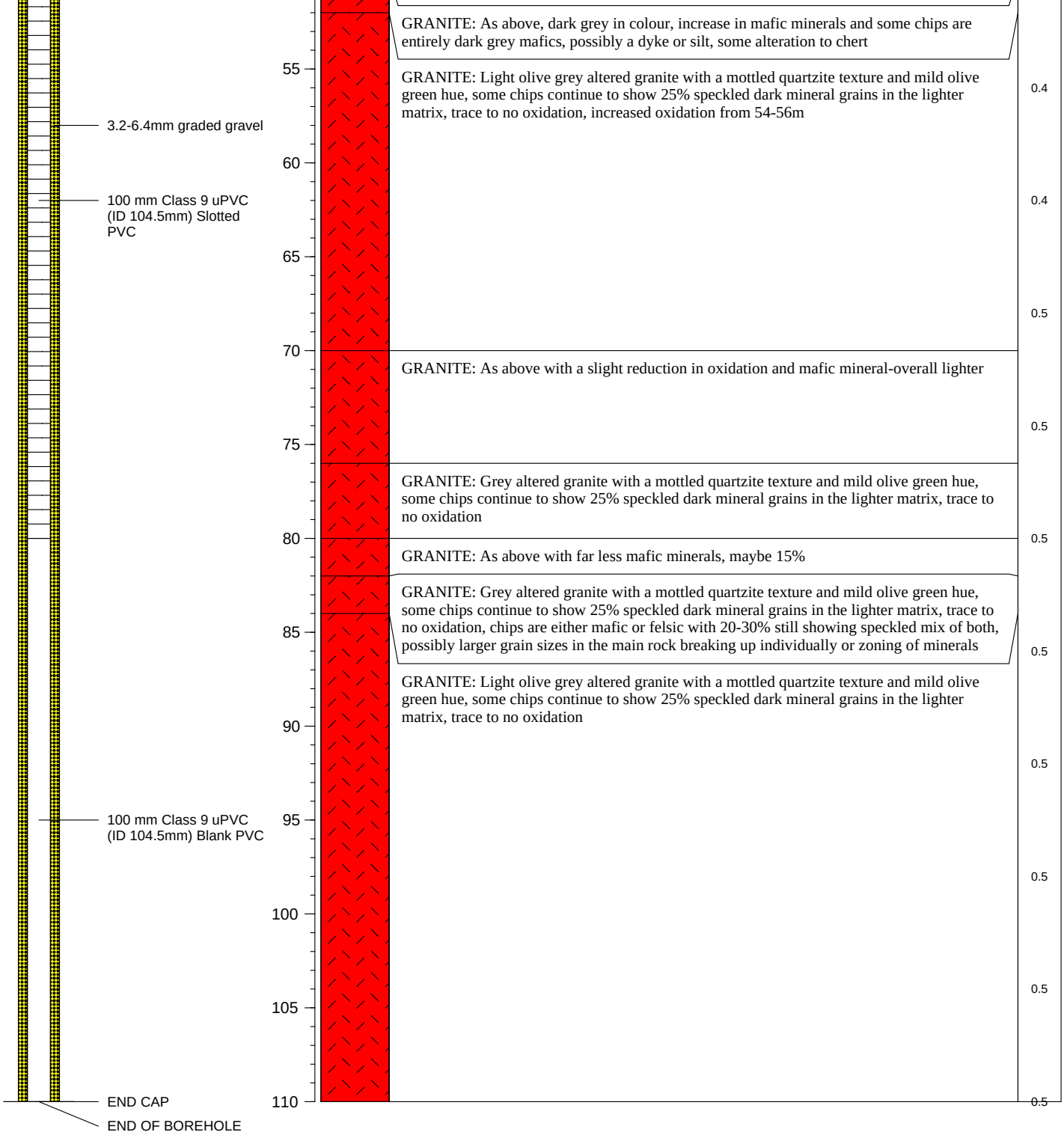
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 1**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **696929.73**
NORTHING (m): **7649727.33**
MEAS PT ELEVATION (mAHD): **201.90**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **9/09/2014** DATE COMPLETED: **11/09/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.642**
Drilled Depth (mbgl):	**110**
Cased Depth (mbgl):	**110**
Casing Stick Up (magl):	**0.065**
Development Airlift Yield (l/s):	**0.05**
Water Level (mbgl) & Date:	**6.83** & **10/04/2015**



Comments:


3.2-6.4mm graded gravel
100 mm Class 9 uPVC (ID 104.5mm) Slotted PVC
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
END CAP
END OF BOREHOLE
55
60
65
70
75
80
85
90
95
100
105
110
GRANITE: As above, dark grey in colour, increase in mafic minerals and some chips are entirely dark grey mafics, possibly a dyke or silt, some alteration to chert
GRANITE: Light olive grey altered granite with a mottled quartzite texture and mild olive green hue, some chips continue to show 25% speckled dark mineral grains in the lighter matrix, trace to no oxidation, increased oxidation from 54-56m
GRANITE: As above with a slight reduction in oxidation and mafic mineral-overall lighter
GRANITE: Grey altered granite with a mottled quartzite texture and mild olive green hue, some chips continue to show 25% speckled dark mineral grains in the lighter matrix, trace to no oxidation
GRANITE: As above with far less mafic minerals, maybe 15%
GRANITE: Grey altered granite with a mottled quartzite texture and mild olive green hue, some chips continue to show 25% speckled dark mineral grains in the lighter matrix, trace to no oxidation, chips are either mafic or felsic with 20-30% still showing speckled mix of both, possibly larger grain sizes in the main rock breaking up individually or zoning of minerals
GRANITE: Light olive grey altered granite with a mottled quartzite texture and mild olive green hue, some chips continue to show 25% speckled dark mineral grains in the lighter matrix, trace to no oxidation
0.4
0.4
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5

Comments:

OBSERVATION WELL BORE LOG

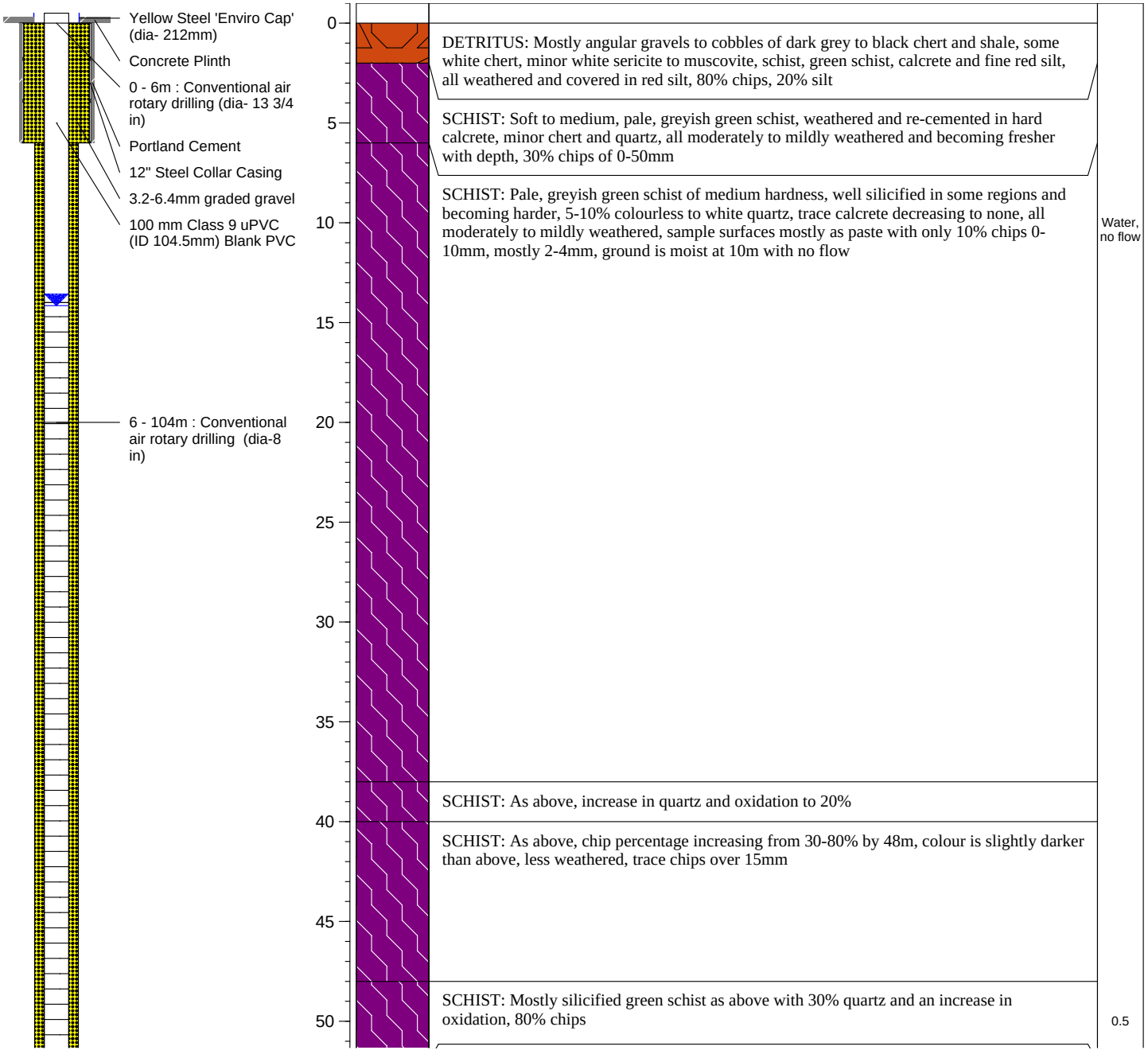
BOREHOLE NUMBER

NS-ObsW07

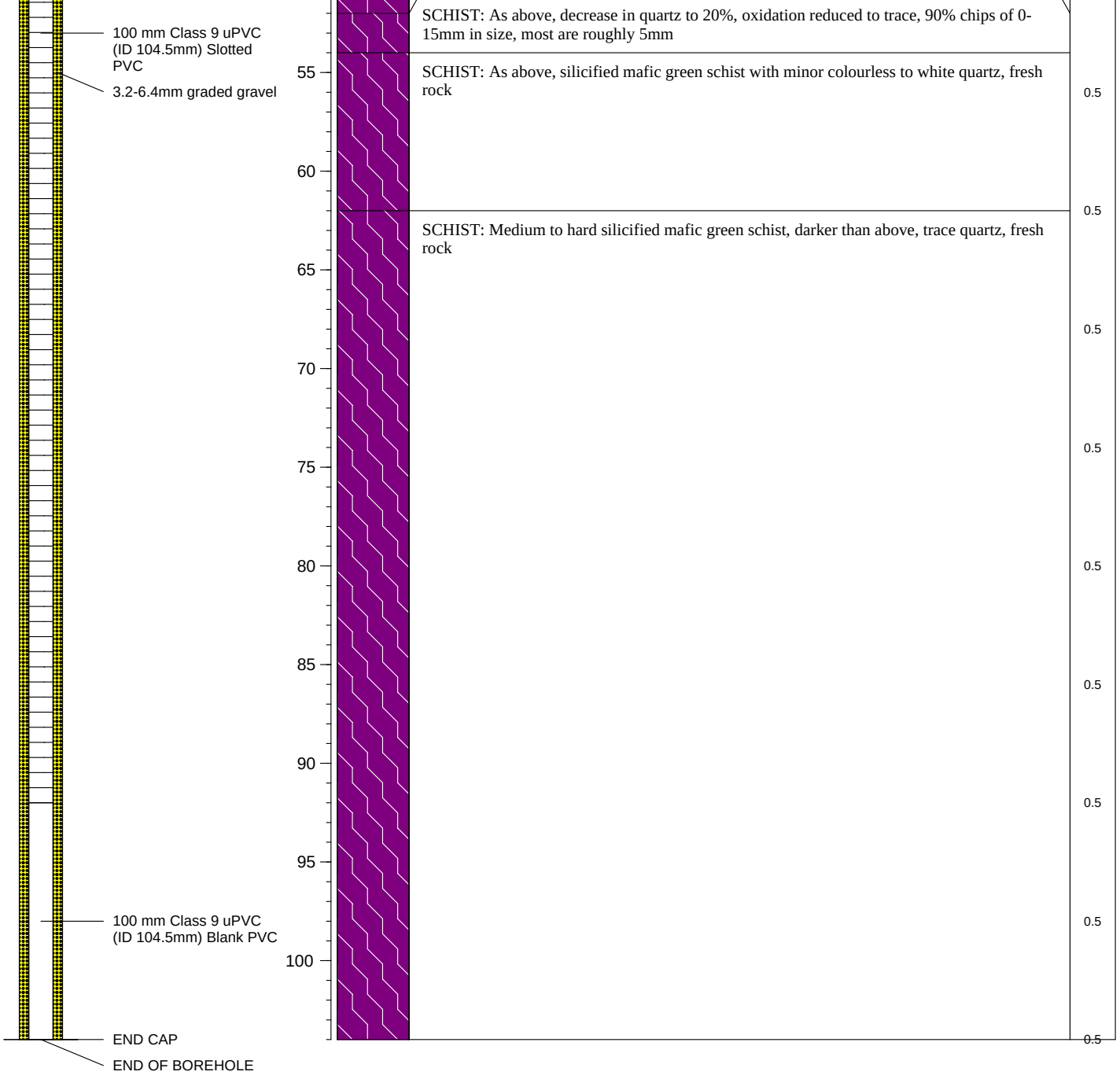
Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**North Star Stage 2**
LOCATION:	**Western Borefield FMG- North Star Site**
DRILLING CO:	**Easternwell**
DRILLING METHOD:	**Conventional air rotary drilling**
LOGGED BY:	**Marisa Mochizuki**
EASTING (m):	**699708.76**
NORTHING (m):	**7648850.97**
MEAS PT ELEVATION (mAHD):	**225.22**
DRILLING DIAMETER(S) (mm):	**203**
DATE BEGUN: **13/10/2014**	DATE COMPLETED: **15/10/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.652**
Drilled Depth (mbgl):	**104**
Cased Depth (mbgl):	**104**
Casing Stick Up (magl):	**0.548**
Development Airlift Yield (l/s):	**0.05**
Water Level (mbgl) & Date:	**14.15** & **10/04/2015**



Comments:


100 mm Class 9 uPVC (ID 104.5mm) Slotted PVC
3.2-6.4mm graded gravel
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
END CAP
END OF BOREHOLE
55
60
65
70
75
80
85
90
95
100
SCHIST: As above, decrease in quartz to 20%, oxidation reduced to trace, 90% chips of 0-15mm in size, most are roughly 5mm
SCHIST: As above, silicified mafic green schist with minor colourless to white quartz, fresh rock
SCHIST: Medium to hard silicified mafic green schist, darker than above, trace quartz, fresh rock
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5

Comments:

OBSERVATION WELL BORE LOG

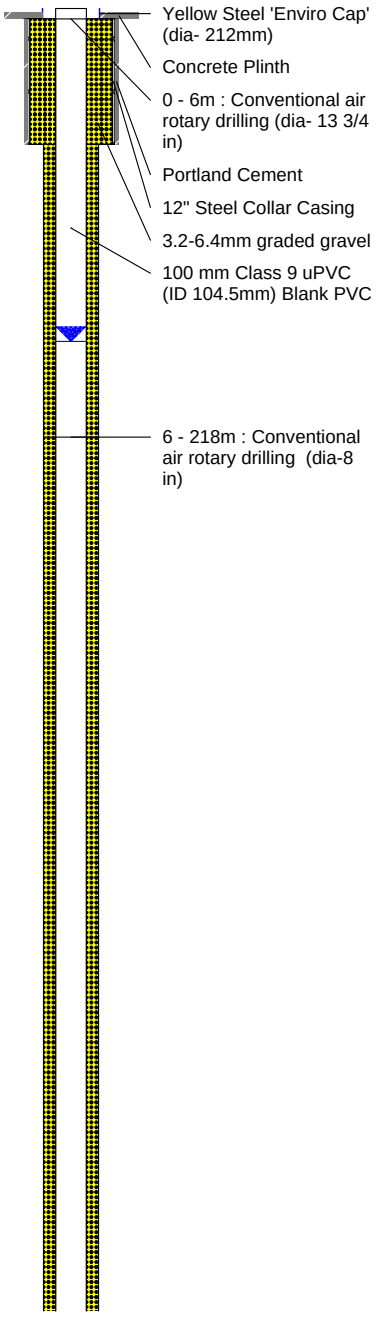
BOREHOLE NUMBER

NS-ObsW09

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

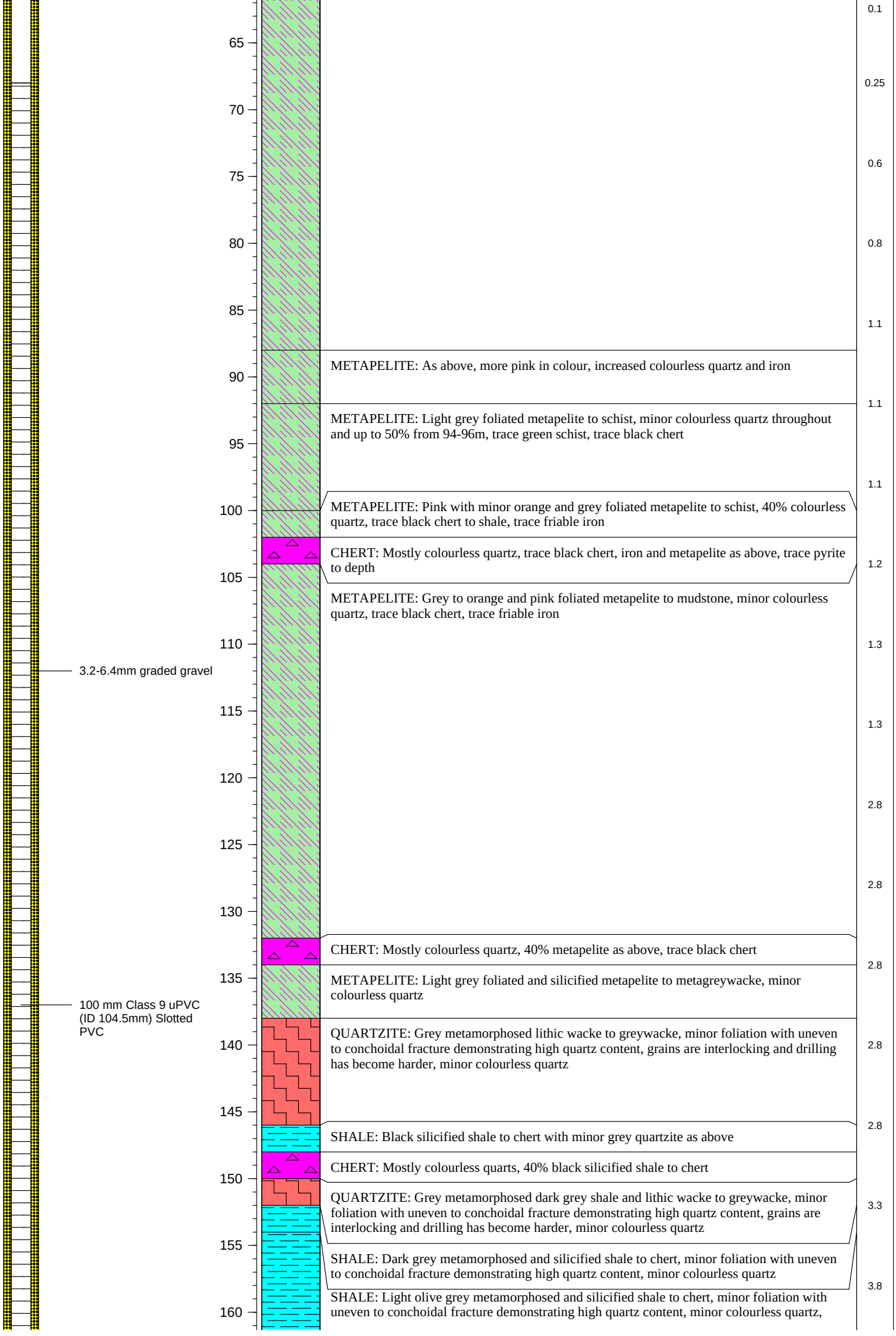
PROJECT NAME: **North Star Stage 2**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **700279.24**
NORTHING (m): **7648237.62**
MEAS PT ELEVATION (mAHD): **232.43**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **15/11/2014** DATE COMPLETED: **18/11/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.686**
Drilled Depth (mbgl):	**218**
Cased Depth (mbgl):	**218**
Casing Stick Up (magl):	**0.249**
Development Airlift Yield (l/s):	**2**
Water Level (mbgl) & Date:	**15.42** & **10/04/2015**



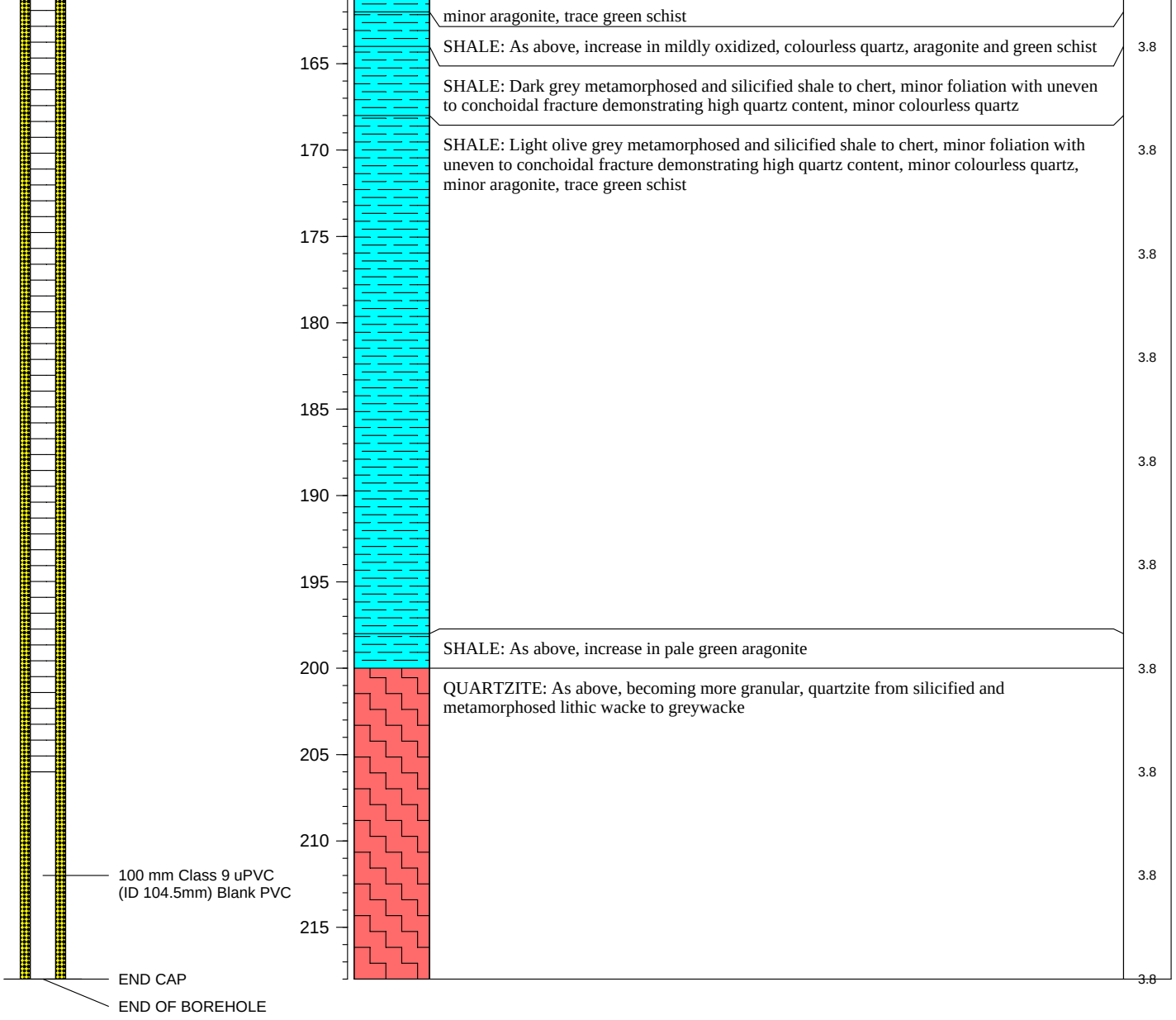
DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
0			
		METAPELITE: White, light yellow and light orange metamorphosed talc to silt, foliated schist texture and very soft, few chips with most of the sample as slit	
5			
		METAPELITE: Even mix of reddish orange and yellow foliated mudstone to schist, slightly harder than above with 30-50% surfacing as chips, 25% black chert to silicified and metamorphosed shale with mild foliation and trace conchoidal fracture, minor friable iron and iron cement, reddish colour reduces with depth becoming lighter yellow	
10			
		METAPELITE: As above, the colour is pale orange, yellow to white, there is an increase of black to grey chert to shale and colourless quartz to 40%	
15			
		METAPELITE: Yellowish white foliated metapelite to schist, no black chert to shale, trace colourless quartz	
20			
		METAPELITE: Even mix of reddish orange and yellow foliated metapelite to schist, 25% black chert to shale, minor friable iron and iron cement	
25			
		METAPELITE: Yellowish white with trace pink foliated metapelite to schist, no black chert to shale, trace colourless quartz	
30			
		METAPELITE: Pink, orange and yellowish white foliated metapelite to schist, minor colourless quartz, trace black chert to shale increasing to 25% from 38-44m	
35			
40			
		METAPELITE: Yellowish orange with minor white and pink foliated metapelite to schist, trace black chert to shale, minor colourless quartz	
45			
		METAPELITE: Pink with minor orange and yellowish white foliated metapelite to schist, minor colourless quartz, trace black chert to shale	
50			Water, no flow
		METAPELITE: Grey with minor orange and pink foliated metapelite to schist, minor colourless quartz, trace black chert to shale, trace friable iron, ground becoming slightly harder, chip percentage gradually increases from 40% at 50m to 60% at 56m and to 80% at 74m, driller notes fracture at 84m	
55			0.1
60			

Comments:



	0.1
	0.25
	0.6
	0.8
	1.1
METAPELITE: As above, more pink in colour, increased colourless quartz and iron	1.1
METAPELITE: Light grey foliated metapelite to schist, minor colourless quartz throughout and up to 50% from 94-96m, trace green schist, trace black chert	1.1
METAPELITE: Pink with minor orange and grey foliated metapelite to schist, 40% colourless quartz, trace black chert to shale, trace friable iron	
CHERT: Mostly colourless quartz, trace black chert, iron and metapelite as above, trace pyrite to depth	1.2
METAPELITE: Grey to orange and pink foliated metapelite to mudstone, minor colourless quartz, trace black chert, trace friable iron	1.3
	1.3
	2.8
	2.8
CHERT: Mostly colourless quartz, 40% metapelite as above, trace black chert	2.8
METAPELITE: Light grey foliated and silicified metapelite to metagreywacke, minor colourless quartz	
QUARTZITE: Grey metamorphosed lithic wacke to greywacke, minor foliation with uneven to conchoidal fracture demonstrating high quartz content, grains are interlocking and drilling has become harder, minor colourless quartz	2.8
SHALE: Black silicified shale to chert with minor grey quartzite as above	2.8
CHERT: Mostly colourless quarts, 40% black silicified shale to chert	
QUARTZITE: Grey metamorphosed dark grey shale and lithic wacke to greywacke, minor foliation with uneven to conchoidal fracture demonstrating high quartz content, grains are interlocking and drilling has become harder, minor colourless quartz	3.3
SHALE: Dark grey metamorphosed and silicified shale to chert, minor foliation with uneven to conchoidal fracture demonstrating high quartz content, minor colourless quartz	
SHALE: Light olive grey metamorphosed and silicified shale to chert, minor foliation with uneven to conchoidal fracture demonstrating high quartz content, minor colourless quartz,	3.8

Comments:


minor aragonite, trace green schist
SHALE: As above, increase in mildly oxidized, colourless quartz, aragonite and green schist
SHALE: Dark grey metamorphosed and silicified shale to chert, minor foliation with uneven to conchoidal fracture demonstrating high quartz content, minor colourless quartz
SHALE: Light olive grey metamorphosed and silicified shale to chert, minor foliation with uneven to conchoidal fracture demonstrating high quartz content, minor colourless quartz, minor aragonite, trace green schist
SHALE: As above, increase in pale green aragonite
QUARTZITE: As above, becoming more granular, quartzite from silicified and metamorphosed lithic wacke to greywacke
165
170
175
180
185
190
195
200
205
210
215
3.8
100 mm Class 9 uPVC
(ID 104.5mm) Blank PVC
END CAP
END OF BOREHOLE

Comments:

OBSERVATION WELL BORE LOG

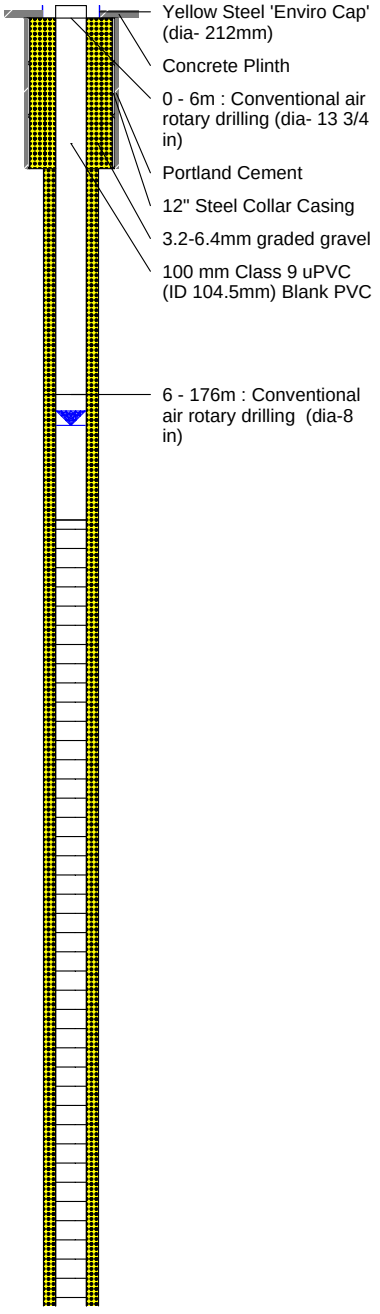
BOREHOLE NUMBER

NS-ObsW10

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

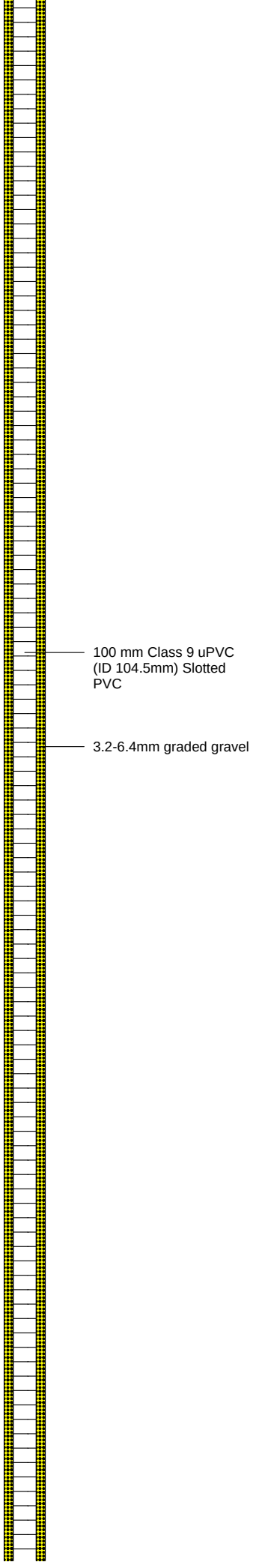
PROJECT NAME: **North Star Stage 2**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **703130.59**
NORTHING (m): **7646764.28**
MEAS PT ELEVATION (mAHD): **234.89**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **31/10/2014** DATE COMPLETED: **2/11/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.688**
Drilled Depth (mbgl):	**176**
Cased Depth (mbgl):	**176**
Casing Stick Up (magl):	**0.61**
Development Airlift Yield (l/s):	**5**
Water Level (mbgl) & Date:	**16.23** & **10/04/2015**



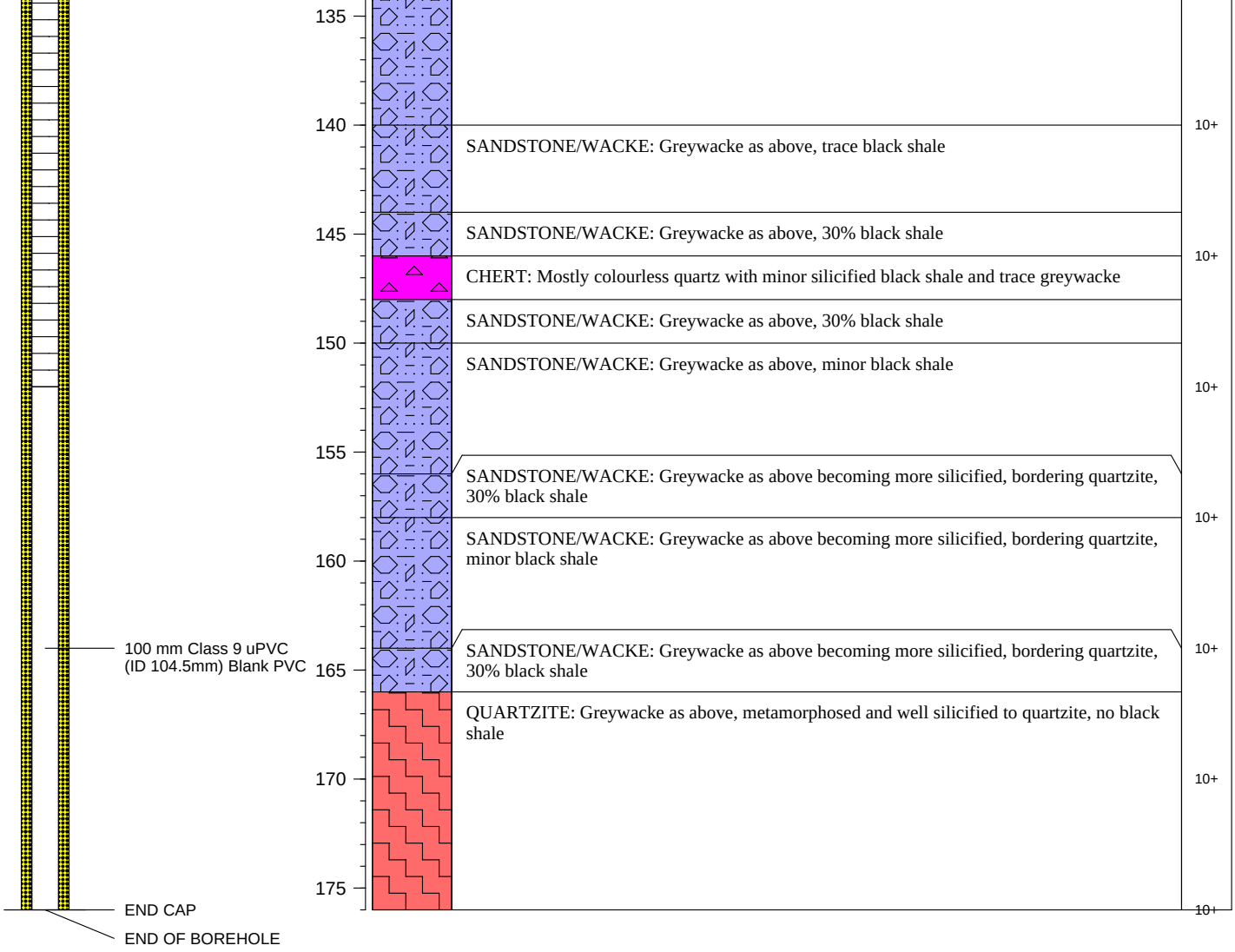
DEPTH	DESCRIPTION	YIELD (L/sec)
0	SHALE: Mostly well weathered black, grey to colourless chert to silicified shale with no foliation and some conchoidal fracture, white to orange calcrete, minor red to orange sand and silt, increased calcrete at 12-16m	
25	SHALE: Mostly silicified black shale to chert as above, mildly weathered and becoming more fresh with depth, trace to minor grey sandy mudstone to greywacke at 30m and increasing with depth	
30	SANDSTONE/WACKE: Grey sandy, mildly metamorphosed mudstone to metapelite not foliated, fine sand in a fine matrix of silt to clay, greywacke chips are mostly 1-2mm subrounded from the drilling process, minor black shale, shale increases to 40% at 34-36m	
35	SHALE: Mostly silicified black shale to chert as above, mildly weathered, minor colourless quartz and trace greywacke as above	5.5
40	SHALE: Mostly silicified black shale to chert as above, mildly weathered, increased colourless quartz and greywacke	
45	SHALE: Mostly silicified black shale to chert as above, mildly weathered, minor colourless quartz and trace greywacke	10+
50	SANDSTONE/WACKE: Greywacke as above, minor angular chips of colourless quartz and trace angular chips of black silicified shale	10+

Comments:



55	SANDSTONE/WACKE: 60% greywacke as above and 40% black silicified shale as above with minor colourless quartz	10+
60		
	SHALE: Mostly silicified black shale to chert as above, mildly weathered, minor colourless quartz and trace greywacke	10+
65	SANDSTONE/WACKE: Well weathered greywacke with an orange tinge, minor ironstone and minor black silicified shale	
	SANDSTONE/WACKE: As above, only mildly weathered	10+
	SHALE: Well silicified black shale with minor colourless quartz and greywacke	
70	SANDSTONE/WACKE: Well silicified greywacke border lining quartzite	
	SANDSTONE/WACKE: Metamorphosed greywacke with high silica content bordering quartzite, trace grains visible, chips are no longer 1-2mm and subrounded but 3-20mm platy chips, trace black shale	10+
75		
80		10+
85		10+
90		10+
95		10+
100		10+
105		10+
110		10+
115		10+
	SANDSTONE/WACKE: Metamorphosed greywacke as above, chips become smaller and more rounded, texture is more granular, slight increase in black shale	
120	SANDSTONE/WACKE: Metamorphosed greywacke as above, chips become smaller and more rounded, texture is more granular, trace black shale	10+
125		10+
130		
	SANDSTONE/WACKE: Greywacke as above, increase in black shale to 30%	10+

Comments:


135
140
145
150
155
160
165
170
175
SANDSTONE/WACKE: Greywacke as above, trace black shale
SANDSTONE/WACKE: Greywacke as above, 30% black shale
CHERT: Mostly colourless quartz with minor silicified black shale and trace greywacke
SANDSTONE/WACKE: Greywacke as above, 30% black shale
SANDSTONE/WACKE: Greywacke as above, minor black shale
SANDSTONE/WACKE: Greywacke as above becoming more silicified, bordering quartzite, 30% black shale
SANDSTONE/WACKE: Greywacke as above becoming more silicified, bordering quartzite, minor black shale
SANDSTONE/WACKE: Greywacke as above becoming more silicified, bordering quartzite, 30% black shale
QUARTZITE: Greywacke as above, metamorphosed and well silicified to quartzite, no black shale
10+
10+
10+
10+
10+
10+
10+
10+
100 mm Class 9 uPVC
(ID 104.5mm) Blank PVC
END CAP
END OF BOREHOLE

Comments:

OBSERVATION WELL BORE LOG

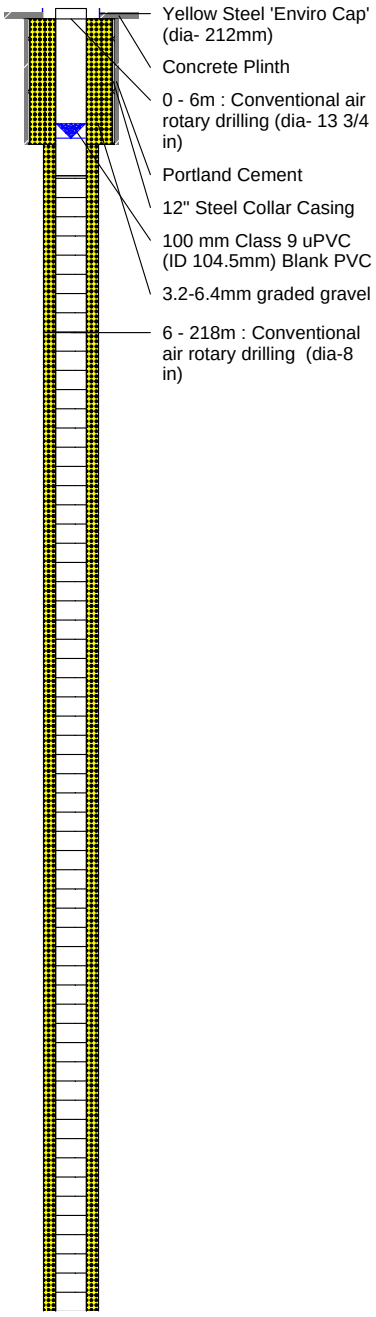
BOREHOLE NUMBER

NS-ObsW17

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

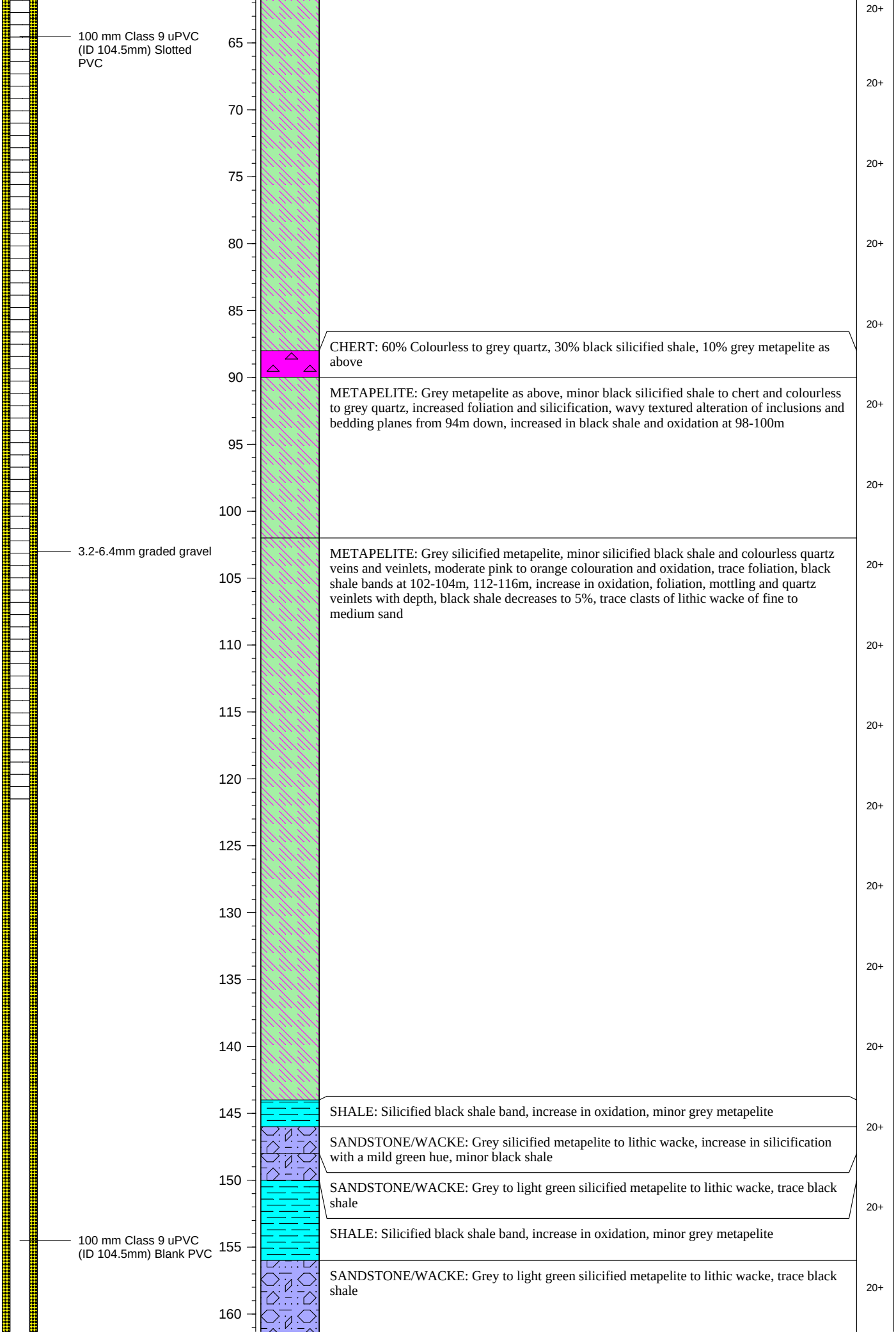
PROJECT NAME: **North Star Stage 2**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Conventional air rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **704228.32**
NORTHING (m): **7646826.74**
MEAS PT ELEVATION (mAHD): **224.47**
DRILLING DIAMETER(S) (mm): **203**
DATE BEGUN: **2/12/2014** DATE COMPLETED: **5/12/2014**

FINAL BORE DETAILS	
Completion Stick Up (magl):	**0.686**
Drilled Depth (mbgl):	**200**
Cased Depth (mbgl):	**199.5**
Casing Stick Up (magl):	**0.694**
Development Airlift Yield (l/s):	**7.5**
Water Level (mbgl) & Date:	**5.7** & **10/04/2015**

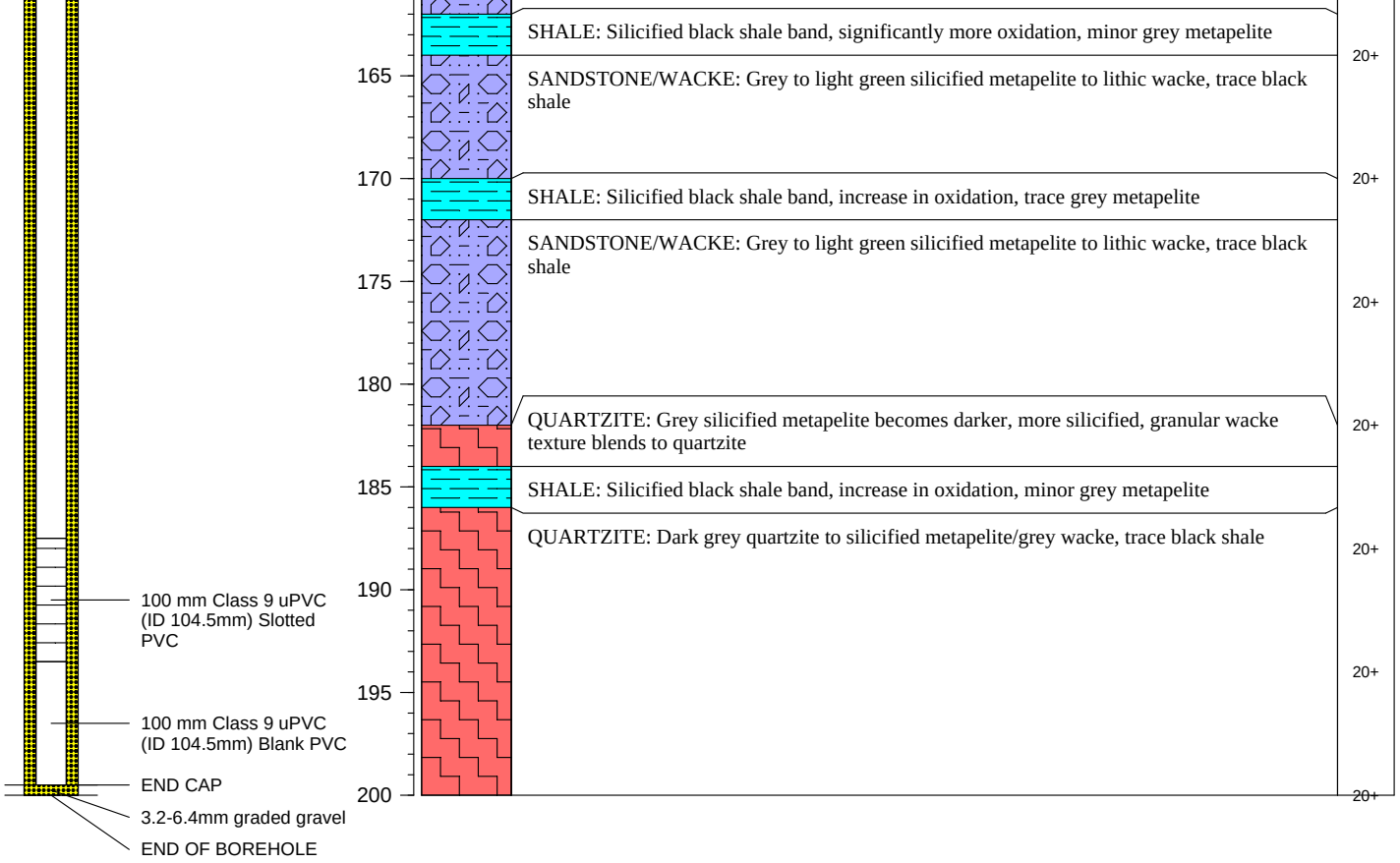


DEPTH	DESCRIPTION	YIELD (L/sec)
0	DETRITUS: Fine red silt, fine sand to gravels of rounded to angular black shale, chert, ironstone and minor ultramafics, all well weathered	
5	DETRITUS: coarse sand to gravels of rounded to angular, mostly black chert with minor white to colourless quartz veins, high white carbonate content, trace ironstone and ultramafics, fine light grey to silty clay coating all cuttings, chips are 0-50mm. Driller notes hard drilling, possibly drilling through large chert/quartz boulder as formation turns to lose ground below	
10	ALLUVIUM: Fine sand to gravels of rounded to angular black shale, chert, white carbonates, grey metapelite and minor ironstone, light silty clay from metapelite and carbonate clay coating sample chips, carbonate content reducing with depth to trace by 16m, grey metapelite increasing with depth, chips are 0-50mm, driller notes loose ground	0.5 0.5
15	METAPELITE: 60% Grey metapelite with trace foliated texture and tiny yellow inclusions, 30% black shale, increased oxidation and colourless quartz veinlets, chips are 0-50mm with an increase in smaller chips	
20	SHALE: 60% Black silicified shale to chert, 30% grey metapelite, 10% colourless quartz, chips are 0-50mm	10
25	CHERT: 40% Grey metapelite as above, 30% black silicified shale to chert, 30% colourless to grey quartz, well oxidized, angular chips with grey metapelite reducing to 5% by 26-28m, then begins to increase again by 28-30m	10
30		20+
35	METAPELITE: 60% Grey metapelite as above, 30% black silicified shale to chert, 10% colourless to grey quartz	
	METAPELITE: 70% Grey metapelite as above, 15% black silicified shale to chert, 15% colourless to grey quartz	20+
40	CHERT: 50% Grey metapelite as above, 25% black silicified shale to chert, 25% colourless to grey quartz	
45	METAPELITE: Grey metapelite as above with minor to trace black silicified shale and colourless to grey quartz	20+
50	SHALE: Black silicified shale with increased oxidation, minor to trace grey metapelite	20+
55	METAPELITE: Grey metapelite as above, with minor to trace black silicified shale, becomes slightly darker at 56m, slight increase in black shale and oxidation at 64-66m	20+
60		

Comments:


100 mm Class 9 uPVC (ID 104.5mm) Slotted PVC
3.2-6.4mm graded gravel
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
CHERT: 60% Colourless to grey quartz, 30% black silicified shale, 10% grey metapelite as above
METAPELITE: Grey metapelite as above, minor black silicified shale to chert and colourless to grey quartz, increased foliation and silicification, wavy textured alteration of inclusions and bedding planes from 94m down, increased in black shale and oxidation at 98-100m
METAPELITE: Grey silicified metapelite, minor silicified black shale and colourless quartz veins and veinlets, moderate pink to orange colouration and oxidation, trace foliation, black shale bands at 102-104m, 112-116m, increase in oxidation, foliation, mottling and quartz veinlets with depth, black shale decreases to 5%, trace clasts of lithic wacke of fine to medium sand
SHALE: Silicified black shale band, increase in oxidation, minor grey metapelite
SANDSTONE/WACKE: Grey silicified metapelite to lithic wacke, increase in silicification with a mild green hue, minor black shale
SANDSTONE/WACKE: Grey to light green silicified metapelite to lithic wacke, trace black shale
SHALE: Silicified black shale band, increase in oxidation, minor grey metapelite
SANDSTONE/WACKE: Grey to light green silicified metapelite to lithic wacke, trace black shale
20+

Comments:


165
170
175
180
185
190
195
200
SHALE: Silicified black shale band, significantly more oxidation, minor grey metapelite
SANDSTONE/WACKE: Grey to light green silicified metapelite to lithic wacke, trace black shale
SHALE: Silicified black shale band, increase in oxidation, trace grey metapelite
SANDSTONE/WACKE: Grey to light green silicified metapelite to lithic wacke, trace black shale
QUARTZITE: Grey silicified metapelite becomes darker, more silicified, granular wacke texture blends to quartzite
SHALE: Silicified black shale band, increase in oxidation, minor grey metapelite
QUARTZITE: Dark grey quartzite to silicified metapelite/grey wacke, trace black shale
20+
20+
20+
20+
20+
20+
20+
20+
100 mm Class 9 uPVC (ID 104.5mm) Slotted PVC
100 mm Class 9 uPVC (ID 104.5mm) Blank PVC
END CAP
3.2-6.4mm graded gravel
END OF BOREHOLE

Comments:

PRODUCTION WELL BORE LOG

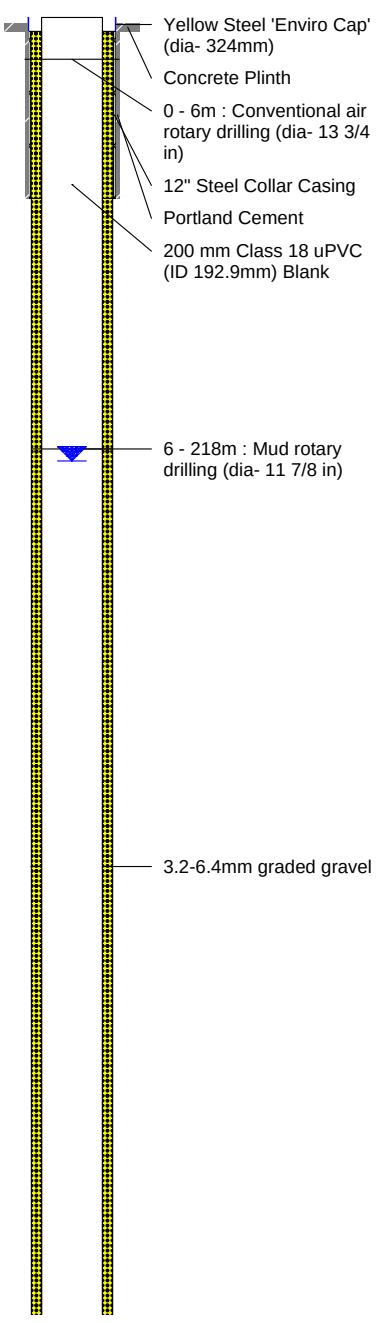
BOREHOLE NUMBER

NS-PBW08

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **North Star Stage 2**
LOCATION: **Western Borefield FMG- North Star Site**
DRILLING CO: **Easternwell**
DRILLING METHOD: **Mud rotary drilling**
LOGGED BY: **Marisa Mochizuki**
EASTING (m): **700162.50**
NORTHING (m): **7648328.09**
MEAS PT ELEVATION (mAHD): **232.652**
DRILLING DIAMETER(S) (mm): **304**
26D LICENCE #:
DATE BEGUN: **18/11/2014** DATE COMPLETED: **27/11/2014**

FINAL BORE DETAILS	
Collar Stick Up (magl):	**0.6023**
Drilled Depth (mbgl):	**218**
Cased Depth (mbgl):	**215**
Casing Stick Up (magl):	**0.418**
Development Airlift Yield (l/s):	**20**
Water Level (mbgl) & Date:	**15.43** & **10/04/2015**



DEPTH	DESCRIPTION	YIELD (l/s)
0	METAPELITE: White, light yellow and light orange metamorphosed pelite of foliated silt/mudstone to schist and very soft, few chips with most of the sample as slit, trace colourless quartz, trace calcrete from 0-6m	
15	METAPELITE: As above with 30-50% surfacing as chips, trace friable iron and iron cement	
20	METAPELITE: As above, the colour is pale orange, there is an increase in iron and orange colouration, slight increase in colourless quartz, trace dark grey to black chert, chip percentage is 50-60%	
25	METAPELITE: Light grey to white foliated metapelite to schist, 25% colourless quartz, trace black chert to shale	
30	CHERT: Quartz infill, larger chips and well oxidised mix of 30% reddish orange and yellow foliated and silicified metapelite to schist, 30% black chert to silicified shale, 30% colourless to orange chert, 10% friable iron and iron cement, chips have exposed fractures and craggy texture throughout	
35	METAPELITE: Light grey with trace orange and pink foliated metapelite to schist, no black chert to shale, trace to minor colourless quartz	
40	METAPELITE: As above with 40% colourless quartz and trace black chert	
45		

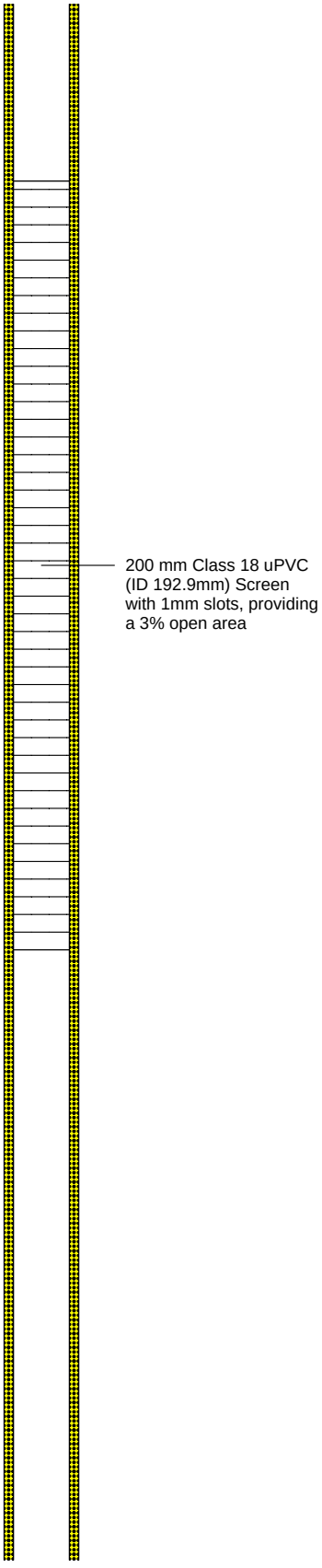
Comments: **Drilled 8in with air, reamed 11 7/8in with air, redrilled with 11 7/8in with mud to keep hole open**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PBW08

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	DESCRIPTION	YIELD (L/sec)
50	CHERT: Colourless quartz, minor black chert, minor grey metapelite as above	
	METAPELITE: Light grey with trace orange and pink foliated metapelite to schist, minor colourless quartz, trace black chert to shale, trace friable iron	0.1
55	METAPELITE: As above with 40% colourless quartz and trace black chert	
	CHERT: Colourless quartz, minor black chert, minor to trace metapelite as above	0.25
60	METAPELITE: Grey with foliated metapelite to schist, 40% black chert to shale, trace colourless quartz	
	SHALE: Black moderately oxidized silicified shale to with foliated texture, minor to trace colourless to grey quartz, trace grey to sliver foliated sericite	0.25
65	SHALE: Black silicified shale to with foliated texture, minor grey to sliver foliated sericite, trace to minor colourless to grey quartz	
70		0.5
75	CHERT: Colourless quartz, minor black shale, minor to trace metapelite and sericite as above	0.5
	CHERT: Colourless quartz, minor pink and grey with trace orange foliated sericite, trace black chert to shale	
80	METAPELITE: Grey with trace pink and orange foliated sericite, minor colourless quartz, trace black chert to shale	1.25
85		1.5
90		1.5
95		1.5
100		1.5
105		

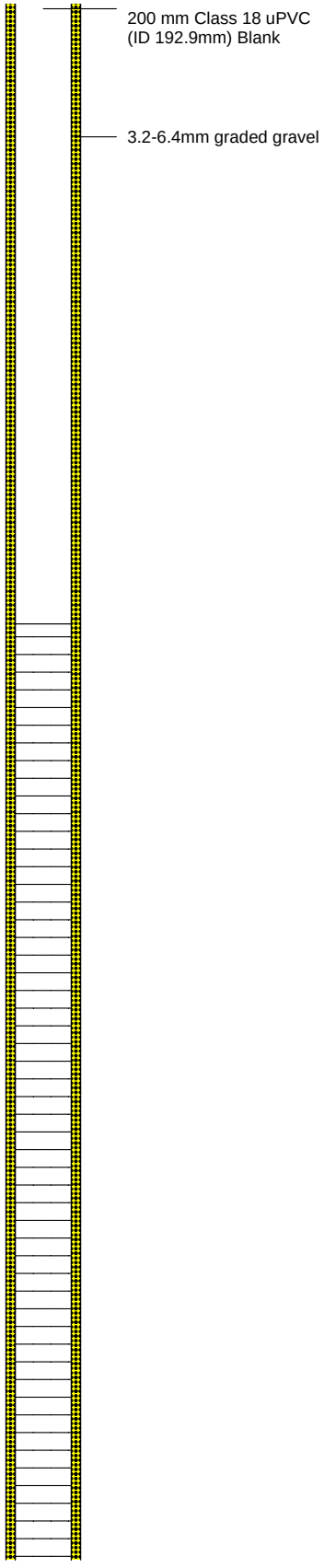
Comments: **Drilled 8in with air, reamed 11 7/8in with air, redrilled with 11 7/8in with mud to keep hole open**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PBW08

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



DEPTH	LITHOLOGY	DESCRIPTION	YIELD (L/sec)
110		METAPELITE: As above, with an increase in pink and orange colouration and friable iron, trace pyrite at 122m	1.5
115			1.5
120			1.5
125			1.5
130		METAPELITE: As above, minor quartz infill	
		METAPELITE: As above, increase in iron oxidation at 132-134m	1
135		METAPELITE: As above, increase in pyrite and trace mica, chert content increasing with depth reaching 40% by 138m	
140			2.5
		METAPELITE: Pink and grey metapelite to sericite as above, minor colourless quartz, trace pyrite	
145			2.5
		METAPELITE: As above, trace quartz and iron infill, trace green chlorite schist	
150		CHERT: Colourless quartz, minor grey foliated metapelite to sericite, trace friable iron and oxidation	2.5
155		SANDSTONE/WACKE: Grey with minor pale green, foliated, sandy metapelite to metamorphosed wacke, soft and crumbles under significant finger pressure, minor colourless quartz with increased amounts at 156-158m	
		SANDSTONE/WACKE: Grey with minor pale green and trace orange specks, foliated, sandy metapelite to metamorphosed wacke as above 30-40% colourless quartz, trace pyrite to depth	2.5
160		CHERT: Colourless quartz, minor grey foliated metapelite as above	
			2.5
165		SANDSTONE/WACKE: Pale grey with trace pale green and orange specks, foliated, sandy metapelite to metamorphosed wacke as above, minor colourless quartz	

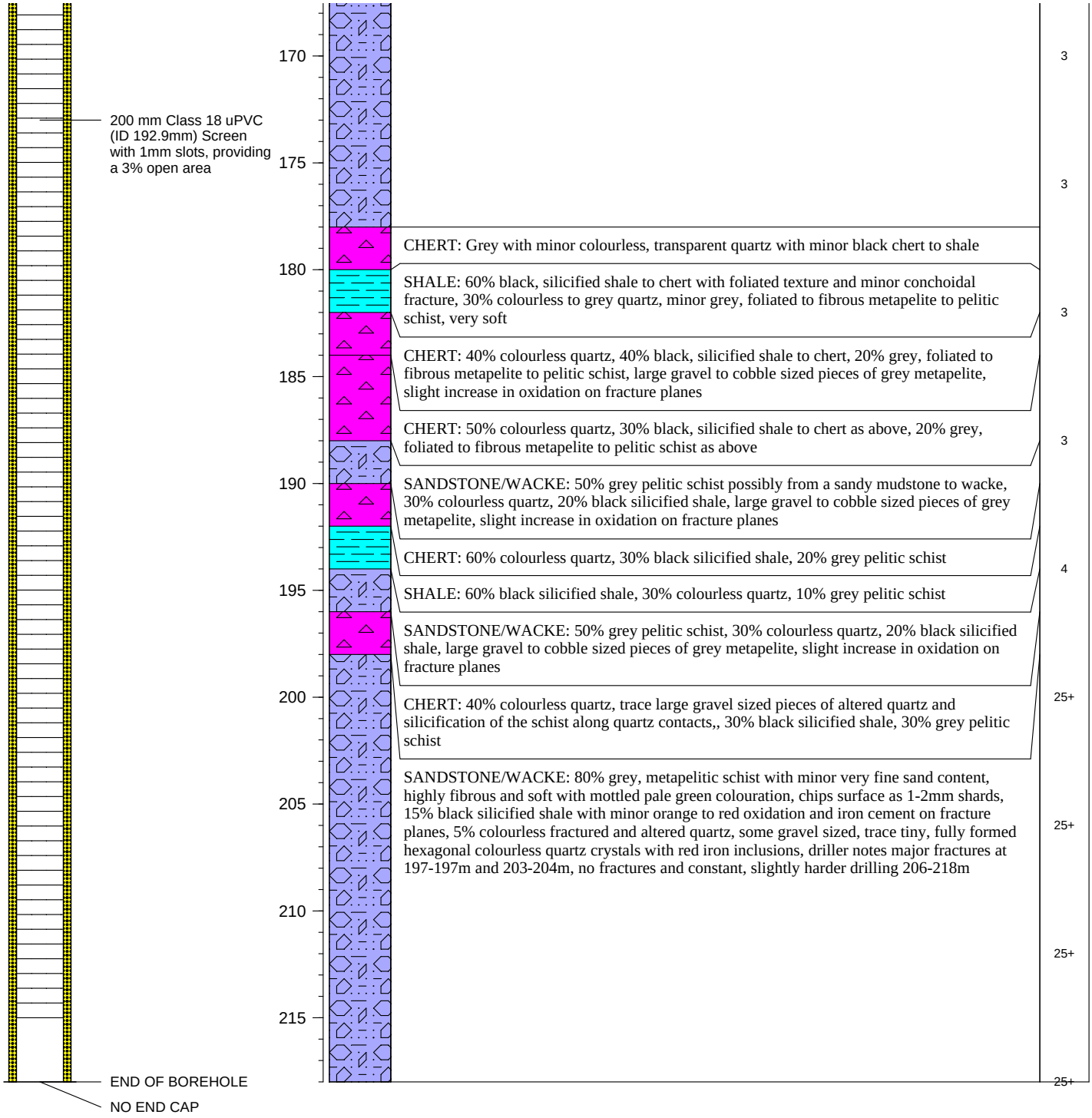
Comments: **Drilled 8in with air, reamed 11 7/8in with air, redrilled with 11 7/8in with mud to keep hole open**

OBSERVATION WELL BORE LOG

BOREHOLE NUMBER

NS-PBW08

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880



Comments: **Drilled 8in with air, reamed 11 7/8in with air, redrilled with 11 7/8in with mud to keep hole open**

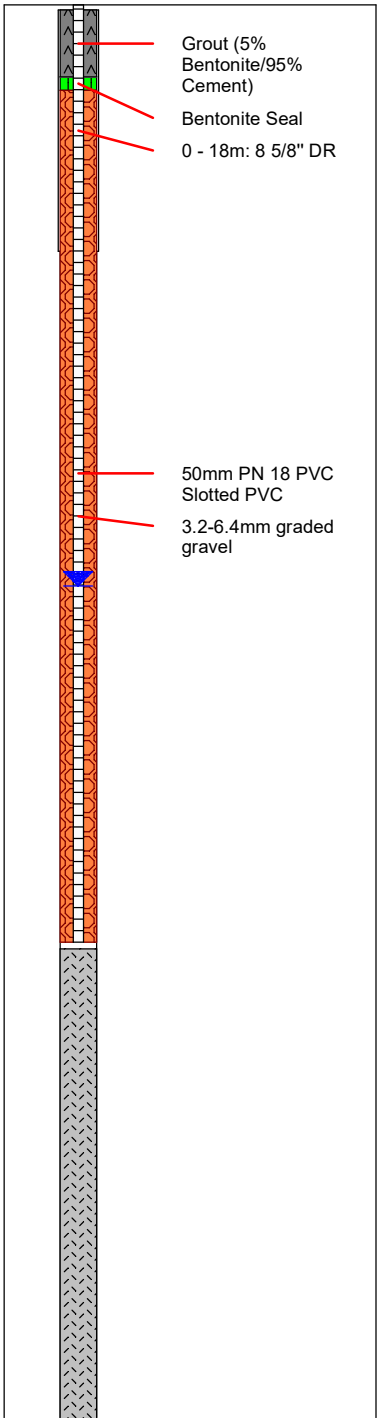
MONITORING BORE LOG

BORE NUMBER
IB_ELC_M03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
PILOT HOLE ID: **NS-DEW004**
EASTING: **713829.247**
NORTHING: **7649566.863**
ELEVATION (mAHD): **382.03**
DATE BEGUN: **14-May-2020** DATE COMPLETED: **17-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	200	
Cased Depth (mbgl):	69.5	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	42.95	25/06/2020
Quality - pH & EC (uS/cm):	N/A	N/A



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	AGi	0 - 14m Laterite: Yellow to redish brown, oxidised, well weathered, relatively hard, sun angular to subrounded. Some ooiltes to pisolitic laterite and traces of silty resish clays and vitreous goethite.			
15	AGi	14 - 50m Partly mineralised BIF; Consisting of maghemite, magnetite and hematite with redish brown chert/jasper, well weathered, hard, poorly sorted, angular. Trace yellowish brown goethite and some redish brown pisolites.			
50	AGi	50 - 96m Mineralised BIF: Dark grey ,mostly consisting of hematite and less magnetite and red jasper, relatively fresh, angular, hard and relatively well sorted. Traces of translucent to white quartz. At 52 and 62m abundant pisolitic laterite, yellow to redich brown, hard, rounded and relatively well sorted.	0.5	1137	7.73
55			0.5	1079	7.88
60			1.33	1056	7.88
65			1.48	1089	8.04
70			1.37	1151	8.2
75			1.38	1102	8.26
80			1.43	1057	8.13
85			1.55	1087	8.31
90			1.48	1102	8.22
95	AGi	96 - 118m Mineralised BIF: Dark grey to near black, magnetite rich with some hematite, banded with brownish red chert/jasper, moderately well sorted, relatively fresh minor weathering, hard, fairly well sorted. Minor	1.73	1094	8.35
100					
105					

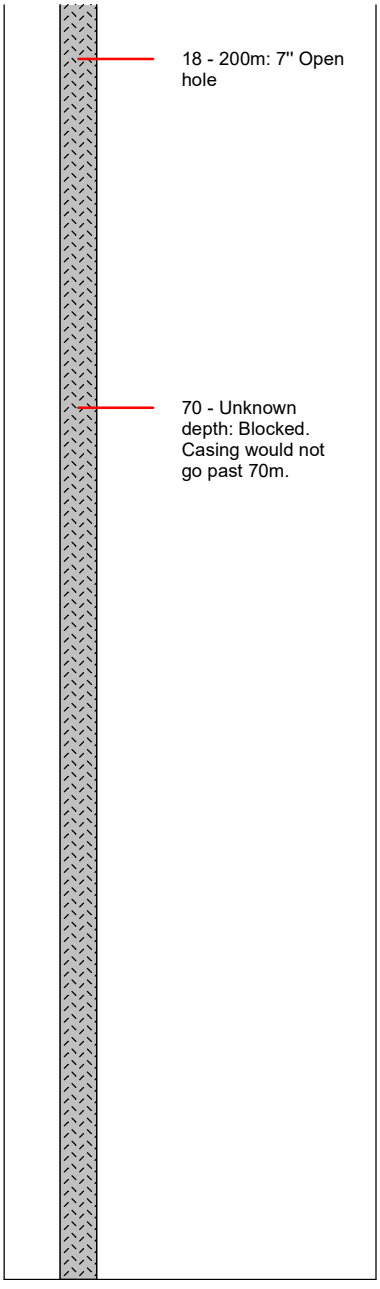
MONITORING BORE LOG

BORE NUMBER
IB_ELC_M03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
PILOT HOLE ID: **NS-DEW004**
EASTING: **713829.247**
NORTHING: **7649566.863**
ELEVATION (mAHD): **382.03**
DATE BEGUN: **14-May-2020** DATE COMPLETED: **17-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	200	
Cased Depth (mbgl):	69.5	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	42.95	25/06/2020
Quality - pH & EC (uS/cm):	N/A	N/A



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
105		white to translucent hard quartz.	1.67	1078	8.21
110					
115			1.54	1075	8.2
120	AGi	Mineralised BIF: Dark grey to near black, magnetite rich with increasing hematite and less red jasper banding, fairly sorted with minor weathering, hard (slow ROP), angular.	1.43	1068	8.17
125	AGi	Partly mineralised BIF, less mineralisation than above, with magnetite and hematite, red jasper and light coloured chert banding. Minor offwhite to semi translucent quartz.	1.52	1065	8.24
130					
135			1.51	1061	8.26
140			1.31	1088	8.43
145			1.49	1107	7.8
150	AGi	Partly mineralised BIF: Dark grey to near black and some purple staining, less magnetite with more hematite and quartz bands, hard, poorly sorted, angular and relatively fresh. Minor red jasper banding and trace chert.	1.45	1092	8.14
155			1.37	1082	8.26
160					
165			1.71	1068	8.04
170			1.4	1075	8.17
175	AGi	Partly mineralised BIF: Dark grey and highly magnetic with purple jasper and offwhite chert banding, hard, angular, relatively fresh and poorly sorted.	1.53	1120	8.35
180			1.46	1085	8.31
185	AGi	Chert: Grey to offwhite and greenish, hard, angular, poorly sorted and fresh. Partly mineralised BIF, dark grey, with magnetite, redish purple jasper and offwhite chert banding, hard with some quartz.	1.57	1225	8.36
190					
195			1.5	1083	8.15
200					

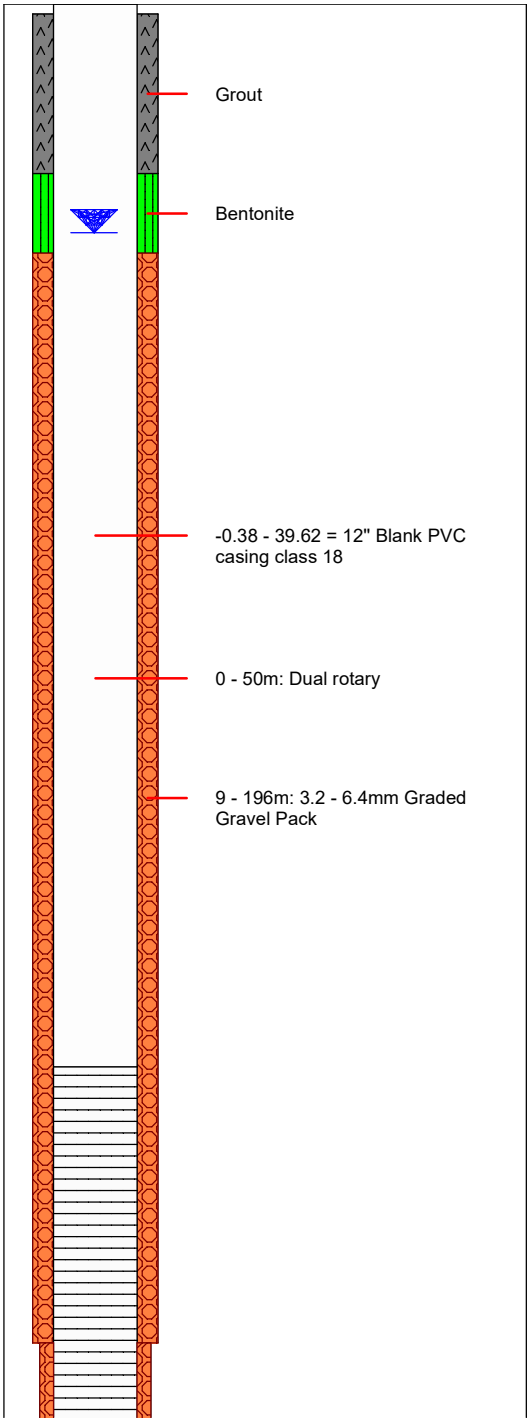
PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_NB_P01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Northern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
FIELD BOOK NO: **(blank)**
EASTING: **707375.22**
NORTHING: **7648930.87**
ELEVATION (mAHD): **256.874**
DATE BEGUN: **26-Nov-2019** DATE COMPLETED: **15-Dec-2019**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	202	
Cased Depth (mbgl):	196	
Stick Up (magl):	0.38	
Airlift Yield (L/s):	1	
Water Level (mbgl) & Date:	8.23	15/12/2019
Quallity - pH & EC (uS/cm):	8.78	1988



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	ASkuk		BASALT: Greenish grey metabasalt, fresh to lightly weathered, poorly sorted (2 - 20mm), sub-angular, med-hard to hard, silicious. Some mudstone fines and trace greenish grey chert.			
5	ASkuk		BASALT: As above, less mudstone fines.			
	ASkuk		BASALT: Grey to a light greenish grey metabasalt, moderately sorted, slight weathering, sub-angular to angular, siliceous, medium hardness to soft. Minor hard light grey chert and mudstone.			
10						
15	ASkuk		BASALT: As above. Well sorted with trace quartz.			
20	ASkuk		BASALT: As above but harder with fracture at 36m, no increase in yields observed.	0.5	1810	7.53
25				1	2640	7.68
30				1	2010	7.8
35				1	2040	7.87
40	ASkuk		BASALT: Grey metabasalt, moderately sorted, lightly weathering mostly fresh, relatively hard, sub-angular. Minor light grey and brittle mudstone and trace chert.	2	1980	7.81
45						
50	ASkuk		BASALT: Grey metabasalt, moderately well sorted, relatively hard, some light weathering and sub-angular. Minor light grey mudstone and traces	2	no data	no data

PRODUCTION BORE LOG

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PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Northern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
FIELD BOOK NO: **(blank)**
EASTING: **707375.22**
NORTHING: **7648930.87**
ELEVATION (mAHD): **256.874**
DATE BEGUN: **26-Nov-2019** DATE COMPLETED: **15-Dec-2019**

FINAL BORE DETAILS		
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Cased Depth (mbgl):	196	
Stick Up (magl):	0.38	
Airlift Yield (L/s):	1	
Water Level (mbgl) & Date:	8.23	15/12/2019
Quallity - pH & EC (uS/cm):	8.78	1988

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	55			of light grey chert with quartz.	2	no data	no data
		ASkuk		BASALT: As above with increase in mudstone and traces of pyrite.			
	60	ASkuk		BASALT: Grey metabasalt, mod-well sorted, sub-angular, relatively hard and some light weathering. Some greenish mudstone borderline chert, very fined grained, hard and brittle.	2	no data	no data
	65				2	1820	8.07
	70				2-3	1960	7.69
	75				2-3	1860	7.88
	80				2-3	1850	8.02
	85				2-3	1700	8.19
	90				2-3	1900	7.91
	95	ASkuk		BASALT: As above, slight increase in greenish grey mudstone.	2-3	1730	7.91
	100						
	105						

PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_NB_P01

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PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Northern Borefield**
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EASTING: **707375.22**
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ELEVATION (mAHD): **256.874**
DATE BEGUN: **26-Nov-2019** DATE COMPLETED: **15-Dec-2019**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	202	
Cased Depth (mbgl):	196	
Stick Up (magl):	0.38	
Airlift Yield (L/s):	1	
Water Level (mbgl) & Date:	8.23	15/12/2019
Quallity - pH & EC (uS/cm):	8.78	1988

DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
110				2-3	1840	7.95
115				2-3	1850	7.81
120	ASkuk		BASALT: As above, less mudstone and more quartz.	2-3	1800	7.93
125	ASkuk		BASALT: Dominant greenish grey metabasalt as above. Traces of quartz but mudstone absent.	2-3	1850	7.78
130	ASkuk		BASALT: Major greyish metabasalt, mod-sorted, sub-angular, med-hard to hard, lightly weathered to fresh. Trace greenish mudstone, hard, poorly sorted and fresh (band).	2-3	1780	7.94
135	ASkuk		BASALT: Dominant greenish grey metabasalt, fine grained to aphanitic, mod-well sorted (2-5mm), med-hard to hard, relatively fresh. Minor greenish mudstone, hard and brittle. trace quartz.	2-3	1845	8.02
140						
145	ASkuk		BASALT: As above with 10-20% green smooth quartzite, some larger chips 5-12mm (10%), slight grey clay at 154m	2-3	1780	7.8
150						
155	ASkuk		BASALT: Light grey, poorly-mod sorted,angular-rounded, predominantly greenish grey metabasalt and grey wacke, 10-20% green quartzite and 10% grey clay. 5-10% of chips 10-15mm and 5-10% coarse to v coarse grain size.	2-3	1852	7.9

PRODUCTION BORE LOG

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IB_NB_P01

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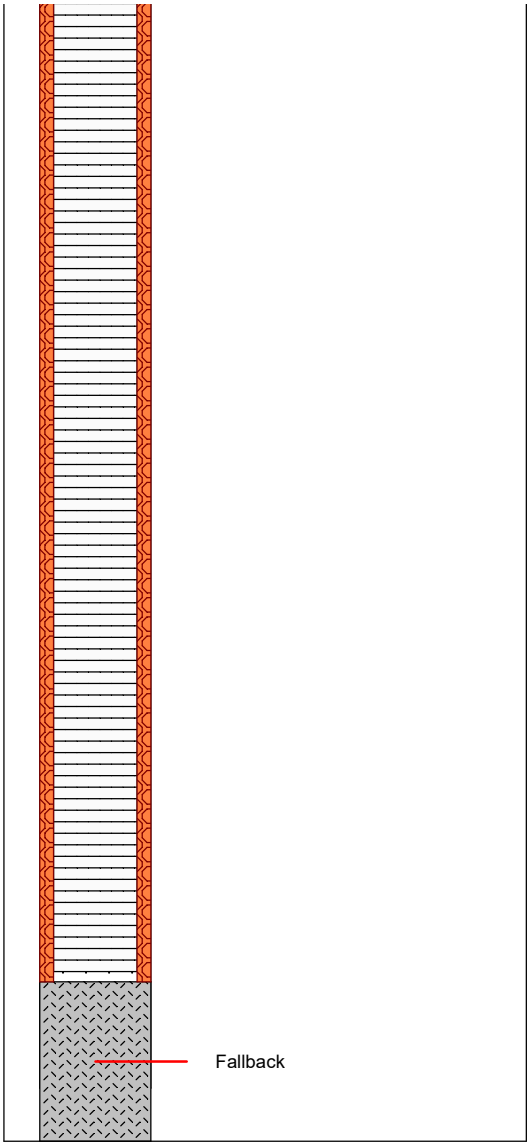
PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Northern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
FIELD BOOK NO: **(blank)**
EASTING: **707375.22**
NORTHING: **7648930.87**
ELEVATION (mAHD): **256.874**
DATE BEGUN: **26-Nov-2019** DATE COMPLETED: **15-Dec-2019**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	202	
Cased Depth (mbgl):	196	
Stick Up (magl):	0.38	
Airlift Yield (L/s):	1	
Water Level (mbgl) & Date:	8.23	15/12/2019
Quallity - pH & EC (uS/cm):	8.78	1988



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
160	ASkuk		BASALT: Slightly darker grey than 154-160, angular to sub-rounded, Mineralogy as above, 5-10% of chips 5-10mm <5% coarse - v coarse and <5% clay	2-3	1873	8.19
165	ASkuk		BASALT: As per 154-160, moderately sorted with 10-15% clay	2-3	1968	8.00
170	ASkuk		BASALT: Grey to light grey, angular to subrounded, poor-mod sorted, predominantly greenish grey metabasalt and grey wacke with pyritic andesite tuff and 10-15% green quartzite. X			
	ASkuk		BASALT: Light grey, mineralogy as above with 5% grey clay, poorly sorted angular-subrounded.	2-3	1792	8.31
175	ASkuk		BASALT: Grey-light grey, angular-subrounded, moderate to well sorted metabasalt, wacke and pyrite andesite tuff and 5% green quartzite			
	ASkuk		BASALT: Light grey, angular to subrounded, poor-mod sorted, predominantly greenish grey metabasalt and grey wacke with pyritic andesite tuff and 5% green quartzite. Flow decreased at 178m to 0.5-1L/s	2-3	1694	8.19
180						
185	ASkuk		BASALT: Grey, mod-well sorted, angular to subrounded, metabaslt and wacke with andesite tuff and 10-15% green quartzite.	1	1584	8.16
	ASkuk		BASALT: Light grey, predominant mineraloghy as above, with 5-10% light grey clay and 5-10% quartzite.			
190	ASkuk			1	1760	8.2
	ASkuk		BASALT: Grey, mod-well sorted, angular to subrounded, metabaslt and wacke with andesite tuff and 5-10% green quartzite.			
195	ASkuk		BASALT: Light grey, predominant mineralogy as above, with 5-10% light grey clay and 5% quartzite.	1	1777	8.15
200			BASALT: Dominant grey metabasalt, fresh, sub-rounded to sub-angular, well sorted (2-5mm), relatively hard. Minor greenish grey mudstone, hard, brittle and angular. Trace greenish chert.			

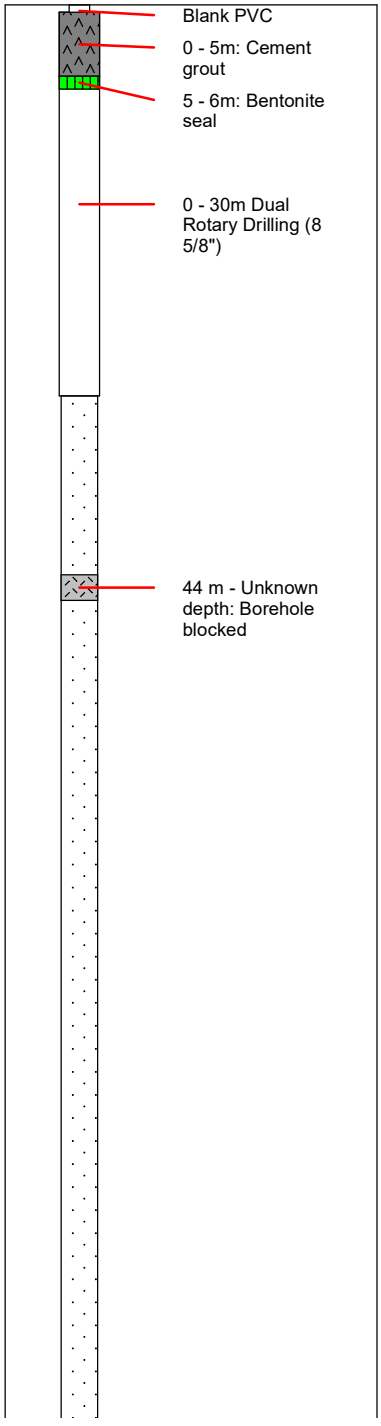
MONITORING BORE LOG

BORE NUMBER
IB_NST_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
PILOT HOLE ID: **NS-DEW001**
EASTING: **713600.53**
NORTHING: **7648129.162**
ELEVATION (mAHD): **386.435**
DATE BEGUN: **15-Apr-2020** DATE COMPLETED: **19-Apr-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	210	
Cased Depth (mbgl):	Uncased	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	25	
Water Level (mbgl) & Date:	35.74	25/06/2020
Quality - pH & EC (uS/cm):	N/A	N/A



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	PS	Limonitic SANDSTONE; yellow to brown, well weathered, angular, poorly sorted and hard. Interbed with SILSTONE/TUFF; Light yellow to off-white, very fine grained, relatively soft, poorly sorted and well weathered. Minor BIF red to brown, angular and weathered. Trace QUARTZ and possibly vitrious goethite.			
10	PS				
20	POX	SANDSTONE; Dark brown, poorly sorted, moderately weathered, angular and hard.			
25		BIF/SHALE; Redish brown, moderately weathered, poorly sorted (2 - 30mm) angular to sub-angular, hard.			
30	PBR	BIF; As above with dark grey HEMATITE; minor weathering sub-angular to sub-rounded, hard. Trace QUARTZ; Off-white, angular and hard.			
40	PS	SHALE; Redish brown oxidesed, relatively fresh minor weathering, angular, poorly sorted and hard. BASALT; Dark grey, fresh, angular, moderately sorted, hard gravels.			
55	PS	SHALE; As above with trace QUARTZ vaining. 84 - 88m oxidised shale band.	1	801	7.94
60			1	777	7.95
65			1	813	8.07
70			1	775	8.06
75			1	762	7.86
80			1	813	7.94
85					
90	PBK	Abundant PYRITE film on shale surface.	1	774	8.07
95	PBK	DOLERITE; dyke intrusion, light to dark grey, poorly sorted, angular to sub-rounded, well weathered and hard with minor white QUARTZ inclusions.	1	758	8.18
100			1	819	8.37
105			1	762	8.34
110					

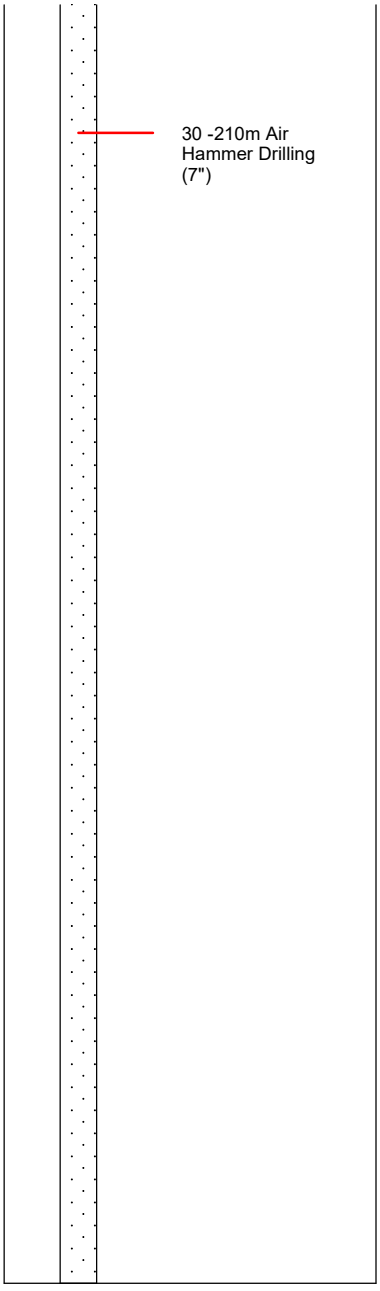
MONITORING BORE LOG

BORE NUMBER
IB_NST_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
PILOT HOLE ID: **NS-DEW001**
EASTING: **713600.53**
NORTHING: **7648129.162**
ELEVATION (mAHD): **386.435**
DATE BEGUN: **15-Apr-2020** DATE COMPLETED: **19-Apr-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	210	
Cased Depth (mbgl):	Uncased	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	25	
Water Level (mbgl) & Date:	35.74	25/06/2020
Quality - pH & EC (uS/cm):	N/A	N/A



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
110			1	783	8.39
115					
120	PBK	BIF; Dark grey and oxidesed banding, highly magnetic, moderately weathered, angular, poorly sorted and hard. Minor SHALE dak grey as above.	1	853	8.34
125			1	746	8.15
130			1	776	8.43
135					
140			1	764	8.56
145	PBK	SHALE; as above.	1	831	8.6
150	PBK	BIF and SHALE; as 120 - 144m with traces of QUARTZ and less CHERT	1	772	8.41
155			1	795	8.67
160			1	846	8.17
165					
170			1	825	8.06
175			1	761	8.03
180			1	784	8.12
185			1	768	7.97
190					
195			1	762	8.02
200			1	741	8.07
205			1	780	8.05
210					

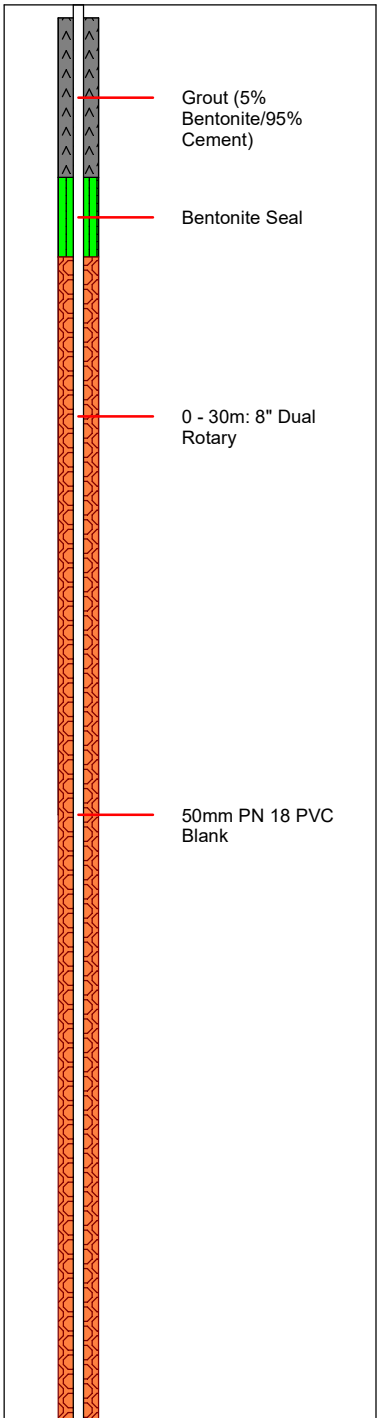
MONITORING BORE LOG

BORE NUMBER
IB_NST_M02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Chris Mulcahy**
PILOT HOLE ID: **NS-DEW005**
EASTING: **713576.802**
NORTHING: **7647675.165**
ELEVATION (mAHD): **412.882**
DATE BEGUN: **08-May-2020** DATE COMPLETED: **13-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	200	
Cased Depth (mbgl):	198.5	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.3	
Water Level (mbgl) & Date:	73.34	25/06/2020
Quality - pH & EC (uS/cm):	8.06	920



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	TD		Predominantly weathered BIF, with calcrete, minor hematite and hematitic sandstone, Ang-Sub Angular, 30% >20mm			
10	TD		as above with 10-20% weathered goethite and kaolanitic clay bands , Ang-Sub Angular			
15	TD		Predominantly BIF with 10-20% weathered goethite and trace calcrete, Ang-Sub Angular, 20% fine clay, >50% 2-8mm			
20	TD		BIF with goethite and 10-20% calcrete, Ang-Sub Angular			
25	TD		BIF with goethite and trace calcrete, hematite is darker in colour and soft, Ang-Sub Angular			
30	AGi		Predominantly hematite with goethite, BIF decreased, weathered silica clay bands, Ang-Sub Angular			
40	AGi		Predominantly hematite (highly oxidised) and 20% magnetite (blue/grey), very fine clay >50% of sample, clay was predominantly silicate and goethitic			
45	AGi					
50	AGi		Predominantly goethite, less hematite than above, magnetite 10-20%, larger chip size with 10% > 25mm, Ang-Sub Angular	0.5	1768	7.87
	AGi		Predominantly magnetite with 30% hematite, 10-20% goethite and 10% grey/cream silicate clays and trace goethitic clay, Ang-Sub			

MONITORING BORE LOG

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DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Chris Mulcahy**
PILOT HOLE ID: **NS-DEW005**
EASTING: **713576.802**
NORTHING: **7647675.165**
ELEVATION (mAHD): **412.882**
DATE BEGUN: **08-May-2020** DATE COMPLETED: **13-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	200	
Cased Depth (mbgl):	198.5	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.3	
Water Level (mbgl) & Date:	73.34	25/06/2020
Quality - pH & EC (uS/cm):	8.06	920

BORE CONSTRUCTION	FIELD NOTES	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
3.2 - 6.4mm graded gravel		55	AGi		Angular			
					As above with smaller chip size (2-8mm chip size) Ang-Sub Angular,	0.5	1775	8.1
		60	AGi		Predominantly magnetite with silicified clay, trace goethitic clay with 10-20% of chips >10mm, Ang-Sub Angular	0.5	1780	8.15
			AGi		Predominantly magnetite with 10-20% BIF and trace goethite, fine chips with >50% <1mm and 30-40% 2-8mm			
		65			Predominantly magnetite with 20-30% hematite and trace hematitic and goethitic clay, chip size 20-30%<1mm 50% 2-8mm and 10% >8mm<15mm, Ang-Sub Angular	0.5	1659	8.02
			AGi		Predominantly magnetite with 30% hematite 5-10% fresh BIF and 5% goethite, trace silicate clay and trace quartz			
		70	AGi		Magnetite with 30-40% BIF and trace goethitic clay, 10% of chips >15mm, Ang-Sub Angular	0.5	1722	8.31
		75						
						0.5	1584	8.42
		80						
		85	AGi		Magentite with minor hematite and trace quartz, chip size very fine 70% < 3mm 10% 3-7mm and 1% >7mm, Ang-Sub Angular	0.5	1693	8.41
		90	AGi		Predominantly magnetite with 10-20% hematite & BIF, trace quartz	0.5	1749	8.33
			AGi		Predominantly magnetite and hematite with trace goethite			
		95	AGi		as above with trace quartz			
					Predominantly BIF and hematite fresh trace goethite and fresh quartz, chip size increase with 10-20% >10mm, Ang-Sub Angular	0.5	1749	8.38
			AGi					
		100	AGi		Predominantly BIF and magnetite with 2-3% quartz	0.5		
			AGi		as above with 2-3% goethite and quartz, some quartz grey in colour			
		105	AGi					

MONITORING BORE LOG

BORE NUMBER
IB_NST_M02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Chris Mulcahy**
PILOT HOLE ID: **NS-DEW005**
EASTING: **713576.802**
NORTHING: **7647675.165**
ELEVATION (mAHD): **412.882**
DATE BEGUN: **08-May-2020** DATE COMPLETED: **13-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	200	
Cased Depth (mbgl):	198.5	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.3	
Water Level (mbgl) & Date:	73.34	25/06/2020
Quality - pH & EC (uS/cm):	8.06	920

BORE CONSTRUCTION	FIELD NOTES	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
30- 200m 7" Air Hammer		110	AGi		Mineralogy as 102m with 5% goethite and 5% quartz, quartz chips larger ~10mm and some banded within BIF	0.5		
					Predominantly BIF and magnetite with trace quartz and goethite, larger chip size 40-50% 10-30mm	0.5		
		115	AGi		as above with increase quartz 2-3% and trace goethite			
			AGi		Predominantly BIF and magnetite with grey silicate clay and 2% quartz and goethite, quartz decreases to trace from 124-126	0.5		
		120						
			AGi		Predominatly BIF and magnetite with increase goethite 10-20%, 2 % quartz and silicate clay bands (grey), larger chip size 10-25mm	0.5		
50mm PN 18 PVC Slotted		125						
			AGi		Increase % BIF >50%, magnetite 20-30% ,2-5% quartz and 2% goethite, silicate clay bands absent	0.5		
		130						
			AGi		Magnetite-rich BIF, dark grey to almost black with iron oxides magnetite and hematite with alternating bands of red chert/jasper. Minor traces of white quartz and yellow to light brown siltstone.	1.8		
		135						
		140						
		145				1.33	1254	7.95
		150				1	1267	7.85
		155				1	1241	7.91

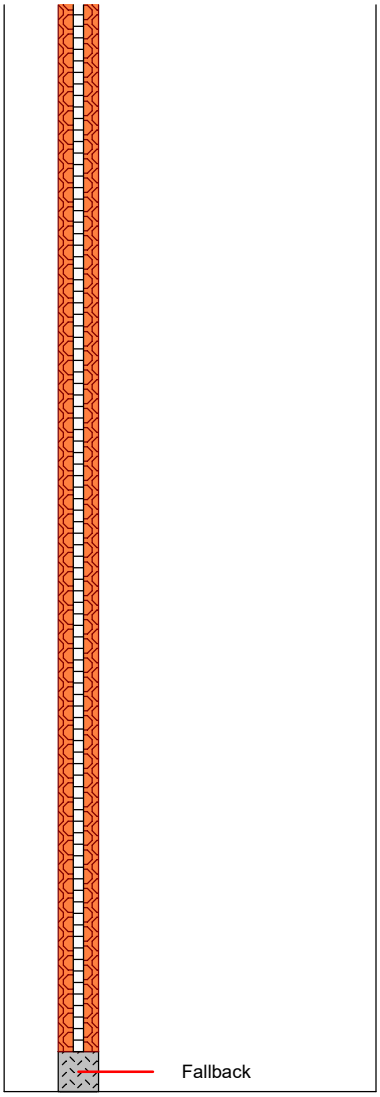
MONITORING BORE LOG

BORE NUMBER
IB_NST_M02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Chris Mulcahy**
PILOT HOLE ID: **NS-DEW005**
EASTING: **713576.802**
NORTHING: **7647675.165**
ELEVATION (mAHD): **412.882**
DATE BEGUN: **08-May-2020** DATE COMPLETED: **13-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	200	
Cased Depth (mbgl):	198.5	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.3	
Water Level (mbgl) & Date:	73.34	25/06/2020
Quality - pH & EC (uS/cm):	8.06	920



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
160						
				1	1277	7.85
165						
				1	1510	8.19
170						
				1	1432	8.29
175						
				1	1243	7.99
180						
				1	1284	8.31
185						
				1	1263	7.78
190						
				1	1285	7.87
195						
200						

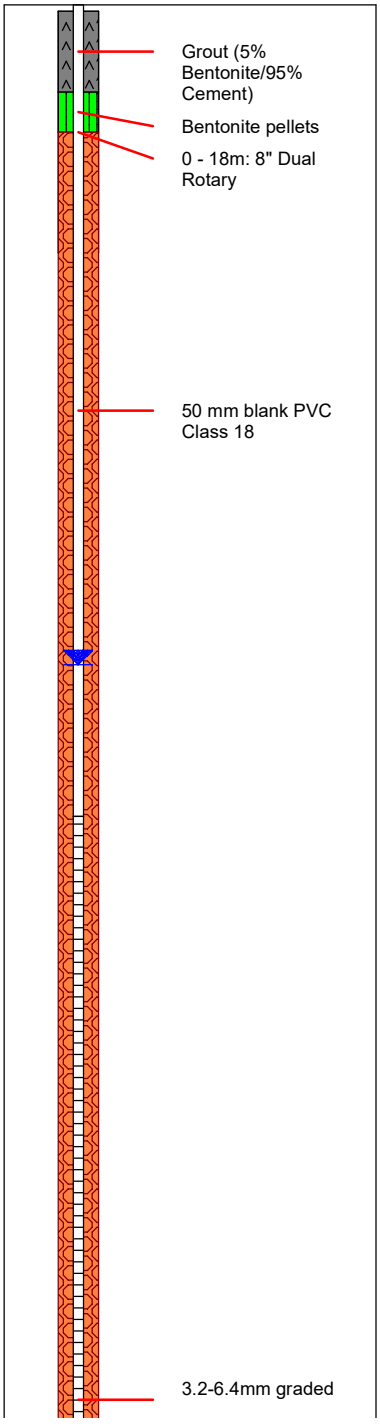
MONITORING BORE LOG

BORE NUMBER
IB_NST_M03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Matthew Wojcik**
PILOT HOLE ID: **NS-DEW006**
EASTING: **712840.634**
NORTHING: **7649965.048**
ELEVATION (mAHD): **386.653**
DATE BEGUN: **18-May-2020** DATE COMPLETED: **23-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	200	
Cased Depth (mbgl):	198	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.4	
Water Level (mbgl) & Date:	48.71	25/06/2020
Quality - pH & EC (uS/cm):	8.33	783



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	POX	Orange brown to red brown, well weathered upper layer of topsoil. Subrounded chips 5 - 20mm. Mainly goethite and hematite with some glassy goethite within clay matrix. Some oolitic texture visible and some reddish brown pisolites throughout.			
10	POX	Brown to pale brown subangular (5 - 20mm) medium hard to hard goethite with some ochrous goethite and glassy goethite. Increase of clay from 20m bgl. Traces of chert.			
35		Transition zone into BIF: Brown grey angular chips. Partially magnetic BIF. Some goethite and goethetic shales throughout. Highly magnetic			
40	PBB				
45	PBG	Grey to light grey angular, hard to medium hard BIF with some quarz. Traces of goethite. Hard drilling. Partially magnetic.			
55			0.5	1865	8.27
60	PBG	Fresh BIF becomes noticeable. Grey blue, angular, hard to medium hard BIF with some chert. Traces of goethite and quarz. Hard drilling. Highly magnetic	0.5	1866	8.44
65			0.5	1951	8.51
70			0.5	1862	8.58
75			0.5	1891	8.64
80			1	1740	8.69
85	PFG	Grey to grey blue, angular chips highly silicified BIF and chert. Traces of quarz and goethite. Highly Magnetic. From 102m drilling becomes less hard according to drillers.	1	1683	8.79
90			1	1587	8.82
95			1	808	8.97
100					
105					

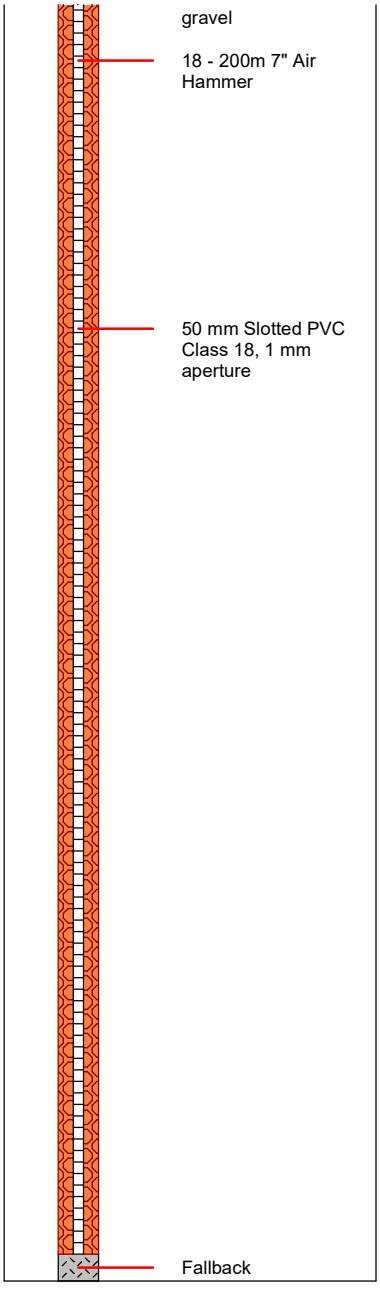
MONITORING BORE LOG

BORE NUMBER
IB_NST_M03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Matthew Wojcik**
PILOT HOLE ID: **NS-DEW006**
EASTING: **712840.634**
NORTHING: **7649965.048**
ELEVATION (mAHD): **386.653**
DATE BEGUN: **18-May-2020** DATE COMPLETED: **23-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	200	
Cased Depth (mbgl):	198	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.4	
Water Level (mbgl) & Date:	48.71	25/06/2020
Quality - pH & EC (uS/cm):	8.33	783



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
105						
110	PBG		grey to dark grey angular chips (5-10mm), hard magnetic BIF interbedded with some chert/quarz. Sparkly. Traces of reddish,purple chert/jasper? Fairly sorted relatively Hard drilling	1	770	8.56
115				1	1221	8.16
120				1	1072	8.47
125	PFG		light grey angular chips, silicified BIF and chert. Traces of quarz and goethite. Highly Magnetic	1	815	8.04
130	PBG		grey to dark grey angular chips (5-10mm), hard magnetic BIF interbedded with some chert/quarz. Sparkly. Traces of reddish, purple chert/jasper? Fairly sorted, relatively Hard drilling	1	1194	8.31
135				1	1361	8.4
140				1	1312	8.52
145				1	1240	8.42
150	PFG		light grey to offwhite angular (5-15mm) moderately hard chips. Cherty BIF, poorly sorted with traces of quarz. Some chert banding. Semi magnetic	1	1331	8.4
155				1	1053	8.42
160				1	825	8.31
165				1	831	8.32
170				1	897	8.51
175				0.5	1360	8.5
180				0.5	903	8.6
185				0.5		
190						
195						
200						

PRODUCTION BORE LOG

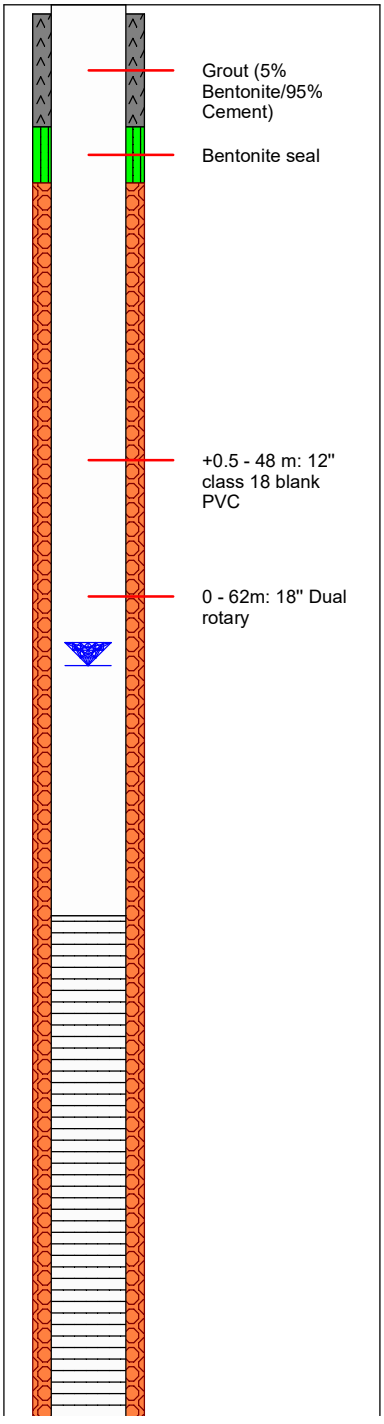
BORE NUMBER
IB_NST_P01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**Iron Bridge Near Mine**
LOCATION:	**North Star**
DRILLING CO:	**Boart Longyear**
DRILLING METHOD:	**DualRotary/AirHammer**
LOGGED BY:	**Chris Mulcahy**
PILOT HOLE ID:	**NS-DEW002**
EASTING:	**713230.52**
NORTHING:	**7649632.88**
ELEVATION (mAHD):	**386.72**

DATE BEGUN: **25-Apr-2020** DATE COMPLETED: **2-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	212	
Cased Depth (mbgl):	212	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	2.08	
Water Level (mbgl) & Date:	34.67	25/06/2020
Quality - pH & EC (uS/cm):	8.05	998



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	Cz		LATERITE and GRAVELS: Orange - red - brown in colour.			
5	Cz		GRAVELS: Clayey and sandy gravel orange to brown in colour; subangular to angular; highly weathered; low to medium hardness; chips up to 30mm - 60mm.			
45				4		
50			SHALE: Highly weatered; orange to brown in colour; non-magnetic; medium hardness; fine grained; platy.	4		
55	AGi		SHALE/Low grade ore: Fine grained/microcrystalline, dark grey and in some sections layered on mm to cm scale with olive green or purple material; moderately magnetic; medium hardness; sample highly contaminated from 30 - 56 interval. Pincunah Formation from 56 to EOH	4		
60	AGi			4	993	7.69
65	AGi		60m: 1% chips minor surface oxidation As per 56 - 60m interval	4	915	7.48
70						
75						

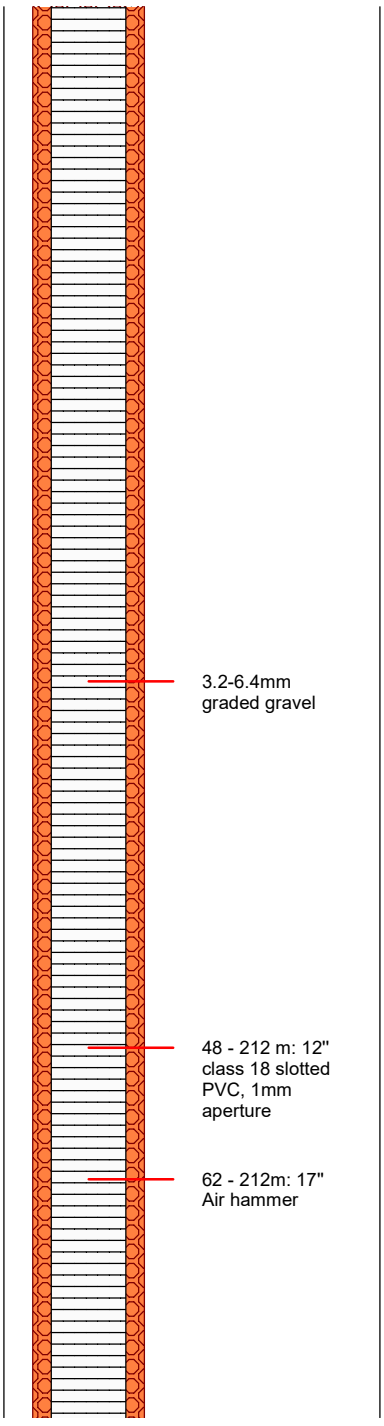
PRODUCTION BORE LOG

BORE NUMBER
IB_NST_P01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **North Star**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Chris Mulcahy**
PILOT HOLE ID: **NS-DEW002**
EASTING: **713230.52**
NORTHING: **7649632.88**
ELEVATION (mAHD): **386.72**
DATE BEGUN: **25-Apr-2020** DATE COMPLETED: **2-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	212	
Cased Depth (mbgl):	212	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	2.08	
Water Level (mbgl) & Date:	34.67	25/06/2020
Quality - pH & EC (uS/cm):	8.05	998



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
75	AGi		As per 56 - 60m interval with minor pyrites seen from 74 to EOH, very minor surface oxidation at 74m.	4	910	7.4
80				4	1015	7.63
85				4	1094	7.78
90						
95	AGi		As per 56 - 60m interval with some mica growth on platy surfaces.	4	985	7.86
100	AGi		As per 56 - 60m interval.	4	1097	7.81
105				5	1095	8.1
110	AGi		As per 56 - 60m interval with minor quartz vien from 108 - 110m.	5	1048	8.05
115				5	1001	7.97
120	AGi		SHALE and CHERT: Dark grey and olive green fine grained; magnetic; moderate hardness; pyrite; Chert present between 25 and 50% of sample.			
125						
130	AGi		As above, some of sample oxidised, small fracture?			
135	AGi		As per 120 - 130m interval but chert content 50%; increased hardness; slower drilling			
140	AGi		As per 120 to 130m interval; frequent pyrite at 140m	5	1049	8.19
145	AGi		SHALE/Low grade ore: Dark grey and purple in colour; fresh; magnetic; occasional chert; minor oxidised sample at 144m; hard drilling; minor quartz; pyrite present; low grade ore?	5	953	8.15
150						

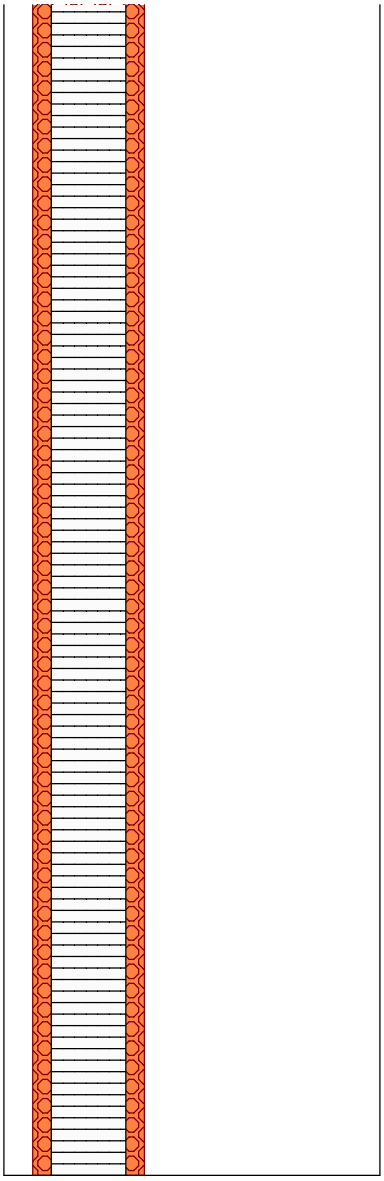
PRODUCTION BORE LOG

BORE NUMBER
IB_NST_P01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **North Star**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Chris Mulcahy**
PILOT HOLE ID: **NS-DEW002**
EASTING: **713230.52**
NORTHING: **7649632.88**
ELEVATION (mAHD): **386.72**
DATE BEGUN: **25-Apr-2020** DATE COMPLETED: **2-May-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	212	
Cased Depth (mbgl):	212	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	2.08	
Water Level (mbgl) & Date:	34.67	25/06/2020
Quality - pH & EC (uS/cm):	8.05	998



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
150			5	985	8.22
155					
160			5	1034	8.29
	AGi	SHALE/MAGNETIC BIF/ORE: Dark grey, purple, and grey interbedded; fine grained; highly magnetic; moderate hardness; fresh; magnetic bif variably interbedded with chert.	5		
165	AGi	As above with vuggy, well oxidised sample present (>1%) (might be contamination)			
170	AGi	SHALE/MAGNETIC BIF/ORE: As per 162 - 166m interval	7	1066	8.09
175	AGi	As above: very small chips, hard drilling			
	AGi	SHALE/ MAGNETIC BIF/ ORE: As per 162 - 166m interval	7	1219	8.48
180			7	1337	8.26
185					
190			7	1252	8.26
195			7	1259	8.4
200			7	1221	8.42
205	AGi	SHALE/ MAGNETIC BIF/ ORE: quartz vien at 204m otherwise as above	7	990	8.3
210					

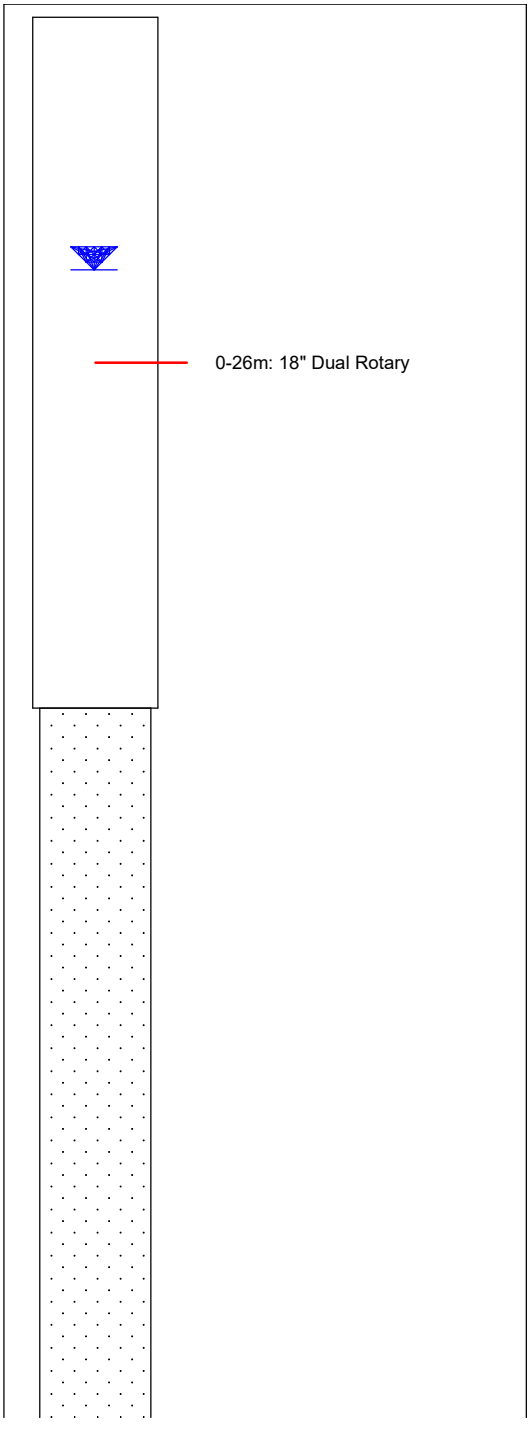
PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_SB_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO:
EASTING: **708733.922**
NORTHING: **7644900.199**
ELEVATION (mAHD): **269.221**
DATE BEGUN: **4-Mar-2020** DATE COMPLETED: **19-Mar-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	178	
Cased Depth (mbgl):	Not Cased	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	No Airlift	
Water Level (mbgl) & Date:	9.51	19/03/2020
Quallity - pH & EC (uS/cm):	7.99	1099



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	ASkbm	COLLUVIUM: COLLUVIUM: Grey-brown-orange in colour, angular, quartz and weathered volcanics, low hardness, minor sands.			
5	ASkbm	BASALT: WEATHERED MAFICS; light grey in colour with green/blue tinge; friable to low hardness; chips returned typically 1 - 30mm; very minor oxidation on some surfaces; weathered/altered to sandy silt; remnant texture visible			
10		BASALT: WEATHERED MAFICS; as above plus quartz vein (~40% of sample); minor surface oxidation on some chips			
15	ASkbm	BASALT: WEATHERED MAFICS; as above plus quartzite; quartzite is dark grey - purple in colour and shows evidence of shearing			
20	ASkbm	BASALT: WEATHERED MAFICS; light grey in colour with green/blue tinge; friable to low hardness; chips returned typically 1 - 30mm; very minor oxidation on some surfaces; 5 - 10% quartz; weathered/altered to sandy silt; remnant texture visible			
25	ASkbm	BASALT: WEATHERED MAFICS; as above but chip size decrease to mainly 1 - 3mm; 40% quartz			
30		BASALT: MAFICS; light grey in colour with green/blue tinge, especially when wet; chip size generally smaller than above intersected (1 -10 mm); rock becoming more fresh; 10 - 30% quartz; moderate oxidation of quartz fragments; microcrystalline texture resembling texture of quartzite with mafic inclusions; chip size increase from 32 - 36m possibly reflects fracture noted from driller at 36m (0.5 L/s)	0.5	no data	no data
40	ASkbm	BASALT: MAFICS; as above but colour change to medium grey; chip size increase; fine to medium grained vesicluar tuff returned in 44 - 46m interval; minor oxidation of some chips; possible fractured zone			
50	ASkbm	BASALT: MAFICS; light grey in colour with green/blue tinge that is especially evident when wet; chip size generally 1 - 3mm; rock becoming more fresh; 10 - 30% smoky quartz; moderate oxidation of quartz fragments; microcrystalline	1	no data	no data

PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_SB_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO:
EASTING: **708733.922**
NORTHING: **7644900.199**
ELEVATION (mAHD): **269.221**
DATE BEGUN: **4-Mar-2020** DATE COMPLETED: **19-Mar-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	178	
Cased Depth (mbgl):	Not Cased	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	No Airlift	
Water Level (mbgl) & Date:	9.51	19/03/2020
Quallity - pH & EC (uS/cm):	7.99	1099

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	55			texture resembling texture of quartzite with mafic inclusions	1	1107	7.71
	60				1	1047	8.09
	65				1	1103	7.69
	70				1	1160	7.84
	75	ASkbm		BASALT: MAFICS; light grey in colour with green/blue tinge that is especially evident when wet; chip size generally 1 - 3mm; fresh; high hardness; 10% smoky quartz; microcrystalline texture resembling texture of quartzite with mafic inclusions; slow drilling	1	1318	8.28
	80						
	85				2	1211	7.99
		ASkbm		BASALT: AS ABOVE; 20% sample moderatley oxidised; possible small fracture			
	90	ASkbm		BASALT: MAFICS; as per 74 - 86m	2	1143	7.74
		ASkbm		BASALT: MAFICS; as above with 5 - 10% of quartz oxidised			
	95				2	1163	7.92
		ASkbm		BASALT: MAFICS; as per 74 - 86m			
	100						
26-178m: 17" A Hammer		ASkbm		BASALT: MAFICS; as above but slightly larger chips up to 10mm; 1 % chips are moderately oxidised	2.5	1121	7.92
	105						

PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_SB_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO:
EASTING: **708733.922**
NORTHING: **7644900.199**
ELEVATION (mAHD): **269.221**
DATE BEGUN: **4-Mar-2020** DATE COMPLETED: **19-Mar-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	178	
Cased Depth (mbgl):	Not Cased	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	No Airlift	
Water Level (mbgl) & Date:	9.51	19/03/2020
Quallity - pH & EC (uS/cm):	7.99	1099

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	110				no data	no data	no data
		ASkbm		BASALT: MAFICS; as per 74 - 86m			
	115				no data	no data	no data
		ASkbm		BASALT: MAFICS; as per 74 - 86m			
	120				no data	no data	no data
		ASkbm		BASALT: MAFICS; as per 74 - 86m; 30% quartz			
	125				no data	no data	no data
		ASkbm		BASALT: BASALT; dark grey to black (when wet), fine grained, trace pyrite, high hardness; fresh; slightly metamorphosed?; 5% of chips oxidised at transition interval (128 - 130m); softer drilling than overlying			
	130				no data	no data	no data
	135				no data	no data	no data
	140	ASkbm		BASALT: BASALT; dark grey to black, moderate weathering but mostly fresh, hard, angular and relatively well sorted 2-10mm gravel. Trace MAFICS; light green blue, relatively hard and fresh, angular 1-5mm	2	1102	7.98
	145						
		ASkbm		BASALT: BASALT; As above. Minor QUARTZ; white to translucent, hard, angular, fresh, 2-5mm.			
	150				2	1173	8.02
	155				2	1278	7.9

PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_SB_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO:
EASTING: **708733.922**
NORTHING: **7644900.199**
ELEVATION (mAHD): **269.221**
DATE BEGUN: **4-Mar-2020** DATE COMPLETED: **19-Mar-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	178	
Cased Depth (mbgl):	Not Cased	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	No Airlift	
Water Level (mbgl) & Date:	9.51	19/03/2020
Quallity - pH & EC (uS/cm):	7.99	1099

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	160	ASkbm		BASALT: BASALT; As above.	2	1314	7.72
	165				2	1113	7.85
	170	ASkbm		BASALT: BASALT; As above. Minor smoky QUARTZ, microcrystalline texture resembling texture of quartzite with mafic inclusions.	2	1203	7.88
	175						

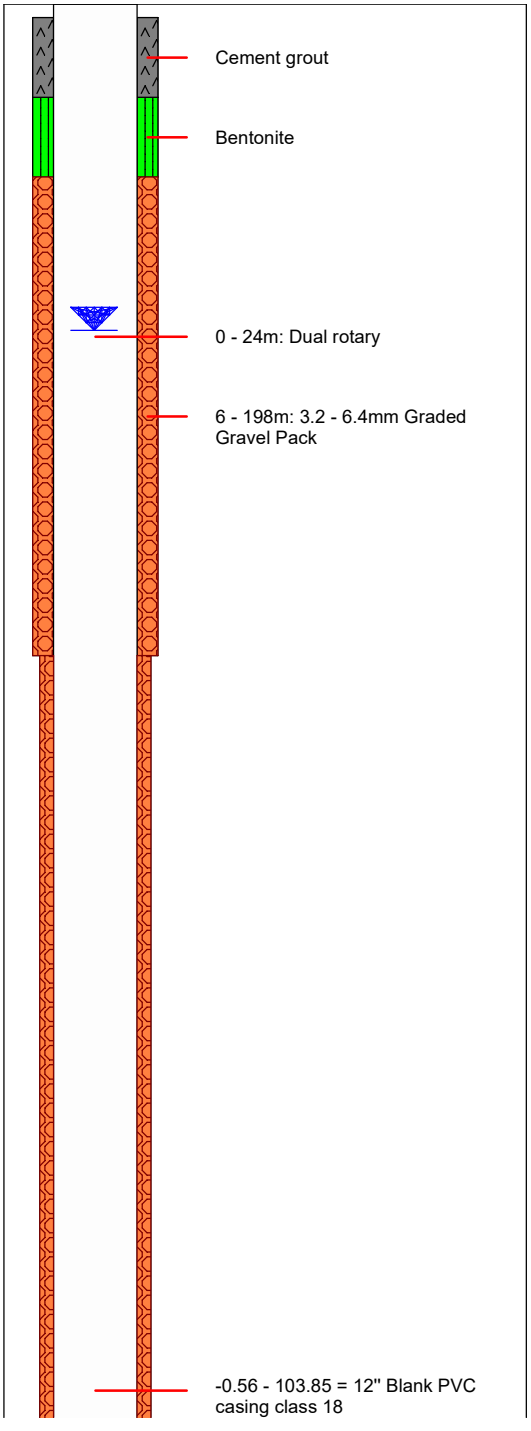
PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_SB_P01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
FIELD BOOK NO: **(blank)**
EASTING: **709469.718**
NORTHING: **7644925.541**
ELEVATION (mAHD): **273.571**
DATE BEGUN: **5-Feb-2020** DATE COMPLETED: **23-Feb-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	199.85	
Cased Depth (mbgl):	199.85	
Stick Up (magl):	0.516	
Airlift Yield (L/s):	17.64	
Water Level (mbgl) & Date:	11.76	23/02/2020
Quallity - pH & EC (uS/cm):	8.17	1164



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	ASkuk	MUDSTONE: Redish pink and light grey to off-white, arenaceous, well weathered, relatively hard but brittle, sub-angular to sub-rounded,			
5	ASkuk	MUDSTONE: Off-white to a light pink staining and purple, mod weathered, arenaceous.			
10	ASkuk	SANDSTONE: Light grey, arenaceous, minor chert and sandstone, lightly weathered, relatively hard, minor very hard angular quartz. More sandstone with depth.			
15					
20					
25					
30	ASkuk	SANDSTONE: Light grey with minor pinkish, white and translucent larger quartz gravels, mod weathered.			
35			no data	1155	7.78
40	ASls	SANDSTONE: Light grey with minor pinkish sandstone, well weathered to cemented gravels, relatively hard minor white, translucent and smoky quarts.	7.41	1162	7.83
45					
50	ASls	SANDSTONE: Slightly darker than above with very dark to black angular and hard chert with some quarts veining. Increased quartz and some oxidation.	7.26	no data	no data

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Quallity - pH & EC (uS/cm):	8.17	1164

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	55				8.03	no data	no data
	60				10.8	no data	no data
	65				9.7	1127	7.95
	70				11.77	1079	7.74
	75				11.38	1079	7.81
	80				11.97	1091	7.85
	85				12.79	1078	7.79
	90				13.64	1072	7.83
	95				12.79	1070	7.82
	100	ASIs		SANDSTONE: Grey as above, some weathering but more lithified and slightly darker, quartz gravels still present, slight oxidation.			
	105						

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Quallity - pH & EC (uS/cm):	8.17	1164

DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
110				13.4	1082	7.86
115	ASIs		SANDSTONE: Darker grey than above, lithifications seems to be increasing, moderately weathered, hard, sub-angular cuttings with increased quartz, some reddish pink oxidation, trace lightly coloured chert. Fractures between 122 - 130m and 140 - 144m.	14.53	1172	7.83
120				14.53	1094	7.74
125				14.53	1112	7.74
130				15.92	1092	7.72
135				15.92	1103	7.78
140				17.14	1142	8.15
145						
150	ASIs		SANDSTONE: Sandstone/quartzite with 2-5% black chert and 5% quartz (smokey grey, white and clear), slightly weathered with minor iron staining in quartz, subrounded to angular, Chip size 2-10mm	16.4	1132	8.14
	ASIs		SANDSTONE: As above with increase in chert 5-10% and quartz 5-10%, slightly larger chip size 2-5% >10mm-<15mm, larger white quartz up to 10mm			
155	ASIs		SANDSTONE: As per 152 but increased chip size with 10% over 10mm, only trace chert at 158m	17.64	1139	8.09

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Stick Up (magl):	0.516	
Airlift Yield (L/s):	17.64	
Water Level (mbgl) & Date:	11.76	23/02/2020
Quallity - pH & EC (uS/cm):	8.17	1164

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	160				19.47	1145	8.39
	165	ASIs		SANDSTONE: Sandstone/quartzite with 2-5% black chert and 5-7% quartz (smokey grey, white and clear), slightly weathered, subrounded-angular, chip size 2-10mm with 3-5% >10mm - <15mm	24.99	1134	8.44
	170	ASIs		SANDSTONE: Slightly darker grey, sandstone/quartzite slight increase in sandstone compared to quartzite, trace chert and 5-7% quartz, more angular to subangular and increase in chip size with 10% >10mm - <15mm	21.98	1156	8.23
	175	ASIs		SANDSTONE: Light grey sandstone/quartzite as above, increase in chert 2-5% and quartz 10-20%, subrounded-subangular, chip size as above with larger quartz chips 10-15mm at 174-178m	22.27	1232	7.93
	180	ASIs		SANDSTONE: Light grey sandstone/quartzite with trace chert and reduction in quartz 5-10%	22.86	1357	7.86
	185	ASIs		SANDSTONE: As above with slight increase in chert 2-5% and trace iron staining in quartz	24.6	1164	7.96
	190	ASIs		SANDSTONE: Light grey sandstone/quartzite with increase sandstone, more angular and smaller chip size 2-10mm, chert 5% and quartz 5-7%, trace pink sandstone	26.8	1128	8.34
	195	ASIs		SANDSTONE: As above with increase in chert 10% and quartz 10%, iron staining in quartz			

PRODUCTION BORE LOG

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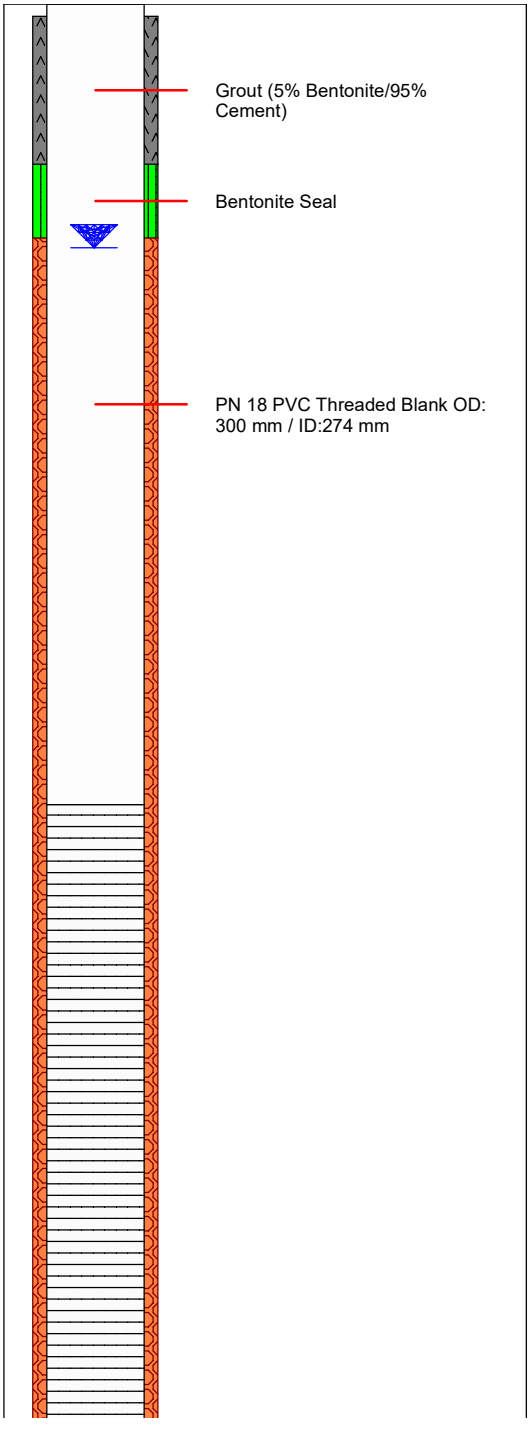
PROJECT NAME:	**Iron Bridge Near Mine**
LOCATION:	**Iron Bridge Near Mine**
DRILLING CO:	**Boart Longyear**
DRILLING METHOD:	**DualRotary/AirHammer**
LOGGED BY:	**Jack Earnshaw**
FIELD BOOK NO:	**(blank)**
EASTING:	**708764.758**
NORTHING:	**7644343.611**
ELEVATION (mAHD):	**259.469**
DATE BEGUN:	**21-Mar-2020** DATE COMPLETED: **9-Apr-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	212	
Cased Depth (mbgl):	212	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	12	
Water Level (mbgl) & Date:	9.39	09/04/2020
Quallity - pH & EC (uS/cm):	7.26	1164



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0 – 8	ASkbm	CO: DETRITUS; Highly weathered and oxidised silt and conglomerate material with angular clasts of chert. BASALT; Angular, very hard and moderately weathered.			
8 – 24	ASkbm	BASALT: BASALT; Grey to green, partly weathered some fresh, dark microcrystalline matrix, 1-2mm inclusions, minor oxidation,hard, angular and poorly sorted.			
24 – 38	ASkbm	MUDSTONE: MUDSTONE; Light grey, relatively soft, fine grained, well weathered and poorly sorted, some dark basalt inclusions, some very fine and soft white clay inclusions dotted within the mudstone .			
38 – 52	ASkbm	MUDSTONE: MUDSTONE; As above with some surface oxidation.	no data	1075	8.07
52 – 55	ASkbm	CH: CHERT; black, very hard, fresh, angular and relatively well sorted. Minor QUARTZ; Dark smoky to white and traslucent, very hard, angular, fresh, moderately sorted.	10	1019	7.9

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Airlift Yield (L/s):	12	
Water Level (mbgl) & Date:	9.39	09/04/2020
Quallity - pH & EC (uS/cm):	7.26	1164

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	60				10	1125	8.38
	65	ASkbm		SANDSTONE: SANDTONE; Light grey to pick, fine sand and silica matrix, hard, sub-angular, relatively fresh only minor weathering. Trace CHERT; As above, incresed at 78m and 84m.	10	1116	8.23
	70				10	1012	7.96
	75				10	1156	8.42
	80				10	1141	8.23
	85	ASkbm		SANDSTONE: SANDSTONE; Darker than above but still lightly coloured, hard, angular, relatively well sorted and fresh, some black chert vaining.	10	1114	8.46
	90	ASkbm		SANDSTONE: SANDSTONE; Continues to get darker with depth but still light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh, black chert bands at 94, 110 and 112m.	10	1102	8.46
	95				10	1140	8.34
	100				10	1062	7.72
	105						
3.2-6.4mm graded gravel	110						

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Cased Depth (mbgl):	212	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	12	
Water Level (mbgl) & Date:	9.39	09/04/2020
Quallity - pH & EC (uS/cm):	7.26	1164

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
PN 18 PVC Threaded Slotted OD: 300 mm / ID:274 mm	115			SANDSTONE: WACKE SANDSTONE; Light brown, fine grained blended in to silica matrix, hard, angular, well sorted, fresh gravel.	10	1049	7.62
	120	ASkbm		SANDSTONE: SANDSTONE; Continues to get darker with depth but still light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh, black chert bands at 122, 130 and 138-140m.	10	1018	7.63
	125	ASkbm					
	130				10	1002	7.75
	135				14	1037	7.83
	140	ASkbm		SANDSTONE: WACKE/SANDSTONE; Light grey to light brown, fine grain in silica and light carbonate matrix, hard, angular and lightly weathered.	14	1043	7.73
	145				15	no data	no data
	150	ASkbm		SANDSTONE: Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.	15	1113	8.83
	155						
	160				15	1040	7.84
		ASkbm		CH: CHERT; Black, very hard, fresh, angular and relatively well sorted			
	165	ASkbm		SANDSTONE: SANDSTONE; Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.	15	1035	7.95
	170	ASkbm		SANDSTONE: SANDSTONE; As above. Minor	15	1060	7.99

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Cased Depth (mbgl):	212	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	12	
Water Level (mbgl) & Date:	9.39	09/04/2020
Quallity - pH & EC (uS/cm):	7.26	1164

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	175			QUARTZ: White to off-white, hard angular, fresh and angular.	15	1073	8.02
	180	ASkbm		CH: CHERT; As per 162 - 164m	15	1059	7.96
	185	ASkbm		SANDSTONE: SANDSTONE; Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.	15	1060	8.14
	190	ASkbm		SANDSTONE: SANDSTONE; As above, minor chert band (~5% of sample).			
		ASkbm		SANDSTONE: SANDSTONE; Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.	15	1079	8.02
	195	ASkbm		SANDSTONE: CHERT and SANDSTONE; Black, very hard, fresh, 30 - 50% Sandstone in sample			
	200	ASkbm		SANDSTONE: SANDSTONE; as above but fracture or weathered zone within 200 - 204m interval, 20mm well oxidised chips; white to orange in colour; friable	18	1052	8.17
		ASkbm					
	205	ASkbm		SANDSTONE: SANDSTONE; Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.	18	1042	8.23
	210			SANDSTONE: SANDSTONE; Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh. Minor QUARTZ: White to off-white, hard angular, fresh and angular.			

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IB_TSF_M01

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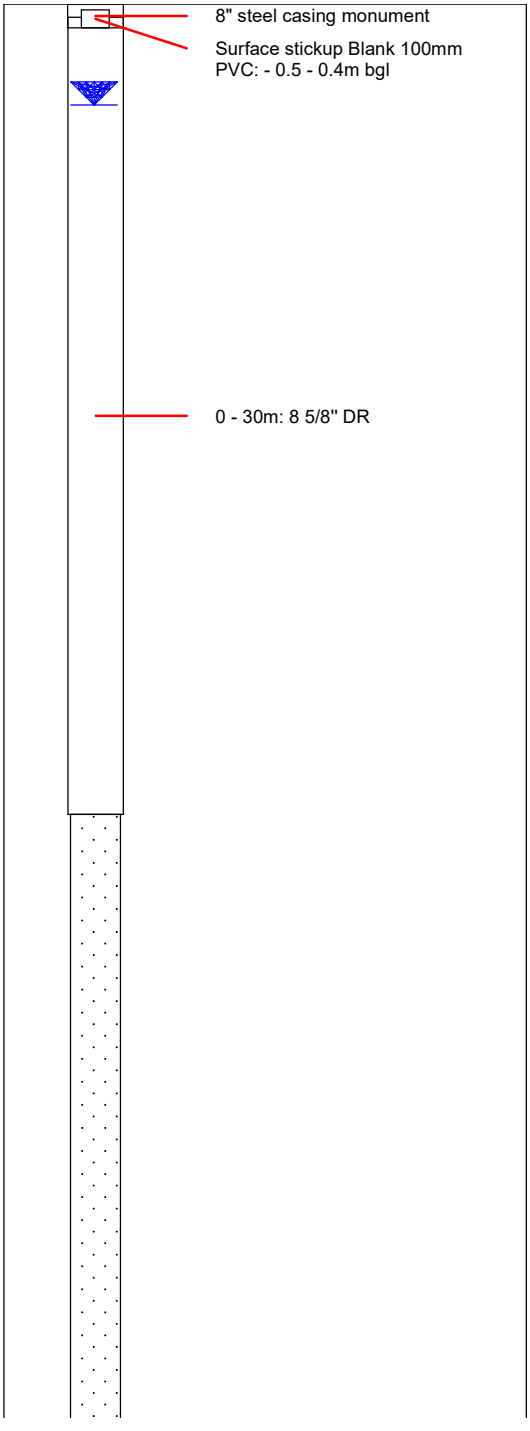
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO: **1**
EASTING: **709169.6**
NORTHING: **7655183**
ELEVATION (mAHD): **236.474**
DATE BEGUN: **10-Apr-2020** DATE COMPLETED: **13-Apr-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	168	
Cased Depth (mbgl):	no internal casing	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	no data	
Water Level (mbgl) & Date:	3.3	24/04/2020
Quallity - pH & EC (uS/cm):	no data	no data



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0		Grv: GRAVEL: Alluvial gravels of BIF, chert, mudstone, sandstone, and volcanics; grainsize ranges from very coarse sand to small cobbles; degree of rounding fom subangular to rounded.			
10	AGct	MetS: METASEDIMENTS: Dark grey to purple in colour; fine grained; medium hardness, angular chips, goethite and hematite, minor surface oxidation of some chips.			
15	AGct	MUDSTONE: MUDSTONE: Grey and purple interbedded/layered; friable; probably comprised of clay and silt particles; minor oxidation of some surfaces			
	AGct				
	AGct	MetS: METASEDIMENTS: Fine grained; low hardness and friable; very dark grey to black in colour with a green hue; weathered			
20	AGct				
	AGct	MetS: METASEDIMENTS: Dark grey to purple in colour; fine grained; medium hardness; angular chips; hematite; minor surface oxidation of some chips; harder drilling	0.5	no data	no data
25	AGct				
	AGct	MetS: 20 - 22m: Oxidaton on fracture surfaces seen			
30	AGct	MetS: METASEDIMENTS: Dark grey, moderate hardness and moderately indurated; fine grained; faintly banded and some intervals are 'shaley'.	0.5	1969	7.76
		MetS: 24 - 26m: Minor conglomerate lens in this interval; comprised of very coarse grained quartz and ferrous cement.			
35		MetS: 26 - 28m: Possible fracture, oxidation on surfaces	0.5	1949	7.84
	AGct	MetS: METASEDIMENTS: Metasandstone; dark grey; fine grained; moderate hardness; very minor shaley sections but generally massive; some chips show increased hematite content but not related to fracture or increased flow; some sections show remnant layering on the mm scale.	0.5	1990	7.64
40	AGct				
45		MetS: 38 - 40m: As above, very minor oxidation of few chips.			
	AGct	MetS: METASEDIMETNS: Shaley sandstone/siltstone from 40 - 50m; fine grained; dark grey; alteration and hematite on planar surfces; flow increase from 0.5 to 1 L/s in this interval	1	1954	7.72
50	AGct				

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FIELD BOOK NO: **1**
EASTING: **709169.6**
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ELEVATION (mAHD): **236.474**
DATE BEGUN: **10-Apr-2020** DATE COMPLETED: **13-Apr-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	168	
Cased Depth (mbgl):	no internal casing	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	no data	
Water Level (mbgl) & Date:	3.3	24/04/2020
Quallity - pH & EC (uS/cm):	no data	no data

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	55			MetS: 48 - 50m: As above, quartz conglomerate lens, well oxidised (>1% of sample)	1	1981	7.71
				MetS: METASEDIMENTS: Metasandstone; dark grey; fine grained; harder drilling; trace quarts between 1 and 5%; moderate hardness; chip size decrease; occasional fragments of BIF not clear if contamination.			
	60	AGct			1	1992	7.69
		AGct		MetS: METASEDIMENTS: Shaley siltstone/sandstone; dark grey; fine grained; mildly platey; alteration on planar surfaces; trace sulphides.			
	65			MetS: Penetration rate decreases	1	2006	7.81
	70						
				MetS: 74 - 76m: As above; few chips hematite enriched; few chips are oxidised; possible small fractured zone.	1	1963	7.66
	75	AGct					
		AGct		MetS: As per 60 to 62; harder drilling			
	80				1	1968	7.79
	85				1	1927	7.54
	90				1.5	1473	7.47
		AGct		MetS: 92 - EOH: Shaley metasediments; fine grained; dark grey; harder drilling; quartz viens on cm scale (2 - 5% of sample) however not associated with increase in weathering; trace sulphides and alteration on platy surfaces; otherwise fresh; driller notes 1 foot fracture at 93m.			
	95				1.5	1940	7.69
30 - 168m: 7" Open hole	100				1	1854	7.76
	105			MetS: As per 92 - 104m, with hematite and possible slickensides on some chip surfaces.			

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Stick Up (magl):	0.5	
Airlift Yield (L/s):	no data	
Water Level (mbgl) & Date:	3.3	24/04/2020
Quallity - pH & EC (uS/cm):	no data	no data

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
		AGct					
	110	AGct		MetS: As above	1	1881	7.7
	115	AGct		MetS: 114 - 116m: Very minor surface oxidation of larger chips.	1	1930	7.56
		AGct		MetS: 116 - 118m: Quartz vien 1 cm scale			
	120	AGct		MetS: 118 - 148m: trace chips are highly weathered/altered to friable; occasional large fragments <30mm returned	1	1861	8
	125				1	1848	7.83
	130				1	1923	7.77
	135				1	1855	7.83
	140						
	145				2	1862	7.8
	150	AGct		MetS: 148 - 156m: As per 92m with trace oxidised quartz sandstone (coarse grained), trace pisolite.	2	1785	7.74
	155						
		AGct		MetS: 156 - 158m: Evidence of slickensides on surfaces of platy chips; shear zone?	2.5	1834	7.97
		AGct		MetS: 158 - 160m: As per 92m, trace pisilote			

PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_TSF_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO: **1**
EASTING: **709169.6**
NORTHING: **7655183**
ELEVATION (mAHD): **236.474**
DATE BEGUN: **10-Apr-2020** DATE COMPLETED: **13-Apr-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	168	
Cased Depth (mbgl):	no internal casing	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	no data	
Water Level (mbgl) & Date:	3.3	24/04/2020
Quallity - pH & EC (uS/cm):	no data	no data

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	160	AGct		MetS: 160 - 168m: Shaley sandstone/siltstone as per 92m; unweathered; quartz in sample is smokey.	2.5	1874	8.07
	165						

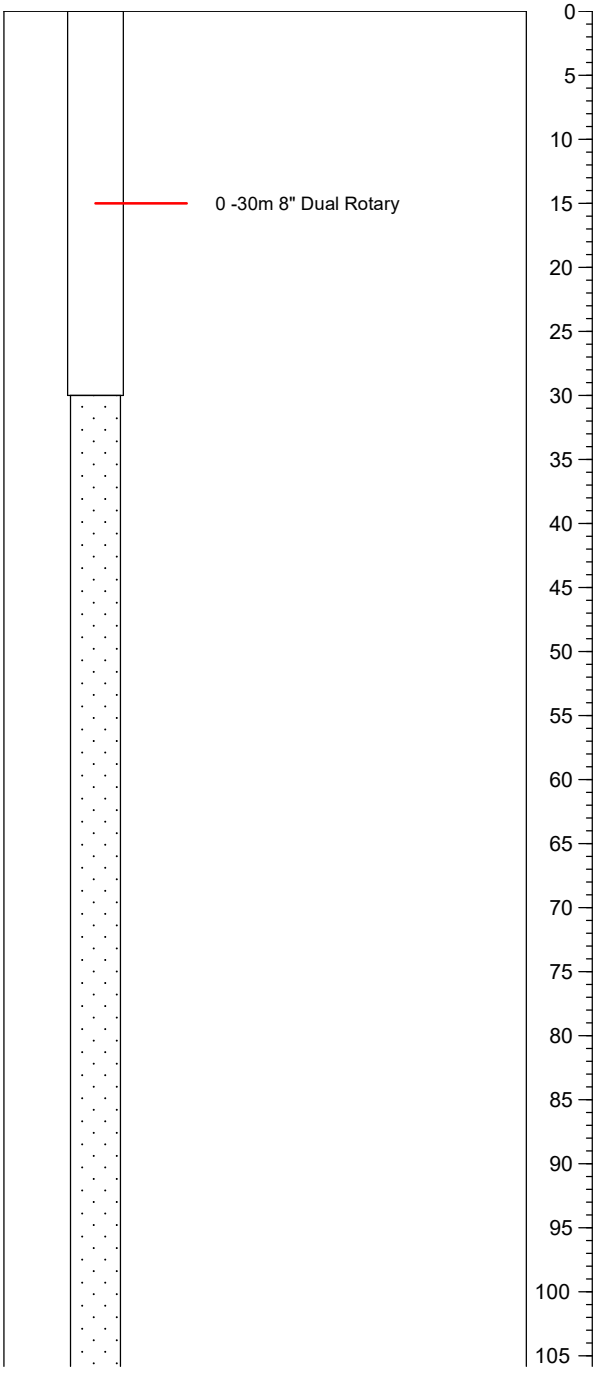
PILOT HOLE LOG

BOREHOLE NUMBER
NS-DEW002

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Northstar**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO: **1**
EASTING: **713249**
NORTHING: **7649656**
ELEVATION (mAHD):
DATE BEGUN: **20-April-2020** DATE COMPLETED: **24-April-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	210 (pilot hole of IB_NST_P01)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):		
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0			GRAVELLY CLAY: LATERITE and GRAVELS: Orange - red - brown in colour.			
5			GRAVELLY CLAY: GRAVELS: Clayey and sandy gravel orange to brown in colour; subangular to angular; highly weathered; low to medium hardness; chips up to 30mm - 60mm.			
10						
15						
20						
25						
30						
35						
40						
45					883	7.36
50			SH: SHALE: Highly weatered; orange to brown in colour; non-magnetic; medium hardness; fine grained; platy.	1	858	7.5
55				1	889	7.22
60			SH: SHALE/Low grade ore: Fine grained/microcrystalline. dark grey and in some sections layered on mm to cm scale with olive green or purple material; moderately magnetic; medium hardness; sample highly contaminated from 30 - 56 interval. Pincunah Formation from 56 to EOH	1	952	7.64
65				1	984	7.67
70			SH: 60m: 1% chips minor surface oxidation	1	948	7.8
75			SH: As per 56 - 60m interval	1	969	7.84
80			SH: As per 56 - 60m interval with minor pyrites seen from 74 to EOH. very minor surface oxidation at 74m.	3	930	7.49
85				3	925	8.15
90			SH: As per 56 - 60m interval with some mica growth on platy surfaces.	3	915	8.04
95			SH: As per 56 - 60m interval.	3	922	7.85
100						
105						

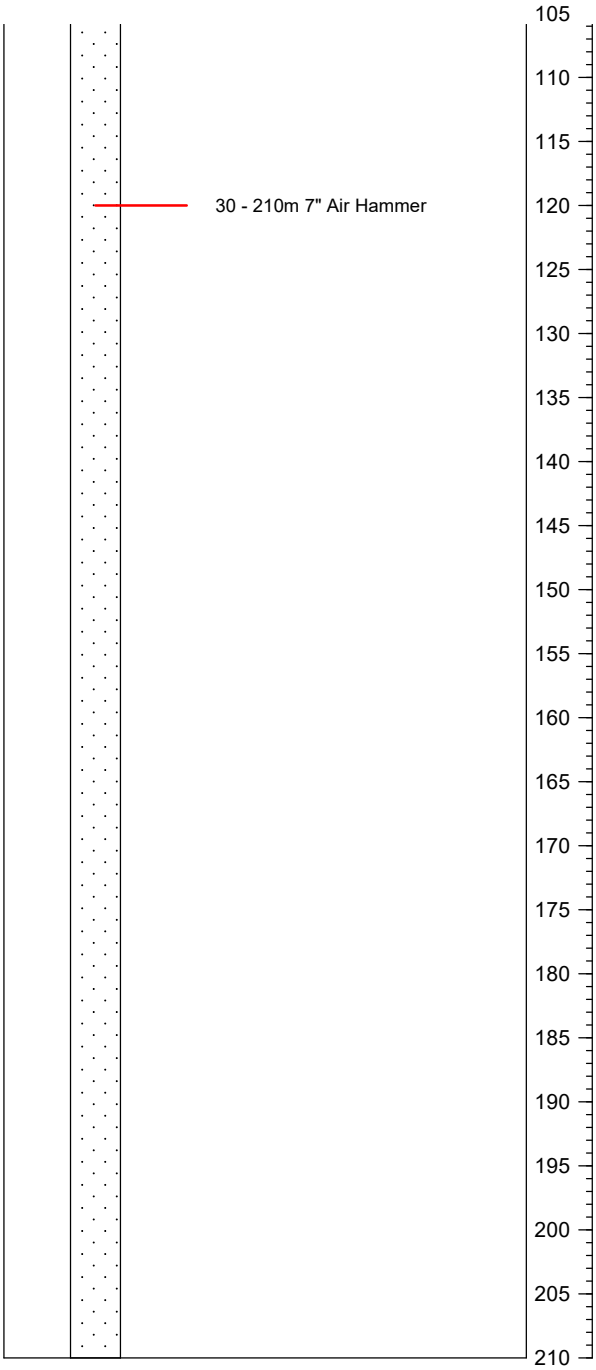
PILOT HOLE LOG

BOREHOLE NUMBER
NS-DEW002

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Northstar**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO: **1**
EASTING: **713249**
NORTHING: **7649656**
ELEVATION (mAHD):
DATE BEGUN: **20-April-2020** DATE COMPLETED: **24-April-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	210 (pilot hole of IB_NST_P01)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):		
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A



DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
SH: As per 56 - 60m interval with minor quartz vien from 108 - 110m.	3.33	919	7.97
	4	1039	7.45
SHALE & CHERT: SHALE and CHERT: Dark grey and olive green fine grained; magnetic; moderate hardness; pyrite; Chert present between 25 and 50% of sample.	4	975	8.18
	4	945	8.12
SHALE & CHERT: As above. some of sample oxidised. small fracture?	4	962	8.24
SHALE & CHERT: As per 120 - 130m interval but chert content 50%; increased hardness; slower drilling	3.33	951	8.35
SHALE & CHERT: As per 120 to 130m interval; frequent pyrite at 140m	4	930	8.12
SH: SHALE/Low grade ore: Dark grey and purple in colour; fresh; magnetic; occasional chert; minor oxidised sample at 144m; hard drilling; minor quartz; pyrite present; low grade ore?	4	965	8.23
	3.33	1073	8.31
Banded Iron Formation: SHALE/MAGNETIC BIF/ORE: Dark grey. purple. and grey interbedded; fine grained; highly magnetic; moderate hardness; fresh; magnetic bif variably interbedded with chert.	3.33	941	7.85
	3.33		
Banded Iron Formation: As above with vuggy. well oxidised sample present (>1%) (might be contamination)	3.33	950	8.08
Banded Iron Formation: SHALE/MAGNETIC BIF/ORE: As per 162 - 166m interval	2.85	949	7.95
Banded Iron Formation: As above: very small chips. hard drilling	3.33	1053	8.16
Banded Iron Formation: SHALE/ MAGNETIC BIF/ ORE: As per 162 - 166m interval	3.33	913	7.99
		910	8.09
Banded Iron Formation: SHALE/ MAGNETIC BIF/ ORE: quartz vien at 204m otherwise as above		912	8.07

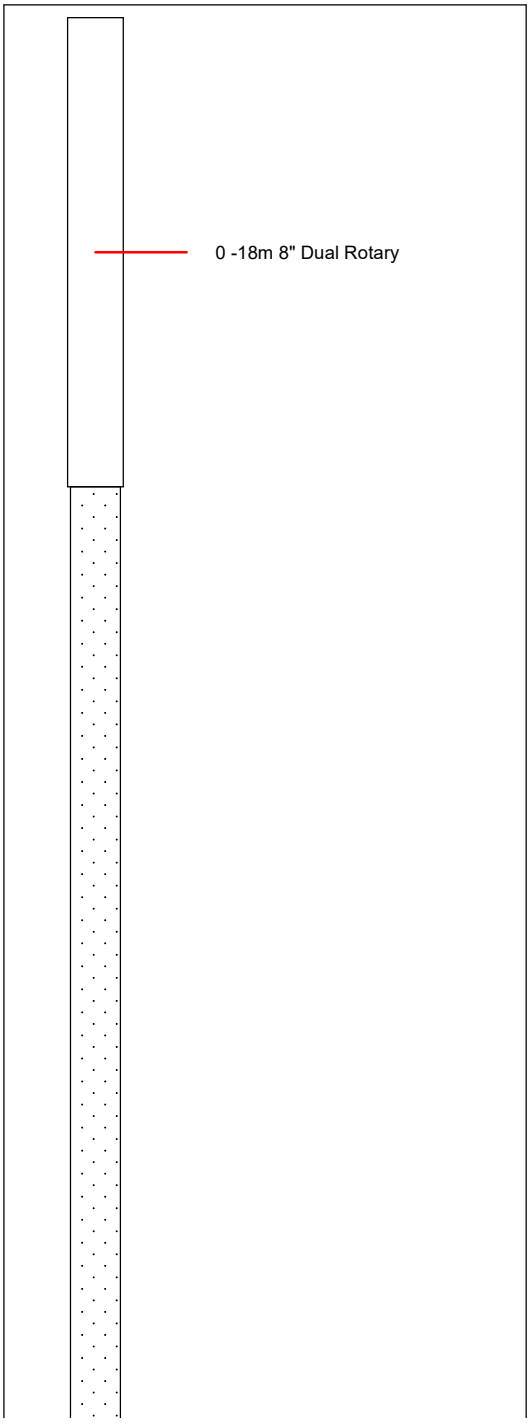
PRODUCTION BORE LOG

BOREHOLE NUMBER
NS-WS001

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO:
EASTING: **708766**
NORTHING: **7644348**
ELEVATION (mAHD): **0**
DATE BEGUN: **21-Mar-2020** DATE COMPLETED: **25-Mar-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204 (pilot hole)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	ASkbm		CO: DETRITUS; Highly weathered and oxidised silt and conglomerate material with angular clasts of chert. BASALT; Angular, very hard and moderately weathered.			
10	ASkbm		BASALT: BASALT; Grey to green, partly weathered some fresh, dark microcrystalline matrix, 1-2mm inclusions, minor oxidation,hard, angular and poorly sorted.			
25	ASkbm		MUDSTONE: MUDSTONE; Light grey, relatively soft, fine grained, well weathered and poorly sorted, some dark basalt inclusions, some very fine and soft white clay inclusions dotted within the mudstone .		1050	7.58
35				3	1019	7.65
40	ASkbm		MUDSTONE: MUDSTONE; As above with some surface oxidation.	3	1032	7.7
45				3	1002	7.74
50				3	1075	8.07
	ASkbm		CH: CHERT; black, very hard, fresh, angular and			

PRODUCTION BORE LOG

BOREHOLE NUMBER
NS-WS001

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO:
EASTING: **708766**
NORTHING: **7644348**
ELEVATION (mAHD): **0**
DATE BEGUN: **21-Mar-2020** DATE COMPLETED: **25-Mar-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204 (pilot hole)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	55			relatively well sorted. Minor QUARTZ; Dark smoky to white and traslucent, very hard, angular, fresh, moderately sorted.			
	60				3	1007	7.75
	65	**ASkbm**		SANDSTONE: SANDTONE; Light grey to pick, fine sand and silica matrix, hard, sub-angular, relatively fresh only minor weathering. Trace CHERT; As above, incresed at 78m and 84m.	3	1044	7.86
	70				3	1026	7.78
	75				3	1033	7.75
	80						
	85	**ASkbm**		SANDSTONE: SANDSTONE; Darker than above but still lightly coloured, hard, angular, relatively well sorted and fresh, some black chert vaining.	3	1072	7.8
	90	**ASkbm**		SANDSTONE: SANDSTONE; Continues to get darker with depth but still light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh, black chert bands at 94, 110 and 112m.	3	1077	7.82
	95				3	1126	7.91
	100				3	1046	7.84
	105						

PRODUCTION BORE LOG

BOREHOLE NUMBER
NS-WS001

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PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO:
EASTING: **708766**
NORTHING: **7644348**
ELEVATION (mAHD): **0**
DATE BEGUN: **21-Mar-2020** DATE COMPLETED: **25-Mar-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204 (pilot hole)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
18 - 204m 7" Air Hammer	110				3	1076	7.88
	115				3	1085	7.97
		ASkbm		SANDSTONE: WACKE SANDSTONE; Light brown, fine grained blended in to silica matrix, hard, angular, well sorted, fresh gravel.			
	120	ASkbm		SANDSTONE: SANDSTONE; Continues to get darker with depth but still light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh, black chert bands at 122, 130 and 138-140m.	3	1120	7.77
	125				3	1075	7.76
	130				3	1039	7.69
	135				3	1047	7.73
	140	ASkbm		SANDSTONE: WACKE/SANDSTONE; Light grey to light brown, fine grain in silica and light carbonate matrix, hard, angular and lightly weathered.	3	1036	7.69
	145						
	150	ASkbm		SANDSTONE: Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.	4	1011	7.68
	155				4	1027	7.66
	160			CH: CHERT; Black, very hard, fresh, angular and			

PRODUCTION BORE LOG

BOREHOLE NUMBER
NS-WS001

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
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PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO:
EASTING: **708766**
NORTHING: **7644348**
ELEVATION (mAHD): **0**
DATE BEGUN: **21-Mar-2020** DATE COMPLETED: **25-Mar-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204 (pilot hole)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
		ASkbm		relatively well sorted	4	1036	7.86
	165	ASkbm		SANDSTONE: SANDSTONE; Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.	4	1024	7.66
	170	ASkbm		SANDSTONE: SANDSTONE; As above. Minor QUARTZ: White to off-white, hard angular, fresh and angular.	4	1026	7.63
	175	ASkbm		CH: CHERT; As per 162 - 164m	4	1023	7.64
	180	ASkbm		SANDSTONE: SANDSTONE; Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.	4	1033	7.62
	185	ASkbm		SANDSTONE: SANDSTONE; As above, minor chert band (~5% of sample).	4	1044	7.75
	190	ASkbm		SANDSTONE: SANDSTONE; Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.	4	1025	7.65
	195	ASkbm		SANDSTONE: CHERT and SANDSTONE; Black, very hard, fresh, 30 - 50% Sandstone in sample			
	200	ASkbm		SANDSTONE: SANDSTONE; as above but fracture or weathered zone within 200 - 204m interval, 20mm well oxidised chips; white to orange in colour; friable			
		ASkbm		SANDSTONE: SANDSTONE; Light grey colour, fine sand in a silica matrix, metamorphosed, hard, angular, relatively well sorted and fresh.			

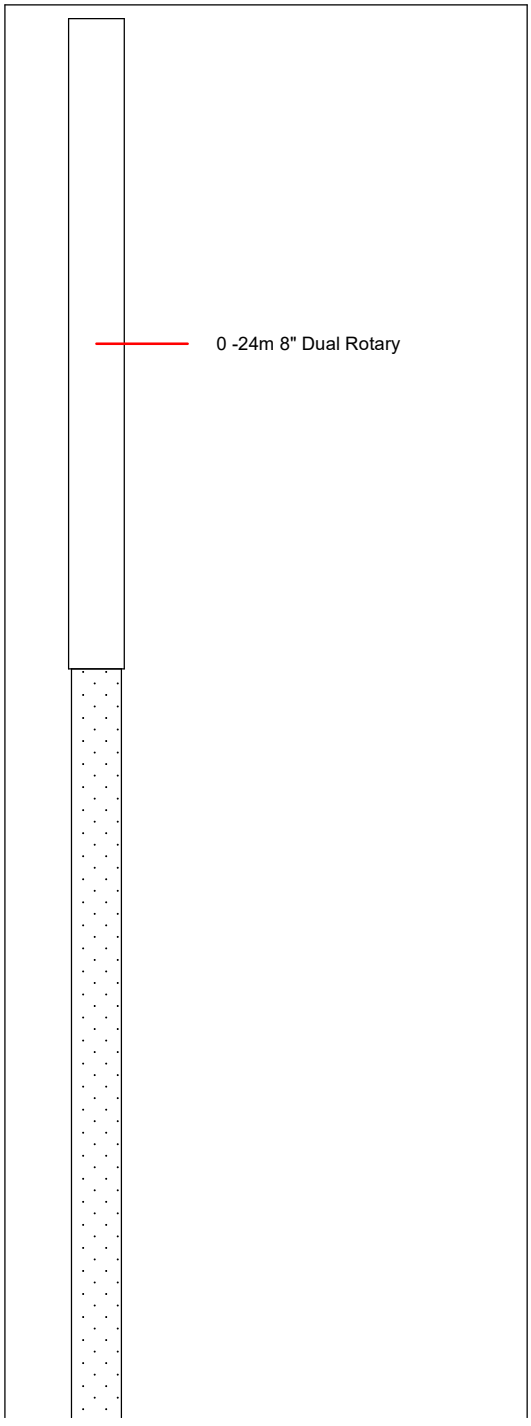
PRODUCTION BORE LOG

BOREHOLE NUMBER
NS-WS005

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**Iron Bridge Near Mine**
LOCATION:	**Iron Bridge Southern Borefield**
DRILLING CO:	**Boart Longyear**
DRILLING METHOD:	**DualRotary/AirHammer**
LOGGED BY:	**Moshe Caro**
FIELD BOOK NO:	**1**
EASTING:	**709469.718**
NORTHING:	**7644925.541**
ELEVATION (mAHD):	**273.571**
DATE BEGUN:	**5-Feb-2020** DATE COMPLETED: **12-Feb-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	198 (pilot hole)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	ASkuk		MUDSTONE: Redish pink and light grey to off-white, arenaceous, well weathered, relatively hard but brittle, sub-angular to sub-rounded,			
5	ASkuk		MUDSTONE: Off-white to a light pink staining and purple, mod weathered, arenaceous.			
10	ASkuk		SANDSTONE: Light grey, arenaceous, minor chert and sandstone, lightly weathered, relatively hard, minor very hard angular quartz. More sandstone with depth.			
15						
20						
25						
30	ASkuk		SANDSTONE: Light grey with minor pinkish, white and translucent larger quartz gravels, mod weathered.			
35						
40	ASls		SANDSTONE: Light grey with minor pinkish sandstone, well weathered to cemented gravels, relatively hard minor white, translucent and smoky quarts.			
45						
50	ASls		SANDSTONE: Slightly darker than above with very dark to black angular and hard chert with some quarts veining. Increased quartz and some oxidation.			

PRODUCTION BORE LOG

BOREHOLE NUMBER
NS-WS005

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**Iron Bridge Near Mine**
LOCATION:	**Iron Bridge Southern Borefield**
DRILLING CO:	**Boart Longyear**
DRILLING METHOD:	**DualRotary/AirHammer**
LOGGED BY:	**Moshe Caro**
FIELD BOOK NO:	**1**
EASTING:	**709469.718**
NORTHING:	**7644925.541**
ELEVATION (mAHD):	**273.571**
DATE BEGUN:	**5-Feb-2020** DATE COMPLETED: **12-Feb-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	198 (pilot hole)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	55						
	60						
	65						
	70						
	75						
	80						
	85						
	90						
	95						
	100	**ASIs**		SANDSTONE: Grey as above, some weathering but more lithified and slightly darker, quartz gravels still present, slight oxidation.	1.2	1446	8.31

PRODUCTION BORE LOG

BOREHOLE NUMBER
NS-WS005

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Southern Borefield**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
FIELD BOOK NO: **1**
EASTING: **709469.718**
NORTHING: **7644925.541**
ELEVATION (mAHD): **273.571**
DATE BEGUN: **5-Feb-2020** DATE COMPLETED: **12-Feb-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	198 (pilot hole)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
24 - 198m 7" Air Hammer	105				2.9	1382	8.3
	110						
	115	ASIs		SANDSTONE: Darker grey than above, lithifications seems to be increasing, moderately weathered, hard, sub-angular cuttings with increased quartz, some reddish pink oxidation, trace lightly coloured chert. Fractures between 122 - 130m and 140 - 144m.	1.8	1262	8.17
	120				2.9	1256	8.17
	125				3.3	1291	8.15
	130				4.9	1326	7.95
	135				6.8	1050	7.98
	140				6.8	1068	8.03
	145						
	150	ASIs		SANDSTONE: Sandstone/quartzite with 2-5% black chert and 5% quartz (smokey grey, white and clear), slightly weathered with minor iron staining in quartz, subrounded to angular, Chip size 2-10mm	5.5	1120	8.08
	155	ASIs		SANDSTONE: As above with increase in chert 5-10% and quartz 5-10%, slightly larger chip size 2-5% >10mm-<15mm, larger white quartz up to 10mm			

PRODUCTION BORE LOG

BOREHOLE NUMBER
NS-WS005

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**Iron Bridge Near Mine**
LOCATION:	**Iron Bridge Southern Borefield**
DRILLING CO:	**Boart Longyear**
DRILLING METHOD:	**DualRotary/AirHammer**
LOGGED BY:	**Moshe Caro**
FIELD BOOK NO:	**1**
EASTING:	**709469.718**
NORTHING:	**7644925.541**
ELEVATION (mAHD):	**273.571**
DATE BEGUN:	**5-Feb-2020** DATE COMPLETED: **12-Feb-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	198 (pilot hole)	
Cased Depth (mbgl):	N/A	
Stick Up (magl):	N/A	
Airlift Yield (L/s):	N/A	
Water Level (mbgl) & Date:	N/A	
Quallity - pH & EC (uS/cm):	N/A	N/A

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	160	ASIs		SANDSTONE: As per 152 but increased chip size with 10% over 10mm, only trace chert at 158m	6.1	1084	8.06
					6.8	1232	7.8
	165	ASIs		SANDSTONE: Sandstone/quartzite with 2-5% black chert and 5-7% quartz (smokey grey, white and clear), slightly weathered, subrounded-angular, chip size 2-10mm with 3-5% >10mm - <15mm			
					8.3	1115	7.92
	170	ASIs		SANDSTONE: Slightly darker grey, sandstone/quartzite slight increase in sandstone compared to quartzite, trace chert and 5-7% quartz, more angular to subangular and increase in chip size with 10% >10mm - <15mm			
	175	ASIs		SANDSTONE: Light grey sandstone/quartzite as above, increase in chert 2-5% and quartz 10-20%, subrounded-subangular, chip size as above with larger quartz chips 10-15mm at 174-178m	8.3	1103	7.89
	180	ASIs		SANDSTONE: Light grey sandstone/quartzite with trace chert and reduction in quartz 5-10%	8.3	1106	8.36
		ASIs		SANDSTONE: As above with slight increase in chert 2-5% and trace iron staining in quartz			
	185				8.3	1154	8.36
	190	ASIs		SANDSTONE: Light grey sandstone/quartzite with increase sandstone, more angular and smaller chip size 2-10mm, chert 5% and quartz 5-7%, trace pink sandstone	9	1156	7.95
	195	ASIs		SANDSTONE: Light grey sandstone/quartzite with increase sandstone, more angular and smaller chip size 2-10mm, chert 5% and quartz 5-7%, trace pink sandstone	9	1095	7.91
		ASIs		SANDSTONE: As above with increase in chert 10% and quartz 10%, iron staining in quartz			
		ASIs		SANDSTONE: As above with increase in chert 10% and quartz 10%, iron staining in quartz			

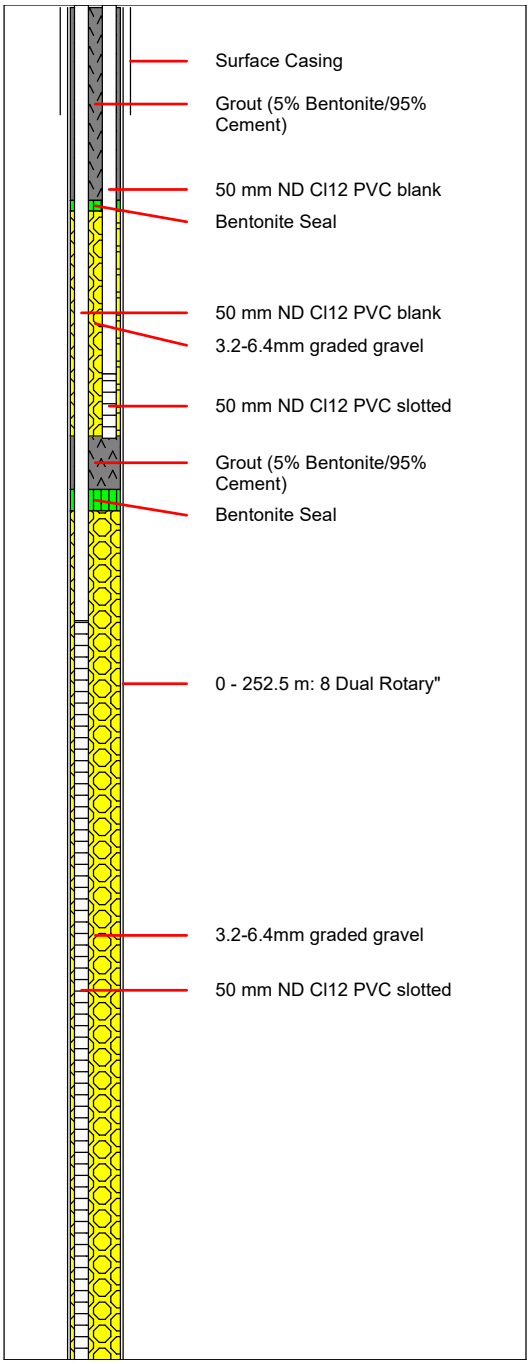
MONITORING BORE LOG

BOREHOLE NUMBER
GVM01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **North Star**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Fumba Donzo**
FIELD BOOK NO:
EASTING: **713151**
NORTHING: **7649401**
ELEVATION (mAHD): **386.5**
DATE BEGUN: **18/09/2018** DATE COMPLETED: **21/09/2018**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	252.5
Cased Depth (mbgl):	252.5
Stick Up (magl):	0.5
Airlift Yield (L/s):	0.5
Water Level (mbgl):	49.04
Quallity - pH & EC (uS/cm):	



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	TE		Clay: Yellow brown clay with unconsolidated & subangular gravel clasts of BIF. Geothite and hematite; clay content is more than 50%.			
5						
10	POX		Hematite: Purplish to reddish brown hematite with minor BIF; non-magnetic to weakly magnetic oxidised zone;strongly weathered zone; angular chips			
15						
20						
25						
30			Banded Iron Formation: Red- grayish grey BIF with minor hematite; weakly-moderately magnetic oxidised zone; Moderately weathered.			
35						
40			Banded Iron Formation: Purplish to reddish brown hematite with minor BIF; weakly-magnetic to moderately magnetic oxidised zone;strongly weathered zone; angular chips			
45						
50						
55			Banded Iron Formation: Reddish - grayish grey BIF; Moderately magnetic oxidised zone; moderately weathered; angular chips			
60						
65	PBG		Banded Iron Formation: Purplish to reddish brown hematitc BIF; moderately magnetic oxidised zone;strongly weathered zone; angular chips			
70						
75				0.05	356	7.74
80			Banded Iron Formation: reddish- grayish grey BIF with minor hematite; moderately magnetic oxidised zone; transition between POX and PCG			
85						
90						
95			Banded Iron Formation: Mostly grey BIF; moderately magnetic fresh PBG; angular chips.			
100						
105			Banded Iron Formation: Reddish brown - purplish grey hematitic BIF; strongly magnetic fresh PBR; minor quartz vein & cherty shale throughtout; angular chips.			
110						
115						
120						
125						
130						
135						
140					488	7.33
145					491	7.3
150					564	7.15
155					524.6	7.2
160					621	7.2
165					350	7.43
170					353	7.22
175					360	7.45
180					311	7.38
185					300	7.74
190					331	7.57
195					334	7.63
200					311	7.64
205					342	7.76
210					325	7.68
215					304	7.5
220			Banded Iron Formation: Reddish grey - greenish grey BIF; moderately magnetic fresh PBG;minor quartz vein throughtout.		301	7.61
225					309.4	7.79
230					301	7.57
235					323.7	7.65
240			Banded Iron Formation: Reddish grey - greenish grey BIF; strongly magnetic fresh PBG;minor quartz vein throughtout.			
245						
250	PBR		Banded Iron Formation: Reddish grey - purplish grey hematitic			

MONITORING BORE LOG

BOREHOLE NUMBER
GVM01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **North Star**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Fumba Donzo**
FIELD BOOK NO:
EASTING: **713151**
NORTHING: **7649401**
ELEVATION (mAHD): **386.5**
DATE BEGUN: **18/09/2018** DATE COMPLETED: **21/09/2018**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	252.5	
Cased Depth (mbgl):	252.5	
Stick Up (magl):	0.5	
Airlift Yield (L/s):	0.5	
Water Level (mbgl):	49.04	
Quallity - pH & EC (uS/cm):		

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
				BIF; strongly magnetic fresh PBR;minor quartz vein throughtout..			

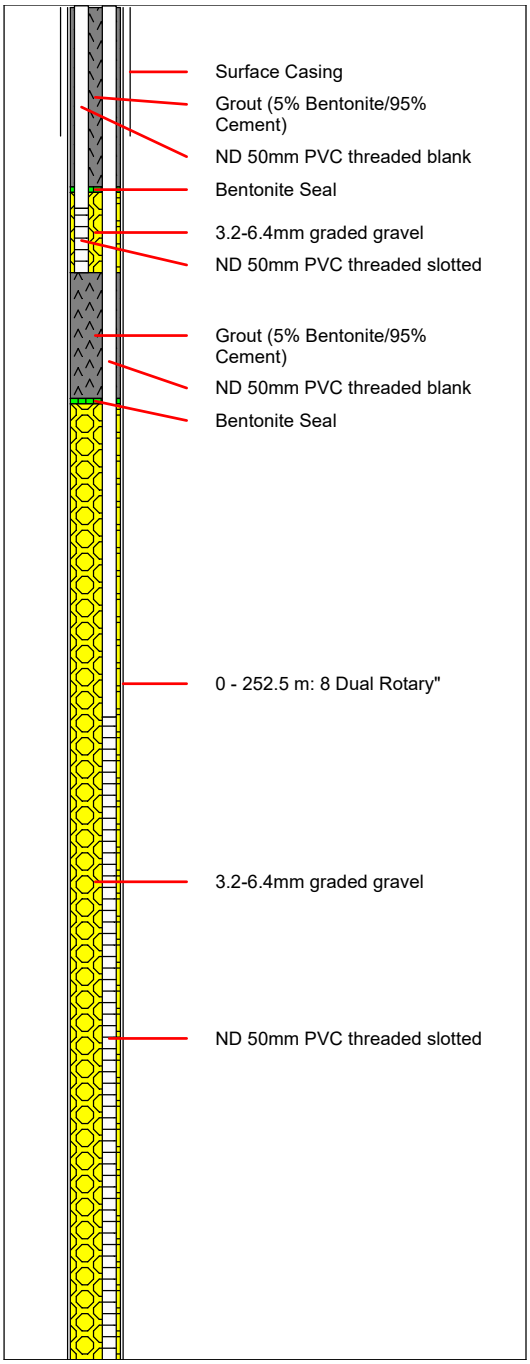
MONITORING BORE LOG

BOREHOLE NUMBER
GVM02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **Glacier Valley**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Fumba Donzo**
FIELD BOOK NO:
EASTING: **713669**
NORTHING: **7644749**
ELEVATION (mAHD): **396.5**
DATE BEGUN: **7/09/2018** DATE COMPLETED: **14/09/2018**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	252.5
Cased Depth (mbgl):	252.5
Stick Up (magl):	0.3
Airlift Yield (L/s):	0.5
Water Level (mbgl):	38.09
Quallity - pH & EC (uS/cm):	



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	PM		Clay: Light brown clay with unconsolidated clasts of cherty and geothitic gravel. Clay content is about 15%; intersection likely to be filled material			
5						
10	PHC		Banded Iron Formation: Yellow brown to pale light yellow geothitic BIF with minor hematite; partially mineralised zone; clay content is 20 %; Subangular chips; Intense weathered zone			
15						
20	POX		Banded Iron Formation: Brown dark hematitic BIF with minor geothite; partially mineralised; subangular chips; moderately -highly weathered zone. Clay content is 25%			
25						
30						
35	PBN		Banded Iron Formation: Brown - greenish grey BIF; minor clay and hematite. Transition between oxidation and fresh ore zone. Angular chips; clay content is 20%			
40						
45	PBR		Banded Iron Formation: Greenish grey BIF; weakly magnetic fresh; minor hematite and quartz vein; trace of pyrite in some intervals.			
50						
55						
60			Banded Iron Formation: greenish - reddish BIF; moderatelly magnetic fresh; minor quartz vein. water hits around 46-48m. angular chips			
65						
70						
75			Banded Iron Formation: Greenish - reddish BIF; strongly magnetic fresh; minor quartz vein throughout			
80						
85						
90			Banded Iron Formation: Greenish grey shaley BIF; non to weakly magnetic fresh; minor quartz vein; angular chips	0.05	478	8.15
95				0.05	442	8.2
100			Banded Iron Formation: greenish - reddish BIF; strongly magnetic fresh; minor quartz vein;	0.05	636	8.16
105				0.05	620	8.07
110			Chert: green cherty BIF. with quartz and pyrite vein; non magnetic fresh green.	0.05	601	8.3
115				0.05	715	8.38
120			Banded Iron Formation: reddish grey BIF; strongly magnetic fresh; minor quartz vein throughout.	0.05	717	8.23
125				0.05	761	8.22
130			Chert: Green cherty BIF. with quartz vein; non magnetic fresh green; angular chips.	0.05	686	8.17
135				0.05	739	8.24
140				0.05	810	8.44
145				0.05	384	8.63
150				0.05	690	8.45
155				0.05	794	8.53
160			Banded Iron Formation: Reddish to greenish grey BIF; weakly magnetic fresh grey. Angular chips.	0.05	858	8.54
165				0.05	785	8.55
170			Banded Iron Formation: Reddish to greenish grey BIF; moderately magnetic fresh grey. Angular chips.	0.05	1153	8.82
175				0.05	769	8.45
180			Banded Iron Formation: Reddish to greenish grey BIF; moderately to strongly magnetic fresh grey. Angular chips.	0.05	1060	8.77
185				0.05	723	8.41
190			Banded Iron Formation: Reddish to greenish grey BIF. with quartz vein throughout; strongly magnetic fresh grey. Angular chips.	0.05	737	7.8
195				0.05	964	7.92
200			Chert: Green cherty BIF. with quartz vein; non magnetic fresh green; angular chips.	0.05	807	8.06
205				0.05	754	8
210			Banded Iron Formation: Reddish to greenish grey BIF; strongly magnetic fresh grey. Angular	0.05	498	8
215				0.05	674	8
220			Chert: Green cherty BIF. with quartz vein; non magnetic fresh green; angular chips.	0.05	570	8.02
225						
230						
235			Banded Iron Formation: Reddish to greenish grey BIF. with quartz vein throughout; strongly magnetic fresh grey. Angular chips.			
240						
245	PCN		Chert: Green cherty BIF. with quartz vein; non magnetic fresh green; angular chips. E.O.H			
250						

MONITORING BORE LOG

BOREHOLE NUMBER
GVM02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **Glacier Valley**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Fumba Donzo**
FIELD BOOK NO:
EASTING: **713669**
NORTHING: **7644749**
ELEVATION (mAHD): **396.5**
DATE BEGUN: **7/09/2018** DATE COMPLETED: **14/09/2018**

FINAL BORE DETAILS	
Drilled Depth (mbgl):	252.5
Cased Depth (mbgl):	252.5
Stick Up (magl):	0.3
Airlift Yield (L/s):	0.5
Water Level (mbgl):	38.09
Quallity - pH & EC (uS/cm):	

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
		PFR					

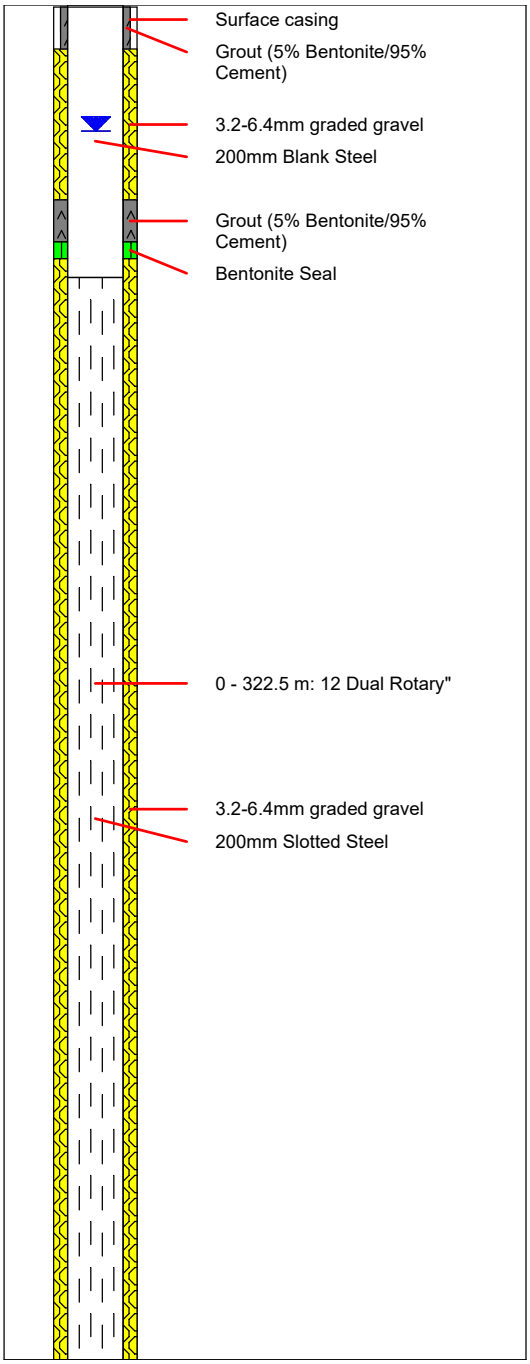
PRODUCTION BORE LOG

BOREHOLE NUMBER
GVP01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **Glacier Valley**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Fumba Donzo**
FIELD BOOK NO:
EASTING: **713496.18**
NORTHING: **7644588.1**
ELEVATION (mAHD): **409.5**
DATE BEGUN: **27/09/2018** DATE COMPLETED: **5/10/2018**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	322.5	
Cased Depth (mbgl):	322.5	
Stick Up (magl):	0.97	
Airlift Yield (L/s):		
Water Level (mbgl) & Date:		
Quallity - pH & EC (uS/cm):	8.5	356



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	POX	Banded Iron Formation: Oxidise Pincunah. Martite with red shales and minor chert/quartz			
5		No Sample: No Sample return due to cavity. Grouted up from 22m to 5m			
10		Banded Iron Formation: Red martitic BIF. quartz/chert and pink shales			
15					
20					
25					
30					
35					
40					
45					
50	PFR	Banded Iron Formation: red pink Pincunah. martite with chert. quartz and pink shales. Minor goethite			
55					
60					
65					
70					10
75		Banded Iron Formation: cherty oxidised BIF. Red martite with minor red shales			10
80					10
85					10
90					10
95		Banded Iron Formation: Cherty oxidised BIF. red martite with minor shales			10
100					8.93
105					9.94
110		Banded Iron Formation: White and red chert with with minor to medium magnetite content			9.1
115					8.91
120					9.88
125		Banded Iron Formation: White and red chert. medium to high content og magnetite			9.21
130					8.65
135					8.43
140		Banded Iron Formation: Red chert. white chert. increasing magnetite			8.82
145					8.52
150					8.91
155		Banded Iron Formation: red chert. white chert. increasing magnetite			9.8
160					
165					
170					
175					
180					
185		Banded Iron Formation: red chert. white chert. increasing magnetite			
190					
195					7.85
200		Banded Iron Formation: green white chert. decreasing red chert. minor magnetite			7.67
205					
210					
215		Banded Iron Formation: Green white chert. red chert. minor magnetite			
220					
225					
230		Banded Iron Formation: green and red chert. white chert with minor to no magnetite			
235					
240					
245		Banded Iron Formation: white and green chert. red chert. minor magnetite			
250					
255					
260		Banded Iron Formation: red chert. white green chert. minor magnetite			
265					
270					
275					
280		Banded Iron Formation: Red chert. white/green chert. minor magnetite. Decreaseing chip size. possible marker of broken ground.			
285					
290					
295					
300	PBR				8.13
305		Banded Iron Formation: Red chert. white/green chert. minor magnetite. Decreaseing chip size. possible marker of broken ground.			
310					
315	PFN				
320					

PRODUCTION BORE LOG

BOREHOLE NUMBER
GVP01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **Glacier Valley**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Fumba Donzo**
FIELD BOOK NO:
EASTING: **713496.18**
NORTHING: **7644588.1**
ELEVATION (mAHD): **409.5**
DATE BEGUN: **27/09/2018** DATE COMPLETED: **5/10/2018**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	322.5	
Cased Depth (mbgl):	322.5	
Stick Up (magl):	0.97	
Airlift Yield (L/s):		
Water Level (mbgl) & Date:		
Quallity - pH & EC (uS/cm):	8.5	356

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
	320	PFG		Banded Iron Formation: Reddish grey PFR. moderately magnetic fresh red. Minor quartz vein throughout.			
				Banded Iron Formation: Reddish - greenish grey BIF. moderately magnetic fresh red; minor quartz vein throughout.			
				Banded Iron Formation: Greenish grey BIF; weakly magnetic fresh grey; minor quartz vein throughtout; E.O.H at 319.5 m			

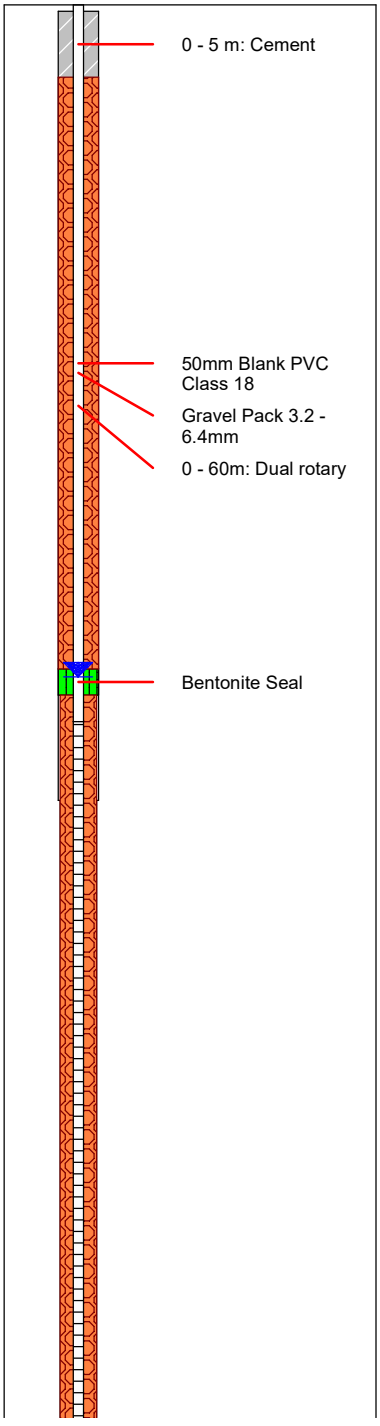
MONITORING BORE LOG

BORE NUMBER
IB_GVS_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Glacier Valley**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
PILOT HOLE ID: **GV-DEW008R**
EASTING: **713944.77**
NORTHING: **7644272.45**
ELEVATION (mAHD): **421.63**
DATE BEGUN: **15-Jul-2020** DATE COMPLETED: **24-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204	
Cased Depth (mbgl):	204	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.15	
Water Level (mbgl) & Date:	50.61	20/07/2020
Quality - pH & EC (uS/cm):	7.59	1331



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0		Sandy GRAVEL: Red to brown in colour, very angular.			
10	PBB	BIF: Brown to purple in colour; fine grained; angular; high hardness; small chips sometimes platy and tabular; metallic; magnetic.			
30	PBY	BIF: Yellow-white-brown in colour; fine grained; subangular; moderate hardness; less magnetic than above, bedded; increased chip size; occasiaonal chert; goethite; oxidation and alteration on chip surfaces; Particulary large block fragments returned at 36 - 38m and 42 - 44m; weathered/broken zone from 28m to 56m likely permeable but unsaturated.			
55	PBG	BIF: Grey-purple-green-red in colour; fine grained; angular; high hardnesss; bedded on mm scale; strongly magnetic; ore; fresh.			
60	AGi	BIF: Red to yellow in colour; low in hardness; light in weight; original bedding fabric sometimes visible; not magnetic; small vuggs; Particulary weathered.	0.7	1039	7.26
65	PBG		0.7	1102	7.82
70		BIF: Grey-purple-green-red in colour; fine grained; angular; high hardnesss; strongly magnetic; ore; fresh; bedded; 5% quartz; banded on mm scale. Weathered interval at 84-86m possibly associated with increase in flow rate measured at 90m.	0.7	1087	8.05
80			0.7	1106	8.23
85			0.7	1108	8.19
90	AGi	MUDSTONE/SHALE: Dark grey to black; fine grained; light in weight; freqyent pyrite; not magnetic; no bedding fabric; not permeable.	1.5	1241	8.14
95	AGi	BIF (unmineralised): Light grey-light purple-light green; fine grained; high hardness; not magnetic; fine grained; 5% quartz; fresh and not permeable.	1.5	1191	8.1
100			1.5	1161	8.1
105					

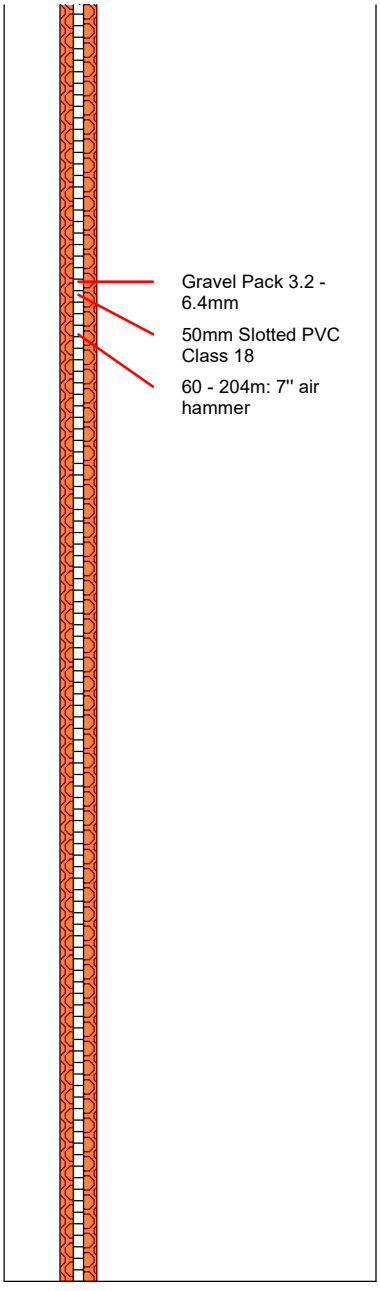
MONITORING BORE LOG

BORE NUMBER
IB_GVS_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Glacier Valley**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
PILOT HOLE ID: **GV-DEW008R**
EASTING: **713944.77**
NORTHING: **7644272.45**
ELEVATION (mAHD): **421.63**
DATE BEGUN: **15-Jul-2020** DATE COMPLETED: **24-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204	
Cased Depth (mbgl):	204	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.15	
Water Level (mbgl) & Date:	50.61	20/07/2020
Quality - pH & EC (uS/cm):	7.59	1331



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
110			1.5	1172	8.21
115			1.5	1207	8.16
120			1.5	1182	8.23
125			1.5	1220	7.67
130			1.5	1097	7.7
135	AGi	MUDSTONE/SHALE: Dark grey in colour; fine grained; angular; high hardness; light in weight; not bedded; metamorphosed; 1% quartz; frequent pyrite; typically fresh with small weathered interval at 150m however not yielding.	1.5	1090	7.65
140			1.5	1138	7.67
145			1.5	1144	7.7
150			1.5	1196	7.72
155			1.5	1133	7.79
160			1.5	1146	7.98
165			1.5	1179	7.98
170			1.5	1133	8.02
175			1.5	1105	7.94
180	AGi	MUDSTONE/SHALE and CHERT: Overall dark grey in colour; typically a SHALE/MUDSTONE (70%) as described above interbedded with a grey or clear CHERT (30%); not permeable.	1.5	1096	8
185			1.5	1169	7.75
190					
195					
200					

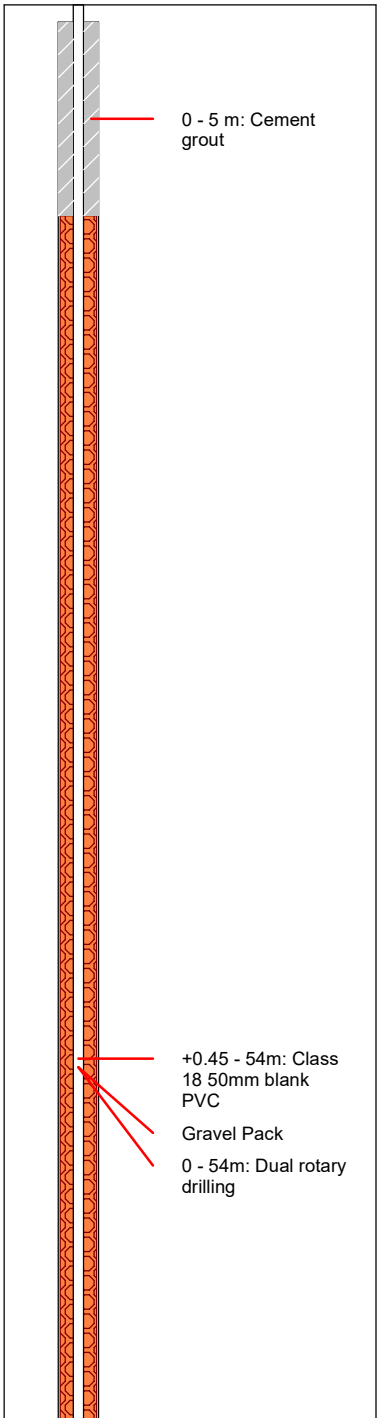
MONITORING BORE LOG

BORE NUMBER
IB_GVS_M02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Glacier Valley**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
PILOT HOLE ID: **GV-DEW007**
EASTING: **713883.98**
NORTHING: **7645048.03**
ELEVATION (mAHD): **416.30**
DATE BEGUN: **20-Jul-2020** DATE COMPLETED: **26-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204	
Cased Depth (mbgl):	204	
Stick Up (magl):	0.45	
Bore Airlift Yield (L/s):	0.004	
Water Level (mbgl) & Date:	54.94	27/07/2020
Quality - pH & EC (uS/cm):	7.73	789



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	HC		0 – 8m HARDCAP: Brown to grey to red in colour; glassy goethite; frequent pisolites; angular and well rounded.			
8	AGi		8 – 16m Very weathered; angular; leached? Cream to purple in colour.			
16	AGi		16 – 38m Very weathered Pincunah Hill Formation: BIF+SHALE/MUDSTONES; yellow - purple - grey in colour; fine to medium grained; low hardness; soft chips; angular; not magnetic; original bedding fabric seen; occasional quartz; very oxidised and weathered; some of sample weathered to clay.			

MONITORING BORE LOG

BORE NUMBER
IB_GVS_M02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**Iron Bridge Near Mine**
LOCATION:	**Glacier Valley**
DRILLING CO:	**Boart Longyear**
DRILLING METHOD:	**DualRotary/AirHammer**
LOGGED BY:	**Moshe Caro**
PILOT HOLE ID:	**GV-DEW007**
EASTING:	**713883.98**
NORTHING:	**7645048.03**
ELEVATION (mAHD):	**416.30**
DATE BEGUN:	**20-Jul-2020** DATE COMPLETED: **26-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204	
Cased Depth (mbgl):	204	
Stick Up (magl):	0.45	
Bore Airlift Yield (L/s):	0.004	
Water Level (mbgl) & Date:	54.94	27/07/2020
Quality - pH & EC (uS/cm):	7.73	789

BORE CONSTRUCTION	FIELD NOTES	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
Bentonite pellet seal		40	AGi		38 – 58m Weathered Pincunah Hill Formation: BIF+SHALE/MUDSTONES; yellow - purple - grey in colour; fine to medium grained; low hardness; soft chips; angular; not magnetic; original bedding fabric seen; occasional quartz; very oxidised and weathered; as above slightly less weathered.			
		60	AGi		58 – 80m MUDSTONE or SHALE: Dark grey; fine grained; moderate to high hardness; not magnetic; pyrite; minor quartz veins; fresh; water strike at base of weathered zone ~59-60m (0.1 L/s)	0.1	1288	7.75
		65				0.1	1308	8.12
		70				0.1	1324	8.17

MONITORING BORE LOG

BORE NUMBER
IB_GVS_M02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Glacier Valley**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
PILOT HOLE ID: **GV-DEW007**
EASTING: **713883.98**
NORTHING: **7645048.03**
ELEVATION (mAHD): **416.30**
DATE BEGUN: **20-Jul-2020** DATE COMPLETED: **26-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204	
Cased Depth (mbgl):	204	
Stick Up (magl):	0.45	
Bore Airlift Yield (L/s):	0.004	
Water Level (mbgl) & Date:	54.94	27/07/2020
Quality - pH & EC (uS/cm):	7.73	789

BORE CONSTRUCTION	FIELD NOTES	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
		75				0.1	1354	8.28
		80	AGi		80 – 84m MUDSTONE or SHALE: Dark grey; fine grained; moderate to high hardness; typically, no bedding fabric; not magnetic; pyrite; minor quartz veins; fresh; some of sample is weakly magnetic.			
		85	AGi		84 – 86m As above; oxidised quartz present; no measurable increase in yield.	0.1	1232	8.26
			AGi		86 – 104m MUDSTONE or SHALE: Dark grey; fine grained; moderate to high hardness; typically no bedding fabric; not magnetic; pyrite; minor quartz veins; fresh; some of sample is weakly magnetic.			
		90				0.1	1348	8.32
		95				0.1	1375	8.33
		100				0.1	1412	8.45
		105	AGi		104 – 134m Cherty BIF: Pincunah formation poorly mineralised; grey - olive green - red in colour; fine grained; bedded; high hardness; frequent small quartz veins; frequent pyrite; contamination from above present; some oxidation of sample from 126 to 130m, otherwise fresh.	0.1	1361	8.46

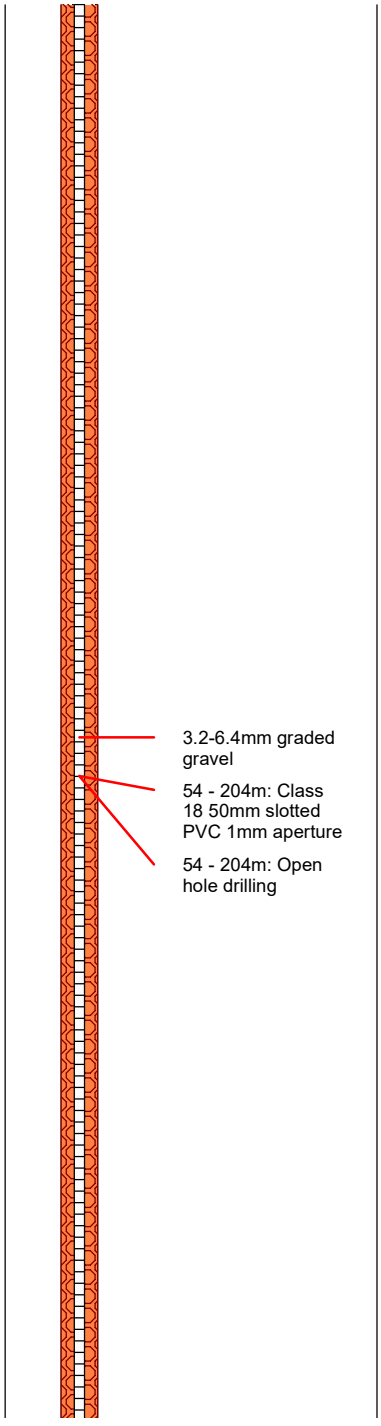
MONITORING BORE LOG

BORE NUMBER
IB_GVS_M02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Glacier Valley**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
PILOT HOLE ID: **GV-DEW007**
EASTING: **713883.98**
NORTHING: **7645048.03**
ELEVATION (mAHD): **416.30**
DATE BEGUN: **20-Jul-2020** DATE COMPLETED: **26-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204	
Cased Depth (mbgl):	204	
Stick Up (magl):	0.45	
Bore Airlift Yield (L/s):	0.004	
Water Level (mbgl) & Date:	54.94	27/07/2020
Quality - pH & EC (uS/cm):	7.73	789



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
110						
115				0.1	1335	8.45
120				0.1	1341	8.47
125				0.1	1397	8.54
130				0.1	1337	8.45
135	AGi		134 – 142m Cherty BIF: Dark grey to reddish grey, hard, moderately weathered, relatively well sorted, sub-angular, some mineralisation and light oxidation.	0.1	1337	8.52
140	AGi		142 – 146m BIF: Light to dark grey, lightly mineralised, hard, some weathering, moderately sorted, sub-round to sub-angular. Minor QUARTZ: Off-white to white, hard, fresh, banding.	0.1	1286	8.47
145						

MONITORING BORE LOG

BORE NUMBER
IB_GVS_M02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Glacier Valley**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
PILOT HOLE ID: **GV-DEW007**
EASTING: **713883.98**
NORTHING: **7645048.03**
ELEVATION (mAHD): **416.30**
DATE BEGUN: **20-Jul-2020** DATE COMPLETED: **26-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204	
Cased Depth (mbgl):	204	
Stick Up (magl):	0.45	
Bore Airlift Yield (L/s):	0.004	
Water Level (mbgl) & Date:	54.94	27/07/2020
Quality - pH & EC (uS/cm):	7.73	789

BORE CONSTRUCTION	FIELD NOTES	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
		150	AGi		146 – 162m Cherty BIF: Grey to light grey, minor weathering, hard, poorly sorted, sub-angular. Minor MUDSTONE: light grey, very fine grained, hard, brittle and fresh.	0.1	1347	8.57
		155				0.1	1320	8.59
		160						
		165	AGi		162 – 172m BIF: Grey to light grey, relatively fresh, hard, poorly sorted, sub-angular to sub-round. Minor MUDSTONE: As above. Trace QUARTZ: As above.	0.1	1361	8.62
		170				0.1	1252	8.29
		175	AGi		172 – 184m BIF: Light to dark grey, relatively fresh, moderately sorted, oxidation bands, sub-angular. Minor CHERT: Light grey, hard, minor weathering, relatively well sorted. Trace MUDSTONE: Light grey, fine grained, fresh, hard. Trace QUARTZ, Off-white to semi translucent.	0.1	1331	8.51
		180				0.1	1190	8.18

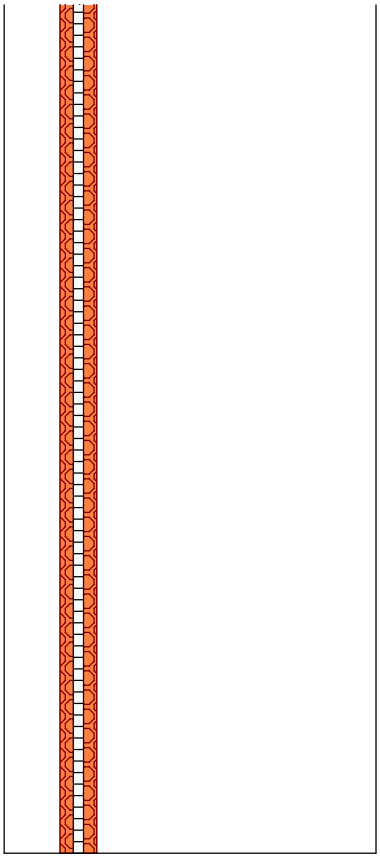
MONITORING BORE LOG

BORE NUMBER
IB_GVS_M02

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Glacier Valley**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro**
PILOT HOLE ID: **GV-DEW007**
EASTING: **713883.98**
NORTHING: **7645048.03**
ELEVATION (mAHD): **416.30**
DATE BEGUN: **20-Jul-2020** DATE COMPLETED: **26-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	204	
Cased Depth (mbgl):	204	
Stick Up (magl):	0.45	
Bore Airlift Yield (L/s):	0.004	
Water Level (mbgl) & Date:	54.94	27/07/2020
Quality - pH & EC (uS/cm):	7.73	789

BORE CONSTRUCTION	FIELD NOTES	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
		185 190 195 200	AGi AGi AGi AGi AGi AGi AGi		172 – 184m BIF: Light to dark grey, relatively fresh, moderately sorted, oxidation bands, sub-angular. Minor CHERT: Light grey, hard, minor weathering, relatively well sorted. Trace MUDSTONE: Light grey, fine grained, fresh, hard. Trace QUARTZ, Off-white to semi translucent. 184 – 190m CHERT: Light grey to greenish and off-white, hard, fresh, angular, some veining. Minor BIF: As Above. Trace PYRITE: Speckled on cuttings 184 – 190m CHERT: Light grey to greenish and off-white, hard, fresh, angular, some veining. Minor BIF: As Above. Trace PYRITE: Speckled on cuttings 190 – 196m BIF: As above. Minor MUDSTONE: As above. Trace QUARTZ: As above. 190 – 196m BIF: As above. Minor MUDSTONE: As above. Trace QUARTZ: As above. 196 – 204m CHERT: Light grey to greenish, hard, relatively fresh, angular, banded and veined, Minor MUDSTONE: Grey, very fine grained, fresh. Minor BIF: Light to dark grey, hard, relatively fresh, sub-angular. Trace QUARTZ: White to semi translucent, hard. 196 – 204m CHERT: Light grey to greenish, hard, relatively fresh, angular, banded and veined, Minor MUDSTONE: Grey, very fine grained, fresh. Minor BIF: Light to dark grey, hard, relatively fresh, sub-angular. Trace QUARTZ: White to semi translucent, hard.	0.1 0.1 0.1	1341 1156 1336	8.49 8.19 8.48

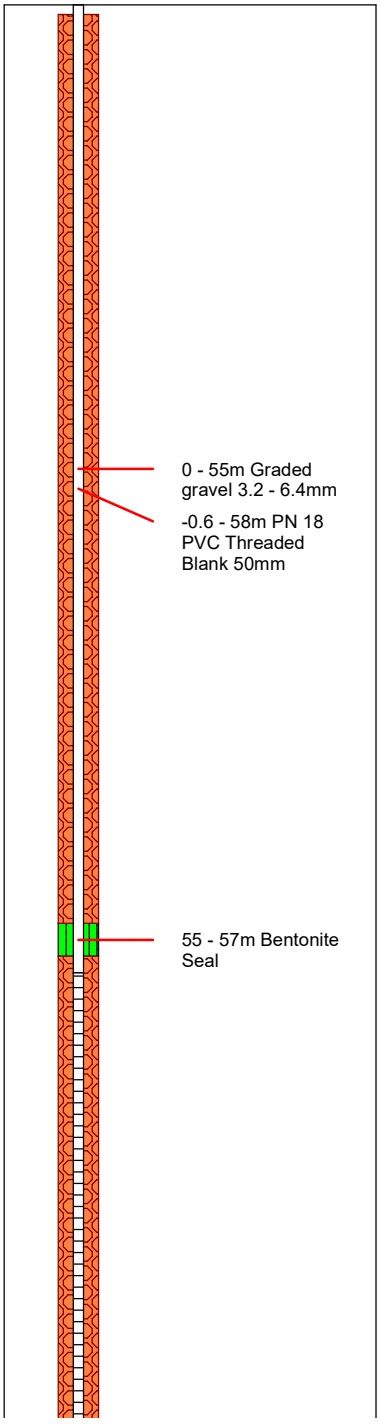
MONITORING BORE LOG

BORE NUMBER
IB_GVN_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**Iron Bridge Near Mine**
LOCATION:	**Glacier Valley**
DRILLING CO:	**Boart Longyear**
DRILLING METHOD:	**DualRotary/AirHammer**
LOGGED BY:	**Moshe Caro/Jack Earnshaw**
PILOT HOLE ID:	**GV-DEW009**
EASTING:	**713627.37**
NORTHING:	**7646253.17**
ELEVATION (mAHD):	**415.93**
DATE BEGUN:	**27-Jul-2020** DATE COMPLETED: **27-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	160	
Cased Depth (mbgl):	160	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.2	
Water Level (mbgl) & Date:	88.43	02/08/2020
Quality - pH & EC (uS/cm):	7.62	726



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	POX	0 - 8m LATERITE: Reddish brown to yellowish orange, well weathered, angular to sub-angular, hard, poorly sorted. CHERT: Reddish brown, smooth, hard. angular, banded & moderate weathering.			
10	PCR	8 – 12m LATERITE: As above but lightly leached. Minor CHERT: As above. MUDSTONE: Light greenish, hard, some weathering, angular. Trace SHALE: Reddish, Well weathered, hard, angular & poorly sorted.			
15	PBG				
20		12 – 24m BIF: Un-mineralised, light grey, moderately weathered, hard, banded, poorly sorted & angular. CHERT: Grey to reddish brown (smoky), very hard, some weathering, some banding. MUDSTONE/SHALE: Pale grey, oxidised bands, angular, moderately weathered & hard.			
25	PS				
30		24 – 34m SHALE: Red to reddish brown, well weathered, relatively hard, sub-angular, fine grained. CHERT: As above. Trace BIF: As above.			
35	PS				
40		34 – 48m SHALE: Yellowish brown to reddish, goethitic, relatively hard, well weathered, poorly sorted & angular. Minor HEMATITE: Dark grey, hard, weathered, angular & poorly sorted. Trace CHERT: Reddish brown & hard.			
45					
50	PBK	48 – 62m MAGNETITE: Dark grey to brownish, magnetic, some pisolites, moderately sorted, hard, sub-angular to sub-round, well weathered. GOETHITIC CLAY: Brownish yellow, extremely weathered, very fine.			
55					
60					
65	PBK	62 – 78m HEMATITE: Greyish to brown, mineralised, hard, well weathered, poorly sorted & angular, non-magnetic, increasing with depth. MAGNETITE: As above but reducing with depth, minor pisolites. Trace QUARTZ: White, hard, relatively fresh, angular & poorly sorted.	1	1305	7.37
70			1	1272	7.76
75					
80	PBK	78 – 88m HEMATITE: Dark grey, non-mineralised, moderately weathered but relatively fresh, hard, poorly sorted, angular. Minor QUARTZ: As above.	1	1328	7.94
85			1	1335	7.95

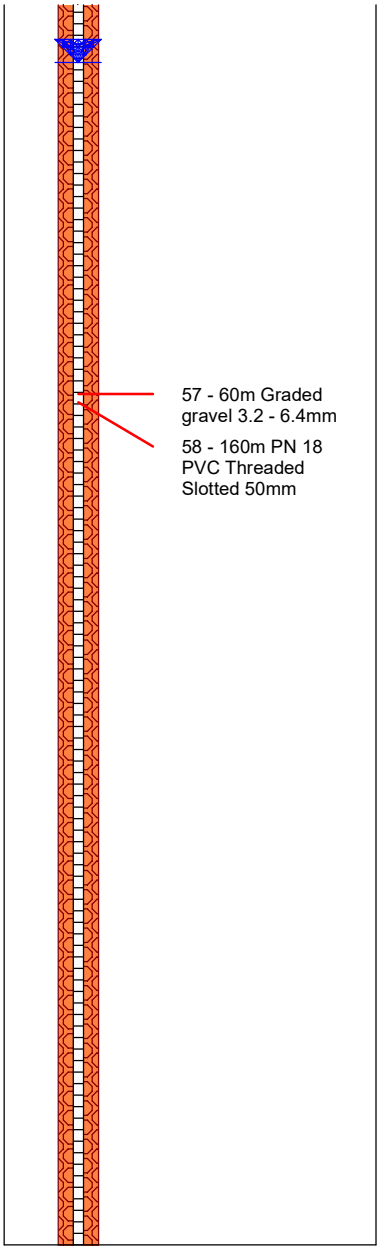
MONITORING BORE LOG

BORE NUMBER
IB_GVN_M01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Glacier Valley**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Moshe Caro/Jack Earnshaw**
PILOT HOLE ID: **GV-DEW009**
EASTING: **713627.37**
NORTHING: **7646253.17**
ELEVATION (mAHD): **415.93**
DATE BEGUN: **27-Jul-2020** DATE COMPLETED: **27-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	160	
Cased Depth (mbgl):	160	
Stick Up (magl):	0.5	
Bore Airlift Yield (L/s):	0.2	
Water Level (mbgl) & Date:	88.43	02/08/2020
Quality - pH & EC (uS/cm):	7.62	726



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
85						
90	AGi		88 – 158m JASPILITE BIF: Banded vivid red and grey, highly mineralised & crystallised, relatively fresh but weathering increasing with depth, hard, angular & moderately sorted with some quartz veining.	1	1252	7.98
95				1	1339	8.11
100				1	1276	8.37
105				1	1287	8.5
110				1	1331	8.49
115				1	1338	8.46
120				1	1370	8.04
125				1	1292	8.24
130				1	726	7.98
135				1	1294	8.36
140				1	1235	8.51
145				1	1254	7.54
150						
155	AGi		156 - 158: MUDSTONE: Dark grey, magnetic, fine grained, not bedded.			
160	AGi		158 – 160m JASPILITE BIF: Banded vivid red and grey, highly mineralised			

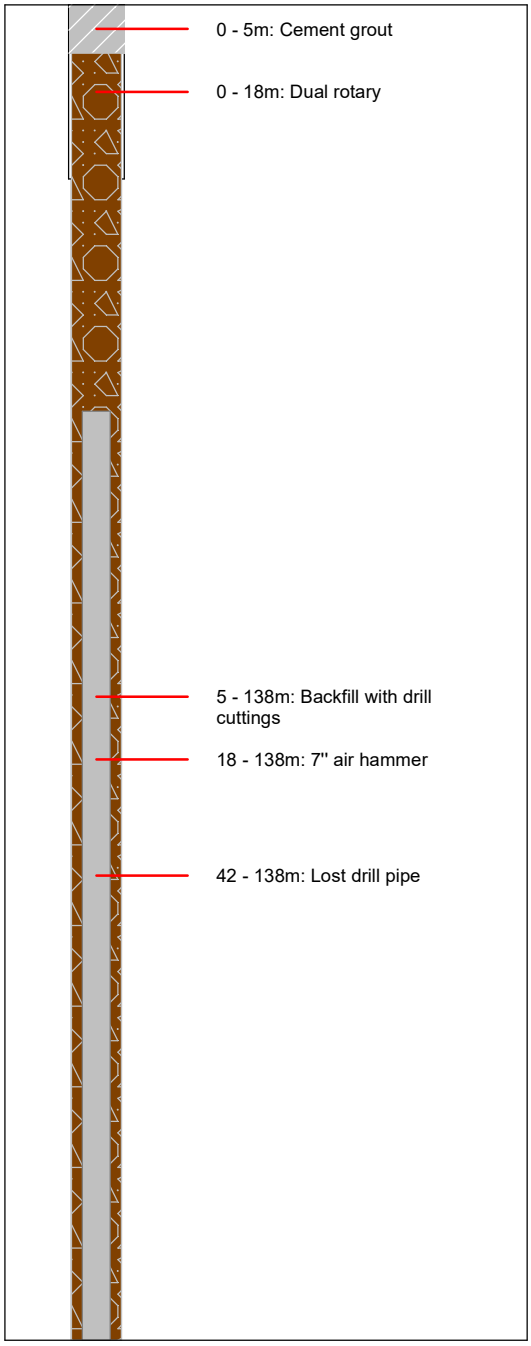
PILOT BOREHOLE LOG

BOREHOLE NUMBER
GV-DEW008

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge Near Mine**
LOCATION: **Iron Bridge Near Mine**
DRILLING CO: **Boart Longyear**
DRILLING METHOD: **DualRotary/AirHammer**
LOGGED BY: **Jack Earnshaw**
FIELD BOOK NO: **Decommissioned borehole**
EASTING: **713934**
NORTHING: **7644273**
ELEVATION (mAHD): **421**
DATE BEGUN: **10-Jul-2020** DATE COMPLETED: **14-Jul-2020**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	138	
Cased Depth (mbgl):	-	
Stick Up (magl):	-	
Airlift Yield (L/s):	0.15	
Water Level (mbgl) & Date:	-	
Quallity - pH & EC (uS/cm):	-	-



DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0			Grv: Sandy GRAVEL: Red to brown in colour, very angular.			
5			BIF: BIF: Brown to purple in colour; fine grained; angular; high hardness; small chips sometimes platy and tabular; metallic; magnetic.			
10						
15						
20						
25						
30			BIF: BIF: Yellow-white-brown in colour; fine grained; subangular; moderate hardness; less magnetic than above, bedded; increased chip size; occasiaonal chert; goethite; oxidation and alteration on chip surfaces; Particulary large block fragments returned at 36 - 38m and 42 - 44m; weathered/broken zone from 28m to 56m likely permeable but unsaturated.			
35						
40						
45						
50			BIF: BIF: Grey-purple-green-red in colour; fine grained; angular; high hardnesss; bedded on mm scale; strongly magnetic; ore; fresh.			
55						
60			BIF: BIF: Red to yellow in colour; low in hardness; light in weight; original bedding fabric sometimes visible; not magnetic; small vuggs; Particulary weathered.	0.7		
65				0.7		
70			BIF: BIF: Grey-purple-green-red in colour; fine grained; angular; high hardnesss; strongly magnetic; ore; fresh; bedded; 5% quartz; banded on mm scale. Weathered interval at 84-86m possibly associated with increase in flow rate measured at 90m.	0.7		
75				0.7		
80				0.7		
85				0.7		
90			MUDSTONE: MUDSTONE/SHALE: Dark grey to black; fine grained; light in weight; freqyent pyrite; not magnetic; no bedding fabric; not permeable.	0.7		
95				0.7		
100			BIF: BIF (unmineralised): Light grey-light purple-light green; fine grained; high hardness; not magnetic; fine grained; 5% quartz; fresh and not permeable.	0.7		
105				0.7		
110				0.7		
115				0.7		
120				0.7		
125			MUDSTONE: MUDSTONE/SHALE: Dark grey in colour; fine grained; angular; high hardness; light in weight; not bedded; metamorphosed; 1% quartz; frequent pyrite; typically fresh with small weathered interval at 150m however not yielding.	0.7		
130						
135				0.7		

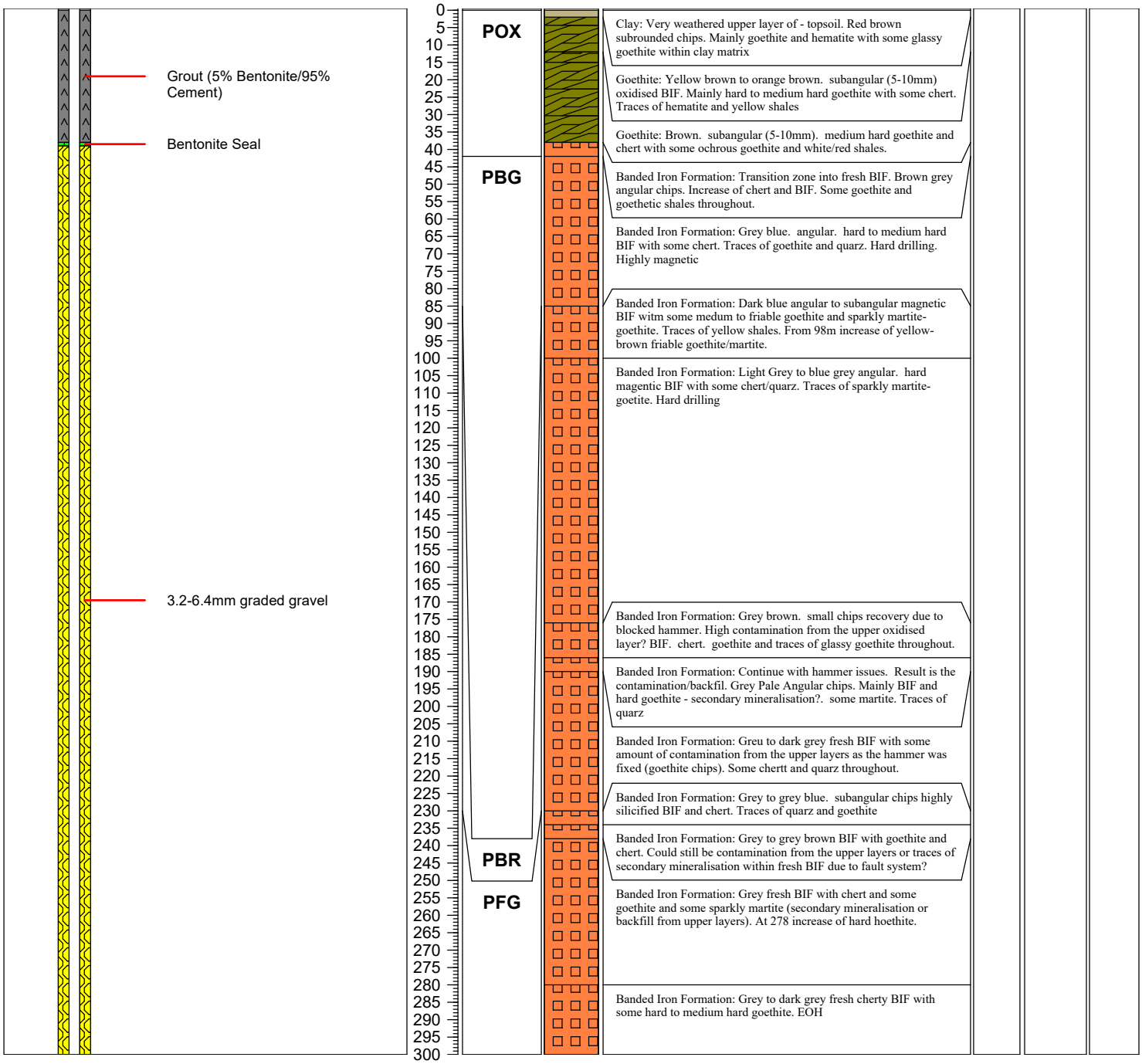
MONITORING BORE LOG

BOREHOLE NUMBER
NSM01

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **North Star**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Fumba Donzo**
FIELD BOOK NO:
EASTING: **713151**
NORTHING: **7649401**
ELEVATION (mAHD): **386.5**
DATE BEGUN: **26/07/2018** DATE COMPLETED: **1/08/2018**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	300	
Cased Depth (mbgl):	300	
Stick Up (magl):	0.6	
Airlift Yield (L/s):	0.5	
Water Level (mbgl):		
Quallity - pH & EC (uS/cm):	8.38	1162



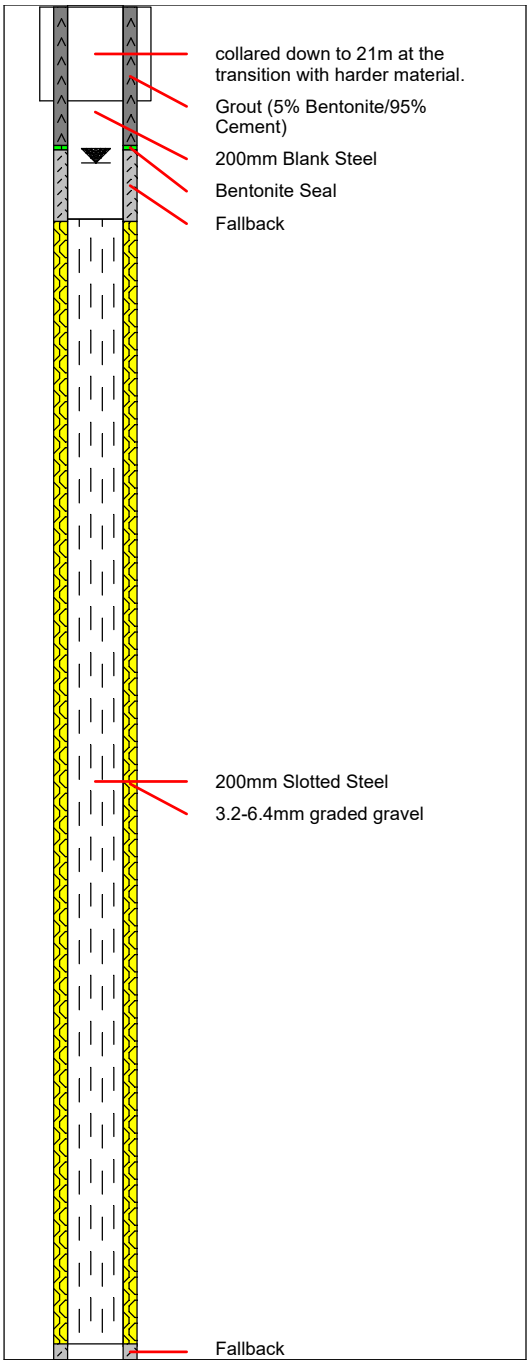
PRODUCTION BORE LOG

BOREHOLE NUMBER
NSP01R

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **North Star**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Paolo Calafa**
FIELD BOOK NO:
EASTING: **713023.49**
NORTHING: **7649397.02**
ELEVATION (mAHD): **382.5**
DATE BEGUN: **16/08/2018** DATE COMPLETED: **21/08/2018**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	303	
Cased Depth (mbgl):	299.46	
Stick Up (magl):	0.63	
Airlift Yield (L/s):		
Water Level (mbgl) & Date:		
Quallity - pH & EC (uS/cm):	8.32	1534



DEPTH (mbgl)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	POX	Banded Iron Formation: No Samples. Hole collared and annulus grouted from 0 to 21m. T piece installed after collaring			
21	PBR	Banded Iron Formation: Transition to Fresh BIF. hard goethite-martite and red/white chert interlayered with minor goethitic shales.			
60		Banded Iron Formation: Grey red cherty BIF. Predominant red chert with minor medium hardness geothite-martite interlayered with goethitic shales.			8.58
75		Banded Iron Formation: Grey to red chert BIF interlayered with magnetite and major white shales			8.97
90		Banded Iron Formation: Grey red chert BIF. Major white/red chert. magnetite interlayered with moderate white shales content.			8.29
105		Banded Iron Formation: red/green chert BIF with magnetite interlayered with major white shales conten. Minor goethitic shales.			8.31
120	PBW				8.25
126	PFN	Banded Iron Formation: Red chert BIF with minor magnetite and major white shales. Minor goethitic shales.			8.41
135		Banded Iron Formation: red/white chert BIF with minor magnetite			8.49
150		Banded Iron Formation: red/white chert BIFwith increasing magnetite content.			8.52
165		Banded Iron Formation: Red/green chert BIF interlayered with magnetite			8.66
180		Banded Iron Formation: Red/white chert interlayered with magnetite. Very minor to rare goethitic shales.			8.57
210	PBG	Banded Iron Formation: Red/green chert interlayered with magnetite. Very minor to rare goethitic shales.			8.63
225	PFW	Banded Iron Formation: Red chert BIF with minor green and white chert interlayered with magnetite. Very minore to no Goethitic shales.			8.74
240		Banded Iron Formation: Red chert interlayered with magnetite. Minor to medium white chert.			8.63
270		Banded Iron Formation: Red and white chert BIF. Increasing white chert interlayered with magnetite			8.69
285		Banded Iron Formation: Red and white chert.			8.61
300					8.44
					8.58
					8.56
					8.52
					8.65
					8.66
					8.91
					8.52
					8.56
					8.59
					8.93
					8.62
					8.65
					8.63
					8.6
					8.72
					8.95
					8.56
					8.65
					8.6
					8.41
					8.36
					8.88
					8.69
					8.7
					8.77

PRODUCTION BORE LOG

BOREHOLE NUMBER
NSP01R

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **North Star**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Paolo Calafa**
FIELD BOOK NO:
EASTING: **713023.49**
NORTHING: **7649397.02**
ELEVATION (mAHD): **382.5**
DATE BEGUN: **16/08/2018** DATE COMPLETED: **21/08/2018**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	303	
Cased Depth (mbgl):	299.46	
Stick Up (magl):	0.63	
Airlift Yield (L/s):		
Water Level (mbgl) & Date:		
Quallity - pH & EC (uS/cm):	8.32	1534

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
				Increasing white chert. decreasing red chert. decreasing magnetite.			
				Banded Iron Formation: Predominant white/green chert. decreasing red chert interlayered with decreasing magnetite			
				Banded Iron Formation: Predominant green white chert over red chert and decreasing magnetite			
				Banded Iron Formation: Predominant grey/green chert. decreasing red chert interlayered with minor magnetite.			
				Banded Iron Formation: Predominant grey/green chert. very minor red chert. quartz. Minor magnetite.			
				Banded Iron Formation: Grey/Green chert. minor red chert. increasing magnetite.			
				Banded Iron Formation: Grey/green chert. increasing white chert. minor red chert and minor magnetite.			
				Banded Iron Formation: Green grey cherty BIF. quartz. minor red chert and minor magnetite.			
				Banded Iron Formation: Green/white cherty BIF. increasing quartz. minor red chert and minor magnetite.			
				Banded Iron Formation: White green chert. minor red chert. major white chert/quartz. minor magnetite.			
				Banded Iron Formation: White green cherty BIF. major white chert and quartz. minor red chert and minor magnetite.			
				Banded Iron Formation: White/green cherty BIF. white chert and quartz. green chert and minor red chert. minor magnetite			
				Banded Iron Formation: Green white cherty BIF. White Green chert. minor red chert. increasing quartz and minor magnetite			
				Banded Iron Formation: green white cherty BIF. White green chert. minor to no red chert. Some quartz. Minor magnetite. Mdium chip size.			
				Banded Iron Formation: Green white cherty BIF. Green white chert. minor to no red chert. decreasing quartz. minor magnetite.			
				Banded Iron Formation: Green white cherty BIF.			

PRODUCTION BORE LOG

BOREHOLE NUMBER
NSP01R

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
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PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **North Star**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Paolo Calafa**
FIELD BOOK NO:
EASTING: **713023.49**
NORTHING: **7649397.02**
ELEVATION (mAHD): **382.5**
DATE BEGUN: **16/08/2018** DATE COMPLETED: **21/08/2018**

FINAL BORE DETAILS		
Drilled Depth (mbgl):	303	
Cased Depth (mbgl):	299.46	
Stick Up (magl):	0.63	
Airlift Yield (L/s):		
Water Level (mbgl) & Date:		
Quallity - pH & EC (uS/cm):	8.32	1534

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
				Green white chert with minor red chert. no quartz. minor magnetite. max chip size 2 cm			
				Banded Iron Formation: Green white cherty BIF. Green white chert. minor to no red chert. minor quartz. minor magnetite. Max chip size 2.5 cm			
				Banded Iron Formation: Green white chert. minor red chert. increasing magnetite. increasing quartz. Chip size 2.5 cm max			
				Banded Iron Formation: Predominant white chert/quartz. green chert. no red chert. increasing magnetite. Average small chip size 1 cm. Potential broken ground			
				Banded Iron Formation: White green chert. minor red chert. minor magnetite. Max chip size 1.5 cm			
				Banded Iron Formation: White green chert. minor red chert. increasing quartz. no to minor magnetite.			
				Banded Iron Formation: White green chert with increasing quartz. no to minor magnetite			
				Banded Iron Formation: White chert/quartz. minor red chert. increasing quartz. Average chip size 0.5 cm. Possible broken ground.			
				Banded Iron Formation: White chert. predominant quartz. chip size less than 1 cm. possible broken ground.			
				Banded Iron Formation: White chert/quartz. chip size less than 1 cm. Probable marker of broken ground.			
				Banded Iron Formation: White chert. green chert. minor red chert. very minor magnetite chip size less than 1 cm. probable broken ground.			
				Banded Iron Formation: White chert. green chert. no red chert. minor to no magnetite. Chip size less than 1 cm.			
				Banded Iron Formation: White/green chert. no red chert. no magnetite. . chip size less than 1 cm.			
				Banded Iron Formation: White and green chert. minor increasing red chert. minor magnetite. chip size less than 1 cm.			
				Banded Iron Formation: white green chert. increasing minor red chert. minor to no magnetite. chip size less 1.5 cm.			

PRODUCTION BORE LOG

BOREHOLE NUMBER
NSP01R

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **Iron Bridge**
LOCATION: **North Star**
DRILLING CO: **FMG**
DRILLING METHOD: **Air Hammer**
LOGGED BY: **Paolo Calafa**
FIELD BOOK NO:
EASTING: **713023.49**
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ELEVATION (mAHD): **382.5**
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FINAL BORE DETAILS		
Drilled Depth (mbgl):	303	
Cased Depth (mbgl):	299.46	
Stick Up (magl):	0.63	
Airlift Yield (L/s):		
Water Level (mbgl) & Date:		
Quallity - pH & EC (uS/cm):	8.32	1534

BORE CONSTRUCTION	DEPTH (mbgl)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH

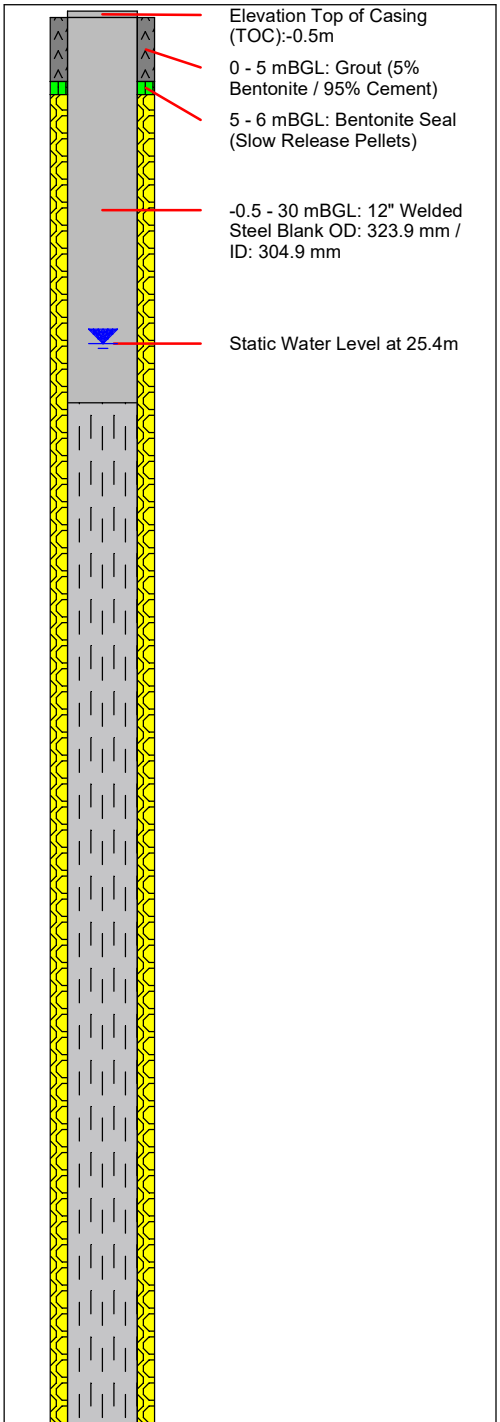
PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_SB_PB03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**FY23 Near Mine Supply Borefield**
LOCATION:	**Iron Bridge**
DRILLING COMPANY:	**Pentium**
DRILLING METHOD:	**Dual Rotary;Conventional**
LOGGED BY:	**CSN/CAA**
EASTING:	**710890.207**
NORTHING:	**7644617.279**
ELEVATION (mAHD):	**270.434**
DATE BEGUN: **22/01/2023**	DATE COMPLETED: **19/02/2023**

FINAL BORE DETAILS		
Drilled Depth (mBGL):	268	
Cased Depth (mBGL):	260.5	
Stick Up (mAGL):	-0.5	
Airlift Yield (L/s):	30	
Water Level (mBGL) & Date:	24	01/03/2023
Quality - EC (µS/cm) & pH:	1210	7.9



DEPTH (mBGL)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	POX		Clay & Sandstone: 90% clay, 10% sandstone, very poorly sorted, 1mm-20mm, reddish brown, brown, dark grey, heavily weathered, sub-angular to sub rounded			
5	POX					
10	POX					
10	POX					
10	PCB		Sandstone & Clay: Heavily weathered, 60% sandstone, 40% clay, very poorly sorted, 1mm-10mm, sub-angular to sub-rounded, brown, beige, dark grey,			
15	POX					
15	POX					
20	ASkbm		Clay and sandstone: 70% clay, 30% sandstone, leached zone, very poorly sorted, 1mm-30mm, reddish brown, brown, white, heavily weathered, sub-angular to sub rounded	3	4099	6.5
25				3	1401	6.92
30			Sandstone & Clay: 70% clay, 30% sandstone, leached zone, very poorly sorted, 1mm-40mm, white, purple, heavily weathered, sub-angular to sub rounded	3	1082	6.91
35				3	1077	6.91
40			Clay & sandstone: 70% clay, 30% sandstone, leached zone, quartz vein, very poorly sorted, wet sample, 1mm-40mm, reddish brown, purple,brown, dark grey, white, heavily weathered, sub-angular to sub rounded	3	1082	7.22
45				3	1394	6.76
50						
55	ASkbm		Chert & sandstone: 50% chert, 50% sandstone, leached zone, very poorly sorted, 1mm-40mm, orange, brown, reddish brown, purple, heavily weathered, sub-angular to sub rounded	3	1254	7.27
60				3	1195	7.27
65			Sandstone & Martite: 90% sandstone, 10% magnetite, heavily weathered, very poorly sorted, 1mm-80mm, reddish brown, brown, sub-angular to sub rounded.	3	1160	7.37
70				3	1152	7.67
75			Sandstone & Magnetite: As above. Leached zone	3	1151	7.68
80	ASkbm		Sandstone, White with red staining through intervals	3	1198	7.48
85			White sandstone, moderately sorted within cemented matrix.	3	1160	7.82
90			Sanstone Grey in colour. Minor chert and pyroxenite, red staining. fractured.	3	1080	7.6
95	ASkbm		Sandstone, white, sub rounded- angular chips, moderately sorted.	3	1099	7.63
100						
105						

PRODUCTION BORE LOG

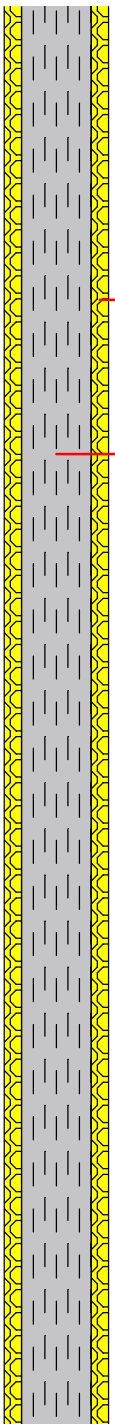
BOREHOLE NUMBER

IB_SB_PB03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **FY23 Near Mine Supply Borefield**
LOCATION: **Iron Bridge**
DRILLING COMPANY: **Pentium**
DRILLING METHOD: **Dual Rotary;Conventional**
LOGGED BY: **CSN/CAA**
EASTING: **710890.207**
NORTHING: **7644617.279**
ELEVATION (mAHD): **270.434**
DATE BEGUN: **22/01/2023** DATE COMPLETED: **19/02/2023**

FINAL BORE DETAILS		
Drilled Depth (mBGL):	268	
Cased Depth (mBGL):	260.5	
Stick Up (mAGL):	-0.5	
Airlift Yield (L/s):	30	
Water Level (mBGL) & Date:	24	01/03/2023
Quality - EC (µS/cm) & pH:	1210	7.9



DEPTH (mBGL)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
110				3	1140	7.63
115				3	1102	7.86
120				3	1020	8.19
125				3	1043	8.1
130				3	1136	8
135				3	1171	7.68
140	ASkbm		Sandstone, greyish to light green in colour. sub-rounded to angualr grains. trace of chert.	3	1129	7.66
145				3	1128	8.35
150				3	1129	8.41
155				3	1128	8.38
160				3	1136	8.39
165				3	1124	8.4
170				3	1164	8.17
175				3	1214	7.63
180				3	1121	7.53
185				3	1114	7.59
190				3	1219	7.79
195				3	1209	7.68
200						
205						
210						
215						
220						

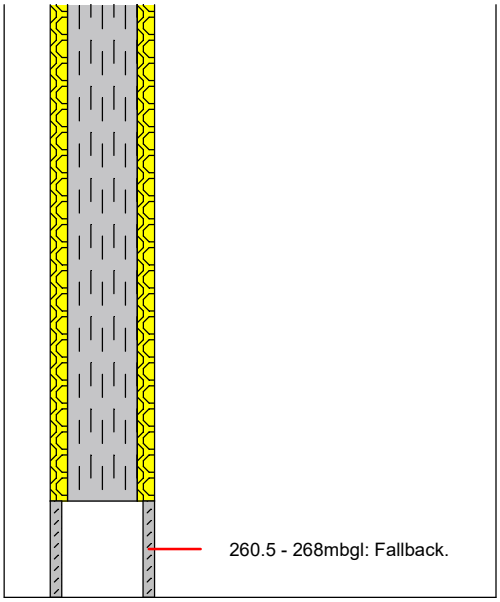
PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_SB_PB03

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME:	**FY23 Near Mine Supply Borefield**
LOCATION:	**Iron Bridge**
DRILLING COMPANY:	**Pentium**
DRILLING METHOD:	**Dual Rotary;Conventional**
LOGGED BY:	**CSN/CAA**
EASTING:	**710890.207**
NORTHING:	**7644617.279**
ELEVATION (mAHD):	**270.434**
DATE BEGUN:	**22/01/2023** DATE COMPLETED: **19/02/2023**

FINAL BORE DETAILS		
Drilled Depth (mBGL):	268	
Cased Depth (mBGL):	260.5	
Stick Up (mAGL):	-0.5	
Airlift Yield (L/s):	30	
Water Level (mBGL) & Date:	24	01/03/2023
Quality - EC (µS/cm) & pH:	1210	7.9



DEPTH (mBGL)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
225				7	1218	7.72
230				12	1184	7.43
235				12	1311	7.65
240	**ASkbm**		Sandstone, Grey with trace of green chips. increase in chert content. sub-rounded to angualr grains. Coarse grains, poorly sorted. Fractured/broken.	12	1202	7.6
245				20	1241	7.77
250				20	1329	7.8
255				20	1285	7.96
260						
265						

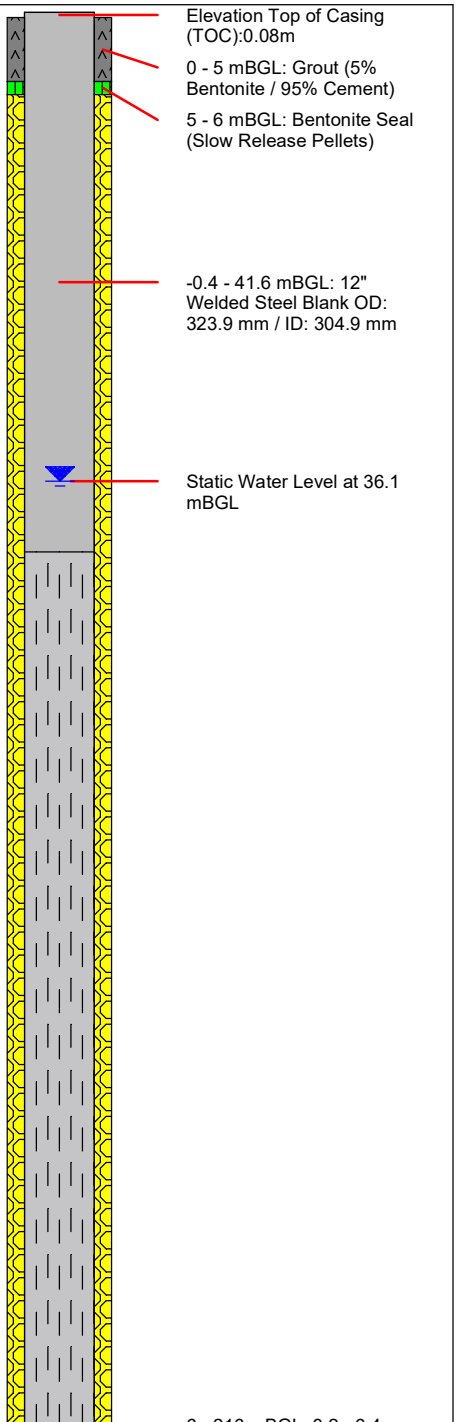
PRODUCTION BORE LOG

BOREHOLE NUMBER: IB_SB_PB04

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **FY23 Near Mine Supply Borefield**
LOCATION: **Iron Bridge**
DRILLING COMPANY: **Pentium**
DRILLING METHOD: **Dual Rotary;Conventional**
LOGGED BY: **CSN/CAA**
EASTING: **709214.445**
NORTHING: **7644854.258**
ELEVATION (mAHD): **272.887**
DATE BEGUN: **20/2/2023** DATE COMPLETED: **10/03/2023**

FINAL BORE DETAILS		
Drilled Depth (mBGL):	226	
Cased Depth (mBGL):	214,64	
Stick Up (mAGL):	-0.40	
Airlift Yield (L/s):	>20	
Water Level (mBGL) & Date:	36.1	13/03/2023
Quality - EC (µS/cm) & pH:	1256	7.81



DEPTH (mBGL)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
0	POX	Clay & Sandstone: 80% clay, 20% sandstone, trace quartz vein, very poorly sorted, 1mm-20mm, brown, dark grey, heavily weathered, sub-angular to sub rounded,			
5	POX				
10					
15	PM	Sandstone & clay: 90% sandstone, 10% clay, heavily weathered , quartz vein minor, very poorly sorted, 1mm-50mm, mainly green and orange, sub-angular to sub rounded			
20					
25	PM	Mudstone, Pale grey, trace of orange staining. fine grain sub-angular chips.			
30		Mudstone, Orange/Pale grey, highly weathered, fracture planes dominant with orange straining. Sub-rounded to sub angular chips. minor chert content.			
35					
40	PCB	Chert, Orange/ Brown, highly weathered, fracture planes dominant with orange straining. vuggy texture. trace of shale. sub-angular to angular chips. fine grain. WET	0.5		
45					
50					
55					
60					
65	PBN	Quartzite (fuchsite); Bright green in color, ~30% black chert. angular grains. fine grain. chips showing fractures with infill. WET	5	1440	7.68
70			8	1485	7.63
75					
80		Chert, Black in colour. minor green quartzite with chert infil and red staining within fracture planes. fine grain angular chips. WET.	8	1340	7.49
85					
90	AGi	Quartzite, grey in color. minor black chert @92 - 94m. fractured, vuggy texture.sub-angular to angular chips.trace of red quartzite.yellow staining within fracture planes. Yield increase ~60L/s.WET	10	1333	7.55
95	AGi		10	1261	7.68
100			10	1237	7.63
105			10	1241	7.79
	AGi	Quartzite, pale green/grey in color fractured			

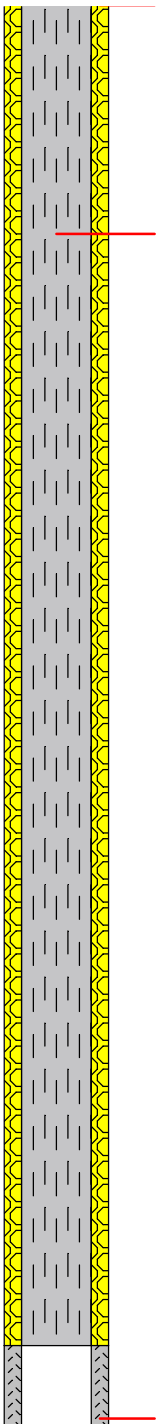
PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_SB_PB04

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **FY23 Near Mine Supply Borefield**
LOCATION: **Iron Bridge**
DRILLING COMPANY: **Pentium**
DRILLING METHOD: **Dual Rotary;Conventional**
LOGGED BY: **CSN/CAA**
EASTING: **709214.445**
NORTHING: **7644854.258**
ELEVATION (mAHD): **272.887**
DATE BEGUN: **20/2/2023** DATE COMPLETED: **10/03/2023**

FINAL BORE DETAILS		
Drilled Depth (mBGL):	226	
Cased Depth (mBGL):	214,64	
Stick Up (mAGL):	-0.40	
Airlift Yield (L/s):	>20	
Water Level (mBGL) & Date:	36.1	13/03/2023
Quality - EC (µS/cm) & pH:	1256	7.81



DEPTH (mBGL)	STRATIGRAPHY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
110					
115		vuggy texture, soft - medium.sub-angular chips.trace of red staining within fracture planes. Yield increase ~60L/s.WET	25	1232	7.72
120			40	1235	7.59
125			40	1268	7.54
130	AGi	Quartzite (fuchsite); Bright green in color, trace of red quartzit. orange/red staining within frature planes. angular grains. fine grain. chips . soft to medium. WET	40	1252	7.67
135			60	1174	7.05
140			60	1172	7.86
145		Quartzite, Red/ pale green, fractured, staining in the frature planes. soft to medium. sub-rounded chips. vuggy texture. Increase in yield >60 L/s. WET			
150	AGi		60	1305	8.09
155	AGi	Quartzite, pale green/grey in color.fractured, vuggy texture, soft - medium.sub-angular chips.trace of red staining within fracture planes. Yield increased >60L/s.WET	60	1236	8.1
160					
165					
170	AGi	Sandstone, pale green (fuchsite)/red. minor translucent quartz, fractured, porous, .sub-angular chips, very poorly sorted, lighly leached, Yield increased >60L/s.WET	60	1270	7.4
175	AGi		60	1318	7.72
180		Sandstone, pale green (fuchsite)/grey. minor translucent quartz, fractured, porous, .sub-angular chips, very poorly sorted, Yield increased >60L/s.WET		1297	7.63
185			60	1285	7.81
190	AGi	Sandstone, pale green (fuchsite)/grey. increased translucent quartz, fractured, porous, sub-angular chips, smaller chip, moderately sorted, Yield increased >60L/s.WET	60	1290	7.56
195			60	1292	7.97
200					
205	AGi	As above, less quartz	60	1299	7.98
210	AGi	Sandstone, pale green (fuchsite)/grey. increased translucent quartz, fractured, porous, sub-angular chips, smaller chip, moderately sorted, Yield increased >60L/s.WET	80	1248	8.02
215	AGi		80	1281	8.08
220		Sandstone, pale green (fuchsite)/red. minor			

PRODUCTION BORE LOG

BOREHOLE NUMBER
IB_SB_PB04

Fortescue Metals Group Ltd
Level 2, 87 Adelaide Terrace
East Perth, WA 6004
PH: 08 62188888 FAX: 08 62188880

PROJECT NAME: **FY23 Near Mine Supply Borefield**
LOCATION: **Iron Bridge**
DRILLING COMPANY: **Pentium**
DRILLING METHOD: **Dual Rotary;Conventional**
LOGGED BY: **CSN/CAA**
EASTING: **709214.445**
NORTHING: **7644854.258**
ELEVATION (mAHD): **272.887**
DATE BEGUN: **20/2/2023** DATE COMPLETED: **10/03/2023**

FINAL BORE DETAILS		
Drilled Depth (mBGL):	226	
Cased Depth (mBGL):	214,64	
Stick Up (mAGL):	-0.40	
Airlift Yield (L/s):	>20	
Water Level (mBGL) & Date:	36.1	13/03/2023
Quality - EC (µS/cm) & pH:	1256	7.81

BORE CONSTRUCTION	DEPTH (mBGL)	STRATIGRAPHY	LITHOLOGY	DESCRIPTION	YIELD (L/s)	EC (µS/cm)	pH
Fallback	225			chips, smaller chip, moderately sorted, Yield increased 60 - 80 L/s.WET			

Appendix 4: 2022 Iron Bridge Hydrogeological Investigation Summary

Memo

2022 Iron Bridge Hydrogeological Investigation Summary

OUR REF	662NS-0000-MU-HY-0001	**DATE**	4/02/2022
TO	Sylvie Ogier-Halim	**CC**	Doug Brown
FROM	Callum Gilligan		

1. INTRODUCTION

This memorandum summarises the historical hydrogeological investigations undertaken at Iron Bridge (IB) near mine between 2012 and 2020 and provides an updated IB near mine hydrogeological conceptual model.

A brief overview of the hydrogeological investigation programs undertaken at IB near mine is provided in Table 1.

Table 1: Iron Bridge Near Mine Hydrogeological Investigations Summary.

Program	Year	Area Tested	Objectives	Number of Tests		
				Constant Rate Tests	Falling Head Tests	Packer Tests
Worley Parsons Preliminary Pit Dewatering Assessment	2012	Orebody, TSF Area	Define hydraulic parameters in the pit area and estimate pit dewatering volumes	5		5
Iron Bridge Stage 1 Near Mine Water Supply Borefield Investigation	2015	Western Borefield, Southern Borefield, Northern Borefield, TSF Area	Investigate and establish the near-mine water supply	37		
Iron Bridge Near Mine Falling Head Test and Test Pumping Program	2018	Orebody, TSF Area	Further define hydraulic parameters in the pit and TSF area	2	13	
Iron Bridge Stage 2 Near Mine Water Supply Borefield Investigation	2020	Southern Borefield, Northern Borefield, TSF Area	Increase the available near-mine water supply	7		
Iron Bridge Near Mine Falling Head Test Program	2020	Orebody	Further define hydraulic parameters in the pit area		7	

2. BACKGROUND INFORMATION - PROJECT GEOLOGICAL AND HYDROGEOLOGICAL SUMMARY

The present geological and hydrogeological understanding of the Iron Bridge Project area, described in the Iron Bridge Feasibility Study (IBO, 2019) and the Iron Bridge Near-Mine Hydrogeology Report (IBO, 2020), is provided below.

Locations of all tested bores are provided below in Figure 1, and locations relative to regional geology are shown in Figure 2.

2.1 Geology

The IB deposit is hosted within the Paleoarchean Pincunah Banded-iron Member of the Sulphur Springs Group.

The Sulphur Springs Group is comprised from base to top of:

- the Leilira Formation, composed of metamorphosed quartz sandstone and minor layered quartz carbonate rock and siltstone, overlain by
- the Kunagunarrina Formation, composed of greenschist facies, dominantly of komatiitic, high-Mg and tholeiitic metabasalt, and
- the Kangaroo Caves Formation, representing a differentiated volcanic-volcaniclastic pile of mainly tholeiitic magmatic affinity, varying from basalt to rhyolite, with comagmatic granite. It includes chert, local polymictic mega breccia and iron-formation, and calc-alkaline rhyodacite. The Pincunah Banded-iron Member occurs at the top of this unit and comprises metamorphosed jaspilitic banded-iron formation (BIF) with minor layered chert and shale.

Structurally, the ore body is located on the western limb of the regional Pilgangoora Syncline within the Pincunah BIF. The Pincunah BIF varies in stratigraphic thickness from 350 to 450 m, forming a north-south oriented flat-top strike-ridge with an elevation of 80 to 120 m above the surrounding countryside. The host BIF dips between 70°E and 80°W and is continuous to at least 500 m below the surface. Small scale folding is evident, although no macrofolds have been recognised.

The western footwall sequence of the host BIF comprises highly recessive, poorly exposed shales up to 500 m thick (Kangaroo Formation). The contact between the shales and the host BIF, which is likely a sheared/faulted zone, forms on surface a prominent cliff. The eastern hanging wall sequence of the host BIF is over 400 m thick and is made up of inter-bedded shales, mudstones, cherts, BIF and quartzite typically between 1 and 20 m thick (Corboy Formation).

The Corboy Formation of the Gorge Creek Group is a predominantly sandstone and conglomerate sequence, with some locally interbedded siltstone and shale in part. Pebbles in the conglomerate consist mostly of chert. In the Pincunah Belt, the basal portion of the Corboy Formation is made-up of a transitional sequence from the underlying Pincunah Hill Formation of quartzite interbedded with siltstone, wackes and shaley siltstone, progressing upward to lithic sandstone or greywacke.

The Southern and Northern Borefields of the Iron Bridge project are located within the Sulphur Springs Group, while the Eastern Borefield is located within the Gorge Creek Group.

Faults within the Southern and Northern Borefields generally trend in a north-northwest – south-southwest direction, while faults in the Eastern Borefield/TSF Catchment area trend in a north-west – south-east direction. Faulting is most concentrated within the Southern Borefield area.

2.2 Hydrogeology

At the IB mine, the hydrogeology is defined by four key hydrostratigraphic units:

- Alluvial sand and gravel deposits adjacent to some creeks. They are a few metres thickness, mostly restricted to the immediate stream channel area, and intermittently saturated following major rainfall events.
- The weathered and oxide/fresh transition zone that is up to 60-70 m depth. Fractured rock aquifers within the weathered profile present transmissivity values that can be locally high, but generally low. It is considered a poor aquifer in terms of storage and transmissivity and is highly reliant on rainfall recharge.
- The deep fractured bedrock that consists of various greenstone rocks of mainly igneous basalt, ultramafic and andesitic tuff, and sedimentary rocks of sandstone, siltstone, shale, chert and banded iron-formation (i.e. Corboy Formation, Pincunah Hill Formation and Kangaroo Caves Formation).
- The shale units, that structurally sandwich the host BIF in a syncline (i.e. western shale of the Kangaroo Formation and Eastern inter-bedded shales of the Corboy Formation), form a poorly developed aquifer(s).

At the IB mine, groundwater is found mainly within the weathered rock mass and fractured bedrock. The fractured-rock aquifers in the Project area are compartmentalised (i.e. boundaries identified from test pumping analysis) and present variable transmissivity values ($1.9 < T < 2{,}000$ m2/day) that are constrained by the local fault(s) and fracturing rather than by lithology. Drilling sites were positioned on local structural features to target deeper fractured-rock aquifers during the Stage 2 Near-Mine Water Supply program.

Groundwater recharge is primarily driven by infiltration of rainfall associated with cyclonic events and the interaction with intermittent stream flows occurring during the wet season, while the main discharge mechanisms are seepage into creek beds and evapotranspiration.

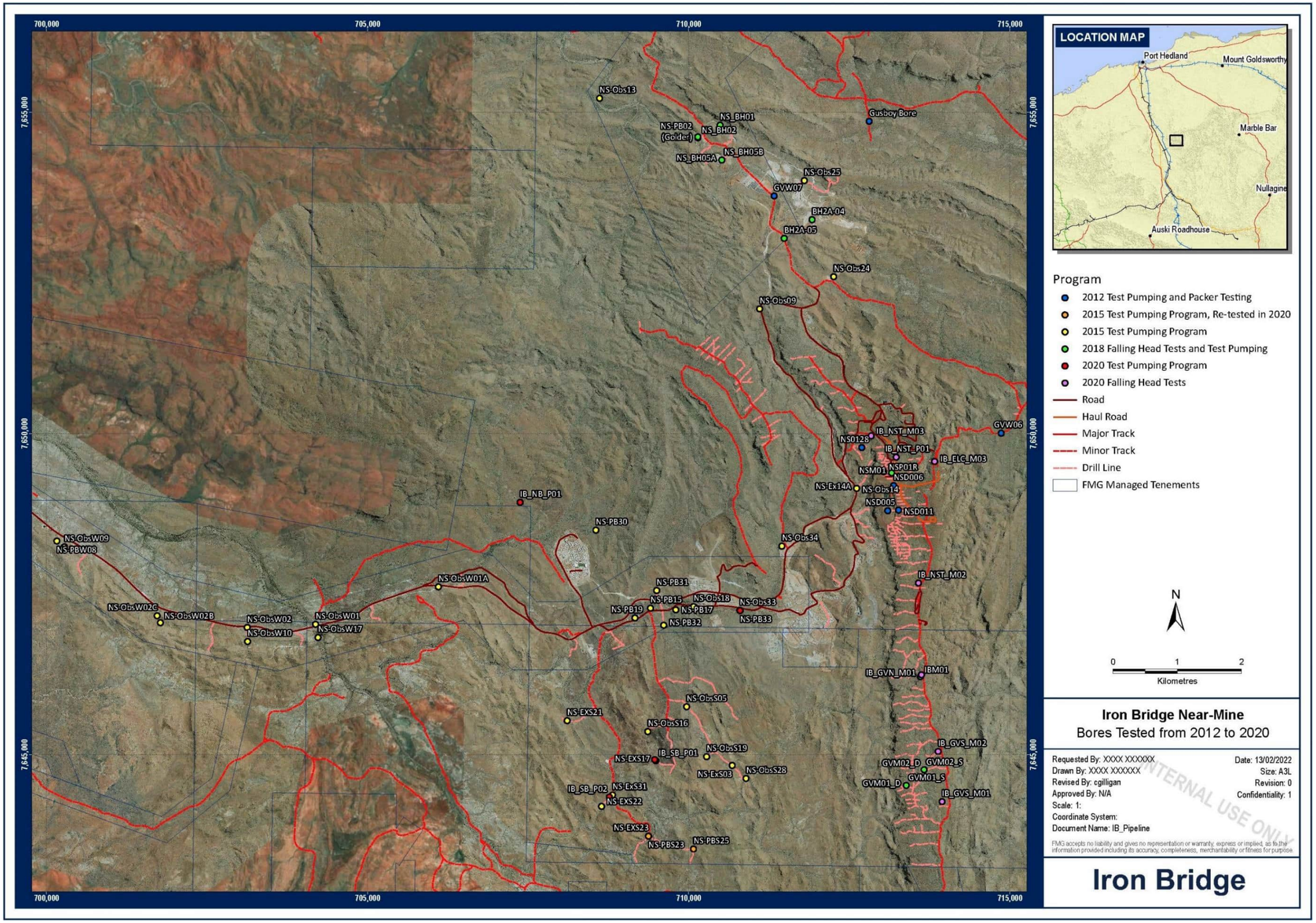


Figure 1: Overview of Iron Bridge Near-Mine Bores Tested.

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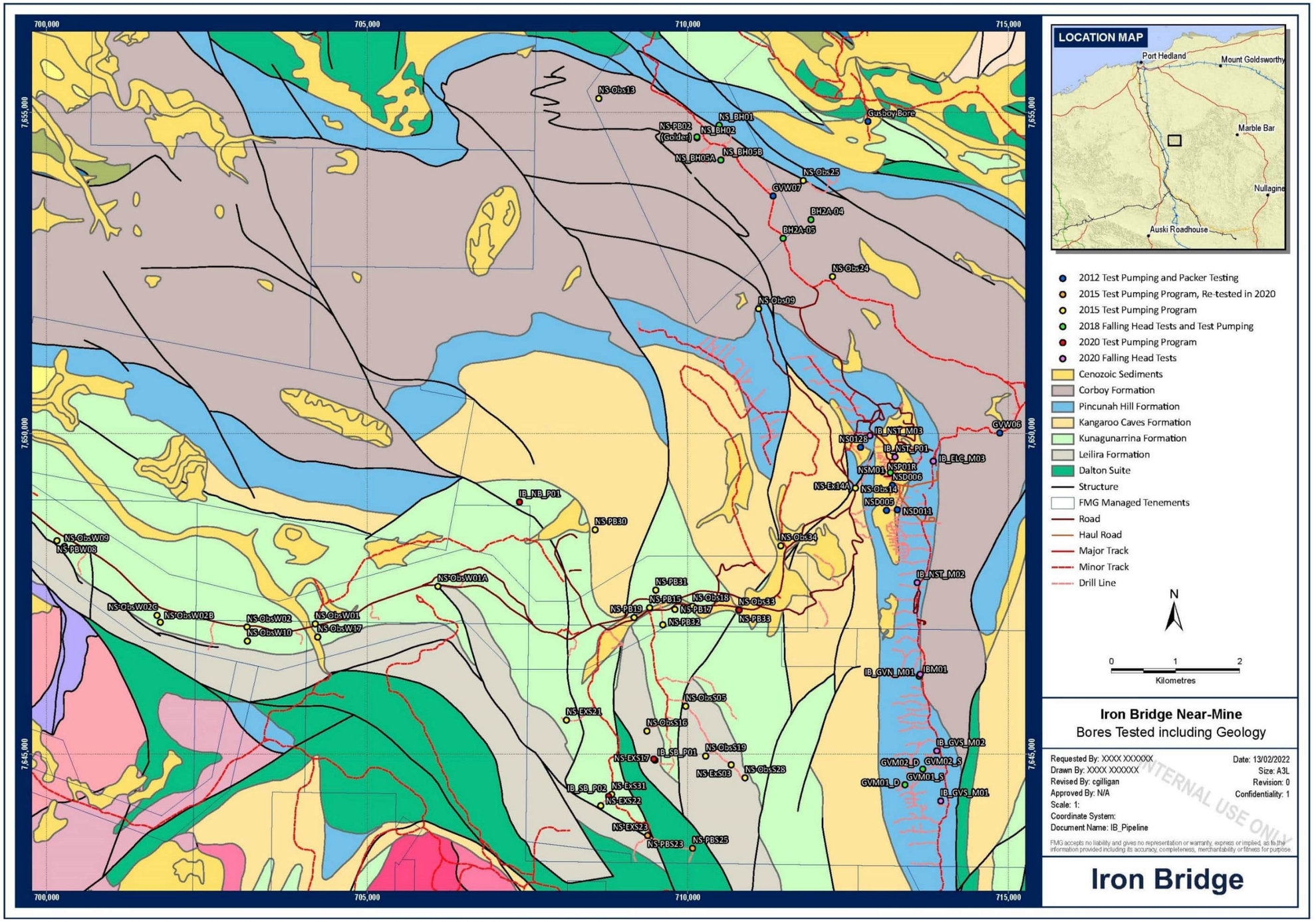

Figure 2: Overview of Iron Bridge Near-Mine Bores Tested (Including 1:250,000 Geology Mapping).

3. PRELIMINARY PIT DEWATERING ASSESSMENT FOR THE PROPOSED IRON BRIDGE PROJECT – WORLEY PARSONS (2012)

Worley Parsons performed a preliminary pit dewatering assessment for the Iron Bridge project in 2012. This study was divided into:

- A desktop study including interpretation of existing exploration core data;
- Field work including test pumping and packer testing of exploration holes; and
- Groundwater numerical modelling using test pumping and packer testing results to predict potential dewatering volumes.

Results are provided in Table 2.

Packer testing was performed on four bores testing shales within the hanging wall and footwall of a NNE-SSW trending shear zone which intersects the ore body. A lack of flow within test sections of shale and unweathered zones of the BIF indicates that the transmissivity values of these rocks are likely very low and thus, they are likely not a significant source of groundwater within the area. Transmissivity values calculated within the weathered and/or fractured BIF units ranged from 1.26 E-2 m2/day to 3.3 E-1 m2/day, indicating groundwater can be more readily transmitted through the weathered BIF, but that the transmissivity values are still very low within this unit.

Aquifer testing of the alluvial aquifer was also performed at four bores (GVW06, GVW07, Gusboy Bore, Packer Bore) located outside the Project disturbance area, north of the TSF area within a different catchment (i.e. Strelley River Catchment). Another aquifer test was performed along a perceived shear zone which runs in a north easterly direction on top of the Iron Bridge deposit in the exploration hole NS0128. Transmissivity values of the alluvial aquifer ranged from 0.32 m2/day to 2.3 m2/day, while the transmissivity of the shear zone was estimated at 4.3 m2/day.

Initial hydrogeological conceptualization reveals that a minimal amount of water exists and is perched along shear zone which transects the ore deposit in a north easterly direction. Minimal groundwater will be encountered through the shear zone, until the second deeper aquifer is encountered. When the pit is opened to a point below the regional groundwater elevation, groundwater will more than likely enter the pit at these shear locations. The amount of groundwater entering the pits should be minimal, and a floating sump pump system delivering water out of the pit should be able to handle the nuisance water.

Table 2: Iron Bridge 2012 Pit Dewatering Assessment - Test Results.

Bore Name	Easting (mE)	Northing (mN)	RL (mAHD)	EOH (mbgl)	Dip	Azimuth	Sample Point Type	Formation	Hydraulic Test	S	Transmissivity T (m2/day)	Hydraulic Conductivity K (m/day)	Hydraulic Conductivity K (m/s)
GVW06	714,866	7,650,007	317	60.1	-90	0	Test hole	Alluvial overlaying shear zone	Pumping test	0.42	0.32	0.008	8.82E-08
GVW07	711,330	7,653,700	247	77.6	-90	0	Monitoring Bore	Alluvial	Pumping test	0.63	0.79	0.014	1.58E-07
Gusboy Bore	712,810	7,654,862	260.0	63.8	-90	0	Production Bore	Alluvial	Pumping test	0.92	0.73	0.024	2.82E-07
Packer Bore	716,905	7,653,454	234.1	46	-90	0	Production Bore	Alluvial	Pumping test	0.39	2.30	0.055	6.34E-07
NS0128	712,695	7,649,783	379.3	280	-60	270	Test hole	Alluvial then shear zone	Pumping test		4.30	0.800	9.26E-06
NSD005	713,099	7,648,800	385.6	300	-60	270	Open HQ hole	Weathered BIF	Packer test @36m		0.33	0.081	9.41E-07
NSD006	713,192	7,649,192	388.2	263	-60	270	Open HQ hole	Weathered BIF	Packer Test @ 54m		0.01	0.003	3.60E-08
								Fractured BIF	Packer Test @ 185m		0	0	Low - < 1E-9
NSD010	713,242	7,648,000	395.2	334	-60	270	Open HQ Hole	Shale (Footwall)	Packer Test @ 330m		0	0	Low - < 1E-9
								Fractured Shale (Footwall)	Packer Test @ 289m		0	0	Low - < 1E-9
								Fractured Shale (Footwall)	Packer Test @ 267m		0	0	Low - < 1E-9
								Fractured Chert	Packer Test @ 189m		0	0	Low - < 1E-9
								Fractured Chert	Packer Test @ 181m		0	0	Low - < 1E-9
								Fractured BIF	Packer Test @ 139m		0	0	Low - < 1E-9
NSD011	713,267	7,648,810	384.2	354	-70	90	Open HQ hole	Shale	Packer test @ 171m		0	0	Low - < 1E-9
								Fractured mineralised BIF	Packer test @ 185m		0	0	Low - < 1E-9
								Host BIF	Packer test @ 55m		0	0	Low - < 1E-9

NS-0000-TE-AD-0008_2

4. IRON BRIDGE STAGE 1 - NEAR MINE WATER SUPPLY BOREFIELD INVESTIGATION – IBO (2015)

An extensive groundwater investigation program was undertaken in 2014 and 2015 at the Project to determine the potential water supply of the local fractured aquifers. This investigation included i) both ground based and airborne geophysical surveys to delineate structurally significant areas, in order to optimize bore productivity; ii) exploration drilling and development of 76 test holes in four target areas (i.e. Northern, Eastern, Southern and Western areas); and iii) test pumping of production and monitoring bores constructed to estimate aquifer properties, potential production yield, and water quality.

Amongst the 76 test holes, 11 were developed as production bores and 55 as observation bores. Drilling and completion details of the exploration holes, and monitoring and production bores in the Northern, Eastern, Southern and Western areas as well as the composite logs of the production and observation bores can be found in the report IBO (2015). Aquifer tests were performed on all production and observation bores. Summary results of the pumping test analysis are provided in Table 3, while individual test details can be found in the report IBO (2015).

Some calculated hydraulic values have been highlighted in Table 3, where the test pumping interpretation has been disputed. These tests have typically ignored hydraulic regime changes during late-stage test pumping, and have overestimated hydraulic conductivity and/or storativity.

Results of the pumping test indicated that the fractured-rock aquifers in the Project area are compartmentalised (i.e. boundaries identified from pumping test analysis) and present variable transmissivity values ($1.9 < T < 2{,}000$ m2/day) that are constrained by the local fault(s) and fracturing rather than by the local geology.

Geographically, the aquifer transmissivity is typically:

- less than 20 m2/day, except for bore PB02 (T~ 140 m2/day), in the TSF area;
- greater than 40 m2/day in the Northern borefield area;
- greater than 50 m2/day for most bores in the Western borefield area; and
- greater than 100 m2/day for most bores in the Southern borefield area.

Data analysis also indicated that majority of the bores will have a relatively low flow production rate (i.e. 5 to 10 L/s) as storage is not readily available as for a saturated porous-medium aquifer.

Outcomes of this investigation also indicated that the local fractured aquifer(s) has a limited storage capacity due to its secondary porosity (i.e. fractures mainly developed in the upper weathered zone) and is dependency on the yearly local rainfall recharge to the aquifers. The local fractured aquifer(s) can therefore only provide a short-term water supply to the Project of up to 2.5-3 GL/a.

Table 3: 2015 Iron Bridge Water Supply Investigation - Test Pumping Results.

Location	Bore Name	Lithology	Slotted interval (m bgl)	Observation Bores	Distance (m)	Date	Flowrate (L/s)	Drawdown (m)	Solution Analysis	Saturated Thickness (m)	Transmissivity T (m^2/day)	Hydraulic Conductivity K (m/day)	Hydraulic Conductivity K (m/s)	Specific Yield (-)	Specific Capacity (L/s/m)
Northern Borefield	NS-PB15	Serpentine	12 - 90	Obs15	47	11/03/2014	20	4.8	Moench, fractured	120	850	7.08	8.20E-05	0.02	4.17
	NS-PB17	Basalt, chert, calcareous chert	6 - 144	Obs17	5	29/03/2014	19	3.5	Moench, fractures and parallel boundaries	40	2000	50.00	5.79E-04	0.001	5.43
	NS-PB19	Sandstone/wacke, siltstone	1 -157	Obs19, Obs15	14, 285	10/03/2014	22	11.6	Moench, fractures	150	460	3.07	3.55E-05	0.03	1.9
	NS-PB30	Basalt	18-140			12/04/2014	1	35.7	Moench	40	5	0.13	1.45E-06	0.003	0.03
	NS-PB31	Calcareous chert	6-59 65-83	Obs31	7.8	4/06/2014	4.3	1.69	Moench, fractures	40	240	6.00	6.94E-05	0.012	2.54
	NS-PB32	Basalt	10-70	Obs15	344	9/04/2014	18	11	Moench, fractures, dewatering	60	540	9.00	1.04E-04	0.24	1.6
	NS-Obs18	Basalt	12-84 116-158			23/03/2014	4.1	5	Moench, fractures	100	60	0.60	6.94E-06	0.2	0.82
	NS-Ex23	Basalt				20/03/2014	4.2	5.5	Moench, fractures	156	78	0.50	5.79E-06	0.031	0.76
	NS-Obs33	Basalt, shale	12-54 96-102 144-156			20/09/2014	5.1	2.02	Moench, fractures	132	528	4.00	4.63E-05	0.009	2.52
	NS-Obs34	Serpentine, shale	20-56			24/09/2014	2	40	Moench, fractures and dewatering	40	2	0.05	5.79E-07		0.05
Eastern Borefield/ TSF Area	NS-Obs09	Sandstone/wacke	6-204			17/10/2014	2.2	35	Not Analysed	165					0.06
	NS-Obs13	Alluvium, Sandstone/wacke	12-72			12/01/2014	2.4	17	Moench	84	12.6	0.15	1.74E-06	0.00673	0.14
	NS-Obs13	Alluvium, Sandstone/wacke	12-72			12/01/2014	2.4	17	Moench, recovery	84	3.3	0.04	4.55E-07	0.003	0.14
	NS-Obs14	Shale	0-120			18/03/2014	4	12	Moench Fractured	120	10.8	0.09	1.04E-06	0.043	0.33
	NS-Ex14A	Shale		NS-Obs14	0.1	18/03/2014	4	12.6	Moench Fractured,	130	12	0.09	1.07E-06	0.048	0.32
	NS-Ex14A	Shale		NS-Obs14	0.1	18/03/2014	4	12.6	Moench Fractured, recovery	130	7.8	0.06	6.94E-07	0.065	0.32
	NS-Obs24	Sandstone/wacke	14-152			1/10/2014	4.8	15.8	Moench Fractured, recovery, boundaries	40	2.4	0.06	6.94E-07	0.06	0.304
	NS-Obs25	Shale, sandstone/wacke	14-182			1/10/2014	3.7	8.05	Moench Fractured	175	24.5	0.14	1.62E-06	0.16	0.46
	NS-PB02	Sandstone/wacke	9-99	NS-BH02	10	24/11/2013	15	13.2	Moench Fractured	106	140	1.32	1.53E-05	0.014	1.14
Southern Borefield	NS-EXS03	Sandstone/wacke	Open hole	Obs19, Obs28		30/01/2015	20	4.3	Moench Fractured	210	556	2.65	3.06E-05	0.001	4.65
	NS-ObsS05	Sandstone/wacke, chert	186-288			28/01/2015	3	17	Moench Fractured	220	22	0.10	1.16E-06	0.018	0.18
	NS-ObsS16	Sandstone/wacke, shale	101-269			18/02/2015	1	31	Moench Fractured	235	1.9	0.01	9.36E-08	0.118	0.03
	NS-EXS17	Sandstone/wacke				13/02/2015	15	11.2	Moench Fractured	200	88	0.44	5.09E-06	0.4	1.34
	NS-ObsS19	Mudstone, Sandstone/wacke	156-312			23/01/2015	3.5	7	Moench Fractured	255	49	0.19	2.22E-06	0.009	0.5
	NS-ObsS19	Mudstone, Sandstone/wacke	156-302			23/01/2015	3.5	7	Moench Fractured	255	262	1.03	1.19E-05	0.051	0.5
	NS-EXS21	Siltstone, chert				20/02/2015	2.7	19	Moench fractured, with boundaries, dewatering	25	50	2.00	2.31E-05	0.005	0.14
	NS-EXS22	Sandstone/wacke, chert, shale				6/03/2015	10	22	Moench fractured, with boundaries, dewatering	85	68	0.80	9.26E-06		0.45
	NS-ObsS22	Sandstone/wacke, chert, shale				6/03/2015	10	22	Moench fractured, with boundaries, dewatering	85	102	1.20	1.39E-05	0.034	0.45
	NS-ObsS28	Sandstone/wacke, schist	80-176			21/01/2015	4	4	Moench Fractured	100	270	2.70	3.13E-05	<0.001	1
	NS-ObsS28	Sandstone/wacke, schist	80-176			21/01/2015	4	4	Moench Fractured	100	200	2.00	2.31E-05	>0.25	1
	NS-ExS31	Basalt, chert	Open hole			1/03/2015	5	37	Moench confined with leakage	270	3.4	0.01	1.46E-07	0.004	0.14
	NS-PBS23	Sandstone/wacke, schist	99-183	ObsS23	4.2	10/03/2015	10	24.1	Moench confined with leakage	190	91.2	0.48	5.56E-06	0.09	0.41
	NS-PBS23	Sandstone/wacke, schist	99-183	ObsS23	4.2	10/03/2015	10	24.1	Moench Fractured	190	171	0.90	1.04E-05	0.04	0.41
	NS-PBS25	Schist, chert, sandstone/wacke	4-82	ObsS25	7.5	15/03/2015	22	4.7	Moench fractured, with boundaries, dewatering	40	1480	37.00	4.28E-04	0.024	4.69
Western Borefield	NS-ObsW01	Serpentine	10-142			27/08/2014	5.2	4.5	Moench Leaky Confined	60	90	1.50	1.74E-05	0.002	1.16
	NS-ObsW01	Serpentine	10-142			27/08/2014	5.2	4.5	Moench Leaky Confined, recovery	60	50	0.83	9.65E-06	0.002	1.16
	NS-ObsW01A	Basalt, Calcareous chert	20-140			28/10/2014	5	8.3	Theis, dewatering	70	160	2.29	2.65E-05	0.003	0.6
	NS-ObsW02	Serpentine, Shale	11-125			29/08/2014	3.9	1.5	Moench Fractured	80	72	0.90	1.04E-05	0.104	2.6
	NS-ObsW02	Serpentine, Shale	11-125			29/08/2014	3.9	1.5	Moench, Fractured, recovery	80	160	2.00	2.31E-05	0.032	2.6
	NS-ObsW02B	Cherty shale, Sandstone/wacke	38-206			11/11/2014	2	4.7	Moench, Fractured	155	35.65	0.23	2.66E-06	0.025	0.43
	NS-ObsW02B	Cherty shale, Sandstone/wacke	38-206			11/11/2014	2	4.7	Moench, fractured, recovery	155	77.5	0.50	5.79E-06	0.026	0.43

NS-0000-TE-AD-0008_2

	NS-ObsW02C	Cherty shale	20-146			4/09/2014	5	1.71	Moench, fractured	100	260	2.60	3.01E-05	0.25	2.92
Location	**Bore Name**	**Lithology**	**Slotted interval (m bgl)**	**Observation Bores**	**Distance (m)**	**Date**	**Flowrate (L/s)**	**Drawdown (m)**	**Solution Analysis**	**Saturated Thickness (m)**	**Transmissivity T (m^2/day)**	**Hydraulic Conductivity K (m/day)**	**Hydraulic Conductivity K (m/s)**	**Specific Yield (-)**	**Specific Capacity (L/s/m)**
Western Borefield	NS-ObsW02C	Cherty shale	20-1246			4/09/2014	5	1.71	Moench fractured, recovery	100	600	6.00	6.94E-05	0.01	2.92
	NS-PBW08	Cherty shale	53-83	NS-ObsW09	148	12/12/2014	3.8	1.87	Moench Fractured	35	170.8	4.88	5.65E-05	0.084	2.03
	NS-PBW08	Cherty shale	53-83	NS-ObsW09	148	12/12/2014	19	24	Moench Fractured, recovery	35	122.5	3.50	4.05E-05	0.175	0.79
	NS-ObsW09	Cherty shale	68-206			19/11/2014	3.2	34	Moench Fractured	85	3.4	0.04	4.63E-07	0.068	0.09
	NS-ObsW09	Cherty shale	68-206			19/11/2014	3.2	34	Moench Fractured	85	11.9	0.14	1.62E-06	0.017	0.09
	NS-ObsW10	Sandstone/wacke	20-152			8/11/2014	5	1.28	Moench, unconfined	100	126	1.26	1.46E-05	0.01	3.91
	NS-ObsW17	Alluvium, cherty shale	7-121			24/12/2014	4	0.3	Moench Fractured	35	840	24.00	2.78E-04	0.049	13.33
	NS-ObsW17	Alluvium, cherty shale	7-121			24/12/2014	4	0.3	Moench fractured, recovery	35	945	27.00	3.13E-04	0.056	13.33

5. *Cells highlighted red have ignored late-stage test pumping data, and as such, have overestimated hydraulic conductivity values.

6. IRON BRIDGE NEAR MINE FALLING HEAD TEST AND TEST PUMPING PROGRAM – 2018 IBO

Falling head tests were undertaken in December 2018 on 13 production and observation bores, while 2 pumping tests were undertaken in February 2019 on bores NSP01R and GVP01. These tests were performed to further define the hydrogeological parameters of the pit and TSF areas. A summary of the results are provided in Table 4 and Table 5.

Outcomes of this investigation indicated that the fractured-rock aquifers in the Project area, independently of the lithology, present transmissivity values that generally decrease with depth. Fractured rock aquifers within the weathered profile present transmissivity values (11.1 < T< 590 m2/d) of one to two order of magnitude higher than in the weathered/fresh transition zone (0.5 < T < 1 m2/d) which in turn present transmissivity values higher than in the fresh fractured rock aquifers located at depth (T < 0.5 m2/d).

Only when local faults/fractures encountered at depth act as transmissive features, transmissivity values may increase by one or two order of magnitude (i.e., GVM02_D with 78 < T < 100 m2/d or NSP01R with T~4.3 m2/d.

7. 2020 IRON BRIDGE NEAR MINE HYDROGEOLOGY REPORT – FMG (2020)

An additional groundwater investigation drilling and testing program was undertaken between November 2019 and August 2020, to expand the near mine water supply available for the early works and construction phase of Iron Bridge Phase 2. Drilling aimed to supplement the existing borefield areas and establish a water supply within the pit area for dust suppression and pit dewatering purposes. This program included:

- Drilling of six (6) proposed water supply bores, of which three (3) were constructed as production bores;
- Drilling of eight (8) proposed ex-pit dewatering bores, of which one (1) was constructed as a production bore; and
- Step-rate and constant rate test pumping of four (4) existing production bores and three (3) newly constructed production bores.

Summary results of the pumping test analysis are provided in Table 6, while individual test details can be found in the report IBO (2020).

Table 4: 2018 Iron Bridge Falling Head Test Program - Test Results.

Site Name	Bore Name	Easting	Northing	RL (mAHD)	Sample Point Type	Rock mass	Lithology	Slotted Interval	Hydraulic Conductivity K (m/s)					Thickness (m)	Transmissivity T (m2/d)					Solution
		(m E)	(m N)					(m bgl)	Test1	Test2	Test3	Test4	Test5		Test1	Test2	Test3	Test4	Test5	
TSF Area	NS_BH05B	710517	7654261	245	Monitoring	Weathered	Sandstone	2.2-8.2	9.81E-04	2.47E-05	1.87E-05			6	508.6	12.8	9.7			Hvorsley (1951)
							Sandstone	2.2-8.2	1.14E-03	1.63E-05	1.44E-05			6	590.5	8.4	7.5			Bower-Rice (1976)
	BH2A-04	711921	7653330	257.4	Monitoring		Shale	12 - 15	4.28E-05	4.07E-05	4.10E-05	4.07E-05	4.11E-05	3	11.1	10.6	10.6	10.6	10.7	Hvorsley (1951)
							Shale	12 - 15	5.61E-05	3.05E-05	3.05E-05	3.11E-05	3.14E-05	3	14.5	7.9	7.9	8.1	8.1	Bower-Rice (1976)
	BH2A-05	711487	7653040	258.9	Monitoring		Shale	12 - 15	1.46E-04	2.34E-04	2.08E-04	2.04E-04	5.59E-05	3	37.9	60.6	53.8	52.8	14.5	Hvorsley (1951)
							Shale	12 - 15	1.15E-04	1.84E-04	1.64E-04	1.85E-04	4.39E-05	3	29.7	47.8	42.5	47.8	11.4	Bower-Rice (1976)
	NS_BH05A	710515	7654259	245.3	Monitoring		Sandstone	21-27	1.13E-04	9.84E-05	1.11E-04	3.58E-05		6	58.4	51	57.6	18.5		Hvorsley (1951)
							Sandstone	21-27	9.00E-05	8.21E-05	7.68E-05	3.21E-05		6	46.7	42.6	39.8	16.6		Bower-Rice (1976)
	NS_BH01	710489	7654801	266	Monitoring		Sandstone	24-30	2.76E-06					6	1.4					Hvorsley (1951)
							Sandstone	24-30	1.91E-06					6	1					Bower-Rice (1976)
	NS_BH02	710142	7654619	241.3	Monitoring		Sandstone	24-30	2.91E-04	2.69E-04	3.04E-04	2.70E-04		6	150.6	139.2	157.5	139.7		Hvorsley (1951)
							Sandstone	24-30	2.52E-04	2.48E-04	2.40E-04	2.71E-04		6	130.8	128.3	124.5	140.5		Bower-Rice (1976)
Pit Area	GVM02_S	713496	7644741	396.5	Monitoring	Transition zone	BIF	40-50	1.10E-06					10	0.95					Hvorsley (1951)
							BIF	40-50	9.60E-07					10	0.83					Bower-Rice (1976)
	GVM01_S	713495	7644489	386.5	Monitoring		BIF	70-80	6.01E-07					10	0.52					Hvorsley (1951)
							BIF	70-80	5.38E-07					10	0.46					Bower-Rice (1976)
	GVM02_D	713496	7644741	396.5	Monitoring	Fresh	Cherty BIF	130-252.5	7.38E-06					123	78.15					Hvorsley (1951)
							Cherty BIF	130-252.5	9.41E-06					123	99.62					Bower-Rice (1976)
	GVM01_D	713495	7644489	386.5	Monitoring		Fractured/fresh BIF	115-245	1.12E-07					130	1.26					Hvorsley (1951)
							Fractured/fresh BIF	115-245	1.19E-07					130	1.33					Bower-Rice (1976)
	NSP01R	713023	7649397	382.5	Production		BIF	30-299.46	6.10E-08	6.80E-08				260	1.37	1.53				Hvorsley (1951)
							BIF	30-299.46	4.95E-08	5.51E-08				260	1.11	1.24				Bower-Rice (1976)
	NSM01	713184	7649401	386.5	Monitoring		BIF	40-240	5.00E-08	5.89E-08				200	0.86	1.02				Hvorsley (1951)
							BIF	40-240	4.15E-08	4.89E-08				200	0.72	0.84				Bower-Rice (1976)
	IBM01	713588	7646203	413.5	Monitoring		Cherty BIF	70-143.8	4.77E-08					74	0.3					Hvorsley (1951)
							Cherty BIF	70-143.8	6.33E-08					74	0.4					Bower-Rice (1976)

Table 5: 2019 Iron Bridge Test Pumping Program - Test Results.

	Bore Name	Easting (m E)	Northing (m N)	RL (mAHD)	EOH (m)	Slotted Interval (m bgl)	Lithology	Observation Bores	Distance (m)	Date	Flow rate (L/s)	Drawdown (m)	Solution Analysis	Saturated Thickness (m)	Transmissivity T (m2/day)	Hydraulic Conductivity K (m/s	Storativity (-)	Specific Capacity (L/s/m)
Pit Area	NSP01R	713023	7649397	382.5	300	30-300	BIF	NSM01	125	43510	0.46	12.3	Theis (1935)	262.6	4.32	1.90E-07	7.30E-05	0.04
													Hantush-Jacob (1955) Leaky	262.6	4.21	1.90E-07	7.30E-05	
	GVP01	713496	7644588	409.5	320	60-320	BIF	GVM01S	133	16/02/2019	0.36	19.98	Theis (1935)	275.9	0.71	3.00E-08	0.1	0.02
								GVM02S	more than 900	no DD observed			Hantush-Jacob (1955) Leaky	275.9	0.7	3.00E-08	0.1	

Table 6: 2020 Iron Bridge Test Pumping Program - Test Results.

Location	Bore Name	Lithology	Slotted interval (m bgl)	Date	Flowrate (L/s)	Test Pumping Length (hrs)	Production Bore Drawdown (m)	Observation Bores	Distance (m)	Observation Bore Drawdown (m)	Solution Analysis	Saturated Thickness (m)	Transmissivity T (m^2/day)	Hydraulic Conductivity K (m/day)	Hydraulic Conductivity K (m/s)	Hydraulic Conductivity K (m/day)	Hydraulic Conductivity K (m/s)
Northern Borefield	IB_NB_P01	Basalt, Chert	39.5 - 195.5m	28/03/2020	2	7	65.26	NS-PB30	1250	0	Theis Recovery	156	0.63	4.00E-03	4.70E-08	2.06E-02	2.38E-07
											Theis-Hantush		3.6	2.30E-02	2.70E-07		
											Moench		8.53	5.50E-02	6.30E-07		
											Cooper-Jacob		0.09	5.80E-04	6.70E-09		
	NS-PB33	Basalt, Shale	5 - 56m	16/04/2020	10	1.1	1.725	NS-Obs33	5	1	Theis Recovery	50	606.6	1.20E+01	1.40E-04	8.20E+00	9.50E-05
											Theis-Hantush		598.2	1.20E+01	1.40E-04		
											Moench		60	1.20E+00	1.40E-05		
											Cooper-Jacob		376	7.50E+00	8.70E-05		
TSF Area	NS-PB02	Shale, Sandstone/wacke	9 - 99m	9/04/2020	11.5	48	9.85	NS-BH02	13	2.7	Theis Recovery	80	39.94	5.00E-01	5.80E-06	1.55E+00	1.79E-05
											Theis-Hantush		213.5	2.70E+00	3.10E-05		
											Moench		16	2.00E-01	2.30E-06		
											Cooper-Jacob		225.7	2.80E+00	3.30E-05		
Southern Borefield	IB_SB_P01	Sandstone	102 - 198m	17/03/2020	25	48	76.47	NS-EXS17	7	7.7	Theis Recovery	96	7.93	8.30E-02	9.60E-07	7.86E-01	9.10E-06
											Theis-Hantush		57.99	6.00E-01	7.00E-06		
											Moench		72	7.50E-01	8.70E-06		
											Cooper-Jacob		96.36	1.00E+00	1.20E-05		
	NS-PBS23	Sandstone/wacke, Chert, Schist	99 - 183m	25/03/2020	17	48	49.37	NS-EXS23	4	10.1	Theis Recovery	80	31.81	4.00E-01	4.60E-06	6.24E-01	7.22E-06
											Theis-Hantush		54.31	6.80E-01	7.90E-06		
											Moench		64.69	8.10E-01	9.40E-06		
											Cooper-Jacob		48.9	6.10E-01	7.10E-06		
	NS-PBS25	Schist, Chert, Sandstone/wacke	5- 83m	1/04/2020	20	48	2.2	NS-ObsS25	7.5	2	Theis Recovery	40	434.9	1.10E+01	1.30E-04	4.54E+00	5.31E-05
											Theis-Hantush		127.4	3.20E+00	3.70E-05		
											Moench		21.48	5.40E-01	6.20E-06		
											Cooper-Jacob		134.4	3.40E+00	3.90E-05		
	IB_SB_P02	Sandstone/wacke, Chert, Mudstone	32 - 212m	14/04/2020	10.5	48	108.32	NS-EXS22	54	6	Theis Recovery	180	2.52	1.40E-02	1.60E-07	3.55E-02	4.11E-07
											Theis-Hantush		9.65	5.40E-02	6.20E-07		
											Moench		9.9	5.50E-02	6.40E-07		
											Cooper-Jacob		3.5	1.90E-02	2.20E-07		

8. 2020 IRON BRIDGE NEAR MINE FALLING HEAD TEST PROGRAM – FMG (2020)

Falling head tests were performed on bores completed during the 2020 ex-pit dewatering bore drilling scope, to provide more data within the pit area. Falling head tests were performed due to insufficient yields to perform test pumping. One (1) production bore and six (6) monitoring bores were tested in August 2020. A summary of results are provided in Table 7

Calculated hydraulic conductivity values ranged from 4E-08 to 1.9E-06 m/s, or 3.5E-03 to 1.6E-01 m/day. These values align with values derived from the previous FHT program undertaken at IB in 2018 (1.4E-03 to 4.4E-02) and packer testing performed on the fractured/mineralized BIF in the NS pit area (3.1E-03 to 8.1E-02) (Worley Parsons, 2012).

Reliability of results are limited by bore construction where screens have been installed above the static water level within the bore, as at IB_NST_M02, IB_ELC_M03 and IB_GVN_M01. This could have potentially increased the flowrate from the bore casing to the formation and increased the calculated hydraulic conductivity values.

Table 7: 2020 Iron Bridge Falling Head Test Program - Test Results.

Bore	Constructed Depth (mbgl)	Screened Interval (mbgl)	Diameter (mm)	SWL (mbgl)	K (m/s)				Average K (m/day)	Solution	Comments
					Test 1	Test 2	Test 3	Average			
IB_NST_P01	212	48 - 212	300	39.08	1.47E-06	2.73E-06		1.86E-06	1.6E-01	Hvorslev (1951)	
					1.14E-06	2.11E-06				Bouwer-Rice (1976)	
IB_NST_M02	200	61 - 198.5	50	72.88	7.46E-08	6.03E-08	3.79E-08	6.55E-08	5.7E-03	Hvorslev (1951)	Screened above SWL
					9.42E-08	7.96E-08	4.62E-08			Bouwer-Rice (1976)	
IB_NST_M03	198	60 - 198	50	48.31	9.81E-08	1.30E-07		1.01E-07	8.7E-03	Hvorslev (1951)	
					7.59E-08	9.84E-08				Bouwer-Rice (1976)	
IB_ELC_M03	70	0-70	50	45.49	7.10E-08			6.89E-08	6.0E-03	Hvorslev (1951)	Invalid due to bore construction (Slotted to surface)
					6.69E-08					Bouwer-Rice (1976)	
IB_GVN_M01	160	58 - 160	50	88.43	7.08E-08	1.12E-07		9.69E-08	8.4E-03	Hvorslev (1951)	Screened above SWL
					8.30E-08	1.22E-07				Bouwer-Rice (1976)	
IB_GVS_M01	204	54 - 204	50	51.43	2.12E-07			2.13E-07	1.8E-02	Hvorslev (1951)	
					2.15E-07					Bouwer-Rice (1976)	
IB_GVS_M02	204	54 - 204	50	54.8	3.73E-08			4.07E-08	3.5E-03	Hvorslev (1951)	
					4.42E-08					Bouwer-Rice (1976)	

NS-0000-TE-AD-0008_2

9. UPDATED HYDROGEOLOGICAL CONCEPTUAL MODEL

Hydraulic testing performed across all programs has been compiled and displayed in Table 8. Testing has been grouped to align with the conceptual hydrogeological model described below. Distribution of test values for each unit is shown in Figure 3. Location of all bores tested are shown in Figure 4.

The hydrogeological conceptual model provided earlier has been slightly updated to reflect derived parameters across all testing programs:

At the IB mine, the hydrogeology is defined by six hydrostratigraphic units:

- Alluvial sand and gravel deposits adjacent to some creeks. They are a few metres thickness, mostly restricted to the immediate stream channel area, and intermittently saturated following major rainfall events. These units are predominantly drilled in the TSF Area/Eastern Borefield. Hydraulic conductivity values of the alluvial aquifer are relatively high (8.8E-08 m/s < K < 1.7E-06 m/s) and the storage capacity is considered reasonably high, however, this unit is not extensive across the site.
- The Pincunah Banded-Iron Member of the Kangaroo Caves Formation that hosts the orebody and is bound by shale units of the Kangaroo Caves Formation and Corboy Formation. This unit is separated into a surficial weathered zone, extending up to 60-70m in depth, and an underlying fresh zone that is open at depth.
    - Groundwater storage within the weathered zone is predominantly within interconnected fracture networks, and larger regional structures. Hydraulic conductivity values are low, increasing where significant geological structures are present (3.6E-08 m/s < K < 2.1E-06 m/s).
    - The underlying fresh Pincunah Banded-Iron Member, which has little to no transmissivity or storage, except along very localised geological structures. In absence of any structures, hydraulic conductivity values are low (1E-9 m/s < K < 2.2E-07 m/s). Packer testing on short intervals of the fresh orebody predominantly showed no transmissivity. Where geological structures have been intersected, hydraulic conductivity values are one to two orders of magnitude higher (7.4E-06 m/s < K < 9.4E-06 m/s).
- The Archean units outside of the orebody, consisting of various greenstone rocks of mainly igneous basalt, ultramafic and andesitic tuff, and sedimentary rocks of sandstone, siltstone, shale, chert and banded iron-formation (i.e. Corboy Formation, Kangaroo Caves Formation, Kunagunarrina Formation and Leilira Formation). These units are separated into a surficial weathered zone, extending up to 60-70m in depth, and an underlying fresh zone that is open at depth.
    - Fractured rock aquifers within the weathered profile present transmissivity values that can be locally high, but generally low. It is considered a poor aquifer in terms of storage and transmissivity and is highly reliant on rainfall recharge. The hydraulic conductivity values of the weathered rock mass (6.9E-07 m/s < K < 5.8E-04 m/s) are higher than the underlying fresh bedrock.

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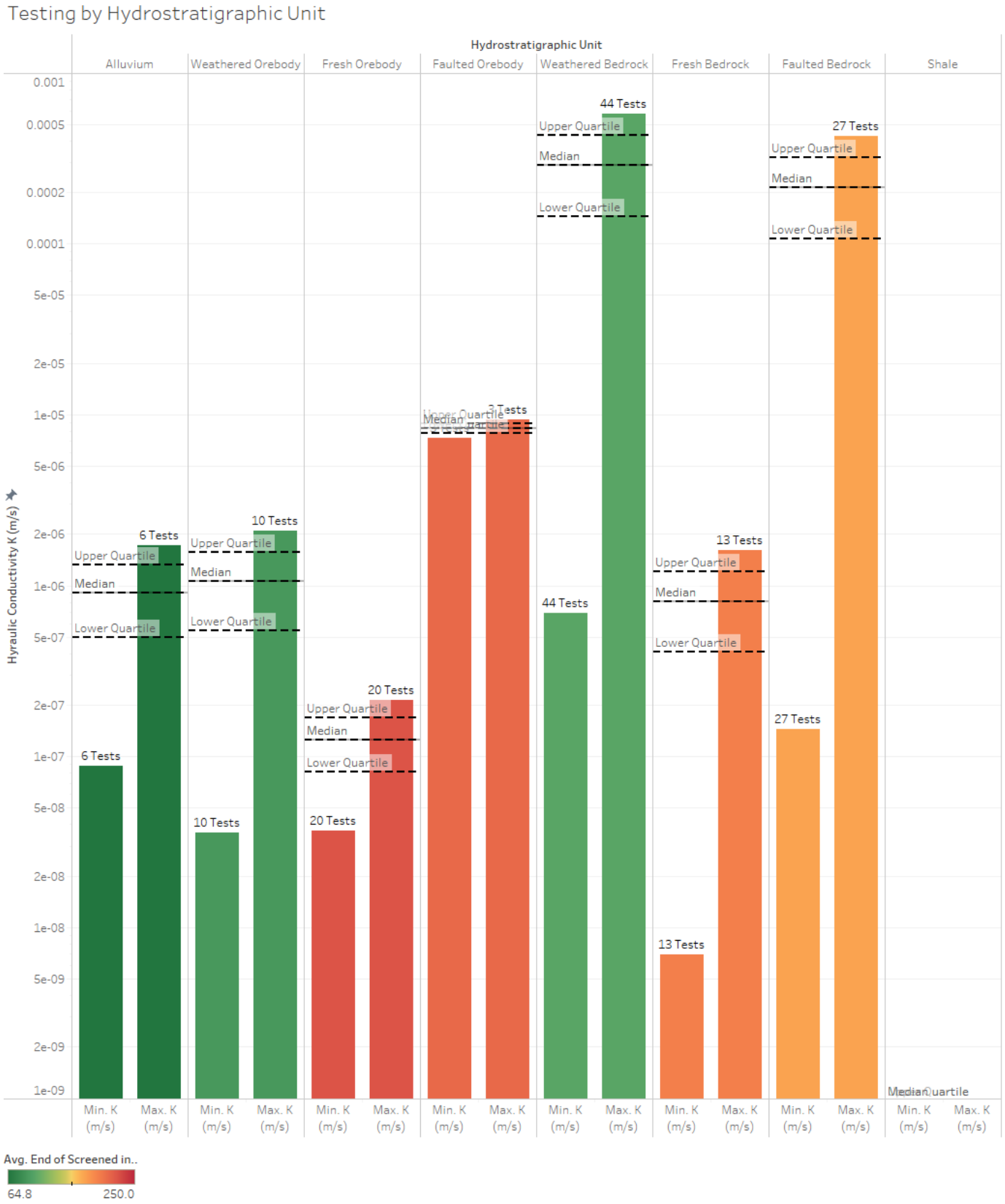

Figure 3: Distribution of Hydraulic Conductivity (m/s) values for each unit.

    - The underlying fresh bedrock has no appreciable transmissivity and water storage, except along very localised geological structures. Hydraulic conductivity values are significantly lower than the weathered area (6.7E-09 m/s < K < 1.6E-06 m/s). Where regional faults are intersected below the weathered zone, hydraulic conductivity values are approximately one order of magnitude higher (1.5E-07 m/s < K < 4.3E-04 m/s). Intersection of faults were primarily recorded in the Southern Borefield area, where regional faults were targeted during the 2015 and 2020 water supply drilling programs.
- The shale units, that structurally sandwich the host BIF in a syncline (i.e. western shale of the Kangaroo Formation and Eastern inter-bedded shales of the Corboy Formation), form a poorly developed aquifer(s). The shale units are over 400m thick on both sides of the ore body and generally present very low permeability values (K < 1E-9 m/s). Where major fractures are encountered, the permeability values can increase by up to 2 orders of magnitude (1E-7 m/s < K < 1E-6 m/s). Water yield from storage in this unit is expected to be very low, especially at depth.

Within the IB near-mine area, groundwater is found mainly within the weathered rock mass and fractured bedrock. The fractured-rock aquifers in the near-mine area are compartmentalised (i.e. boundaries identified from test pumping analysis) and present variable transmissivity values (1.9 < T <2,000 m2/day) that are constrained by the local fault(s) and fracturing rather than by lithology.

Groundwater recharge is primarily driven by infiltration of rainfall associated with cyclonic events and the interaction with intermittent stream flows occurring during the wet season, while the main discharge mechanisms are seepage into creek beds and evapotranspiration.

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Table 8: Compiled Iron Bridge Near-Mine Test Results - Grouped by Hydrogeological Units.

Conceptual Model Unit	Bore	E	N	Program	Area	Lithology	Weathering	Screen Top	Screen Bottom	Test Type	Solution	S	K (m/s)	K (m/day)	Average K (m/s)
Alluvium	Gusboy Bore	712810	7654862	WP2012	TSF Area	Alluvium	Weathered	12	42	CRT	Averaged	0.92	2.8E-07	0.02	5.6E-07
	GVW06	714866	7650007	WP2012	TSF Area	Alluvium	Weathered	12	60	CRT	Averaged	0.42	8.8E-08	0.01	
	GVW07	711330	7653700	WP2012	TSF Area	Alluvium	Weathered	18	77.5	CRT	Averaged	0.63	1.6E-07	0.01	
	NS-Obs13	708612	7655220	IBO2015	TSF Area	Alluvium	Weathered	12	72	CRT	Moench	0.01	1.7E-06	0.15	
										CRT	Moench, recovery	0.00	4.6E-07	0.04	
	Packer Bore	716905	7653454	WP2012	TSF Area	Alluvium	Weathered	18	65	CRT	Averaged	0.39	6.3E-07	0.05	
Weathered Orebody	GVM01_S	713387	7644525	FHT2018	Pit Area	Pincunah BIF	Weathered	68.42	80.42	FHT	Hvorsley (1951)	-	6.0E-07	0.05	8.0E-07
										FHT	Bower-Rice (1976)	-	5.4E-07	0.05	
	GVM02_S	713665	7644768	FHT2018	Pit Area	Pincunah BIF	Weathered	37.5	49.5	FHT	Hvorsley (1951)	-	1.1E-06	0.10	
										FHT	Bower-Rice (1976)	-	9.6E-07	0.08	
	IB_ELC_M03	713829	7649567	FHT2020	Pit Area	Pincunah BIF	Weathered	0	69.5	FHT	Hvorslev (1951)	-	7.1E-08	0.01	
										FHT	Bouwer-Rice (1976)	-	6.7E-08	0.01	
	IB_NST_P01	713231	7649633	FHT2020	Pit Area	Pincunah BIF	Weathered	48	212	FHT	Hvorslev (1951)	-	2.1E-06	0.18	
										FHT	Bouwer-Rice (1976)	-	1.6E-06	0.14	
	NSD005	713099	7648800	WP2012	Pit Area	Pincunah BIF	Weathered	33.2	36.3	Packer	Averaged	-	9.4E-07	0.08	
	NSD006	713192	7649192	WP2012	Pit Area	Pincunah BIF	Weathered	54	58	Packer	Averaged	-	3.6E-08	0.00	
Fresh Orebody	GVM01_D	713387	7644525	FHT2018	Pit Area	Pincunah BIF	Fresh	114.5	252.5	FHT	Bower-Rice (1976)	-	1.2E-07	0.01	9.9E-08
										FHT	Hvorsley (1951)	-	1.1E-07	0.01	
	IB_GVN_M01	713624	7646246	FHT2020	Pit Area	Pincunah BIF	Fresh	58	160	FHT	Bouwer-Rice (1976)	-	1.0E-07	0.01	
										FHT	Hvorslev (1951)	-	9.1E-08	0.01	
	IB_GVS_M01	713945	7644272	FHT2020	Pit Area	Pincunah BIF	Fresh	54	204	FHT	Bouwer-Rice (1976)	-	2.2E-07	0.02	
										FHT	Hvorslev (1951)	-	2.1E-07	0.02	
	IB_GVS_M02	713884	7645053	FHT2020	Pit Area	Pincunah BIF	Fresh	54	204	FHT	Bouwer-Rice (1976)	-	4.4E-08	0.00	
										FHT	Hvorslev (1951)	-	3.7E-08	0.00	
	IB_NST_M02	713577	7647675	FHT2020	Pit Area	Pincunah BIF	Fresh	60.5	198.5	FHT	Bouwer-Rice (1976)	-	7.3E-08	0.01	
										FHT	Hvorslev (1951)	-	5.8E-08	0.01	
	IB_NST_M03	712841	7649965	FHT2020	Pit Area	Pincunah BIF	Fresh	60	198	FHT	Hvorslev (1951)	-	1.1E-07	0.01	
										FHT	Bouwer-Rice (1976)	-	8.7E-08	0.01	
	IBM01	713608	7646218	FHT2018	Pit Area	Pincunah BIF	Fresh	71.8	143.8	FHT	Bower-Rice (1976)	-	6.3E-08	0.01	
										FHT	Hvorsley (1951)	-	4.8E-08	0.00	
	NSM01	713160	7649389	FHT2018	Pit Area	Pincunah BIF	Fresh	42	300	FHT	Hvorsley (1951)	-	5.4E-08	0.00	
										FHT	Bower-Rice (1976)	-	4.5E-08	0.00	
	NSP01R	713035	7649405	FHT2018	Pit Area	Pincunah BIF	Fresh	47.46	299.46	CRT	Theis (1935)	0.00	1.9E-07	0.02	
										CRT	Hantush-Jacob (1955) Leaky	0.00	1.9E-07	0.02	
										FHT	Hvorsley (1951)	-	6.5E-08	0.01	
										FHT	Bower-Rice (1976)	-	5.2E-08	0.00	
Faulted Orebody	GVM02_D	713665	7644768	FHT2018	Pit Area	Pincunah BIF	Fresh	132.5	252.5	FHT	Bower-Rice (1976)	-	9.4E-06	0.81	8.7E-06
										FHT	Hvorsley (1951)	-	7.4E-06	0.64	
	NS0128	712695	7649783	WP2012	Pit Area	Pincunah BIF	Fresh	72	132	CRT	Averaged	-	9.3E-06	0.80	
Weathered Bedrock	NS-Obs33	710795	7647249	IBO2015	Northern Borefield	Basalt	Weathered	12	156	CRT	Moench, fractures	0.01	4.6E-05	4.00	9.1E-05
	NS-PB15	709405	7647283	IBO2015	Northern Borefield	Serpentinite	Weathered	12	90	CRT	Moench, fractured	0.02	8.2E-05	7.08	

NS-PB17	709799	7647257	IBO2015	Northern Borefield	Basalt	Weathered	6	144	CRT	Moench, fractures and parallel boundaries	0.00	5.8E-04	50.03
NS-PB30	708555	7648498	IBO2015	Northern Borefield	Basalt	Weathered	18	140	CRT	Moench	0.00	1.5E-06	0.13
NS-PB31	709501	7647558	IBO2015	Northern Borefield	Chert	Weathered	6	83	CRT	Moench, fractures	0.01	6.9E-05	6.00
NS-PB32	709611	7647018	IBO2015	Northern Borefield	Basalt	Weathered	10	70	CRT	Moench, fractures, dewatering	0.24	1.0E-04	8.99
NS-PB33	710800	7647246	IBO2020	Northern Borefield	Basalt	Weathered	5	59	CRT	Theis Recovery	-	1.4E-04	12.10
									CRT	Theis-Hantush	-	1.4E-04	12.10
									CRT	Cooper-Jacob	-	8.7E-05	7.52
									CRT	Moench	-	1.4E-05	1.21
NS-EXS21	708107	7645532	IBO2015	Southern Borefield	Siltstone	Weathered	0	261	CRT	Moench fractured, with boundaries, dewatering	0.01	2.3E-05	2.00
BH2A-04	711921	7653330	FHT2018	TSF Area	Shale	Weathered	12	15	FHT	Hvorsley (1951)	-	4.1E-05	3.56
									FHT	Bower-Rice (1976)	-	3.6E-05	3.10
BH2A-05	711487	7653040	FHT2018	TSF Area	Shale	Weathered	12	15	FHT	Hvorsley (1951)	-	1.7E-04	14.65
									FHT	Bower-Rice (1976)	-	1.4E-04	11.96
NS_BH01	710489	7654801	FHT2018	TSF Area	Sandstone/wacke	Weathered	24	30	FHT	Hvorsley (1951)	-	2.8E-06	0.24
									FHT	Bower-Rice (1976)	-	1.9E-06	0.17
NS_BH02	710142	7654619	FHT2018	TSF Area	Sandstone/wacke	Weathered	24	30	FHT	Hvorsley (1951)	-	2.8E-04	24.49
									FHT	Bower-Rice (1976)	-	2.5E-04	21.84
NS_BH05A	710515	7654259	FHT2018	TSF Area	Sandstone/wacke	Weathered	21	27	FHT	Hvorsley (1951)	-	9.0E-05	7.74
									FHT	Bower-Rice (1976)	-	7.0E-05	6.07
NS_BH05B	710517	7654261	FHT2018	TSF Area	Siltstone	Weathered	2.2	8.2	FHT	Bower-Rice (1976)	-	3.9E-04	33.72
									FHT	Hvorsley (1951)	-	3.4E-04	29.50
NS-Obs24	712257	7652443	IBO2015	TSF Area	Sandstone/wacke	Weathered	14	152	CRT	Moench Fractured, recovery, boundaries	0.06	6.9E-07	0.06
NS-Obs25	711800	7653939	IBO2015	TSF Area	Shale	Weathered	14	182	CRT	Moench Fractured	0.16	1.6E-06	0.14
NS-PB02 (Golder)	710143	7654606	IBO2015and20	TSF Area	Sandstone/wacke	Weathered	9	99	CRT	Cooper-Jacob	-	3.3E-05	2.85
									CRT	Theis-Hantush	-	3.1E-05	2.68
									CRT	Theis Recovery	-	5.8E-06	0.50
									CRT	Moench	-	2.3E-06	0.20
									CRT	Moench Fractured	0.01	1.5E-05	1.32
NS-ObsW01	704190	7647032	IBO2015	Western Borefield	Serpentinite	Weathered	10	142	CRT	Moench Leaky Confined	0.00	1.7E-05	1.50
									CRT	Moench Leaky Confined, recovery	0.00	9.7E-06	0.83
NS-ObsW01A	706103	7647616	IBO2015	Western Borefield	Basalt	Weathered	20	140	CRT	Theis, dewatering	0.00	2.7E-05	2.29
NS-ObsW02	703126	7646983	IBO2015	Western Borefield	Serpentinite	Weathered	11	126	CRT	Moench, Fractured, recovery	0.03	2.3E-05	2.00
									CRT	Moench Fractured	0.10	1.0E-05	0.90
NS-ObsW02B	701774	7647057	IBO2015	Western Borefield	Sandstone/wacke	Weathered	38	207	CRT	Moench, fractured, recovery	0.03	5.8E-06	0.50
									CRT	Moench, Fractured	0.03	2.7E-06	0.23
NS-ObsW02C	701723	7647165	IBO2015	Western Borefield	Metapelite	Weathered	20	146	CRT	Moench fractured, recovery	0.01	6.9E-05	6.00
									CRT	Moench, fractured	0.25	3.0E-05	2.60
NS-ObsW10	703131	7646764	IBO2015	Western Borefield	Sandstone/wacke	Weathered	20	152	CRT	Moench, unconfined	0.01	1.5E-05	1.26
NS-ObsW17	704228	7646827	IBO2015	Western Borefield	Metapelite	Weathered	7	121	CRT	Moench fractured, recovery	0.06	3.1E-04	27.04
									CRT	Moench Fractured	0.05	2.8E-04	24.02
NS-EXS22	708643	7644198	IBO2015	Southern Borefield	Sandstone/wacke	Fresh	0	260	CRT	Moench fractured, with boundaries, dewatering	0.03	1.4E-05	1.20
									CRT	Moench fractured, with boundaries, dewatering	-	9.3E-06	0.80

Fresh Bedrock	IB_NB_P01	707375	7648931	IBO2020	Northern Borefield	Basalt	Fresh	39.62	195.62	CRT	Moench	-	6.3E-07	0.05	4.9E-07
										CRT	Theis-Hantush	-	2.7E-07	0.02	
										CRT	Theis Recovery	-	4.7E-08	0.00	
										CRT	Cooper-Jacob	-	7.0E-09	0.00	
	NS-Obs34	711451	7648249	IBO2015	Northern Borefield	Serpentinite	Fresh	20	146	CRT	Moench, fractures and dewatering	-	5.8E-07	0.05	
	IB_SB_P02	708765	7644344	IBO2020	Southern Borefield	Sandstone/wacke	Fresh	32	212	CRT	Moench	-	6.4E-07	0.06	
										CRT	Theis-Hantush	-	6.2E-07	0.05	
										CRT	Cooper-Jacob	-	2.2E-07	0.02	
										CRT	Theis Recovery	-	1.6E-07	0.01	
	NS-ObsS16	709363	7645362	IBO2015	Southern Borefield	Sandstone/wacke	Fresh	101	269	CRT	Moench Fractured	0.12	9.4E-08	0.01	
	NS-Obs14	712615	7649148	IBO2015	TSF Area	Shale	Fresh	0	120	CRT	Moench Fractured	0.04	1.0E-06	0.09	
	NS-ObsW09	700279	7648238	IBO2015	Western Borefield	Metapelite	Fresh	68	206	CRT	Moench Fractured	0.02	1.6E-06	0.14	
										CRT	Moench Fractured	0.07	4.6E-07	0.04	
Faulted Bedrock	IB_SB_P01	709470	7644926	IBO2020	Southern Borefield	Sandstone/wacke	Fresh	103.85	199.85	CRT	Cooper-Jacob	-	1.2E-05	1.04	3.6E-05
										CRT	Moench	-	8.7E-06	0.75	
										CRT	Theis-Hantush	-	7.0E-06	0.60	
										CRT	Theis Recovery	-	9.6E-07	0.08	
	NS-Obs18	710076	7647308	IBO2015	Northern Borefield	Basalt	Fault	12	158	CRT	Moench, fractures	0.20	6.9E-06	0.60	
	NS-PB19	709163	7647131	IBO2015	Northern Borefield	Siltstone	Fault	1	157	CRT	Moench, fractures	0.03	3.6E-05	3.07	
	NS-ExS03	710677	7644835	IBO2015	Southern Borefield	Sandstone/wacke	Fault	0	210	CRT	Moench Fractured	0.00	3.1E-05	2.64	
	NS-EXS17	709488	7644909	IBO2015	Southern Borefield	Sandstone/wacke	Fault	0	248	CRT	Moench Fractured	0.40	5.1E-06	0.44	
	NS-ExS31	708813	7644375	IBO2015	Southern Borefield	Basalt	Fault	0	270	CRT	Moench confined with leakage	0.00	1.5E-07	0.01	
	NS-ObsS05	709967	7645749	IBO2015	Southern Borefield	Sandstone/wacke	Fault	186	288	CRT	Moench Fractured	0.02	1.2E-06	0.10	
	NS-ObsS19	710279	7644972	IBO2015	Southern Borefield	Sandstone/wacke	Fault	156	312	CRT	Moench Fractured	0.05	1.2E-05	1.03	
										CRT	Moench Fractured	0.01	2.2E-06	0.19	
	NS-ObsS28	710892	7644633	IBO2015	Southern Borefield	Sandstone/wacke	Fault	80	176	CRT	Moench Fractured	-	3.1E-05	2.70	
										CRT	Moench Fractured	-	2.3E-05	2.00	
	NS-PBS23	709373	7643734	IBO2015and20	Southern Borefield	Sandstone/wacke	Fault	99	183	CRT	Moench Fractured	0.04	1.0E-05	0.90	
										CRT	Moench	-	9.4E-06	0.81	
										CRT	Theis-Hantush	-	7.9E-06	0.68	
										CRT	Cooper-Jacob	-	7.1E-06	0.61	
										CRT	Moench confined with leakage	0.09	5.6E-06	0.48	
										CRT	Theis Recovery	-	4.6E-06	0.40	
	NS-PBS25	710074	7643535	IBO2015and20	Southern Borefield	Sandstone/wacke	Fault	4	82	CRT	Moench fractured, with boundaries, dewatering	0.02	4.3E-04	36.98	
										CRT	Theis Recovery	-	1.3E-04	11.23	
										CRT	Cooper-Jacob	-	3.9E-05	3.37	
										CRT	Theis-Hantush	-	3.7E-05	3.20	
										CRT	Moench	-	6.2E-06	0.54	
	NS-PBW08	700162	7648328	IBO2015	Western Borefield	Sandstone/wacke	Fault	53	83	CRT	Moench Fractured	0.08	5.7E-05	4.88	
										CRT	Moench Fractured, recovery	0.18	4.1E-05	3.50	
Shale	NSD011	713267	7648810	WP2012	Pit Area	Shale	Fresh	0	354	Packer	Averaged	-	0.0E+00	0.00	0.0E+00
	NSD010	713242	7648000	WP2012	Pit Area	Shale	Fresh	0	334	Packer	Averaged	-	0.0E+00	0.00	

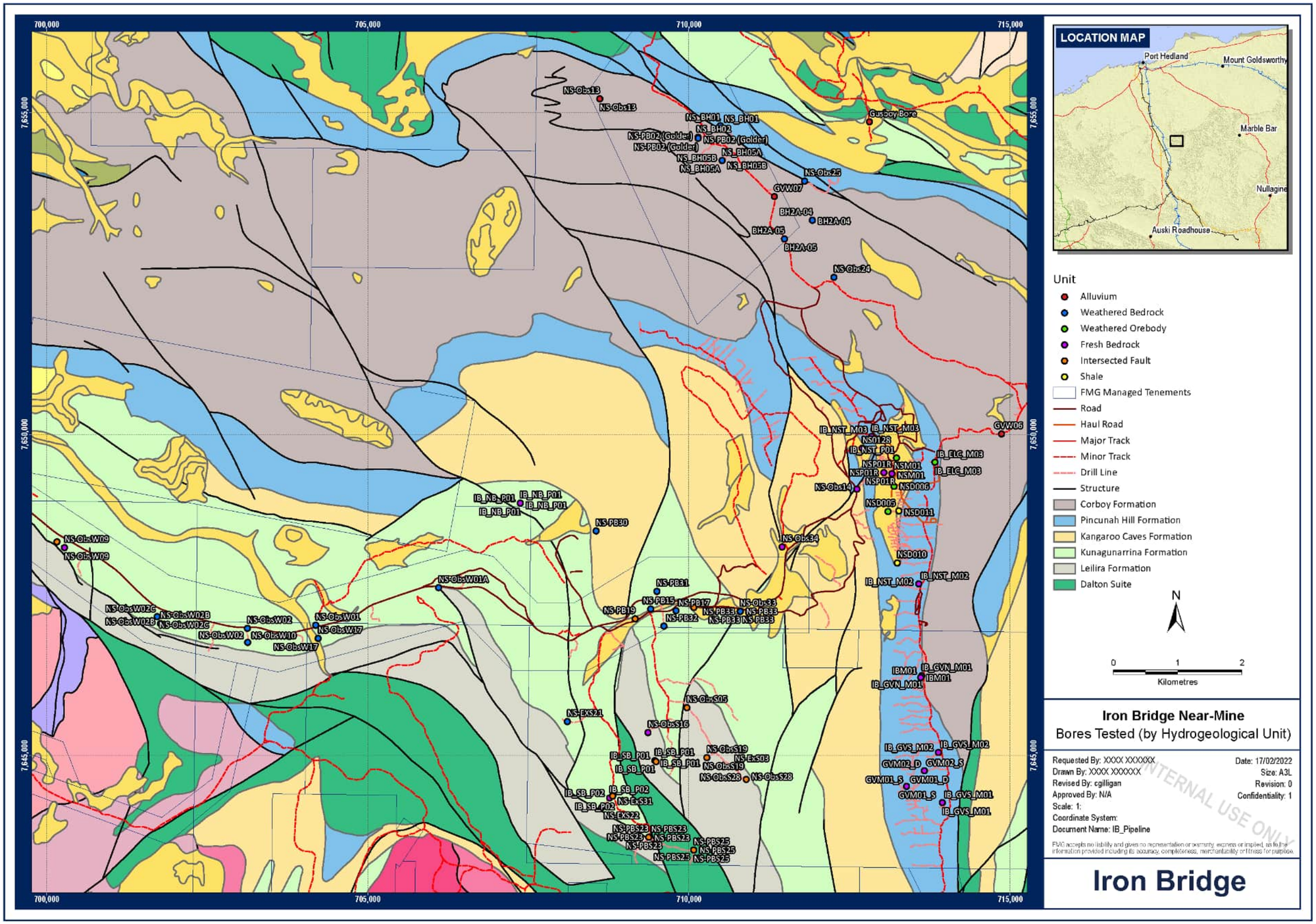
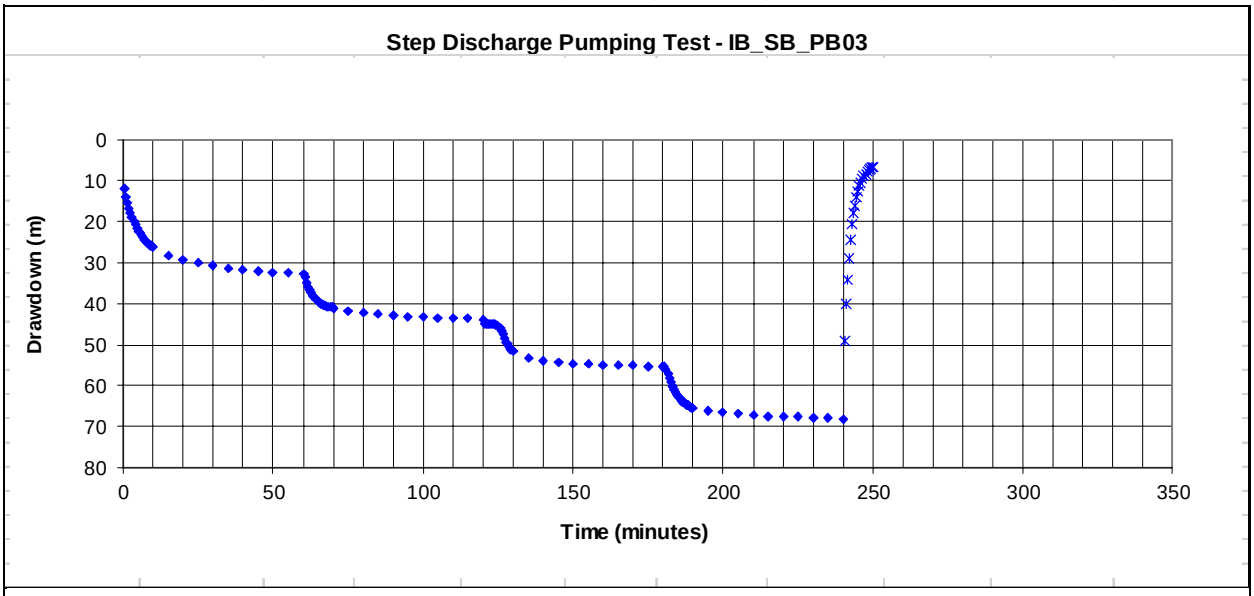
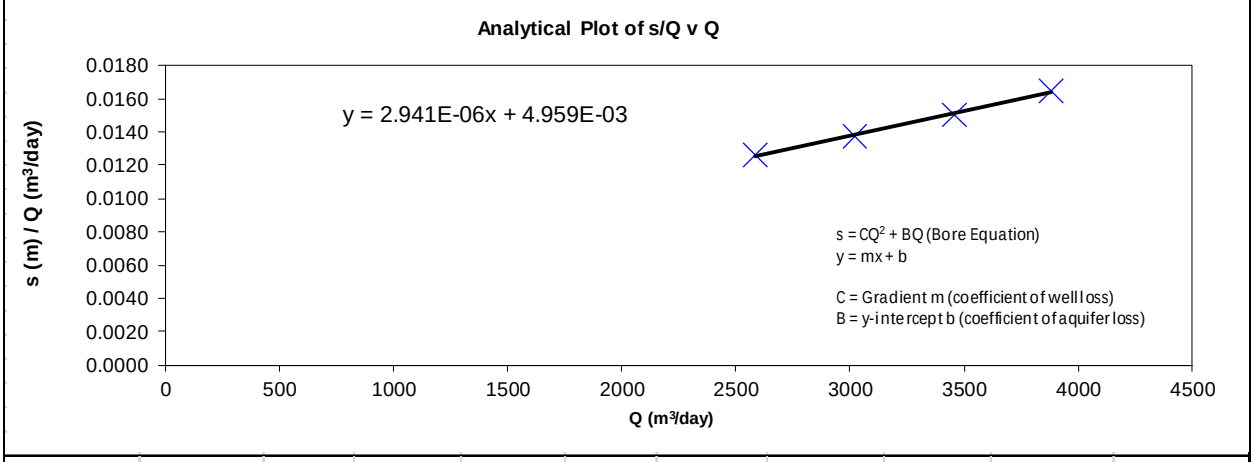


Figure 4: Iron Bridge Near-Mine - Bores Tested Grouped by Hydrogeological Unit.

- NS-0000-TE-AD-0008_2

Appendix 5: Test Pumping data and analysis for IB_SB_PB03 and IB_SB_PB04





From plot of s/Q v Q (trend line equation):

Gradient (C)	2.941E-06
Intercept (B)	4.959E-03

ANALYSIS TABLE 0 Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (60 minutes duration)	Discharge (l/s)	Discharge (Q) (m³/d)	Incremental **Analysed step** drawdown (m)	Cumulative **Analysed step** drawdown (m)	**Predicted** drawdown using Bore Equation (m)	**Actual** total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %	Specific Capacity (L/s/m)
1	30	2588	32.8	32.8	32.53	32.80	0.0127	39	0.91
2	35	3023	8.8	41.6	41.87	43.77	0.0138	36	0.84
3	40	3459	10.4	51.9	52.33	55.37	0.0150	33	0.77
4	45	3882	12.1	64.0	63.57	68.07	0.0165	30	0.70
Predicted		#N/A			#N/A				#N/A
									Average SP 0.81

Analysis Date: 04/04/2023 Hydrogeologist: M Carroll

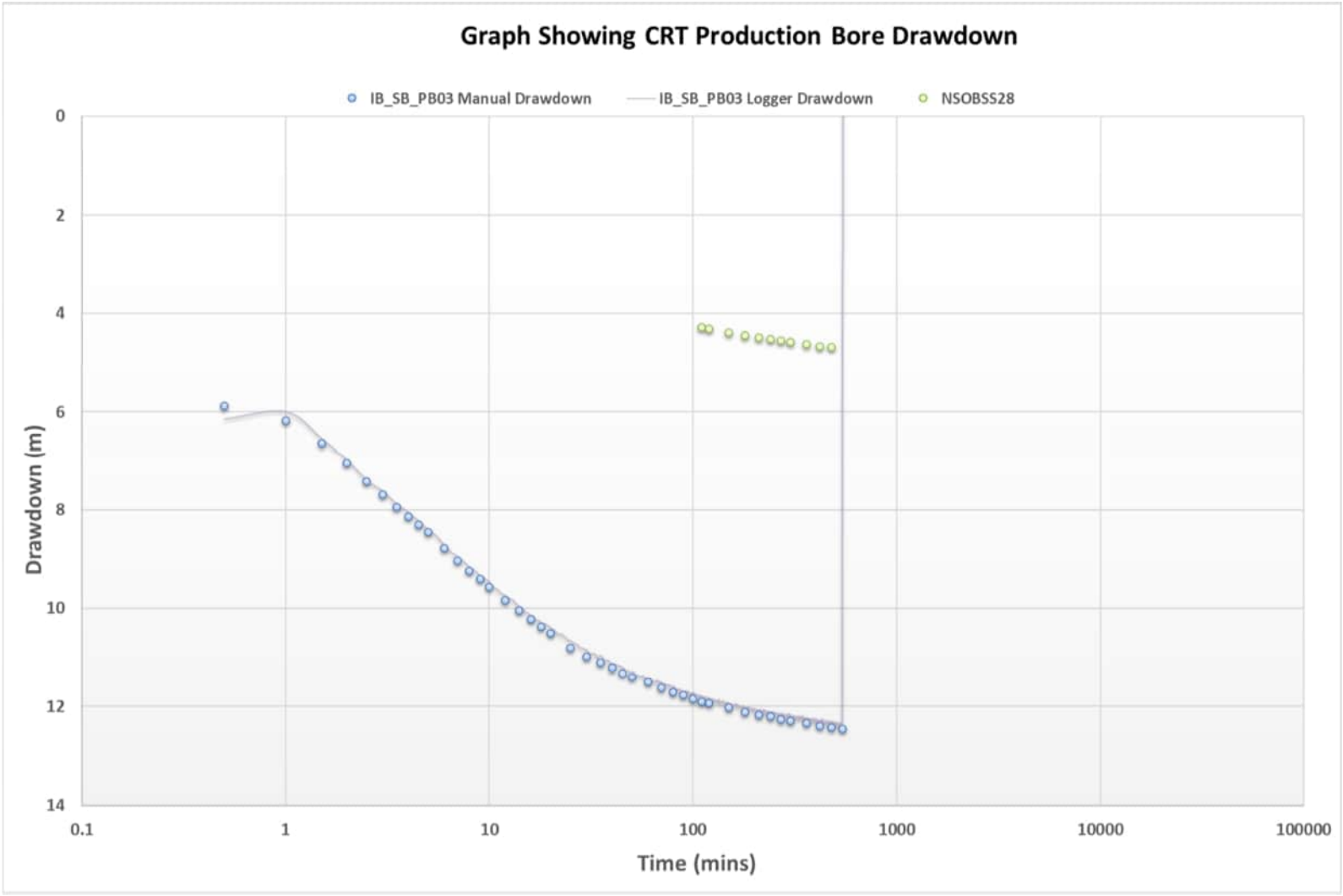
Testing Information

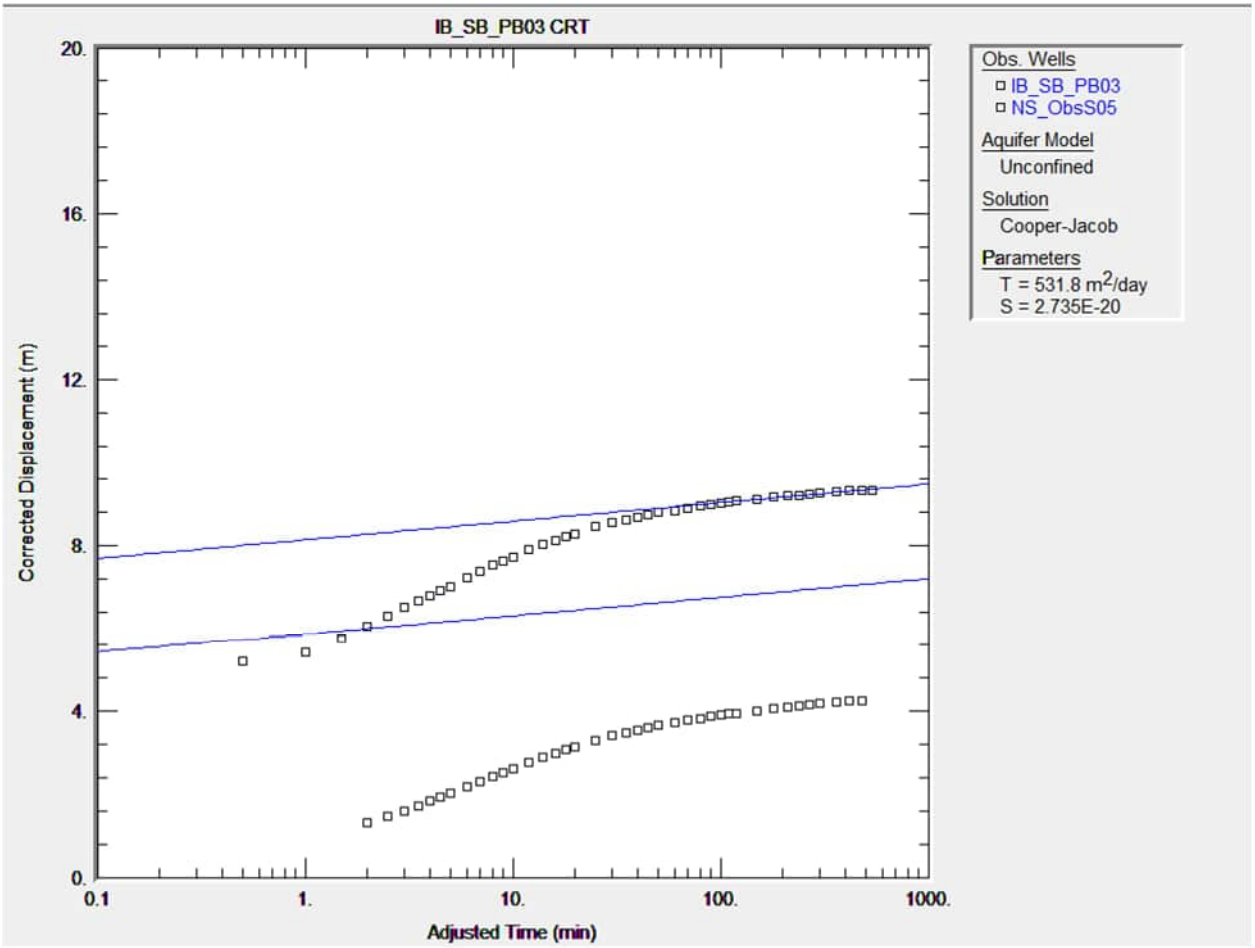
Name:	Adrian Turner			Date:	24.02.23
Client:	FMG			Rig:	4
Location	Iron Bridge	**Production Bore**	IB_SB_PB03	**Bore Depth**	261
Static Water Level	25	**Date SWL Taken**	24.02.23	**Pump Inlet Setting**	127
CRT Flow Rate (l/s)	15	**CRT Length** (mins)	540	**CRT Recovery Length** (mins)	1440
Production Bore Logger Time Interval	0.5	**Length of Discharge** (i.e. 200m)	15	**Traffic Control Needed** (Y/N)	N

Observation Bores	SWL	Logger Time Interval (mins)	Distance From PB		
NSOBSS28	25.24	0.5			
NSOBS05	45.8	0.5			
NSEX17	42.78	0.5			
NSOBSS18	37.38	0.5			
IBSBM01	16.31	0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			

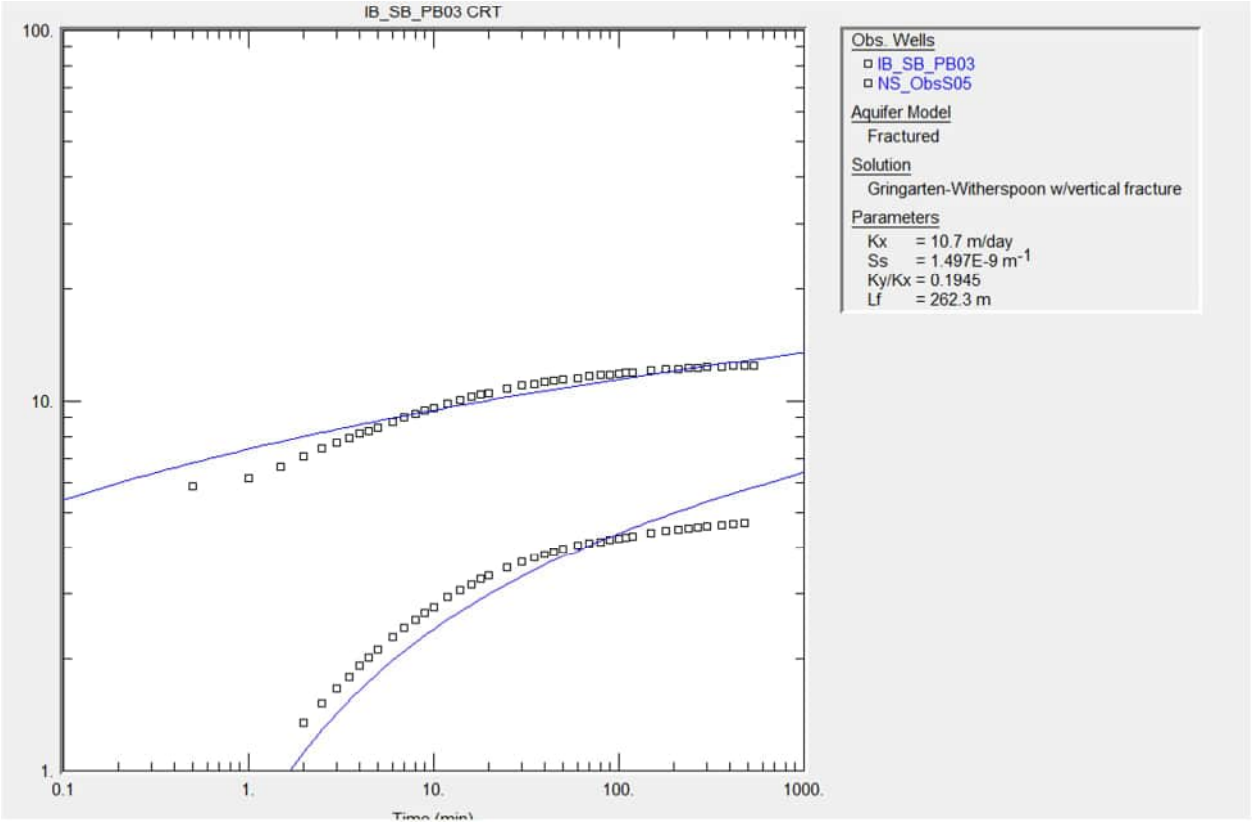
Diary/Comments for Production Bore

Date	Time	Comment
20.01.2023	3:00PM	Pumping well, diacharge management into creek and pump working with no issues
20.01.2023	5:00PM	steady drawdown on both monitoring and production bore
21.01.2023	5:30AM	Steady drawdown overnight. Bore has drawndown 5 meters overnight
21.02.2023	8:30AM	Bore has drawn down two meters within an hour
21.02.2023	9:30AM	Hydro and client confirm Production pumps turned on in area
21.02.2023	9:30AM	Subsequently effecting drawdown on production bore 2

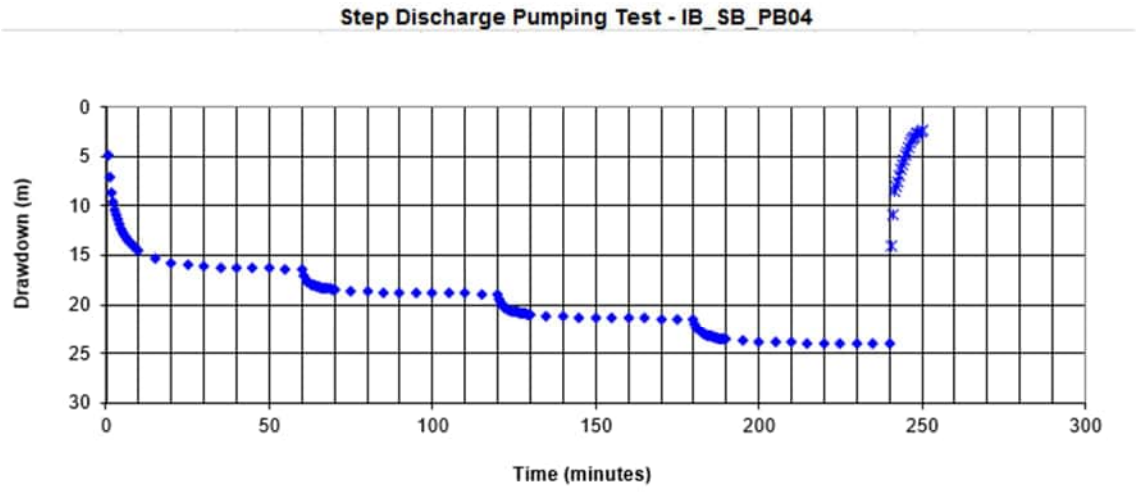

Graph Showing CRT Production Bore Drawdown
IB_SB_PB03 Manual Drawdown
IB_SB_PB03 Logger Drawdown
NSOBSS28
Drawdown (m)
0
2
4
6
8
10
12
14
0.1
1
10
100
1000
10000
100000
Time (mins)

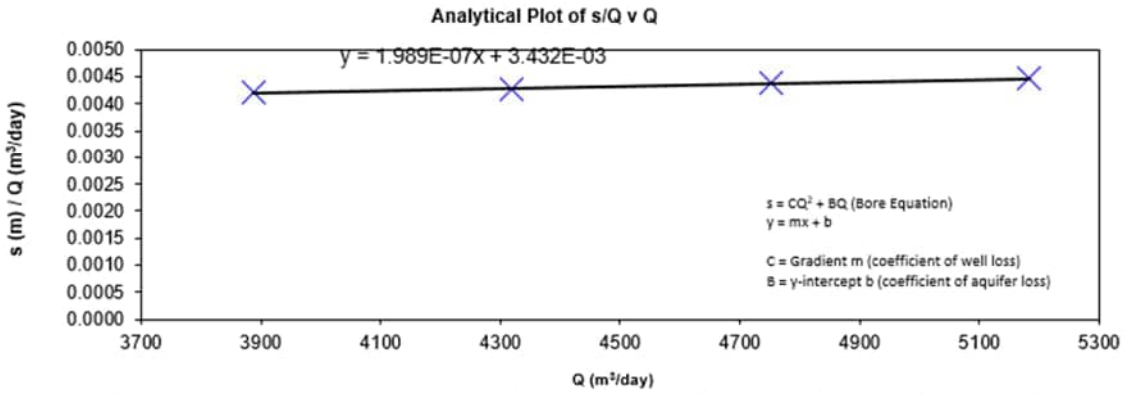


Initial check using Cooper Jacob indicates monitoring bore is unlikely to be located in direct connection with abstraction bore. Diagnostic plots indicate fracture flow



Fracture flow solution achieved an improved match in aquifer response, and supported the high permeability and low storage concept expected. Likely the bore is behaving primarily as a fracture inflow, but with contribution from weathered matrix.





From plot of s/Q v Q (trend line equation):

Gradient (C)	1.99E-07
Intercept (B)	3.432E-03

ANALYSIS TABLE 0 Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (60 minutes duration)	Discharge (l/s)	Discharge (Q) (m^3/d)	**Incremental Analysed step** drawdown (m)	Cumulative **Analysed step** drawdown (m)	**Predicted** drawdown using Bore Equation (m)	**Actual** total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %	Specific Capacity (L/s/m)
1	45	3888	16.4	16.4	16.35	16.39	0.0042	82	2.75
2	50	4320	2.1	18.5	18.54	18.89	0.0043	80	2.71
3	55	4752	2.3	20.8	20.80	21.46	0.0044	78	2.65
4	60	5184	2.4	23.2	23.14	24.08	0.0045	77	2.59
Predicted		#N/A			#N/A				#N/A
ANALYSIS COMMENTS									Average SP 2.67

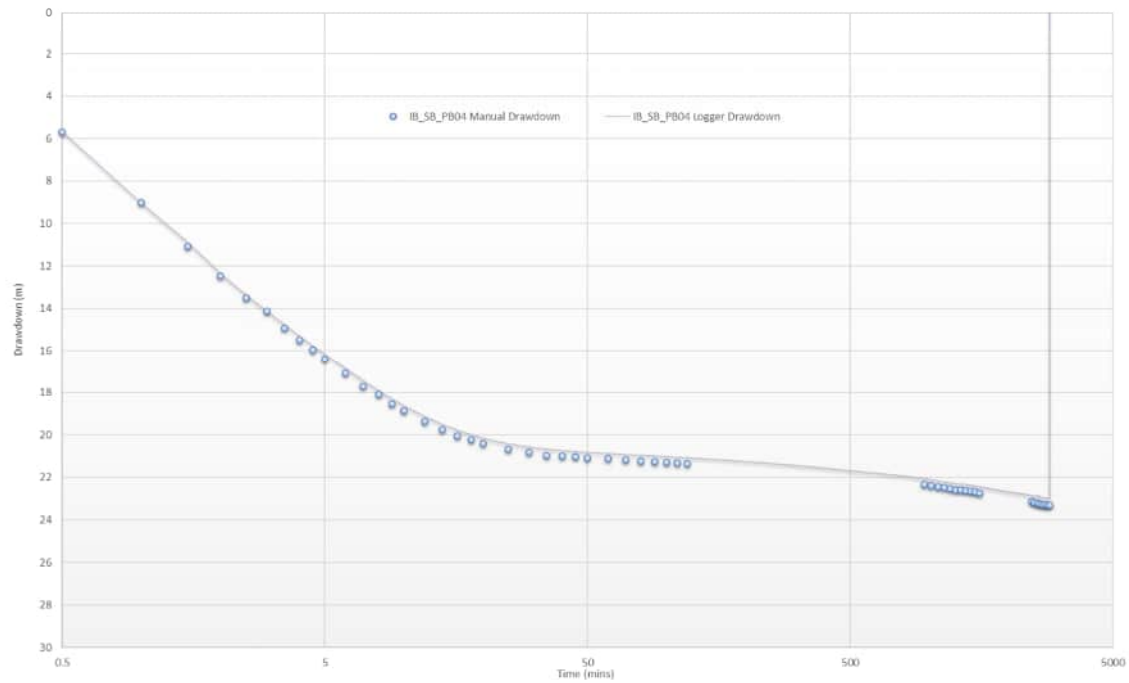
Analysis Date: 7/5/2023 Hydrogeologist: JLG

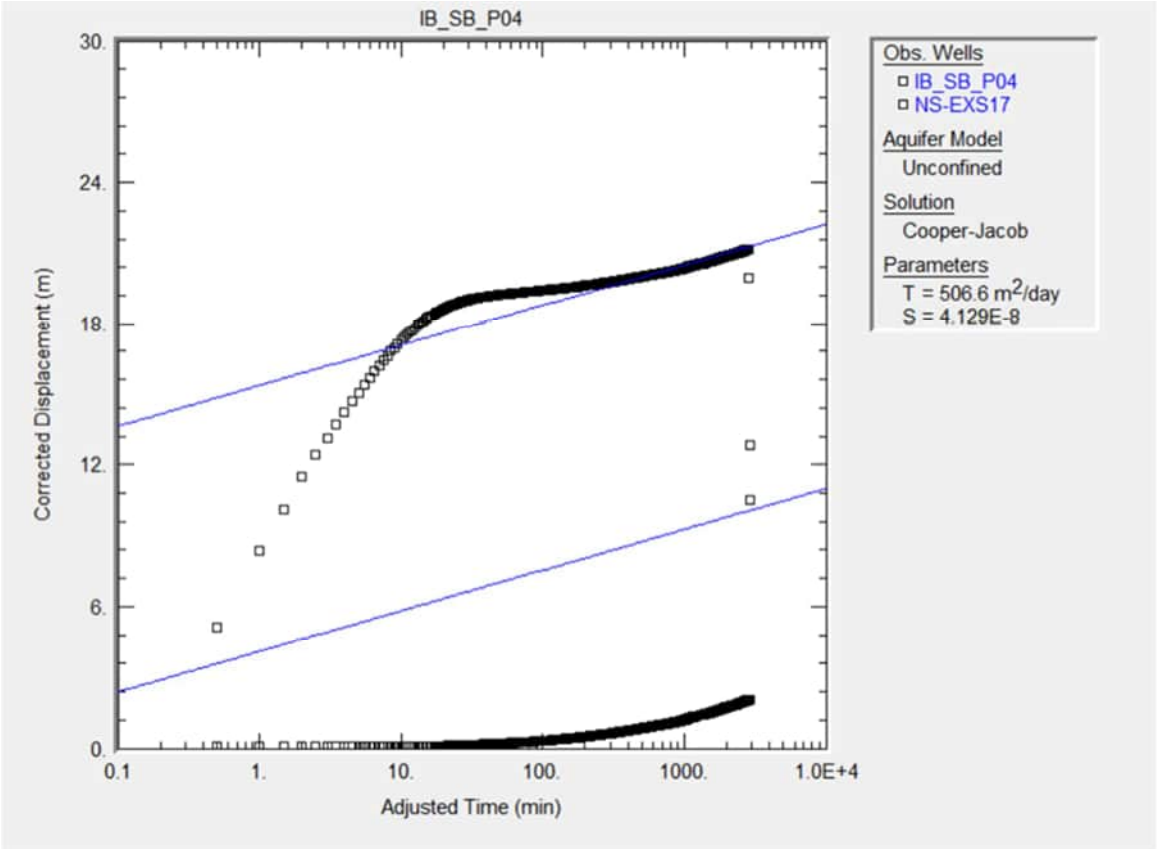
Testing Information

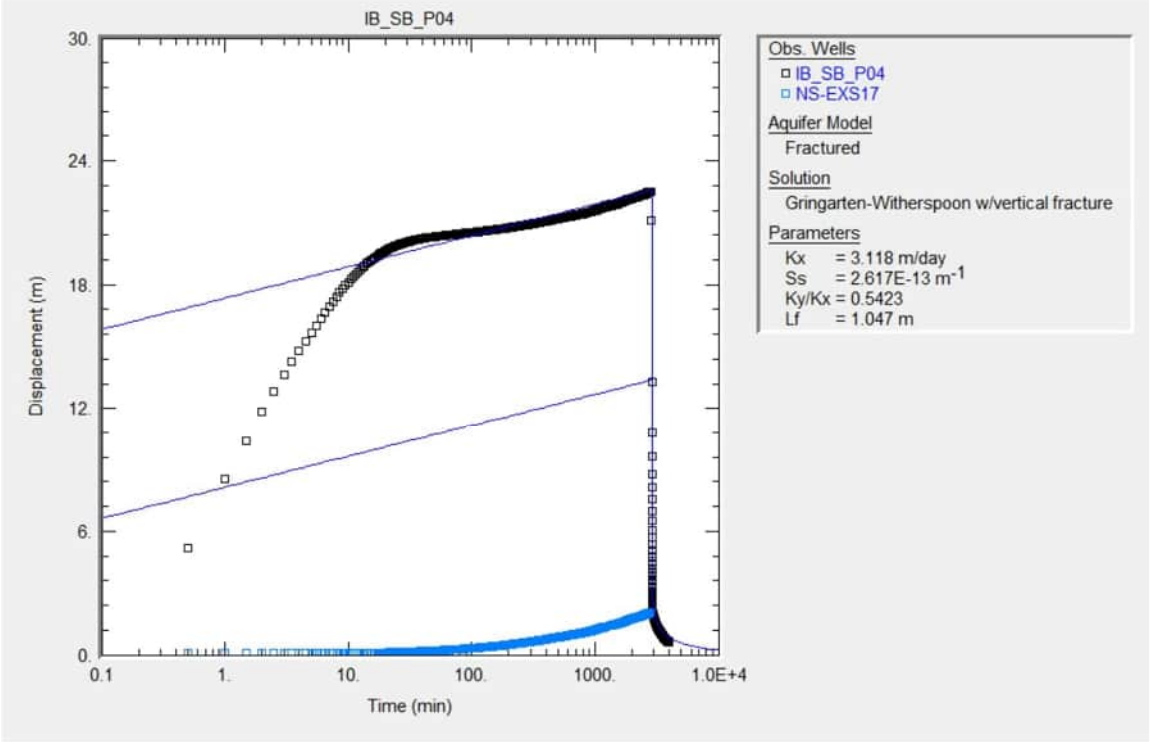
Name:	T Cross			Date:	22.04.2023
Client:	FMG			Rig:	2
Location	Iron Bridge	Production Bore	IB_SB_PB04	Bore Depth	226m
Static Water Level	37.06	Date SWL Taken	22.04.2023	Pump Inlet Setting	89.7m
CRT Flow Rate (l/s)	55	CRT Length (mins)	2880	CRT Recovery Length (mins)	180
Production Bore Logger Time Interval	0.5	Length of Discharge (i.e. 200m)	40	Traffic Control Needed (Y/N)	N

Observation Bores	SWL	Logger Time Interval (mins)	Distance From PB		
NSOBSS18	39.66	0.5			
NSOBSS05	47.91	0.5			
NSOBSS19	40.09	0.5			
NSEXS31	25.26	0.5			
NSEXS30	17.24	0.5			
NSESS21	20.99	0.5			
NSEXS17	38.18	0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			
		0.5			

Graph Showing CRT Production Bore Drawdown




IB_SB_P04
Corrected Displacement (m)
30.
24.
18.
12.
6.
0.
0.1
1.
10.
100.
1000.
1.0E+4
Adjusted Time (min)
Obs. Wells
IB_SB_P04
NS-EXS17
Aquifer Model
Unconfined
Solution
Cooper-Jacob
Parameters
T = 506.6 m2/day
S = 4.129E-8


IB_SB_P04
Displacement (m)
30.
24.
18.
12.
6.
0.
0.1
1.
10.
100.
1000.
1.0E+4
Time (min)
Obs. Wells
IB_SB_P04
NS-EXS17
Aquifer Model
Fractured
Solution
Gringarten-Witherspoon w/vertical fracture
Parameters
Kx = 3.118 m/day
Ss = 2.617E-13 m-1
Ky/Kx = 0.5423
Lf = 1.047 m

Appendix 6: Tabulated water quality data statistics for Iron Bridge

	Groundwater				Pools			
Analyte	Number of Samples	Average	Maximum	Minimum	Number of Samples	Average	Maximum	Minimum
Acidity as CaCO3	14	1.30E+01	3.30E+01	1.00E+00	110	2.95E+00	1.70E+01	1.00E+00
Ag	245	3.68E-04	1.00E-03	1.00E-04	35	2.13E-04	1.00E-03	1.00E-05
Al	368	1.20E-02	3.29E-01	0.00E+00	54	2.26E-02	4.30E-01	5.00E-03
As	329	1.02E-02	2.27E-01	2.00E-04	87	2.23E-03	2.30E-02	3.00E-04
B	383	7.75E-01	2.28E+01	8.00E-03	60	2.68E-01	6.72E-01	5.00E-02
Ba	226	3.28E-02	1.83E-01	1.90E-03	60	4.44E-02	1.94E-01	6.00E-03
Be	329	4.20E-04	1.00E-03	1.00E-04	60	3.55E-04	1.00E-03	1.00E-04
Bi	169	5.00E-05	5.00E-05	5.00E-05	26	5.00E-05	5.00E-05	5.00E-05
Ca	359	4.04E+01	1.26E+02	1.90E+00	124	3.42E+01	1.20E+02	2.00E+00
Cd	329	1.04E-04	9.00E-04	5.00E-05	118	6.86E-05	1.00E-04	5.00E-05
Cl	349	1.99E+02	1.16E+03	7.00E+00	123	1.29E+02	1.00E+03	1.50E+01
Co	329	3.18E-03	7.84E-02	1.00E-04	60	5.30E-04	2.70E-03	1.00E-04
CO3 as CaCO3	330	2.05E+00	3.70E+01	1.00E+00	124	5.06E+01	3.92E+02	1.00E+00
Cr	97	9.59E-04	6.20E-03	2.00E-04	48	3.77E-04	1.70E-03	2.00E-04
Cu	329	4.06E-03	7.13E-02	5.00E-04	120	1.23E-03	8.50E-03	5.00E-04
EC	377	1.40E+03	5.42E+03	1.84E+02	93	1.10E+03	2.26E+03	1.34E+02
F	194	4.04E-01	1.17E+00	2.90E-02	108	1.63E-01	6.15E-01	1.00E-02
Fe	374	6.02E-01	3.80E+01	0.00E+00	118	4.99E-02	9.20E-01	2.00E-03
HCO3 as CaCO3	330	4.19E+02	6.88E+02	1.00E+00	124	4.18E+02	7.78E+02	1.00E+00
Hg	329	1.24E-04	1.42E-02	4.00E-05	120	6.23E-05	1.00E-04	4.00E-05
K	359	4.18E+00	5.40E+01	2.00E-01	124	2.60E+00	3.50E+01	3.00E-01
La	169	1.00E-03	1.00E-03	1.00E-03	30	1.00E-03	1.00E-03	1.00E-03
Mg	359	1.02E+02	2.53E+02	4.00E+00	124	1.08E+02	2.95E+02	4.00E+00
Mn	383	1.59E-01	1.88E+00	5.00E-04	120	6.16E-02	2.03E+00	5.00E-04
Mo	227	2.73E-03	3.98E-02	1.00E-04	29	5.21E-04	1.90E-03	2.00E-04
Na	359	1.26E+02	7.24E+02	1.73E+01	124	7.33E+01	2.85E+02	4.00E+00
Ni	329	1.82E-02	6.06E-01	5.00E-04	120	1.55E-03	1.20E-02	5.00E-04
NO3 as N	245	4.97E-01	8.37E+00	0.00E+00	93	1.33E-01	6.71E+00	1.00E-02
OH as CaCO3	327	1.00E+00	1.00E+00	1.00E+00	124	1.00E+00	1.00E+00	1.00E+00
Pb	329	5.30E-04	6.10E-03	1.00E-04	120	4.30E-04	1.00E-03	1.00E-04
pH	377	7.77E+00	8.79E+00	3.95E+00	93	8.29E+00	9.09E+00	4.27E+00
PO4	39	6.39E-02	5.00E-01	5.00E-03	39	1.68E-01	6.40E-01	1.00E-02
Sb	172	6.48E-04	1.71E-02	2.00E-04	62	2.39E-04	1.00E-03	2.00E-04
Se	329	4.06E-03	2.07E-02	2.00E-04	60	3.07E-03	1.00E-02	2.00E-04
Si	300	2.56E+01	8.30E+01	2.20E-01	10	1.89E+01	3.25E+01	5.74E+00
Sn	175	2.89E-04	8.80E-03	2.00E-04	29	2.41E-04	1.00E-03	2.00E-04
SO4 & SO4 - Duplicated	359	1.22E+02	7.38E+02	1.00E+00	122	4.69E+01	3.07E+02	5.00E+00
Sr	325	2.77E-01	1.01E+00	4.00E-03	38	1.83E-01	1.06E+00	1.30E-02
Tl	169	2.42E-05	1.00E-04	2.00E-05	28	2.00E-05	2.00E-05	2.00E-05
Total Dissolved Solids	367	9.01E+02	3.17E+03	1.11E+02	46	7.27E+02	1.70E+03	8.60E+01
U	224	6.22E-03	1.65E-01	5.00E-05	28	2.88E-04	7.30E-04	1.10E-04
V	329	3.27E-02	2.40E-01	2.00E-04	120	8.41E-03	2.67E-02	2.00E-04
Zn	329	7.53E-02	6.51E+00	1.00E-03	120	8.97E-03	1.34E-01	1.00E-03

Appendix 7: Groundwater Modelling Report

Groundwater Consulting Pty Ltd

Fortescue Metals Group Limited

North Star Magnetite Project - Groundwater Model

24 July 2023

Groundwater Consulting Pty Ltd

ABN: 25-651-401-406

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Table of Contents

Water Supply Potential v
Mine Dewatering Requirements v
Drawdown Predictions v
Water Balance vi

Section 1 Introduction 7

1.1 Background 7
1.2 Project objectives and scope 8

Section 2 Conceptual Model 10

2.1 Hydrostratigraphy 10
2.2 Groundwater Recharge and Throughflow 11
2.3 Parameter Estimates 12

Section 3 Groundwater Model 14

3.1 Introduction 14
3.2 Model Setup 14
3.3 Borefield Abstraction 17
3.4 Rainfall Recharge 19

Section 4 Model Calibration 20

4.1 Approach to Model Calibration 20
4.2 Steady State Calibration 20
4.3 Transient Calibration 21

Section 5 Model Predictions 24

5.1 Approach 24
5.2 Prediction Setup 24
5.3 Prediction Results 25

Section 6 Uncertainty Analyses 28

6.1 Uncertainty Setup 28
6.2 Uncertainty Results 28
6.2.1 Rainfall Recharge Runs 28
6.2.2 Storage Runs 29
6.2.3 Hydraulic Conductivity Runs 31

Section 7 Summary and Recommendations 33

7.1 Groundwater Modelling 33
7.2 Mine Plan 33
7.3 Water Supply and Dewatering 33
7.4 Drawdown Impacts 34

Section 8 References 35

Figures

Figure 1-1 Location map 7
Figure 1-2 Current and future borefields (note that “development” is no longer considered a target and was not simulated in this assessment) 8
Figure 2-1 Pit hydrostratigraphy 10
Figure 2-2 Bore locations vs structural features 11
Figure 2-3 Modelled drainage 12
Figure 3-1 Snapshot from the Leapfrog model 14
Figure 3-2 Cross section A from the Leapfrog model 15
Figure 3-3 Cross section B from the Leapfrog model 15
Figure 3-4 Model extent 16
Figure 3-5 Modelled outflow boundaries 17
Figure 3-6 Historical borefield abstraction 18
Figure 3-7 Bore locations 18
Figure 3-8 Measured monthly rainfall 19
Figure 5-1 Predicted mine dewatering 25
Figure 5-2 Predicted water supply borefield abstraction 26
Figure 6-1 Predicted water supply borefield abstraction (recharge runs) 28
Figure 6-2 Predicted mine dewatering (recharge runs) 29
Figure 6-3 Predicted water supply borefield abstraction (storage runs) 30
Figure 6-4 Predicted mine dewatering (storage runs) 31
Figure 6-5 Predicted waters supply borefield abstraction (conductivity runs) 31
Figure 6-6 Predicted mine dewatering (conductivity runs) 32

Tables

Table 2-1 Summary of test pumping results 13
Table 3-1 Extent of model domain 16
Table 4-1 Steady state water balance 21
Table 4-2 Estimated hydraulic conductivities in m/d 22
Table 4-3 Estimated storage 22
Table 4-4 Estimated recharge 23
Table 4-5 Calibration water balance (Average rates over calibration period) 23
Table 5-1 Water supply bores used in the prediction runs 24
Table 5-2 Predicted water balance (average rates over the prediction period) 27

Appendices

Appendix A – Modelling Figures
Appendix B – Prediction Runs

Executive Summary

Fortescue is planning groundwater abstraction in the vicinity of the North Star mine to support water supply and dewatering requirements for the North Star mine. This study was designed to determine water supply potential of the existing and proposed borefields in the vicinity of the North Star mine as well as dewatering requirements for the mine.

The model domain covers an area of 567 km^2 and spans 28 km in the east-west direction and 20 km in the north-south direction.

The model was calibrated to both steady state conditions and time varying responses to historical abstraction over a twelve-year period between May 2010 to June 2022. The stochastic approach to model calibration and uncertainty assessment was unsuccessful due to the large heterogeneity and anisotropy of the system. It is recommended to split the current model into series of smaller models which would provide a better reflection of aquifer capacity and drawdown impacts. Having smaller models means thy could be highly refined and highly parametrised for each individual borefield area providing better calibration to historical abstraction in the area. Most of all, using PEST on a smaller model would provide more robust uncertainty assessment.

Water Supply Potential

The results suggest that there is a limit to the duration at which borefield capacity can be sustainably utilised. Simulated borefield abstraction of 3.5 GL/year would be sustained for approximately 2.5 years. From around December 2024 until December 2031 borefield abstraction is predicted to decrease to around 3 GL/year. This is followed further by a decrease to below 2 GL/year at the end of mining (June 2044). In the current model borefield abstraction and pit dewatering are both sourced from aquifer storage which is replenished via rainfall infiltration or simulated recharge. Therefore, sensitivity and uncertainty results suggest that simulated borefield abstraction is highly sensitive to storage and recharge values adopted in the base case runs and that simulated target borefield abstraction of 3.5 GL/year could potentially be sustained for longer if aquifer storage or aquifer recharge are higher than the base case values.

Mine Dewatering Requirements

Dewatering requirements for the North Star pits were predicted to increase to a peak of 1.1 GL/year in July 2024 followed by a decrease to below 0.2 GL/year from July 2036 until the end of mine life. Predicted cumulative dewatering requirements are approximately 8 GL over the life of mine. These numbers are for groundwater abstraction (i.e. from sumps and bores) only, as does not include dewatering of incident rainfall and runoff into the pit.

Drawdown Predictions

Maximum drawdown of 300+ m is predicted in the immediate dewatering area, with predicted drawdown reducing with distance from the below water table pits. Eastern and western shales are predicted to stop drawdown from propagating further to the east and west.

Twenty-two years of water supply borefield abstraction are predicted to lower the water table by around 60-75m below its pre-development level in the Northern and Southern borefield areas at the end of the run. Presence of low permeability shales (Western Shales) on the northern side of these two borefields truncates the extent of predicted drawdown in this direction. In the Western borefield area, predicted drawdown at the end of the run was around 15m at NS-PBW08. Presence of shales to the north is also predicted to prevent drawdown from propagating in this direction. However, drawdown was predicted to propagate further to the west. Predicted drawdown of 5m is predicted some 4 km west of the NS-PBW08. In the northern section of the Eastern borefield area, predicted drawdown was around 35m at NS-PB02, at the end of the model run. Since this is the only simulated bore in this section of the Eastern Borefield, drawdown is predicted to be localised and not predicted to continue propagating further to north past NS-PB02.

Water Balance

Water balance estimates suggest that water supply abstraction and pit dewatering are sourced from the available storage in the system. Storage is replenished via infiltration of rainfall in the model. The amount of storage in the system that would be available for future water supply needs to be looked at in more details if more detailed borefield estimates are required. Splitting the current model into a series of smaller scale models that would simulate individual borefield areas would aid this process.

Section 1 Introduction

1.1 Background

North Star is a magnetite mine in Western Australia. The mine is being developed under the Iron Bridge Operations Pty Ltd as agent for and on behalf of Iron Bridge Joint Venture between Formosa Iron & Steel, Fortescue and Baosteel.

The mine is currently being developed and expanded under a $2.6bn project (Stage 2), which follows the successful completion of the $500m (Stage 1), which involved the construction of large-scale pilot and demonstration plants.

Located 145 km south of Port Hedland (Figure 1-1), the North Star mine incorporates the world class North Star and Glacier Valley magnetite ore bodies.

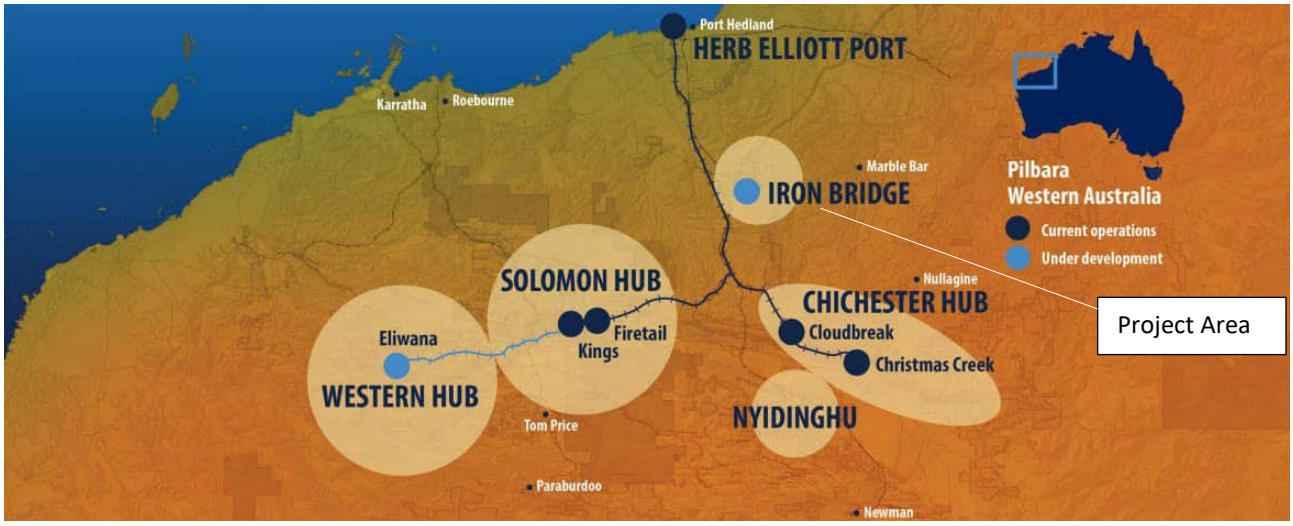


Figure 1-1 Location map

Both orebodies are located in a mesa, an isolated, elevated flat-topped hill. Mineralisation is hosted in low permeability units that belong to the Pincunah Hill Formation, which can be described as magnetic deep marine banded iron formation and layered chert. Both orebodies are bounded on the eastern and western sides by low permeability shales, that belong to the Kangaroo Caves Formation and Corboy Formation, which are close to being vertical.

There is an existing model that covers both North Star and Glacier Valley orebodies, developed by Fortescue. The model was designed to access mine dewatering requirements and has already undergone several iterations, last one completed in January 2021. Previous modelling estimated average pit dewatering rates of 1 GL/year for the project, which is typical for such low permeability environment (FMG, 2021).

Extensive hydrogeological investigations were undertaken in the vicinity of the North Star mine, to develop borefields that can supply process water to meet the mine's water demand.

This demand will be partially sourced from a number of borefields located within a 12 km radius of the Stage 2 mining area. Fortescue is also developing another borefield in the West Canning area, which located 200 km away from the mine.

The current and the proposed borefields in the near mine project area are presented in Figure 1-2.

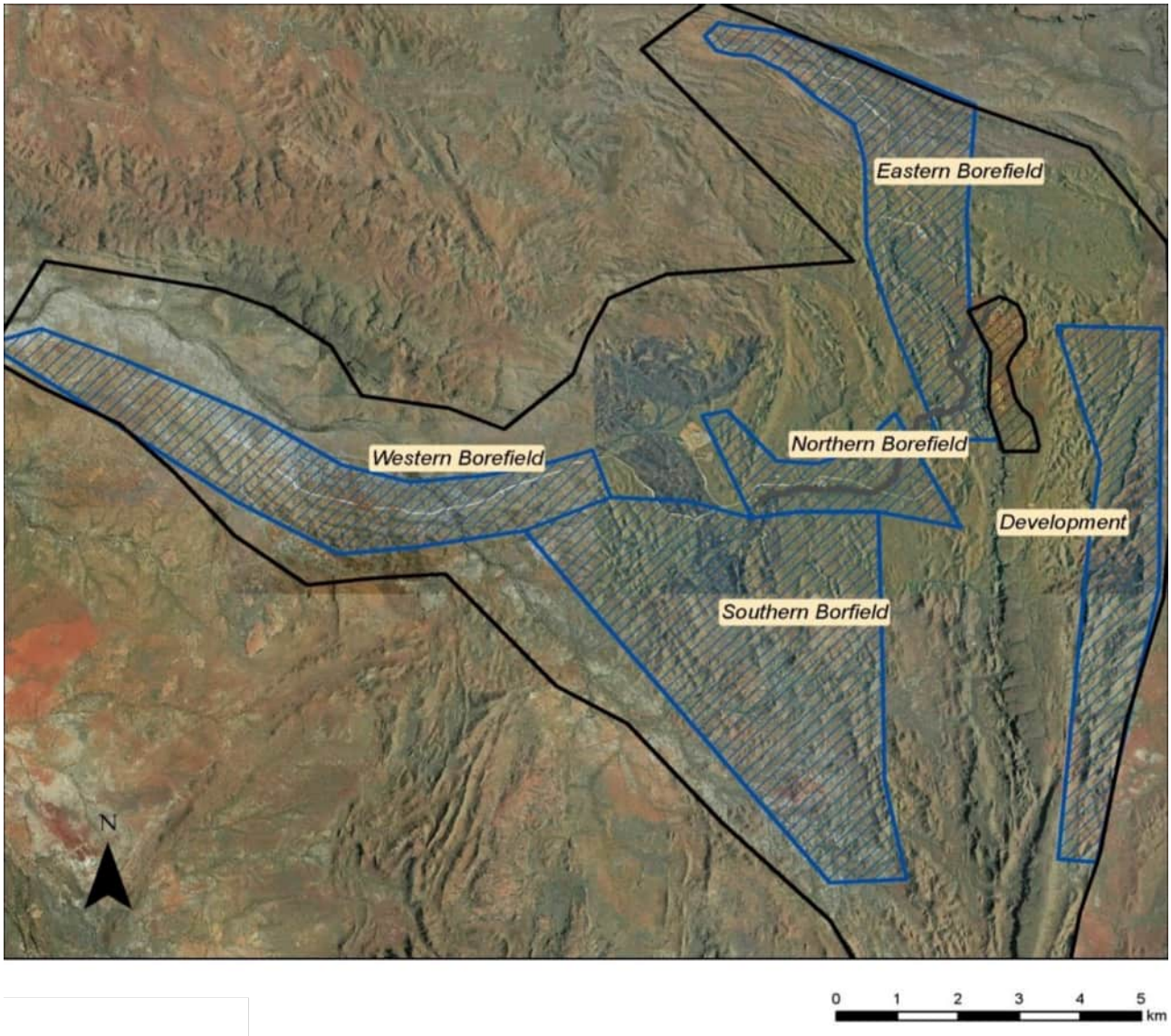


Figure 1-2 Current and future borefields (note that "development" is no longer considered a target and was not simulated in this assessment)

Details related to the water supply plans and estimates are provided in the 2023 H3 Hydrogeological assessment for a revision to the near mine groundwater abstraction licence (FMG, 2023).

As part of this study, Fortescue has identified the need to engage external consultant support to undertake numerical groundwater flow modelling for the project. Modelling objectives, scopes and methodology are described in the following chapters of this report.

1.2 Project objectives and scope

Originally, the model was supposed to be developed for the pit area only, to assess dewatering and closure requirements for the mine. Borefields were added to the scope later on, changing the overall objectives of this study to include the water supply potential of the proposed borefields surrounding the North Star mine. Closure assessment was excluded from the scope.

The main scope of this study was to develop a robust numerical solution consistent with the latest hydrogeological conceptualisation and data. Details of the project scope are outlined below:

- Review of all relevant hydrogeological data provided pertaining to the conceptualisation and numerical modelling of the broader North Star area to date.
- Construction and calibration of a numerical groundwater model suitable to address the project objectives.
- Completion of sensitivity and uncertainty analyses to evaluate the relative influence of key parameters and suitability of the model.
- Undertake mine dewatering and water supply assessments.
- Provision of a detailed modelling report detailing the model construction, calibration, sensitivity and uncertainty analysis together with a description of model runs and outputs.

Section 2 Conceptual Model

The conceptual hydrogeological model of the study area presented below is provided by Fortescue. It is derived by integrating all available information, including background information from previous investigations and ongoing monitoring data.

2.1 Hydrostratigraphy

The hydrostratigraphy of the mine area is described in FMG 2019 (662NS-1000-RP-HY-0005), FMG 2020 (NS-03018-RP-WM-0001) and Worley 2012 (301012-01426) reports.

Hydrogeological investigations show that there are no major aquifers in the project area, neither in the mine area nor in the borefields area.

Conceptually, the mine area is sandwiched between what could be described as highly recessive, poorly exposed shales of the Kangaroo Formation to the west, and inter-bedded shales, mudstones, cherts, BIF and quartzite of the Corboy Formation to the east. In Figure 2-1 they are presented as West and East Shales.

The Pincunah Hill Formation of the George Creek Group hosts the orebody at North Star. Magnetite mineralisation is mainly confined to the Banded Iron Formation (BIF). Based on physical and geochemical characteristics, BIF has been divided into the Oxide zone which is present at the surface down to 30–50 m below ground. In this zone magnetite (Fe_3O_4) has been oxidised to hematite (Fe_2O_3). Goethite (FeO (OH)) is also a major mineral in this zone as well. Below this zone the Pincunah Hill Formation has no appreciable transmissivity or water storage capacity, except along very localised geological structures. Reported permeability values are lower than 0.5 m/d (FMG, 2019).

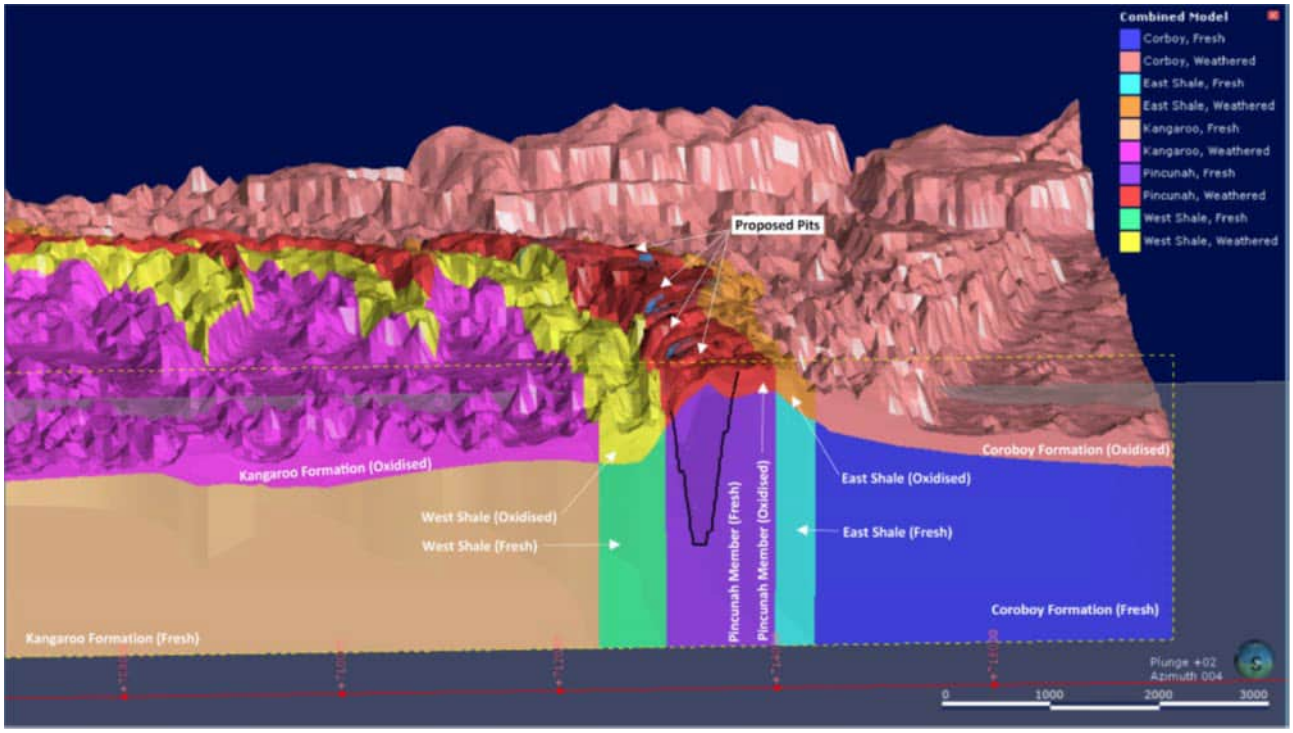


Figure 2-1 Pit hydrostratigraphy

The hydrostratigraphy of the water supply borefield areas is also described in FMG 2019 (662NS-1000-RP-HY-0005), FMG 2020 (NS-03018-RP-WM-0001) and Worley 2012 (301012-01426) reports. A weathered profile is developed within the upper 20 m upon the igneous rocks and is typically silty and clayey. Water yields are usually low from the weathered profile. Larger yields of water have been obtained from fractured bedrock where the fractures are well developed (FMG, 2015).

In the Leapfrog model provided by Fortescue, a weathered/fractured zone was depicted which sits above the fresh bedrock units. The depth of weathered/fractured zone was restricted in the Leapfrog model to about 50 m depth (Figure 2-1) and extends throughout the entire model domain.

It should be noted that data analyses provided in the FMG 2019 report indicated that majority of the bores associated with the water supply borefields will have a relatively low flow production rate (i.e. 5 to 10 L/s) as storage is not readily available as for a saturated porous-medium aquifer. Outcomes of this investigation also indicated that water supply bores are abstracting from localised fractured units that have a limited storage capacity due to its secondary porosity (i.e. fractures mainly developed in the upper weathered zone). These zones are also highly dependent on rainfall events which replenish water storage to a certain extent. The report also suggests that these localised fractured zones can therefore only provide a short-term water supply (less than 3 years) to the Project of up to 2.5-3 GL/year.

If bore locations are plotted against the structural features (faults and dykes), as shown in Figure 2-2, it is evident that drilling campaigns in the water supply borefields were targeting faults and splays in the area. That is, it is less likely that a homogeneous weathered/fractured/oxidised zone, that sits on top of fresh bedrock, exists to the extent provided in the Leapfrog model. These bores are rather tapped into discrete zones of variable length, width, depth and extent which test pumping analyses clearly show (massive range of estimated transmissivity and storage). For that reason, if more detailed estimates of water supply potential are required, the existing Leapfrog model needs to be revised to capture those discrete features in more details.

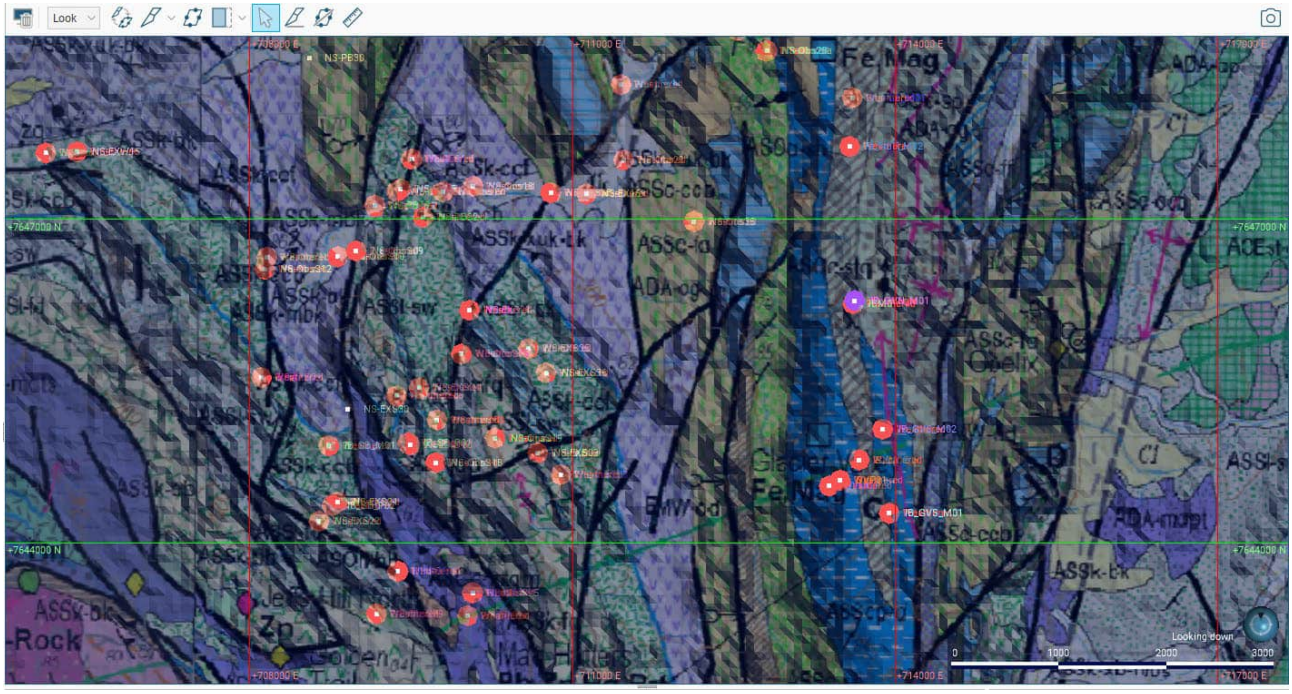


Figure 2-2 Bore locations vs structural features

2.2 Groundwater Recharge and Throughflow

Fractured, weathered and oxidised zones described in the previous chapter of this report receive recharge either from direct rainfall infiltration or via surface runoff and along creeks. Infiltration of rainfall was simulated using the Recharge (RCH) package of Modflow-USG. Rainfall recharge was simulated by applying a percentage of measured rainfall in the model.

Current groundwater monitoring indicates that the groundwater levels are stable and follow the same climatic seasonal trend (FMG, 2019). Groundwater levels are highest during the wet season from January to February/March following large rainfall events, after which they progressively decline during the dry season. Analysis of the monitoring

data indicate that a minimum of 20 mm/day of rain is required before enough infiltration is generated to recharge the local fractured zones (FMG, 2019).

The main discharge mechanisms are seepage into creek beds, discharge via springs along cliffs or steep slopes, and evapotranspiration.

The current model was trying to capture the conceptual understanding which describes mesas hosting the orebodies as groundwater divide. Rainfall, particularly those associated with cyclonic events, that fall onto those elevated areas flows either to the east or west of the orebody via creek channels. To simulate surface water runoff and discharge to creek channels, the Connected Linear Network (CLN) package of Modflow-USG was used (Figure 2-3). The CLN package is an upgraded version of the original Modflow Stream package (STR). They both simulate networks of connected drainage channels and creeks that are present within the model domain. The main difference is that the CLN package is grid independent, meaning that unlike for the STR package, grids do not need to be additionally refined to accommodate these features.

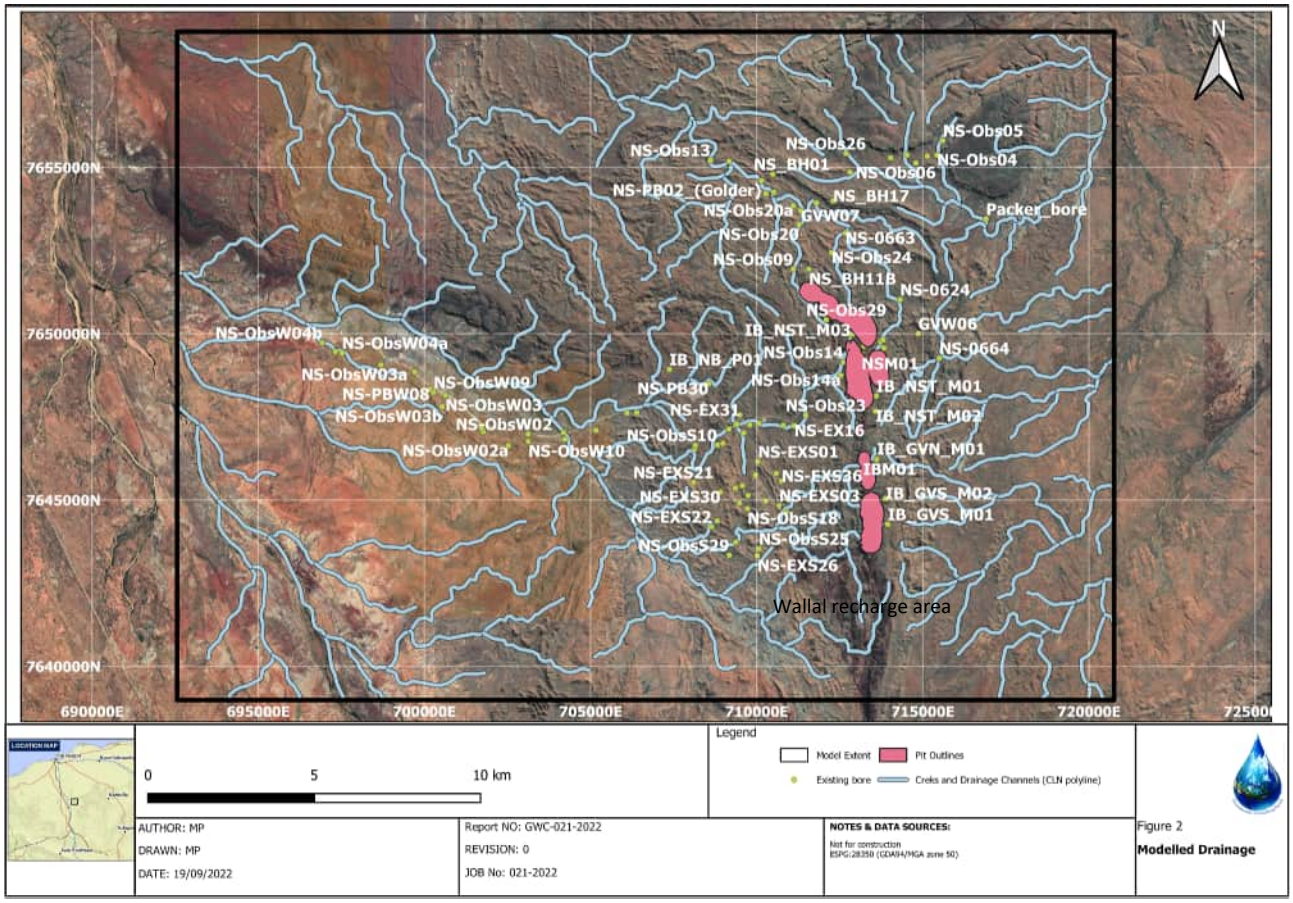


Figure 2-3 Modelled drainage

2.3 Parameter Estimates

Parameter estimates have been derived from the pumping tests completed to date. Parameters are summarised in Table 2-1:

Table 2-1 Summary of test pumping results

Area	Saturated Thickness (m)	Transmissivity (m^2/d)	Unconfined Storage (%)
Eastern Borefield	40 - 175	2.4 - 140	0.3 - 16
Northern Borefield	40 - 156	2 – 2,000	0.1 - 24
Western Borefield	35 - 185	3.4 - 945	0.2 - 25
Southern Borefield	25 - 270	1.9 – 1,480	0.1 - 40
Pit area	49 – 130	4.9 - 130	0.1 - 3

In summary, the presented range of transmissivity and storage values is a good indication of the nature of the system which could not be described as homogeneous and isotropic by any means. In some areas difference between minimum and maximum transmissivity is three orders of magnitude (two orders of magnitude for storage). That is why the term “aquifer” should be used with caution.

Results presented in Table 2-1 above that are on the high end of the spectrum come from the bores that encountered high yielding faults and fractured zones. Only four out of fifty bores were tested at rates greater than 20 L/s, nine at rates between 10 – 20 L/s and the rest of the bores were tested at rates less than 10 L/s. The FMG 2019 report describes typical transmissivity vales as:

- Less than 20 m^2/day, except for bore PB02 (T~ 140 m^2/day), in the Eastern borefield area.
- Greater than 40 m^2/day in the Northern borefield area.
- Greater than 50 m^2/day for most bores in the Western borefield area.
- Greater than 100 m^2/day for most bores in the Southern borefield area.

Section 3 Groundwater Model

3.1 Introduction

The objective of the modelling study was to develop a numerical groundwater flow model that could be used to predict the water supply potential of the proposed borefields within the project area as well as dewatering requirements for the mine.

The model is based on the hydrogeological conceptual model provided by Fortescue. The key features of the hydrogeological conceptual model captured in the numerical model are summarised below:

- Fractured/weathered/oxidised layer covering the fresh basement units of the Kangaroo, Pincunah and Corboy Formations, simulated in model layer 1.
- Borefield abstraction simulated using the CLN package of Modflow-USG.
- Groundwater discharge to surface water channels simulated using the CLN package of Modflow-USG.
- Recharge to groundwater from rainfall recharge simulated using the Recharge package of Modflow-USG.
- Groundwater inflows to the proposed North Star pits simulated using the Drain package of Modflow-USG.

3.2 Model Setup

The numerical groundwater flow modelling code Modflow-USG (Sorab Panday, Transport Version 1.10.0) was used to develop the model operating under the Groundwater Vistas graphical user interface. The Modflow-USG numerical code was chosen to allow simulation of shallow water tables, reduction of water levels in the mining area and subsequent groundwater recovery.

The model geometry reflects the conceptual geological and hydrogeological model, provided in Leapfrog by Fortescue (Figures 3-1, 3-2 and 3-3).

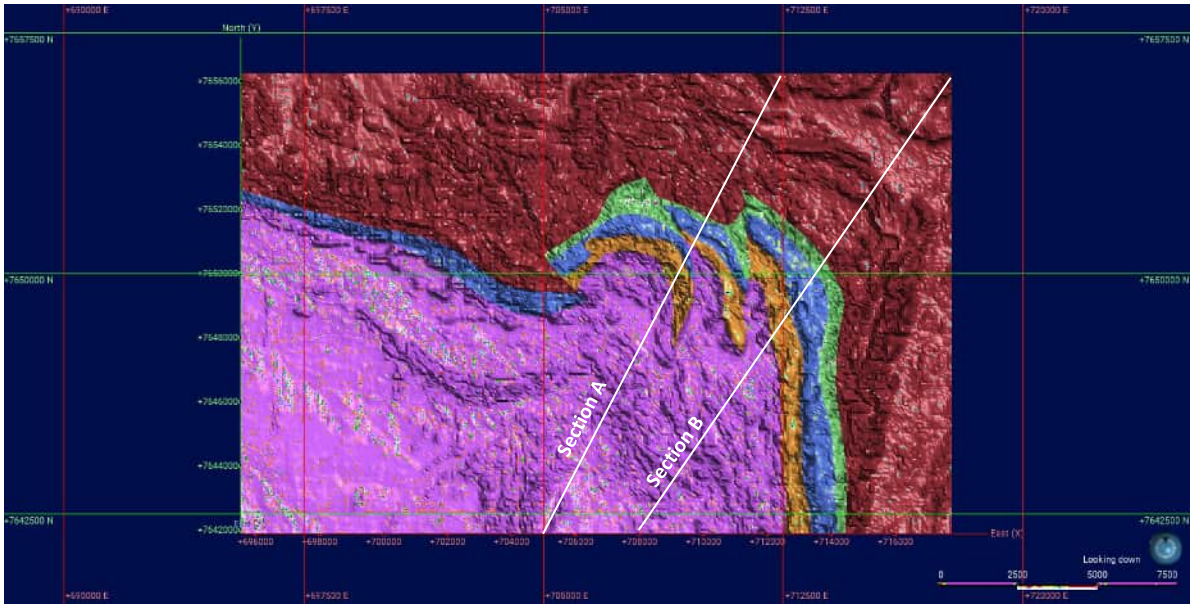


Figure 3-1 Snapshot from the Leapfrog model

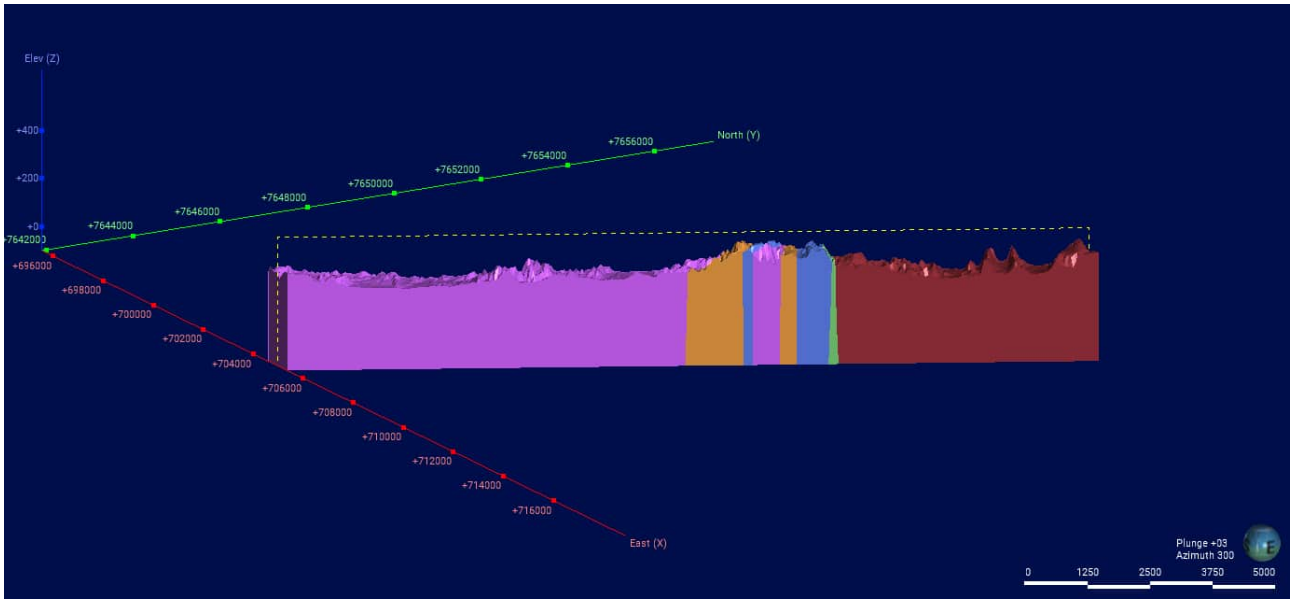


Figure 3-2 Cross section A from the Leapfrog model

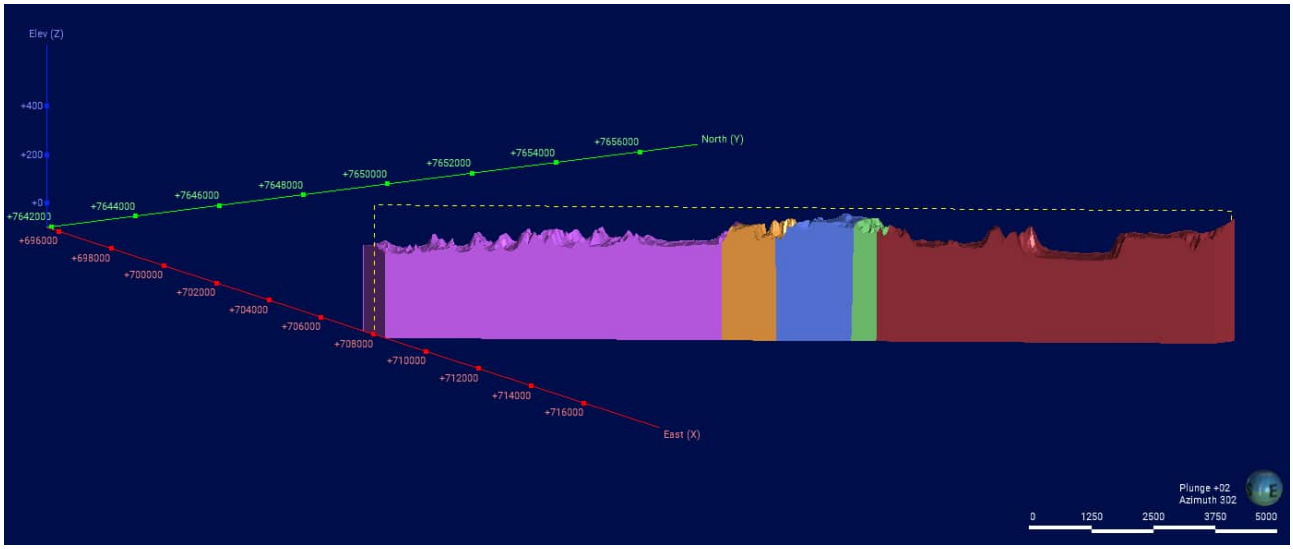


Figure 3-3 Cross section B from the Leapfrog model

The model extent is presented in Figure 3-4 and summarised in Table 3-1. The model extends 28 km in the east-west direction and 20 km in the north-south direction. A uniform model grid of 300 by 300 meters has been applied outside of the mine and borefield areas. Finer grids (75 by 75 meter in size) were applied in the immediate pit and water supply borefield areas. These refinements were necessary to allow better representation of geology surrounding the mine and future dewatering activities in this area. Model layer 1 captures weathered and oxidised zones described in Section 2 of this report. Model layers 2 and 3 represent the basement. The number of active nodes in the model is 27,729 over 3 model layers. Coordinates of the four corners of the model domain are detailed in Table 3-1.

Modelled outflow boundaries are shown in Figure 3-5. Outflow boundaries were simulated using the Drain (DRN) package of Modflow-USG. Western outflow boundaries represent outflow towards the Turner River to the west. Eastern outflow boundaries represent outflow towards the Shaw River to the east. Outflow boundaries were assigned 5 m below the topographic surface since water level monitoring records along the model edges were not available at the time of this study.

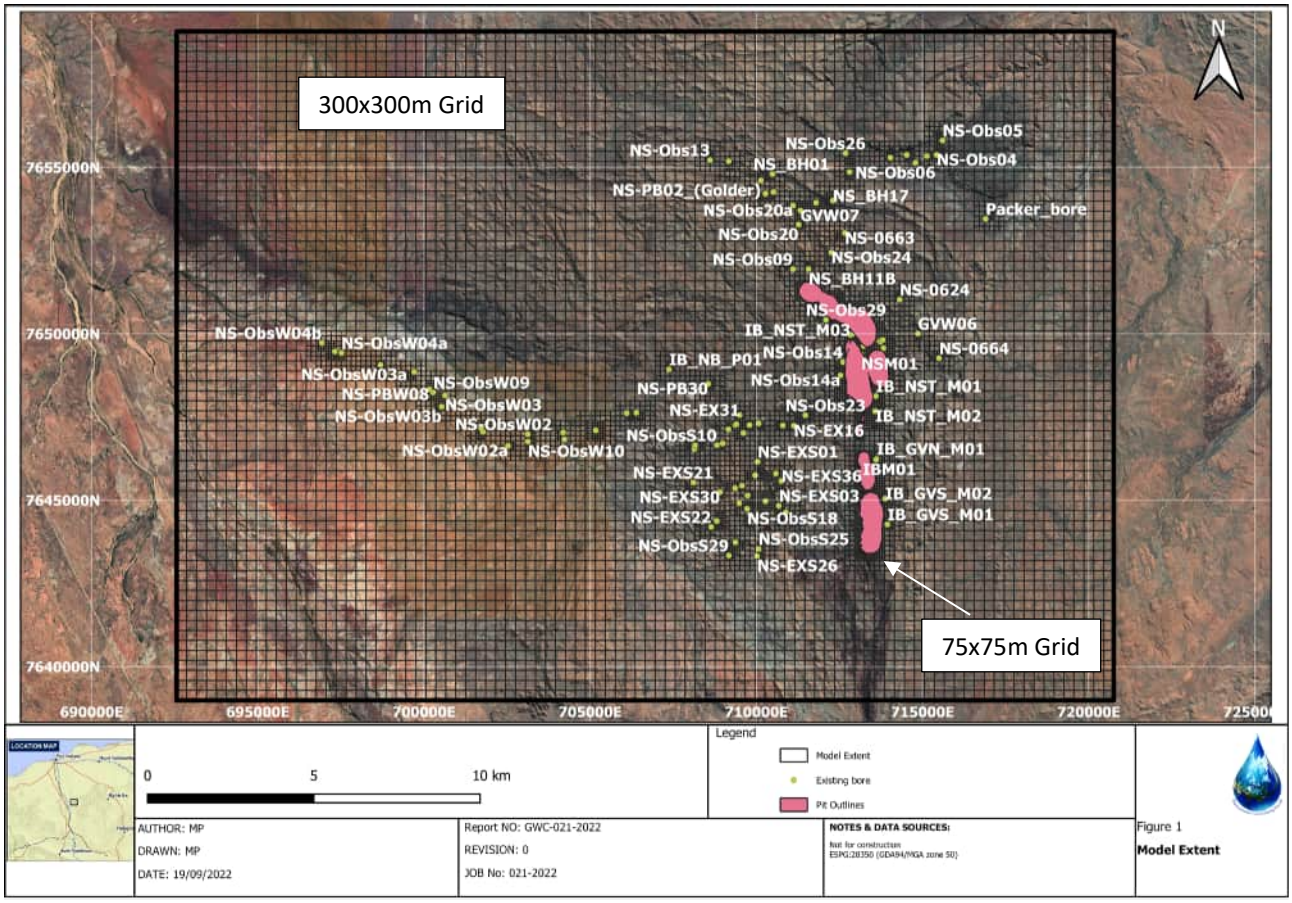


Figure 3-4 Model extent

Table 3-1 Extent of model domain

	Easting (GDA94, MGA, Zone 51)	Northing (GDA94, MGA, Zone 51)
Northwest Corner	692,560	7,659,085
Northeast Corner	720,760	7,659,085
Southwest Corner	692,560	7,638,985
Southeast Corner	720,760	7,638,985

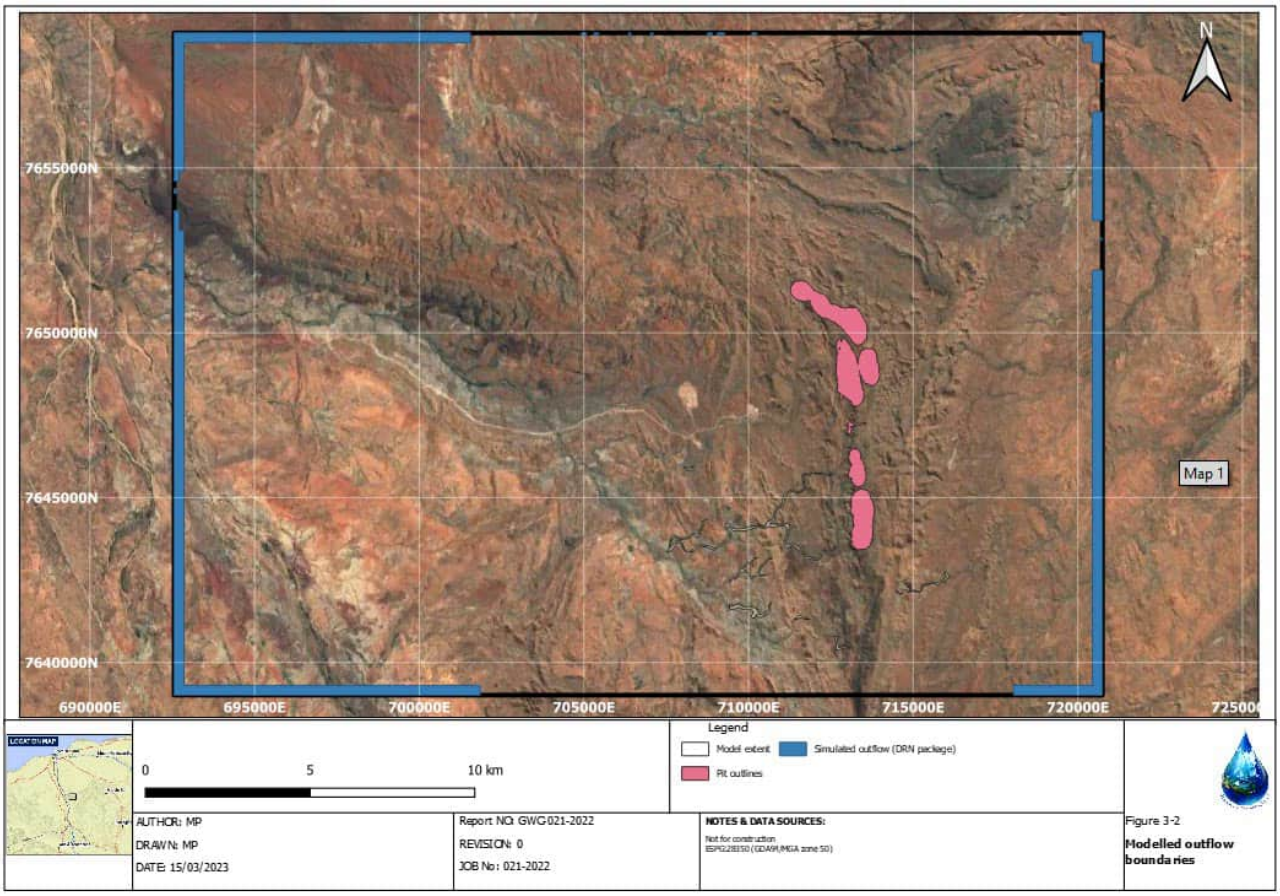


Figure 3-5 Modelled outflow boundaries

3.3 Borefield Abstraction

Groundwater abstraction associated with the existing borefields surrounding the mine was included in the current model.

Borefield abstraction was simulated using the Connected Linear Network package (CLN) of Modflow-USG. Pumping levels applied to abstraction bores were assigned consistent with the bore construction details and screen intervals. Monitoring bores in the model were simulated as Analytic Elements (AE) and were assigned consistent with hydrostratigraphic units they are monitoring. Historical abstraction records for sixteen abstraction bores was provided by Fortescue as measured monthly abstraction in kL. Historical abstraction bores simulated in the model were Gusboy Bore, IB_SB_P01, NS-EXS03, NS-Obs14, NS-Obs18, NS-Obs28a, NS-ObsS09, NS-PB02 (Golder), NS-PB15, NS-PB17, NS-PB19, NS-PB31, NS-PB32, NS-PB33, NS-PBS23, NS-PBS25, NS-PBW08, Packer bore. Historical records were provided from May-2010 to June-2022. Total historical abstraction is presented in Figure 3-6. Bore locations are presented in Figure 3-7.

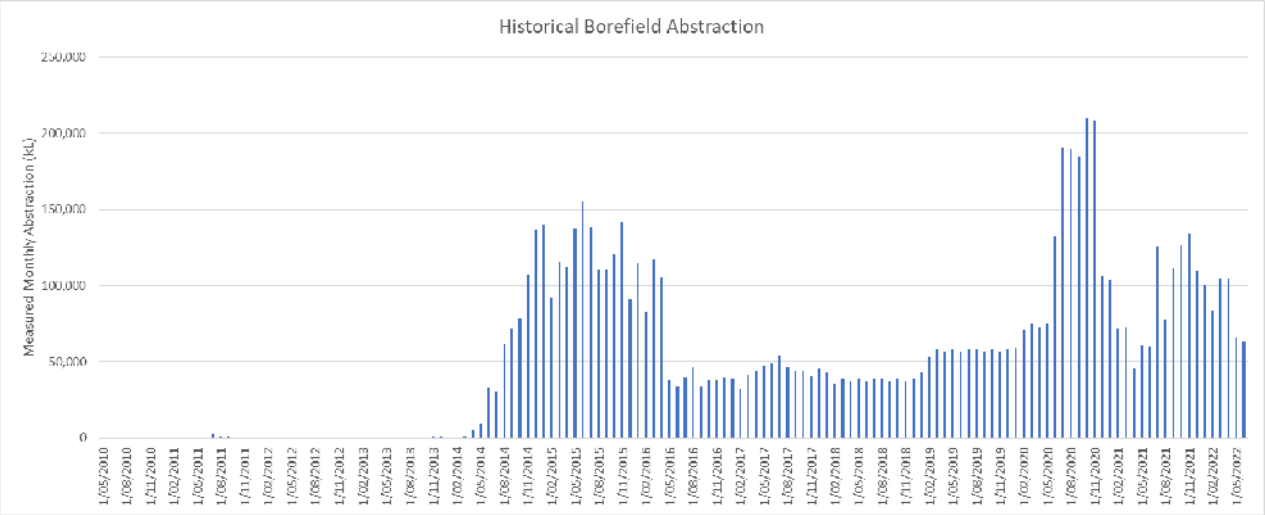


Figure 3-6 Historical borefield abstraction

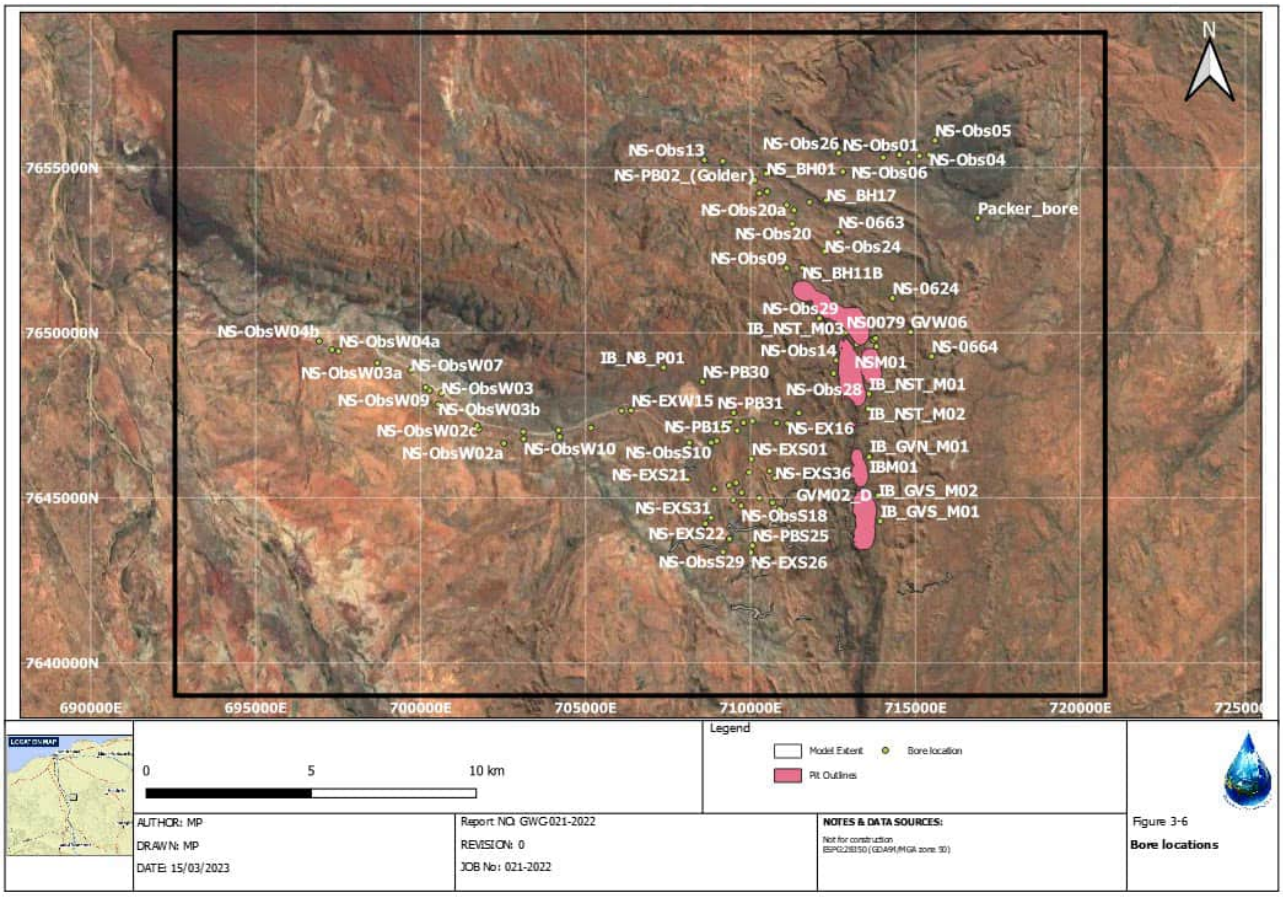


Figure 3-7 Bore locations

3.4 Rainfall Recharge

Inflow to the groundwater system, provided via rainfall recharge, is the main source of inflow in the current model. This recharge is assigned across the entire section of the model. Rainfall data was provided by Fortescue and includes "North Star" rain gauge as well as the rainfall records from the "NS_Nate_WE_WS_01". Gaps in the historical rainfall measurements at "North Star" gauge were filled using records from the nearby "NS_Nate_WE_WS_01" records. The average recorded annual rainfall at "North Star" station between 2011 and 2022 is around 522 mm/year. Recharge in the model was assigned as a percentage of measured rainfall which is discussed in more details in Section 4 of this report. Measured annual rainfall from the North Star area is presented in Figure 3-8.

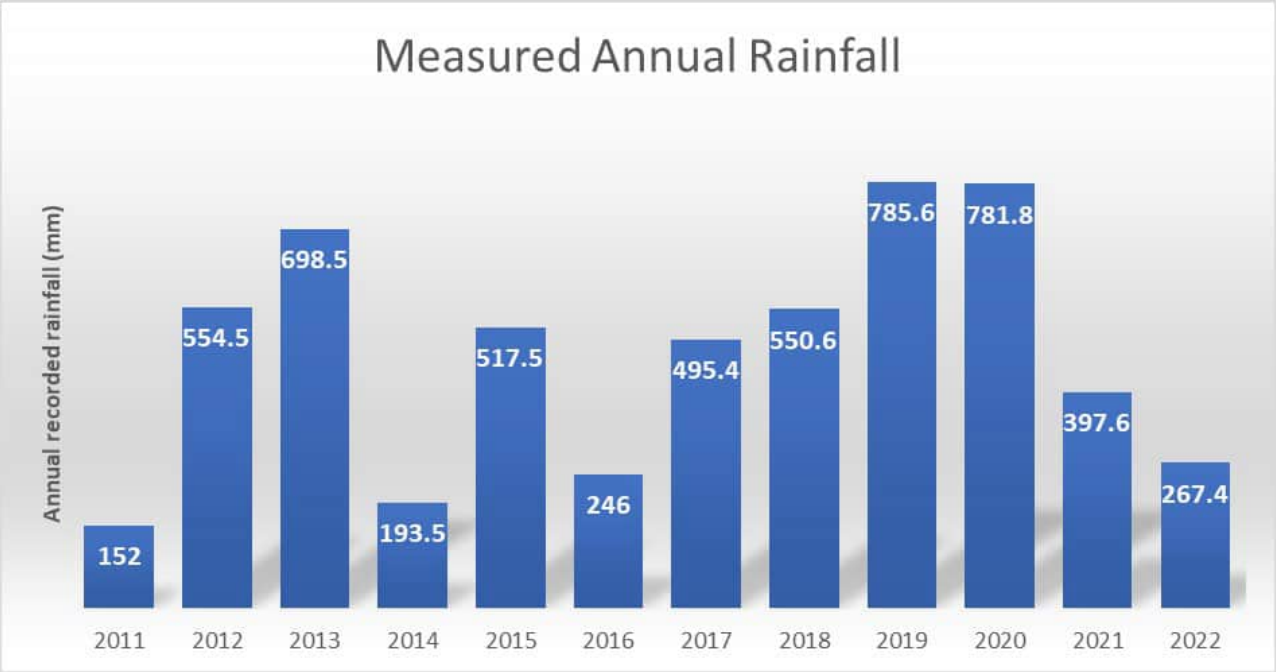


Figure 3-8 Measured monthly rainfall

Section 4 Model Calibration

4.1 Approach to Model Calibration

Model calibration is the process by which the independent variables of a model are adjusted, within realistic limits, to produce the best match between simulated and measured data obtained from groundwater level monitoring. This process typically involves refining the aquifer properties and boundary conditions of the model within prescribed limits.

The current groundwater model was calibrated to both steady state and transient or time varying conditions. This process involved running the model to provide the best match to pre-development conditions and measured responses to an ongoing water supply pumping from the simulated borefields.

4.2 Steady State Calibration

Steady state model calibration typically involves calibrating the model to pre-development or long-term average conditions. The focus of the steady state calibration was to match measured water levels recorded in May 2010 across the catchment and provide initial conditions for the transient model calibration which starts on that date. Therefore, steady state model calibration was an iterative process between the pre-development (steady state) and development (transient) periods until starting conditions at the beginning of development period (May 2010) were matched by the model.

The current steady state model provides:

- A distribution of water levels that reflects the groundwater system prior to May 2010.
- Initial conditions for the transient calibration.
- Quantification of the groundwater flow through the model domain, under average recharge conditions prior to any development.

The model was calibrated to steady state conditions against water levels from a total of 89 bores including:

- 24 monitoring bores, monitoring pit areas.
- 21 monitoring bores in the Eastern Borefield area.
- 28 monitoring bores in the Southern Borefield area.
- 19 monitoring bores in the Western Borefield area.
- 20 monitoring bores in the Northern Borefield area.
- 2 monitoring bores east of the North Star mine.

The locations of monitoring bores used for steady state model calibration are shown in Figures 3-7. The steady state water balance is presented in Table 4-1. The steady state water balance shows that main source of inflow comes from simulated rainfall recharge (5,272 kL/d). Modelled recharge represents ~1% of measured long-term average rainfall. The steady state water balance also shows that the only source of outflow in the current model is throughflow towards the Turner River to the west and the Shaw River to the east. Estimated throughflow is ~5,897 kL/d. Fixed head boundaries assigned to faults are predicted to contribute around 10% of the overall inflow (629 kL/d). They were also predicted to negligible impact on the overall outflow (4 kL/d).

Table 4-1 Steady state water balance

Water Balance Component	Inflow (kL/d)	Outflow (kL/d)
Aquifer storage	-	-
Aquifer recharge	5,272	-
Fixed heads assigned to faults	629	4
Outflow boundaries (Drains)	-	5,897
Creeks (simulated using the CLN) package	-	-
TOTAL	**5,901**	**5,901**

Predicted steady state water levels are presented in Figure A1. One of the goals of the steady state model was to replicate elevated water levels in the immediate mine area and simulate the main ore-hosing mesa as a water divide. The steady state model has successfully achieved that task.

4.3 Transient Calibration

Calibration to transient or time varying conditions was completed over the period May 2010 to June 2022. This period includes water supply pumping from sixteen abstraction bores described in Section 3.3 of this report.

The transient calibration was run using monthly stress periods and includes the following:

- Initial conditions from the steady state calibration.
- Pumping from the existing water supply borefield, varied monthly, consistent with the monitoring records.
- Rainfall recharge was applied to the transient model as a percentage of measured monthly rainfall recorded at the North Star gauge.

PEST-IES was used for both steady state and transient model calibration. Measured time varying water levels were assigned as head targets in the model. Abstraction was simulated using the CLN package by assigning measured monthly abstraction rates in kL/day. Hydraulic conductivity, confined storage, unconfined storage and recharge were varied during the calibration task. This was achieved by assigning a range of parameter values to the pilot points scattered around the model domain.

During the calibration task, PEST identified that anisotropy in the model is high. That is, in some areas parameter values estimated by the PEST were above maximum values assigned to the pilot points. Within a close range, PEST was also trying to reduce parameter values (namely horizontal hydraulic conductivity) to match the observed response to abstraction. PEST was unsuccessful in this task because the modelling approach taken for this study, which assumes having a weathered unit that uniformly sits on top the fresh basement units, is not quite the case. What PEST was trying to achieve is to identify areas of enhanced conductivity in the model (fractured zones) by assigning parameter values above the maximum constraints. Unfortunately, transitions between fractured and non-fractured zones occurs in a relatively short distance spatially and the more appropriate approach to simulate this process would be using the "Conduit Flow Process" approach. This approach has the ability to simulate not only the Darcian laminar flow but the non-laminar flow as well. Calibration parameters with this approach would be diameter/extent of fractured zones/channels, "roughness" and Reynolds numbers. Model grid would likely have to be refined down to ~10 x 10 m in the borefield areas which would introduce an enormous computational burden in term of model run times. Therefore, if more accurate borefield estimates are required in the future our suggestion is to simulate them separately and have highly refined and highly parameterised model for each of the borefield areas.

For the purpose of this assessment, manual constraints were applied to areas outside of the Western, Southern and Northern borefields. Pilot points were only used to calibrate the model within the weathered zone that belongs to the Kangaroo Formation (refer to Figure A21). Parts of this zone outside of the borefield areas were constrained as well as areas that belong to Pincunah and Corboy formations, including shales to the east and west of the orebody, in all layers. Recharge and storage distributions were simulated using the zone-based approach. Some of the faults and shear zones were introduced in the model by digitizing their spatial extents from geological maps. Digitised faults were applied in the model as hydraulic conductivity and storage zones.

Measured and modelled water levels across the catchment are presented in Figures A2 – A20. Water level trends associated with water supply abstraction are well replicated by the model considering challenges described in this chapter. Although at some locations starting water levels were 5 m below measured, responses to water supply abstraction were matched by the model. The model may therefore not be valid as a tool to assess absolute groundwater levels for the purpose of impact assessment; however, rates of change should be adequately represented. As stated above, better accuracy can be achieved with separate small-scale models with areas < 10,000 m^2 where heterogeneity and anisotropy of units could be better represented and matched by the model.

Hydraulic conductivity distribution is presented in Figures A21 – A23. Parameters are summarised in Table 4-2:

Table 4-2 Estimated hydraulic conductivities in m/d

Hydrostratigraphic unit	Model Layer 1	Model Layer 2	Model Layer 3
Corboy Formation	0.5	1e-4	1e-4
Pincunah Hill Formation	0.01	0.001	0.001
Eastern and Western Shales	1e-5	1e-5	1e-5
Kangaroo Formation	0.5	0.001	0.001
Kangaroo Formation (unconstrained)	0.1 – 3.4	0.1 – 3.4	0.001
Faults	5	5	-

Storage distribution is presented in Figure A24. Parameters are summarised in Table 4-3:

Table 4-3 Estimated storage

Hydrostratigraphic unit	Model Layers 1-3 Unconfined Storage	Model Layers 1-3 Confined Storage (1/m)
All Formations aside from Faults	1%	1e-6
Faults	1-10%	1e-6

Modelled recharge distribution is presented in Figure A25. Parameters are summarised in Table 4-4:

Table 4-4 Estimated recharge

Hydrostratigraphic unit	Percentage of measured rainfall
Corboy and Kangaroo Formations	1%
Pincunah Hill Formation	2%
Eastern Shales, Western Shales and Faults	0

The water balance, averaged over the calibration period between May 2010 and June 2022, is presented in Table 4-5. The water balance shows that the main source of inflow in the model is rainfall infiltration (7,290 kL/d on average). The presented water balance estimates also suggest that borefield abstraction is sourced from storage. In that process, storage is partially getting depleted through the simulated borefield abstraction (1,740 kL/d on average) but the majority of it reports as outflow to the Turner River on the west and the Shaw River on the east (6,910 kL/d on average). Storage in the simulated system is getting replenished in the model via rainfall infiltration, mainly during the cyclonic events (on average, 4,700 kL/d of the 7,290 kL/d recharge reports to storage). After those events, the system releases water from the storage (5,570 kL/d on average) and aside from volumes that report to the simulated borefields, the majority reports as outflow. Compared to the overall water balance, outflow to regional areas represents 51% of the water balance while borefield abstraction represents only 13%.

Table 4-5 Calibration water balance (Average rates over calibration period)

Water Balance Component	Inflow (kL/d)	Outflow (kL/d)
Aquifer storage	5,570	4,700
Aquifer recharge	7,290	-
Fixed heads assigned to faults	625	10
Outflow boundaries (Drains)	-	6,910
Creeks (simulated using the CLN) package	105*	230**
Borefield abstraction	-	1,740
TOTAL	**13,590**	**13,590**

* Creek leakage, **Discharge to creeks

Section 5 Model Predictions

5.1 Approach

The calibrated model was used to complete long-term water supply predictions and mine dewatering requirements for the project. Water supply predictions were based on the target water supply abstraction schedule provided by Fortescue. This abstraction schedule is considered nominal only, and it is expected borefield abstraction will vary during the life of operation. Borefield setup included 18 bores presented in Table 5-1, with a combined abstraction of 3.5 GL/year.

Table 5-1 Water supply bores used in the prediction runs

Bore ID	Easting	Northing	Cased Depth (mBGL)	Slotted Interval (mBGL)	Scenario 1 Flow Rate Scenarios (GL/year)
NS-PBW08	700162	7648328	215	54-83; 131-215	0.11
NS-EXS03	710677	7644835	210	uncased	0.23
NS-ObsS09	708989	7646707	140	26-128	0.08
IB_SB_P01	709470	7644926	199	103-199	0.29
NS-PBS23	709373	7643734	188	98-182	0.19
NS-PBS25	710074	7643535	86	5-83,	0.24
NS-PB15	709403	7647283	120	12-90,	0.01
NS-PB19	709162	7647131	157	2-157	0.33
NS-PB31	709501	7647558	101	5-83,	0.06
NS-PB32	709611	7647018	76	10-70,	0
NS-PB33	710800	7647246	59	5-53,	0.01
NS-PB02	710143	7654606	105	9-99,	0.04
IB_SB_P02	708764	7644343	212	32-212	0.24
NS-EXS17	709487	7644908	248	uncased	0.57
NS-EXW14	705170	7647097	188	uncased	0.23
NS-PB17	709799	7647257	150	6-144	0.42
IB_SB_P03	710896	7644622	230	100-230	0.23
IB_SB_P04	709207	7644854	250	100-250	0.23
				TOTAL	**3.5**

Pit shells were provided by Fortescue in a form of meshes in the Leapfrog. Meshes were provided for each mining year starting from FY 2022 (July 2022).

5.2 Prediction Setup

Details of the model prediction are summarised below and in Table 6-2:

- Abstraction from the existing and proposed borefields commences in July 2022 and continues until June 2044 (i.e., 22 years of abstraction).
- Initial conditions were taken from the end of the transient calibration (June 2022).

- Water supply pumping was simulated using the Connected Linear Network package (CLN) in Modflow-USG.
- Bore rates were set consistent with the schedule presented in 5-1. Bore locations are presented in B1.
- Pit dewatering was simulated using the Drain (DRN) package of Modflow-USG. Drain elevations were set consistent with the pit shell layouts (meshes) provided by Fortescue. Drain conductance was set sufficiently high (1,000 m^2/day) such that they do not provide any resistance to flow coming from the simulated hydrostratigraphic units in the model.
- The model was run using annual time increments (or stress period) for the entire prediction period.
- Two rainfall scenarios were simulated (long-term average and time varying). Long-term average case simulated a measured local rainfall record of 522.1 mm/year over the prediction period. Time varying rainfall was provided by Fortescue, and it was varied on annual basis consistent with the records.
- Predicted drawdown is calculated by subtracting predicted water levels at the end of the prediction run from predicted water levels at the end of the "No-Development" run. The No-Development run was setup to simulate the system including all "natural" processes such as rainfall recharge and throughflow. The No-Development model excludes all anthropogenic elements such as borefield abstraction, dewatering etc. That is, the No-Development model was used to estimate where would water levels be in June 2044 if the system was in its natural state and had not been stressed.

5.3 Prediction Results

Predicted dewatering inflow rates for the Project, for both rainfall scenarios are presented in Figure 5-1. Groundwater inflows were predicted to increase to a peak of 1.1 GL/year in July 2024 followed by a decrease to below 0.2 GL/year from July 2036 until the end of mine life. Predicted cumulative dewatering requirements are approximately 8 GL over the life of mine.

The results show that difference between long term average and time varying rainfall scenarios was negligible. In fact, predicted dewatering for the time varying rainfall case was slightly lower compared to the long-term average rainfall case. The reason for that is that the total rainfall over the time varying period is lower compared to the long-term average period. Total rainfall over the time varying period is 8,849.8 mm and in the long-term average case is 11,486.2 mm.

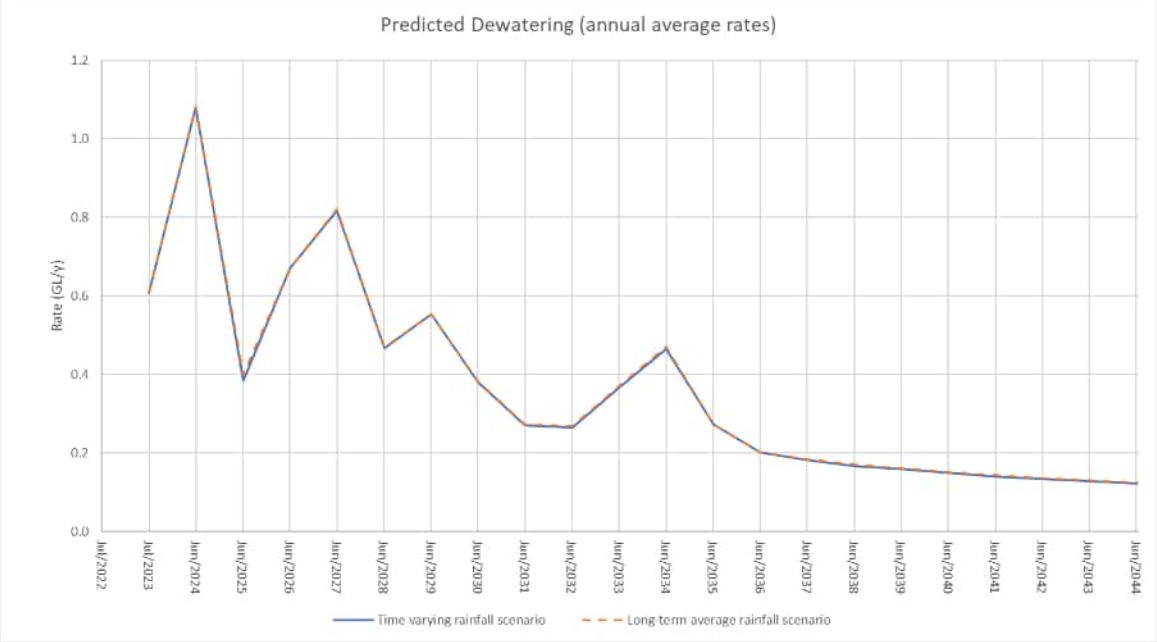


Figure 5-1 Predicted mine dewatering

Predicted borefield abstraction is presented in Figure 5-2. In both cases, long-term and time varying rainfall cases, the results show that simulated borefield abstraction of 3.5 GL/year would be sustained for approximately 2.5 years. From around December 2024 until December 2031 borefield abstraction is predicted to decrease to around 3 GL/year. This is followed further by a decrease to below 2 GL/year at the end of mining (June 2044). Consistent with the pit dewatering predictions, the results show that there was not much difference between the two rainfall scenarios adopted in the prediction runs. Predicted borefield abstraction was slightly lower for the time varying case due to less simulated rainfall recharge.

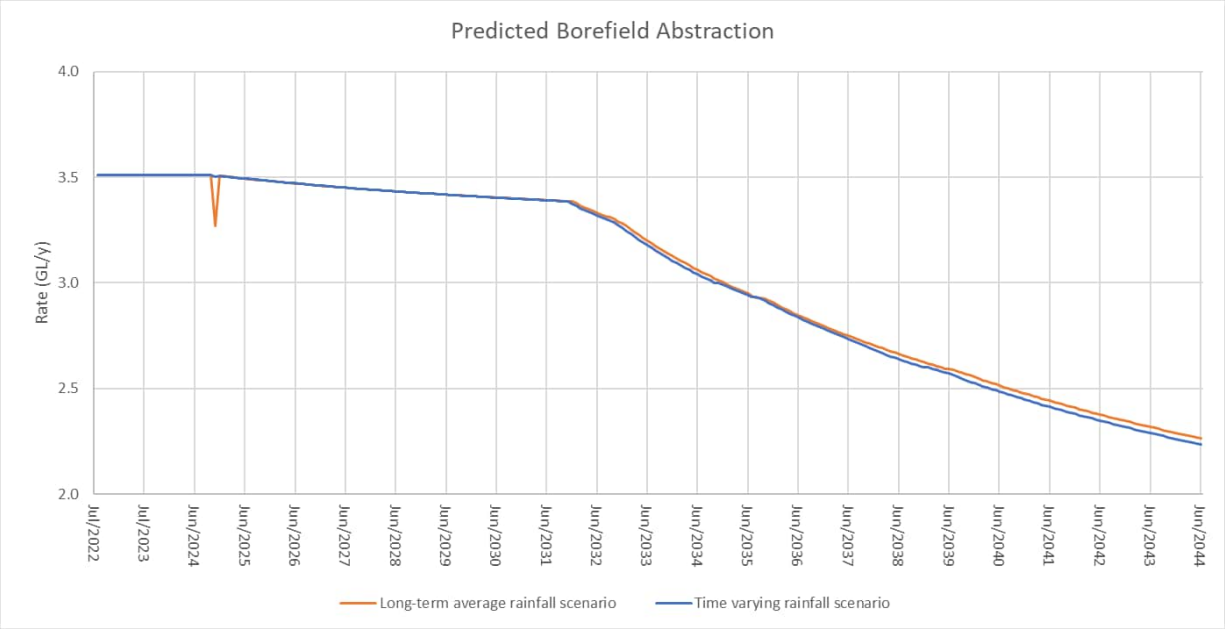


Figure 5-2 Predicted water supply borefield abstraction

Predicted dewatering drawdown at the end of the long-term average rainfall run in presented in Figure B3. Maximum drawdown of 300+ m is predicted in the immediate mining area, with predicted drawdown reducing with distance from the mine. Eastern and western shales are predicted to stop drawdown from propagating further to the east and west.

Twenty-two years of borefield abstraction are predicted to lower the water table by around 60-75m below its pre-development level in the Northern and Southern borefield areas at the end of the run. In the Western borefield area, predicted drawdown at the end of the run was around 15m at NS-PBW08. Drawdown was predicted to propagate further to the west. Predicted drawdown of 5m is predicted some 4 km west of the NS-PBW08. In the Eastern borefield area, predicted drawdown was around 35m at NS-PB02, at the end of the model run. Drawdown is not predicted to continue propagating further to north past NS-PB02.

The predicted water balance, for the long-term average rainfall scenario, is presented in Table 5-2. The results suggest that pit dewatering and borefield abstraction are mainly sourced from storage. Storage release was predicted to increase by 65% compared to the pre-mining (calibration) period. It is a result of pit dewatering being simulated in this model run. Predicted inflow from storage (storage release) was 9,228 kL/d in the prediction run and 5,570 kL/d in the calibration run.

Lowering of the water table across the model domain, and mainly in the simulated faults that most of the water supply bores are tapped into, is predicted to increase inflows to the faults from regional areas by 75% (predicted at 1,008 kL/d in the prediction run vs 625 kL/d in the calibration run). For the same reasons, outflow towards the of the Turner River on the west is predicted to decrease by 11%. The model predicts that regional outflow towards the Shaw River on the east will not be impacted due to the presence of low permeability shales (Eastern Shales) surrounding the mine and borefields.

Table 5-2 Predicted water balance (average rates over the prediction period)

Water Balance Component	Inflow (kL/d)	Outflow (kL/d)
Aquifer storage	9,228	51
Aquifer recharge	5,272	
Fixed heads assigned to faults	1,088	7
Outflow boundaries (Drains)	-	6,176
Creeks (simulated using the CLN) package	67	81
Borefield abstraction	-	8,338
Pit dewatering	-	1,002
TOTAL	**16,655**	**16,655**

Section 6 Uncertainty Analyses

6.1 Uncertainty Setup

Uncertainty analyses have been conducted on the time varying rainfall prediction model to assess the water supply potential and pit dewatering requirement for the project. Influence of the following model parameters was examined as part of the uncertainty assessment:

- Rainfall recharge.
- Horizontal and vertical conductivities.
- Confined and unconfined storage.

The approach to uncertainty analyses was not stochastic and depending on what literature is used, some would rather classify them as sensitivity analyses. Standard Monte Carlo (STMC) approach was used in conjunction with Python scripts that generated input files (realisations) for STMC models. Sixty-nine uncertainty model runs (realisations) have been generated and performed on the Base Case prediction mode to investigate drawdown impacts of the existing and the proposed borefields simulated in the Base Case.

6.2 Uncertainty Results

6.2.1 Rainfall Recharge Runs

Six model runs were performed testing the impact of rainfall recharge setup on predicted water supply potential and pit dewatering requirements. Compared to the time varying recharge setup of the prediction runs, rainfall recharge simulated in the uncertainty runs was up to 50% lower and up to 50% higher. The results are presented in Figure 6-1 and Figure 6-2.

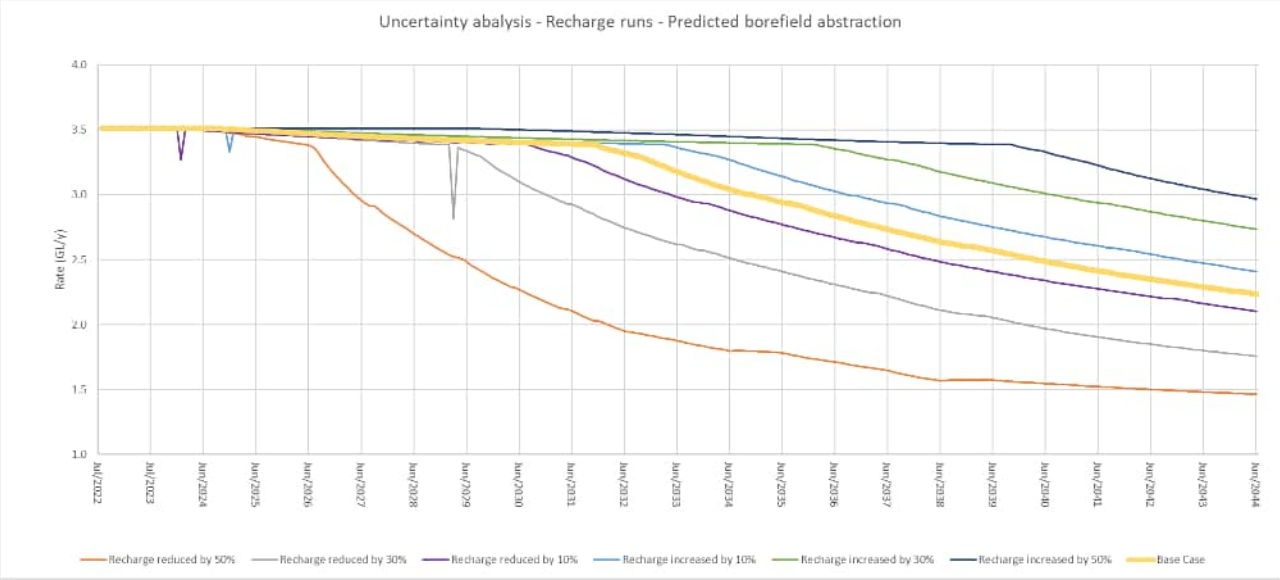


Figure 6-1 Predicted water supply borefield abstraction (recharge runs)

The results suggest that simulated borefield abstraction is sensitive to recharge (Figure 6-1). In case more recharge is simulated in the model, which could mean that cyclonic events bring more rainfall in the immediate borefield area in the future, borefield abstraction could be sustained for a significantly longer period of time. Opposite to that, if rainfall recharge is less than what was simulated in the pre-development period, borefield abstraction could potentially drop off sooner and significantly reduce compared to the prediction run. Predicted drawdown for higher and lower

recharge runs (30% higher compared to the base case and 30% lower) are presented in Figures B4 and B5 respectively. For a higher recharge run, predicted drawdown extent was significantly smaller in the western direction. Predicted 10m drawdown was predicted to travel 5km less in the westward direction compared to the base case (Figure B4). Drawdown in the eastern and northern direction was predicted relatively consistent with the base case owing to the presence of low permeability shales. In the immediate borefield area, predicted drawdown was 10-15m less compared to the base case due to more simulated recharge and water availability for borefield abstraction in this area (Southern and Northern borefields).

For a lower recharge setup (30% lower compared to the base case), predicted drawdown extent was significantly bigger throughout the model domain (Figure B5). It is not necessarily as the result of simulated dewatering and borefield abstraction, it is because predicted drawdown in this case is compared to the base case water levels. In the event future rainfall events produce less rainfall in the area water levels will go below the baseline predicted in the base case. Predicted 5m drawdown was predicted to travel 3km further to the west and east and some 5km further to the north as well. In the immediate borefield area, predicted drawdown was 15-20m higher compared to the base case due to less simulated recharge and water availability for borefield abstraction in this area (Southern and Northern borefields).

The results suggest that the model was relatively insensitive to recharge in the pit area in terms of predicted dewatering requirements (Figure 6-2). Higher rainfall recharge did not produce significantly higher predicted dewatering. In should be noted that this model simulates rainfall infiltration that reports to the groundwater table; incident rainfall or runoff reporting to the pits was not considered in the assessment.

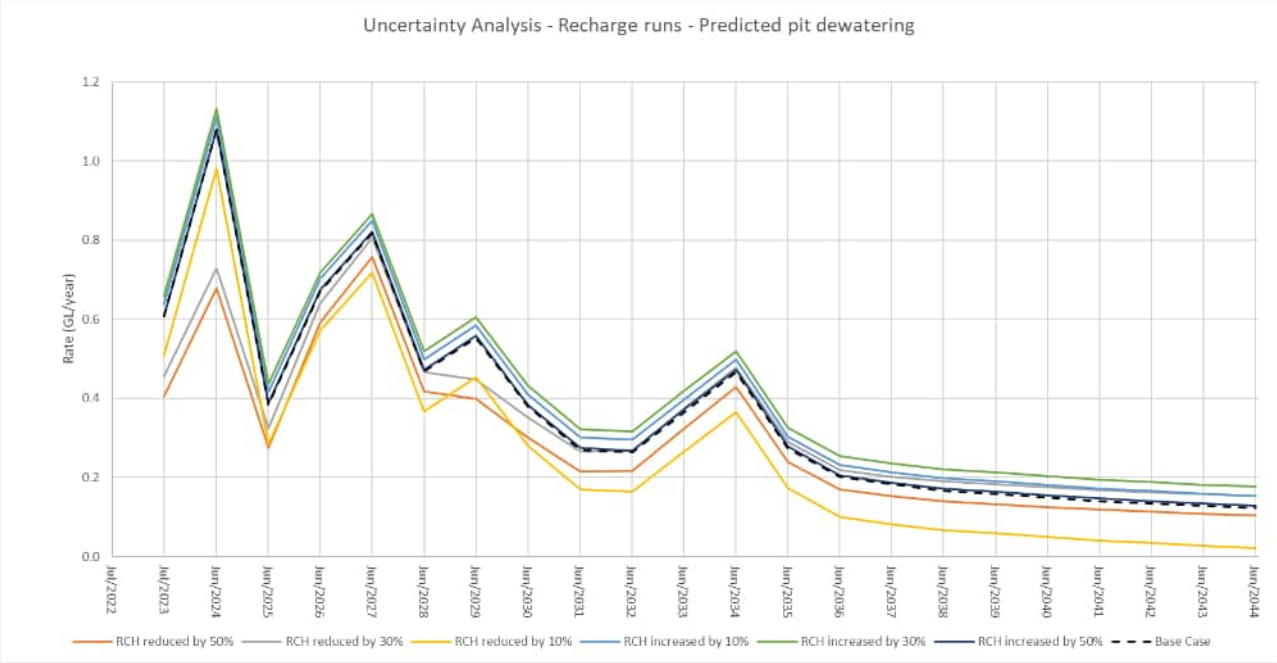


Figure 6-2 Predicted mine dewatering (recharge runs)

6.2.2 Storage Runs

As part of the uncertainty analyses Unconfined (Sy) and Confined (Ss) storage parameters adopted in the calibrated model have been tested to assess their influence of predicted water supply potential and pit dewatering requirements. Analysis has been performed by increasing and lowering storage parameters within a reasonable range as presented in Table 6-1. Tested range of unconfined storage values for all units was from 0.1 to 1%. The tested range of confined storage values was from 1E-7 to 1E-5 per meter. Parameter changes adopted in this assessment have not been cross-checked against the model calibration performance to see if the model still calibrates against these values. The results are presented in Figure 6-3 and Figure 6-4. The results suggest that predicted borefield abstraction and the water supply potential associated with the simulated borefield setup is sensitive to unconfined storage applied to the

Kangaroo Formation and faults. This is consistent with the results described in chapters 4 and 5 of this report which suggest that the water supply borefield is sourcing water from the available storage in the system. That storage is replenished via rainfall infiltration and that is why the results were also sensitive to the amount of rainfall recharge applied to the model as well. It should also be noted that the way weathered Kangaroo Formation is simulated in the model, as a uniform unit that sits on top of the fresh basement, means that volume of this unit in the model is significant. If this unit is applied higher storage potential, the results suggest that borefield abstraction could almost be sustained over the entire prediction period. That should be treated with caution since these borefields are rather tapped into a discrete fractured zones which are highly compartmentalised meaning that storage within these zones is limited.

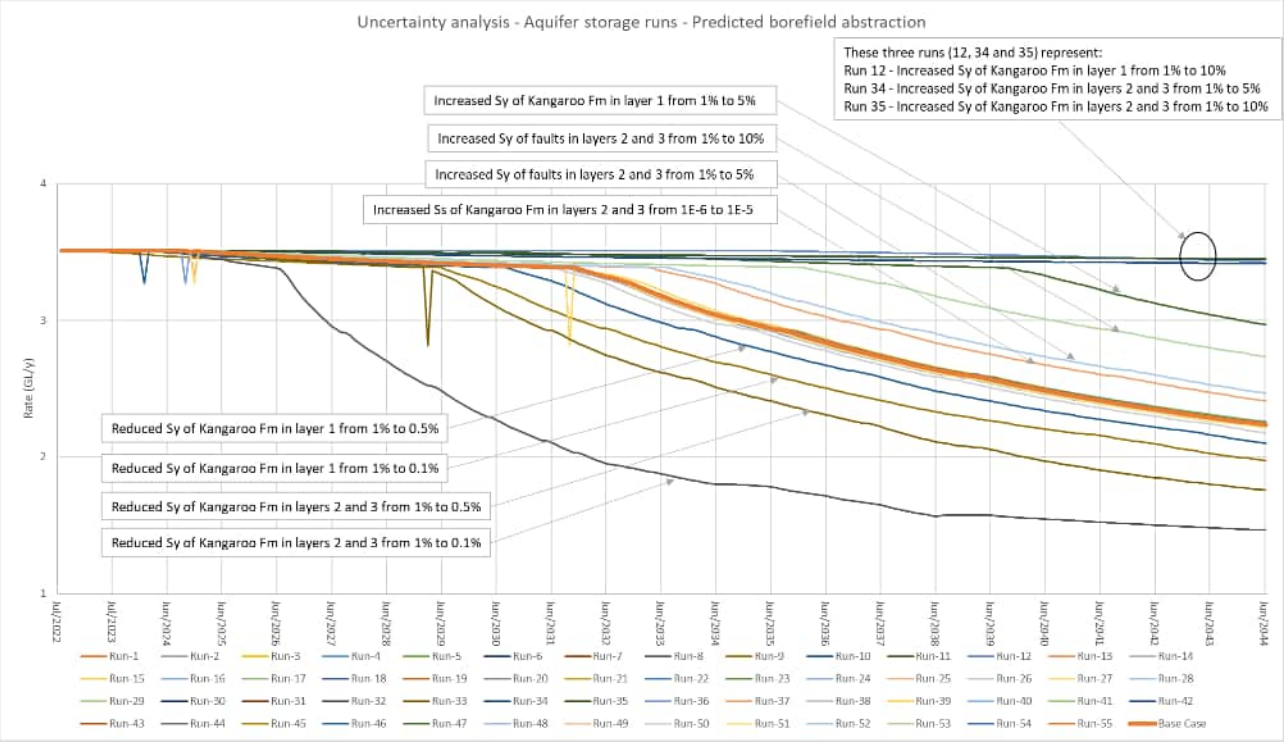


Figure 6-3 Predicted water supply borefield abstraction (storage runs)

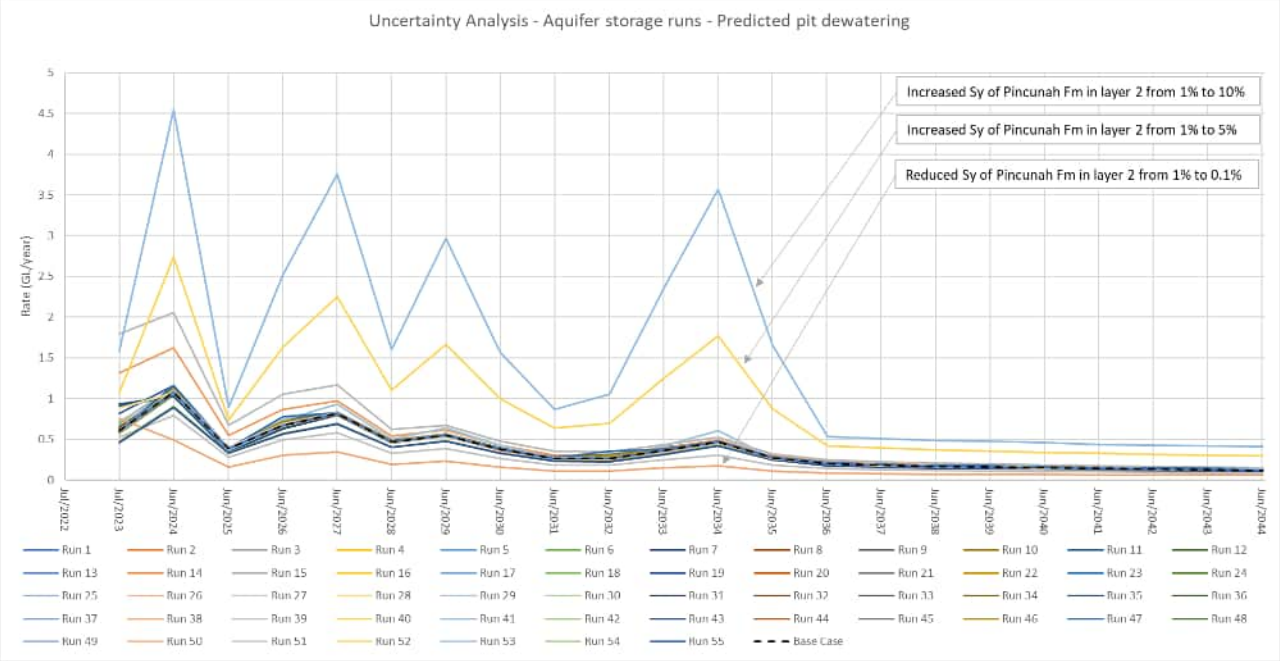


Figure 6-4 Predicted mine dewatering (storage runs)

The results presented in Figure 6-4 suggest that pit dewatering requirements could be significantly higher if unconfined storage of the Pincunah Hill Formation hosting the orebodies is higher. Although uncertainty runs tested the high end of the spectrum values for unconfined storage in the Pincunah Hill Formation of 5 and 10% these values could be described as unrealistic since investigations completed to date suggested that storage of this formation is very limited.

6.2.3 Hydraulic Conductivity Runs

Hydraulic conductivity runs were designed to test impact of adopted hydraulic conductivity values on predicted water supply potential associated with the water supply borefields simulated in the model and pit dewatering requirements. Compared to the pre-development (calibration) and development (prediction) runs, hydraulic conductivity vales of all simulated hydrostratigraphic units in the model were lowered by up to one order of magnitude and increased by up to one order of magnitude. The results are presented in Figure 6-5 and Figure 6-6.

The results suggest that both borefield abstraction and pit dewatering were relatively insensitive to hydraulic conductivity changes tested in the assessment. It should be noted that although abstraction is not sensitive to hydraulic conductivity values, predicted drawdown would be and higher conductivity values would allow propagation of predicted drawdown away from the mine and further away from the simulated borefields. Lower hydraulic conductivity values would produce higher drawdown estimates in the immediate abstraction areas and lower regional drawdown estimates. The reason why the results are not sensitive to hydraulic conductivity values is because the model does not rely on inflows from the regional areas to sustain abstraction and there are no regional inflow boundaries (i.e. fixed head or general head boundaries) assigned around the model edges. If that was the case, higher conductivity values would allow more inflow from those regional areas and lower conductivity values would reduce it. This model only relies on storage and recharge to sustain borefield abstraction and pit dewatering requirements are directly related to the amount of storage that needs to be removed from the pit areas to achieve dry mining conditions.

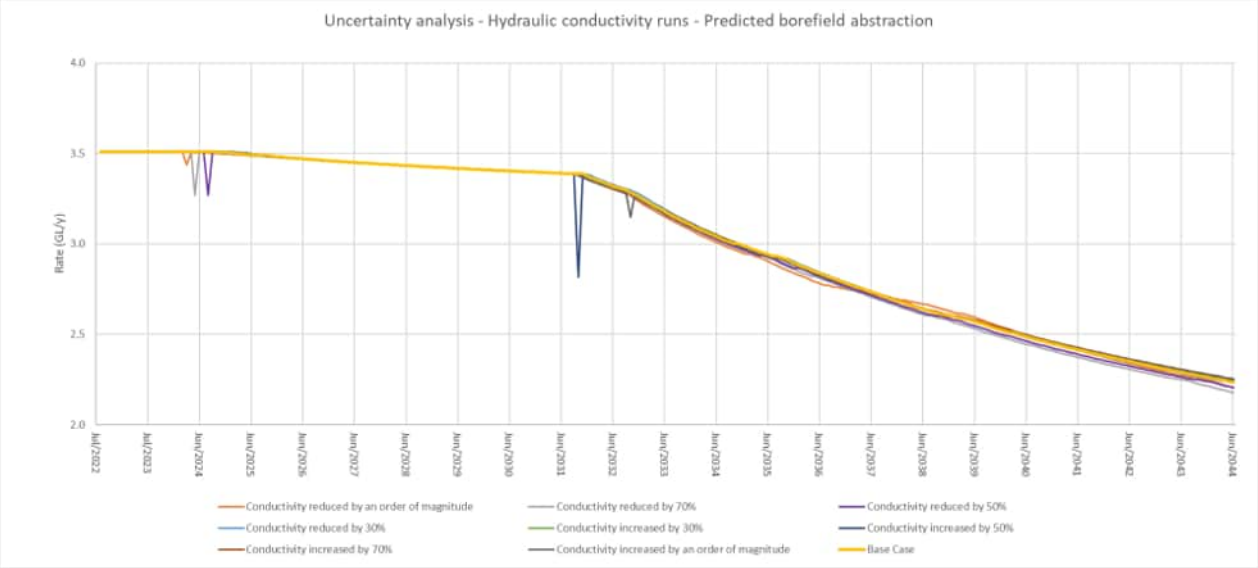


Figure 6-5 Predicted waters supply borefield abstraction (conductivity runs)

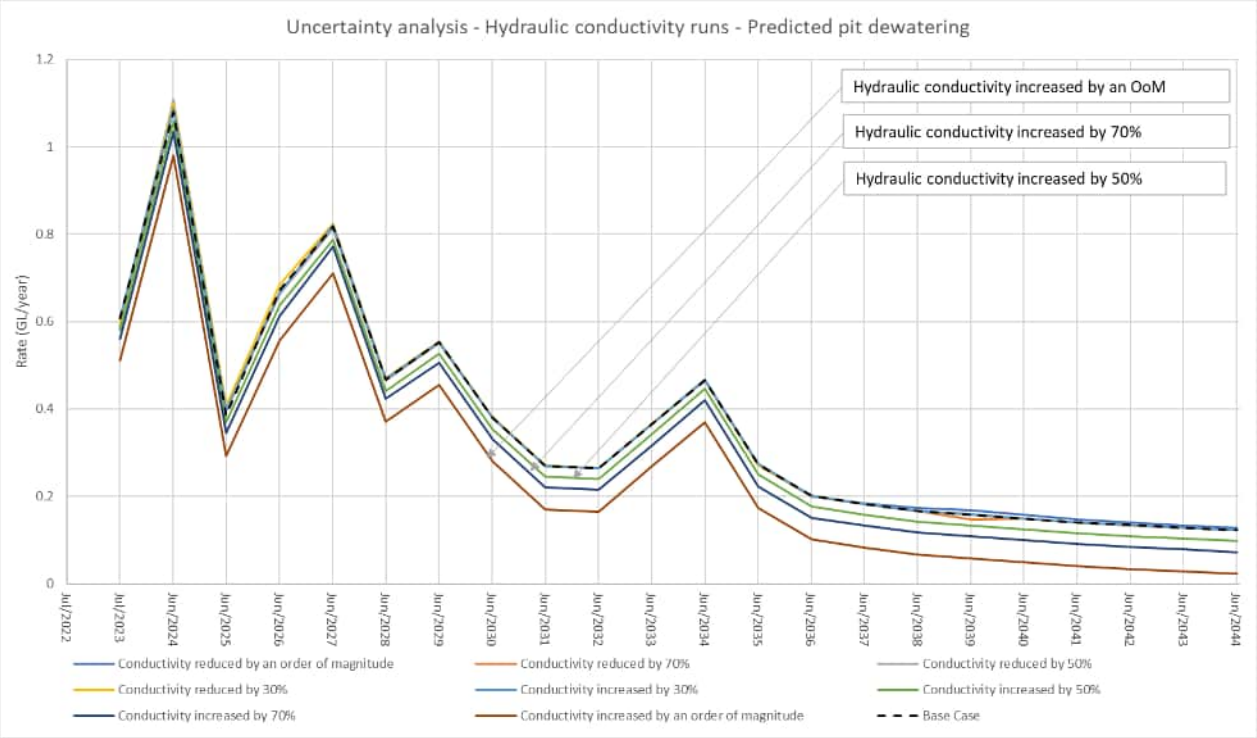


Figure 6-6 Predicted mine dewatering (conductivity runs)

Section 7 Summary and Recommendations

7.1 Groundwater Modelling

Groundwater modelling was conducted to assess the water supply potential of the existing and the proposed borefields in the vicinity of the North Star mine and dewatering rates necessary to facilitate dry mining conditions and impacts to regional groundwater levels from groundwater abstraction. The numerical groundwater flow modelling package Modflow-USG (Sorab Panday, Transport version 1.10.0) was used to develop the model operating under the Groundwater Vistas graphical user interface. The Modflow-USG numerical code was chosen to allow simulation of shallow water tables, reduction of water levels in mining areas and subsequent groundwater recovery. Initial plan to calibrate the model using PEST-IES was not fully achieved to extremely high heterogeneity and anisotropy of the system. The current model replicates historical borefield abstraction and the observed responses to pumping although model calibration would have been improved if the current is split into several smaller models that would simulate borefield areas in more details. That would allow the model to be highly refined and highly parametrised which would help improve model calibration and better drawdown predictions since drawdown associated with the water supply borefields is likely to be constrained and truncated by the fault zones depending on their hydraulics. Smaller model would also allow for a stochastic approach to addressing model uncertainties. The current model is suitable for simulations of future borefield abstraction and pit dewatering. Drawdown responses in the current model might be over or under predicted since absolute water levels could not be precisely matched with the regional setup adopted in the current model.

7.2 Mine Plan

The twenty-two year mine plan that spans from July 2022 to June 2044 involves the excavation of three pits. The final depth for each mining block would vary between 330 to 460 metres below the ground surface. Pit dewatering was simulated using drains which means that the preferred dewatering setup would involve sump pumping rather than using bores since the proposed pits are hosted in a low permeability environment. Bores may still be required if any structural features are encountered which allow for higher flow rates.

7.3 Water Supply and Dewatering

Mining is scheduled to commence in July 2022. Groundwater inflows from dewatering were predicted to peak at 1.1 GL/year in July 2024 followed by a decrease to below 0.2 GL/year from July 2036 until the end of mine life. Predicted cumulative dewatering requirements are approximately 8 GL over the life of mine. These outcomes were not sensitive to recharge but did display sensitivity to storage within the weathered Pincunah Member; an unlikely eventuality given the field results from drilling and testing to date.

Water supply abstraction of 3.5 GL/year is predicted to be successfully sourced from the simulated borefields for approximately 2.5 years. From around December 2024 until December 2031 borefield abstraction is predicted to decrease to around 3 GL/year. This is followed further by a decrease to below 2 GL/year at the end of mining (June 2044). These results are sensitive to the frequency and magnitude of recharge events and estimates of aquifer storage. As noted above, faults dictate groundwater hydraulics and have a major influence on borefield capacity. Greater resolution of data related to faults, and other structural features controlling the flow, may be required if structures continue to be targeted. The model does, however, provide some indication on the regional availability of groundwater, and the risks of abstracting at rates considered unsustainable according to the modelled water balances.

7.4 Drawdown Impacts

A maximum drawdown of 300+ m is predicted in the immediate mining area, to facilitate dry mining of the pit, with predicted drawdown reducing with distance from the mine. Eastern and western shales are predicted to stop drawdown from propagating further to the east and west.

Twenty-two years of borefield abstraction are predicted to lower the water table by around 60-75m below its pre-development level in the Northern and Southern borefield areas at the end of the run. In the Western borefield area, predicted drawdown at the end of the run was around 15m at NS-PBW08. Drawdown was predicted to propagate further to the west. Predicted drawdown of 5m is predicted some 4 km west of the NS-PBW08. In the Eastern borefield area, predicted drawdown was around 35m at NS-PB02, at the end of the model run. Drawdown is not predicted to continue propagating further to north past NS-PB02. These drawdown outcomes are sensitive to the aquifer permeability values and also the presence and orientation of faults or other structures. The extent of drawdown presented should be considered indicative only, and should be used to guide management strategies, including monitoring. Should any receptors exist within or near to the predicted extent of drawdown, then adaptive management may be required to address the risk of drawdown propagating beyond what has been predicted.

Section 8 References

Barnett et al, 2012	-	Australian groundwater modelling guidelines, Waterlines report, National Water Commission, Canberra
FMG, 2015	-	Hydrogeological Assessment of the North Star Water Supply – Stage 2, 662MI-5710-RP-HY-0001
FMG, 2019	-	Iron Bridge Feasibility Study Hydrogeology Report, 662NS-1000-RP-HY-0005
FMG, 2020	-	Iron Bridge – Near Mine Hydrogeology Report, NS-03018-RP-WM-0001
FMG, 2021	-	Groundwater Modelling Assessment of The Proposed Mine Plan "LOMMP_IB_2020Q1_v3" for the North Star Mine Project, 662NS-0000-AS-HY-0001
FMG, 2021	-	Site 12 Pool Water Quality and Quantity Monitoring Plan, 662MI-5700-PL-WM-0001
FMG, 2023	-	Iron Bridge Mine Area Hydrogeological Assessment
Worley, 2012	-	North Star Magnetite Project - Preliminary Dewatering Assessment, 301012-01426

Appendix A

The model replicates elevated water levels in the mine area which slope towards east, west and north- northwest.

FIGURE A1 - PREDICTED STEADY STATE WATER LEVELS

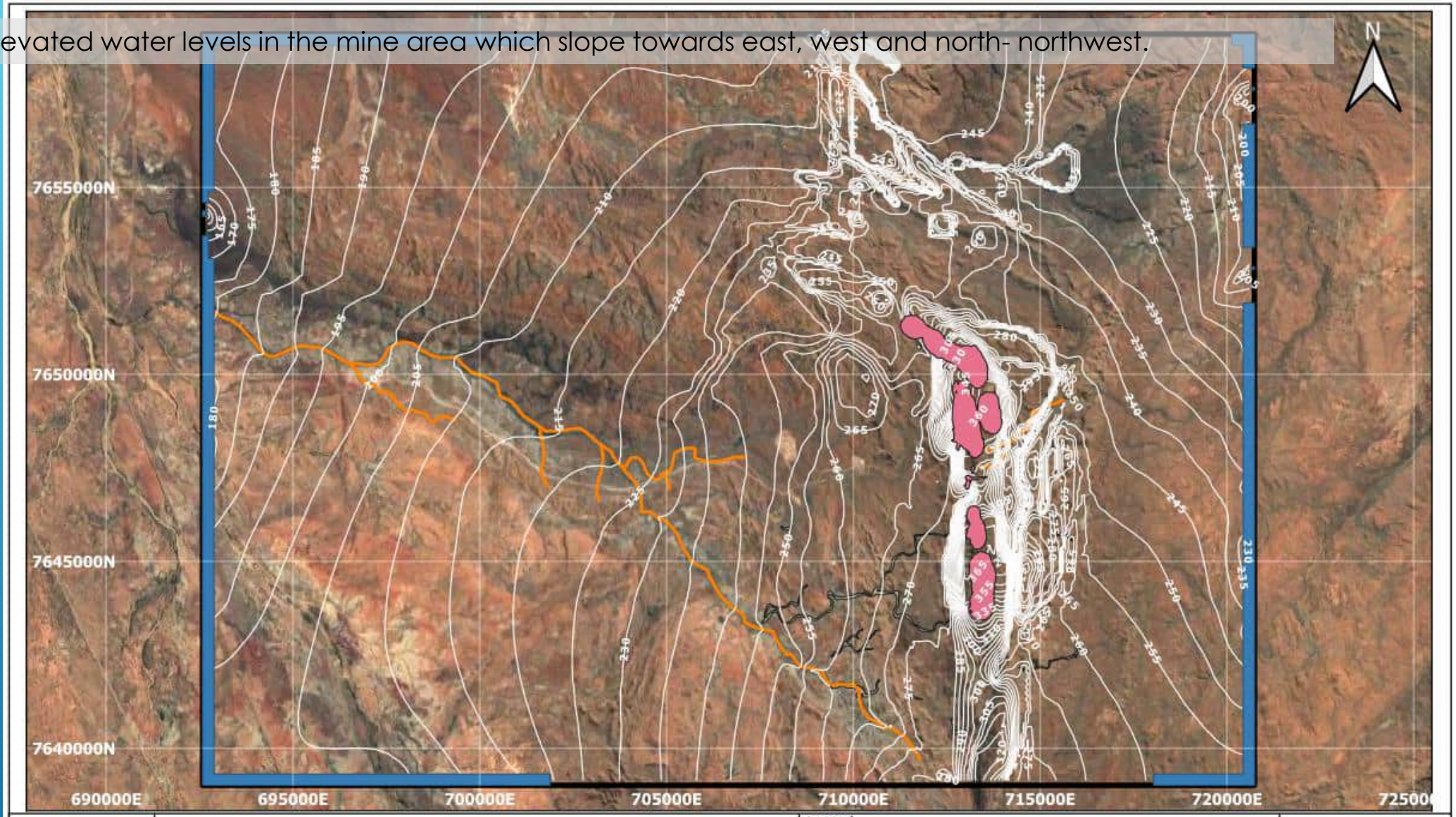


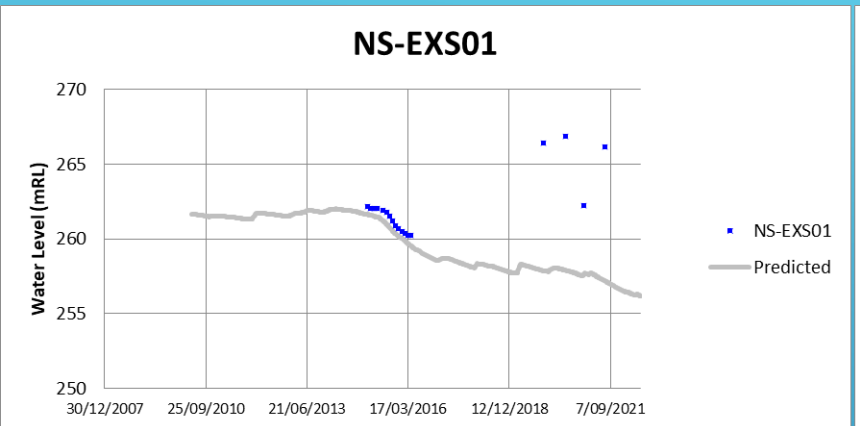
Figure A1

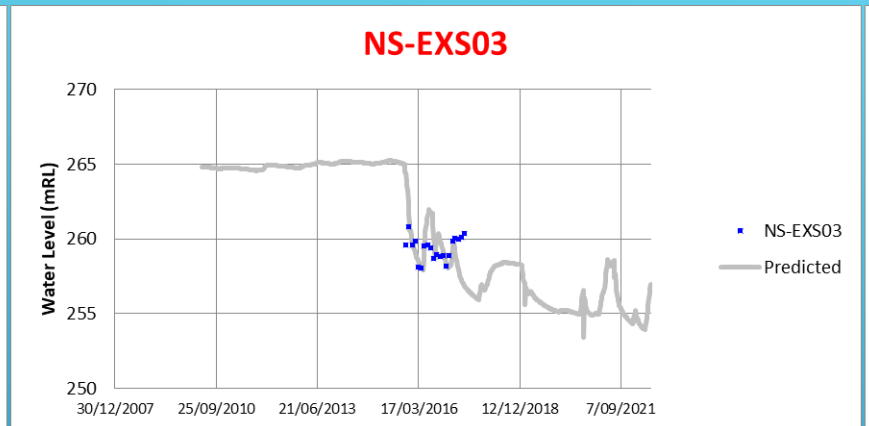
Predicted steady state water levels

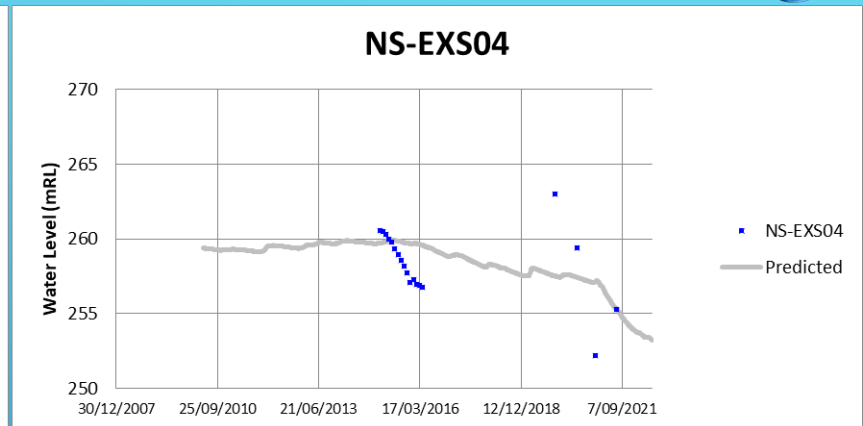
CALIBRATION HYDROGRAPHS

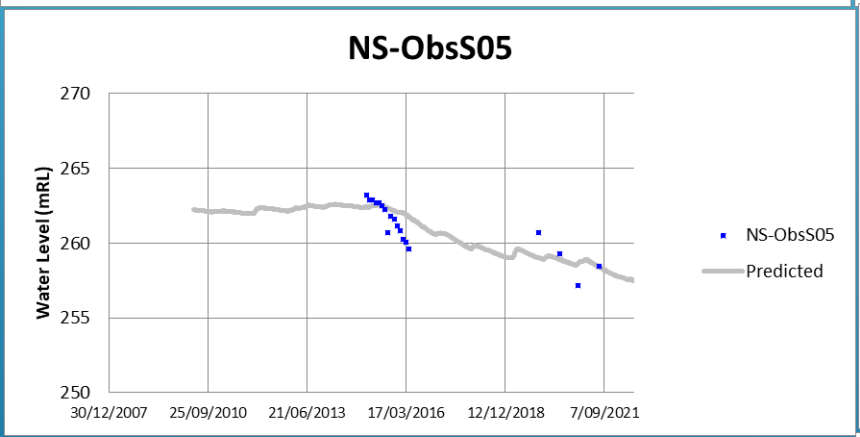
Southern Borefield

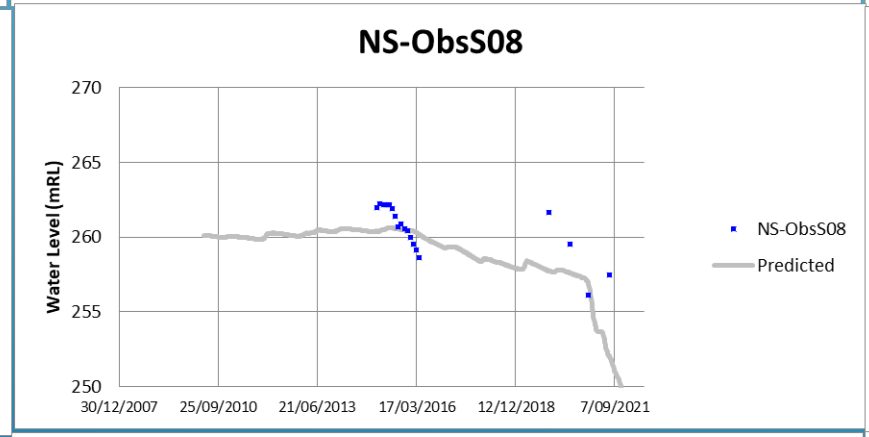
Figure A2 – Calibration hydrographs (Southern Borefield)

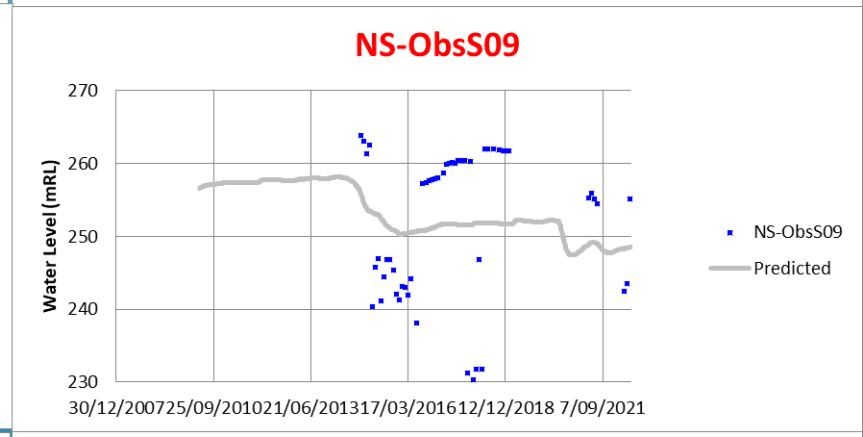


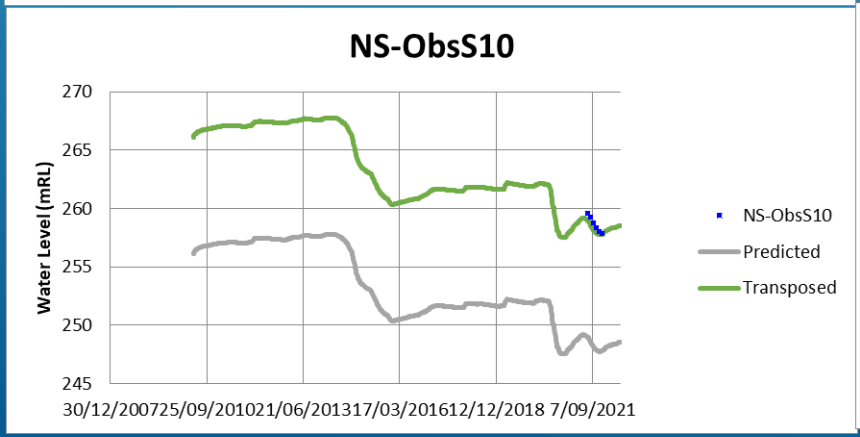


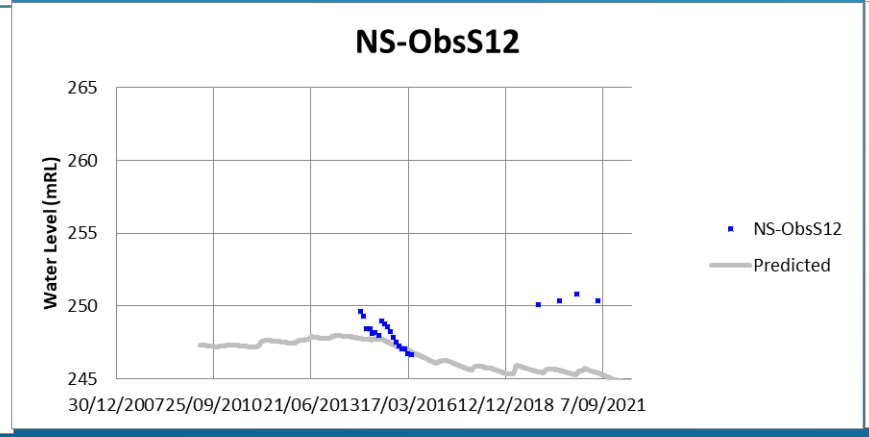












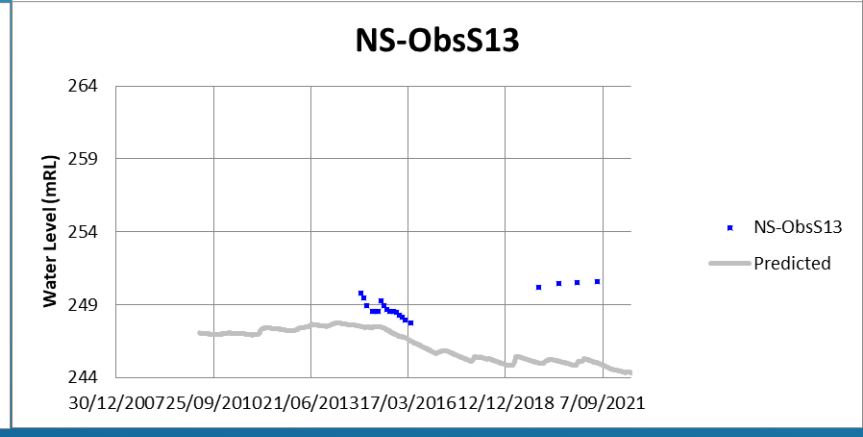
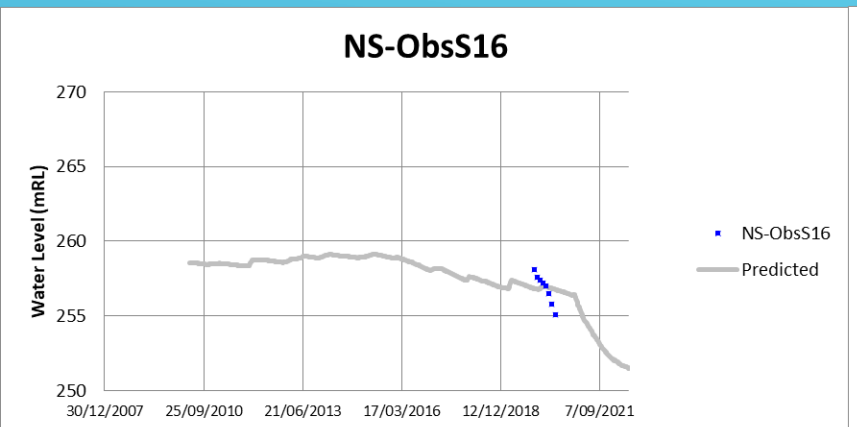
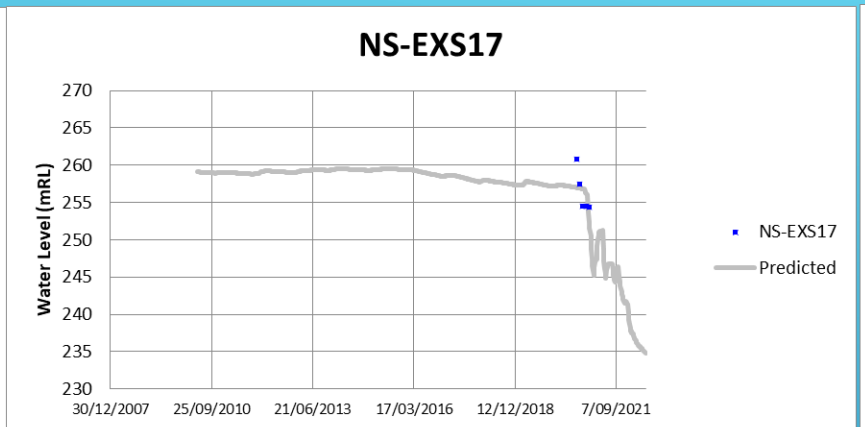
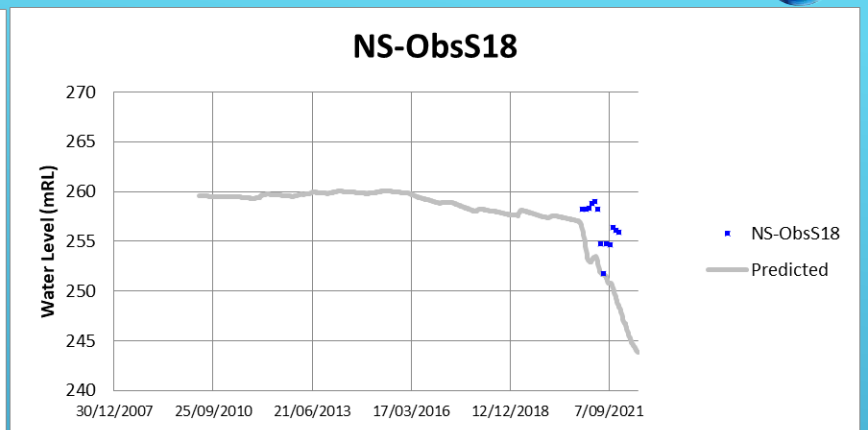
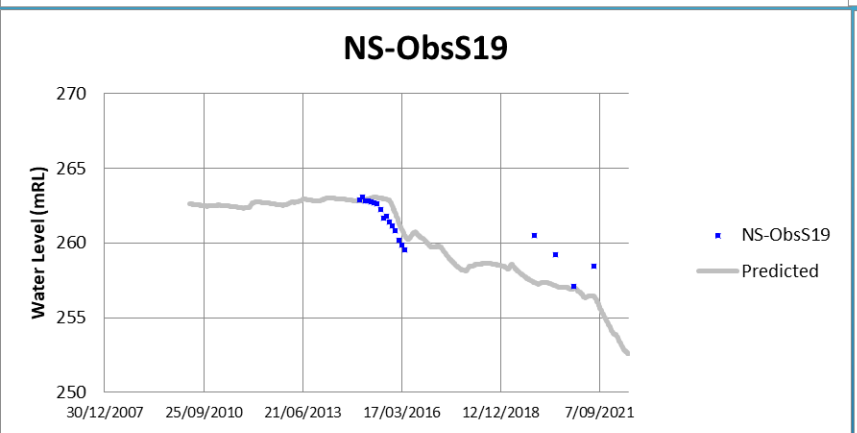


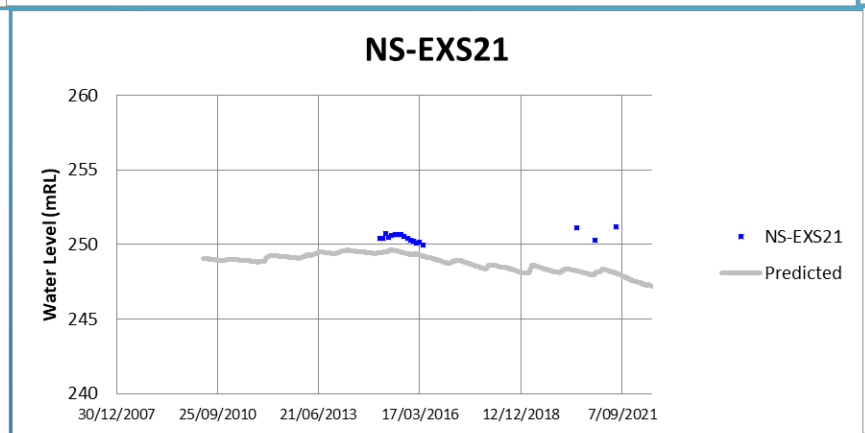
Figure A3 – Calibration hydrographs (Southern Borefield)

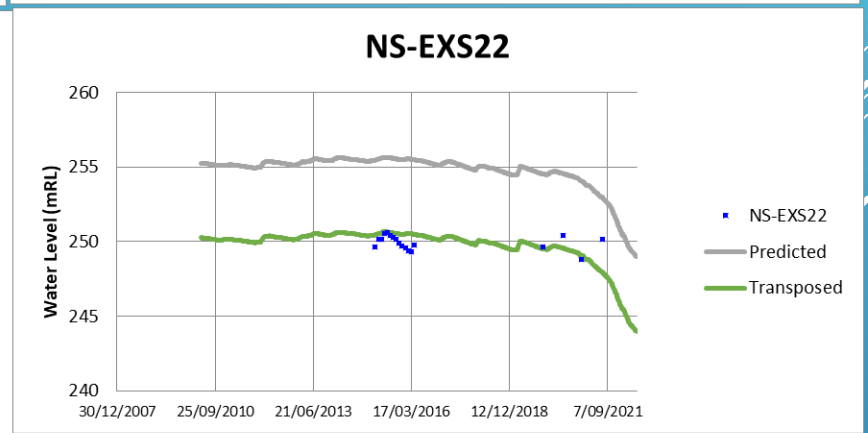


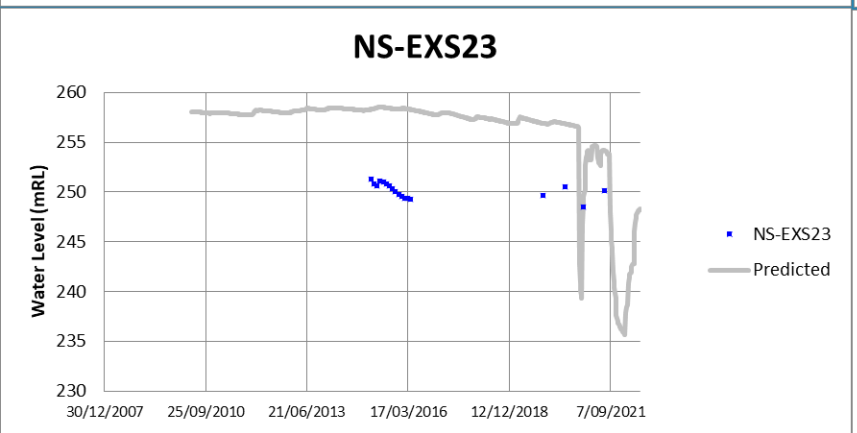


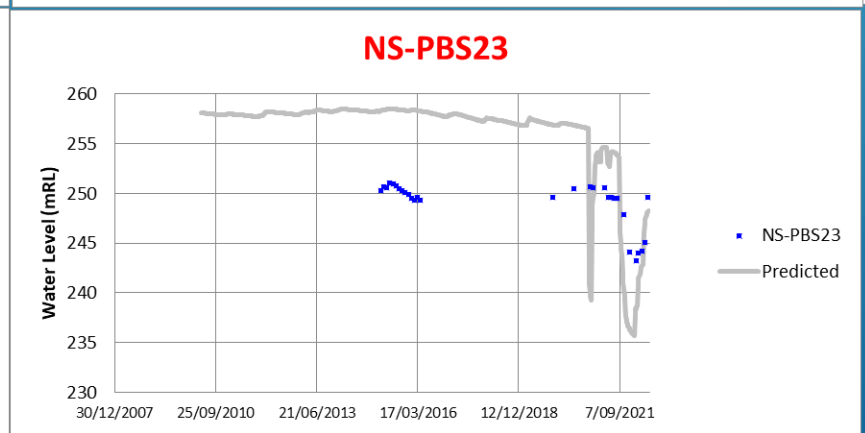












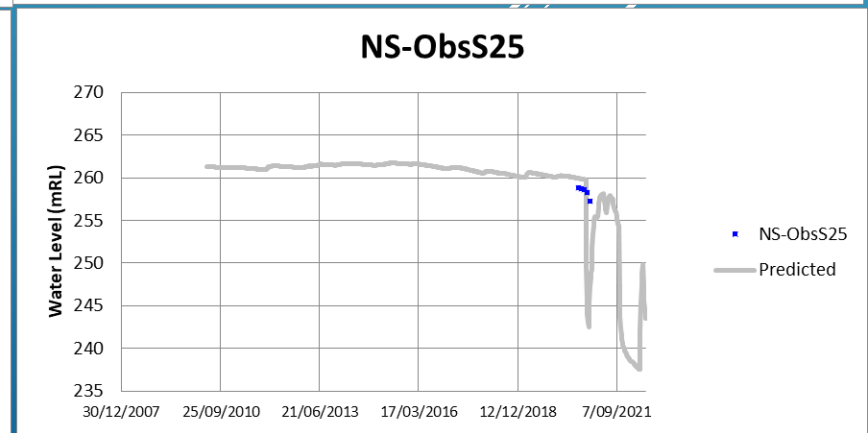
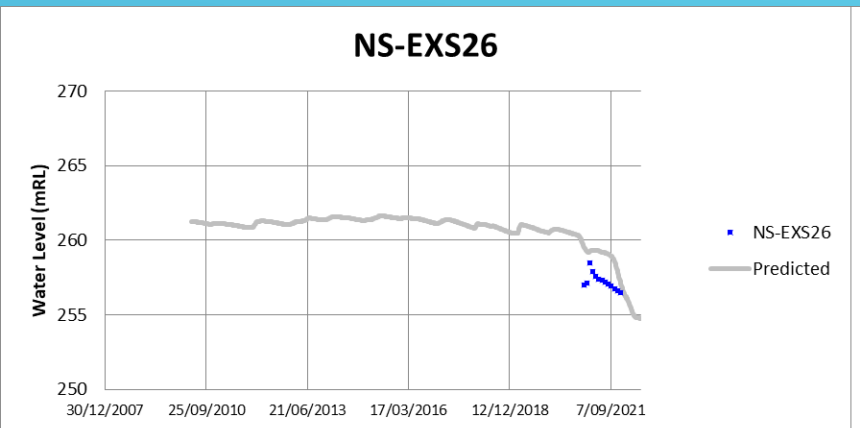
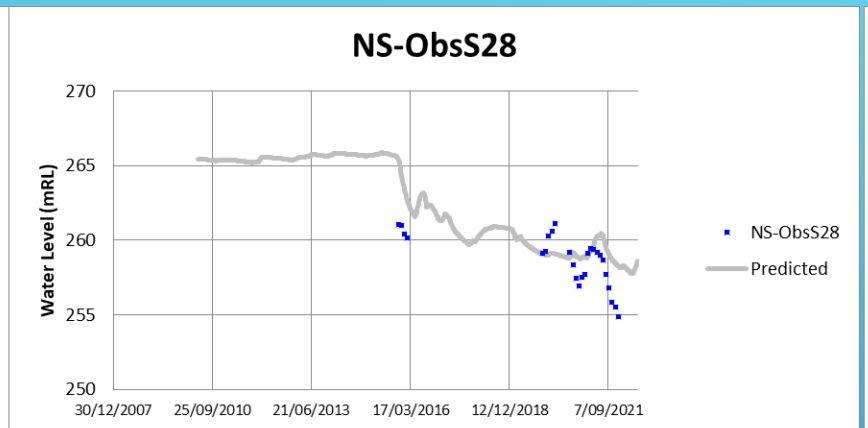
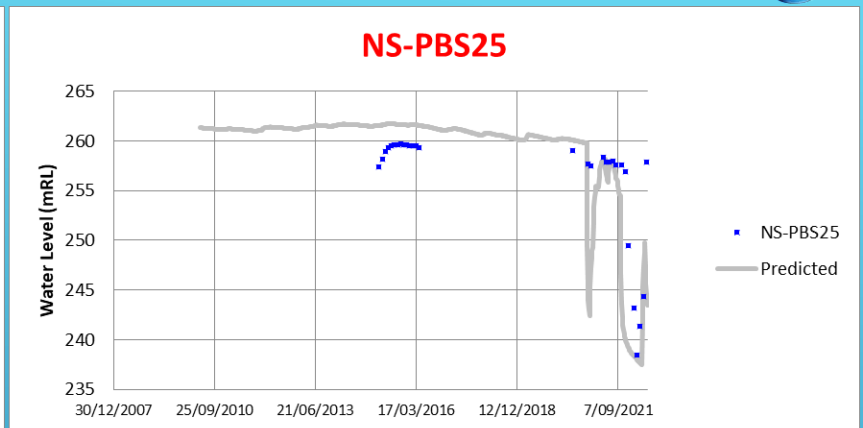
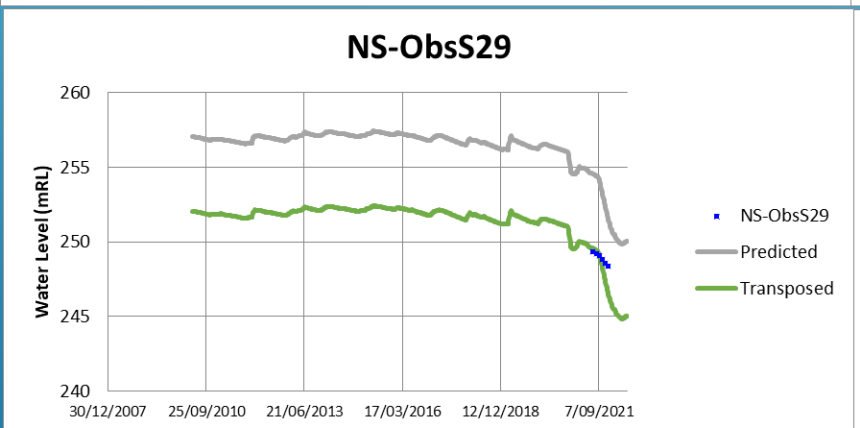


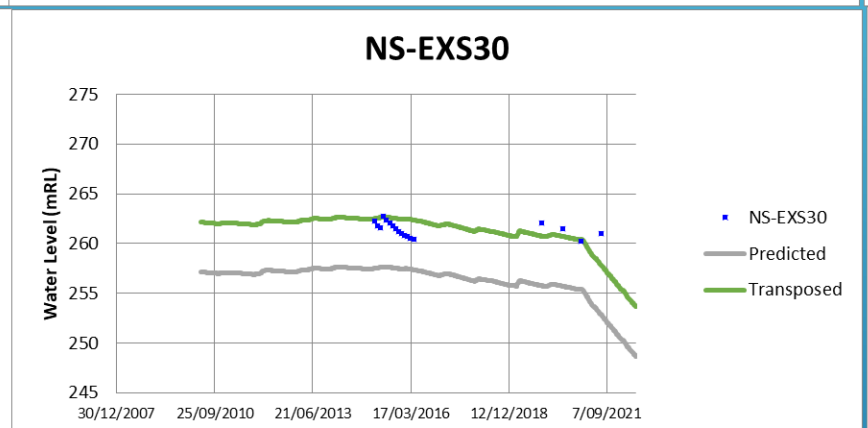
Figure A4 – Calibration hydrographs (Southern Borefield)

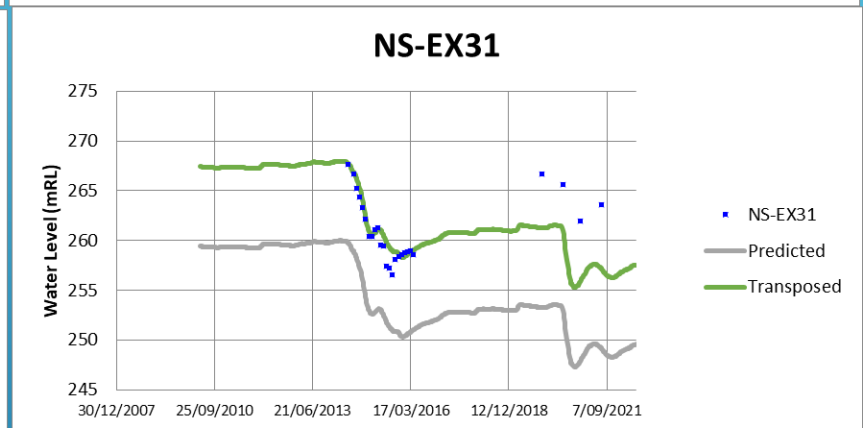


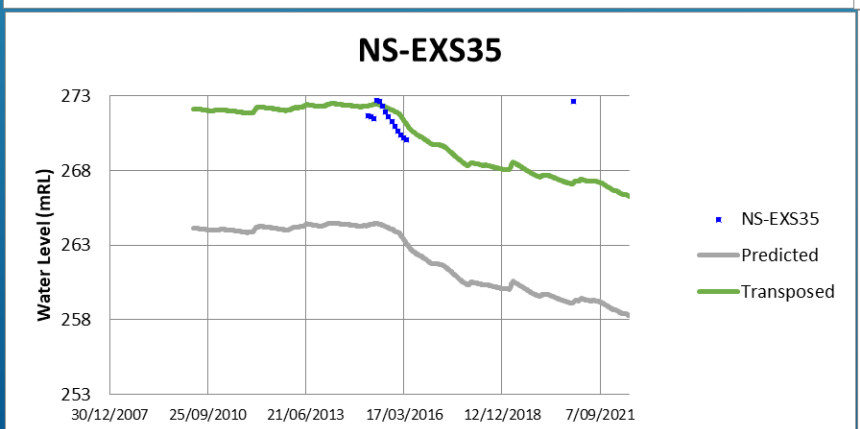












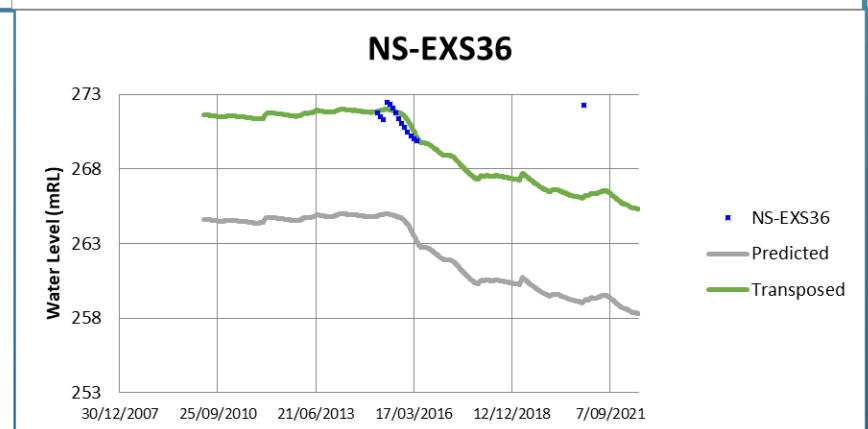
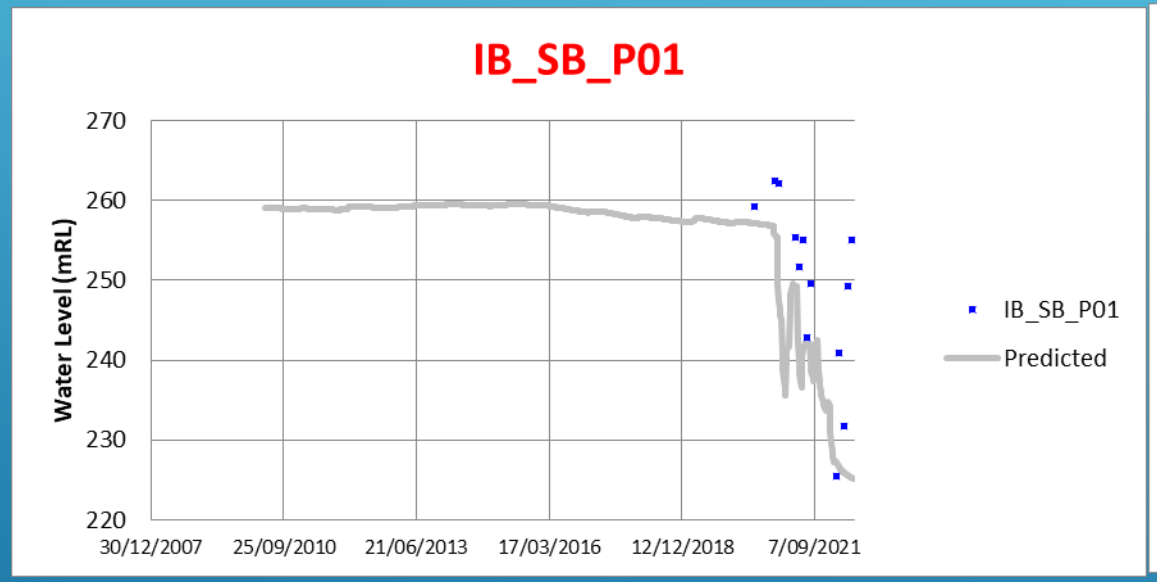
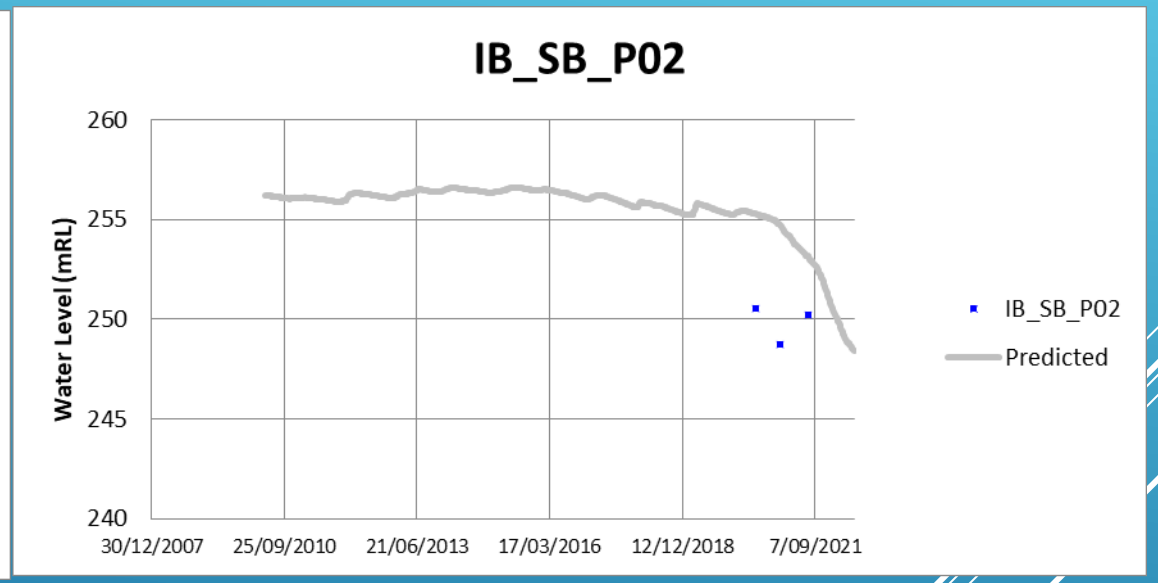


Figure A5 – Calibration hydrographs (Southern Borefield)

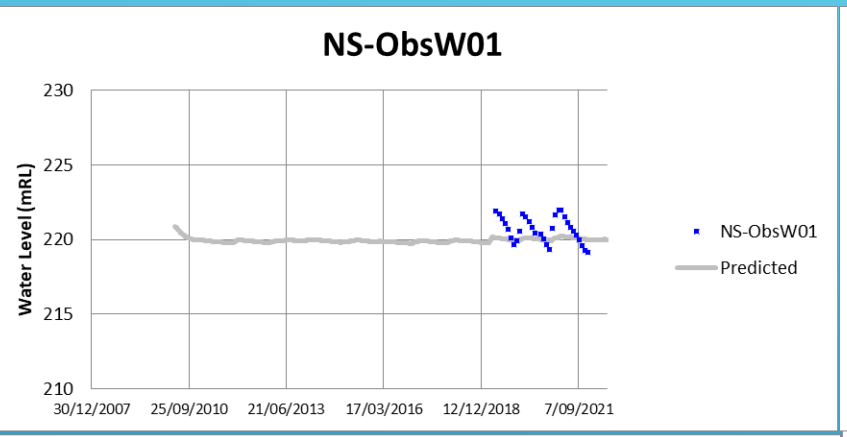


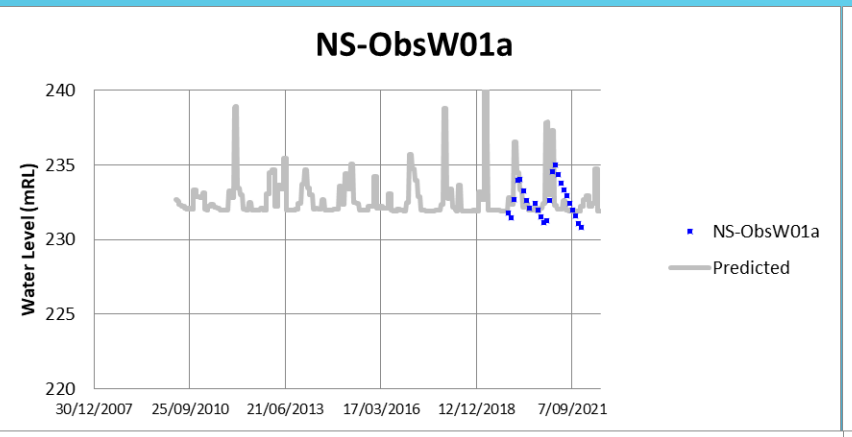


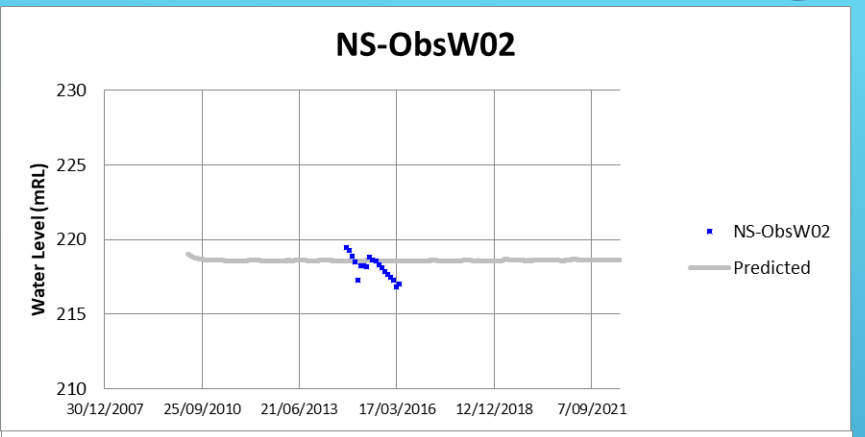
CALIBRATION HYDROGRAPHS

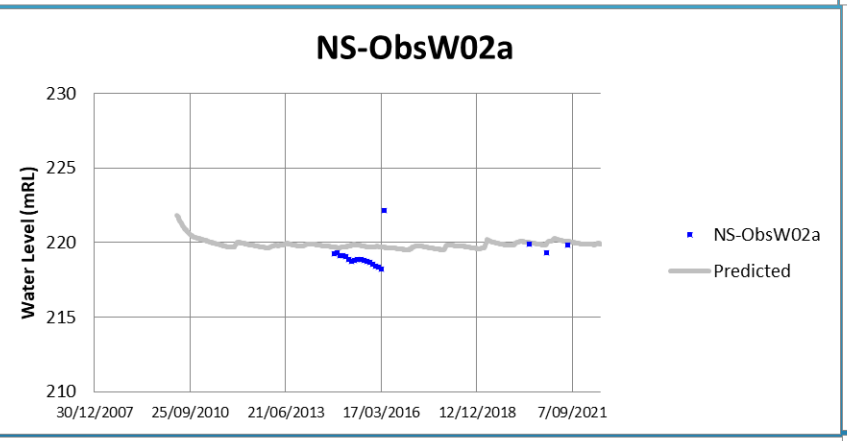
Western Borefield

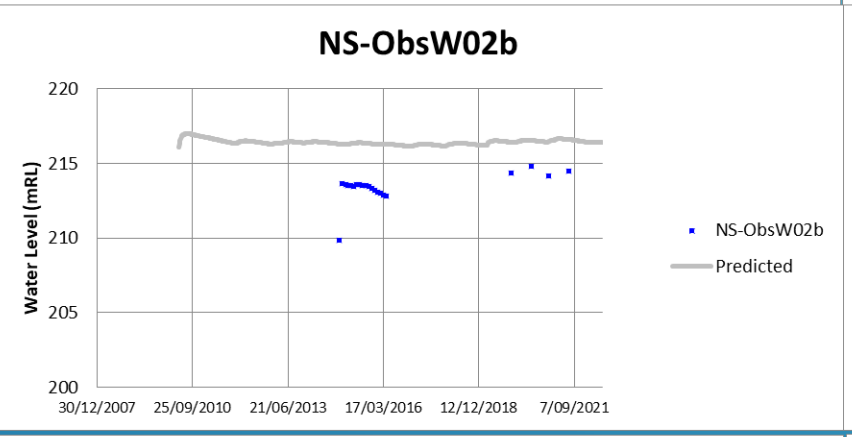
Figure A6 – Calibration hydrographs (Western Borefield)

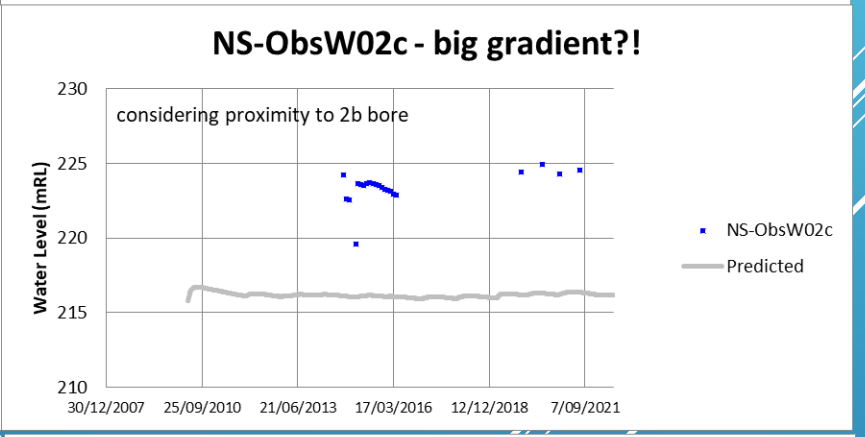


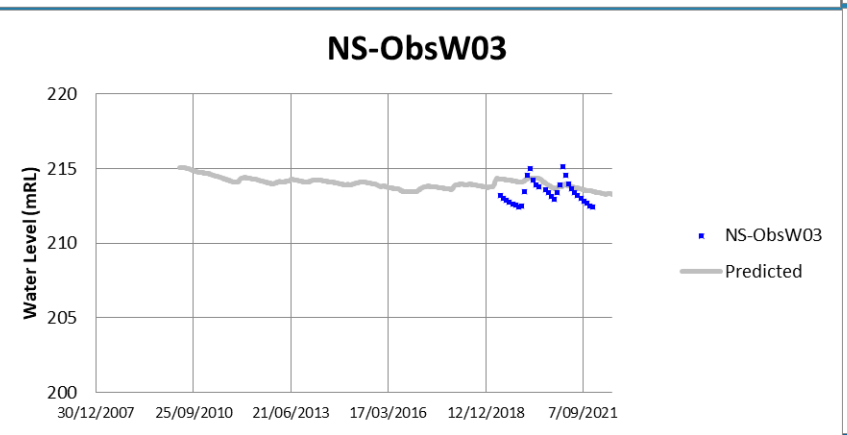


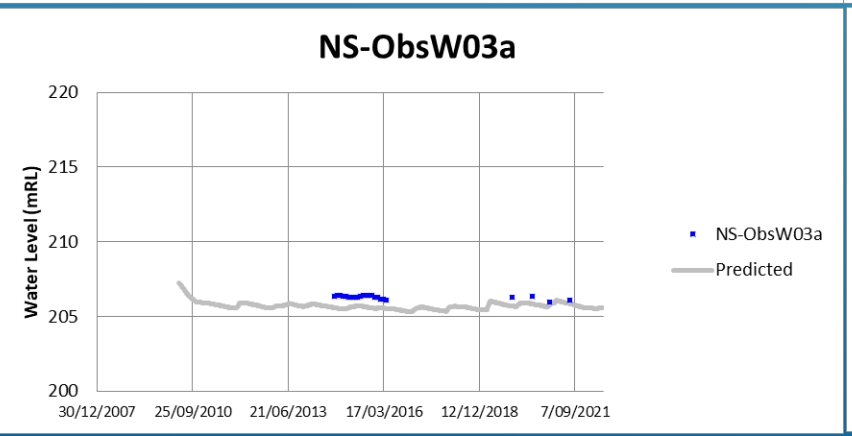












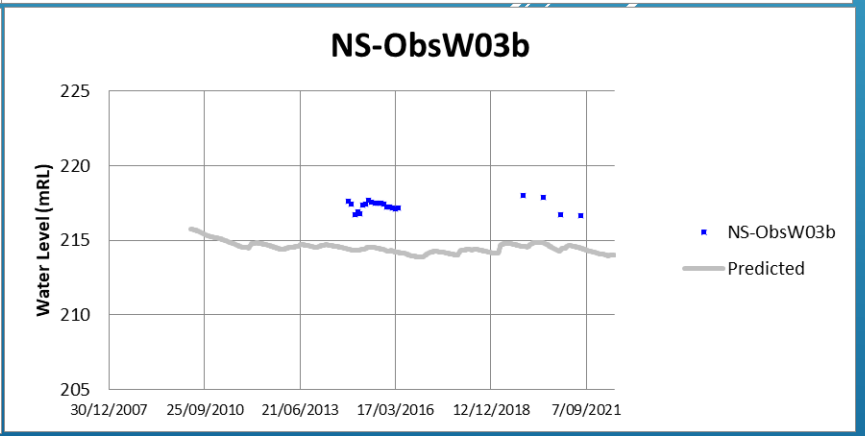
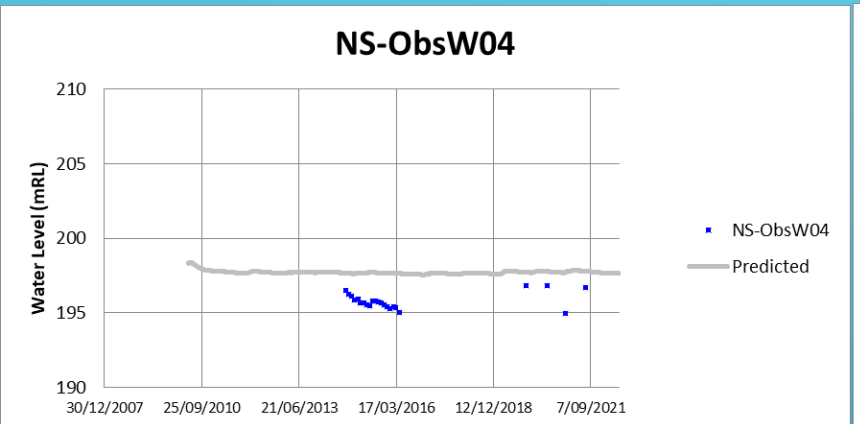
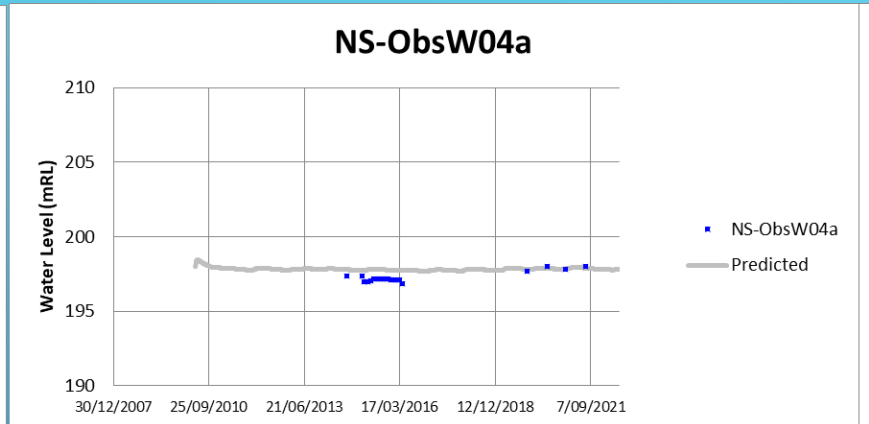
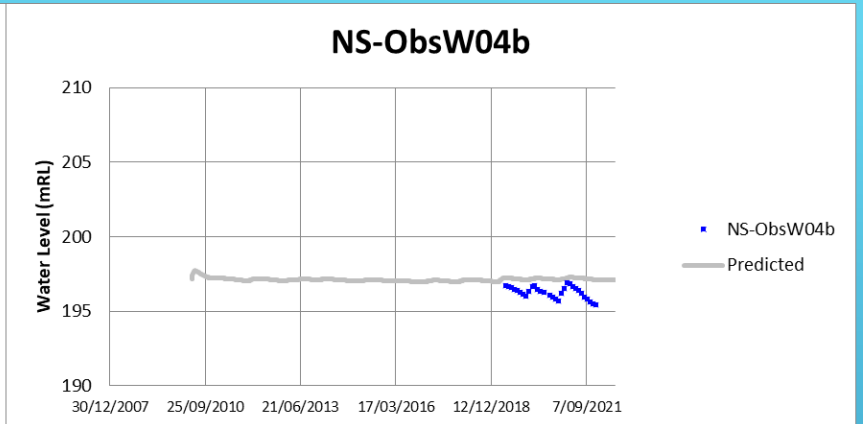
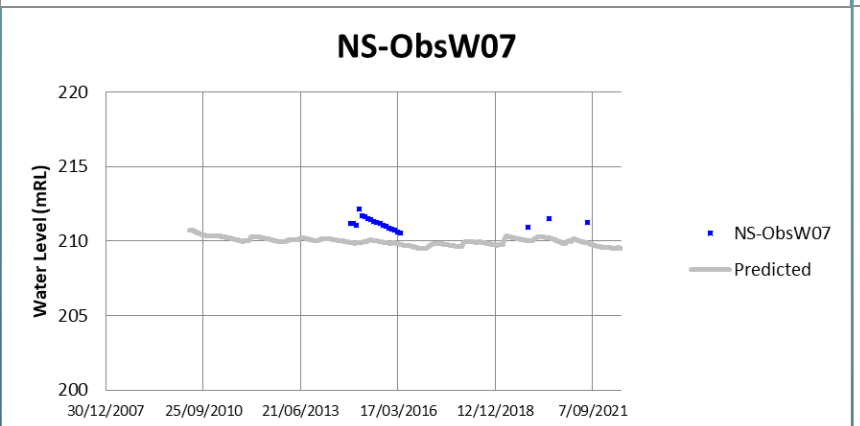


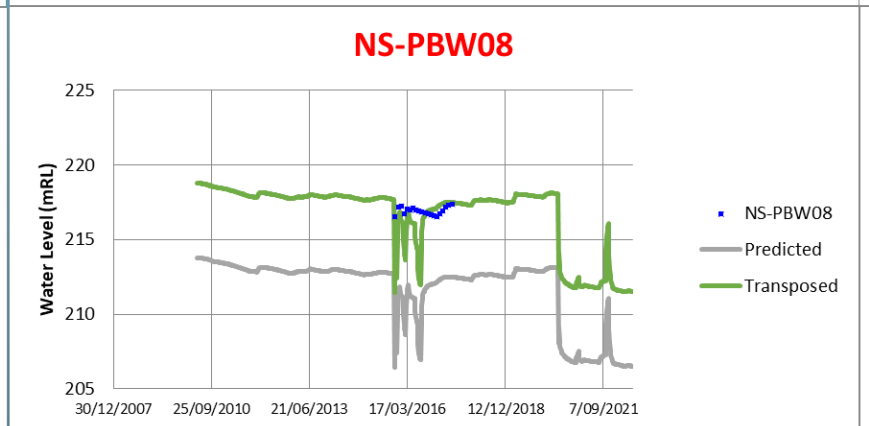
Figure A7 – Calibration hydrographs (Western Borefield)

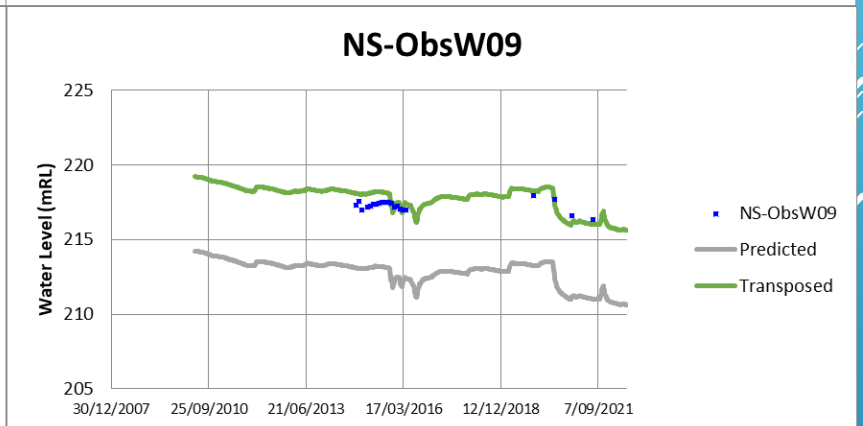


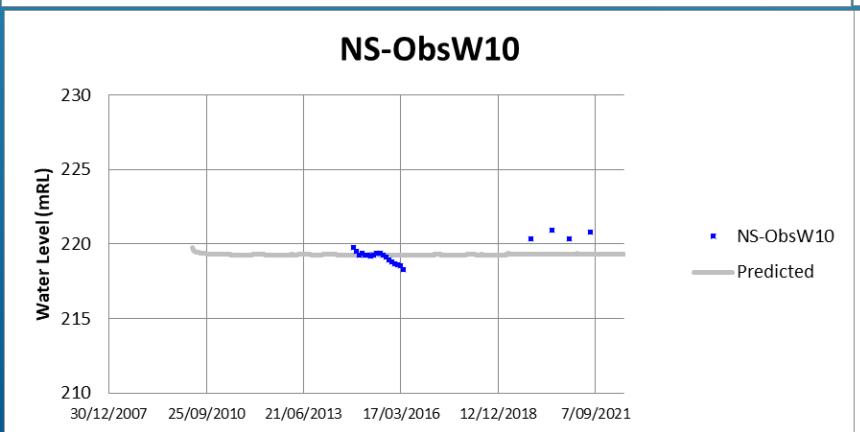


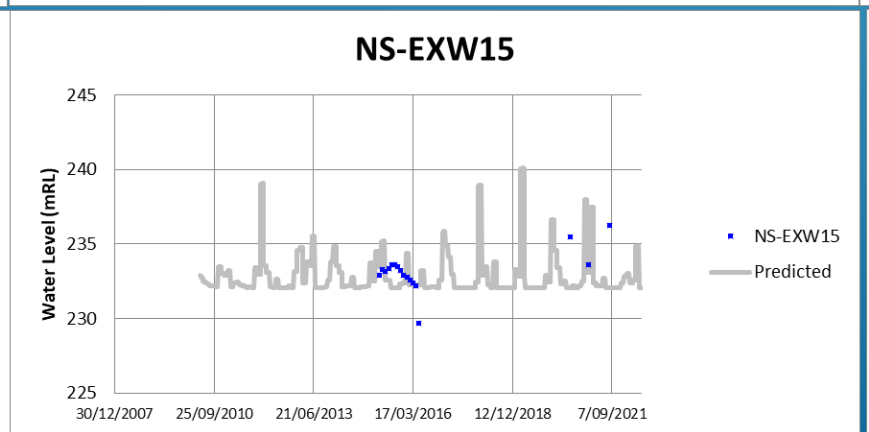












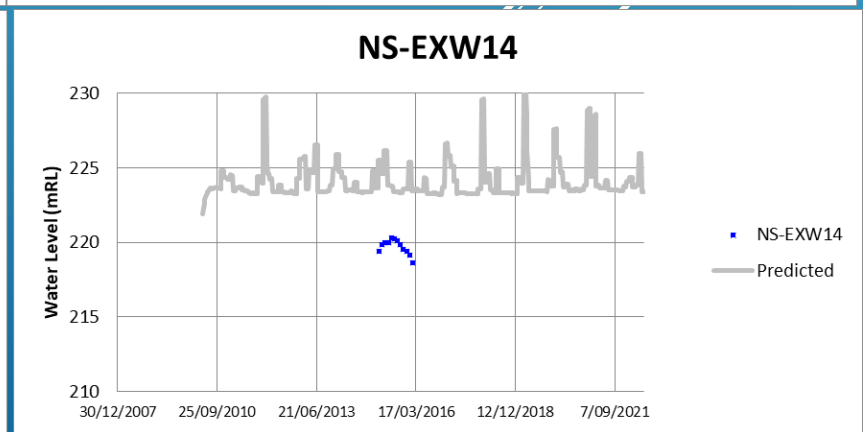
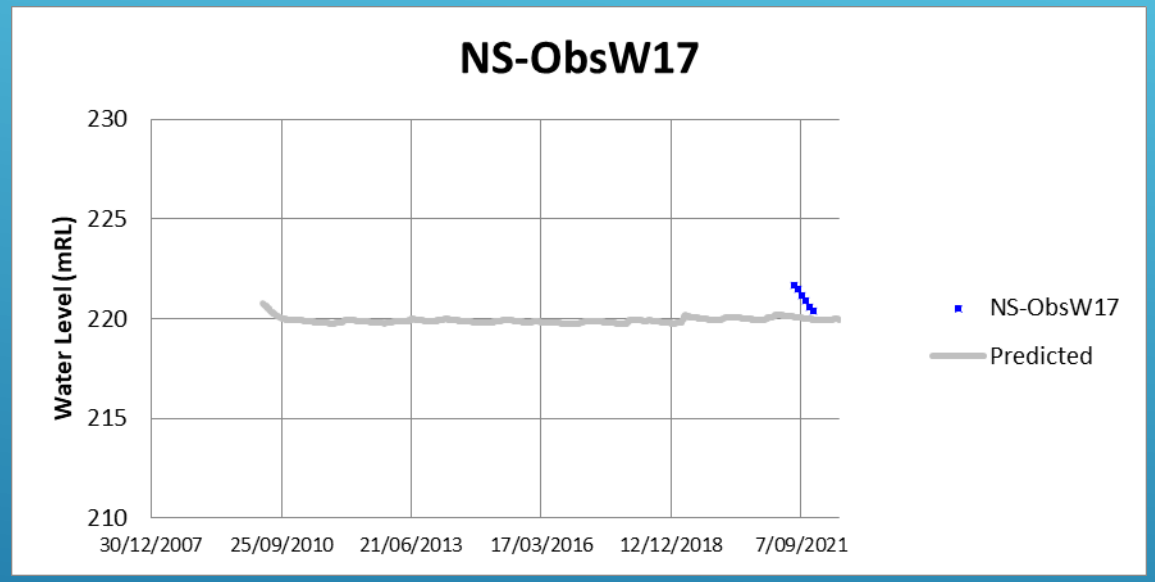


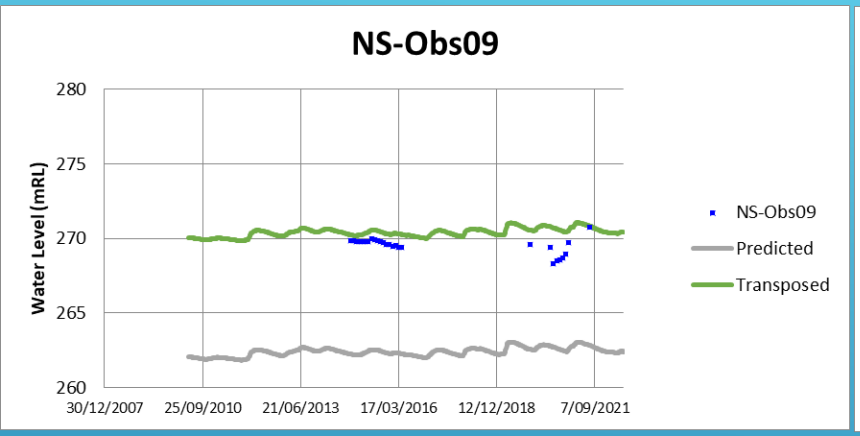
Figure A8 – Calibration hydrographs (Western Borefield)

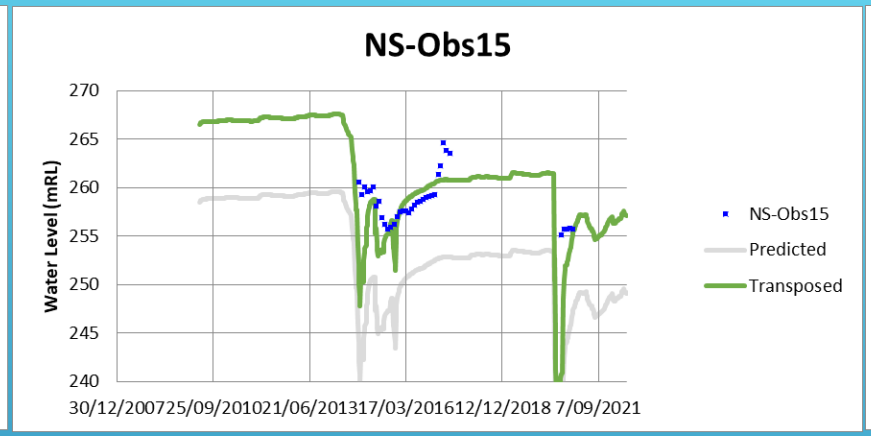


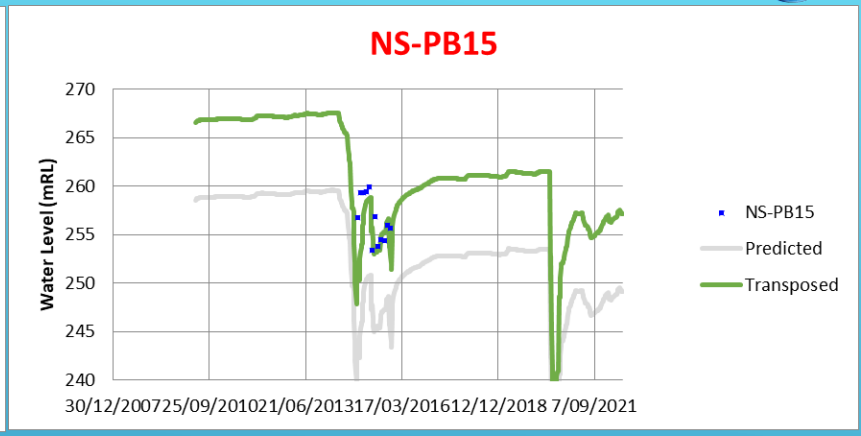
CALIBRATION HYDROGRAPHS

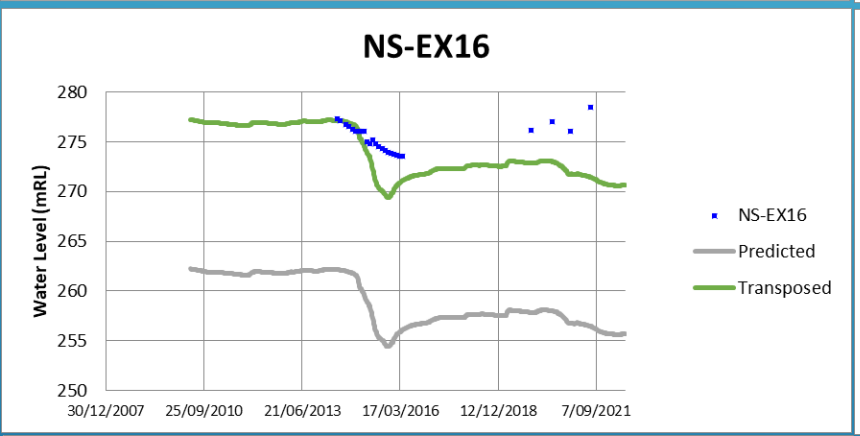
Northern Borefield

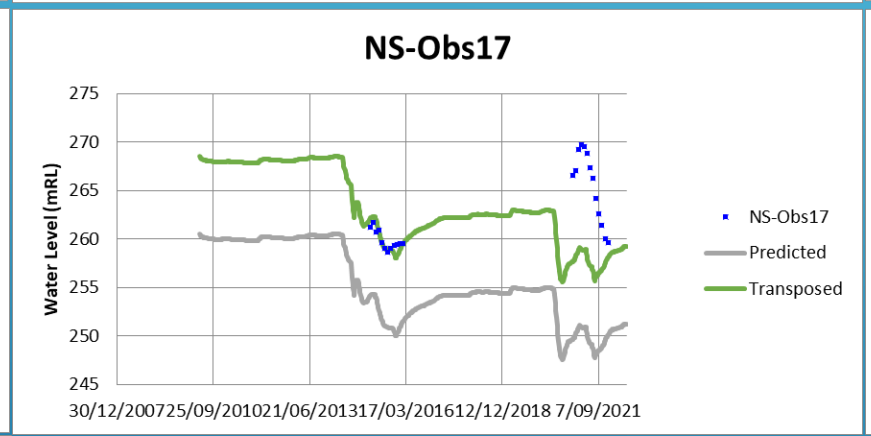
Figure A9 – Calibration hydrographs (Northern Borefield)

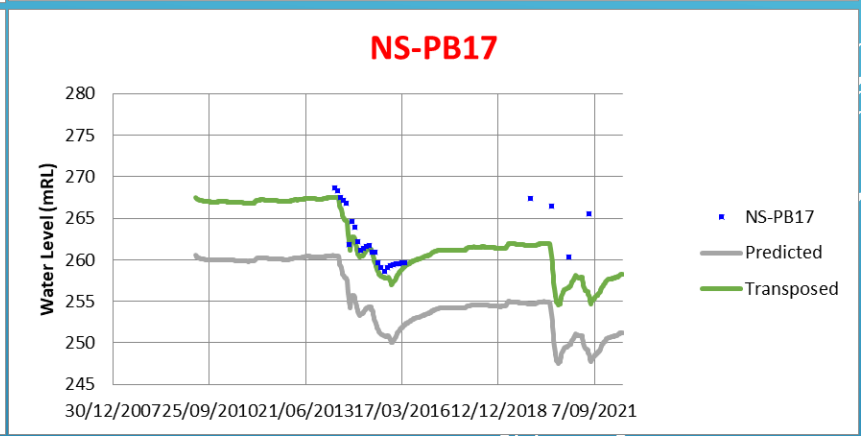


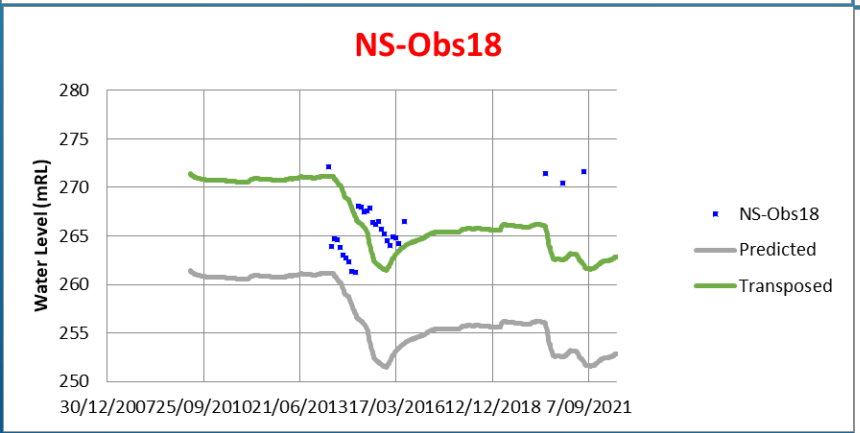


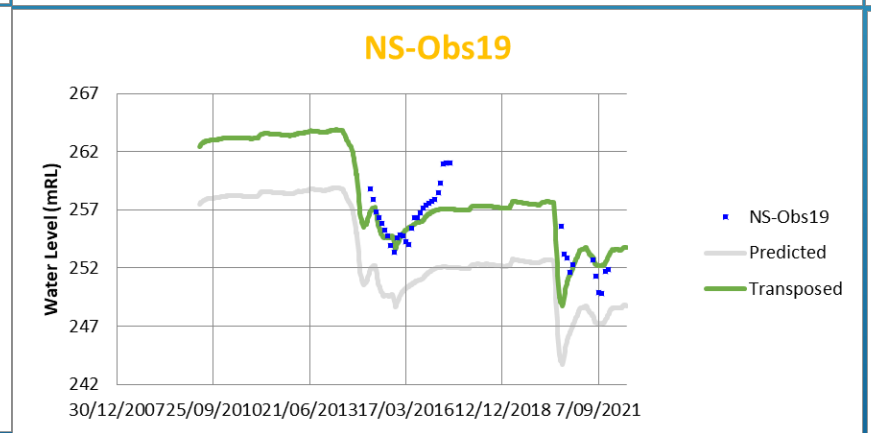












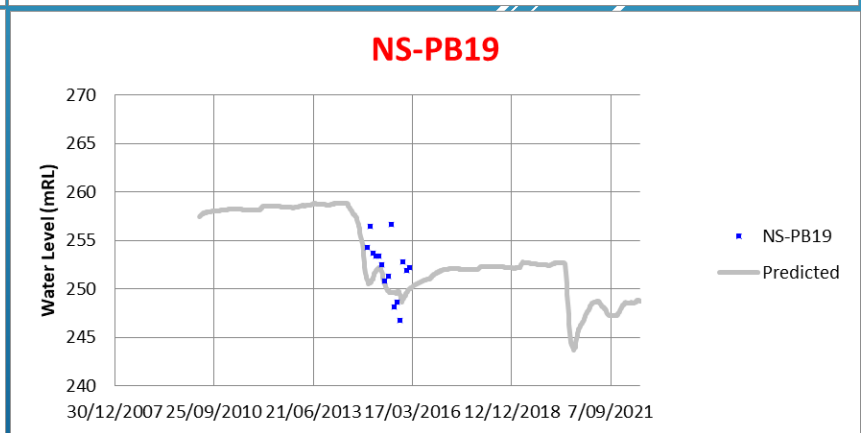
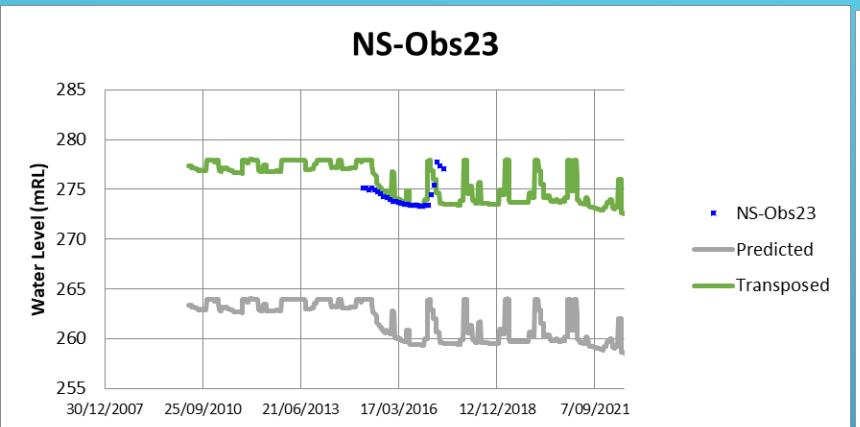
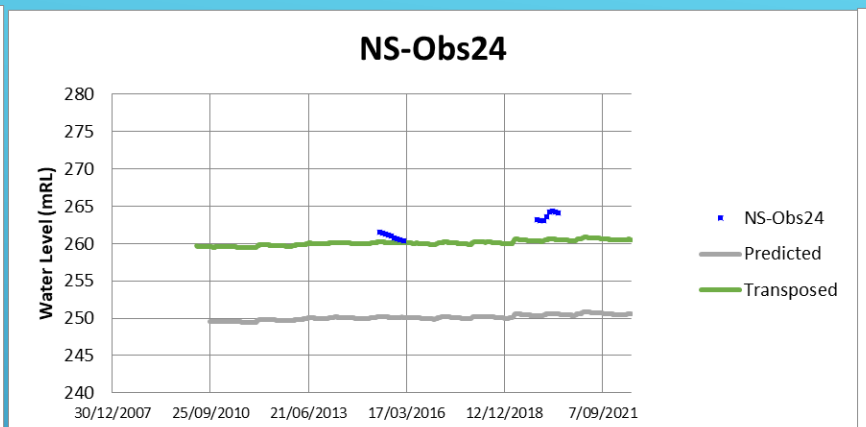
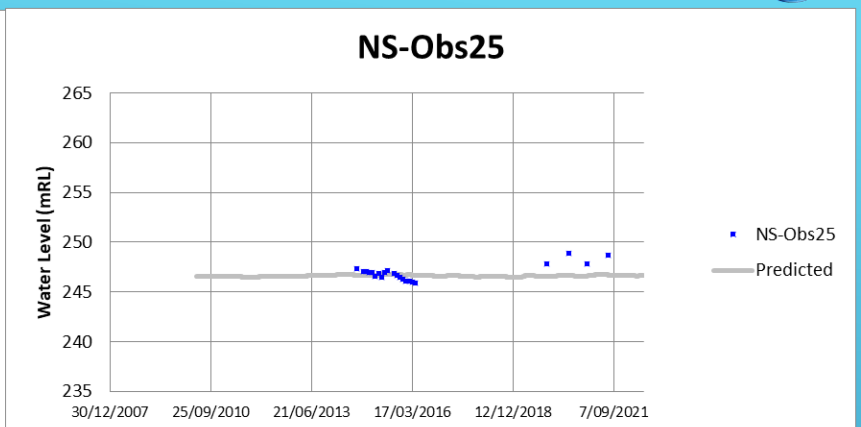
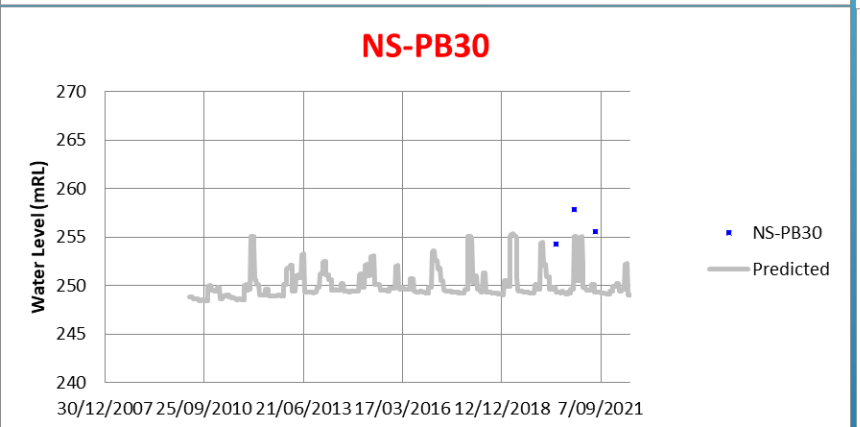


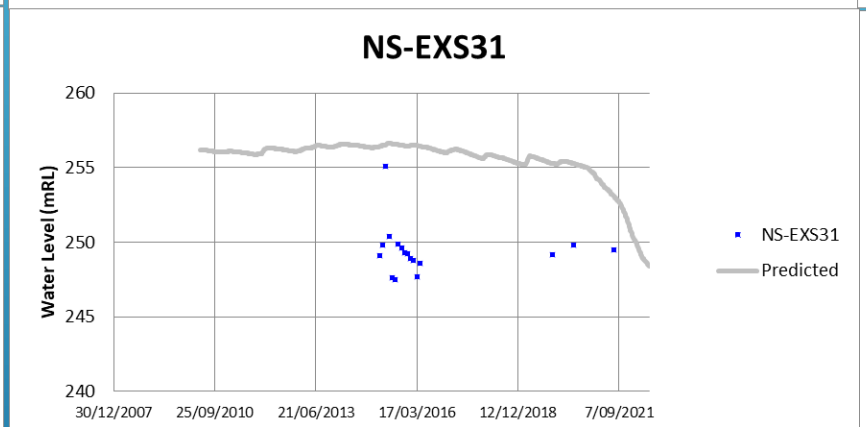
Figure A10 – Calibration hydrographs (Northern Borefield)

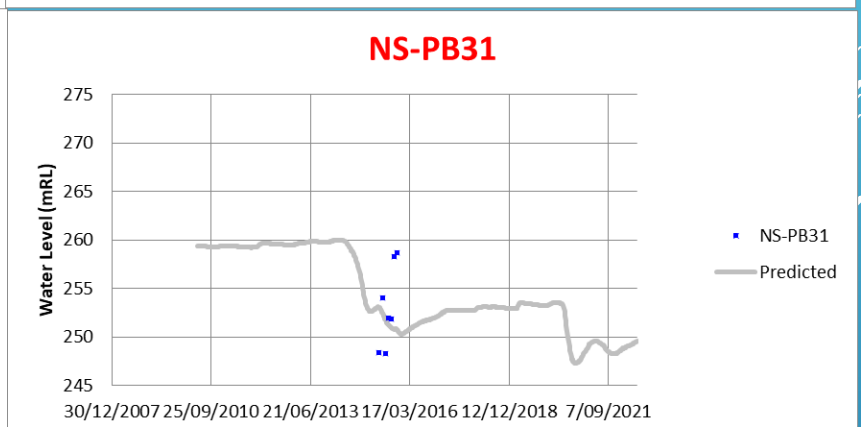


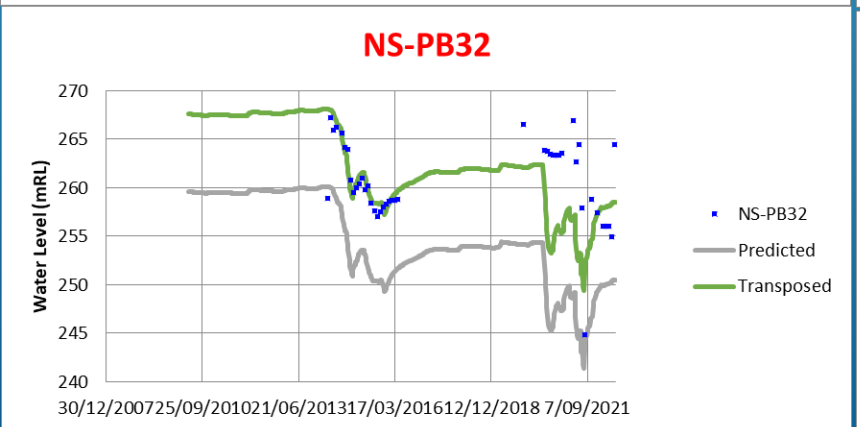


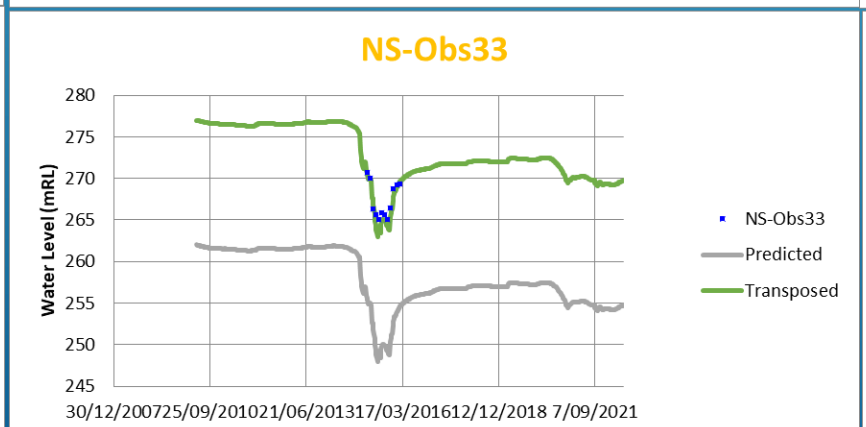












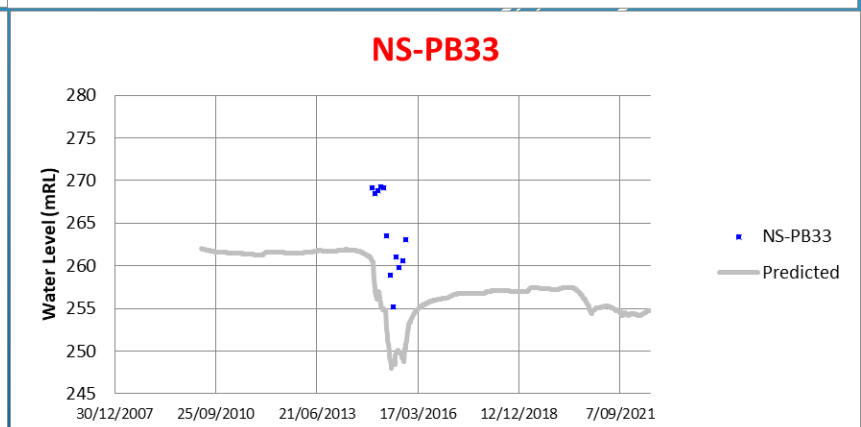
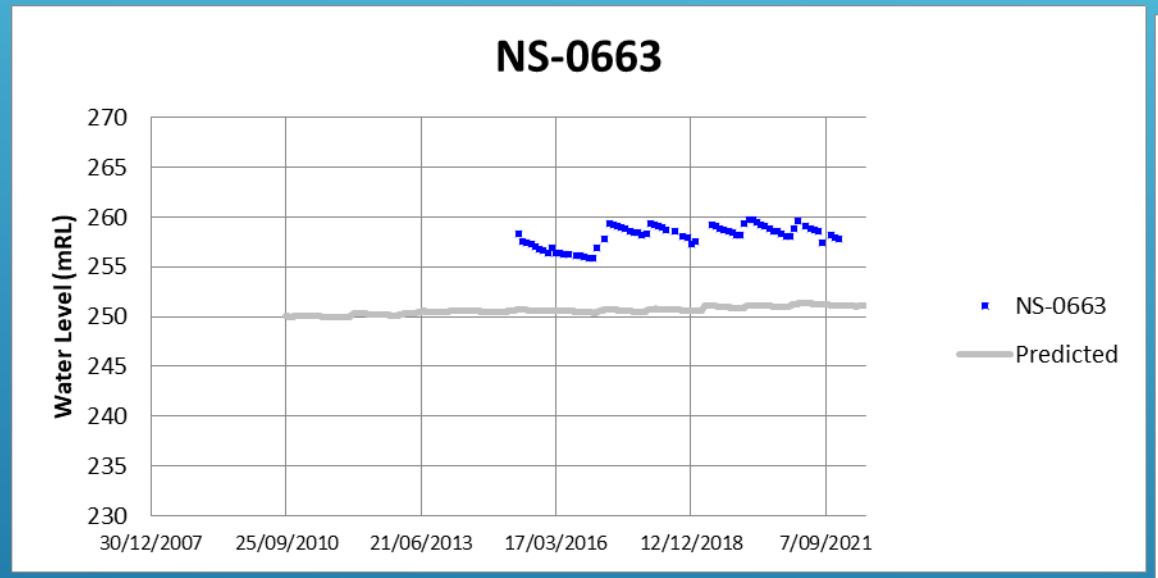
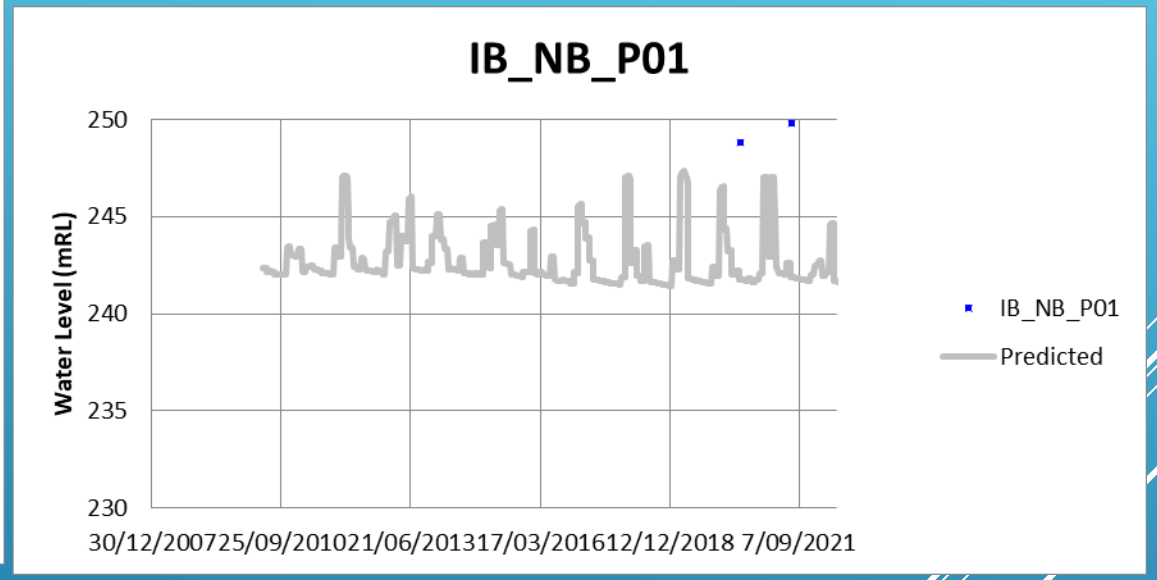


Figure A11 – Calibration hydrographs (Northern Borefield)

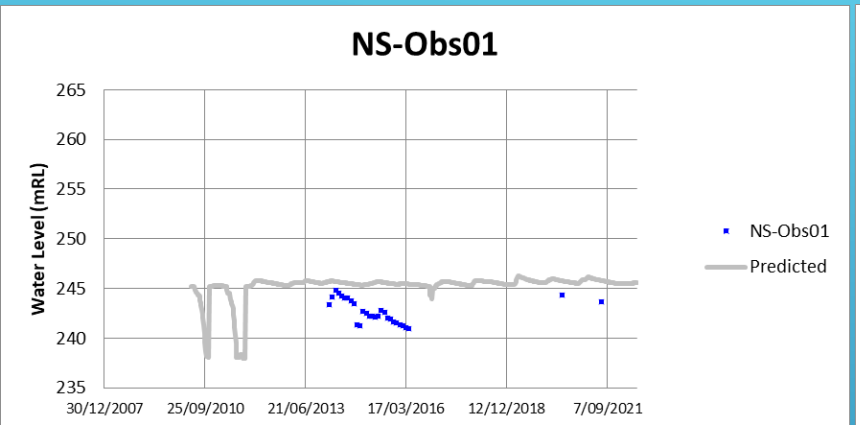


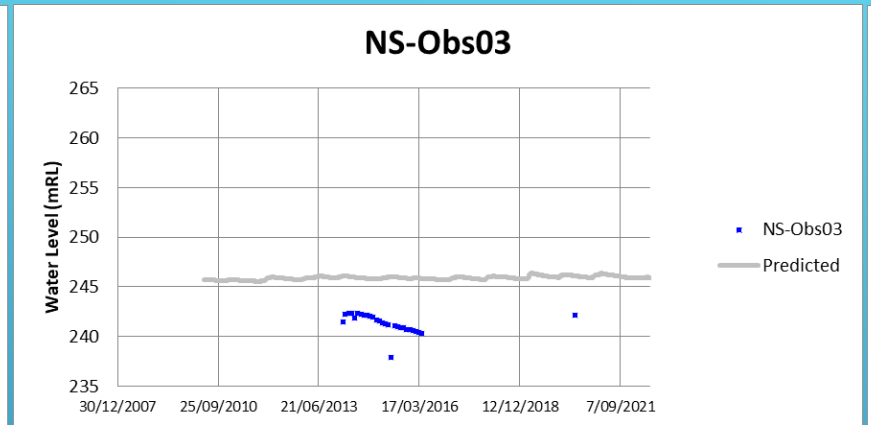


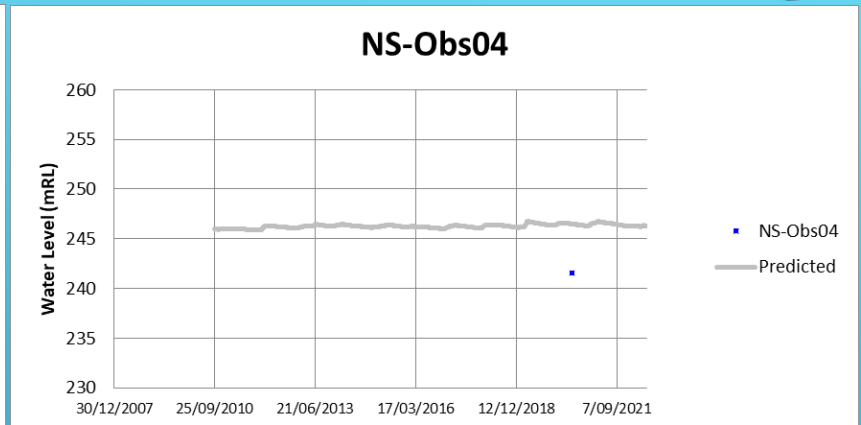
CALIBRATION HYDROGRAPHS

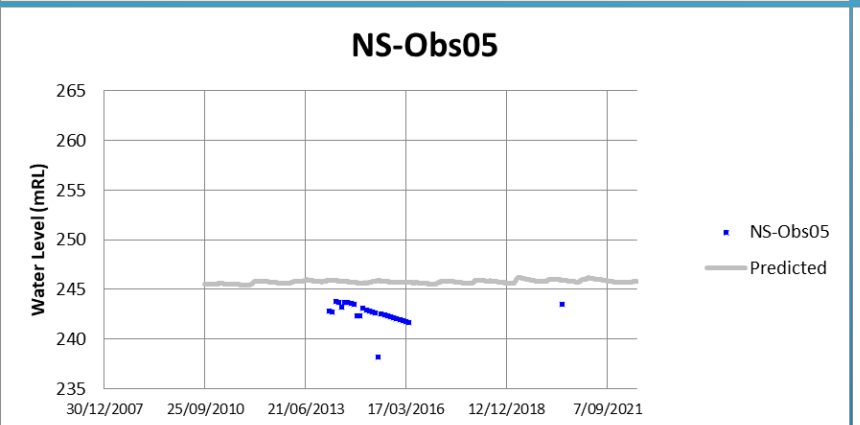
Eastern Borefield

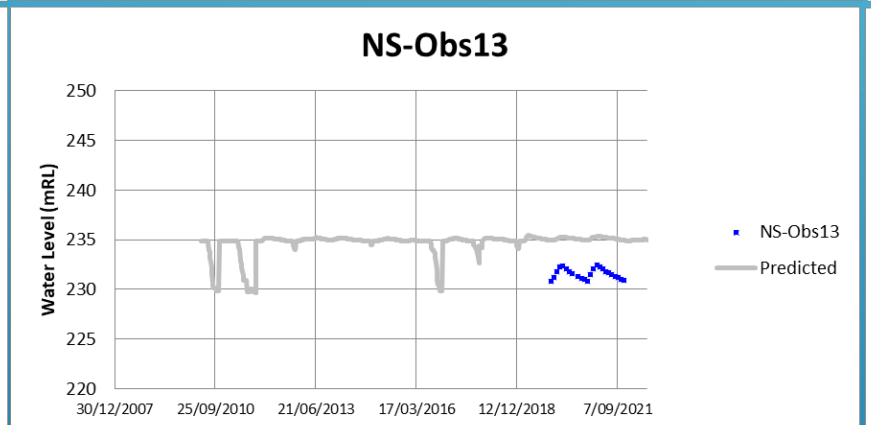
Figure A12 – Calibration hydrographs (Eastern Borefield)

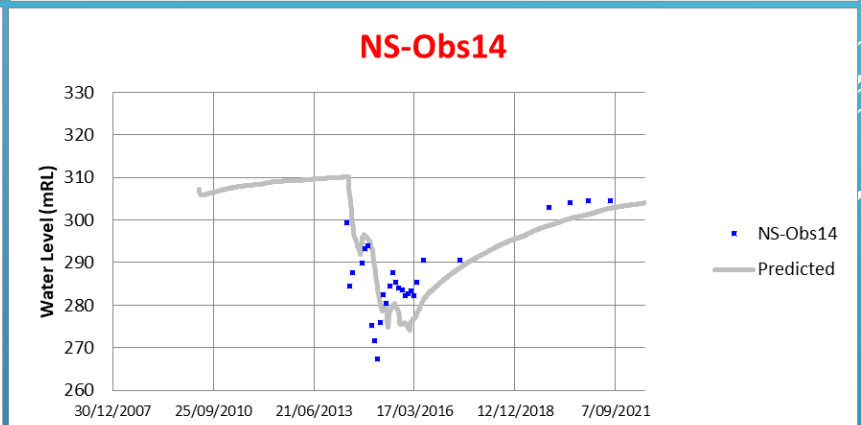


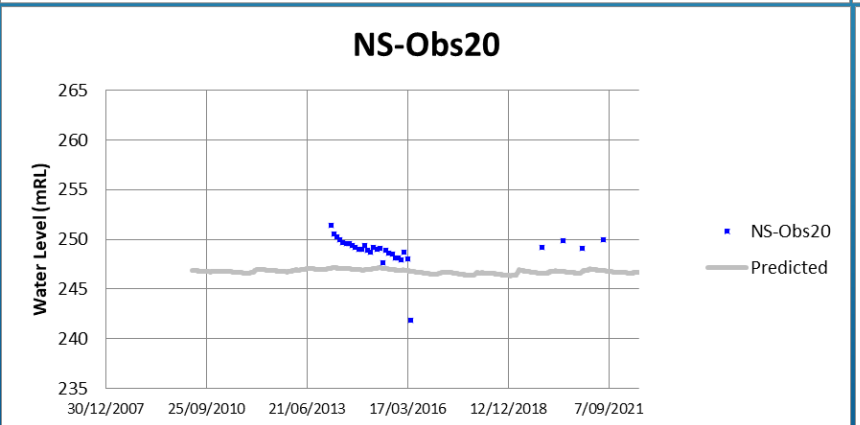


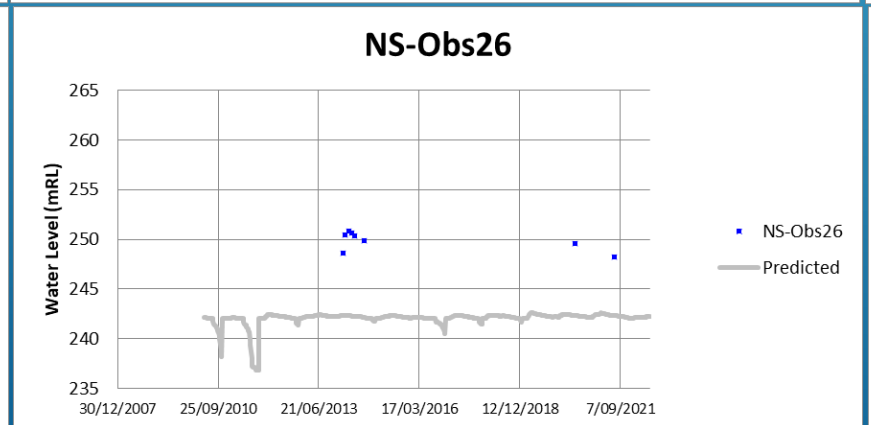












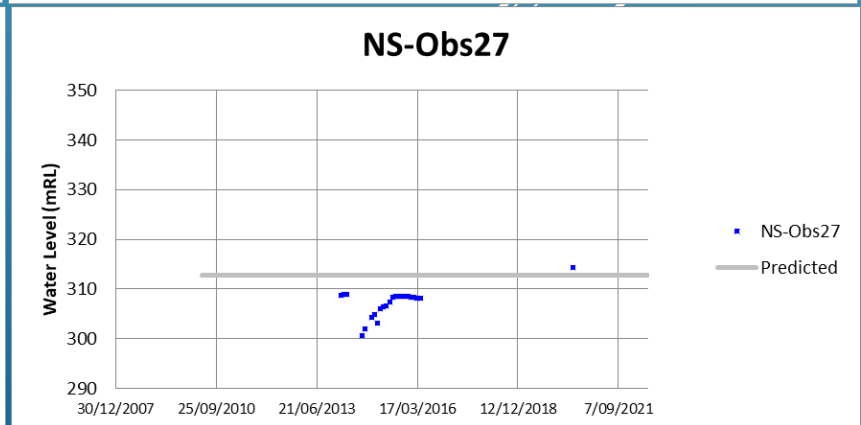
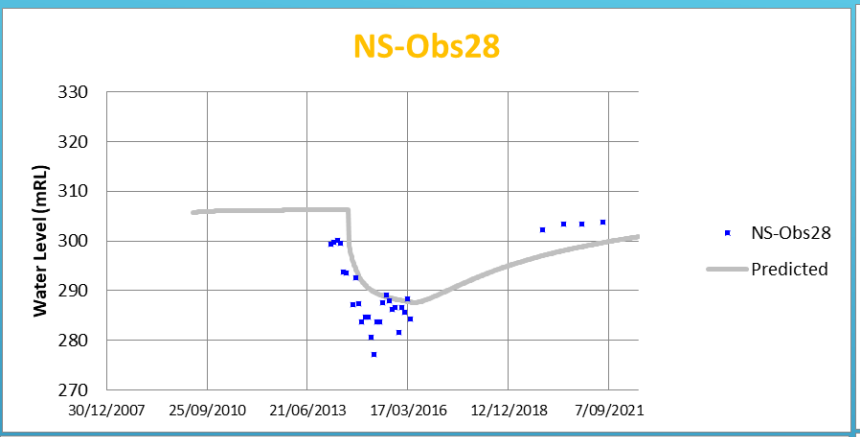
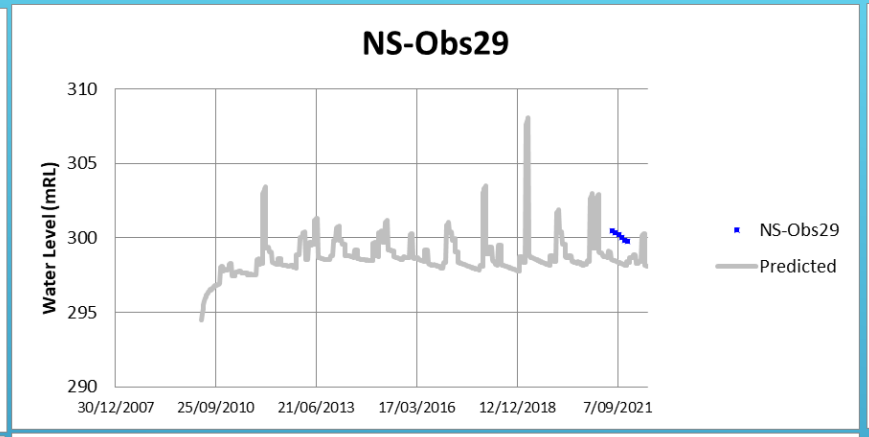
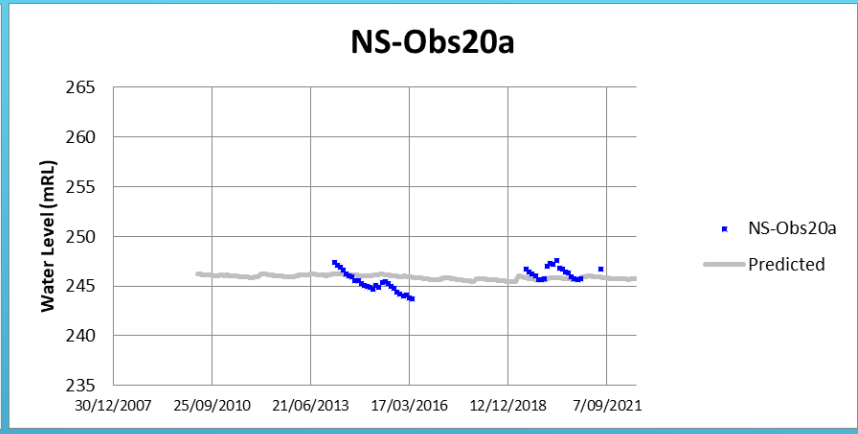
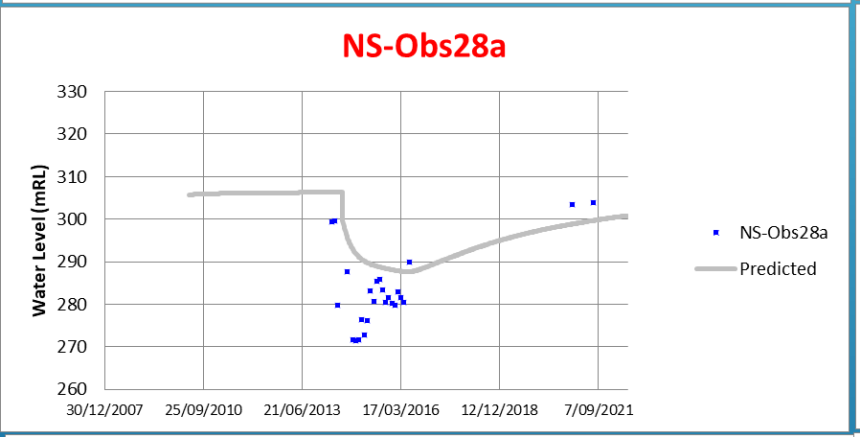


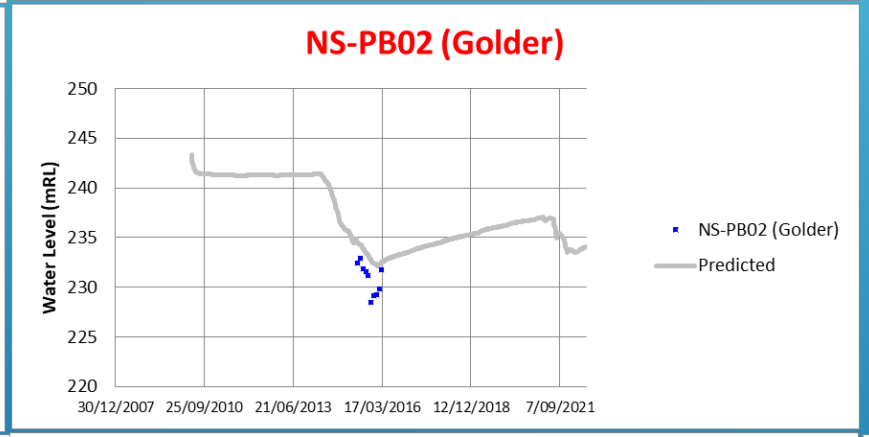
Figure A13 – Calibration hydrographs (Eastern Borefield)

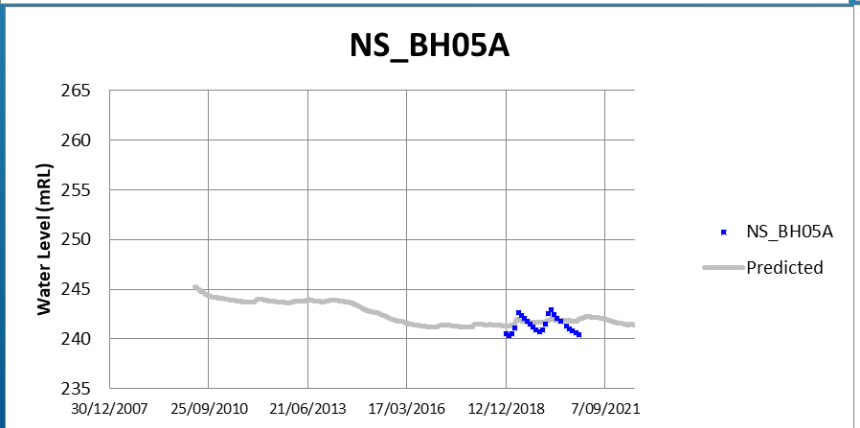


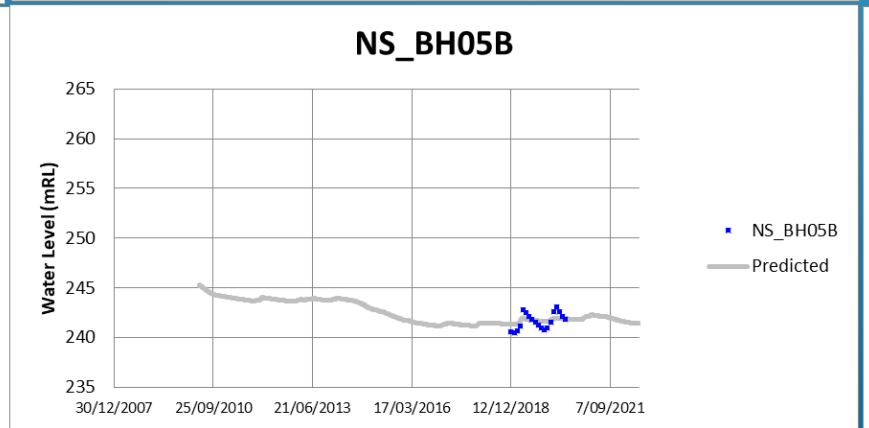












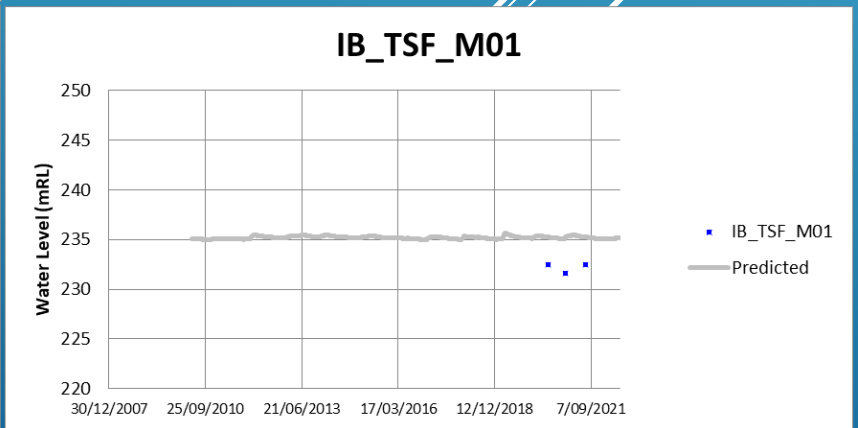
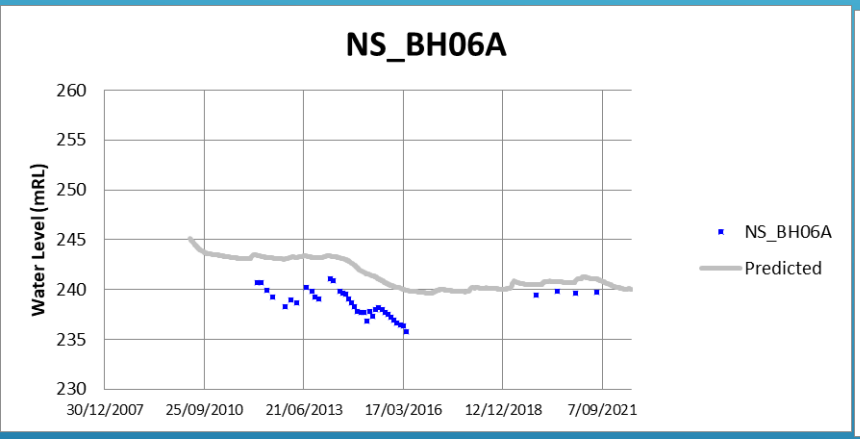
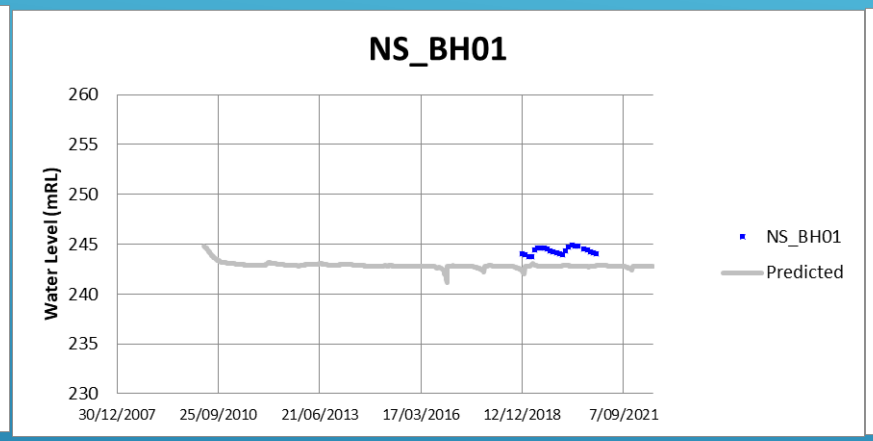
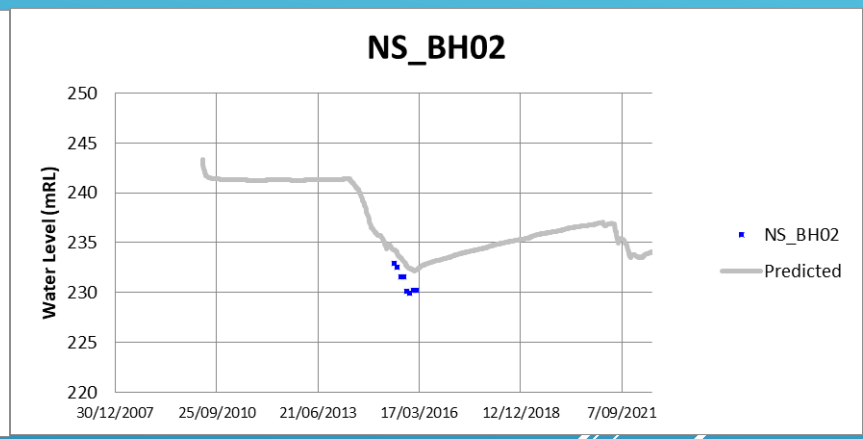


Figure A14 – Calibration hydrographs (Eastern Borefield)





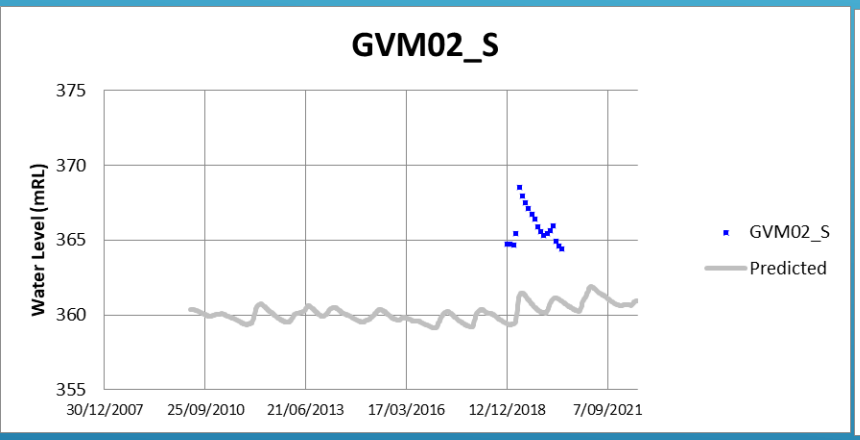


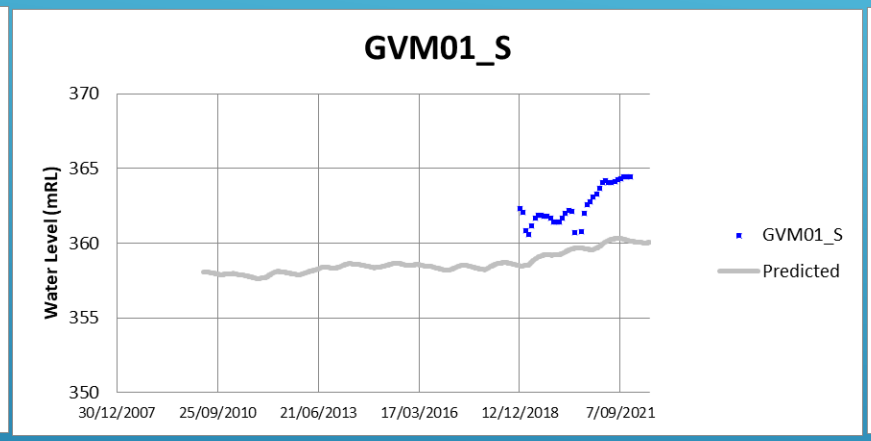
CALIBRATION HYDROGRAPHS

Pit Area

Figure A15 – Calibration hydrographs (Pit area)

Weathered Orebody





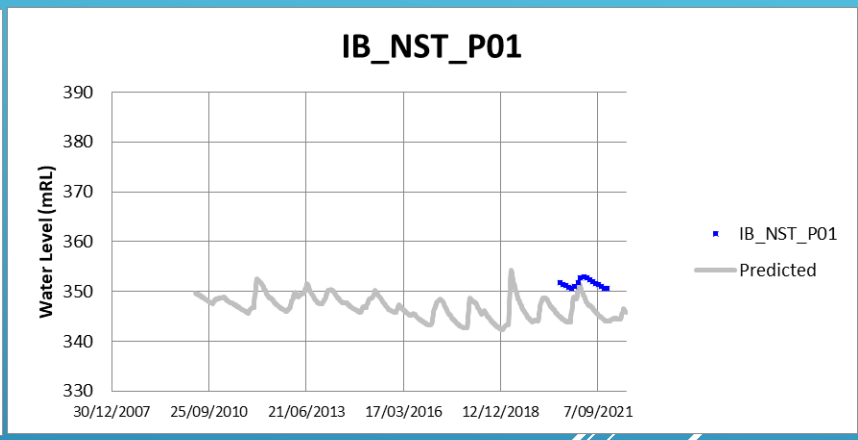
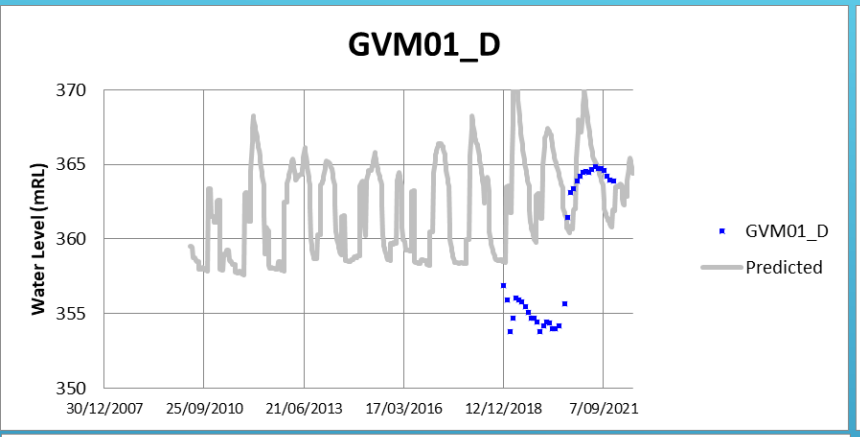
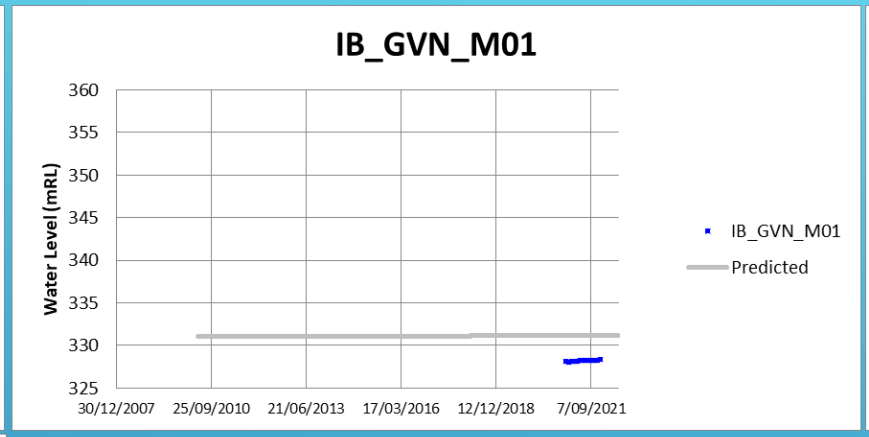
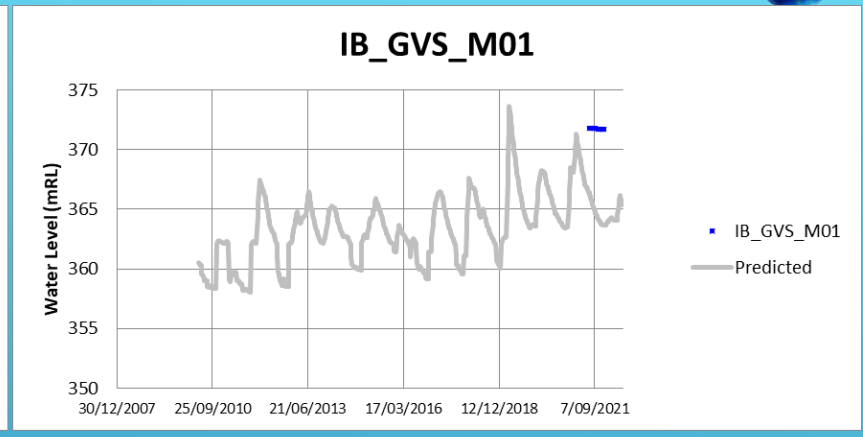


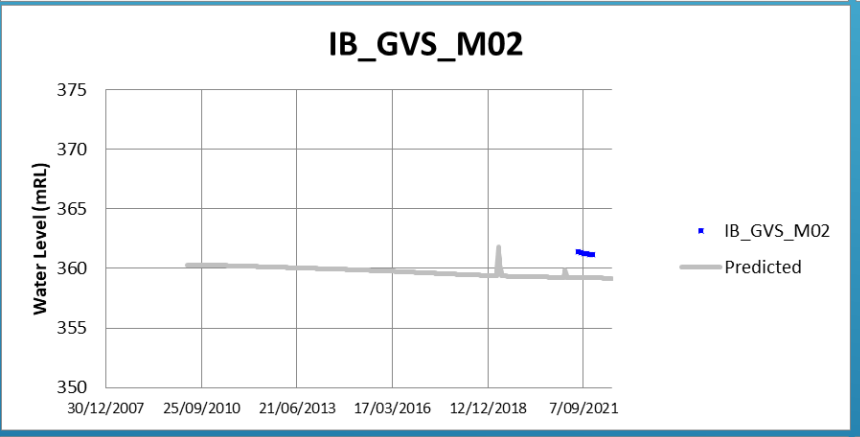
Figure A16 – Calibration hydrographs (Pit area)

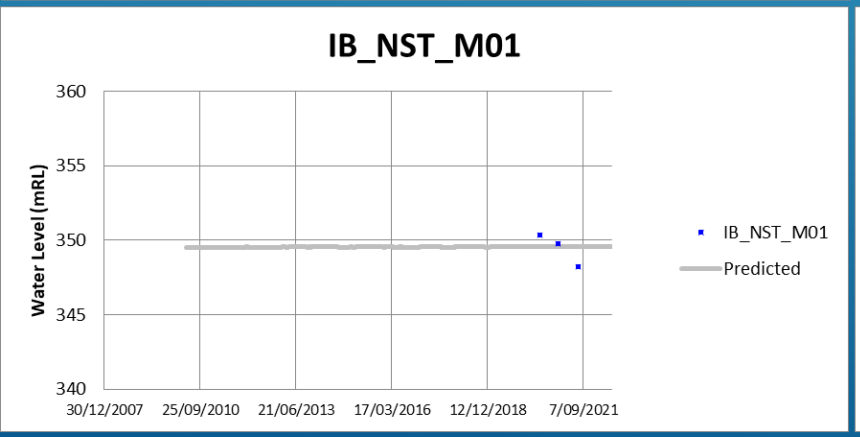
Fresh Orebody

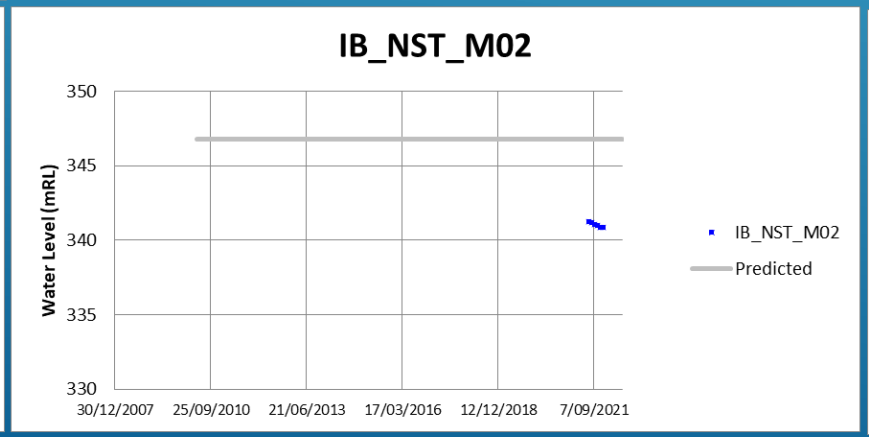












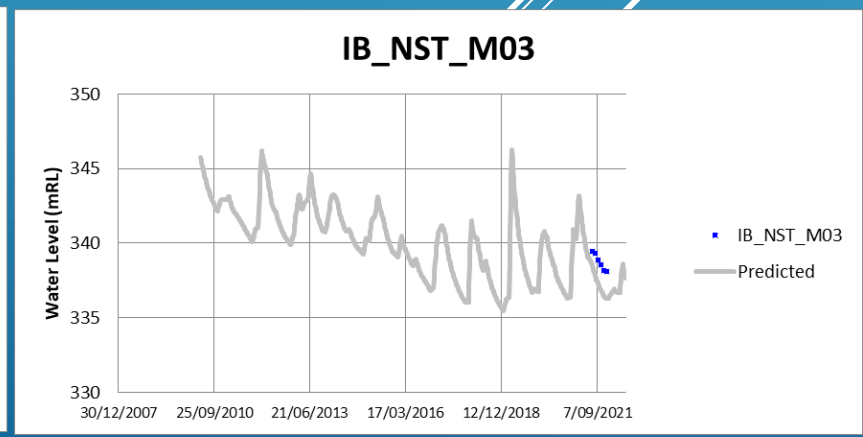
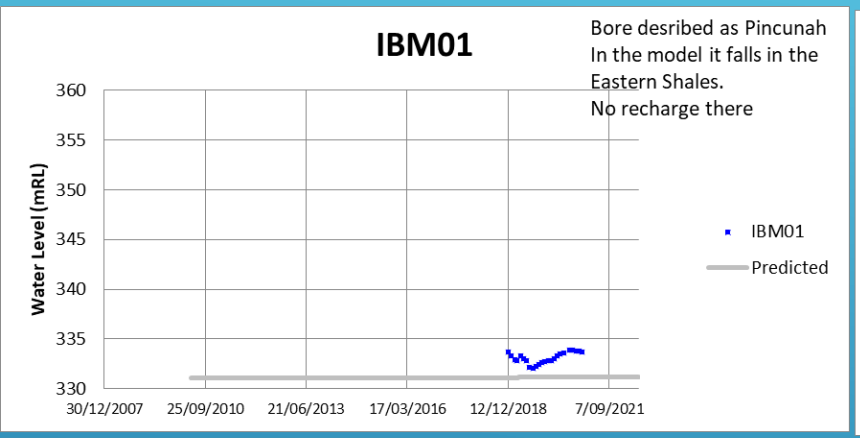
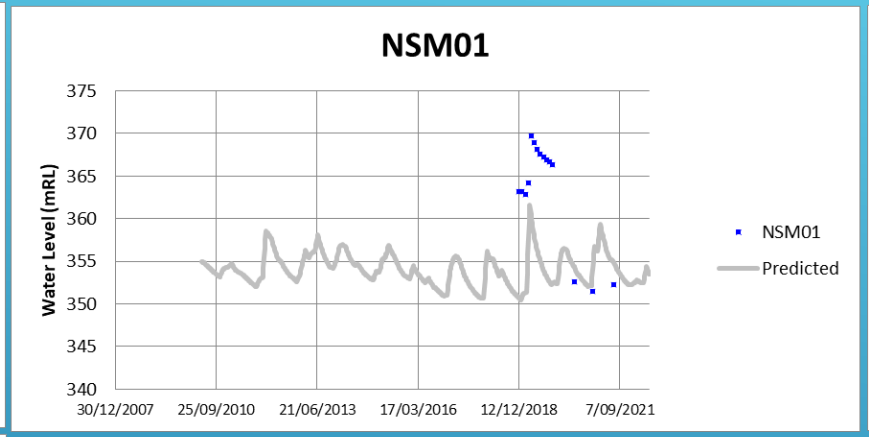
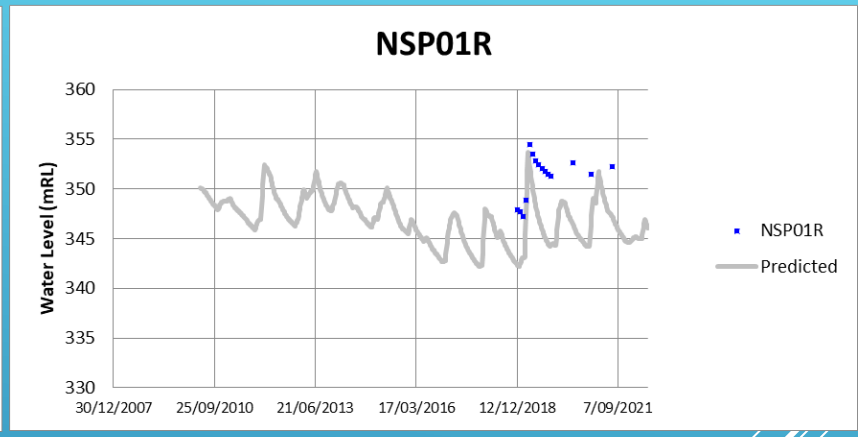


Figure A17 – Calibration hydrographs (Pit area)

Fresh Orebody







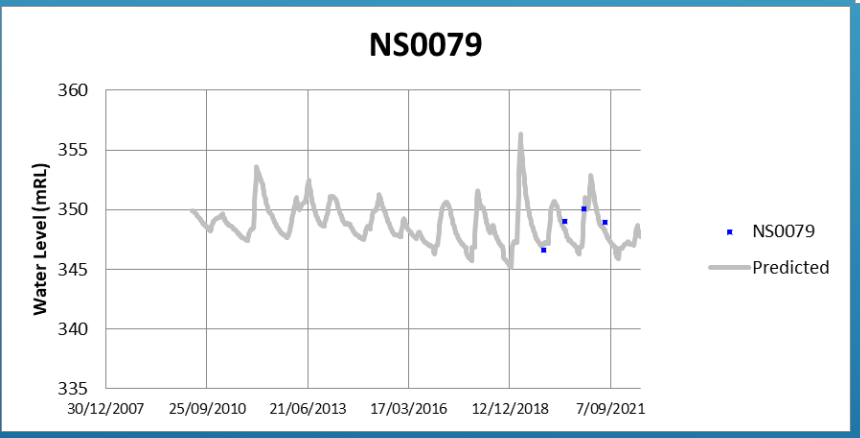
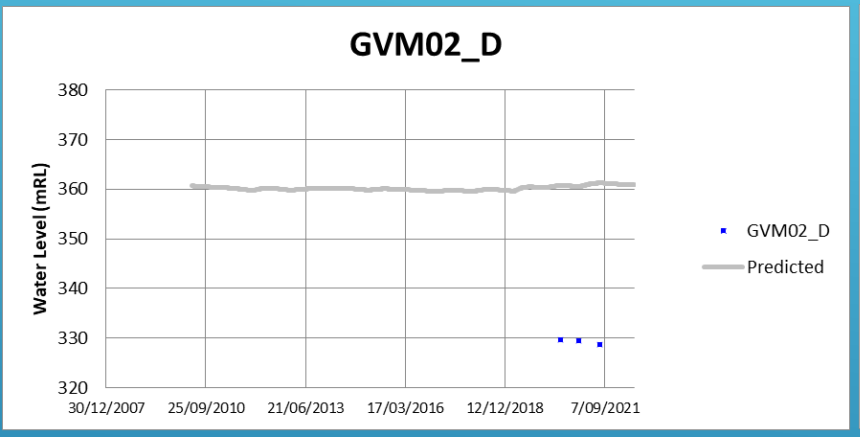
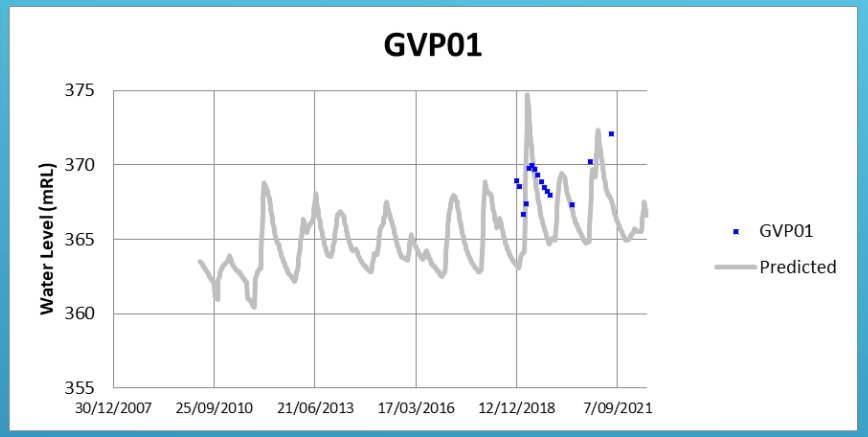
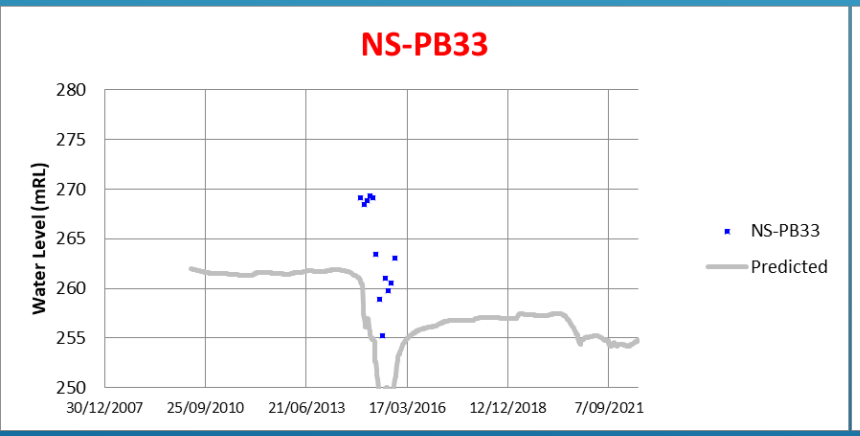


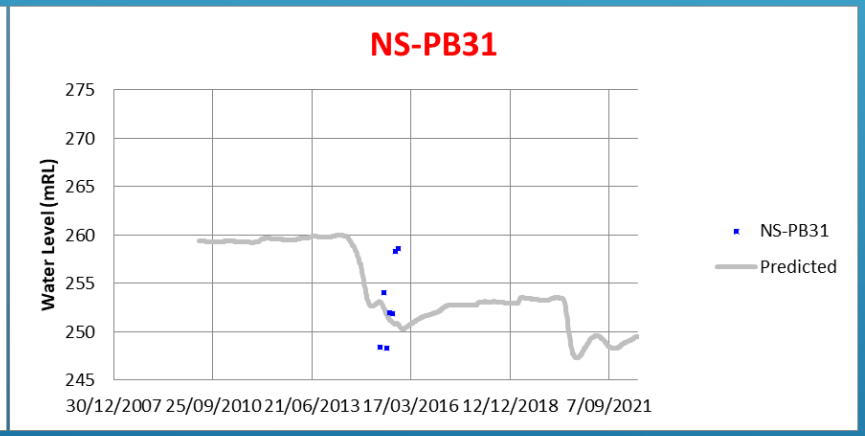
Figure A18 – Calibration hydrographs (Pit area)

Faulted Orebody









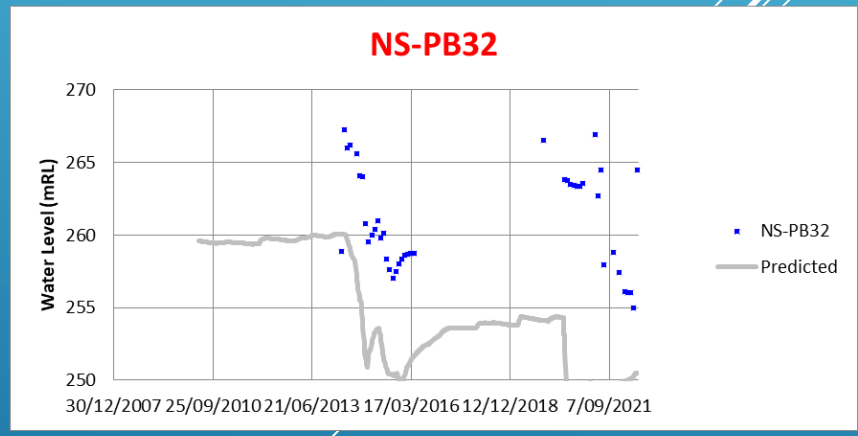
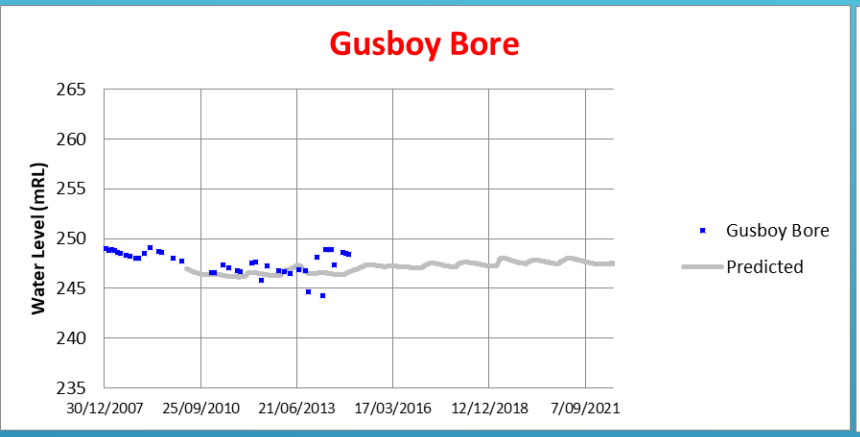
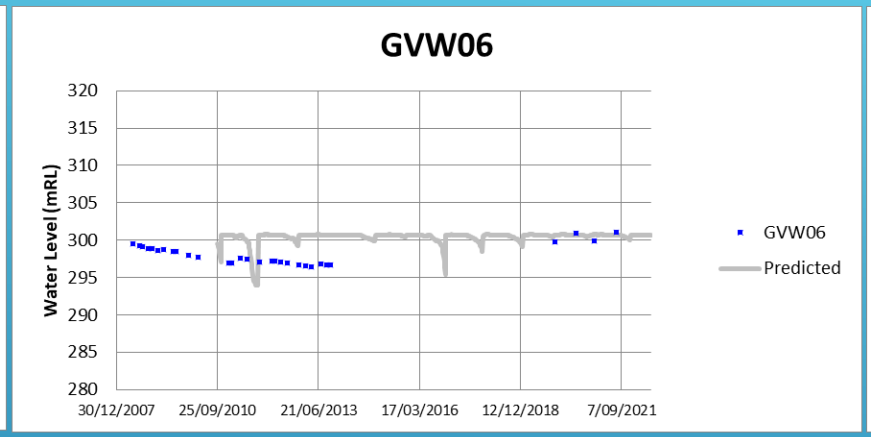
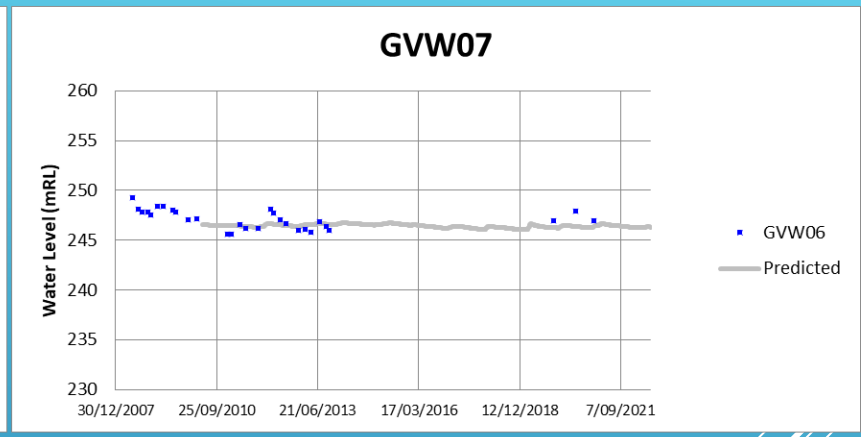


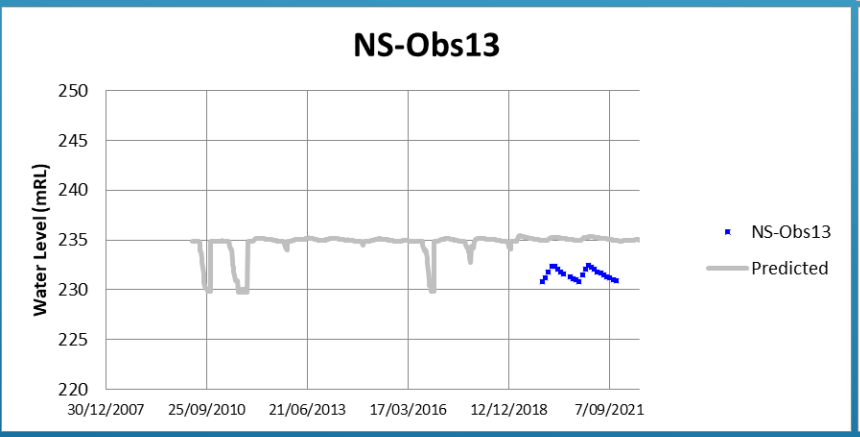
Figure A19 – Calibration hydrographs (Pit area)

Alluvium









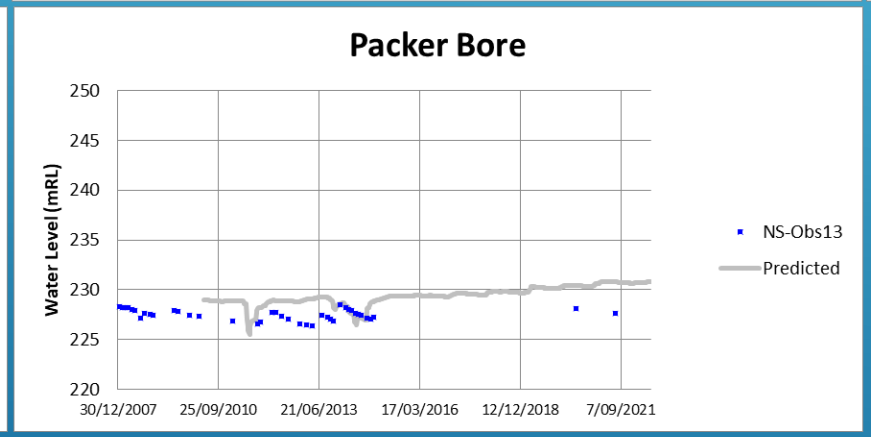
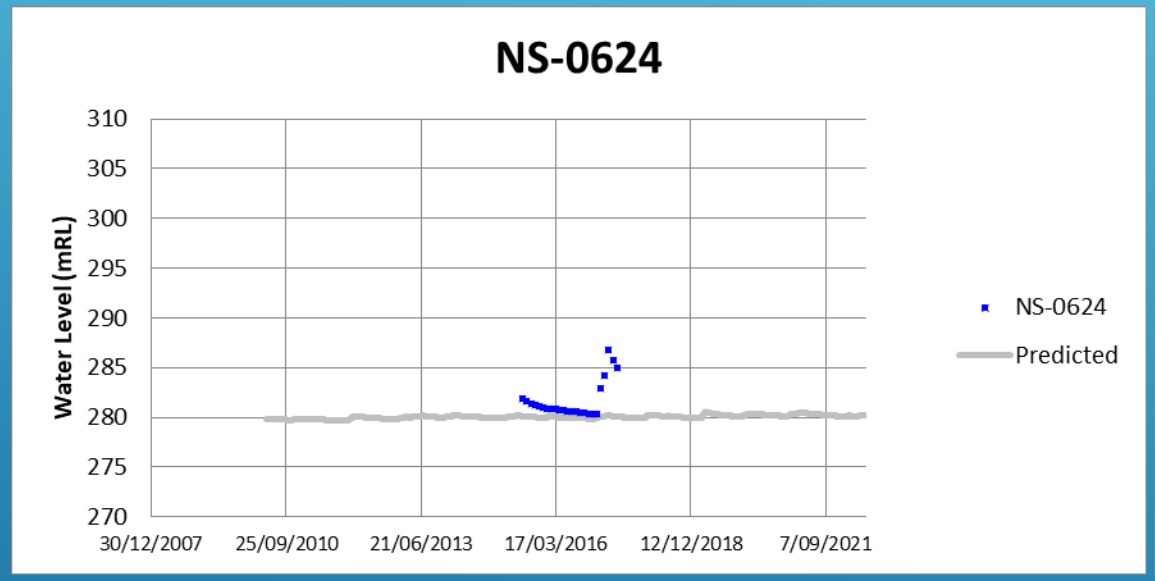


Figure A20 – Calibration hydrographs (Pit area)

Eastern Side



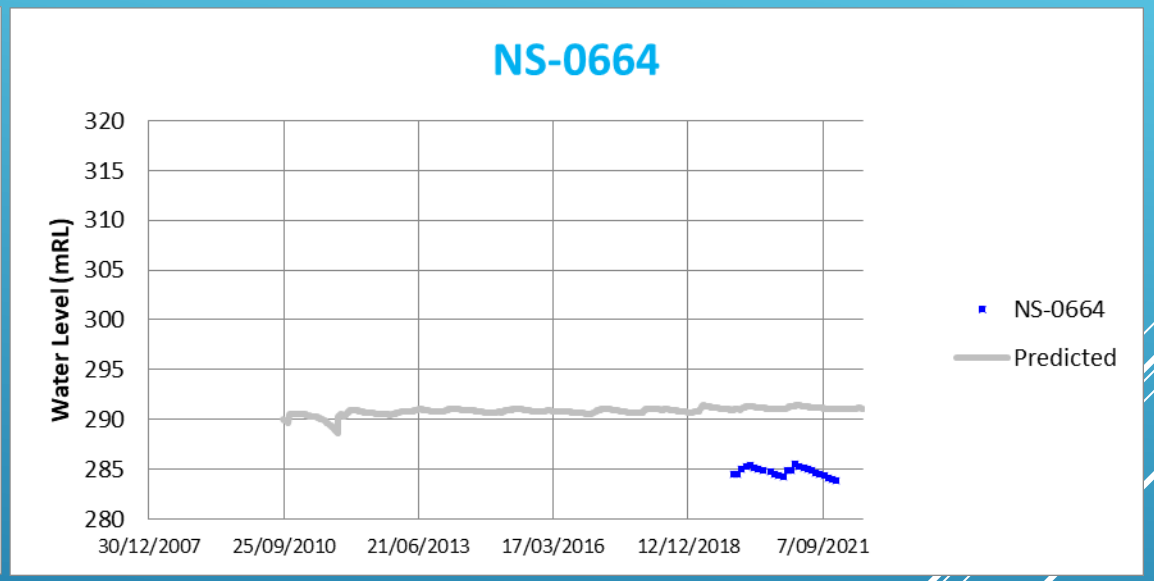
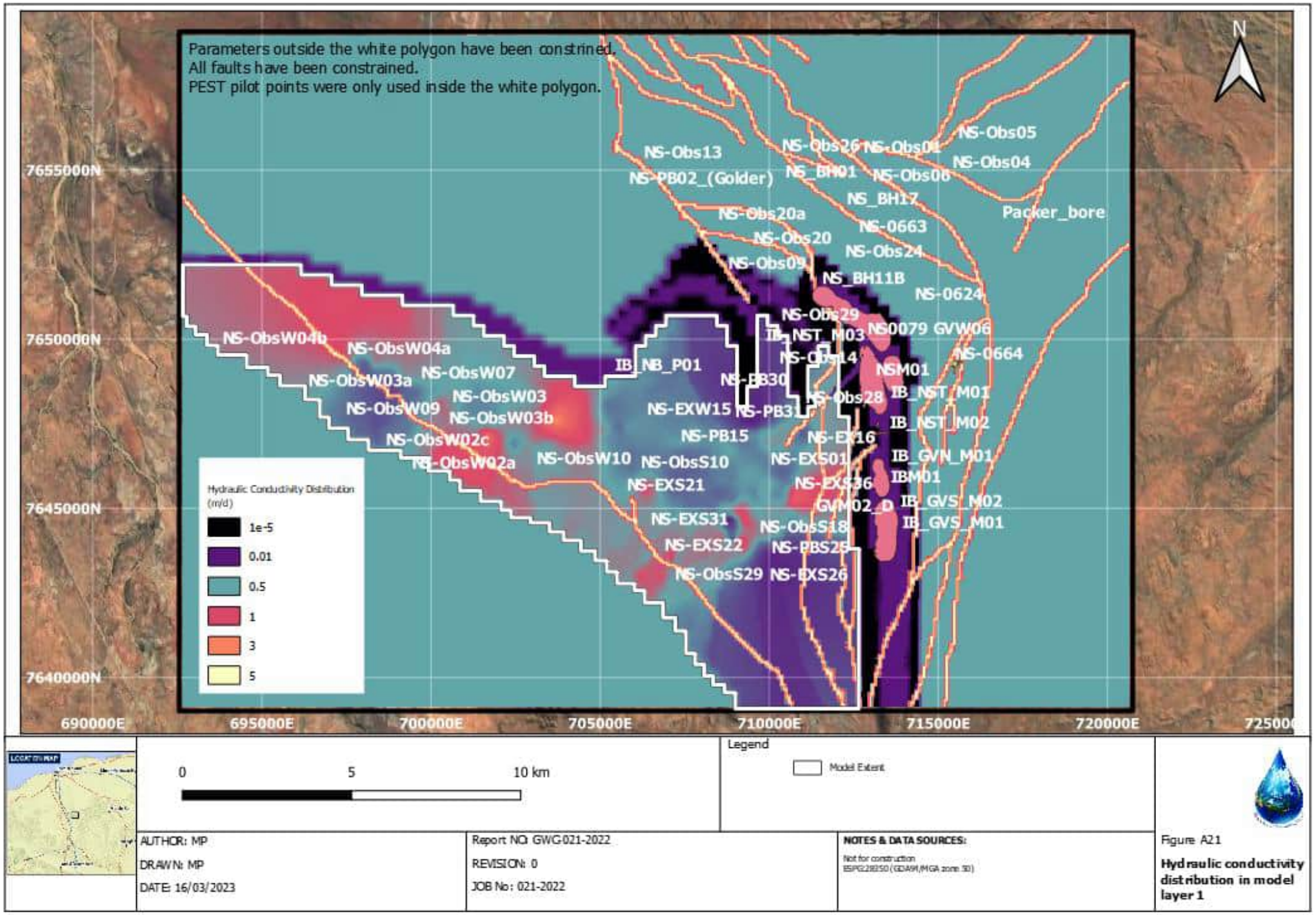


FIGURE A21 - MODELLED HYDRAULIC CONDUCTIVITY DISTRIBUTION LAYER 1



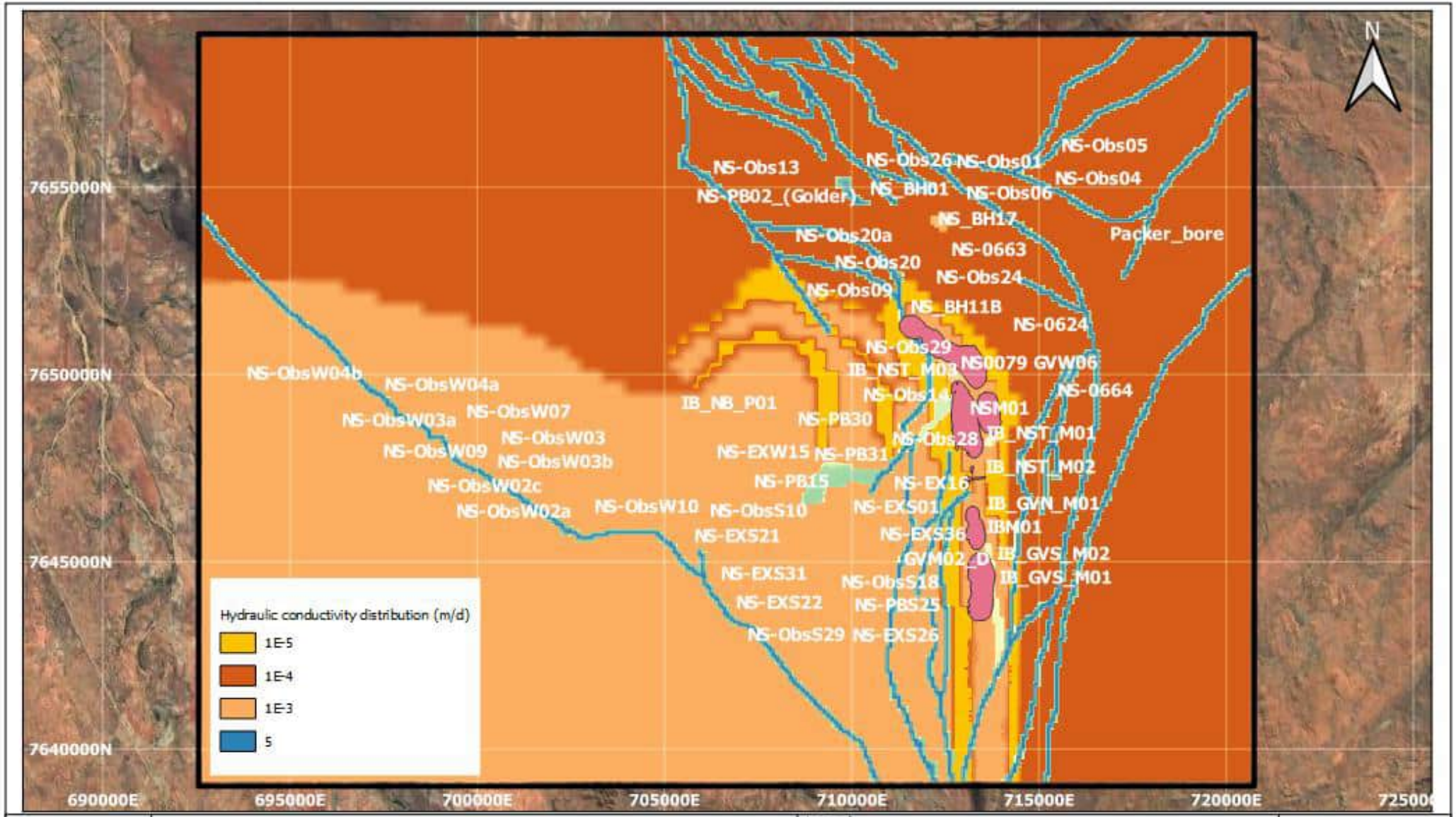
AUTHOR: MP
DRAWN: MP
DATE: 16/03/2023

Report NO: GWG021-2022
REVISION: 0
JOB No: 021-2022

NOTES & DATA SOURCES:
Not for construction
ESPG:28350 (GDA94/MGA zone 50)

Figure A21
Hydraulic conductivity distribution in model layer 1

FIGURE A22 - MODELLED HYDRAULIC CONDUCTIVITY DISTRIBUTION LAYER 2



AUTHOR: MP
DRAWN: MP
DATE: 16/03/2023

Report NO: GWG021-2022
REVISION: 0
JOB No: 021-2022

NOTES & DATA SOURCES:

Not for construction
EPSG:28350 (GDA94/MGA zone 50)

Figure A22
Hydraulic conductivity distribution in model layer 2

FIGURE A23 - MODELLED HYDRAULIC CONDUCTIVITY DISTRIBUTION LAYER 3

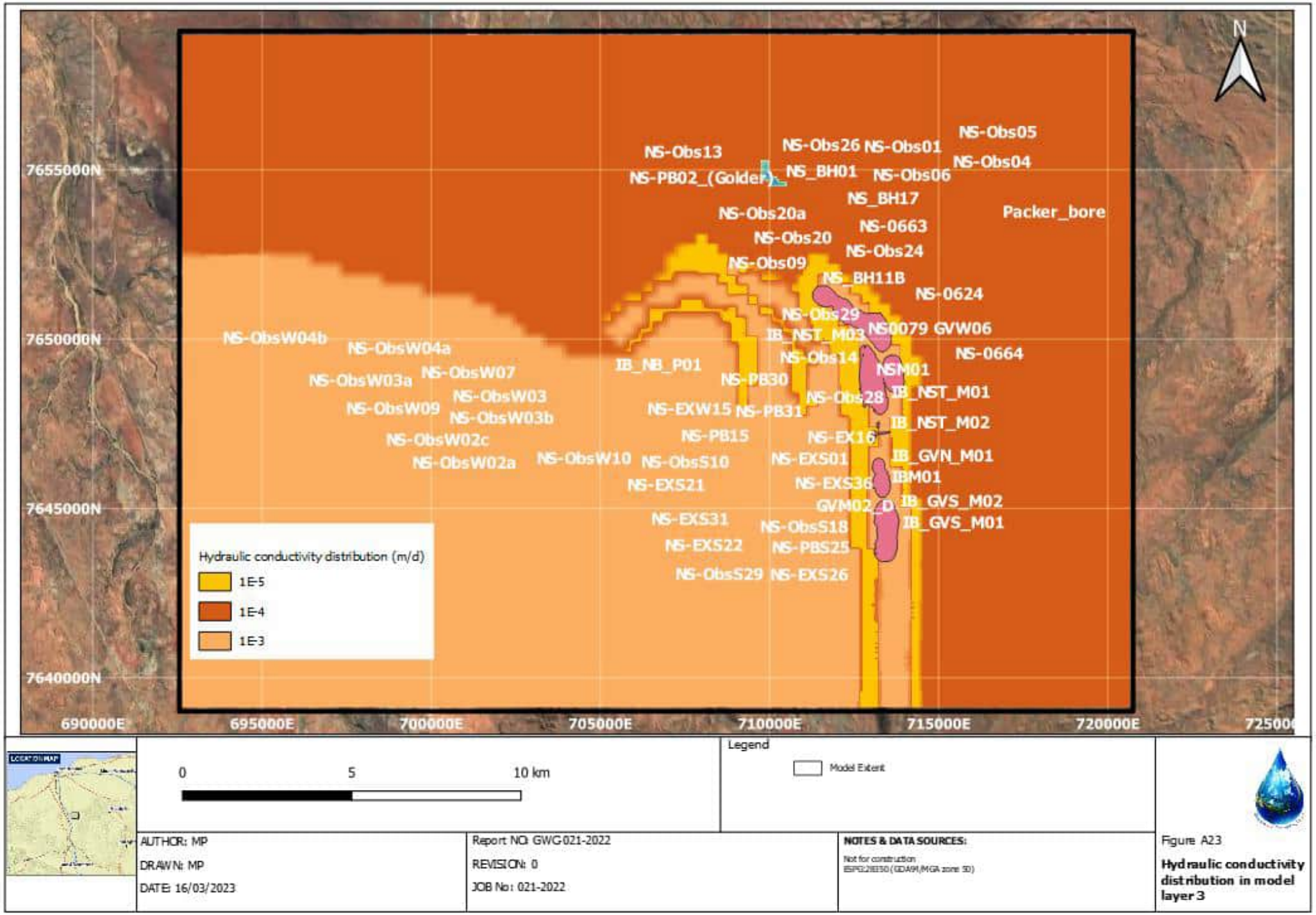
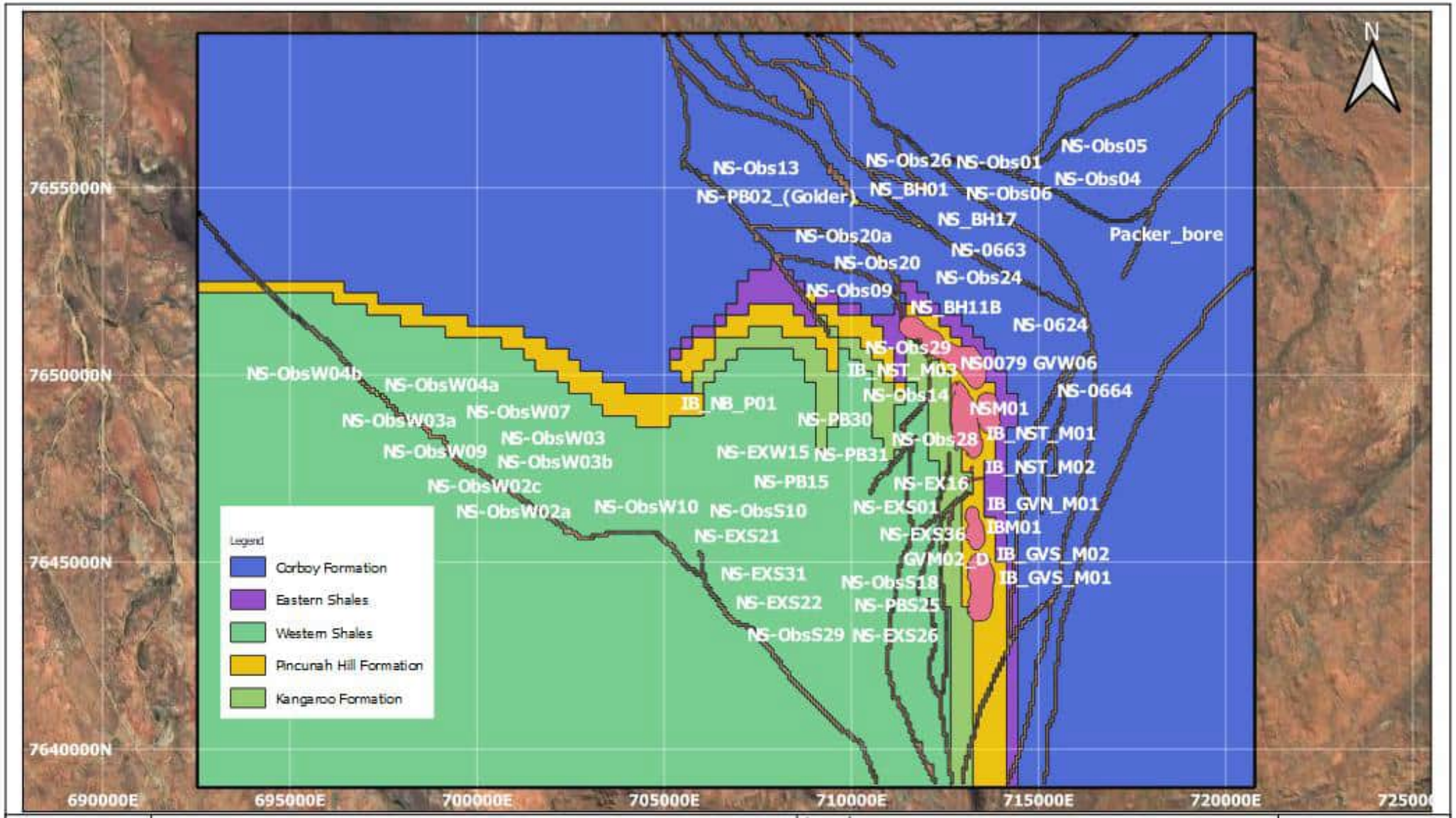


Figure A23

Hydraulic conductivity distribution in model layer 3

FIGURE A24 - MODELLED STORAGE DISTRIBUTION LAYERS 1-3



0 5 10 km

Legend

Model Extent

AUTHOR: MP

DRAWN: MP

DATE: 16/03/2023

Report NO: GWG-021-2022

REVISION: 0

JOB No: 021-2022

NOTES & DATA SOURCES:

Not for construction

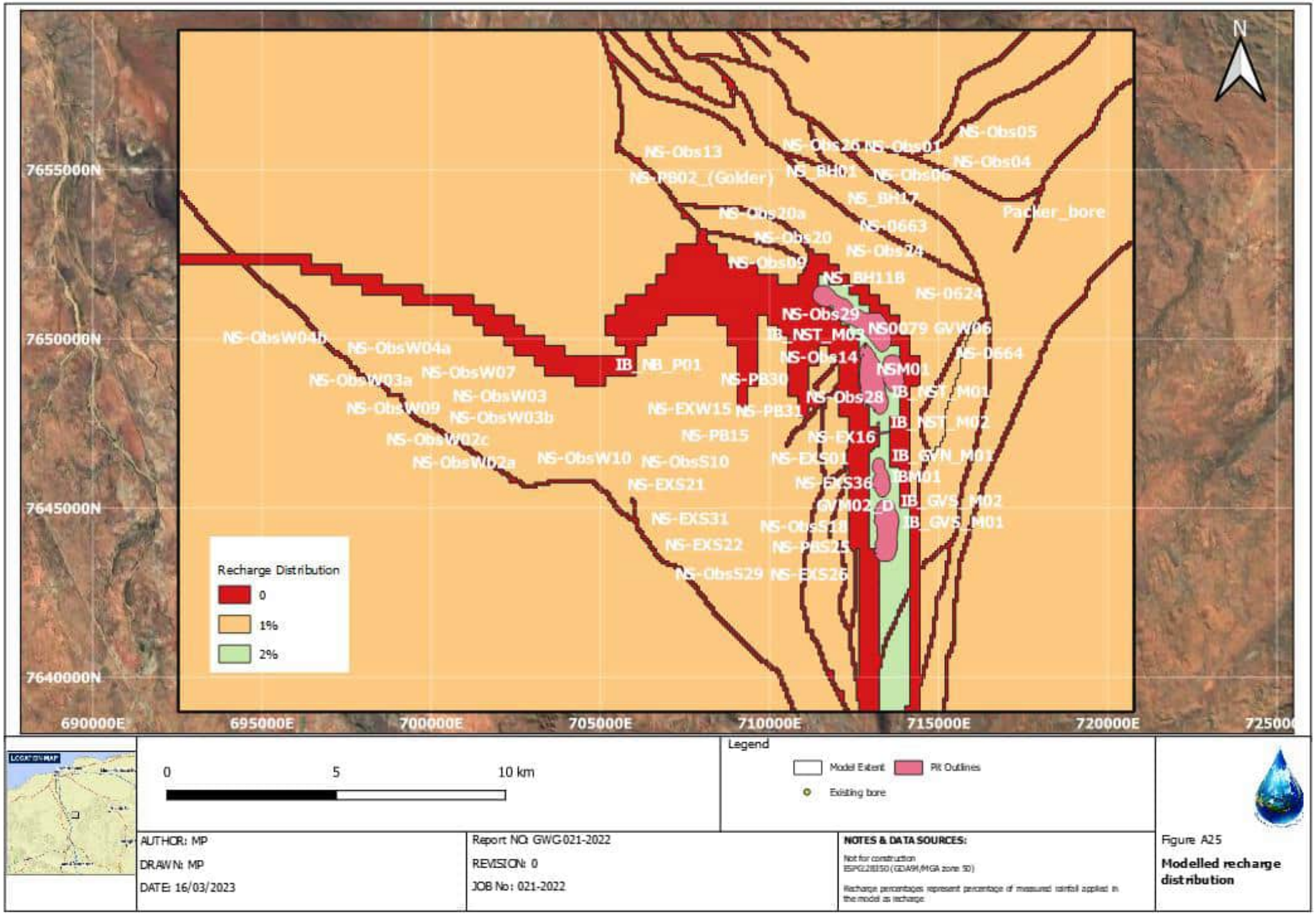
EPSG:28350 (GDA94,MGA zone 50)

Confined storage (Ss) was 1E-6/m for all units in the model

Figure A24

Modelled storage distribution in model layers 1-3

FIGURE A25 - MODELLED RECHARGE DISTRIBUTION



AUTHOR: MP
DRAWN: MP
DATE: 16/03/2023

Report NO: GWG-021-2022
REVISION: 0
JOB No: 021-2022

NOTES & DATA SOURCES:

Not for construction
ESPG:28350 (GDA94, MGA zone 50)

Recharge percentages represent percentage of measured rainfall applied in the model as recharge

Figure A25

Modelled recharge distribution

Appendix B

FIGURE B1 – WATER SUPPLY BORES (PREDICTION SETUP)

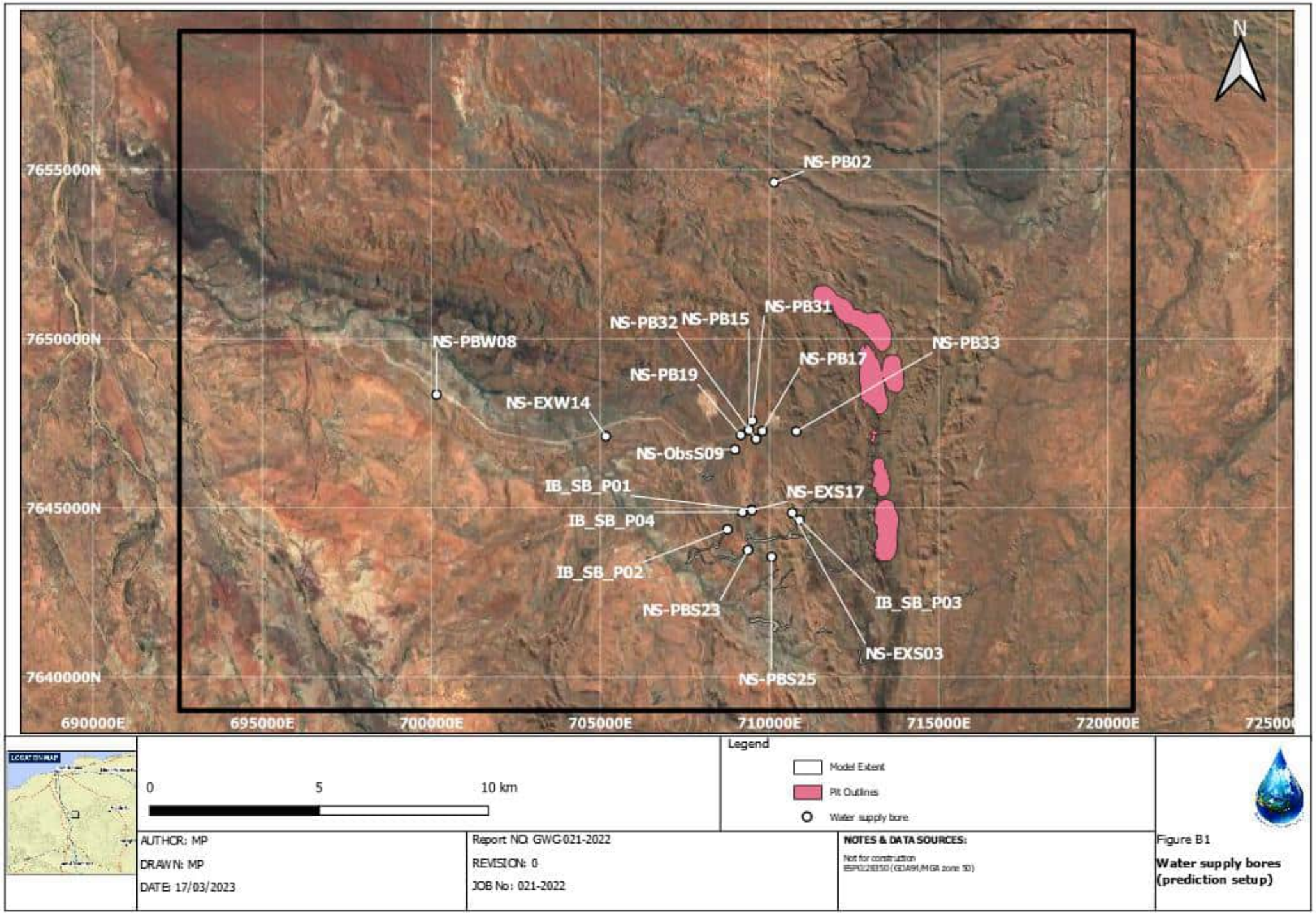


FIGURE B2 – PROPOSED PIT SHELLS (PREDICTION SETUP)

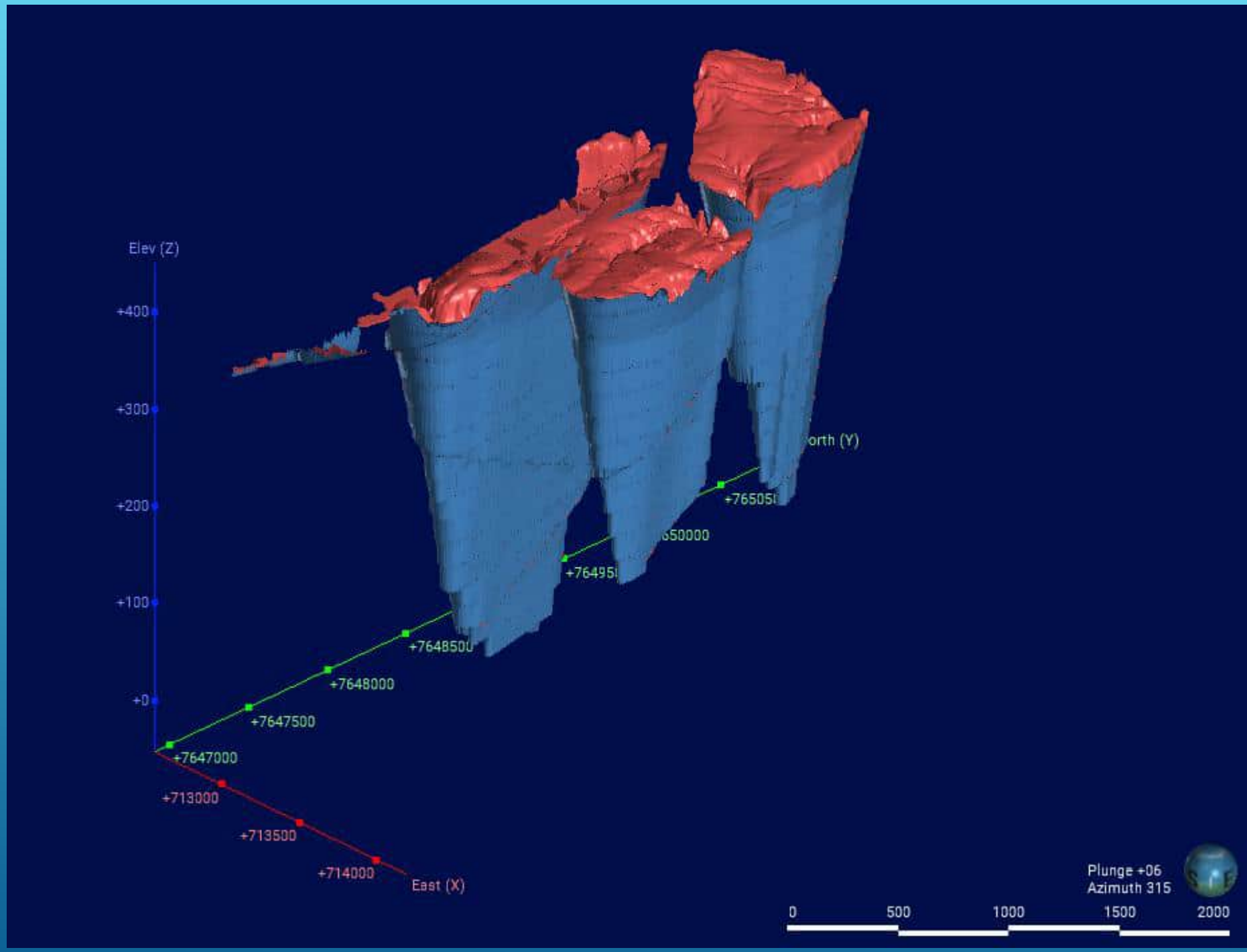
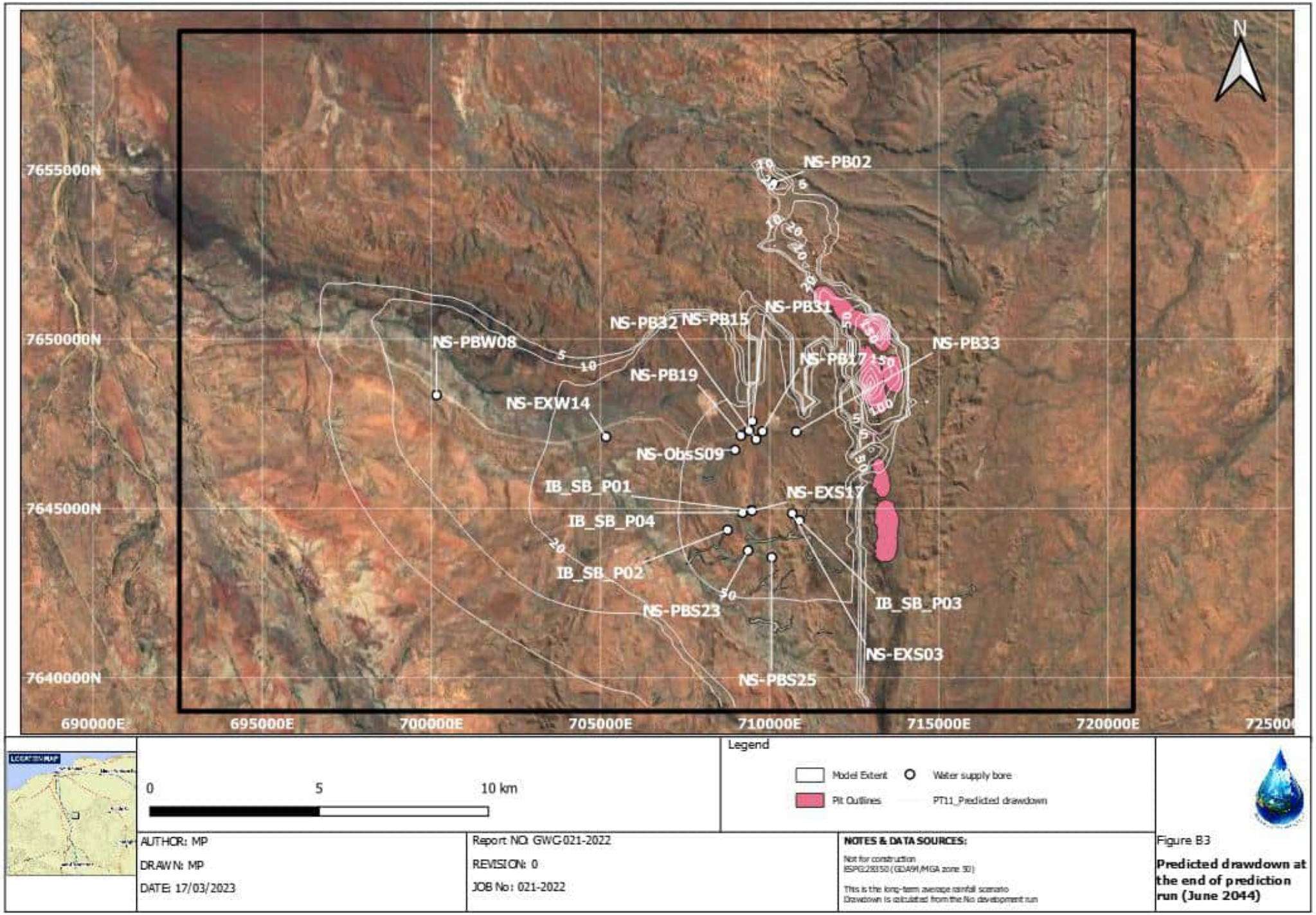
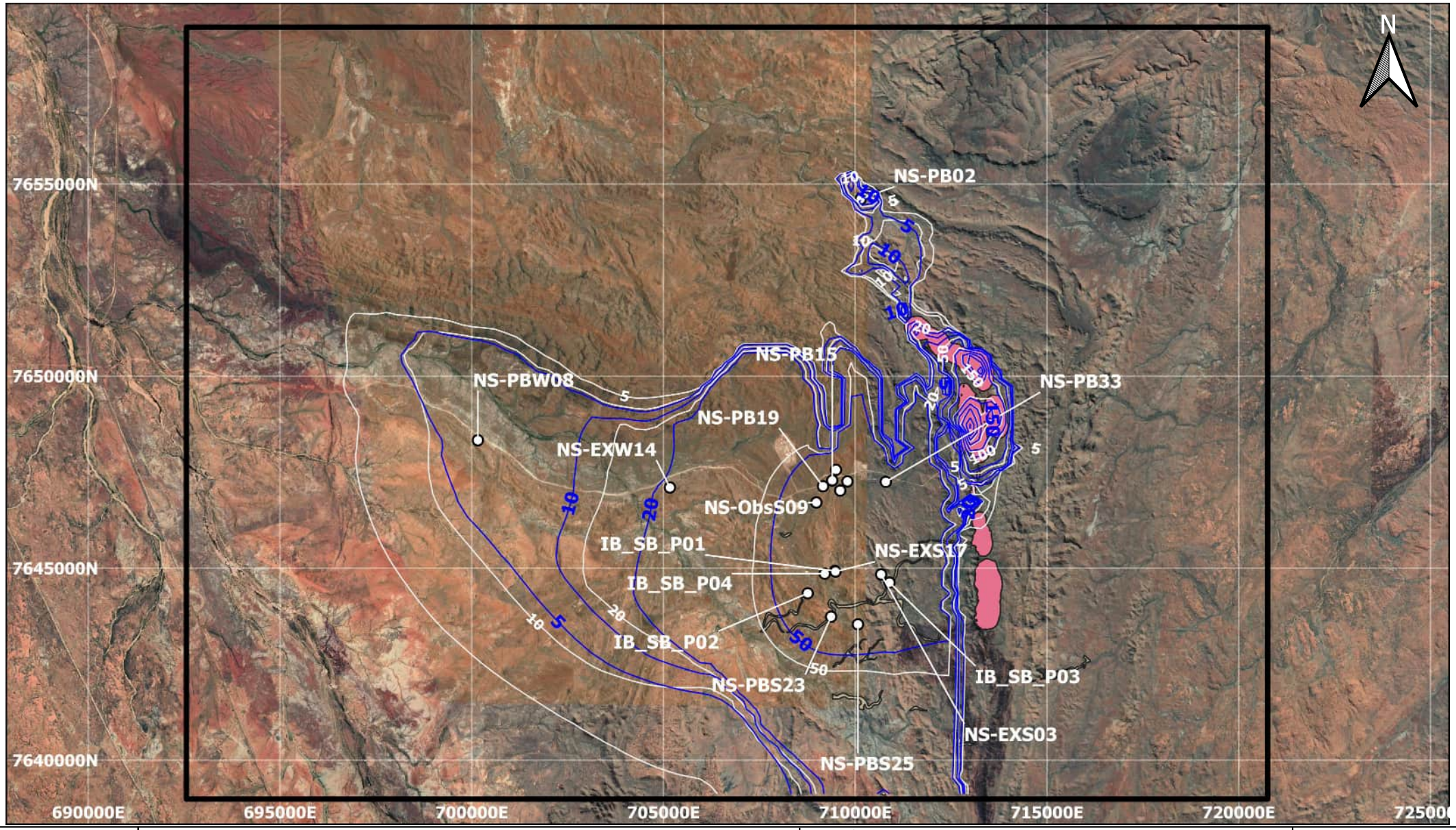


FIGURE B3 – PREDICTED DRAWDOWN (JUNE 2044)





LOCATION MAP

0 5 10 km

Legend

- Model Extent
- Pit Outlines
- Water supply bore
- Predicted drawdown in meters (base case recharge)
- Predicted drawdown in meters (30% higher recharge case)

AUTHOR: MP

DRAWN: MP

DATE: 20/03/2023

Report NO: GWC-021-2022

REVISION: 0

JOB No: 021-2022

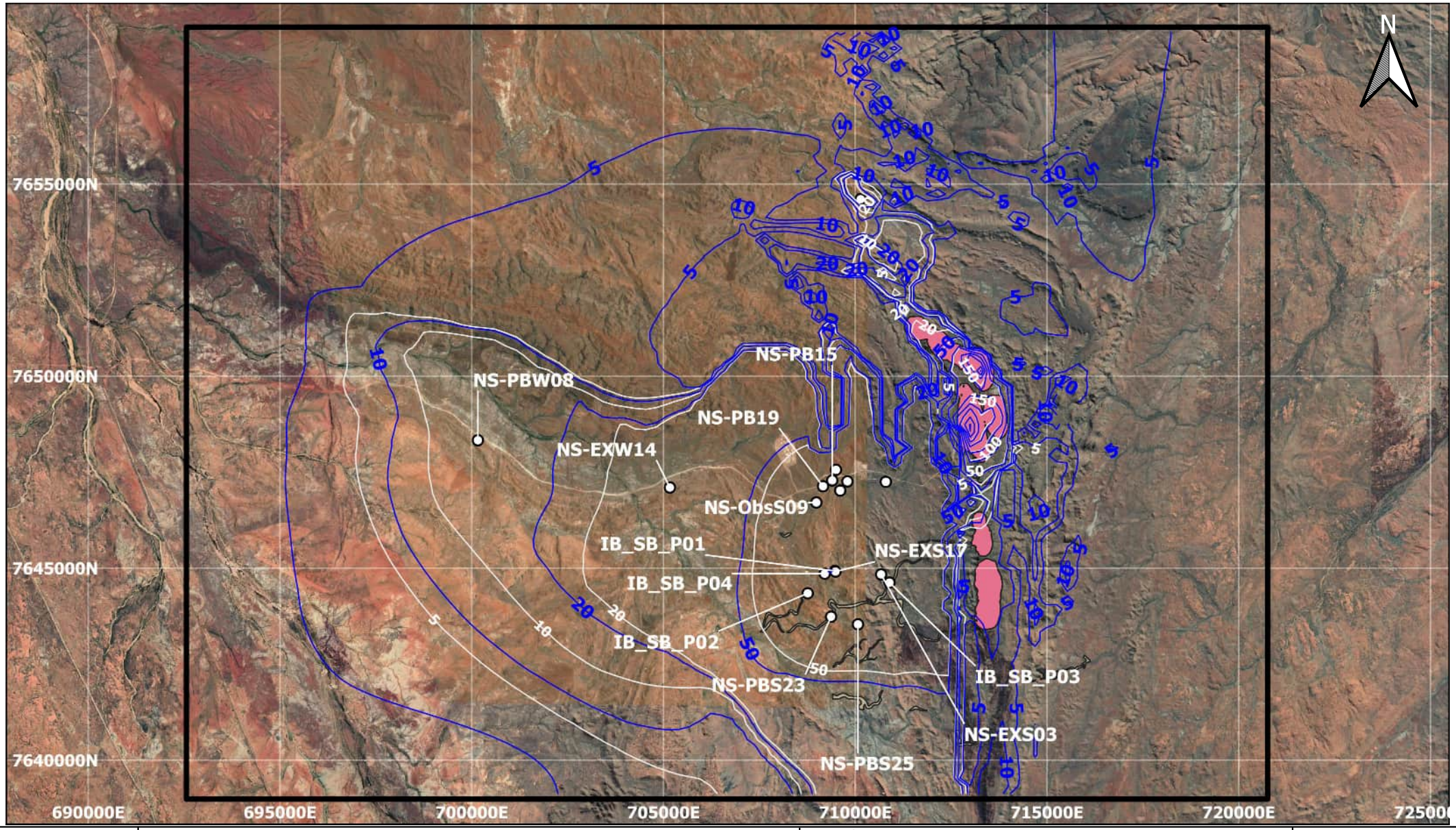
NOTES & DATA SOURCES:

Not for construction
ESPG:28350 (GDA94/MGA zone 50)

This is the long-term average rainfall scenario
Drawdown is calculated from the No development run

Figure B4

Predicted drawdown at the end of prediction run (June 2044)



0 5 10 km

Legend

- Model Extent
- Pit Outlines
- Water supply bore
- Predicted drawdown in meters (base case recharge)
- Predicted drawdown in meters (30% lower recharge case)

AUTHOR: MP

DRAWN: MP

DATE: 20/03/2023

Report NO: GWC-021-2022

REVISION: 0

JOB No: 021-2022

NOTES & DATA SOURCES:

Not for construction
ESPG:28350 (GDA94/MGA zone 50)

This is the long-term average rainfall scenario
Drawdown is calculated from the No development run

Figure B5

Predicted drawdown at the end of prediction run (June 2044)

Appendix 8: Inherent Risk Assessment with no Management / Controls

Rapid Risk Regis

Scope of assessment	Hydrogeological Impact Assessment (H3) for Iron Bridge Mine Area. Considering inherent risk rating only
Preparation date	12/06/2023
Preparer name	M Carroll
Participant names	

NO.	TYPE	TITLE	DESCRIPTION	PROJECT OR OPERATIONS?	MAXIMUM POTENTIAL CONSEQUENCE (MPC)	MPC DESCRIPTION	CONSEQUENCE CATEGORY FOR INHERENT RISK	LIKELIHOOD RATING FOR INHERENT RISK	RISK / OPPORTUNITY RATING (Automated)
1	**Risk**	***Drawdown Impact to Stygofauna, particularly restricted species***	*Groundwater drawdown from water supply or dewatering reduces available habitat and/or connectivity for Stygofauna species, particularly those within limited known range*	*Operations*	*3 - Serious*	Drawdown will deplete approximately 50% of the habitat (based on volume) within the study area but: •large size of the borefields means they may encompass whole ranges of some species; and •all areas with >2-5 m drawdown should be treated as total loss of habitat, Therefore, greater than 50% of habitat is highly likely to be impacted. Borefield is prospective for stygofauna but unsampled; species richness and extent of occurrence is unknown	Environment	B - Highly Likely	*Extreme*
2	Risk	***Drawdown Impact to Groundwater Dependent Vegetation in Southern Borefield***	*Groundwater abstraction from Water Supply borefield reduces groundwater availability for mapped GDE or pGDE (not directly associated with a pool)*	*Operations*	*3 - Serious*	Mapped pGDE communities, whilst known as facultative phreatophytes, exist in areas of shallow groundwater level. It is almost certain drawdown will extend below these areas at a rate exceeding root availability to respond. If they are indeed groundwater dependent, then impacts are certain. The vegetation communities are not restricted/rare; and re-establishment of water availability will allow communities to rebound	Environment	*B - Highly Likely*	*High*
3	Risk	***Drawdown Impact to Groundwater Dependent Vegetation in Western Borefield***	*Groundwater abstraction from Water Supply borefield reduces groundwater availability for mapped GDE or pGDE (not directly associated with a pool)*	*Operations*	*3 - Serious*	Mapped pGDE communities, whilst known as facultative phreatophytes, exist in areas of shallow groundwater level. It is almost certain drawdown will extend below these areas, although the rate of drawdown is not as fast as in the southern borefield. If they are indeed groundwater dependent, then impacts are likely. The vegetation communities are not restricted/rare; and re-establishment of water availability will allow communities to rebound	Environment	*B - Highly Likely*	*High*
4	Risk	***Drawdown Impact to Mundagoora Pool***	*Groundwater abstraction from Water Supply or Dewatering reduces water levels in Mundagoora Pool below baseline.*	*Operations*	*5 - Severe*	Whilst the connection of the pool to groundwater is unclear (might be perched), there is enough information to suggest that drawdown beneath the pool would impact the pool water balance. Equally, drawdown upstream of the pool is also conceptualised to reduce inflow to the pool. The MPC is more associated with the heritage significance of the pool, although it is of high ecological value	Social	*C - Likely*	*Very High*
5	Risk	***Drawdown Impact to Fig Pool and/or Cow Springs***	*Groundwater abstraction from Water Supply or Dewatering dries out pools.*	*Operations*	*3 - Serious*	Whilst drawdown is predicted proximal to the pools, baseline data (during construction abstraction) has indication the pools are not connected to targeted groundwater resources. However, the pools are small and it any connection is likely to result in the drying out of the pools. The pools are not noted as being of as high ecological/heritage significance as Mundagoora Pool	Environment	*E - Unlikely*	*Low*
6	Risk	***Drawdown Impact to Pool_SWGV and Honey Eater Creek Pools***	*Groundwater abstraction from Water Supply or Dewatering reduces water levels in Pool_SWGV below baseline.*	*Operations*	*5 - Severe*	Whilst these pools are still being studied, they are unlikely to be as connected to groundwater as Mundagoora Pool. Regardess, the high cultural values of the pools render the MPC severe, although major could also be argued once baseline conditions are better understood (i.e. the pool may dry out seasonally)	Social	*E - Unlikely*	*Medium*
7	Risk	***Over-extraction of water supply leading to loss of yield***	*Water supply bores dry out and are unable to supply the required volumes to augment processing, potable supply, and dust suppression requirements*	*Operations*	*3 - Serious*	The MPC is related to the financial impacts of production loss and/or increased operational costs associated with operating alternative water supply options (existing and proposed)	Financial impact to Fortescue Group (EBITDA)	*B - Highly Likely*	*High*
8	Risk	***Drawdown impact to Site 12 pool***	*Groundwater abstraction from Dewatering leads to long term drying of pool (beyond the period of drying observed in baseline).*	*Operations*	*3 - Serious*	Arguably, drying out of Site 12 Pool occurs naturally and for several months during droughts. Hence the MPC is related to the Pool's cultural value. Understanding of the pool's setting suggests that drawdown propogation towards Site 12 pool will be reduced by low permeability geology.	Social	*D - Possible*	*Medium*
9	Risk	***Water quality degradation from TSF Seepage***	*Changes in groundwater chemistry result in exceedances of baseline chemistry downstream of TSF*	*Operations*	*2 - Moderate*	Geochemical investigations have not indentified significant source risks with the TSF. Seepage, even if breaching baseline levels, is likely to result in only "unwanted or unplanned" environmental impact.	Environment	*E - Unlikely*	*Low*
10	Risk	***Water quality degradation from WRD1 Seepage***	*Changes in groundwater chemistry result in exceedances of baseline chemistry at Site 12 Pool*	*Operations*	*4 - Major*	In the MPC scenario, PAF material may be leached and seep into groundwater flowing towards Site 12 Pool. This could have a long term water quality impact that will take time to remediate	Environment	*D - Possible*	*Medium*
END	END	END	END	END	END	END	END	END	END

Appendix 9: Existing Groundwater Monitoring and Triggers (Iron Bridge, 2023)

Table 5: Operational Monitoring Schedule

Frequency	Monitoring parameter	Comments	Monitoring locations	Applicable to:	
				Operation	Care & Maint'
Abstraction bores					
Monthly	Volumes	Via bore meter data	Active production bores only	✓	✓
	Groundwater Level	Measured using a field groundwater probe. Pumping water levels to be clearly identified as such		✓	
Monitoring bores					
Monthly	Groundwater level	For drawdown assessments and ongoing hydrogeological assessment. Measured using a field groundwater probe.	Table 6 (Figure 1	✓	✓
	Field electrical conductivity	Salinity is measured using a field electrical conductivity (EC) measurement probe that is lowered to a designated depth within the screen interval. The designated level is nominally set at the mid-point of the screened interval.		✓	✓
Annually	Chemical analysis	• Major ions (Na, K, Ca, Mg, Cl, HCO_3, CO_3, SO_4 and NO_3), • Metals (Al, B, Fe, Cu, Zn, Ag, As, Cr, Pb, Cd, Hg, Ni, Sn, Mn), • Electrical conductivity, pH • Total dissolved solids and Total suspended solids.		✓	✓

Table 6: Operating Strategy Monitoring Bores

Bore	Type	Easting	Northing	Applicable to:	
				Operation	Care & Maint'
NS-ObsW04b	Trigger Monitoring Bore	696930	7649727	✔	✔
NS-ObsW03	Monitoring bore	700635	7648149	✔	✔
NS-ObsW01	Trigger Monitoring Bore	704190	7647032	✔	✔
NS-ObsW01a	Trigger Monitoring Bore	706103	7647616	✔	✔
NS-EXS26	Monitoring bore	710025	7643322	✔	✔
NS-ObsS29	Monitoring bore	709177	7643340	✔	✔
NS-ObsS18	Monitoring bore	709726	7644741	✔	✔
NS-ObsS28	Monitoring bore	710892	7644633	✔	✔
NS-Obs17	Monitoring bore	709795	7647257	✔	✔
NS-Obs13	Trigger Monitoring Bore	708612	7655220	✔	✔
NS-Obs19	Monitoring bore	709165	7647117	✔	✔
NS-ObsS10	Monitoring bore	708817	7646653	✔	✔
NS-Obs29	Monitoring bore	712100	7650421	✔	✔
NS-PB02	Monitoring bore	710143	7654606	✔	✔

8.1 Contingency for Environmental Impact

Issue: Groundwater level or rate of groundwater level decline in NS-OBsW04b, NS-ObsW01, NS-ObsW01a or NS-Obs13 exceed trigger values

Trigger: Individual trigger values derived from each bore's data record are provided in Table 7. In general terms the trigger is defined as groundwater level 1 m below or rate of change 50 % greater than baseline

Contingency: Reduce abstraction from nearest production bore (measured radially) to 75% of recent usage (calculated on a pro rata basis). Conduct assessment to determine likely reason for change. Inform DWER within 72 hours of data entry and engage with DWER to determine further contingency measures or re-evaluation of baseline and trigger levels.

It is worth noting that, as discussed with DoW representatives on 22 April 2016, no contingency is deemed necessary for electrical conductivity values. However, annual changes in EC of greater than 30% will be assessed and discussed in the annual monitoring review.

Following the North Star Triennial Groundwater Monitoring Review (Fortescue, 2020) submitted to DWER in April 2020, the trigger levels have been re-assessed and the recommended changes included in Table 7.

Table 7: Trigger Monitoring Bores

Bore	Baseline Dataset	Baseline Water Level (mAHD)	Baseline Rate of Change (m/yr)	Trigger Level (m AHD)	Trigger Rate of Change (m/yr)	Likely Source of IBO impact
NS-ObsW04b	Oct 2014	192.47	-2.6	191.47	3.9	Western Borefield
NS-ObsW01	May 2015	216.3	-5.4	215.3	8.1	Southern Borefield
NS-ObsW01a	Jan 2015	226.33	-6.9	225.33	10.4	Southern Borefield
NS-Obs13	Jun 2014	228.14	-3.4	227.14	5.1	Northern Borefield

[1] Calculated from the maximum observed average rate of change over three or more consecutive months of declining. Recent large rates of change were ignored

Appendix 10: Residual Risk Assessment with Adaptive Management / Controls

Rapid Risk Regist
Scope of assessment: Hydrogeological Impact Assessment (H3) for Iron Bridge Mine Area. Considering proposed Adaptive Management
Preparation date: 12/06/2023
Preparer name: M Carroll
Participant names

NO.	TYPE	TITLE	DESCRIPTION	PROJECT OR OPERATIONS?	MAXIMUM POTENTIAL CONSEQUENCE (MPC)	MPC DESCRIPTION	MANAGEMENT STRATEGY / TREATMENTS / CONTROLS	CONSEQUENCE DESCRIPTION FOR RESIDUAL RISK	CONSEQUENCE CATEGORY FOR RESIDUAL RISK	CONSEQUENCE RATING FOR RESIDUAL RISK	LIKELIHOOD RATING FOR RESIDUAL RISK	RISK / OPPORTUNITY RATING (Automated)	CONTROL EFFECTIVENESS	ACTIONS
1	Risk	***Drawdown Impact to Stygofauna, particularly restricted species***	*Groundwater drawdown from water supply or dewatering reduces available habitat and/or connectivity for Stygofauna species, particularly those within limited known range*	*Operations*	*3 - Serious*	Drawdown will deplete approximately 50% of the habitat (based on volume) within the study area but: •large size of the borefields means they may encompass whole ranges of some species;	Management is structured to address both existing lack of survey data and precautionary approach to risks of known restricted species. Strategies include: •Undertake additional regional surveys to better understand species	Adoption of trigger levels reduces likelihood of impacts to restricted species, at least in the early stages of borefield drawdown. The commitment to additional surveys will not be assessed	Environment	3 - Serious	C - Likely	*Medium*	*Requires Significant Improvement*	1.1 Commit to additional surveys to better understand stygofauna throughout borefield drawdown extent 1.2 Update impact assessment and GWOS with uplifted stygofauna study outcomes
2	Risk	***Drawdown Impact to Groundwater Dependent Vegetation in Southern Borefield***	*Groundwater abstraction from Water Supply borefield reduces groundwater availability for mapped GDE or pGDE (not directly associated with a pool)*	*Operations*	*3 - Serious*	Mapped pGDE communities, whilst known as facultative phreatophytes, exist in areas of shallow groundwater level. It is almost certain drawdown will extend below these areas at a rate exceeding root availability to respond. If they are indeed groundwater dependent, then impacts are certain. The vegetation communities are not restricted/rare; and re-establishment of water availability will allow communities to rebound.	Monitoring of vegetation response and groundwater level within/adjacent to the vegetation community. Adaptive management strategy for responding to vegetation and groundwater triggers, including: a. Alteration of abstraction regime from nearest bores b. Direct supplementation to creekline to increase soil moisture availability c. Groundwater injection to mitigate localised drawdown and increase groundwater availability d. Reduced abstraction from borefield	If implemented in time (without approval delays), adaptive management strategy should allow for a reduction in the duration of impact to medium term. Similar outcomes have occurred elsewhere.	Environment	*2 - Moderate*	*D - Possible*	*Low*	*Well Controlled*	2.1 Progress approvals to allow supplementation to creekline so that this can commence if required, with minimal delay.
3	Risk	***Drawdown Impact to Groundwater Dependent Vegetation in Western Borefield***	*Groundwater abstraction from Water Supply borefield reduces groundwater availability for mapped GDE or pGDE (not directly associated with a pool)*	*Operations*	*3 - Serious*	Mapped pGDE communities, whilst known as facultative phreatophytes, exist in areas of shallow groundwater level. It is almost certain drawdown will extend below these areas, although the rate of drawdown is not as fast as in the southern borefield. If they are indeed groundwater dependent, then impacts are likely. The vegetation communities are not restricted/rare; and re-establishment of water availability will allow communities to rebound.	Monitoring of vegetation response and groundwater level within/adjacent to the vegetation community. Adaptive management strategy for responding to vegetation and groundwater triggers, including: a. Alteration of abstraction regime from nearest bores b. Direct supplementation to creekline to increase soil moisture availability c. Groundwater injection to mitigate localised drawdown and increase groundwater availability d. Reduced abstraction from borefield	If implemented in time (without approval delays), adaptive management strategy should allow for a reduction in the duration of impact to medium term. Similar outcomes have occurred elsewhere.	Environment	*2 - Moderate*	*D - Possible*	*Low*	*Well Controlled*	3.1 Progress approvals to allow supplementation to creekline so that this can commence if required, with minimal delay.
4	Risk	***Drawdown Impact to Mundagoora Pool***	*Groundwater abstraction from Water Supply or Dewatering reduces water levels in Mundagoora Pool below baseline.*	*Operations*	*5 - Severe*	Whilst the connection of the pool to groundwater is unclear (might be perched), there is enough information to suggest that drawdown beneath the pool would impact the pool water balance. Equally, drawdown upstream of the pool is also conceptualised to reduce inflow to the pool. The MPC is more associated with the heritage significance of the pool, although it is of high ecological value	Monitoring of groundwater levels in dedicated monitoring bores up and downstream of the pool. Adaptive management strategy for responding to trigger levels within these bores, including: a. Alteration of abstraction regime from nearest bores b. Direct supplementation to pool c. Groundwater injection to mitigate localised drawdown d. Reduced abstraction from borefield	Despite controls, the nature of the risk is such that the pool may dry out if the mechanism of drawdown propagation is not reflected in the monitoring bores. Uncertainty over the pool hydrogeology remains. This sort of outcome has occurred in industry	Social	*5 - Severe*	*E - Unlikely*	*Medium*	*Requires Some Improvement*	4.1 Further analysis of baseline water levels from pool and bores. 4.2 Investigate potential for structural geology assessment of the pool's setting, supported by non-destructive geophysical surveys
5	Risk	***Drawdown Impact to Fig Pool and/or Cow Springs***	*Groundwater abstraction from Water Supply or Dewatering dries out pools.*	*Operations*	*3 - Serious*	Whilst drawdown is predicted proximal to the pools, baseline data (during construction abstraction) has indication the pools are not connected to targeted groundwater resources. However, the pools are small and it any connection is likely to result in the drying out of the pools. The pools are not noted as being of as high ecological/heritage significance as Mundagoora Pool.	Continued monitoring of pool water and borefield groundwater levels. Adaptive management strategy for responding to trigger levels within these bores, including: a. Alteration of abstraction regime from nearest bores b. Direct supplementation to pool	Despite controls, the nature of the risk is such that the pool may dry out prior to adaptive management implementation if the mechanism of drawdown propagation is not reflected in the current conceptualisation. Recover will be in the short/medium term.	Environment	*2 - Moderate*	*D - Possible*	*Low*	*Well Controlled*	5.1 Progress approvals to allow for supplementation infrastructure to be constructed if required, with no further delay.
6	Risk	***Drawdown Impact to Pool_SWGV and Honey Eater Creek Pools***	*Groundwater abstraction from Water Supply or Dewatering reduces water levels in Pool_SWGV and/or Honey Eater Creek Pools below baseline.*	*Operations*	*5 - Severe*	Whilst these pools are still being studied, they are unlikely to be as connected to groundwater as Mundagoora Pool. Regardless, the high cultural values of the pools render the MPC severe, although major could also be argued once baseline conditions are better understood (i.e. the pool may dry out seasonally)	Establish monitoring of pool water levels. No immediate adaptive strategy required; update plan once studies progressed.	Despite controls, the nature of the risk is such that pools may dry out if the mechanism of drawdown propagation is not reflected in the monitoring bores. Uncertainty over the pools' hydrogeology remains. This sort of outcome has occurred in industry	Social	*5 - Severe*	*E - Unlikely*	*Medium*	*Requires Some Improvement*	6.1 Further analysis of baseline water levels from pools. 6.2 Investigate potential for structural geology assessment of the pools' setting, supported by non-destructive geophysical surveys 6.3 If warranted by 3.1 and 3.2, consider whether monitoring bores are necessary to establish groundwater triggers in the vicinity of the pool (a bore is already planned for Honey Eater Creek)
7	Risk	***Over-extraction of water supply leading to loss of yield***	*Water supply bores dry out and are unable to supply the required volumes to augment processing, potable supply, and dust suppression requirements*	*Operations*	*3 - Serious*	The MPC is related to the financial impacts of production loss and/or increased operational costs associated with operating alternative water supply options (existing and proposed)	Implement Groundwater Operating Strategy, which includes: - Annual aquifer reviews - Maintain ongoing tracking of borefield performance (yield vs drawdown) - cycling of bore use as required to manage bore yields and drawdown. Establish robust, high frequency water balance reporting tool for operational decision making	Operation of the borefield according to the Groundwater Operating Strategy will not reduce the consequence of a loss of supply to the OPF but rather the likelihood of this occuring without alternative mitigation measures (i.e. reduction in other site demands, optimising alternative existing water supply sources (e.g. TSF recovery)	Financial impact to Fortescue Group (EBITDA)	*3 - Serious*	*E - Unlikely*	*Low*	*Well Controlled*	

8	Risk	***Drawdown impact to Site 12 pool***	*Groundwater abstraction from Dewatering leads to long term drying of pool (beyond the period of drying observed in baseline).*	*Operations*	*3 - Serious*	Arguably, drying out of Site 12 Pool occurs naturally and for several months during droughts. Hence the MPC is related to the Pool's cultural value. Understanding of the pool's setting suggests that drawdown propogation towards Site 12 pool will be reduced by low permeability geology.	Monitoring of groundwater levels in dedicated monitoring bore upstream of the pool. Adaptive management strategy for responding to trigger levels within the bore, including: a. Alteration of abstraction regime from nearest dewatering bores b. Direct supplementation to pool c. Groundwater injection to mitigate localised drawdown d. Reduced abstraction from dewatering borefield	Given the understanding of the pool and the baseline behaviour, management measures can be implemented in sufficient enough time to maintain natural variability of water in the pool. The consequence remains the same; however the controls reduce the likelihood.	Social	*3 - Serious*	*E - Unlikely*	*Low*	*Well Controlled*	8.1 Progress approvals to allow for supplementation infrastructure to be constructed if required, with no further delay.
9	Risk	***Water quality degradation from TSF Seepage***	*Changes in groundwater chemistry result in exceedances of baseline chemistry downstream of TSF*	*Operations*	*2 - Moderate*	Geochemical investigations have not indentified significant source risks with the TSF. Seepage, even if breaching baseline levels, is likely to result in only "unwanted or unplanned" environmental impact.	Monitor groundwater quality and compare to trigger levels defined in Tailings Storage Facility Monitoring Procedure (662NS-0000-PR-EN-0020) Initiate recovery of seepage from bores drilled under Works Approval W6322/2019/1	The controls in place will reduce both consequence and likelihood by identifying any seepage early and reducing the total load of any seepage water by recovery	Environment	*1 - Minor*	*E - Unlikely*	*Low*	*Well Controlled*	
10	Risk	***Water quality degradation from WRD1 Seepage***	*Changes in groundwater chemistry result in exceedances of baseline chemistry at Site 12 Pool*	*Operations*	*4 - Major*	In the MPC scenario, PAF material may be leached and seep into groundwater flowing towards Site 12 Pool. This could have a long term water quality impact that will take time to remediate	Comply with conditions of Mining Proposal 93044, including limiting the dumping of material until a trial and updated seepage modelling has been completed. Monitor groundwater quality at NS-0664 as required by the Site 12 Pool Water Quality and Quantity Monitoring Plan (662MI-5700-PL-WM-0001). Develop and implement the Site 12 Pool Recovery Plan if required as a contingency action. These actions may include: - Equip Plug monitoring bores to enable recovery of seepage (i.e pumping). - Drill and operate additional seepage recovery bores downstream of WRD, in the path of seepage	The controls in place will reduce both consequence and likelihood by restricted seepage (initially), identifying any seepage early and reducing the total load of any seepage water by recovery. The impact of PAF contaminated water (if seeping via an unknown pathway and/or occurring before Recovery Plan activates may still be serious, and require natural flushing of pool by surface water flow	Environment	*3 - Serious*	*E - Unlikely*	*Low*	*Well Controlled*	10.1 Conduct structural geology assessment of WRD and Pool 12 area 10.2 Consider tracer tests from boreholes within the WRD footprint, targeted at structures from 9.1 10.3 Continue to refine seepage modelling based on monitoring data
END	END	END	END	END	END	END	END	END	END	END	END	END	END	END