SARAJI EAST MINING LEASE PROJECT

Environmental Impact Statement

Appendix F-3

Groundwater Resource Technical Report

BMA

BHP Mitsubishi Alliance

Prepared for
BM Alliance Coal Operations Pty Ltd
ABN: 67 096 412 752

Environmental Impact Statement

Groundwater Technical Report

13-Dec-2024
Saraji East Mining Lease Project

aecom.com

Delivering a better world

Environmental Impact Statement

Client: BM Alliance Coal Operations Pty Ltd

ABN: 67 096 412 752

Prepared by

AECOM Australia Pty Ltd
Turrbal and Jagera Country, Level 8, 540 Wickham Street, PO Box 1307, Fortitude Valley QLD 4006, Australia
T +61 1800 868 654 www.aecom.com
ABN 20 093 846 925

13-Dec-2024

Job No.: 60507031

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 and ISO45001.

© AECOM Australia Pty Ltd (AECOM). All rights reserved.

AECOM has prepared this document for the sole use of the Client and for a specific purpose, each as expressly stated in the document. No other party should rely on this document without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified. Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

Table of Contents

Abbreviations i
1.0 Introduction 1
1.1 Project overview 1
2.0 Scope of assessment 3
2.1 Study scope and objectives 3
3.0 Legislation and policy 4
3.1 Federal legislation 4
3.1.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999 4
3.2 Queensland legislation 9
3.2.1 Water Act 2000 9
3.2.2 The Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016 9
3.2.3 Environmental Protection Act 1994 9
3.3 Policies, plans and guidelines 10
3.3.1 Environmental Protection (Water and Wetland Biodiversity) Policy 2019 10
3.3.2 Water Plan (Fitzroy Basin) 2011 10
3.3.3 Environmental Protection (Water) Policy 2009 Fitzroy River Sub-basin Environmental Values and Water Quality Objectives 12
3.3.4 Guideline EP Act Requirements for site-specific and amendment applications - underground water rights 14
4.0 Methodology 15
4.1 Data sources and historical studies 15
4.1.1 Mining method 16
4.2 Mine plan assessment 18
4.2.1 Groundwater assessment approach considering existing and proposed mining 23
4.3 Groundwater modelling 23
4.3.1 Model objectives 23
4.3.2 Conceptual groundwater model 24
4.3.3 Predictive simulations 27
4.3.4 Model code 28
4.3.5 Model extent 29
4.3.6 Model boundaries and design 31
4.3.7 Model stresses and boundary conditions 31
4.3.8 Model layers 32
4.4 Model calibration 43
4.4.1 Groundwater levels 43
4.4.2 Calibration statistics 45
4.4.3 Model water budget 48
4.4.4 Calibrated model parameters 50
4.4.5 Faults 52
4.4.6 Cumulative impacts 52
4.5 Model classification 53
4.6 Model limitations 54
5.0 Description of environmental values 56
5.1 Physical setting 56
5.1.1 Location 56
5.1.2 Land use 56
5.1.3 Topography and drainage 56
5.1.4 Climate 58
5.2 Geology 59
5.2.1 Bowen Basin 60
5.2.2 Structural geology 60
5.2.3 Stratigraphy 66
5.3 Groundwater resources 80
5.3.1 Groundwater monitoring network 80
5.3.2 Registered groundwater bores 85

5.3.3 Bore census 92
5.3.4 Existing hydrogeological understanding 94
5.3.5 Quaternary alluvium 94
5.3.6 Tertiary sediments 97
5.3.7 Permian sediments 100
5.3.8 Groundwater level data 103
5.3.9 Groundwater quality 119
5.3.10 Trigger levels 143
5.3.11 Groundwater dependent ecosystems 147
5.3.12 Springs 152
5.4 Groundwater environmental values 157
5.4.1 Aquatic ecosystems 158
5.4.2 Irrigation 158
5.4.3 Farm water supply/use 158
5.4.4 Stock watering 158
5.4.5 Primary recreation 158
5.4.6 Drinking water 159
5.4.7 Cultural and spiritual values 159
5.4.8 Summary 159
5.5 Sustainable and efficient use of groundwater 159
6.0 Potential impacts 160
6.1 Overview of potential impacts 160
6.1.1 Construction phase 160
6.1.2 Operational phase 160
6.1.3 Mine dewatering 160
6.1.4 Post closure 161
6.2 Predictive modelling 161
6.2.1 Conceptualisation 161
6.2.2 Timing and mining 162
6.2.3 Predictive model scenarios water balance 162
6.2.4 Groundwater ingress estimates 165
6.2.5 Predicted groundwater level changes 165
6.2.6 Maximum incremental drawdown 170
6.2.7 Cumulative drawdown 174
6.3 Incidental water impacts 178
6.3.1 Impacts on alluvium 178
6.3.2 Groundwater – surface water interaction 178
6.4 Recovery modelling 179
6.4.1 Final voids 180
6.5 Sensitivity analysis 183
6.5.1 Calibration identifiability 183
6.5.2 Prediction identifiability 183
6.6 Prediction uncertainty 185
6.6.1 Fault approach 189
6.6.2 Uncertainty results 189
6.6.3 Uncertainty on influence on Alluvium and Surface Water 190
6.6.4 Uncertainty number of realisations 191
6.7 Predictive modelling conclusions 195
6.7.1 Predictive modelling subsidence uncertainty comments 195
6.8 Impact assessment 196
6.8.1 Impacts on groundwater levels 196
6.8.2 Impacts on Saraji Mine infrastructure 199
6.8.3 Impacts on existing groundwater users 201
6.8.4 Cumulative impacts 205
6.8.5 Impacts on groundwater quality 206
6.8.6 Potential environmental impacts 206
7.0 Mitigation measures 208
7.1 Groundwater monitoring bore network 208
7.1.1 Groundwater Monitoring Plan 208
7.1.2 Existing monitoring bores 209
7.1.3 Existing water level monitoring 212

7.2 Additional groundwater monitoring requirements 212
7.2.1 New groundwater monitoring bores 212
7.2.2 Bore design and drilling 213
7.3 Groundwater monitoring bore network assessment 213
7.3.1 Groundwater level change over time 218
7.4 Surface cracking 221
7.4.1 Current understanding 221
7.5 Groundwater monitoring and sampling program 222
7.5.1 Parameters 222
7.5.2 Groundwater level monitoring 222
7.5.3 Groundwater quality monitoring 224
7.5.4 Data analysis process 225
7.5.5 Investigation and response processes 225
7.5.6 Groundwater TARPs 226
7.6 Data reporting 229
7.7 Post-mining period 229
7.8 Future modelling 229
8.0 Residual impacts 230
8.1 Simulated drawdown hydrographs 230
9.0 Summary and conclusions 232
9.1 Introduction and methodology 232
9.2 Geology and groundwater occurrence 232
9.3 Environmental values 232
9.4 Mining alteration 233
9.5 Potential impacts 233
9.6 Uncertainty 234
9.7 Surface cracking 235
9.8 Long-term groundwater levels 235
9.9 Management measures 236
9.9.1 TARPS 236
References 237

Appendix A A
Water Quality Data A

List of Figures

Figure 1 Locality plan 2
Figure 2 Water Plan (Fitzroy Basin) 2011 Schedule 3 Groundwater Management Areas (Project is red dot) 11
Figure 3 Fitzroy Basin Groundwater Zones (Project red dot) 13
Figure 4 Proposed underground mine plan 19
Figure 5 Approved Saraji open-cut mine plan 20
Figure 6 Overlap of mining techniques 21
Figure 7 Saraji Mine open cut mine plan and Project underground mine plan 22
Figure 8 Conceptual west to east regional cross section of the approved Saraji Mine open cut mining 25
Figure 9 Regional Geological and Groundwater components included in the groundwater modelling 26
Figure 10 Model Domain 30
Figure 11 Fracture zones (SLR, 2023) 37
Figure 12 Incidental Mine Gas Regions (from GEOGas, 2016) 39
Figure 13 Location of modelled gas drainage bores 41
Figure 14 Proposed gas well locations and coordinates 42
Figure 15 Groundwater model calibration bores 44
Figure 16 Transient calibration validation average head residuals (m) 47
Figure 17 Topography and surface water features 57
Figure 18 CRD Plot Clermont Post Office and Moranbah Airport 59
Figure 19 Surface Geology 61
Figure 20 Detailed solid geology 62
Figure 21 Inferred and mapped faults and the Project footprint 63

Figure 22 Faults included in the model domain 64
Figure 23 Geological cross-section A-A' 65
Figure 24 Geological cross-section B-B' 65
Figure 25 Geological cross-section C-C' 66
Figure 26 Geological cross-section D-D' 66
Figure 27 Mapped site-specific alluvium 68
Figure 28 Augur hole locations 74
Figure 29 Saraji Mine new alluvium monitoring bores 75
Figure 30 Saraji Mine new Tertiary monitoring bores 77
Figure 31 Saraji seam correlation 79
Figure 32 Groundwater monitoring bores 83
Figure 33 Historic nested piezometers and VWPs 84
Figure 34 Registered bores along strike and down dip of Saraji Mine 86
Figure 35 Bore census bores 93
Figure 36 MB40 / MB19SRM02T hydrograph for 2020/21 98
Figure 37 Hydraulic Conductivity vs Depth – Interburden data 102
Figure 38 Hydraulic Conductivity vs Depth – coal data 102
Figure 39 MB32 hydrograph 104
Figure 40 Groundwater levels in Saraji Mine monitoring bores and the CRD 105
Figure 41 Alluvium bores and saturation status 107
Figure 42 Historic Tertiary groundwater level data 108
Figure 43 Tertiary bores and inferred groundwater flow patterns 110
Figure 44 Average groundwater level contours across the Bowen Basin. Source: Arrow (2012) 112
Figure 45 Permian monitoring bore water level hydrographs 114
Figure 46 Permian groundwater levels and flow (GHD, 2020) 116
Figure 47 Nested monitoring bore hydrographs 118
Figure 48 Identified GDEs and predicted groundwater drawdown in the Tertiary sediments due to the Project (3D Environmental) 151
Figure 49 Aquatic GDEs (Source: GDE Atlas) 153
Figure 50 Terrestrial GDEs (Source: GDE Atlas) 154
Figure 51 Location of Stygofauna Monitoring Bores 155
Figure 52 Registered Springs 156
Figure 53 Predicted groundwater inflows (in ML/year) 165
Figure 54 Predicted Alluvium groundwater level change – Project and Approved predictive model scenarios 167
Figure 55 Predicted Tertiary groundwater level change – Project and Approved predictive model scenarios 168
Figure 56 Predicted Target D coal seam groundwater level change – Project and Approved predictive model scenarios 169
Figure 57 Maximum incremental drawdown in the Alluvium 171
Figure 58 Maximum incremental drawdown in the Tertiary 172
Figure 59 Maximum incremental drawdown in the target D seam 173
Figure 60 Maximum cumulative drawdown in the alluvium 175
Figure 61 Maximum cumulative drawdown in the Tertiary units 176
Figure 62 Maximum cumulative drawdown in the Target D seam 177
Figure 63 Predicted groundwater level recovery within the underground workings 180
Figure 64 Predicted groundwater levels in the D seam at Saraji Mine (SLR, 2023b) 182
Figure 65 Uncertainty contribution (predicted mine inflow) versus identifiability 184
Figure 66 Uncertainty contribution (maximum incremental drawdown) versus identifiability 185
Figure 67 Horizontal hydraulic conductivity of Alluvium parameter distribution 186
Figure 68 Mine ingress uncertainty 190
Figure 69 Uncertainty in predicted 1 m Maximum Incremental Drawdown in the Tertiary 192
Figure 70 Uncertainty in predicted 1 m Maximum Incremental Drawdown in the D Seam 193
Figure 71 95 % Confidence interval for ingress 194
Figure 72 95 % Confidence interval for maximum drawdown 194
Figure 73 Predicted groundwater level – no change between Approved and Project scenarios 197
Figure 74 MB33 water level drawdown – Approved and Project mine scenarios 198
Figure 75 Down dip water level drawdown – Approved and Project mine scenarios 198
Figure 76 MB20SRM04A – Approved and Project mine scenarios 199

Figure 77 Tertiary drawdown predictions and Saraji Mine water and waste storage facilities 200
Figure 78 Bores located within the predicted maximum incremental drawdown in the Tertiary and target D seam 204
Figure 79 Existing groundwater monitoring bores to be included in the Project GMP 211
Figure 80 Proposed monitoring bores 214
Figure 81 Project groundwater monitoring program overview 217
Figure 82 Simulated hydrograph for MB20SRM03P 231

List of Tables

Table 1 Groundwater related Project objectives 3
Table 2 IESC Information Requirements Checklist - Groundwater 5
Table 3 Mining methods options assessment summary for the Project 17
Table 4 Model layers 34
Table 5 Recharge rates 36
Table 6 Hydraulic parameter changes due to longwall mining 38
Table 7 Gas Drainage Simulation 40
Table 8 Calibration statistics for the base case model 45
Table 9 Residual data for each model layer 46
Table 10 Steady-state model water budget 48
Table 11 Transient model water budget 49
Table 12 Model Parameters 50
Table 13 Storage Coefficients 51
Table 14 Hydraulic conductivity of faults (base case model) 52
Table 15 Groundwater model classification table[1,2] 53
Table 16 Climate summary 58
Table 17 Stratigraphy 69
Table 18 Non-perennial creek alluvium and Philips Creek alluvium 70
Table 19 Saraji Mine alluvium monitoring bores 72
Table 20 Saraji Mine Tertiary monitoring bores 76
Table 21 Groundwater Monitoring Bores 80
Table 22 Registered groundwater bores 87
Table 23 Bore census bores 92
Table 24 MB38 / MB19SRM01A groundwater level monthly monitoring records for January 2020 to February 2021 95
Table 25 Hughes Creek / Hughes Creek diversion alluvium permeability estimates 96
Table 26 Permeability Test Results 101
Table 27 Historic Tertiary groundwater level measurements 108
Table 28 Available Tertiary groundwater level data 109
Table 29 Vertical groundwater level assessment (Aug /Sept 2011 data) 117
Table 30 Vertical groundwater level assessment 118
Table 31 Alluvium groundwater quality - MB32 (Gauge, 2021 and GHD, 2021) 121
Table 32 Alluvium groundwater quality – MB20SRM04A (Gauge, 2021) 122
Table 33 Tertiary groundwater quality (Oct/Nov 2011 data) 123
Table 34 MB40 / MB19SRM02T 2020 groundwater quality data and EA trigger levels (Gauge, 2021 and GHD, 2021) 128
Table 35 MB40 / MB19SRM02T 2020 groundwater quality data and Fitzroy Zone 34 guidelines (Gauge, 2021 and GHD, 2021) 129
Table 36 MB19SRM02T (MB40) and MB20SRM02T Tertiary groundwater quality data and Fitzroy Zone 34 guidelines (Gauge, 2021 and GHD, 2021) 130
Table 37 Harrow coal seam groundwater quality (AGE, 2011) 131
Table 38 Dysart coal seam groundwater quality 132
Table 39 MB33 groundwater quality data compared to EA trigger levels (Gauge, 2021 and GHD, 2021) 135
Table 40 MB34 groundwater quality data compared to EA trigger levels (GHD, 2021) 136
Table 41 MB35 groundwater quality data compared to EA trigger levels (GHD, 2021) 137
Table 42 MB36 groundwater quality data compared to EA trigger levels (GHD, 2021) 138
Table 43 MB39 (MB19SRM03P) groundwater quality data compared to EA trigger levels (GHD, 2021) 139
Table 44 New Permian monitoring bore groundwater quality data compared to Fitzroy Zone 34 guidelines 140

Table 45 Total Dissolved Solids ANZECC 1992 Livestock Drinking Water Quality Guideline 142
Table 46 Groundwater contaminant trigger levels (Table I2) 143
Table 47 MB20SRM04A alluvium groundwater quality data 146
Table 48 MB20SRM02T Tertiary groundwater quality data 146
Table 49 MB20SRM02P Permian groundwater quality data 146
Table 50 Questions to determine likelihood of aquatic GDEs 148
Table 51 Questions to determine likelihood of Terrestrial GDEs 149
Table 52 Monitoring bores sampled for stygofauna 152
Table 53 Environmental values for groundwater 157
Table 54 Predictive model Project scenario - water balance 162
Table 55 Predictive model Approved scenario - water balance 163
Table 56 Predictive model Null run - water balance 164
Table 57 Uncertainty parameter range 187
Table 58 Uncertainty range for recharge rates 189
Table 59 Potentially impacted bores located within the predicted maximum incremental drawdown in the Tertiary and target D seam 202
Table 60 Existing groundwater monitoring bores for the Project 210
Table 61 New Project monitoring bores 212
Table 62 SEMLP Groundwater monitoring bore network summary 215
Table 63 Groundwater level prediction summary 219
Table 64 Mining phases and monitoring details 222
Table 65 Field parameter stabilisation criteria prior to sampling 224
Table 66 Draft Groundwater Trigger Action Response Plan 227

Table of plates

Plate 1 Flooded subsided longwall panels at the Bowen Basin Goonyella Broadmeadow Riverside Mine complex 38
Plate 2 Water supply bore locations 91
Plate 3 Saraji Mine groundwater monitoring bore network (Gauge, 2021) 113
Plate 4 MB32 Schoeller diagram (2016 to 2021 data) 119
Plate 5 MB32 Piper plot (2016 to 2021 data) 120
Plate 6 MB40 / MB19SRM02T Piper plot 2020 and 2021 data 125
Plate 7 MB40 / MB19SRM02T Schoeller diagram for 2020 and 2021 data 126
Plate 8 Longwall cracking (after ACARP, 2000). 222

Abbreviations

AECOM	AECOM Australia Pty Ltd
Al	Aluminium
ANZECC	The Australian and New Zealand Environment Conservation Council
As	Arsenic
BMA	BM Alliance Coal Operations Pty Ltd
BoM	Bureau of Meteorology
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
Ca	Calcium
CHPP	Coal Handling and Preparation Plant
Cl	Chloride
CO_3	Carbonate
CRD	Cumulative Rainfall Departure
C_x	Hydrocarbon fractions
DESI	Department of Environment, Science and Innovation
DNRME	Department of Natural Resources, Mines and Energy
DRDMW	Department of Regional Development, Manufacturing and Water
DEE	Department of the Environment and Energy
DEHP	Department of Environment and Heritage Protection
EA	Environmental Authority
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1994*
EPP (Water and Wetland Biodiversity)	Environmental Protection (Water and Wetland Biodiversity) Policy 2019
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERA	Environmentally Relevant Activity
EV	Environmental Value
FCCM	Fort Cooper Coal Measures
Fitzroy Basin WRP	Fitzroy Basin Water Resource Plan 2011
GDE	Groundwater Dependant Ecosystems
GMA	groundwater management area
HCO_3	Bicarbonate
Hg	Mercury
IESC	Independent Expert Scientific Committee
K	Potassium
kh	Horizontal hydraulic conductivity
kv	Vertical hydraulic conductivity
km	kilometre
LTAA	Long-term affected area

LOR	Limit of Reporting
m	metres
MB	Monitoring Bore
mbGL	metres below ground level
MCM	Moranbah Coal Measures
Mg	Magnesium
MIA	Mine Infrastructure Area
ML	Mining Lease
MLA	Mining Lease Application
MNES	Matters of National Environmental Significance
MSES	Matters of State Environment Significance
Mtpa	Million tonnes per annum
Na	Sodium
NATA	National Association of Testing Authorities
NO_3	Nitrate
P	Phosphorous
PEST	Parameter Estimation software
RCM	Rangal Coal Measures
RN	Registration number
ROM	Run-of-Mine
Sb	Antimony
Sc	Storativity
SEMLP	Saraji East Mining Lease Project (the Project)
SO_4	Sulfate
Sy	Specific yield
TDS	Total Dissolved Solids
ToR	Terms of Reference
UWIR	Underground Water Impact Report
VWPs	Vibrating Wire Piezometers
Water Act	*Water Act 2000*

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was engaged by BM Alliance Coal Operations Pty Ltd (BMA) to undertake the groundwater environmental assessment in support of an Environment Impact Assessment (EIS) for the Saraji East Mining Lease Project (the Project).

1.1 Project overview

BMA proposes to develop the Project, a greenfield single-seam underground mine development on Mining Lease Application (MLA) 70383 and MLA 70459 (overlapping part of Exploration permit – coal (EPC) 837 and EPC 2103) commencing from within Mining Lease (ML) 1775.

The Project also includes a Coal Handling and Preparation Plant (CHPP) and associated Mine Infrastructure Area (MIA), and a new rail spur and balloon loop to be located on the site of the existing adjacent Saraji Mine (ML 70142). Mining and the infrastructure required to support the Project is not proposed within the full extent of the Project Site with direct impacts constrained to a smaller area of some 3,425 ha within MLA 70383, MLA 70459, ML 70142 and ML 1775 and ML 1782 (Figure 1).

The Project is expected to produce up to 11 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal and produce up to 8 Mtpa of metallurgical product coal for the export market over an assumed 20-year production schedule.

The current approved mine plan for the adjacent Saraji Mine, an open-cut operation, sees open-cut production across ML 1775 and ML 70142 until approximately 2031.

As a portion of the Project covers an area currently approved for open cut mining (ML 1175), the Project EIS will offer BMA the flexibility to mine the coal within this area using the most effective and economic mining method. For the purpose of the groundwater assessment, areas of underground mining will take precedence over areas previously identified for open cut extraction on the basis that they can only be mined once using one mining method.

Progressive rehabilitation of disturbed areas following completion of mining and decommissioning of the infrastructure areas is planned and will be undertaken in accordance with the approved environmental authority (EA) conditions.

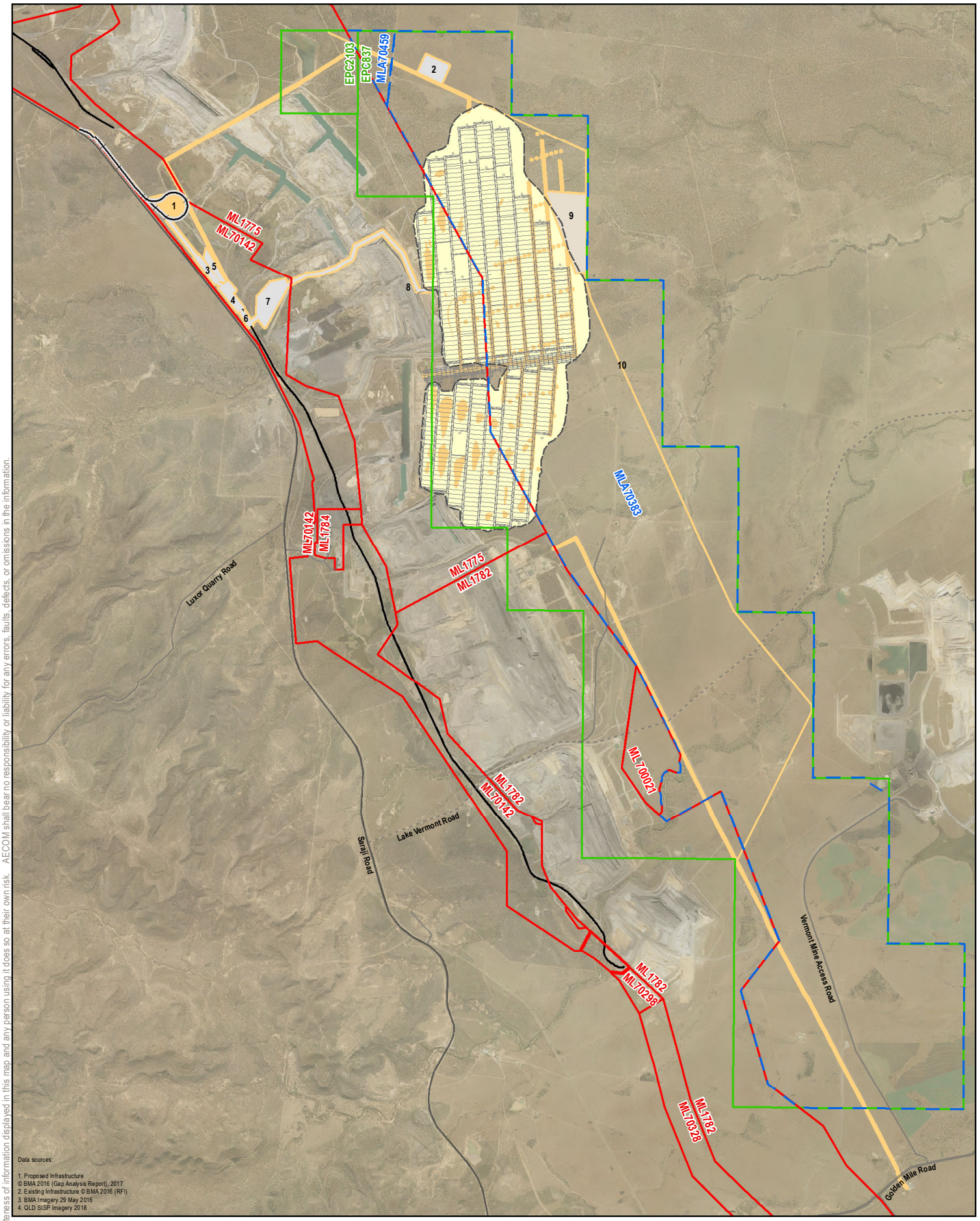
The combined existing approved Saraji Mine and the Project, located approximately 30 kilometres (km) north of Dysart in Central Queensland, are shown in Figure 1.

Figure 1 shows the:

- Relevant mining tenements
- Proposed surface infrastructure and key project elements
- Underground layout – the Project mine layout.

For the purposes of this groundwater technical report the Project Area is defined as the area within a 15 km radius of the Project.

This EIS report assesses the potential environmental impacts associated with the underground layout and associated 20 year production schedule. The underground layout was developed based on consideration of a range of factors including resource recovery, coal quality, production rates and site constraints including social and environmental considerations. The underground layout is designed to provide a generally consistent coal quality and production output.



Data sources:

1. Proposed Infrastructure © BMA 2016 (Gap Analysis Report), 2017
2. Existing Infrastructure © BMA 2016 (RFI)
3. BMA Imagery 29 May 2016
4. QLD SISP Imagery 2018

LEGEND

- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Limit of Subsidence
- Surface Infrastructure
- Haul Road
- Rail Loop
- Private Access Road
- Public Road

Surface Infrastructure

1 Rail Loading Balloon Loop
2 Process Water Dam
3 Product Stockpiles
4 CHPP
5 Raw Water Dam
6 ROM Pad
7 Future MIA
8 Conveyor
9 Construction Village
10 Transport and Infrastructure Corridor

N

Figure 1
Locality Plan

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 1

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

2.0 Scope of assessment

2.1 Study scope and objectives

The groundwater assessment includes a description of the groundwater resources, an assessment of environmental values, conceptualisation of the groundwater resources and the assessment of potential impacts utilising a predictive groundwater model. The information included in the EIS includes additional data and responses to questions raised after the review of the EIS groundwater report.

The objectives of the groundwater environmental assessment, in line with the Project's Terms of Reference (EHP, 2017) (ToR) are provided in Table 1 below.

Table 1 Groundwater related Project objectives

Objective		Relevant Terms of Reference Section
1.	Identify the environmental values of groundwater within the project area and immediately downstream that may be affected by the project with reference to the Environmental Protection (Water) Policy 2009 and section 9 of the *Environmental Protection Act 1994 (*EP Act) including any human uses of the water and any cultural values, as well as the *EIS Information Guideline – Water*	Section 5.4
2.	Define the relevant water quality objectives applicable to the environmental values and demonstrate how these will be met by the project during construction, operation and following completion.	Section 5.3.10
3.	Detail the chemical, physical and biological characteristics of groundwater within the area that may be affected by the project during construction, operation and following completion consistent with the *EIS Information Guideline – Water*.	Section 6.8.5
4.	Provide details of any proposed impoundment, extraction, discharge, injection, use or loss of surface water or groundwater.	Section 6.2
5.	Describe present and potential users and uses of water in areas potentially affected by the project, including municipal, agricultural[2], industrial, recreational and environmental uses of water.	Section 6.7.1
6.	The EIS must include a specific section responding to the information requirements contained in the *IESC's Information Guidelines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals* (Commonwealth of Australia, 2015).	Table 2

The description and assessment of groundwater resources are compiled in this technical groundwater report to supplement the Project EIS submission.

3.0 Legislation and policy

This groundwater technical report has been prepared with consideration to key policies and legislation from the Commonwealth of Australia and the State of Queensland. This section provides an overview of the legislation and policies which are relevant to the Project.

3.1 Federal legislation

3.1.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important environmental assets, defined in the EPBC Act as matters of national environmental significance (MNES).

The 'water trigger' amendment to the EPBC Act includes water resources as MNES in relation to coal seam gas (CSG) and large coal mining developments. This means that CSG and large coal mining developments require federal assessment and approval if they are likely to have a significant impact on a water resource.

The Department of Climate Change, Energy, the Environment and Water (DCCEEW), who are responsible for administering the EPBC Act, has determined that the Project has the potential for significant impacts on water resources.

The EPBC Act requires that all CSG and large coal mining developments, which are expected to have water-related impacts, be referred to the Independent Expert Scientific Committee (IESC) for advice. The EIS for the Project include a specific section responding to the information requirements in the IESC *Information Guidelines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals* (Commonwealth of Australia, 2015). The IESC information requirements checklist relevant to groundwater is presented in Table 2.

The EIS includes a specific section which focusses on MNES including water resources.

Table 2 IESC Information Requirements Checklist - Groundwater

IESC Specific Information Needs - Groundwater	Section in this Report
Description of the Proposal	
A regional overview of the proposed project area including a description of the geological basin, coal resource, surface water catchments, groundwater systems, water-dependent assets, and past, current and reasonably foreseeable coal mining and CSG developments.	Section 5.0
A description of the statutory context including information on the proposal's status within the regulatory assessment process and on any water management policies or regulations applicable to the proposal.	Section 3.0
A description of the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Sections 1.0, 4.1.1 and 4.2
A description of how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Section 3.0
Groundwater – Context and Conceptualisation	
Descriptions and mapping of geology at an appropriate level of horizontal and vertical resolution including: • Definition of the geological sequence/s in the area, with names and descriptions of the formations with accompanying surface geology and cross-sections. • Definitions of any significant geological structures (e.g. faults) in the area and their influence on groundwater, in particular, groundwater flow, discharge or recharge.	Section 5.2
Data to demonstrate the varying depths to the hydrogeological units and associated standing water levels or potentiometric heads, including direction of groundwater flow, contour maps, hydrographs and hydrochemical characteristics (e.g. acidity/alkalinity, electrical conductivity, metals, major ions). Time series data representative of seasonal and climatic cycles.	Sections 5.2.3 and 5.3.8
Description of the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	Sections 4.3.8.2, 5.3.5.2, 5.3.6.2, and 5.3.7.2
Values for hydraulic parameters (e.g. vertical and horizontal hydraulic conductivity and storage characteristics) for each hydrogeological unit.	Sections 5.3.5.3 4.4.4, 5.3.6.3, and 5.3.7.3
Assessment of the frequency, location, volume and direction of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water.	Sections 5.3.8 and 6.3.2
Groundwater – Analytical and Numerical Modelling	
A detailed description of all analytical and/or numerical models used, and any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	Sections 4.3 and 6.2 Groundwater Modelling Peer Review (HydroAlgorithmics, 2023)
Undertaken in accordance with the Australian Groundwater Modelling Guidelines[1], 2009, including peer review.	Section 4.3 Groundwater Modelling Peer Review (HydroAlgorithmics, 2023)

IESC Specific Information Needs - Groundwater	Section in this Report
Calibration with adequate monitoring data, ideally with calibration targets related to model prediction (e.g. use baseflow calibration targets where predicting changes to baseflow).	Section 4.4 Groundwater Modelling Technical Report (SLR, 2023)
Representations of each hydrogeological unit, the thickness, storage and hydraulic characteristics of each unit, and linkages between units, if any.	Section 4.3.8
Representation of the existing recharge/discharge pathways of the units and the changes that are predicted to occur upon commencement, throughout, and after completion of the development activities.	Sections 4.3.7 and 6.2
Incorporation of the various stages of the proposed development (construction, operation and rehabilitation) with predictions of water level and/or pressure declines and recovery in each hydrogeological unit for the life of the project and beyond, including surface contour maps.	Sections 6.1, 6.2, and 6.4
Identification of the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	Sections 6.2.3, and 6.3
An explanation of the model conceptualisation of the hydrogeological system or systems, including key assumptions and model limitations, with any consequences described.	Sections 4.3.2, 5.3.4, 6.2.1, and 4.6
Consideration of a variety of boundary conditions across the model domain, including constant head or general head boundaries, river cells and drains, to enable a comparison of groundwater model outputs to seasonal field observations.	Sections 4.3.6 and 4.3.7
Sensitivity analysis of boundary conditions and hydraulic and storage parameters, and justification for the conditions applied in the final groundwater model.	Section 6.5 Groundwater Modelling Technical Report (SLR, 2023)
An assessment of the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling, particularly with respect to predicted potential impact scenarios.	Section 6.6
A programme for review and update of the models as more data and information become available, including reporting requirements.	Section 7.8
Information on the time for maximum drawdown and post-development drawdown equilibrium to be reached.	Section 6.2.6
Groundwater – Impacts to Water Resources and Water-Dependent Assets	
An assessment of the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts: • Description of any hydrogeological units that will be directly or indirectly dewatered or depressurised, including the extent of impact on hydrological interactions between water resources, surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water. • The effects of dewatering and depressurisation (including lateral effects) on water resources, water-dependent assets, groundwater, flow direction and surface topography, including resultant impacts on the groundwater balance. • Description of potential impacts on hydraulic and storage properties of hydrogeological units, including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units. • Consideration of possible fracturing of and other damage to confining layers.	Section 6.0

IESC Specific Information Needs - Groundwater	Section in this Report
• For each relevant hydrogeological unit, the proportional increase in groundwater use and impacts as a consequence of the development proposal, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal.	
Description of the water resources and water-dependent assets that will be directly impacted by mining or CSG operations, including hydrogeological units that will be exposed/partially removed by open cut mining and/or underground mining.	Sections 5.3.11 and 5.4
For each potentially impacted water resource, a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact.	Sections 6.2 and 6.3
Description of existing water quality guidelines and targets, environmental flow objectives and other requirements (e.g. water planning rules) for the groundwater basin(s) within which the development proposal is based.	Section 5.3.10
An assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Sections 6.2.7 and 6.8.4
Proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	Section 7.0
Description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	Section 7.0
Groundwater – Data and Monitoring	
Sufficient physical aquifer parameters and hydrogeochemical data to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes.	Sections 4.4 and 5.3
A robust groundwater monitoring programme, utilising dedicated groundwater monitoring wells and targeting specific aquifers, providing an understanding of the groundwater regime, recharge and discharge processes and identifying changes over time.	Sections 5.3 and 7.1
Long-term groundwater monitoring, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	Sections 5.3.10 and 7.5
Water quality monitoring complying with relevant National Water Quality Management Strategy (NWQMS) guidelines[2] and relevant legislated state protocols[3].	Sections 5.3.10 and 7.5
Cumulative Impacts – Context and Conceptualisation	
Cumulative impact analysis with sufficient geographic and time boundaries to include all potentially significant water-related impacts.	Section 4.4.6
Cumulative impact analysis identifies all past, present, and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern.	Section 4.4.6, 6.2.7, and 6.8.4
Cumulative Impacts – Impacts	
An assessment of the condition of affected water resources which includes: • Identification of all water resources likely to be cumulatively impacted by the proposed development. • A description of the current condition and quality of water resources and information on condition trends. • Identification of ecological characteristics, processes, conditions, trends and values of water resources. • Adequate water and salt balances.	Section 5.3, 5.3.10, 6.2.7, and 6.8.4

IESC Specific Information Needs - Groundwater	Section in this Report
• Identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).	
An assessment of cumulative impacts to water resources which considers: • The full extent of potential impacts from the proposed development, including alternatives, and encompassing all linkages, including both direct and indirect links, operating upstream, downstream, vertically and laterally. An assessment of impacts considered at all stages of the development, including exploration, operations and post closure / decommissioning. • An assessment of impacts, utilising appropriately robust, repeatable and transparent methods. • Identification of the likely spatial magnitude and timeframe over which impacts will occur, and significance of cumulative impacts. • Identification of opportunities to work with others to avoid, minimise or mitigate potential cumulative impacts.	Section 5.3, 5.3.10, 6.2.7, and 6.8.4
Cumulative Impacts – Mitigation, Monitoring and Management	
Identification of modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts	Section 7.0
Identification of measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies	Section 7.0
Identification of cumulative impact environmental objectives.	Section 7.0
Appropriate reporting mechanisms.	Section 7.0
Proposed adaptive management measures and management responses.	Section 7.0

[1] Barnett et al, 2012.

[2] ANZECC & ARMCANZ, 2000.

[3] DEHP, 2009.

3.2 Queensland legislation

3.2.1 Water Act 2000

General

The *Water Act 2000* (Water Act) provides for the sustainable management of water and the management of impacts on underground water and for other purposes. The main purposes of the Water Act are to provide a framework for the following:

- Sustainable management of Queensland's water resources by establishing a system for the planning, allocation and use of water
- Sustainable and secure water supply and demand management for the south-east Queensland region and other designated regions
- Management of impacts on underground water caused by the exercise of underground water rights by the resource sector
- Effective operation of water authorities.

The Water Act covers water in a watercourse, lake or spring, underground water (or groundwater), overland flow water, or water that has been collected in a dam.

Section 362 of the Water Act refers to bore trigger thresholds. The bore trigger threshold is the maximum allowable groundwater level decline in a groundwater bore, due to the exercise of resource tenure holders' underground water rights, prior to triggering an investigation into the water level decline. The bore trigger threshold for consolidated aquifers is five metres (5 m) and for unconsolidated aquifer it is two metres (2 m). Under the transitional arrangements for the *Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016*, the Project will require an associated water licence (AWL) under the Water Act 2000, which removes the requirement to prepare an Underground Water Impact Report (UWIR) for the Project.

3.2.2 The Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016

On 10 November 2016, the *Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016* (Underground Water Management Act) was passed by the Queensland Parliament. The Underground Water Management Act amended the EP Act and Water Act 2000 to strengthen the effectiveness of the environmental assessment and ongoing management of underground water extraction by resource projects. These amendments commenced on 6 December 2016.

The right to take associated water in the mining sector is granted under s334ZP of the *Mineral Resources Act 1990.* The Project EIS indicated that the Project proponent applied for an environmental authority in 2013. As per s839 of the *Mineral Resources Act 1990*, if the environmental authority was applied for prior to 6 December 2016, s334ZP of the *Mineral Resources Act 1990* does not apply until the mining tenement holder has an AWL.

Thus, as the Environmental Authority (EA) application was made prior to the 6 December 2016, which is when the Underground Water Management Act changes were made. As such, the Project falls within the transitional arrangements, because the take of water from the new mining leases had not commenced, and an AWL under the *Water Act 2000* will be required.

3.2.3 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) has the objective to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes on which life depends i.e. ecologically sustainable development.

BMA is applying for a new site-specific EA for the Project. The Department of Environment and Science (DES), who are responsible for the administration and regulation of resource activities under the EP Act, has confirmed that the Project requires assessment through an EIS.

Environmental values

The EP Act defines an environmental value (EV) as:

- A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or
- Another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

The amendments introduced by the Underground Water Management Act have introduced new information requirements into the EP Act. Section 126A outlines a list of information requirements which must accompany a site-specific application where the resource activity or project involves the exercise of underground water rights. Section 227AA requires that this information also be included with an amendment application where the proposed amendment involves a change in the exercise of underground water rights.

3.3 Policies, plans and guidelines

3.3.1 Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The purpose of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water and Wetland Biodiversity) is to achieve the object of the EP Act in relation to waters and wetlands. That is, protecting Queensland's water environment while allowing for development that is ecologically sustainable.

EVs and water quality objectives (WQOs) are being progressively determined for Queensland waters. EVs define the uses of the water by aquatic ecosystems and for human uses (e.g. drinking water, irrigation, aquaculture, recreation). WQOs define objectives for the physical, chemical and biological characteristics of the water (e.g. nitrogen content, dissolved oxygen, turbidity, toxicants, fish).

The management intent for waters is stated in section 15 of the EPP Water and Wetland Biodiversity. For waters of high ecological value, the water quality is to be maintained. For slightly disturbed waters, the water quality is to be improved where needed, to achieve the WQOs. For moderately disturbed waters, water quality is to be maintained, or improved where needed, to meet the WQOs. In highly disturbed waters, water quality is to be improved so that it achieves the WQOs.

As EVs and WQOs are established for Queensland waters in accordance with the EPP Water and Wetland Biodiversity, after approval they are included in Schedule 1. For waters not included in Schedule 1, the EVs and WQOs are respectively determined in accordance with section 6 and section 11 of the EPP Water and Wetland Biodiversity.

Environmental values relevant to the Project are presented in detail in Section 5.4 of this report.

3.3.2 Water Plan (Fitzroy Basin) 2011

Water plans have been developed under the Water Act to sustainably manage and allocate water resources in Queensland. The Project is located within the Isaac Connors Groundwater Management Area (GMA) as defined in Schedule 3 of the Water Plan (Fitzroy Basin) 2011 (current as at 2 September 2022). Figure 2 indicates the Isaac Connors GMA and the approximate Project location.

Within the Isaac Connors GMA, water licences and/or development permits are not required for stock and domestic bores, generally groundwater monitoring bores are also excluded from the requirement for development permits.

Other groundwater-related activities, such as drilling of test pumping bores and undertaking pumping tests, require authorisation (by way of permits), as well as a development permit to allow drilling and construction of water bores. Any long-term water take or interference from groundwater sources requires authorisation by way of a licence. The Project will require a water licence for groundwater interfered with as a result of mining activities.



Figure 2 Water Plan (Fitzroy Basin) 2011 Schedule 3 Groundwater Management Areas (Project is red dot)

3.3.3 Environmental Protection (Water) Policy 2009 Fitzroy River Sub-basin Environmental Values and Water Quality Objectives

In order to assess the relevant groundwater zone for the Project and identified scheduled WQOs, as requested by the Queensland Department of Environment and Science[1] (DES), a review of the Fitzroy Basin Groundwater Zones was conducted.

The Fitzroy River Sub-basin Environmental Values and Water Quality Objectives (DEHP, 2013) identifies environmental values for groundwater in the Fitzroy River sub-basin, and WQOs to protect or enhance those EVs.

The Groundwater Zones (WQ1310 – Fitzroy Basin Groundwater Zones) identified across the basin with associated EVs is included in Figure 3. As indicated on Figure 3, the Project, although located within the Isaac Connors GMA (Figure 2), is not wholly located within a Fitzroy Basin Groundwater Zone.

The scheduled groundwater WQOs, as included in this EIS, for groundwater zone 34 (the closest groundwater zone which may contain the furthest down dip eastern portion of the Project) was used for the Project impact assessment.

[1] Submission on the Project EIS

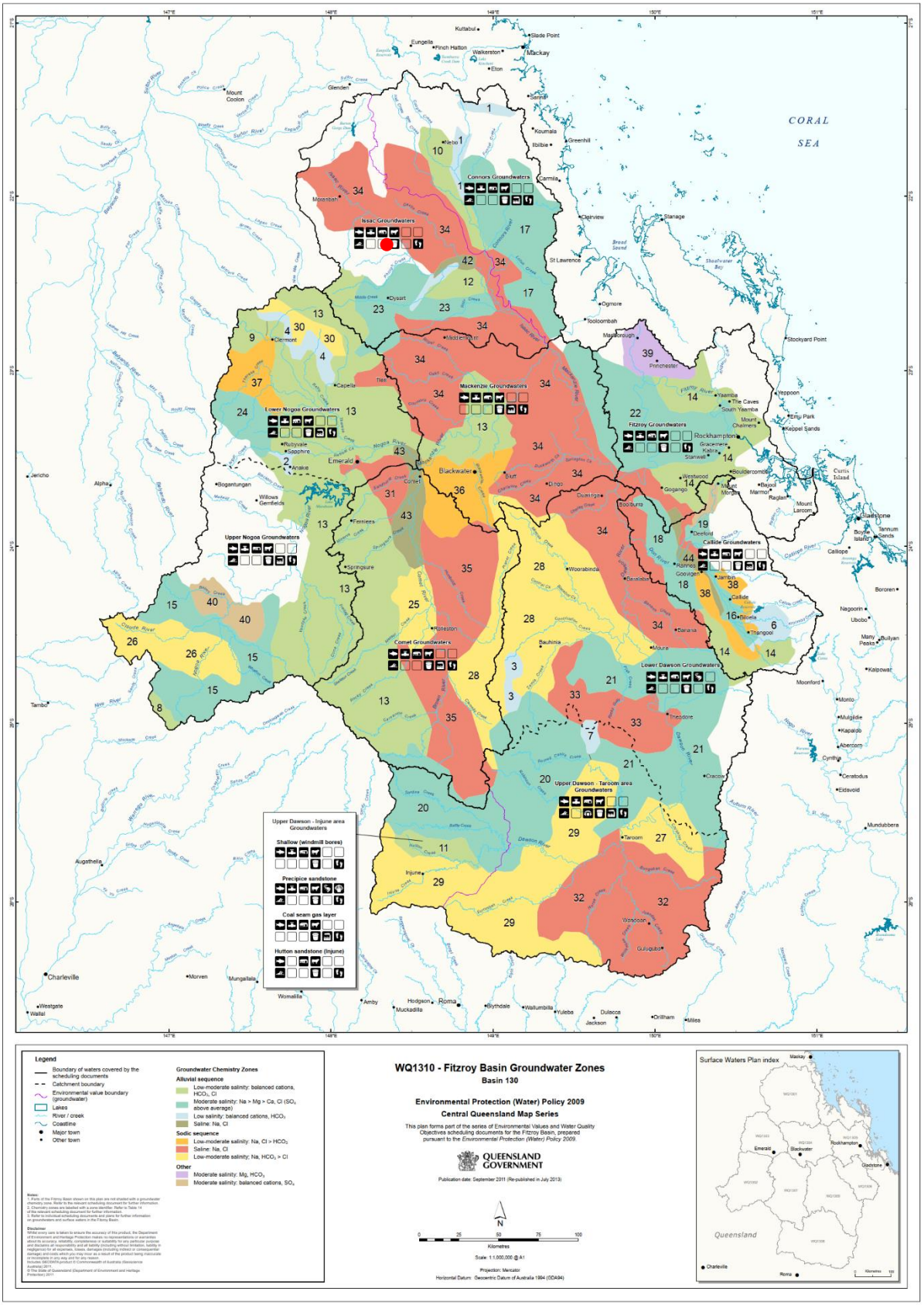


Figure 3 Fitzroy Basin Groundwater Zones (Project red dot)

3.3.4 Guideline EP Act Requirements for site-specific and amendment applications - underground water rights

This guideline provides information requirements for a new EA application or an application to amend an EA for resource projects or activities that:

- are carried out on one or more resource tenures for which the relevant tenure is a mineral development licence, mining lease or petroleum lease; and
- involve the exercise of underground water rights or a change to the exercise of underground water rights.

The guideline provides recommendations about the level of information required to meet the legislative requirements of sections 126A and 227AA of the EP Act. The information requirements of sections 126A and 227AA are similar to requirements for an underground water impact report (UWIR), which is required to be prepared under Chapter 3 of the Water Act 2000 (Water Act).

Underground water rights provide the tenure holder with a statutory right to take or interfere with underground water in the area of the tenure if the taking or interference with that water is necessarily and unavoidably obtained in the process of extracting the resource. For example, mine dewatering to the extent necessary to achieve safe operating conditions. This is also known as associated water.

With these underground water rights comes an obligation that tenure holders comply with underground water obligations provided for in Chapter 3 of the Water Act. Sections 126A and 227AA of the EP Act complement Chapter 3 of the Water Act, by ensuring that an upfront assessment of the impacts to environmental values from the exercise of these underground water rights has been undertaken, and that potential impacts are appropriately managed.

The mandatory information, as outlined in section 126A of the EP Act, that is required includes:

- state any proposed exercise of underground water rights during the period in which resource activities will be carried out under the relevant tenure
- describe the areas in which underground water rights are proposed to be exercised
- for each aquifer affected, or likely to be affected by the exercise of underground water rights, include:
    - a description of the aquifer
    - an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers and surface water
    - a description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights
    - the predicted quantities of water to be taken or interfered with because of the exercise of underground water rights during the period in which resource activities are carried out.
- detail the environmental values that will, or may, be affected by the exercise of underground water rights and the nature and extent of the impacts on the environmental values
- detail any impacts on the quality of groundwater that will, or may, happen because of the exercise of underground water rights during or after the period in which resource activities are carried out
- detail strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater.

It is considered that the information provided to meet the requirements of the Project EIS, will be used, where applicable, to meet the requirements of sections 126A and 227AA of the EP Act.

4.0 Methodology

The groundwater impact assessment comprises two components: a description of the existing hydrogeological environment, and an assessment of the impacts of mining on that environment.

The groundwater assessment was divided between four stages, these being:

Description of existing environment:

Stage 1 – data review

- Included review of historical groundwater studies undertaken for the Project, groundwater management reports for the existing Saraji Mine operations, and publicly available data from bores on the surrounding agricultural land.

Stage 2 – update of geological and groundwater baseline conditions

- Updated the existing geological and groundwater baseline descriptions and conceptualisation of current groundwater resources.

Impact assessment:

Stage 3 – impact assessment

- Included the use of the Bowen Basin regional groundwater flow numerical model to assess and predict groundwater ingress rates to the underground mine and evaluate the potential impact of the Project.

Stage 4 – reporting

- Documenting the findings of the study in this EIS technical groundwater report.

4.1 Data sources and historical studies

A groundwater impact assessment for underground longwall mining for the Project was previously undertaken by AGE (2011) using a now outdated mine plan and schedule. Predicted inflows to the underground mine workings and drawdown extents were further reported by AGE (2012b).

Several previous groundwater studies have been undertaken at the adjacent Saraji Mine, including a groundwater technical report to support an amendment to the Saraji Mine EA to include an extension of the existing open-cut Grevillea Pit AECOM (2016). Other investigations at the Saraji Mine have largely focussed on addressing groundwater issues related to geotechnical and dewatering feasibility studies, characterisation of the hydrogeological regime, and review of groundwater monitoring and water quality data.

Key reports reviewed for the groundwater impact assessment included the following:

- AECOM (2016). Saraji Open-Cut Extension Project – Groundwater Technical Report.
- AGE (2013). Annual Review of Groundwater Data and Monitoring Network – 2013 - Saraji Mine.
- AGE (2012a). Review of Groundwater Monitoring Data – Saraji Mine, dated December 2012.
- AGE (2012b). Australian Groundwater & Environmental Consultants Memorandum – Predicted Inflows and Drawdown Extents – Saraji East Underground Mine, dated 24 February 2012.
- AGE (2011). Report on Saraji East Project Groundwater Impact Assessment.
- AGE (2007). Report on Hydrogeological Regime and Impact Assessment - Saraji Mine.
- BMA Monitoring data spreadsheets.
- Gauge (2016). Annual Groundwater Monitoring Report - Saraji Coal Mine - September 2016.
- Gauge (2015). Annual Groundwater Monitoring Report - Saraji Coal Mine - June 2015.
- Gauge (2019). Annual Groundwater Monitoring Report - Saraji Coal Mine – May 2020.
- Gauge (2020). Annual Groundwater Monitoring Report - Saraji Coal Mine - April 2021.
- Gauge (2021). Annual Groundwater Monitoring Report - Saraji Coal Mine – March 2022.
- GEOGas (2011). Gas Reservoir Assessment – May 2011.

- GEONET (2022). Subsidence over longwall panels – February 2022.
- IESA Annual groundwater monitoring reports 2006 to 2011
- IESA (2011a). Saraji East Mine Stygofauna Survey Report – September 2011.
- IESA (2011b). Saraji East Mine Stygofauna Survey Report – December 2011.
- Mining One (2011). BMA Saraji East Extension: Packer Test Program.
- Minserve, 2022. Subsidence over Longwall Panels – Saraji East Underground Mine, April 2022.
- SKM (2011). Saraji East Coal Mine Project – Baseline Environmental Studies – February 2011.

The above reports and associated data were reviewed to refine understanding of the hydrogeological system within and surrounding the Project.

Numerous reports have also been undertaken for nearby mining projects. The following additional publicly available reports from nearby projects were also reviewed to gain an appreciation of the regional groundwater system within the Project Area:

- Arrow (2012). Arrow Bowen Gas Project EIS - Chapter 14 – Groundwater.
- JBT (2014). Lake Vermont Northern Extension Groundwater Impact Assessment.
- URS (2014). Groundwater Chapter for the Dysart Coal Mine Project prepared for Bengal Coal Pty Ltd, ref. 42627233/GW dated 10 February 2014.
- URS (2012). Report Groundwater Impact Assessment Bowen Gas Project.
- URS (2009). Caval Ridge Groundwater Impact Assessment.

The groundwater modelling technical report, compiled by SLR (SLR, 2023) to assess the potential impacts of the Project on groundwater resources, included more regional geological and hydrogeological data. These data aided in describing and evaluation of the hydrostratigraphic units within and adjacent to the Project Area.

4.1.1 Mining method

BMA selected the longwall underground mining method for the Project after an assessment of technical and economic feasibility was conducted. The feasibility of coal mining method included:

- geological conditions
- overburden characteristics
- coal seam continuity, thickness, structure, quality, and depth
- strength of materials above and below (roof and floor) of the target seam
- topography (altitude and slope)
- climate
- land ownership and use
- surface drainage patterns
- groundwater conditions
- availability of labour and materials
- coal purchaser requirements
- capital investment.

A summary of the mining method options assessment, considering high-level positives and negatives relevant to the Project area, is included in Table 3.

Table 3 Mining methods options assessment summary for the Project

Mining method	Description	Positives	Negatives
Open-cut mining	Continuation of existing open-cut pits at Saraji Mine	No construction phase Existing equipment available Associated infrastructure in place Safer intrinsic operations Higher resource recovery	Deep target coal seams, thick overburden and mine waste (spoils and discard) generation Large surface water diversions required Geotechnical stability studies Large footprint to reach target coal Generation of spoil management Complete removal of overlying environmental values and interruption of hydraulic and hydrologic function Dust and noise Visual impact
Trench-auger mining	The target coal seam is exposed by digging a trench with conventional surface mining equipment. After surface mining the coal from the bottom of the trench, the coal would be extracted with extended-depth augers, operating from the bottoms of the trench.	The augers could be employed within the existing Saraji Mine pits Limited mine waste generation Safer operations, of hydraulically driven drum cutter head and coal handling auger flights can be operated remotely at a safe distance outside the mine workings.	The target coal seam dips to the east, at an average dip of 8 degrees, thus requiring deeper or additional trenches Reduced coal extraction due to subsidence risk Large surface water diversions required Large footprint to reach deep target coal
Longwall mining	The extraction of a panel of coal which allows goaf	Reach deeper seams Less mine waste Proven widely used technology Reduced surface alteration	Subsidence causing surface alteration Surface water management required Requires pumping of groundwater
Bord and Pillar	This method involves the driving of a series of narrow headings in the target coal seam parallel to each other. These headings are connected by cross headings to form pillars	Little or no surface subsidence Access through the existing Saraji Mine high wall, minimal surface disruption / change	Works best in flat coal seams, the Project target coal seam dips at an average dip of 8 degrees Works best with coal 1.8 to 3 m thick, the average thickness of the target D seam is 8.4 m Requires specialist coal mining equipment Limited coal extraction potential Sterilises significant proportion of the coal resource
Hydraulic mining	The hydraulic cutting of coal and hydraulic transport of coal and water	No dust generation	Not suitable for Project High water use

4.2 Mine plan assessment

The Project is a single-seam operation involving extraction of the Dysart Lower (D14 / D24) seam, referred to as the target D seam.

This assessment is informed by groundwater modelling undertaken to simulate the Project underground and the approved Saraji Mine open cut mining. The model incorporates a 20 year production schedule and the open cut mining, which ceases in approximately 2031 (post-mining recovery modelling is described in Section 6.4). The mine plan for the Project is shown in Figure 4.

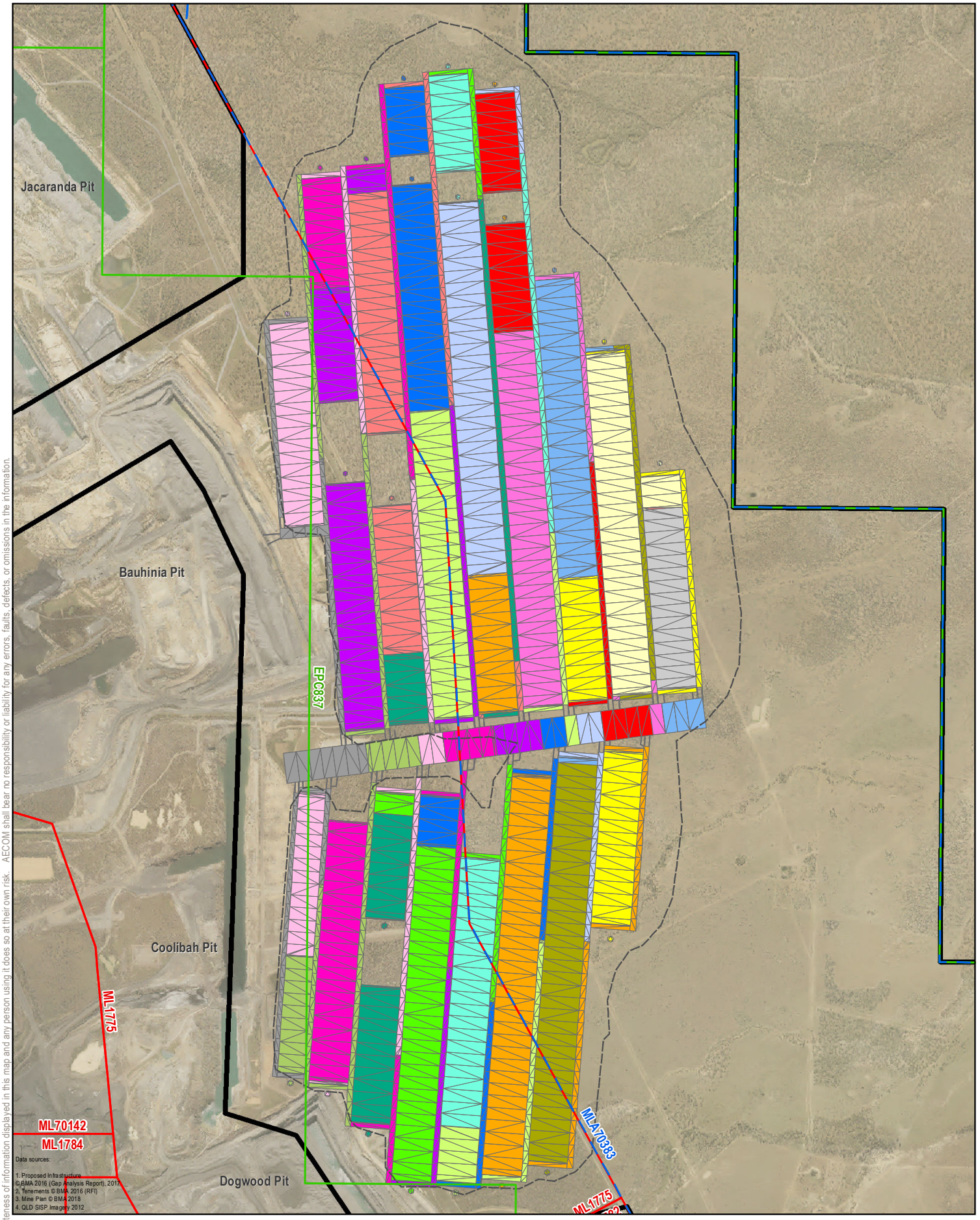
The assessment considers the potential for alteration resulting from longwall mining, as estimated in the most recent subsidence modelling (GEONET, 2022). The subsidence assessment considers the potential subsidence related impacts of mining the Dysart Lower seam (within the MLs and MLAs).

Coal will be mined by longwall methods consisting of a northern region of panels and a southern region of panels separated by a portal which will be progressively mined out and developed as mining progresses. Panels within the northern region will be oriented northwest-southeast whilst panels in the southern section will be oriented northeast-southwest.

Mining will commence from the western end within ML 1775, adjacent to the existing Saraji Mine open-cut operations and progressing towards the east into MLA 70383.

The approved Saraji open-cut mine plan (Figure 5) shows that open-cut operations, which extract coal seams to the Dysart Lower seam, are expected to continue until 2031 (in some pits reaching the ML boundary). According to the assessment scenario for the EIS, this means that the proposed underground mining and approved open-cut mining will occur concurrently on the Project site between assessment scenario Year 1 and Year 9 (2023 and 2031) i.e. 8-9 year overlap.

It is noted that in areas where there are both open-cut mining and underground mining proposed (overlap presented in Figure 6), the sections of open-cut have been removed and replaced by underground mining only (i.e., where there is an overlap between the Saraji Mine opencut pits and Project future mine plans, the opencut mine was removed and replaced by the proposed longwall mining). Figure 7 shows the Project and the revised version of the Saraji Mine opencut used in the predictive groundwater modelling (Section 6.2).



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Limit Of Subsidence

Underground Mine Layout

Year 1	Year 8	Year 15
Year 2	Year 9	Year 16
Year 3	Year 10	Year 17
Year 4	Year 11	Year 18
Year 5	Year 12	Year 19
Year 6	Year 13	Year 20
Year 7	Year 14	

N

Figure 4
Proposed underground mine plan

Groundwater Technical Report
Saraji East Mining Lease Project

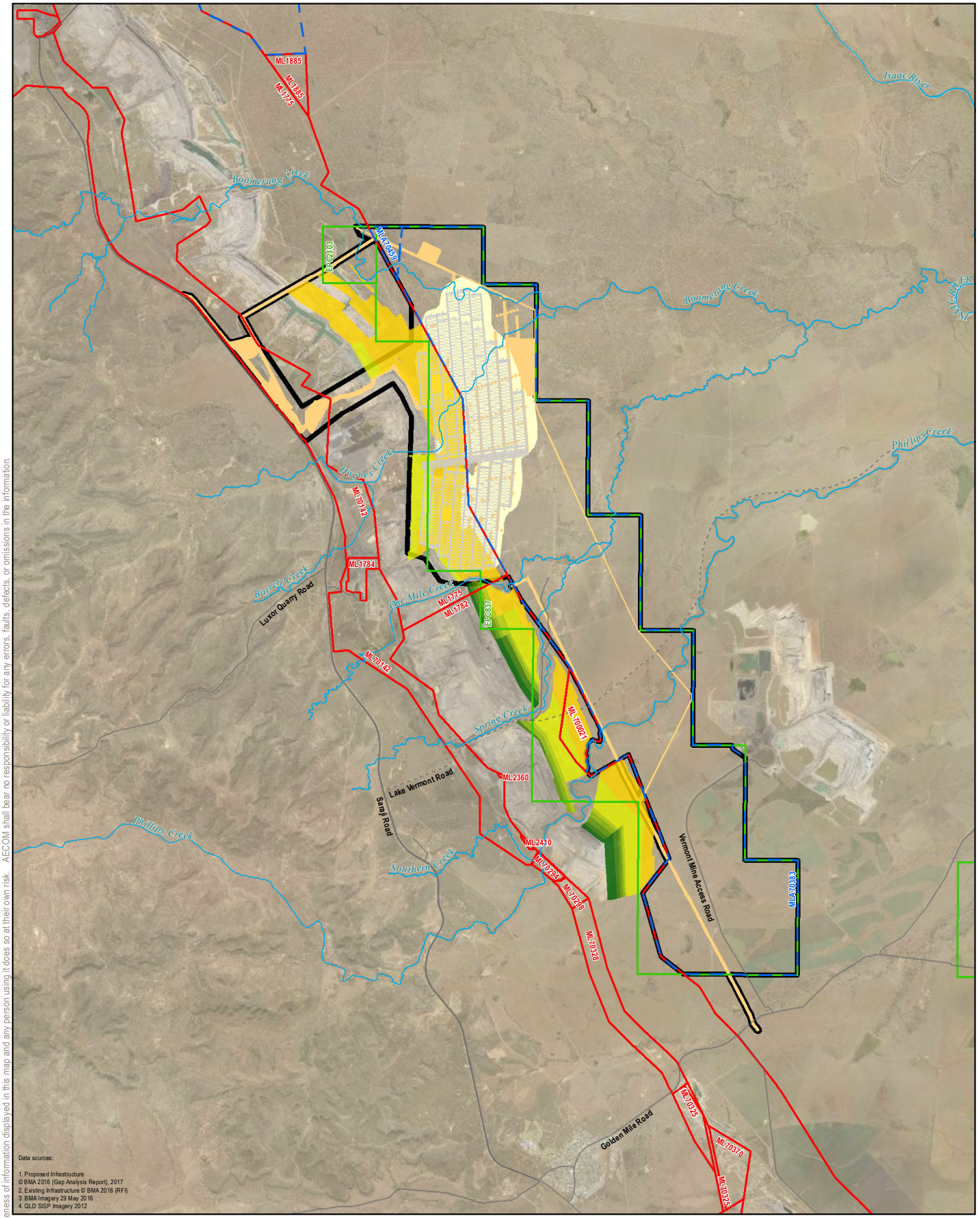
0 0.25 0.5 1
Kilometres

Scale: 1:40,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 21/07/2023 VERSION: 2



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road

Conceptual Mine Plan

- FY2017
- FY2018
- FY2019
- FY2020
- FY2021
- FY2022 - FY2026
- FY2027 - FY2031

N

Figure 5
Approved Saraji Open-cut Mine Plan

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G192_v2_A4P.mxd

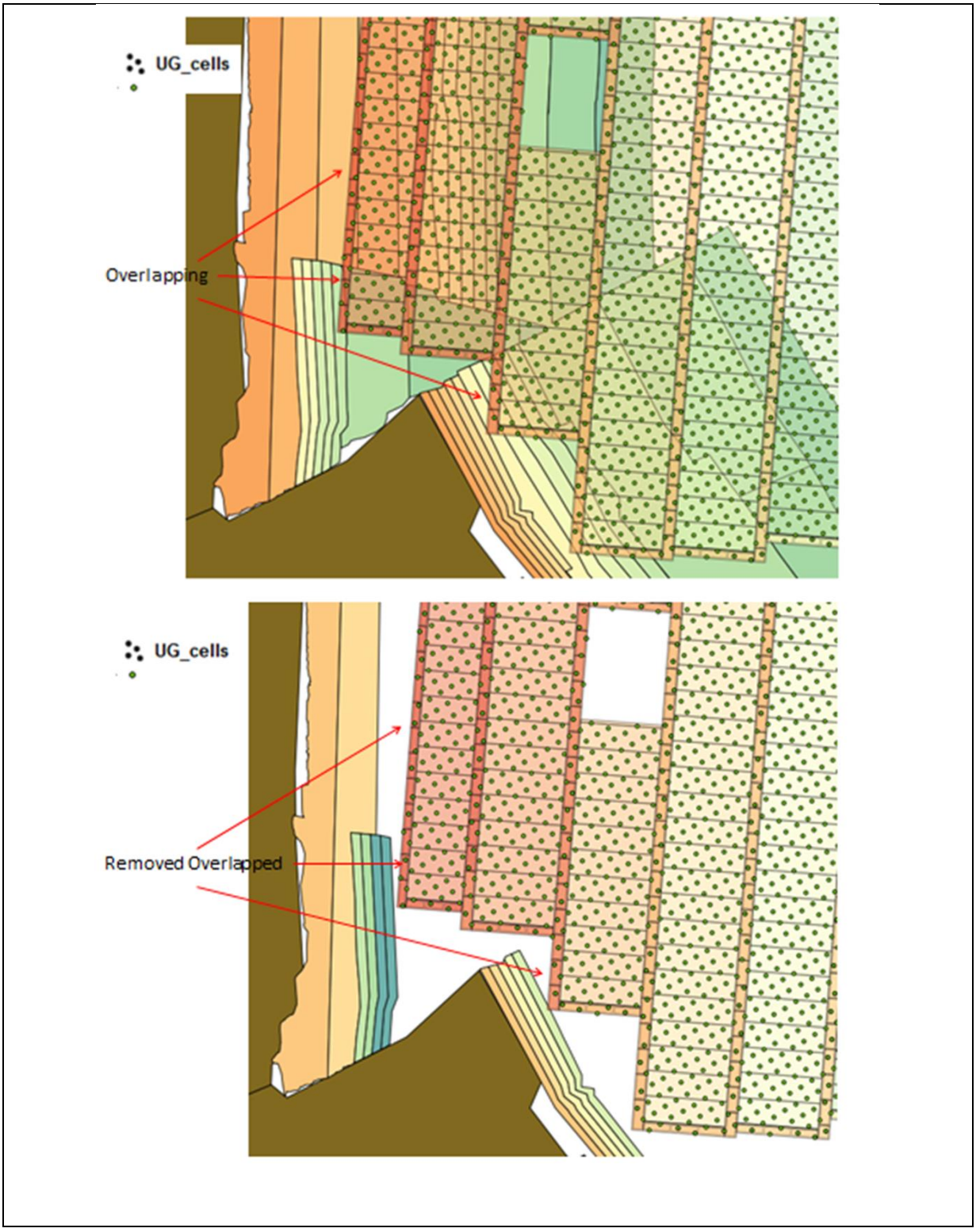
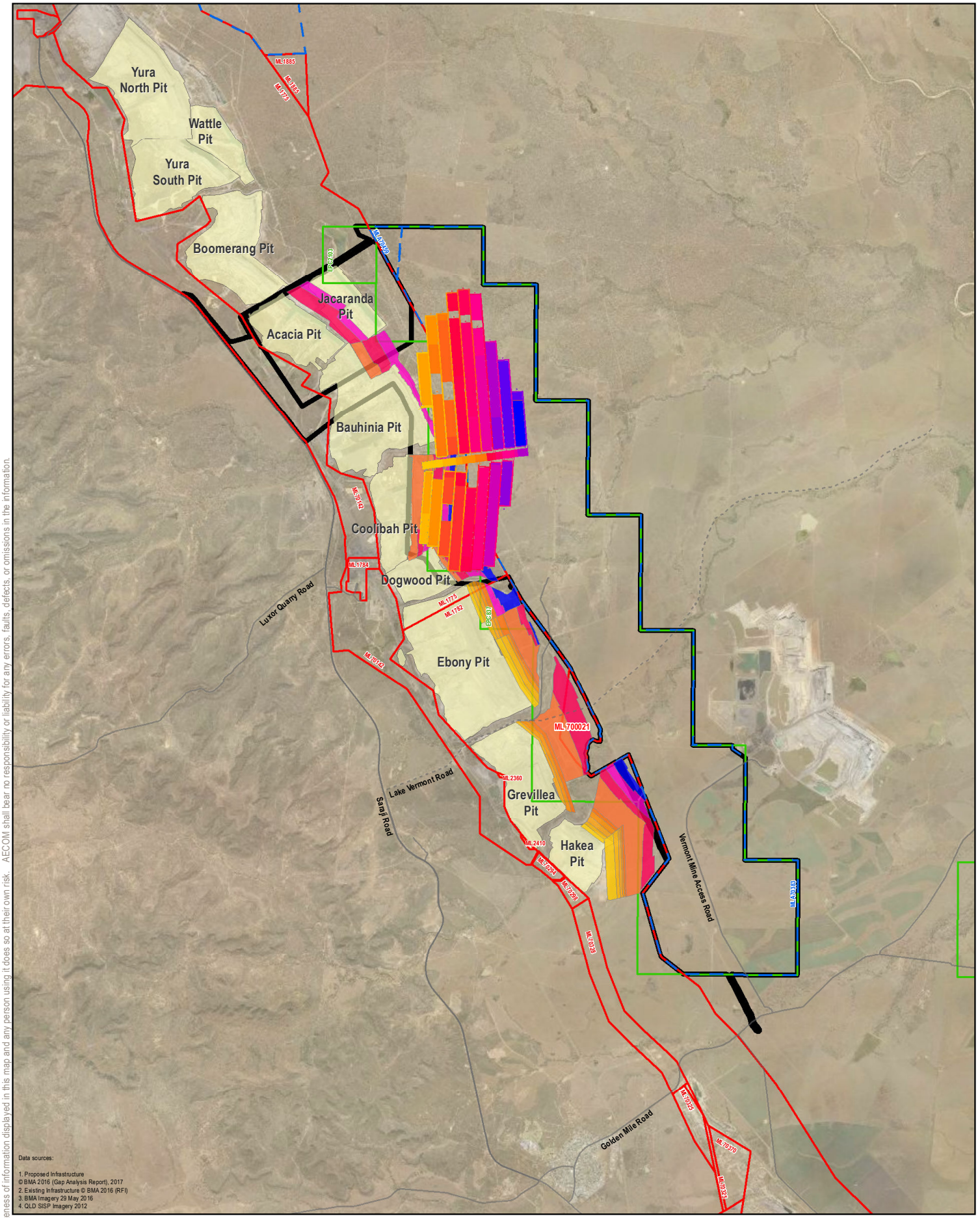


Figure 6 Overlap of mining techniques



Data sources:

1. Proposed Infrastructure © BMA 2016 (Gap Analysis Report), 2017
2. Existing Infrastructure © BMA 2016 (RFI)
3. BMA Imagery 29 May 2016
4. QLD SISP Imagery 2012

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Existing Open-Cut Extent
- Private Access
- Public Road

SRM/SELMP Progression

- Year 1
- Year 2
- Year 3
- Year 4
- Year 5
- Year 6
- Year 7
- Year 8
- Year 9
- Year 10
- Year 11
- Year 12
- Year 13
- Year 14
- Year 15
- Year 16
- Year 17
- Year 18
- Year 19
- Year 20

N

Figure 7
Saraji Mine Open-cut Mine Plan and Project Underground Mine Plan

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 3/07/2023 VERSION: 1

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G432_v0_A4P.mxd

4.2.1 Groundwater assessment approach considering existing and proposed mining

Groundwater impacts from the approved open-cut operations were previously modelled by AECOM (2016) with results showing groundwater drawdown contours extending into the footprint of the proposed underground workings, this scenario was remodelled by SLR in 2023 (refer Section 6.2).

Given that the underground mine and open-cut mine are intrinsically linked through drawdown contour overlap, operational scheduling overlap and proximity, impacts from underground mining were assessed by simulating continuous operation of the open-cut (albeit a revised open-cut mine plan to facilitate the underground mining on the MLs) and underground mining operations. This approach means that drawdown contours and impacts from underground mining can be considered as cumulative impacts with the Saraji Mine open-cut mining.

In addition, the predictive groundwater modelling included a no mining within the region model scenario. This scenario, to assist in addressing IESC requirements, aided in the evaluation of predicted cumulative drawdown impacts.

4.3 Groundwater modelling

Predictive groundwater modelling (SLR, 2023) was conducted to assess the potential impacts of the proposed longwall mining (detailed in Section 6.2). The modelling looked at mine dewatering impacts (groundwater ingress and groundwater level drawdown) considering all approved and foreseeable mining in the region, including the approved Saraji Mine open-cut workings, with and without the Project.

Predictive simulations, including an evaluation of groundwater level drawdown, the prediction of groundwater ingress and an evaluation of groundwater level recovery was conducted.

The objective of groundwater modelling was to use a constructed and calibrated regional model, which has been reviewed and assessed by an independent reviewer, which suitably represents the current conceptual understanding of the groundwater systems within and beyond the Project Area and allows for the prediction of changes in groundwater conditions and water resources due to the Project.

A numerical groundwater model for the Project was developed using BMA's regional numerical groundwater model as the foundation. The updated BMA regional groundwater model, referred to as the Project numerical groundwater model, builds on the regional scale Olive Downs Project model (i.e. the foundational model constructed and calibrated in 2018). The foundational model was subsequently updated for the following Bowen Basin mine projects and assessments:

- Moorvale South Project in 2019
- Winchester South Project in 2020
- Caval Ridge Mine and Horse Pit Extension Project in 2021
- Lake Vermont North Extension Project in 2021
- Millennium Mine Mavis Extension in 2021
- Daunia Mine Water Licence Review in 2021.

It is noted that this regional scale model has already been reviewed and accepted twice by State agencies and once by the Commonwealth for other project approval applications, as well as used by BMA to support various State mining compliance reporting requirements. Data sharing agreements have been established by these project proponents that allow the sharing of groundwater information and modelling. Under these agreements, the groundwater models developed as part of each project's groundwater assessment were adopted as a base for the Project model, where relevant.

Peer review

The numerical groundwater model, refined and calibrated for the Project, was subject to a Peer Review. The review comments are included in Groundwater Modelling Peer Review (HydroAlgorithmics, 2023).

4.3.1 Model objectives

The overall objectives of the predictive groundwater modelling was to:

- Estimate the groundwater inflow to the Project underground mine workings as a function of mine position and timing;

- Simulate and predict the extent of groundwater level drawdown due to the Project
- Identify areas of potential environmental risk, where groundwater impact management measures may be necessary.

4.3.2 Conceptual groundwater model

The existing information and field data were used to develop a conceptual understanding of the groundwater regime(s) across the Project Area.

A conceptualised west to east cross-section showing the underlying geology and the three hydrostratigraphic systems at and adjacent to the existing approved Saraji Mine open-cut pits in Figure 8.

The data used to develop the conceptualisation indicates three hydrostratigraphic separate systems occur within the Project Area; these groundwater systems are associated with the following geological units:

- Seasonal or sporadic alluvium groundwater
- Localised basal sand and gravel at the base of the Tertiary sediments
- Deeper Permian coal seams.

Figure 9 shows the hydrogeological conceptualisation of the more regional model area, which is included in the predictive modelling.

Key understandings from the conceptualisation include the following:

- Differences in groundwater levels measured in the Tertiary and deeper Permian aquifers indicate that there is limited hydraulic connection between these groundwater systems.
- Recharge occurs from infiltration from the rainfall and creek flow into the Tertiary and Permian aquifer sub-crop areas. Minor leakage from overlying aquifers may occur but is not evident based on groundwater level data.
- The regional groundwater levels are a subdued reflection of the surface topography except immediately adjacent to the open-cut mine area where localised discharge / seepage into the pits results in the steeper gradients around the pits.
- Regionally groundwater discharge within the deeper aquifers is complex based on the horst and graben structures within the Bowen Basin. Groundwater flow is considered to flow down dip from sub-crop to the east. Groundwater level data indicates lower groundwater levels to the east even though the permeability decreases with depth (Section 5.3.7.3). It is considered that faulting facilitates more complex groundwater movement to the east of the Project Area.
- Groundwater associated with the alluvium occurs as discontinuous and sporadic resource, which is recognised under the EP Act and Environmental Protection Regulation 2008. As such this limited resource is recognised to have intrinsic environmental values.

The numerical groundwater modelling included the conceptual understanding of the groundwater systems in the Project Area.

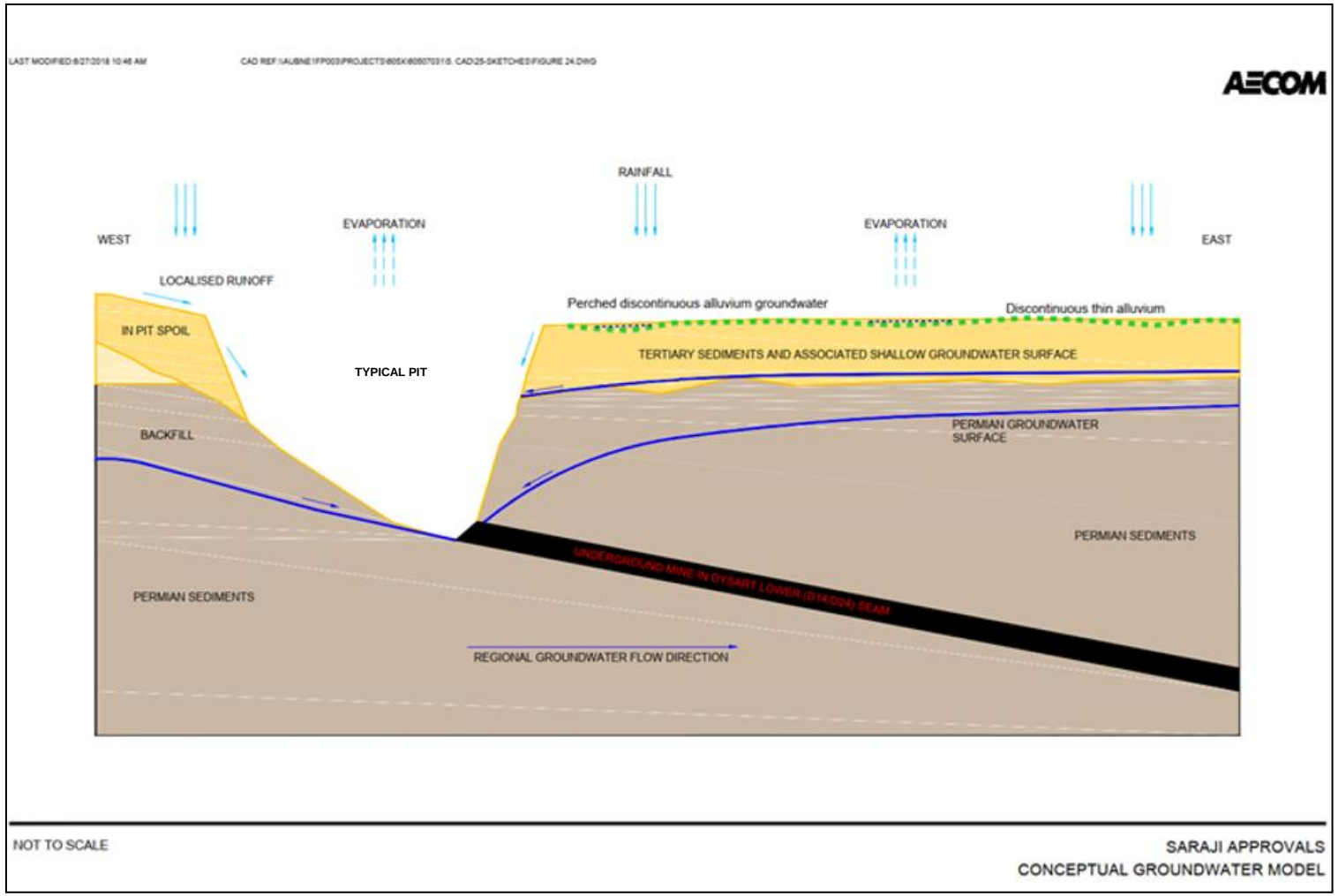


Figure 8 Conceptual west to east regional cross section of the approved Saraji Mine open cut mining

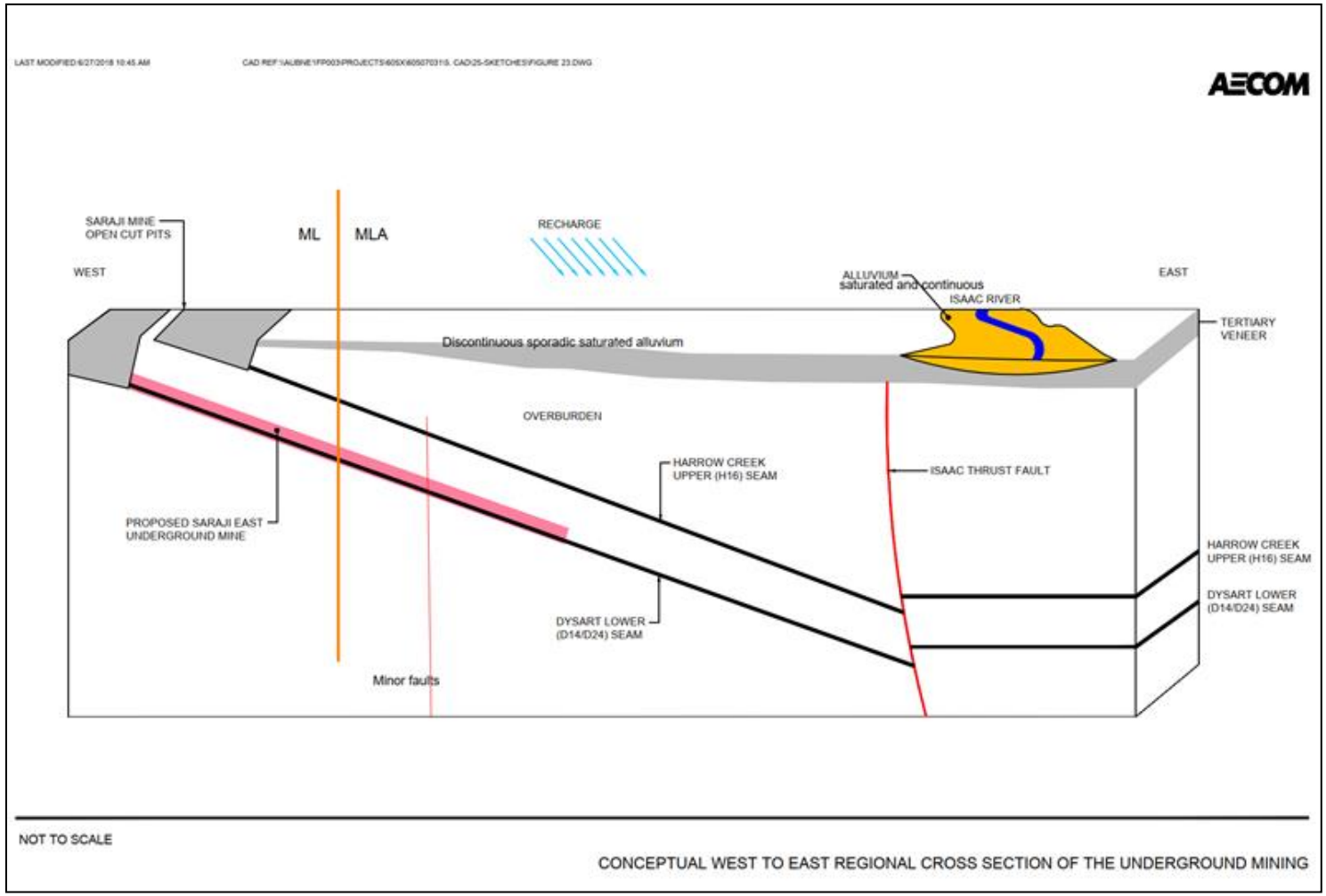


Figure 9 Regional Geological and Groundwater components included in the groundwater modelling

4.3.3 Predictive simulations

The calibrated groundwater model was utilised to assess potential impacts of the Project on groundwater resources. Evaluation of groundwater level drawdown in the following geological layers was undertaken:

- Quaternary age alluvium, colluvium and Tertiary basalt
- Regolith (weathered Tertiary and minor Triassic Clematis Group, weathered Permian, Tertiary basalt)
- Moranbah Coal Measures Q seam, P seam, and H seam
- The target Dysart Lower coal seam (D seam).

As discussed in Section 4.2.1, all model predictions of underground mining impacts also included simulation of the approved Saraji Mine open-cut operations (including the Grevillea Pit extension) as previously undertaken by AECOM (2016) and shown in the open-cut mine plan (Figure 7).

As there was overlap between the approved open-cut mine plan and the proposed underground mine plan, the open-cut mine plan was modified for simulation of underground mining activities by removing those open-pit mining areas which overlapped with the proposed underground workings (Section 4.1.1); the justification being that these areas cannot be mined by open cut mining methods if they are being mined using the underground mining methods. The modifications to the open-cut mine plan are shown in Figure 6.

The predictive model simulations included the following:

- Predictions of groundwater levels from the end of the transient calibration model from January 2022 to January 2044
- Predictions of groundwater level recovery from January 2044 to January 4044 for 2,000 years
- The prediction of groundwater ingress into the proposed Project, allowing for the estimate of groundwater ingress into the underground mine over time.

4.3.3.1 Groundwater level drawdown

A combined steady sate, transient warm-up and transient calibration model was developed, as follows:

- A steady state model with one stress period to simulate the water levels pre-mining
- A transient warm-up model with one 20-year stress period from January 1988 to December 2007
- A transient calibration model with 56 quarterly stress periods from December 2007 to December 2021.

The first stress period of the model was steady-state and did not include any mining. The transient warm-up model was built to incorporate pre-2008 mining activities and their impacts on groundwater levels around the Project. The warm-up model provided appropriate starting conditions for the calibration model (i.e., starting heads and hydraulic properties).

The groundwater model was then used to simulate changes to pre-mining conditions within the model domain in response to the approved open-cut and proposed underground mining plans.

As per the AECOM (2016) model, backfilling of the open-cut pits with spoil was simulated to occur, allowing for the change in model layer parameters, as detailed in Table 12.

The combination of backfill of open-cut pits (recharge), open-cut workings (dewatering), and underground workings (goaf alteration and dewatering) were simulated to allow for the evaluation of groundwater levels in response to complex mining operations.

4.3.3.2 Bore trigger thresholds

Sections 376(b)(iv) and 376(b)(v) of the Water Act refer to bore trigger thresholds. As defined in the Water Act, a bore trigger threshold for an aquifer means a decline in the water level that is:

- 5 m for consolidated aquifers (e.g. sandstones)
- 2 m for unconsolidated aquifers (e.g. sand/ alluvium aquifers).

To align with the requirements of the Water Act, groundwater drawdown contours were produced to be consistent with the bore trigger thresholds as follows:

- The surficial Quaternary/Tertiary sediments (including alluvium) are unconsolidated and thus 2 m drawdown contours were produced which is consistent with the bore trigger threshold for unconsolidated sediments.
- The deeper Tertiary and Permian sediments are consolidated and thus 5 m drawdown contours were produced which is consistent with the bore trigger threshold for consolidated sediments.

The 2 m and 5 m triggers relate to change in groundwater levels from the initial groundwater levels at the start of model predictions (i.e. pre-activities).

4.3.4 Model code

MODFLOW-USG Transport was used as the model code (Panday et al. 2013). MODFLOW-USG is the recent version of industry standard MODFLOW code and was determined to be the most suitable modelling code for accomplishing the model objectives. MODFLOW-USG optimises the model grid and increases numerical stability by using unstructured, variably sized cells. These cells take any polygonal shape, with variable size constraints allowing for refinement in areas of interest (i.e., geological or mining features).

Where previous MODFLOW versions restricted interlayer flow to vertical connectivity, MODFLOW-USG offers lateral connectivity between model layers. Lateral connectivity enables more accurate representations of hydrostratigraphic units, particularly those that pinch out, outcrop, or cross geological faults.

MODFLOW-USG is also able to simulate unsaturated conditions, allowing progressive mine dewatering and post mining rewetting to be represented by the model. For the Project model, vadose zone properties have been excluded, and the unsaturated zone was simulated using the upstream-weighting method.

Fortran code and a MODFLOW-USG edition of the Groundwater Data Utilities (Watermark Numerical Computing) were used to construct the MODFLOW-USG input files.

4.3.4.1 Modelling method

The BMA regional scale groundwater model was adopted as a base for the Project model. A range of updates to the BMA regional groundwater model were deemed required for the model to be considered fit for purpose for the Project[2].

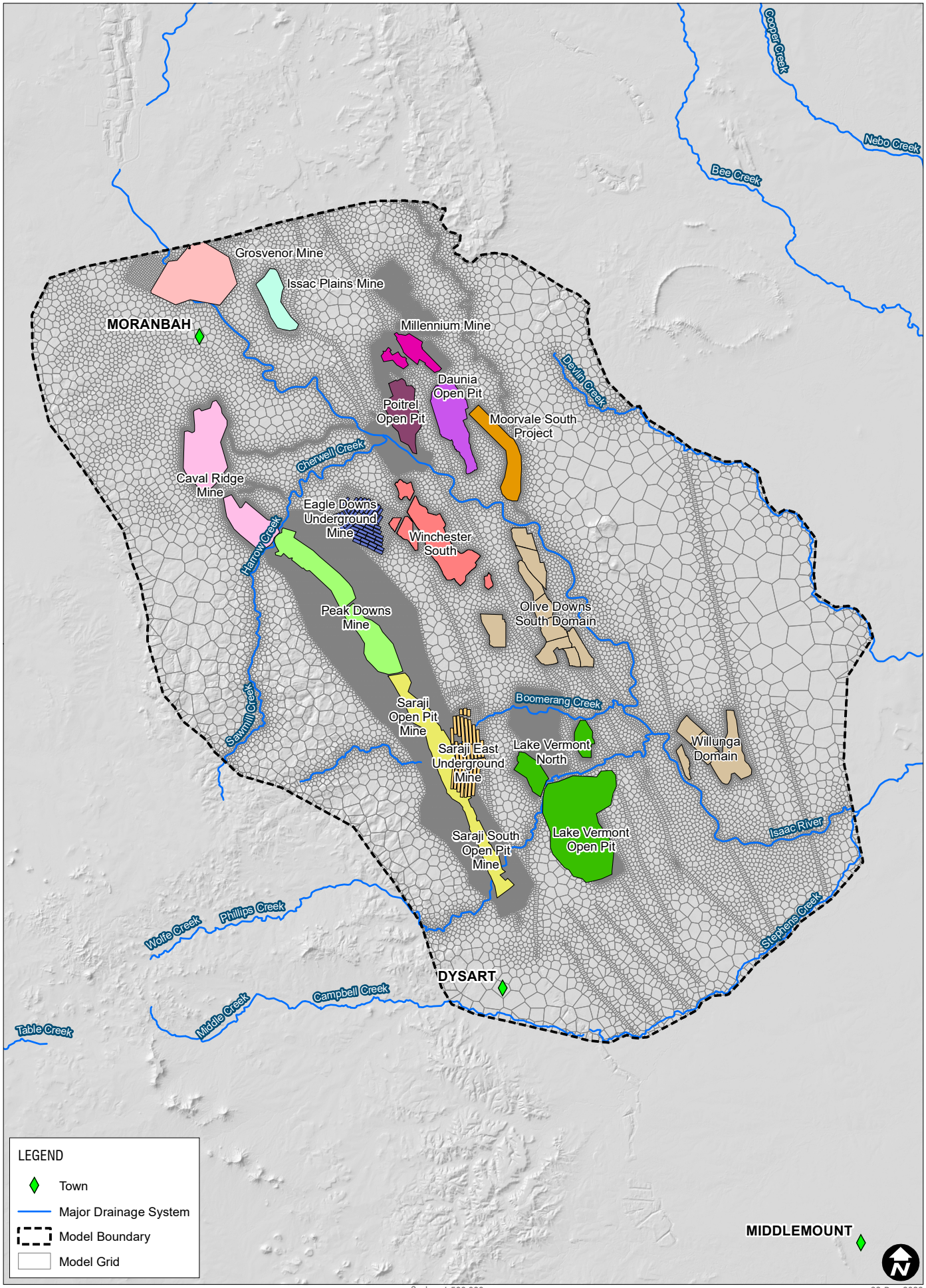
The updates to the model design were as follow:

- Updated fracture zone depth and hydraulic property changes above the proposed Project longwall panels based on the Project subsidence modelling report (Minserve, 2022).
- Updated model layer geometry based on the Peak Downs Mine, Saraji Mine, the Project, and Saraji South[3] latest BMA geological models.
- Implemented historic and approved future mining operations at Saraji Mine and Peak Downs Mine and the proposed project underground operations.
- Refined surface elevations and hydrologic features.

[2] There are two accepted guides to the review of groundwater models: the Murray-Darling Basin Commission (MDBC) Groundwater Flow Modelling Guideline (MDBC, 2000), and guidelines issued by the National Water Commission in June 2012 (Barnett et al., 2012). The National Water Commission Compliance Checklist concludes that the groundwater model is “fit for purpose”, where the purpose is defined by the model objectives (Section 4.3.1).
[3] Formerly known as Norwich Park Mine

4.3.5 Model extent

The model is a regional scale model with the domain extent designed to meet environmental approvals application requirements for cumulative impact assessment, (i.e., the domain is large enough to appropriately consider all potential overlapping groundwater impacts from resource operations in the Bowen Basin). The regional groundwater model extent is shown in Figure 10.



H:\Projects-SLR\620-BNE\620.31025.00000 Saraji East GW Modelling\03 SLR Data\01 CAD\GIS\GIS\620\31025 F2-1 Model Domain.mxd

Scale: 1:500,000
GDA 1994 MGA Zone 55

22-Dec-2022
620.31025

Sheet Size : A4

0 5 10 15 km

SLR
www.slrconsultingaustralia.com

Model Domain

FIGURE 10

4.3.6 Model boundaries and design

The model domain is intended to place boundary conditions sufficiently distant from the Project and surrounding mines to allow the extent of potential impacts from mining activities on the groundwater system to be assessed. At its widest extents, the model is approximately 62 km west-east by 95 km north-south.

The model boundaries, deemed appropriate for the Project model, includes:

- The western boundary is represented by the outcrop boundary of the Back Creek Group, which dips below the coal bearing units and forms the low permeability basement layer of the model.
- The northern model boundary contains the primary geological unit being targeted by the Project and is 50 km away from the proposed longwall panels.
- The southern boundary is set along the Stephens Creek 30 km south of the Project and is expected to be far outside the range of predicted Project related drawdown.
- The eastern boundary is set along the Delvin Creek 40 km east of the Project and is expected to be far outside the range of predicted Project related drawdown.

To allow stable numerical modelling of the large spatial area of the model domain, an unstructured grid with varying Voronoi cell sizes, as evident in Figure 10, was designed. Varying Voronoi cell sizes allowed refinement around areas of interest (such as a longwall panel or fault), while a coarser resolution elsewhere to reduce the total cell count to a manageable size (i.e., reduced model run-times).

The model domain was vertically discretised into 19 model layers, each layer comprising up to 121,225 cells. The total number of cells in the model is 1,362,485.

The following features have been included in the grid design:

- The Isaac River is represented in the model with a 50 m Voronoi cell size constraint.
- Longwall mining for the Project is represented with a 100 m cell size constraint.
- Open cut mine areas for the opencut mines including Peak Downs Mine, Saraji Mine, Caval Ridge Mine, Poitrel, Daunia, Millennium, Lake Vermont, Winchester South, and Olive Downs have a 100 m Voronoi cell size constraint.
- Longwall mining at Grosvenor and Eagle Downs mines has an oriented regular grid of 100 m width squares to represent longwalls.
- Faults are represented using a 200 m Voronoi cell constraint.

4.3.7 Model stresses and boundary conditions

4.3.7.1 Regional groundwater flow

General Head Boundary (GHB) was specified along the eastern, southern, and part of the northern model boundaries. The GHB boundary condition is used to represent the regional flow into and out of the model area and was assigned using GHB cells in all layers using the pre-mining head elevations.

Groundwater enters the model where the head set in the GHB is higher than the modelled head in the adjacent cell and will leave the model when the water level is lower in the GHB. GHB conductance was calculated using the hydraulic conductivity and the dimensions of each GHB cells and is therefore variable in this model due to variable cell-size.

No flow boundary was applied to the western boundary of the model that represents the outcrop of the Back Creek Group.

A drain boundary condition was used in the northern model boundary to simulate the mining at the Grosvenor Mine.

4.3.7.2 Watercourses

Major rivers (including Isaac River) as well as minor creeks were built into the model using the MODFLOW-USG RIV package.

River and creek widths, thickness and conductance values were adopted from the base BMA regional scale groundwater model. The rivers are set with the riverbed 1 to 10 m below the surrounding topography to represent the steep-banked incised channels. The river widths were assumed to be fixed for each river in the model. The river widths were estimated using aerial photography.

The river conductance was calculated using river width, river length, riverbed thickness, and the vertical hydraulic conductivity of river bed material. Therefore, the river conductance is variable due to the non-constant spatial discretisation in each of the model river cells. The vertical hydraulic conductivity of river beds for different rivers in the model were adopted from the base model.

The river stage height in the minor tributaries or drainage lines was set to 0 m (i.e., river stage elevation was equal to river bottom elevation). Therefore, the minor tributaries or drainage lines act as drains to the groundwater system and do not result in any recharge from the watercourse to the groundwater system.

4.3.7.3 Rainfall recharge

The dominant mechanism for recharge to the groundwater system is through diffuse infiltration of rainfall through the soil profile and subsequent deep drainage to underlying groundwater systems. Diffuse rainfall recharge to the model was represented using the MODFLOW-USG Recharge package (RCH).

The recharge rates were established through the calibration process, with bounds based on the conceptual understanding of the system and comparing them with other groundwater models prepared for the region. The starting values adopted in the calibration process were from the base BMA regional scale groundwater model. Rainfall recharge was imposed as a percentage of actual rainfall from the SILO Grid Point observations. Long-term average rainfall was used for the steady-state model. For the transient calibration model, quarterly averages of the historical rainfall data were used (2008 to 2020). For the prediction model, annual averages of 1990-2020 rainfall data was used.

4.3.7.4 Evapotranspiration

The MODFLOW Evapotranspiration (EVT) package was used to simulate evapotranspiration from the groundwater system.

Extinction depths (the depth below land surface below which EVT does not occur) were set to 2 m below ground across the model domain. Maximum potential rates were set using actual evapotranspiration values (from the Bureau of Meteorology), with the average value (600 mm/year) used as the transient calibration evapotranspiration rate.

An EVT rate of 0 was assigned to the model cells representing the rivers.

4.3.7.5 Groundwater use

Private groundwater pumping bores have not been included in the model due to lack of information regarding abstraction rates across the model domain. Due to generally low groundwater abstraction across the Project Area and model domain, it is likely that the bores have limited and localised drawdowns, which will not significantly impact model results.

4.3.7.6 Mining

The MODFLOW Drain (DRN) package was used to simulate mine dewatering in the model for the Project and surrounding mines. Boundary conditions for drain cells allow one-way flow of water out of the model. When the computed head drops below the stage elevation of the drain, the drain cells become inactive. This is an effective way of representing removal of water seeping into a mine over time, with the actual removal of water being via pumping and evaporation.

Project longwall mining groundwater extraction was represented as drain cells in the target D Seam and predicted fracture zone, extending above the Moranbah Coal Measures H seam. The depth of overburden over the target D seam coal varies between 110 m and 470 m. The panel width and extraction height are 320 m and 3.6 m, respectively.

The drain cells representing the surrounding mines are consistent with the base model. To simulate open cut mines in the model, drain cells are applied to all active layers from the surface to the base of the lowermost mined seam. Longwall extraction at Grosvenor Mine and Eagle Downs Mine are represented as drain cells in the target D Seam and the fracture zone, consistent with the base model.

4.3.8 Model layers

The structure of the coal seams within the Project Area comprises a Permian sequence overlain by a surficial covering of Tertiary and alluvium (in places) sediments. The Permian rocks form a regular layered sedimentary sequence which was simplified for the numerical model by merging several formations / strata into model layers. This is most evident when considering the overlying Permian coal measures, where coal seam aquifers and interburden aquitards are considered as one hydrogeological

model layer. This is a conservative approach allowing for higher vertical hydraulic conductivity than can be expected associated with the interburden aquitards.

Topography within the model domain has been defined using numerous sources of varying accuracy, including high resolution (1 m) Digital Elevation Model (DEM) data, which was used to define local surface elevation within the Project Area. Outside the extents of the DEM dataset, LiDAR data and public domain 25 m DEM data sourced from Geoscience Australia was used to define topography in the remainder of the model domain.

The model domain includes 19 model layers, as listed in Table 4. Table 4 includes the average thicknesses across the model domain for each layer. Model layer extents (lateral and vertical) where based on the following sources:

- The BMA Saraji Mine site geological model
- The BMA Saraji South site geological model
- The BMA Daunia Mine site geological model
- The BMA Caval Ridge Mine site geological model and borehole logs
- The BMA Poitrel Mine site geological model
- The Jellinbah Mining Pty Ltd, Lake Vermont, Lake Vermont North and Lake Vermont Meadowbrook site geological models and borehole logs
- The Whitehaven WS Pty Ltd Winchester South Project site geological model and borehole logs
- The MetRes Pty Ltd, Millennium site geological model
- The Peabody Energy Limited, Moorvale South Project site geological model and borehole logs
- The Pembroke Resources Limited, Olive Downs Project site geological model and borehole logs
- The CSIRO Regolith depth survey
- Queensland Globe borehole logs
- Queensland surface geology and basement geological map.

Table 4 Model layers

Model layer	Hydrostratigraphic units	Description	Average thickness (m)
1	Alluvium, colluvium, Tertiary basalt	Surface cover – alluvium, colluvium, and Tertiary basalt	8.3
2	Tertiary sediments, Tertiary basalt	Tertiary and minor Triassic Clematis Group, weathered Permian, Tertiary basalt	19.2
3	Rewan Group	Triassic mudstone and sandstone	117.7
4	Rangal Coal Measures	Leichhardt overburden	36.6
5		Leichhardt seam	4.6
6		Interburden	35.6
7		Vermont seam	3.8
8		Vermont underburden	34.1
9	Fort Cooper Coal Measures	Fort Cooper overburden	206.6
10		Fort Cooper seams (combined)	55.9
11		Fort Cooper underburden	56.1
12	Moranbah Coal Measures	Q seam	3.3
13		Interburden	38
14		P seam	2.9
15		Interburden	56.4
16		H seam	5.5
17		Interburden	67.1
18		D seam (target coal seam)	8.4
19		Base of model – aquitard Back Creek Group	100

Model Layer 1 is extensive across the entire model domain with an average thickness of 8.3 m. It is noted that alluvium is not laterally or vertically extensive across the model domain; as such it was included within Layer 1 as a separate zone but not as a separate layer. With respect to Boomerang Creek (at the Project), the alluvium associated with the creek was set a uniform thickness of 3.75 m consistent with deepest alluvium recorded within the drill hole logs along the creek (Section 5.3.5).

Model Layer 2 is also fully present across the model domain with a minimum thickness of 1 m. The available site geology models were used to define the base of model Layer 2. Outside these site geology models the base of Layer 2 was interpreted from CSIRO regolith survey depths and Queensland Globe bore log lithology data.

The underlying Triassic and Permian layers are present only to their outcrop extents, with some inference made for the presence of older units beneath the surface outcrop due to folding and (horst and graben) faulting. The Rangal Coal Measures and Fort Cooper Coal Measures are consistent with the base BMA regional scale groundwater model.

The Moranbah Coal Measures model layers, include for all the coal seam targets, consistent with the site geological models. As noted, it was not possible to represent every individual coal seam or ply in the model layers representing the Moranbah Coal Measures, therefore a ‘combined thickness’ totalling the approximate thickness of coal for the main seams was used. The major coal seams represented in the model are the Q, P, H and D seams. In doing so, the thicknesses of each individual coal seam (typically < 1m thickness) were combined separately for the major coal seams and the combined thicknesses were used in the model.

The basement layer has the thickness of 100 m and considered to replicate the Back Creek Group. The Back Creek Group, the footwall sediments for the target Moranbah Coal Measures, in general has low

permeability and will act as regional aquitard, suppressing downward vertical flow. Site-specific long-term groundwater level monitoring in the Back Creek Group, adjacent to the Saraji Mine at MB37, does not indicate any dewatering of this aquitard unit below and adjacent to the Saraji Mine (Section 5.3.8).

4.3.8.1 Hydraulic parameters

The groundwater modelling approach included a staged approach, which included:

- A steady state model with one stress period to simulate the water levels pre-mining
- A transient warm-up model with one 20-year stress period from January 1988 to December 2007
- A transient calibration model with 56 quarterly stress periods from December 2007 to December 2021.

The first stress period of the model was steady-state and did not include any mining. The transient warm-up model was built to incorporate pre-2008 mining activities and their impacts on groundwater levels around the Project. The warm-up model provided appropriate starting hydraulic properties (i.e., horizontal, vertical conductivity, specific yield, specific storage, and recharge rates) for the calibration model. The calibrated hydraulic properties are included in Section 4.4.

A transient predictive model was then developed from the end of the transient calibration model from January 2022 to January 2044. The recovery model will then start from January 2044 to January 4044 for 2000 years.

The hydraulic conductivity of the Permian interburden material in the Rangal Coal Measures, Fort Cooper Coal Measures, and Moranbah Coal Measures reduces with depth as recognised in the field observations. As the decrease of hydraulic conductivity within hydraulic conductivity the interburden rock units is driven by an increase in overburden pressure, the relationship between hydraulic conductivity and depth is different from that of coal seams. These relationships were determined using hydraulic conductivity versus depth data for the Rangal Coal Measures, Fort Cooper Coal Measures, and Moranbah Coal Measures interburden and coal seams.

The reducing hydraulic conductivity (exponential and power equations) of the coal seams and interburden with depth (detailed in Section 5.3.7.3) included:

- Coal: $HC = HC_0 \times e(-0.015 \times depth)$ (*Eq. 1*)
- Interburden (RCM and FCCM): $HC = HC_0 \times e(-0.018 \times depth)$ (*Eq. 2*)
- Interburden (MCM): $HC = HC_0 \times -2.1^{depth}$ (*Eq. 3*)

Where:

- HC is horizontal hydraulic conductivity at specific depth
- HC_0 is horizontal hydraulic conductivity at depth of 0 m (intercept of the curve)
- depth is depth of the floor of the layer (thickness of the cover material)
- slope is a term representing slope of the formula (steepness of the curve).

4.3.8.2 Recharge and discharge

The recharge rate was varied across the model, where seven recharge zones were included for the model calibration. The seven recharge zones include:

- Isaac River Flood Plain Alluvium
- Isaac River Channel Alluvium
- Alluvium – rest of the model
- Regolith
- Basalt
- Duaringa Formation
- Weathered Permian units.

The rainfall recharge was refined during the calibration, the recharge rates and per cent Mean Annual Precipitation (MAP), using 565 mm/year, is included in Table 5.

Table 5 Recharge rates

Recharge zone	Rate (mm/year)	% MAP
Isaac River Flood Plain Alluvium	1.3	0.24
Isaac River Channel Alluvium	0.3	0.05
Alluvium – rest of the model	0.7	0.13
Regolith	0.1	0.01
Basalt	2.3	0.40
Duaringa Formation	0.2	0.03
Weathered Permian units	0.5	0.10

The rainfall recharge calibration details and comparison to chloride method estimates are included in Section 4.4.

An enhanced recharge of 100 per cent is applied to residual mine pit voids in the prediction model, where void lakes are not represented. No recharge is applied to constant head cells representing void lakes during recovery predictions. Recharge to mine spoil is set to 1 per cent of average annual rainfall.

Surface discharge of groundwater was included in the model using the MODFLOW river (RIV) package in model Layer 1. The RIV package compares the water level in the aquifer against a reference river depth level, whereby if the aquifer water level is above the reference level, then water is removed at a rate specified by the river bed conductance. Section 4.3.7.2 includes additional discussion.

Groundwater inflow to the mine workings was modelled using the MODFLOW Drain (DRN) package. Using drains involved the setting of a reference (drain target) elevation at the base of the target D seam and a conductance (leakage) term.

4.3.8.3 Impacts of longwall mining - goaf

To estimate mine impacts and estimates of groundwater ingress from underground longwall mining activities, aquifer alteration due to mining (longwall goaf) was taken into consideration.

Longwall mining results in collapse of the overlying rock strata into the void left by coal extraction. The collapsed or disturbed overburden material is referred to as goaf. The collapse propagates upwards from the extracted seam until bulking of the goaf limits vertical movement and the tensile strength of the rock is sufficient to hold up the overburden without failure. Where propagation extends to the land surface, subsidence of the land surface occurs.

4.3.8.4 Simulation of subsidence effects due to goaf alteration

Modelling of subsidence predictions specific to the proposed underground mine workings were undertaken by GEONET (2022). The GEONET subsidence report allowed for an estimate of the vertical extents of alteration above the longwall mining panels. In addition, the GEONET subsidence assessment provided estimates of possible changes to aquifer hydraulic properties, dependent on the hydrostratigraphic unit, because of goaf.

The subsidence model was set up to include the major geological strata with properties which reflected pre-mining conditions. The subsidence model simulated the effect of bed separation, opening of joints and the formation of new cracks in the originally intact overburden rock mass. Changes in stress and the induced deformation in the surrounding rock mass associated with rock fracture and bedding plane separation were calculated.

Main findings of the subsidence modelling are summarised below:

- When overburden thickness is less than 300 m above the target D coal seam, the subsidence modelling results show continual volumetric strain and rock mass damage in the overburden strata extending from longwall edge to the surface. Shear cracks at the surface are predicted to form to a depth of 30 m to 70 m below the ground level.
- When the overburden thickness is more than 300 m, the results indicate that the fractured zone extends to above 30 m to 50 m above the Harrow Creek seam (H Seam, layer 16 in the groundwater model). The overlying units will be undamaged rock mass. Longwall mining also

induces shallow tension cracks which are predicted to extend to a maximum depth of 15 m below ground level.

4.3.8.4.1 Changes in hydraulic properties due to longwall mining

As longwall mining progresses through the coal seam, the void left behind collapses (goaf) and fills with collapsed rock from the formations directly above the coal seam (i.e., the caved zone). There is a sag in the bedded formations above the goaf zone and the deformation causes generally vertical fractures to occur. These fractures can provide new flow paths for groundwater and alter the permeability of the strata overlying longwall mining areas.

Based on the subsidence model findings, two different fracture zones were predicted and included in the model. These include:

- Fracturing where the longwall panels have an overburden thickness > 300 m
- Fracturing where the longwall panels have an overburden thickness < 300 m.

With respect to deeper longwalls (overburden thickness > 300 m), it was assumed that the fracture zone generally extends to 50 m above the Harrow Creek seam (H Seam) and the surface cracking occurs up the depth of 15 m.

Over shallower longwalls (i.e., overburden thickness < 300 m), the surface cracking extend to a depth of 50 m. It was assumed here that the fracturing occurs above the longwall up to the surface cracking zone. These fracture zones, as included in the groundwater model using the time-variant materials (TVM) package of MODFLOW-USG Transport, are included in Figure 11.

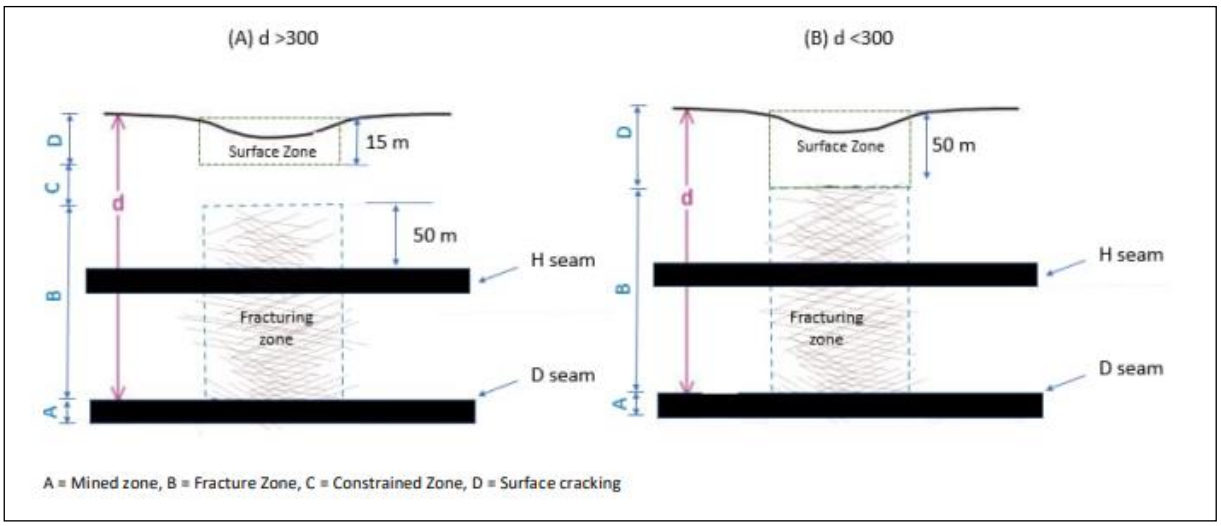


Figure 11 Fracture zones (SLR, 2023)

The hydraulic parameter changes within the goaf induced fracture and surface shear crack zones are included in Table 6. The values are the average numbers being used in the groundwater modelling to simulate the fracturing above the coal seam.

Note: In this study, it was assumed that any change to hydraulic and storage properties remained until the end of model predictive run, (i.e., there is no 'self-sealing of subsidence fracturing over time). This approach is considered to be conservative given that the overlying Tertiary sediments, particularly those at the surface zone, swell and self-seal over time, and therefore any surface cracks fill with sediments reducing their hydrological effect over time. This phenomena is recognised in the Bowen Basin, as evident at the Goonyella Broadmeadow Riverside Mine complex, where water ponding occurs in subsided areas and does not drain vertically (Plate 1).

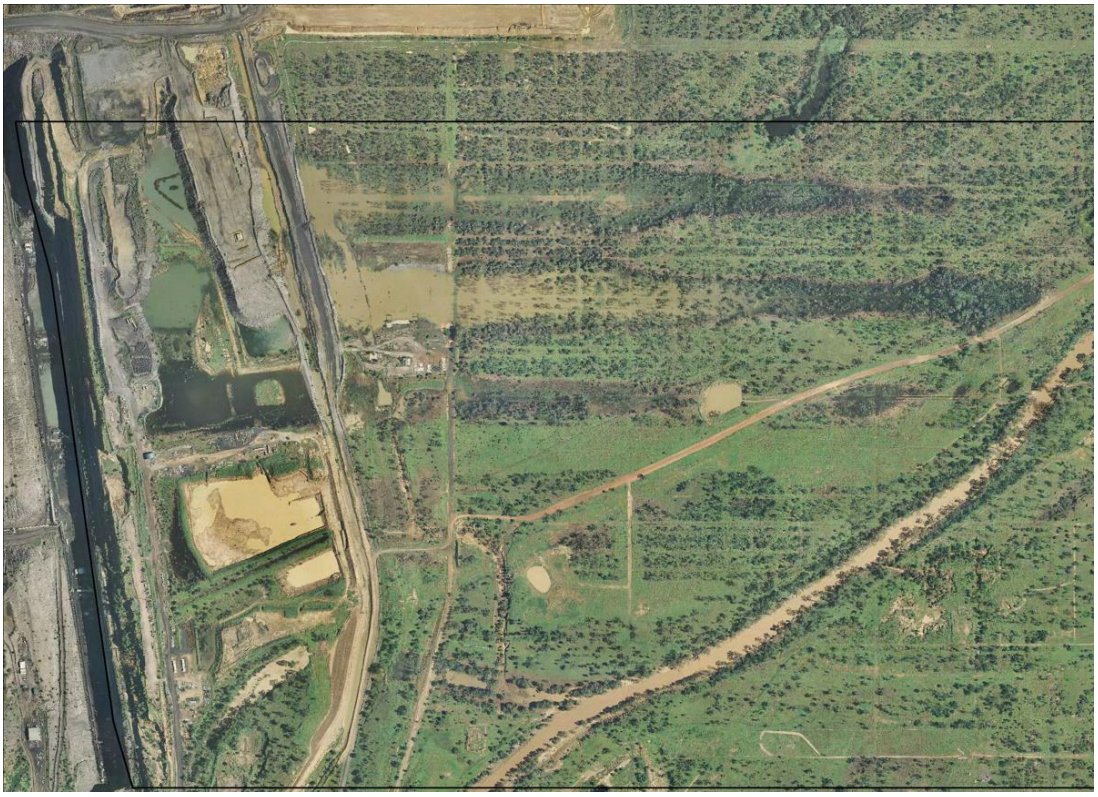


Plate 1 Flooded subsided longwall panels at the Bowen Basin Goonyella Broadmeadow Riverside Mine complex

Table 6 Hydraulic parameter changes due to longwall mining

Fracture zone components	Zone (Figure 11)	Changes
Surface cracking	D	• No change to horizontal hydraulic conductivity • 10 x increase in vertical hydraulic conductivity
Constrained zone	C	• No change
Fracture zone	B	• 3 x increase in horizontal hydraulic conductivity • 100 x increase in vertical hydraulic conductivity
Mined zone (extracted coal)	A	• Horizontal hydraulic conductivity of 100 m/day • Vertical hydraulic conductivity of 100 m/day • Specific yield of 0.16

These changes were included in the predictive modelling to simulate longwall mining alteration.

4.3.8.5 Open cut mining alteration

For open cut mining, the spoil and waste rock are more permeable than the undisturbed strata. Completed open cut mining areas, as identified within the Saraji Mine, have and will be backfilled with waste overburden as the extraction proceeds.

The model includes for the variation in hydraulic properties in the open-cut pits, using the MODFLOW TVM package, based on the operational mine plans. Horizontal hydraulic conductivity of 0.3 m/day and vertical hydraulic conductivity of 0.1 m/day is applied to the spoil. The storage parameters used for the spoil were a specific yield (S_y) of 0.1 and a storage coefficient (S) of 1.0×10^{-5}.

4.3.8.6 Simulation of incidental mine gas extraction

Removal of gas from the Permian sediments is required to ensure that the underground mine workings are unhindered by seam gas emissions during extraction of the coal.

Conceptual gas extraction modelling was undertaken by GEOGas (2016). GEOGas identified five regions with differing gas characteristics (Figure 12). Modelled gas and associated water extractions were simulated from a number of pre-drainage wells to achieve pre-determined gas contents within three years, five years, and eight years following gas and water extraction.

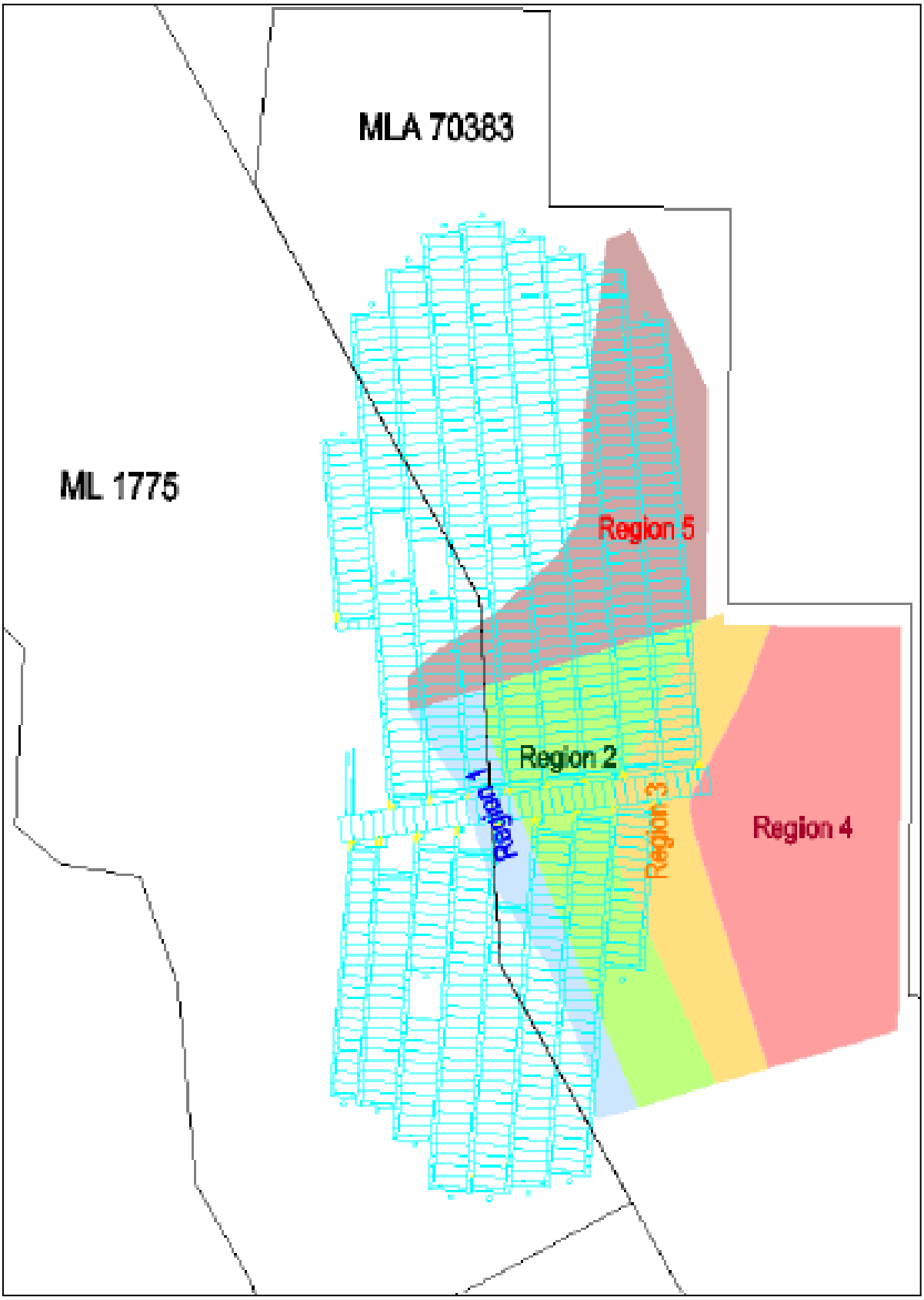


Figure 12 Incidental Mine Gas Regions (from GEOGas, 2016)

The eight-year gas and water extraction predictions, assessed by GEOGas, were adopted for the inclusion in the groundwater modelling. This allowed for the realistic simulation of groundwater extraction before and across longwall panels, as well as the dewatering associated with the actual underground mine panel mining.

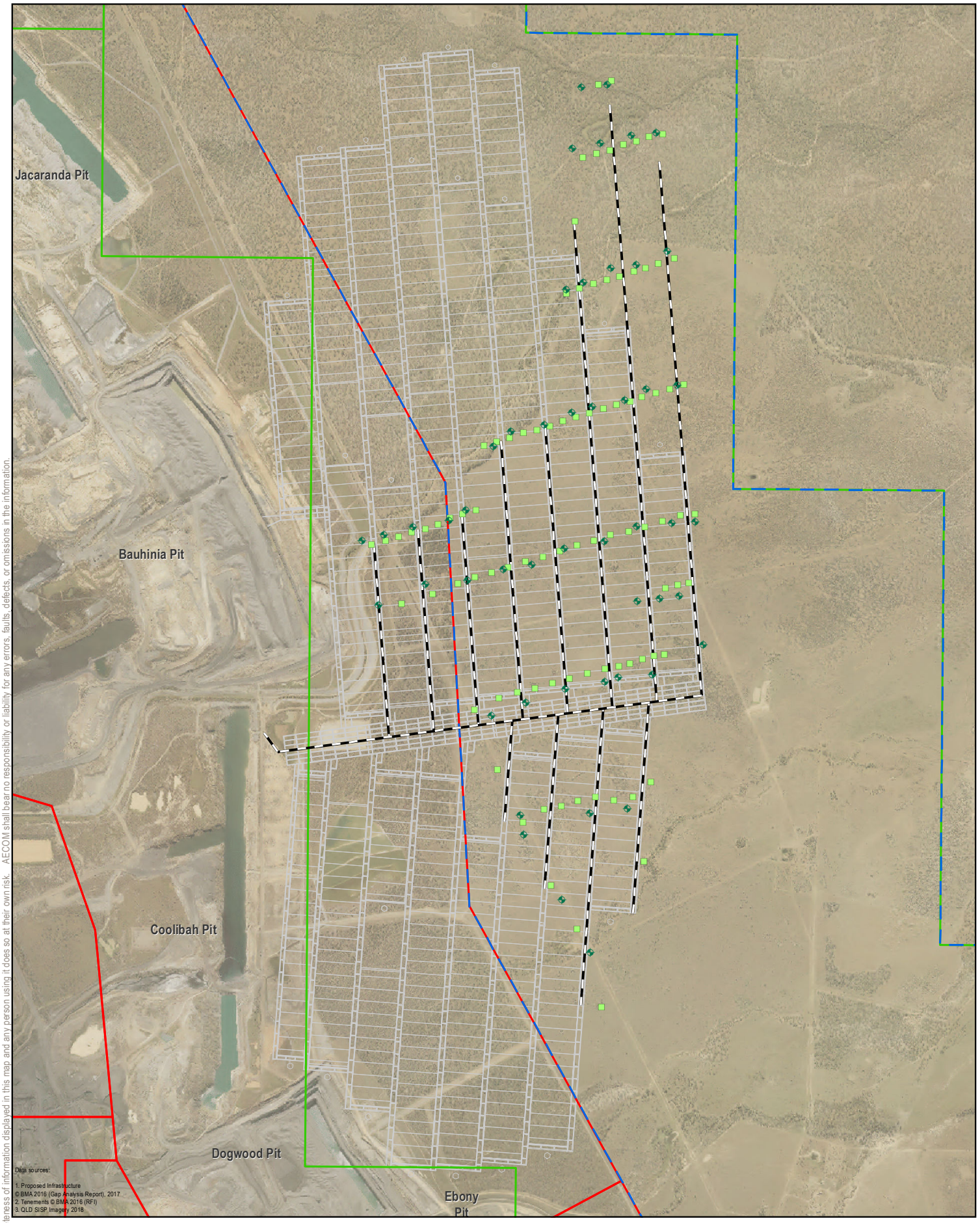
A summary of the drainage bores and water extraction volumes is provided in Table 7. The location of the water extraction bores is shown in Figure 13.

Table 7 Gas Drainage Simulation

	Region 1	Region 2	Region 3	Region 5
ML 1775				
Number of bores	2	-	-	4
Bore spacing (m)	250	-	-	110
Total pumped volume / 8 years (ML)	13,800,000	-	-	7,700,000
Total pumped volume per year (L)	1,725,000	-	-	962,500
Continuous Extraction over 8 years (L/s)	0.05	-	-	0.03
MLA 70783				
Number of bores	4	13	7	20
Bore spacing (m)	250	140	90	110
Total pumped volume / 8 years (L)	23,000,000	57,700,000	18,800,000	70,800,000
Total pumped volume per year (L)	2,875,000	7.212,500	2,350,000	8,850,000
Continuous Extraction over 8 years (L/s)	0.09	0.23	0.07	0.28

Gas extraction ahead of mining also removed groundwater as associated water during the gas extraction process. For the groundwater model, the mine gas extraction from the 50 gas and water extraction wells, was assumed to be starting one year prior to underground mining and continued for a period of 8 years.

The layout of the bores and co-ordinates are included in Figure 13. It is considered that these bores will be located to allow for the longevity of the gas wells (i.e., along longwall pillars), however, these wells will be lost / become dry over time as mining continues down dip.



Data sources:
1. Proposed Infrastructure © BMA 2016 (Gap Analysis Report), 2017
2. Tenements © BMA 2016 (RFI)
3. QLD SISP Imagery 2018

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Modelled Gas Extraction Bore
- Gas Drainage Location
- Gas Collection Line (to be collected at Centrally Located Location)

N

Figure 13
Location of Modelled Gas Drainage Bores

Groundwater Technical Report
Saraji East Mining Lease Project

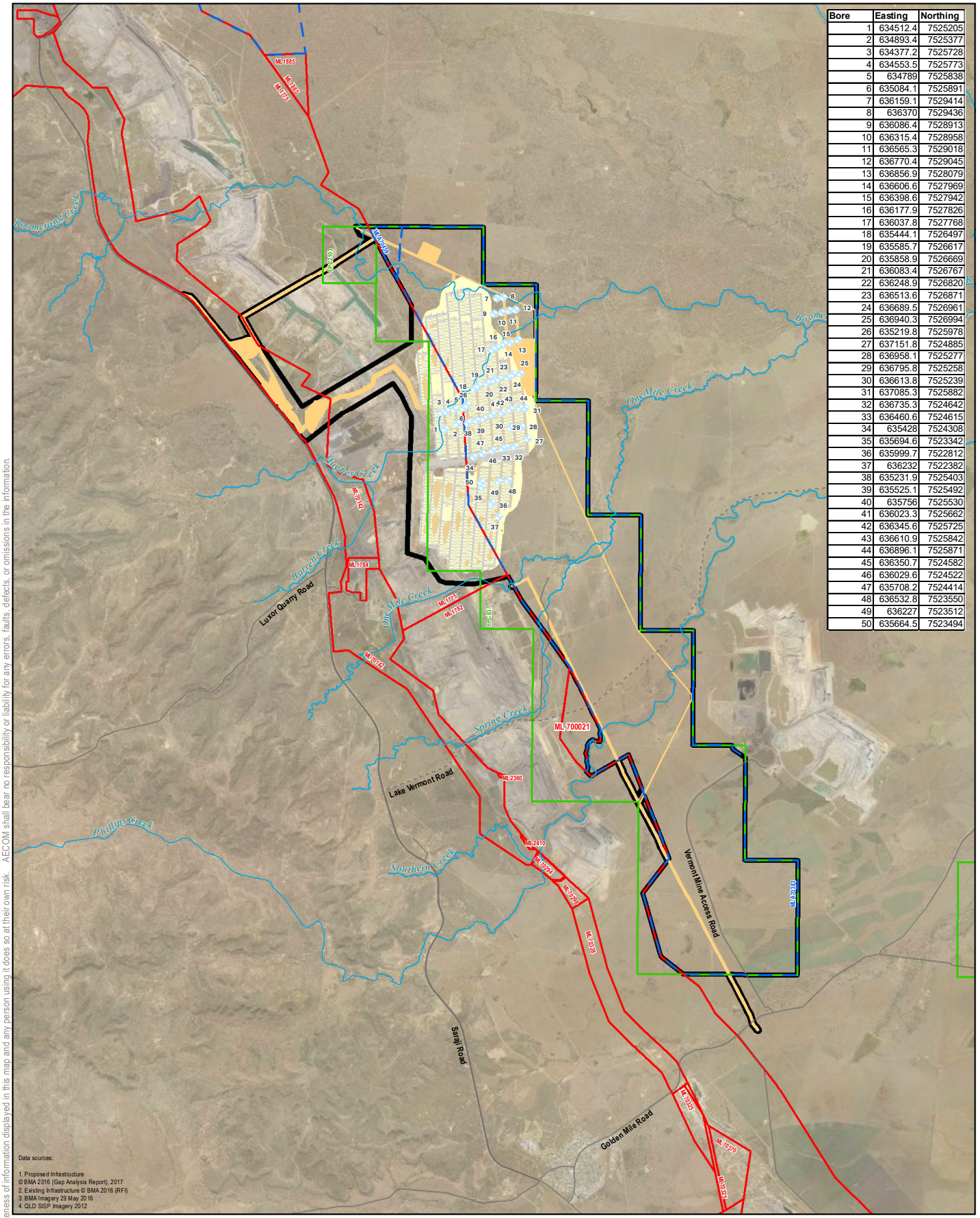
0 0.25 0.5 1
Kilometres

Scale: 1:40,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2



Bore	Easting	Northing
1	634512.4	7525205
2	634893.4	7525377
3	634377.2	7525728
4	634553.5	7525773
5	634789	7525838
6	635084.1	7525891
7	636159.1	7529414
8	636370	7529436
9	636086.4	7528913
10	636315.4	7528958
11	636565.3	7529018
12	636770.4	7529045
13	636856.9	7528079
14	636606.6	7527969
15	636398.6	7527942
16	636177.9	7527826
17	636037.8	7527768
18	635444.1	7526497
19	635585.7	7526617
20	635858.9	7526669
21	636083.4	7526767
22	636248.9	7526820
23	636513.6	7526871
24	636689.5	7526961
25	636940.3	7526994
26	635219.8	7525978
27	637151.8	7524885
28	636958.1	7525277
29	636795.8	7525258
30	636613.8	7525239
31	637085.3	7525882
32	636735.3	7524642
33	636460.6	7524615
34	635428	7524308
35	635694.6	7523342
36	635999.7	7522812
37	636232	7522382
38	635231.9	7525403
39	635525.1	7525492
40	635756	7525530
41	636023.3	7525662
42	636345.6	7525725
43	636610.9	7525842
44	636896.1	7525871
45	636350.7	7524582
46	636029.6	7524522
47	635708.2	7524414
48	636532.8	7523550
49	636227	7523512
50	635664.5	7523494

LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Gas Wells

Figure 14
Proposed Gas Well Locations and Coordinates

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

4.4 Model calibration

The calibration methodology adopted for the Project model involved running the model a number of times using different parameter sets and investigating which model produce the best calibration statistics. In doing so, the previously calibrated parameter set from the base model was used as a starting point to establish 550 realisations of the Project model, and the model was run using those 550 realisations. A full description of the parameter distribution across the 550 realisations is provided in Groundwater Modelling Technical Report (SLR, 2023).

After running the 550 calibration realisations, the calibration statistics for each realisation were assessed and the lowest Scaled Root Mean Square error (SRMS) was considered to be the best calibrated model for the purposes of the Project. The model with the parameter distribution, which produced the lowest SRMS error, was considered the base case model. The remaining 549 realisations were used to quantify the model uncertainty.

The groundwater model was calibrated to groundwater level measurements determined to be representative of water levels prior to mining (i.e. pre-1974). The model calibration considered the relatively low rainfall and high evaporation and tried to obtain a representative simulation of observed versus simulated (modelled) steady-state groundwater levels.

4.4.1 Groundwater levels

The groundwater levels recorded between January 2008 to December 2021 were used for the calculation of SRMS statistics. A total of 3,449 target heads were used from 281 bores across the model domain. The model calibration bores included:

- 34 groundwater level observation sites and VWPs[4] at Saraji Mine and the Project
- 30 groundwater level observations sites and VWPs at Lake Vermont
- 16 bores and two VWPs at Winchester South
- 38 groundwater level observations sites and VWPs at Olive Downs Project
- 6 monitoring bores at Peak Downs Mine
- 33 bores including VWPs at Caval Ridge Mine
- 124 other bores at Moorvale South Mine, Millennium Mine, Lake Vermont Meadowbrook Mine, Eagle Downs Mine, Poitrel Mine, Daunia Mine, Moranbah South Mine and several Queensland Department of Regional Development, Manufacturing and Water (DRDMW) monitoring bores.

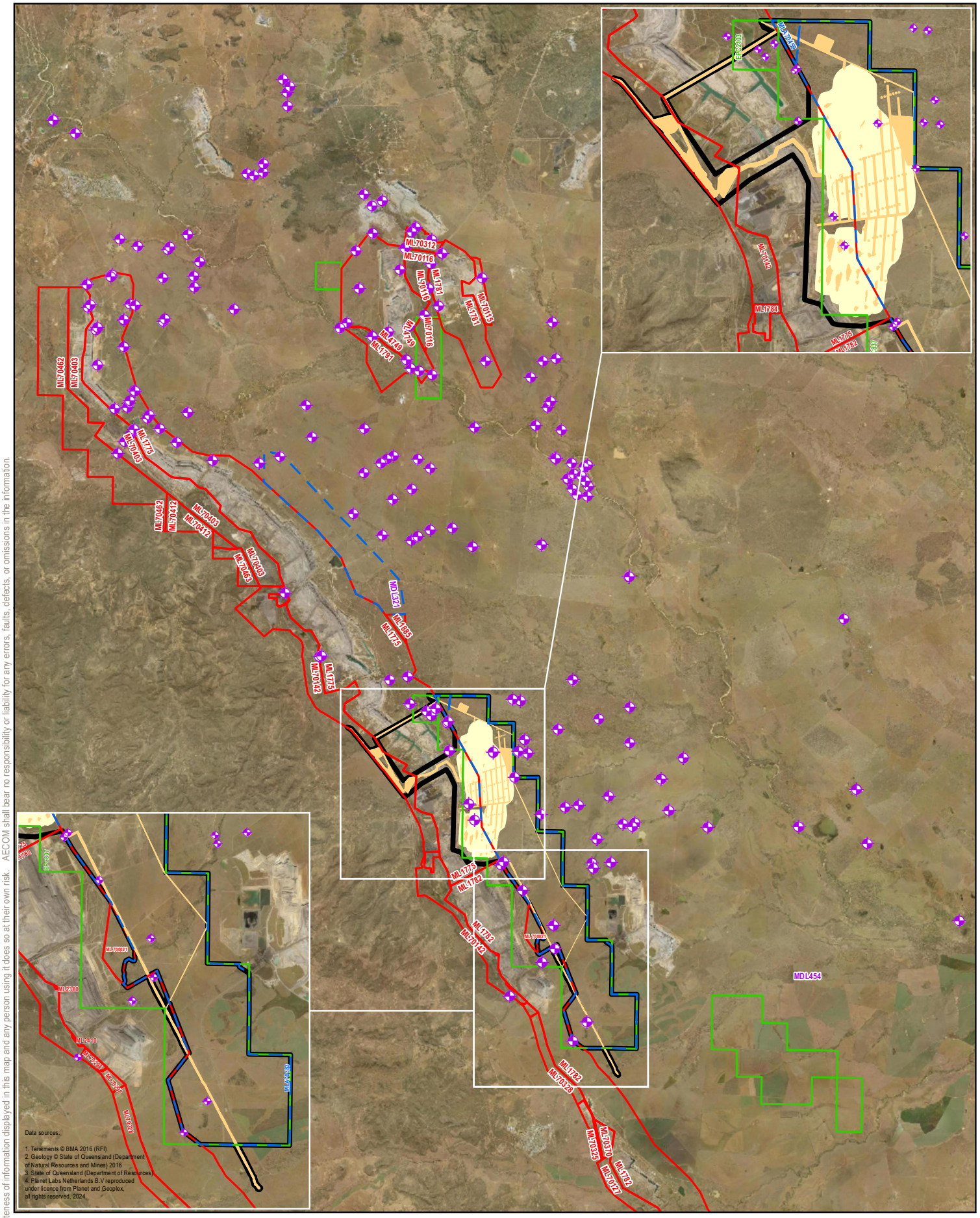
Groundwater targets were selected where:

- Valid information on bore construction or geology information was available for the site
- Targets were manually reviewed to ensure the measurements were accurate.

The hydraulic properties (i.e., horizontal, vertical conductivity, specific yield, and specific storage) and recharge rates were adjusted during the calibration to provide best match between the groundwater level measurements and model simulated heads.

The groundwater monitoring points used in the calibration are included in Figure 15.

[4] Vibrating wire piezometers (VWPs) a vibrating wire pressure transducer to accurately measure the pore water pressure of the ground by responding to changes in water pressure.



LEGEND

- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Calibrated Observation Bores

N

Figure 15
Calibrated Observation Bores

Environmental Impact Statement
Saraji East Mining Lease Project

0 2 4 8
Kilometres

Scale: 1:335,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 5/06/2024 VERSION: 0

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G456_v0_A4P_RePathed.mxd

4.4.2 Calibration statistics

The calibration statistics for the best calibrated model (lowest SRMS error) is included in Table 8. One of the industry standard methods to evaluate the calibration of the model is to examine the statistical parameters associated with the calibration. This is done by assessing the error between the modelled and observed (measured) water levels in terms of the root mean square (RMS). RMS is considered to be the best measure of error if errors are normally distributed. The RMS error calculated for the calibrated model is 10.4 m.

Table 8 Calibration statistics for the base case model

Statistics	Value
Sum of squares (m^2)	275,362.7
Mean of squares (m)	79.8
Square Root of Mean of Squares (RMS) (m)	8.9
Scaled Root Mean Square (SRMS) (%)	5.9
Sum of Residuals (m)	23,035.2
Mean Residuals (m)	6.7
Scaled Mean Residual (%)	4.4
Coefficient of Determination (tend to unity)	1.2
Targets within ±2 m (% of total)	740 (21%)
Targets within ±5 m (% of total)	1,728 (50%)
Targets within ±20 m (% of total)	3,327 (96%)

The acceptable value for the calibration criterion depends on the magnitude of the change in heads over the model domain. The total measured head change across the model domain is 156 m; therefore, the ratio of RMS to the total head change (i.e., scaled root mean square, SRMS) is 5.9 per cent. While there is no recommended universal SRMS error, the Australian Groundwater Modelling Guidelines suggests that setting SRMS targets such as 5 or 10 per cent may be appropriate in some circumstances (Barnett et al, 2012).

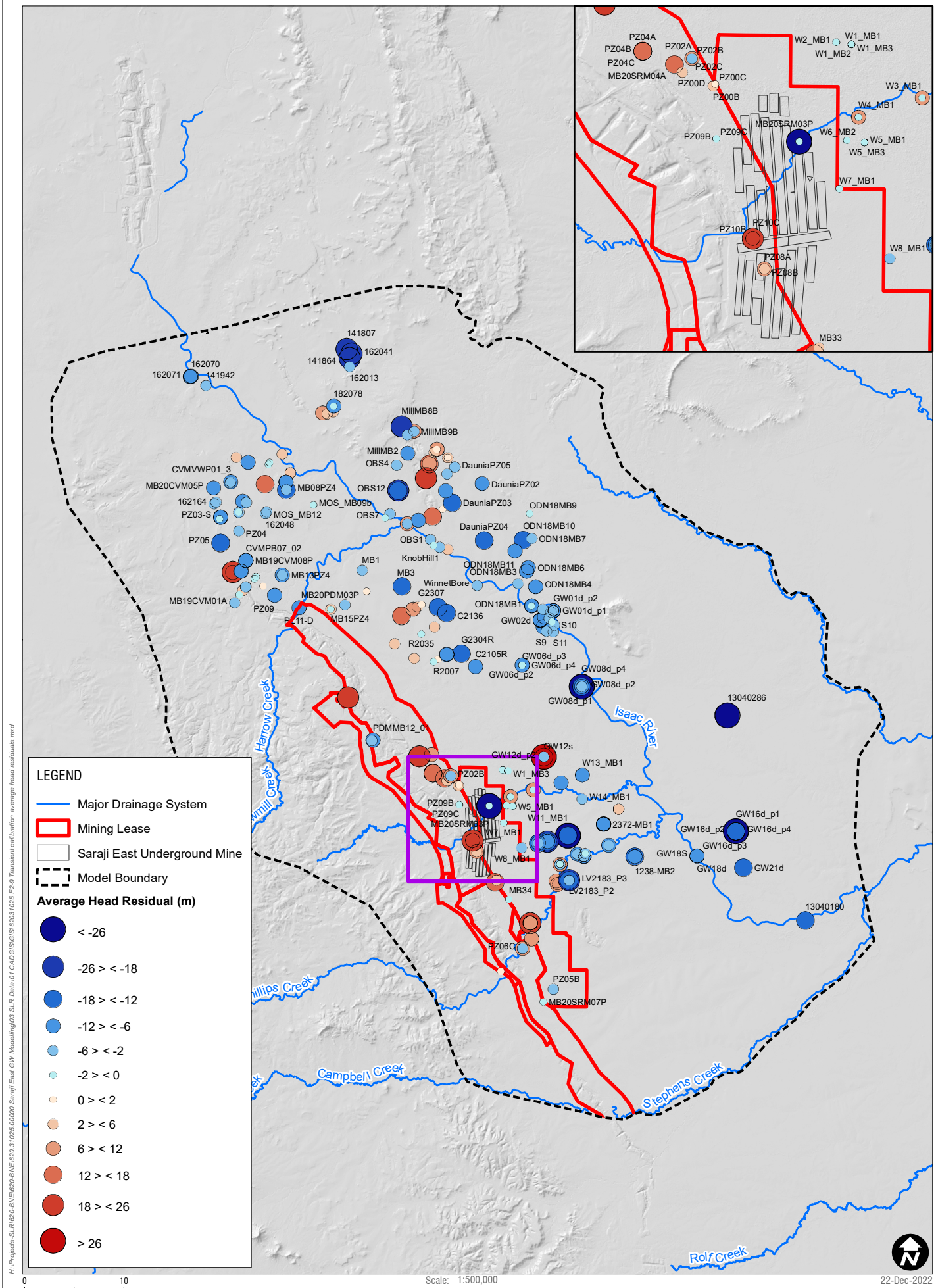
The difference between the measured and the modelled water level at each bore, referred to as the residual, was assessed across the model domain. A negative residual represents an over estimation of water levels, while a positive residual represents an underestimate. The average residual data for each model layer is included in Table 9 and Figure 16.

Table 9 Residual data for each model layer

Model layer	Hydrostratigraphic units	Description	Average residual (m)	Number of targets	Number of bores
1	Alluvium, colluvium, Tertiary basalt	Surface cover – alluvium, colluvium and Tertiary basalt	-5.3	212	18
2	Tertiary sediments, Tertiary basalt	Tertiary and minor Triassic Clematis Group, weathered Permian, Tertiary basalt	2.3	910	93
3	Rewan Group	Triassic mudstone and sandstone	-6.0	153	15
4	Rangal Coal Measures	Leichhardt overburden	-4.6	251	10
5		Leichhardt seam	-2.3	358	28
6		Interburden	-7.2	123	6
7		Vermont seam	-7.4	259	23
8		Vermont underburden	-7.2	175	5
9	Fort Cooper Coal Measures	Fort Cooper overburden	1.3	338	23
10		Fort Cooper seams (combined)	2.9	90	10
11		Fort Cooper underburden	6.8	29	4
12	Moranbah Coal Measures	Q seam	0	117	3
13		Interburden	-2.1	39	2
14		P seam	-2.5	99	6
15		Interburden	-10.4	66	5
16		H seam	-3.7	85	14
17		Interburden	-5.6	7	3
18		D seam	-4.7	138	14
19		Base of model	-	-	-

Table note: No observations in layer 19

The table also show overall the simulated groundwater levels are closer to the observed groundwater levels in the model layers representing the Moranbah Coal Measures (layers 12 to 18), excluding layer 15 which has a small number of observation bores (5).



SLR

Transient Calibration Validation
Average Head Residuals (m)

FIGURE 16

4.4.3 Model water budget

The assumed water volumes, storages and movement rates relevant to the model (known as the model water budget), was assessed to:

- Ensure the converged solution was adequately conserving mass during the simulation
- Assess water movements in and out of the model domain.

4.4.3.1 Steady-State calibration

The water balance for the steady-state model indicates that recharge was the largest net inflow contributor to the steady state model (4.2 ML/day). Regional groundwater inflow and outflow are 2.2 and 0.2 ML/day, respectively, indicating that groundwater enters the model domain through this boundary.

A net outflow of 2.3 ML/day from the steady-state model occurs due to baseflow seepage to the Isaac River (i.e. surface water and groundwater interaction in the Isaac River). Other factors that contribute to outflow from the groundwater system are evapotranspiration (3.1 ML/day outflow) and baseflow seepage to minor drainage systems (0.8 ML/day outflow).

The difference between the calculated model inflows and outflows at the completion of the calibration (known as the mass balance error), was 0 per cent. This indicates the model is stable and achieves an accurate numerical solution (Barnett et al, 2012). Table 10 presents the model water balance for the steady state simulation.

Table 10 Steady-state model water budget

Component	Flow (ML/day)
IN	
Recharge	4.20
ET / EVT	0.0
SW-GW interaction – Isaac River	7.63
SW-GW interaction – other rivers	0.00
Regional groundwater flow	2.21
Mines	0.0
Storage	0.0
TOTAL IN	**14.03**
OUT	
Recharge	0.0
ET / EVT	3.09
SW-GW interaction – Isaac River	9.97
SW-GW interaction – other rivers	0.76
Regional groundwater flow	0.21
Mines	0.00
Storage	0.0
TOTAL OUT	**14.03**
IN - OUT	0
Percent Discrepancy	0.0%

4.4.3.2 Transient calibration

The model water balance for the transient simulation averaged over the duration of the calibration period is presented in Table 12. The mass balance error, that is the difference between calculated

model inflows and outflows at the completion of the transient calibration, was 0.00 per cent, which indicates the model is stable and achieves an accurate numerical solution.

Table 12 shows 3.1 ML/day is lost to evapotranspiration in areas where the water table is within 2 m of the land surface. In total 11.4 ML/day is discharged via surface drainages, with the vast majority of that attributed to the Isaac River. A net flow loss of approximately 2.5 ML/day occurs to the Isaac River (reach within the model domain) indicates a net gaining condition in the river in the calibration period.

Table 11 Transient model water budget

Component	Flow (ML/day)
IN	
Recharge	4.68
ET / EVT	0.0
SW-GW interaction – Isaac River	8.18
SW-GW interaction – other rivers	0.00
Regional groundwater flow	2.26
Mines	0.0
Storage	10.65
TOTAL IN	**25.76**
OUT	
Recharge	0.0
ET / EVT	3.11
SW-GW interaction – Isaac River	10.71
SW-GW interaction – other rivers	0.74
Regional groundwater flow	0.22
Mines	6.32
Storage	4.66
TOTAL OUT	**25.76**
IN - OUT	0
Percent Discrepancy	0.0%

Other rivers contribute to a loss of approximately 0.7 ML/day from the groundwater system over the transient calibration with no inflow component. The regional groundwater flow fluxes (inflow and outflow) are 2.3 and 0.2 ML/day, respectively. This indicates that a small volume of water enters the model domain through this boundary and, therefore, this boundary condition does not have a significant influence on the model predictions.

6.3 ML/day is removed from the model by the Drain boundary condition that represents historical mining (1988 - 2022) in the model. The average simulated historical ingress for major active mines active during the calibration period include:

- Saraji Mine – 1.3 ML/day
- Peak Downs Mine – 1.6 ML/day
- Caval Ridge Mine – 0.6 ML/day
- Daunia Mine – 0.3 ML/day
- Poitrel Mine – 0.3 ML/day
- Millennium Mine – 0.6 ML/day
- Lake Vermont – 0.6 ML/day.

The inflow to mines reported during calibration is an average value over the entire calibration period from when mines are just starting up unto the extents at end of calibration. Whereas the average value reported herein the technical model report is when all of the mines are active and expanding.

4.4.4 Calibrated model parameters

Table 12 presents a summary of the model layer parameter values for horizontal and vertical hydraulic conductivity for the base case groundwater model.

Table 12 Model Parameters

Model Layer	Formation	Unit	Horizontal hydraulic conductivity (m/day)	Anisotropy[5] (Kv / Kx)
1	Alluvium[6]	Surface cover	54	0.28
1	Regolith	Surface cover	4.6	0.04
1	Weathered Permian	Surface cover	0.35	0.40
1	Duaringa Formation	Surface cover	1.8	0.40
1 and 2	Tertiary Basalt	Basalt	2.7	0.10
2	Regolith	Surface cover	0.35	0.20
3	Rewan Group	Aquitard	4.8×10^{-3}	0.50
4	Rangal Coal Measures	Leichhardt overburden	5.0×10^{-5} to 8.5×10^{-3}	0.10
5		Leichhardt seam	1.0×10^{-4} to 1.0×10^{-1}	0.15
6		Interburden	5.0×10^{-5} to 8.9×10^{-4}	0.002
7		Vermont seam	1.0×10^{-4} to 1.9×10^{-2}	0.50
8		Underburden	5.0×10^{-5} to 7.6×10^{-3}	0.03
9	Fort Cooper Coal Measures	Overburden	5.0×10^{-5} to 6.3×10^{-3}	0.001
10		Fort Cooper seam	1.0×10^{-4} to 3.5×10^{-3}	0.50
11		Underburden	5.0×10^{-5} to 3.5×10^{-3}	0.20
12	Moranbah Coal Measures	Q seam	1.0×10^{-4} to 5.9×10^{-2}	0.003
13		Interburden	5.0×10^{-5} to 1.0×10^{-2}	0.06
14		P seam	1.0×10^{-4} to 1.0×10^{-1}	1
15		Interburden	5.0×10^{-5} to 1.0×10^{-2}	0.50
16		H seam	1.0×10^{-4} to 7.4×10^{-2}	0.01
17		Interburden	25.0×10^{-5} to 1.0×10^{-3}	0.20
18		D seam	1.0×10^{-4} to 4.9×10^{-2}	0.20
19		Interburden	5.0×10^{-5} to 6.6×10^{-5}	0.001

Where: K_x = Horizontal hydraulic conductivity and Kv is the vertical hydraulic conductivity

The prediction modelling storage values for specific yield (S_y) and specific storage (S_s) were included in the model, as presented in Table 13.

Note that these base case parameters were used to provide an assessment of groundwater impacts, related to ingress and drawdown cone extent.

[5] An anisotropy ratio relates hydraulic conductivities in different directions.
[6] The horizontal hydraulic conductivity value of the Alluvium is detailed in Section 6.6

Table 13 Storage Coefficients

Model Layer	Formation	Unit	Specific yield (%)	Specific storage (m^{-1})
1	Alluvium	Surface cover	4.2	1.0×10^{-5}
1	Regolith	Surface cover	3.6	5.5×10^{-6}
1	Weathered Permian	Surface cover	1.0	1.0×10^{-6}
1	Duaringa Formation	Surface cover	2.1	1.0×10^{-6}
1 and 2	Tertiary Basalt	Basalt	3.4	1.2×10^{-6}
2	Regolith	Surface cover	2.8	1.0×10^{-6}
3	Rewan Group	Aquitard	4.2	7.0×10^{-7}
4	Rangal Coal Measures	Leichhardt overburden	2.8	4.7×10^{-6}
5		Leichhardt seam	0.8	9.0×10^{-7}
6		Interburden	0.1	7.0×10^{-7}
7		Vermont seam	0.2	3.1×10^{-6}
8		Underburden	0.2	1.6×10^{-6}
9	Fort Cooper Coal Measures	Overburden	0.1	7.0×10^{-7}
10		Fort Cooper seam	0.5	3.2×10^{-6}
11		Underburden	0.6	1.9×10^{-6}
12	Moranbah Coal Measures	Q seam	0.1	4.8×10^{-6}
13		Interburden	0.4	1.7×10^{-6}
14		P seam	0.1	9.0×10^{-6}
15		Interburden	0.13	1.4×10^{-6}
16		H seam	0.1	9.0×10^{-6}
17		Interburden	0.32	3.4×10^{-6}
18		D seam	0.1	9.7×10^{-6}
19		Interburden	0.39	3.5×10^{-6}

4.4.5 Faults

The modelling of faults are included within the groundwater model domain, as detailed in Section 5.2.2. Mesh refinement has been used along fault lines to allow for isolated changes of hydraulic properties along fault zones during calibration.

With regards to the faults, an exponential equation was used to replicate changes in hydraulic conductivities of fault at depth similar to the approach adopted for coal and interburden (Section 4.3.8.1). The equation for faults used was:

- $HC = HC_0 \times e(-0.018 \times depth)$

In order to show how the hydraulic conductivities changes at depth within the faults, the hydraulic parameters within faults were calculated for each layer and shown in Table 14.

Table 14 Hydraulic conductivity of faults (base case model)

Model Layer	Formation	Unit	Horizontal hydraulic conductivity (m/day)	Anisotropy (Kv / Kx)
3	Rewan Group		9.8×10^{-3}	0.35
4	Rangal Coal Measures	Leichhardt overburden	9.1×10^{-3}	0.34
5		Leichhardt seam	9.0×10^{-3}	0.32
6		Interburden	8.5×10^{-3}	0.30
7		Vermont seam	8.0×10^{-3}	0.29
8		Vermont underburden	7.7×10^{-3}	0.27
9	Fort Cooper Coal Measures	Fort Cooper overburden	7.3×10^{-3}	0.35
10		Fort Cooper seam	6.3×10^{-3}	0.18
11		Fort Cooper underburden	4.9×10^{-3}	0.12
12	Moranbah Coal Measures	Q Seam	4.3×10^{-3}	0.17
13		Interburden	4.1×10^{-3}	0.19
14		P seam	3.8×10^{-3}	0.19
15		Interburden	3.7×10^{-3}	0.23
16		H seam	3.3×10^{-3}	0.21
17		Interburden	3.0×10^{-3}	0.22
18		D seam	2.6×10^{-3}	0.21
19		Interburden	1.9×10^{-3}	0.18

The calibrated values for specific storage and specific yield for the faults in the base case model were:

- Specific yield ranged 0.2 to 3.9%
- Specific storage ranged from 7.0×10^{-7} to 6.3×10^{-6}.

4.4.6 Cumulative impacts

The use of a regional scale model with the domain extent was designed to meet environmental approvals application requirements for cumulative impact assessment, (i.e., the domain is large enough to appropriately consider all potential overlapping groundwater impacts from resource operations locally in the Bowen Basin).

The predictive modelling allowed for the simulation of cumulative drawdown to assess whether the zone of impact from the neighbouring operations is predicted to interact with the zone of impact predicted for the Project in different aquifers, including the alluvium, regolith, and Moranbah Coal Measures.

The transient predictive modelling, to aid with assessing cumulative impacts, involved three model scenarios, which included:

- Project – all approved and foreseeable mining in the region including Saraji Mine open-cut pits and the Project (proposed underground mining)

- Approved – all approved and foreseeable mining in the region including Saraji Mine open-cut pits (no Project)
- Null run – no mining within the region.

Maximum cumulative drawdown predictions were determined, which represent the total impact to modelled groundwater levels resulting from all mining within the model domain. These drawdowns were determined by comparing the maximum difference in aquifer groundwater levels for the Project model scenario with those in the theoretical “no mining” Null Run scenario, for all times during the predictive model period.

4.5 Model classification

The groundwater modelling was conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), the Murray Darling Basin Commission (MDBC) Groundwater Flow Modelling Guideline (MDBC, 2000), and the released IESC Explanatory Note for Uncertainty Analysis (IESC, 2018). These are mostly generic guides and do not include specific guidelines on special applications, such as underground coal mine modelling.

The 2012 Australian Groundwater Modelling Guidelines has replaced the model complexity classification of the previous MDBC guideline by a "model confidence level" (Class 1, Class 2, or Class 3 in order of increasing confidence) depending on:

- Available data (and the accuracy of that data) for the conceptualisation, design, and construction.
- Calibration procedures that are undertaken during model development.
- Consistency between the calibration and predictive analysis.
- Level of stresses applied in predictive models.

It is general, a model confidence level of Class 2 is required for mining environmental impact assessment; the 2012 Australian Groundwater Modelling Guidelines state that a Class 2 model may be used for assessing impacts associated with mine dewatering (Barnett et al. 2012).

Table 2.1 of the 2012 Australian Groundwater Modelling Guidelines includes the subjective qualitative criteria allowing model classification. The classification of the Project model is presented in Table 15.

Table 15 Groundwater model classification table[1,2]

Class		Model characteristics				
		Data		Calibration		Prediction
1		Few or poorly distributed data points		Not possible		Predictive timeframe >> calibration timeframe
		Unavailable or sparse data in areas of greatest interest		Unacceptable levels of error		Temporal discretisation is different to calibration
	X	No metered groundwater extraction data		Inadequate distribution of data		Transient prediction but steady state calibration
		Remote climate data		Targets incompatible with model purpose		Unacceptable validation
		Little or no useful data on land- use, soils, or river flows and stage elevations				
2		Some data but may not be adequate throughout domain	X	Reasonable calibration statistics with errors in parts of the model	X	Predictive timeframe > calibration timeframe
		Some metered groundwater extraction data		Long-term trends not replicated in all parts of domain		Long stress periods compared to calibration

Class		Model characteristics				
		Data		Calibration		Prediction
	X	Streamflow and stage measurements are available at some points		Transient calibration not extending to present day		New stresses not in calibration
		Reliable irrigation application data available in part	X	Weak seasonal replication		Poor validation
				No use of calibration targets compatible with model purpose		
			X	Validation not undertaken		
3	X	Spatial and temporal distribution of data adequate	X	Scaled RMS error or other calibration statistics are acceptable		Predictive timeframe ~ calibration timeframe
		Clearly defined aquifer geometry	X	Long-term trends adequately replicated where important	X	Temporal discretisation in predictive model consistent with transient calibration
		Reliable metered groundwater extraction data		Seasonal fluctuations adequately replicated	X	Similar stresses to those in calibration
	X	Rainfall and evaporation data is available	X	Transient calibration is current		Steady state prediction consistent with steady state calibration
	X	Aquifer testing data to define key parameters	X	Model is calibrated to heads and fluxes		Model validation suggests calibration is appropriate
	X	Good quality and adequate spatial coverage of DEM	X	Key modelling outcomes dataset used in calibration		Steady-state predictions when the model is calibrated in steady-state
		Streamflow and stage measurements are available at many points				
		Reliable land-use and soil-mapping data available				
		Reliable irrigation application data available				

[1]Refer Table 2.1 of the 2012 Australian Groundwater Modelling Guidelines (Barnett et al. 2012)

[2]Green highlighted cells = model has been subjectively assessed to meet the classification criteria for that class

The assessment shown in Table 15 indicates that, overall, the Project groundwater model can be classified as primarily Class 3 using the 2012 Australian Groundwater Modelling Guidelines classification system (effectively “high confidence”), with some aspects meeting the Class 2 (“medium confidence”) criteria. This is considered an appropriate level for the Project groundwater assessment.

4.6 Model limitations

The groundwater flow model is a simplification of a real system, so it is subject to limitations. Limitations result from the simplification of the conceptual model upon which the numerical model is based, the model cell scale, the inaccuracies of measurement data, and the incomplete knowledge of the spatial variability of input parameters. Verification of reliability of the model was conducted by undertaking uncertainty analysis for the predictive model.

The IESC Uncertainty analysis – Guidance for groundwater modelling within a risk management framework (2018) identifies four key sources of scientific uncertainty affecting groundwater model simulations:

- Structural/conceptual

- Parameterisation
- Measurement error
- Scenario uncertainties.

These four sources of scientific uncertainty have been qualitatively assessed with regards key aspects of the Project groundwater model, as presented in Section 6.6.

The Project model captures depressurisation due to active mining. The model is numerically stable with no mass balance error. The model shows a good fit between observed and modelled groundwater levels (Section 4.4).

A depth dependence function was used for hydraulic conductivity, with the calibrated values showing a good fit to observed data as presented in Section 4.3.8.1 and Section 5.3.7.3. Overall, the model is considered fit for purpose to achieve the objectives outlined in Section 4.5 based on the data provided and the project timeframe (i.e., the Project model is deemed fit for purpose for the Project impact assessment).

5.0 Description of environmental values

5.1 Physical setting

5.1.1 Location

The Project is located approximately 170 km south-west of Mackay and 30 km north of Dysart in the Isaac Region of central Queensland (Figure 1). The Project is located immediately east of the approved existing open-cut Saraji Mine.

5.1.2 Land use

The Project is located on land which includes both freehold land and a number of utility and access easements. Activities associated with the existing mining have markedly altered the surface profile west of the Project.

Adjacent land uses surrounding the Project are predominantly for coal mining and cattle grazing.

5.1.3 Topography and drainage

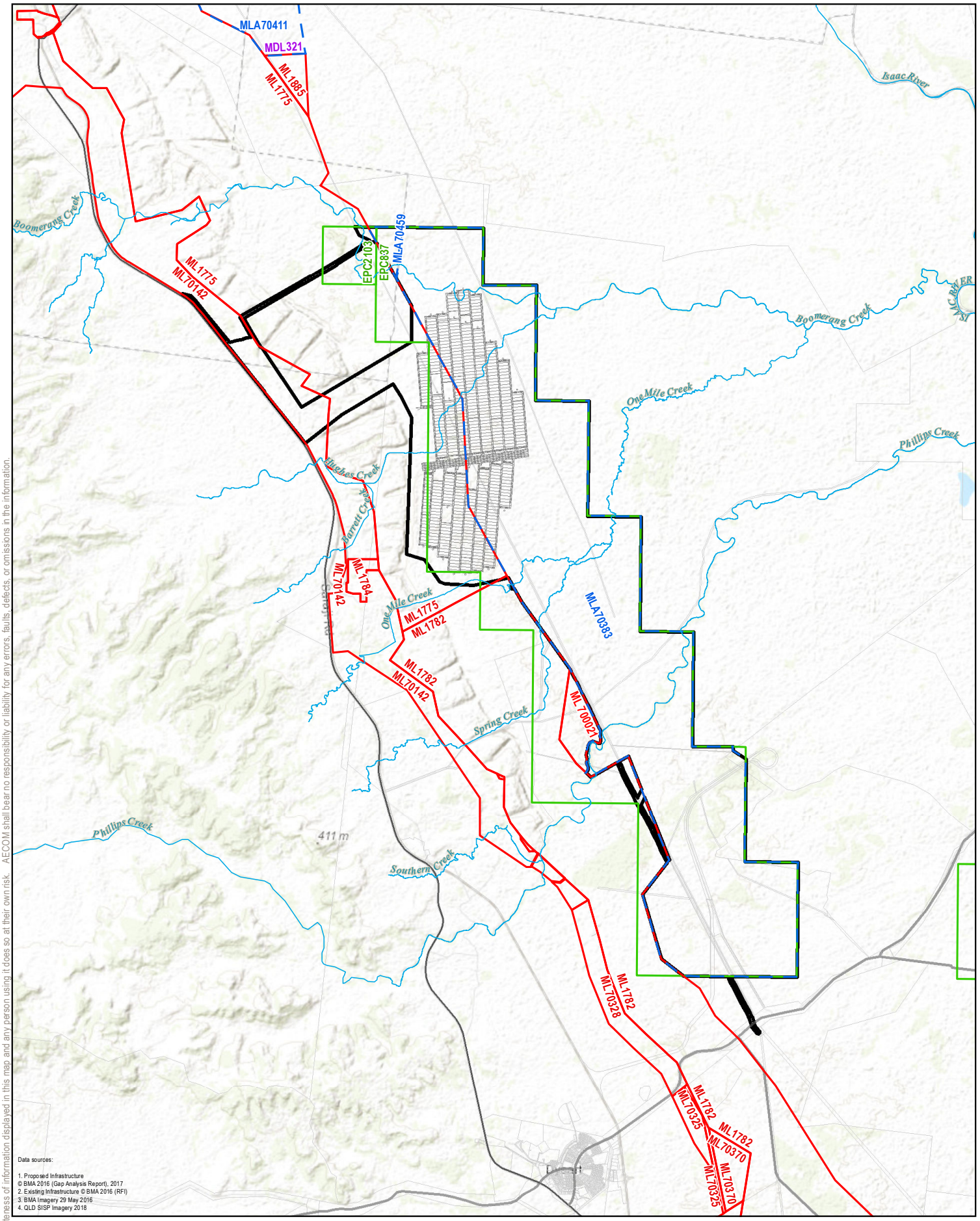
A review of contour data indicates that the majority of the Project Site[7] is flat, with elevations ranging from 180 m Australian Height Datum (AHD) to 200 m AHD. This changes abruptly at the eastern side of the Project Site, where existing mining operations have created artificial elevations ranging from 90 m AHD to 270 m AHD.

The generally flat terrain continues to the north, south and east of the Project Site; however, some three km to the west of the Project Site are the Harrow, Denham and Peak Ranges, with peaks reaching over 680 m AHD.

Eleven intermittent watercourses cross the Project Site, making their way from the ranges in the west to the downs in the east (Figure 17). These include the fourth order Boomerang Creek in the north, into which runs the third order Plumtree Creek. A small oxbow lake has formed just to the south of this confluence. South of this is a section of the former Hughes Creek, a third order watercourse that has been diverted by the existing mines. Further south is the fourth order One Mile Creek and, at the southern end of the Project Site, the fourth order Phillips Creek. All of these watercourses ultimately drain into the sixth order Isaac River, which is 15 km east of the Project Site, and the major watercourse in the catchment area.

These ephemeral creeks are considered to have limited flow, typically only after high intensity rainfall events.

[7] For the purposes of this groundwater technical report the Project Site is bound by Exploration Permit for Coal (EPC) 837, EPC 2103, MLA 70383, MLA 70459, ML 1775, ML 70142 and ML 1782 (see Figure 1).



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- Underground Mine Layout
- Cadastre

N

Figure 17
Topography and Surface Water Features

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 3

5.1.4 Climate

The nearest operating climate weather station is the Bureau of Meteorology (BoM) Station 034035 at Moranbah Airport, which is located approximately 48 km north of the Project. This weather station has only been operational since 2012, which is considered too short of a timeframe to comprehensively assess climate trends within the area.

Data from BoM Station 035019, which is located at the Clermont Post Office, which is approximately 85 km south-west of the Project, was operational from 1870 until 2018 and was used to assess long term rainfall (1870 to 2018), temperature (1910 to 2011), and evaporation (1979 to 2011).

A summary of climate data for BoM Station 035019 is presented in Table 16; the climate data is assumed to be representative of the Project Area.

The data in Table 16 shows that the mean annual rainfall is approximately 660 mm/year, and the average annual evaporation is approximately 2,070 mm/year. Evaporation is recognised to exceed rainfall every month indicating a negative climate budget.

Overall, the climate for the Project Area is sub-tropical characterised by high variability in rainfall, temperature, and evaporation, typical of Central Queensland.

Table 16 Climate summary

Month	Average Temperature (ºC)	Average Rainfall (mm)	Average Daily Pan Evaporation (mm)	Average Monthly Pan Evaporation (mm)
January	34.3	117.8	7.5	232.5
February	33.0	114.4	6.8	190.4
March	32.0	74.6	6.4	198.4
April	29.5	38.2	5.1	153.0
May	26.1	33.9	3.7	114.7
June	23.1	33.2	3.0	90.0
July	23.1	25.1	3.2	99.2
August	25.3	18.6	4.2	130.2
September	28.8	20.0	5.7	171.0
October	31.9	35.2	7.0	217.0
November	33.9	57.0	7.4	222.0
December	34.8	91.5	8.1	251.1
Annual Total	**29.7**	**659.5**	**5.7**	**2,069.5**

Source: BoM Station 035019

5.1.4.1 Cumulative rainfall departure

The Cumulative Rainfall Departure (CRD) method (Weber and Stewart, 2014) depicts monthly rainfall trends compared against long-term average monthly rainfall. A rising trend in the CRD indicates periods of above average rainfall (and possibly increased groundwater recharge to unconfined aquifers), whilst a falling slope indicates periods of below average rainfall.

The CRD for both Clermont Post Office (1870 – 2018) and Moranbah Airport (2012 – 2024) are shown in Figure 18 and can be summarised as follows:

- The area has experienced several climatic fluctuations of above average and below average rainfall since 1900.
- The area experienced a period of below average rainfall between 2001 and 2007 followed by a period of above average rainfall between 2010 and 2013.
- More recently, the Project Area has experienced below average rainfall from 2013 to 2018 (Clermont Post office weather station closed in 2018).
- From Moranbah airport, the period of below average rainfall continued through to 2022.

Groundwater levels in unconfined aquifers that receive direct rainfall recharge could be expected to show a trend which mirrors that of the CRD.

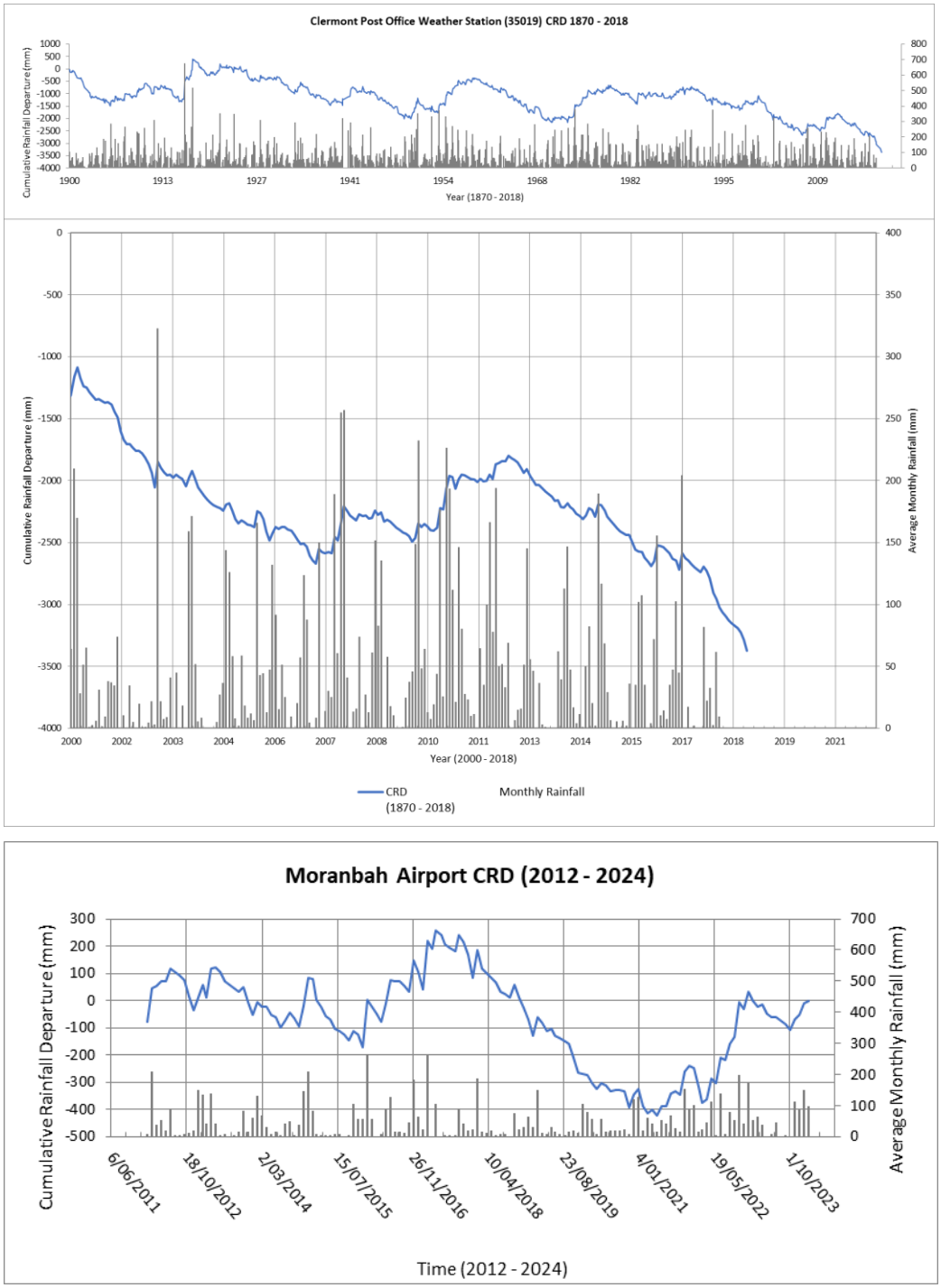


Figure 18 CRD Plot Clermont Post Office and Moranbah Airport

5.2 Geology

The sections below detail the geological setting of the Project. Data used to describe the geology has been obtained from the following sources:

- historical investigations included in published reports
- published surface and basement geological maps
- exploration and resource drilling across the underground mining footprint
- Monitoring bore drilling across MLA 70383 and MLA 70459

- Alluvium auger hole data.

5.2.1 Bowen Basin

The Project is located on the western limb of the northern Bowen Basin; a north-south trending Early Permian to Middle Triassic geological basin.

The Bowen Basin is divided into a number of tectonic structures which comprise north north-west to south south-west trending platforms or shelves, separated by sedimentary troughs. The major regional structural feature surrounding the Project area is the Collinsville Shelf. The Nebo Synclinorium, a major axis of deposition, occurs to the east of the Project area (Dickins et al, 1973).

Folds within the basin are generally gentle and mostly related to drag on thrust faults at the eastern margin of the basin. The boundary between the Collinsville Shelf and adjoining Nebo Synclinorium is marked by a major thrust fault, the Jellinbah Thrust Fault (URS, 2012).

The regional stratigraphic sequence is presented in Section 5.2.3. Summarised, the stratigraphic sequence in the Project Area comprises the following:

- Middle Permian Back Creek Group (basement)
- Late Permian Blackwater Group sediments (and coal measures)
- Tertiary sediments
- Unconsolidated Quaternary alluvium sediments.

The surface geology for the Project Area is shown in Figure 19 and the detailed solid geology is presented in Figure 20.

5.2.2 Structural geology

The location of mapped faults and structures within and surrounding the Project are shown in Figure 20. The faults in the Project Area comprise both normal and thrust faults with mapped trends which describe two dominant structural domains: one trends north north-west, the second trends north-south.

The Isaac Fault, which is located to the east of the Project, separates relatively undisturbed sediments towards the west from a complex zone of folded and faulted sediments to the east.

Inferred and mapped faults (within the Saraji Mine) within the footprint of the proposed underground mine workings is included in Figure 21. The Project mine plan takes these faults into consideration (i.e., longwall panels avoid faults).

The faults within the groundwater model domain are from the base BMA regional scale groundwater model, which used available fault mapping and site-specific geology models where available. Local faults displacements derived from the site-specific geological models have also been captured in the model layer elevations at these sites.

There are three key regional northwest-southeast trending fault zones included in the BMA regional scale groundwater model (as included in Figure 22), these include:

- Extending 50 km, 500 m immediately east of the Project footprint[8]
- Extending 70 km, 12 km to the east of the Project
- Numerous shorter faults within a fault system, 15 km to the east of the Project.

[8] This fault is conservatively included as a continuous fault in the model. The fault is discontinuous in Figure 19.



Data sources:
1. Tenements © BMA 2016 (RFI)
2. Geology © State of Queensland (Department of Natural Resources and Mines) 2016

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Plan
- Existing Open-Cut Extent

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- German Creek Formation (Pbd)
- MacMillan Formation (Pbn)
- Moranbah Coal Measures (Pwb)
- Peak Range Volcanics (Tp)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- Qr\b-QLD (Qr\b)
- TQa-QLD (TQa)
- Tb-QLD (Tb)

Figure 19
Surface Geology
(1:100,000)

Groundwater Technical Report
Saraji East Mining Lease Project

0 1 2 4
Kilometres

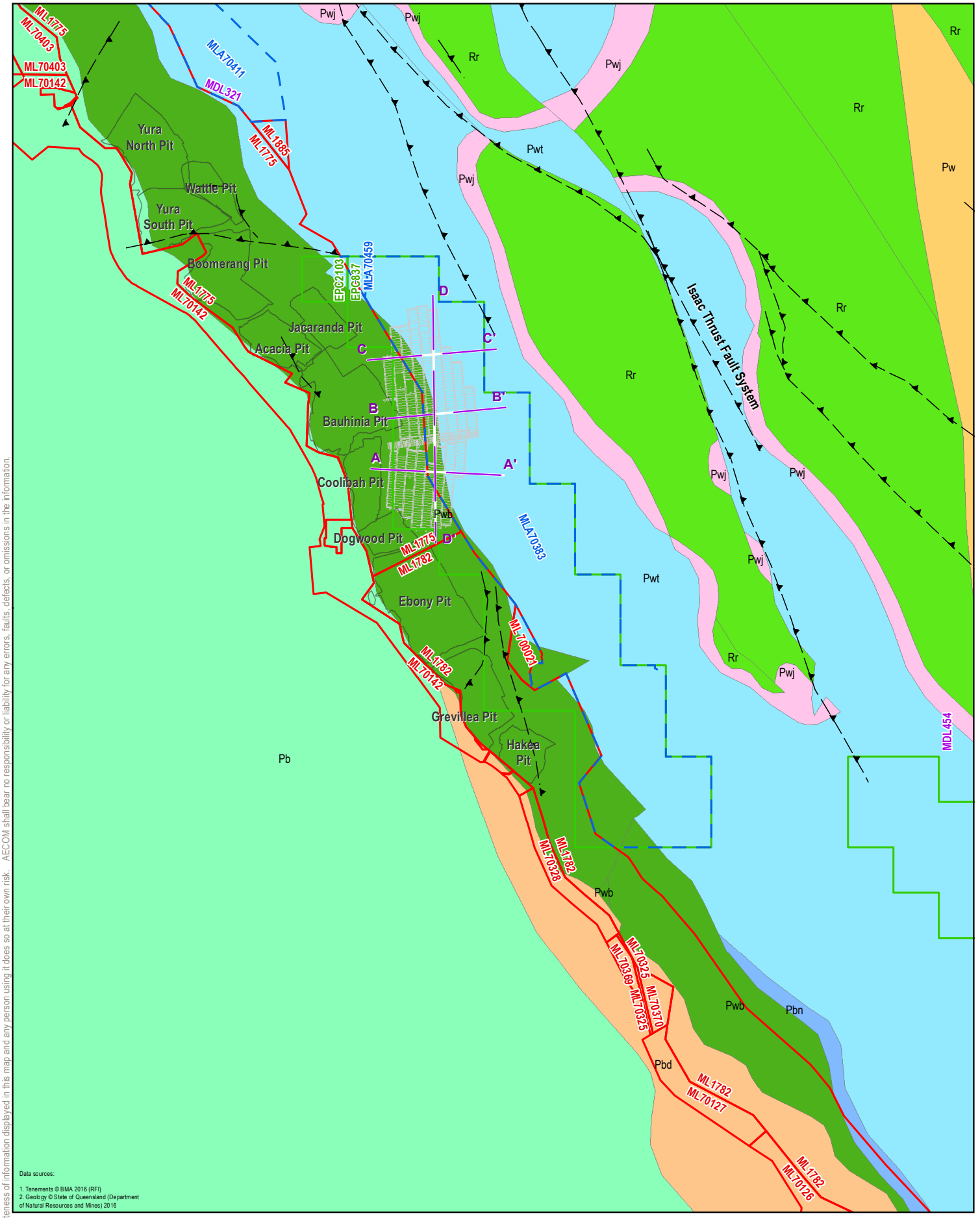
Scale: 1:200,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 1

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G184_v1_A4P.mxd



Data sources:

1. Tenements © BMA 2016 (RFI)
2. Geology © State of Queensland (Department of Natural Resources and Mines) 2016

LEGEND

- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Existing Open-Cut Extent
- Cross Section
- Fault

Bowen Basin Basement Geology

- Pb - Permian Back Creek Group
- Pbd - Permian German Creek Formation
- Pbn - Permian MacMillan Formation
- Pw - Permian Backwater Group
- Pwb - Permian Moranbah Coal Measures
- Pwj - Permian Rangal Coal Measures
- Pwt - Permian Fort Cooper Coal Measures
- Rr - Triassic Rewan Group

N

Figure 20
Basement Geology
(1:500,000)

Groundwater Technical Report
Saraji East Mining Lease Project

0 1 2 4
Kilometres

Scale: 1:200,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

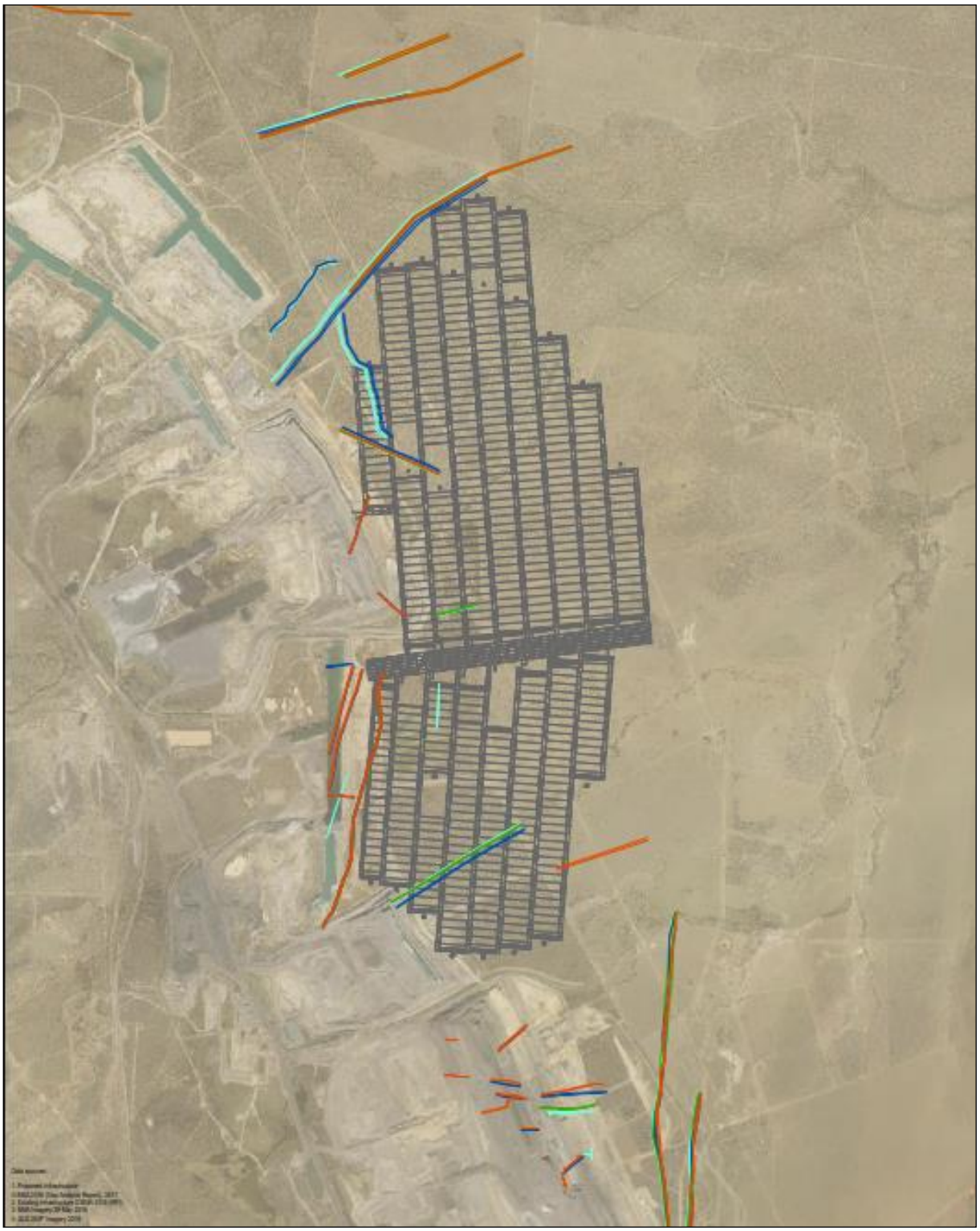
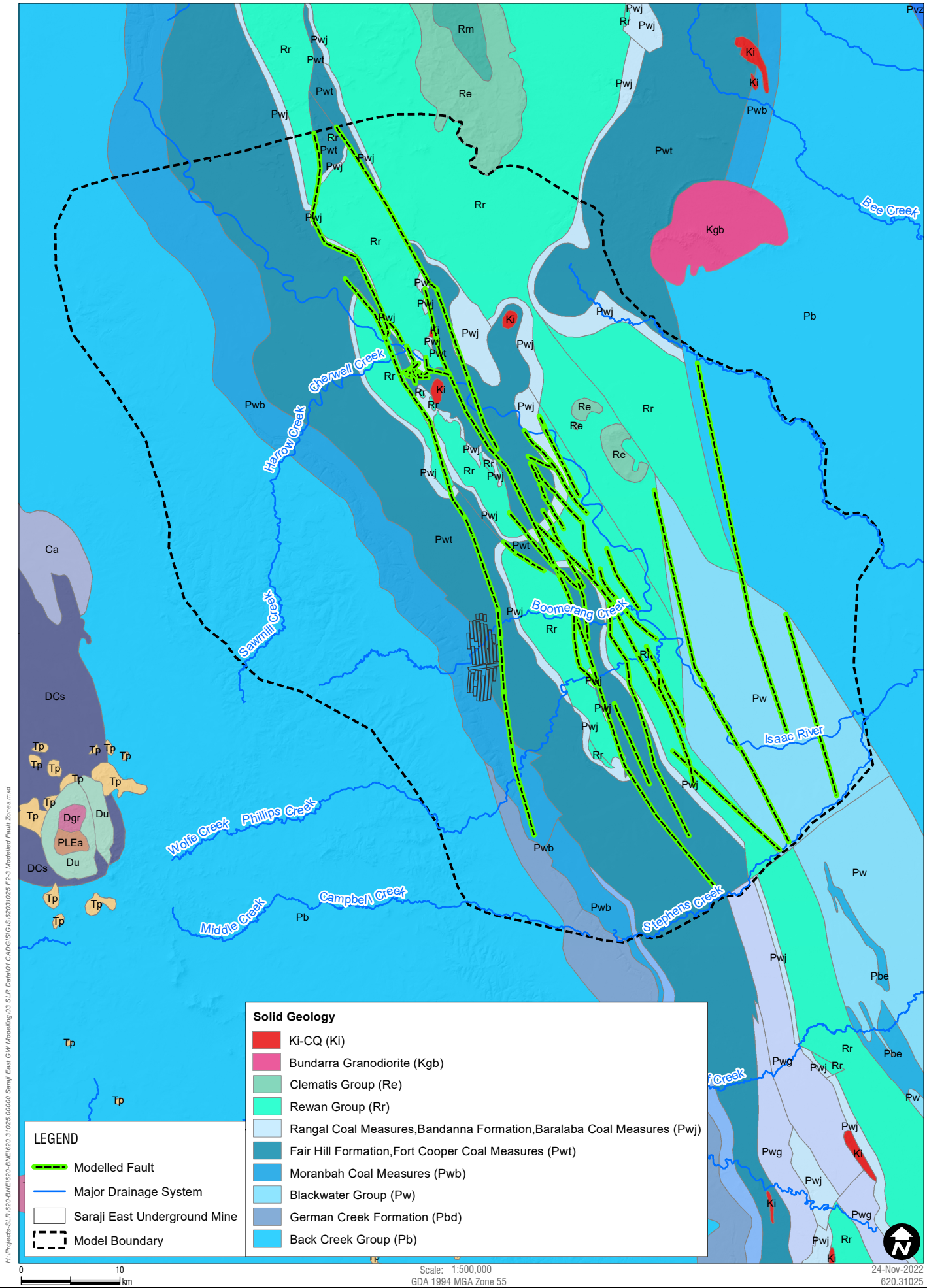


Figure 21 Inferred and mapped faults and the Project footprint



SLR

Modelled Fault Zones

FIGURE 22

5.2.2.1 Local geological cross-sections

To further assess possible structural features within the underground mining footprint, such as faults and folding, three east-west trending geological cross-sections and one north-south trending geological cross-section were generated from exploration data (BMA geological model) to show the lateral extent (dip and strike) of the target coal seam.

The resultant geological cross-sections and exploration bores are shown in Figure 23 to Figure 26 and indicate the following:

- Sediments dip gently towards the east within the MLAs, with an average dip of approximately 8 degrees.
- There is no indication of any marked disruption of coal seams or sediments because of faulting.

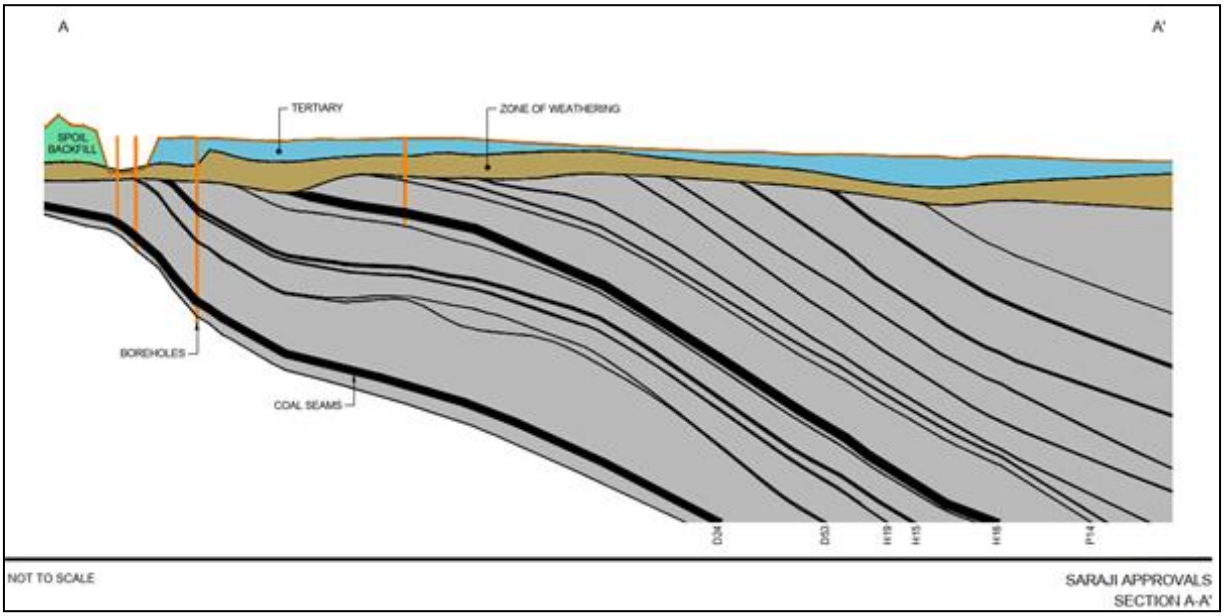


Figure 23 Geological cross-section A-A'

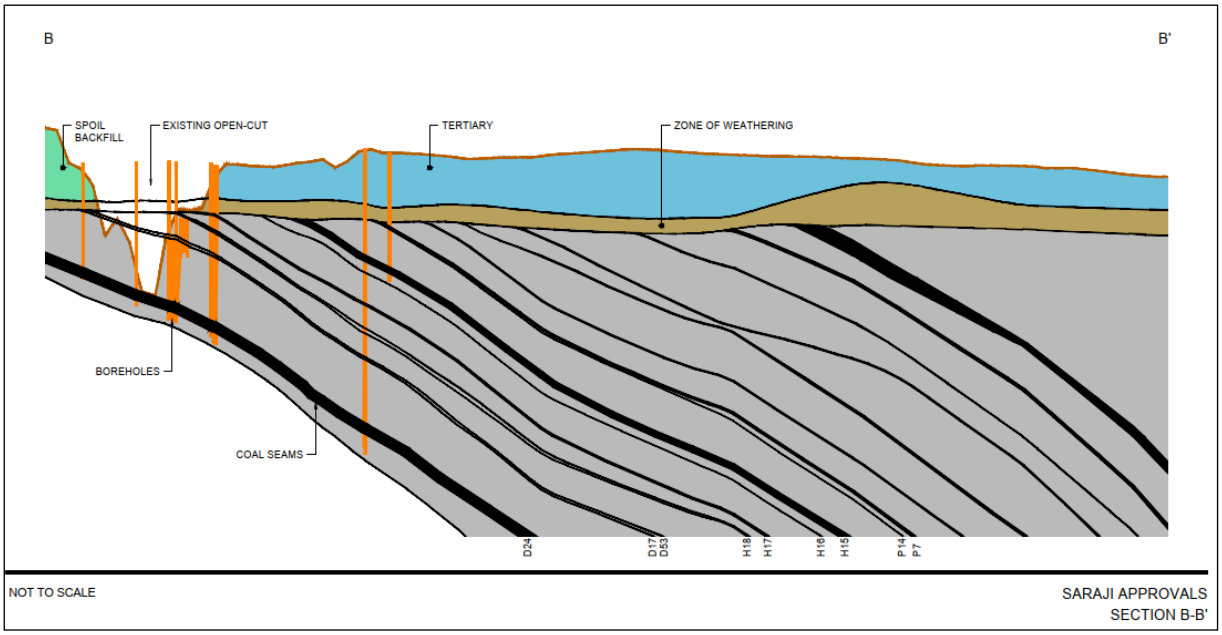


Figure 24 Geological cross-section B-B'

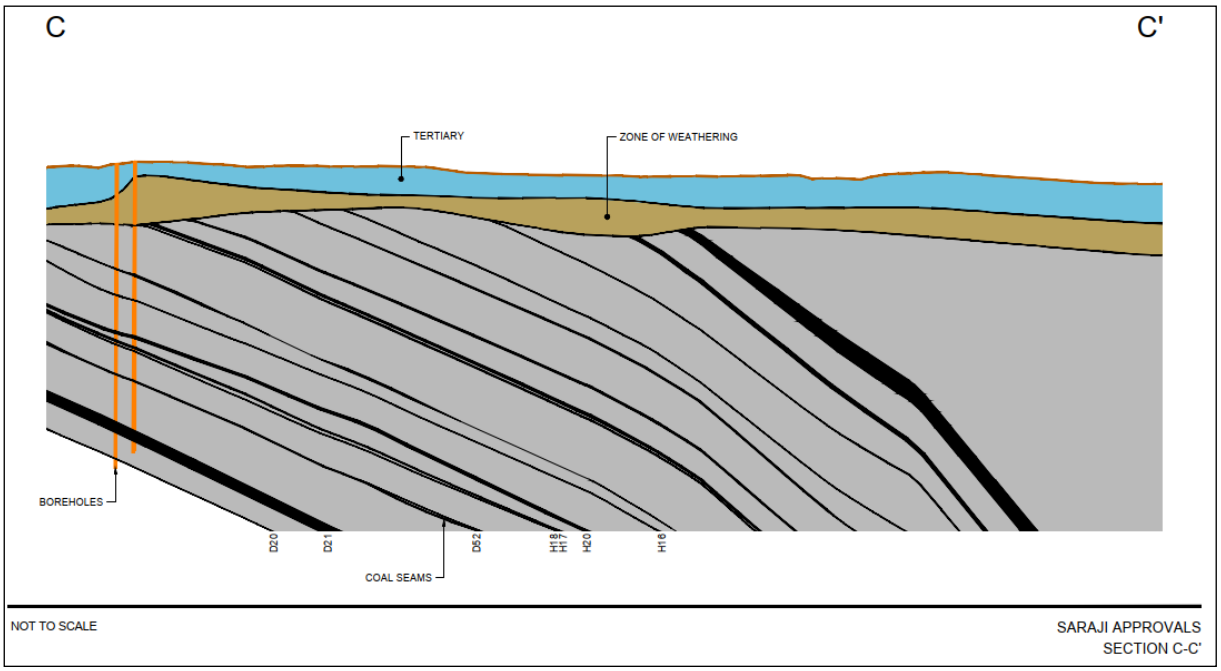


Figure 25 Geological cross-section C-C'

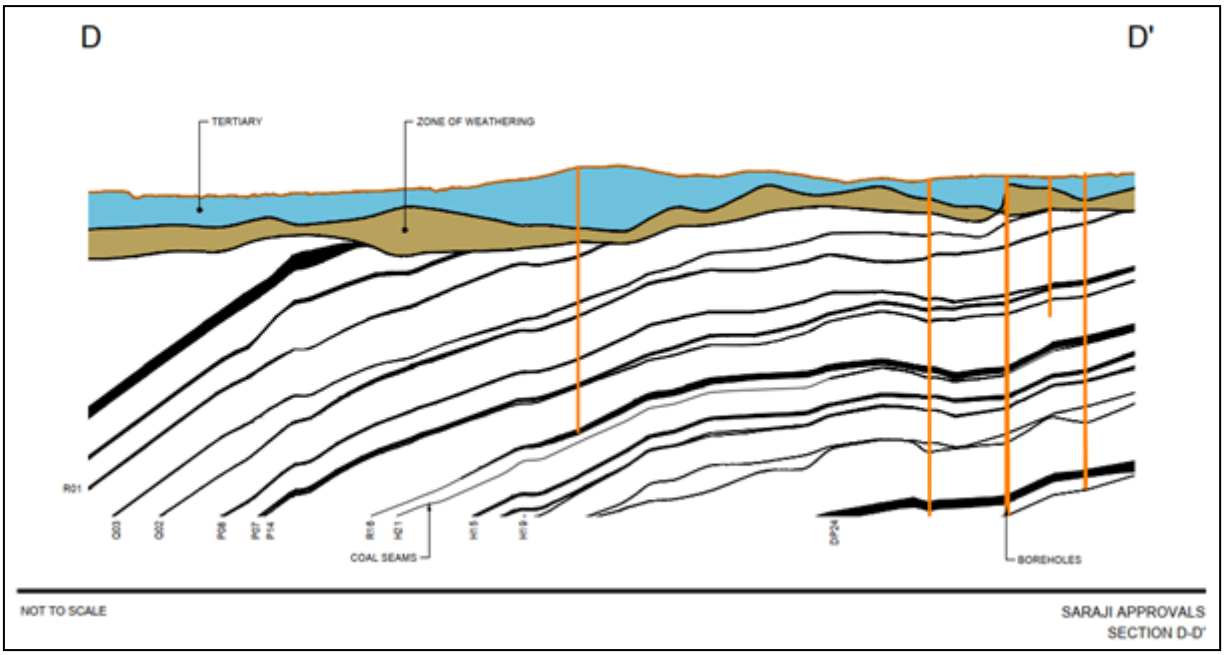


Figure 26 Geological cross-section D-D'

5.2.3 Stratigraphy

Figure 19 presents the surface geology for the Project Area based on the 1:100,000 scale Grosvenor Downs (Sheet 8553) geological map sheet. The basement geology based on the 1:500,000 scale Bowen Basin basement geology map is shown in Figure 20

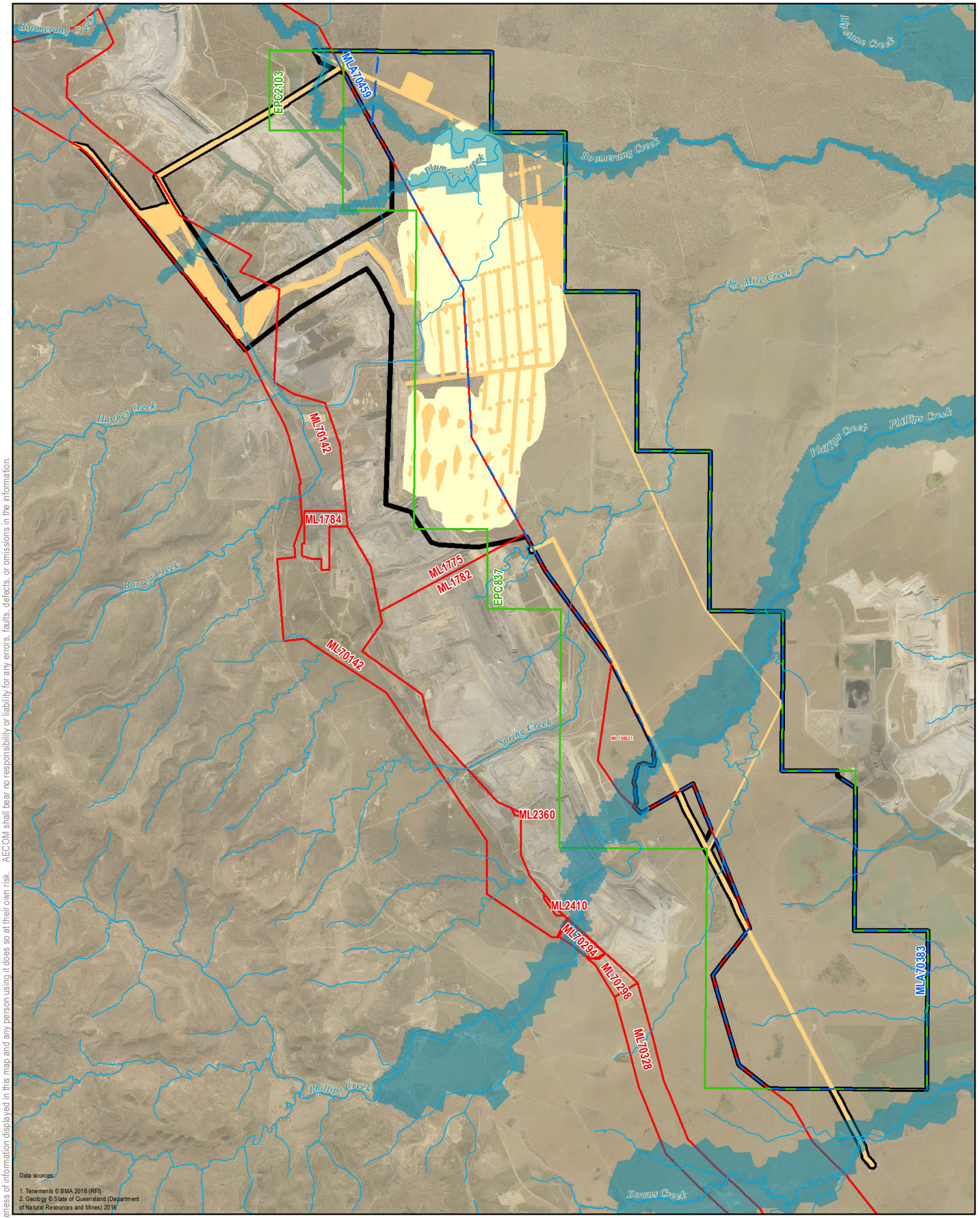
The mapped geology indicates that the stratigraphy typically comprises Permian coal measures overlain by a variable thickness of unconsolidated to poorly consolidated Tertiary and Quaternary age sediments.

Figure 19 shows that Tertiary sediments outcrop throughout the Project Area whilst mapped Quaternary sediments are associated with the present day channels of the Isaac River and Phillips Creek. It is noted that no alluvium is mapped within or adjacent to Boomerang Creek, Plumtree Creek, and the

former Hughes Creek on the 1:100,000 scale maps, which drains across the underground mining footprint (Section 5.1.3).

As no alluvium was mapped associated with creeks draining the SEMLP footprint, bore logs, CSIRO mapping, plus site-specific auguring within the mine footprint were used to delineate the alluvium. The extent and depth of alluvium was extrapolated across the SELMP footprint and included in the predictive groundwater modelling. This allowed for the potential impacts of longwall mining on groundwater resources associated with the alluvium across the Project to be determined. The extrapolated alluvium is included in Figure 27.

Figure 23 to Figure 26 show that the Permian sediments form a regular layered dipping sedimentary sequence while the overlying Tertiary materials are more complex and irregular with a maximum thickness of approximately 45 m across the underground mine footprint. Table 17 summarises the lithostratigraphy of the Project area, including geology outside the Project but within the BMA regional scale model.



LEGEND

- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- Alluvium extent

N

Figure 27
Modelled Alluvium Extent

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:114,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 0

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G455_v0_A4P_RePathed.mxd

Table 17 Stratigraphy

Age	Stratigraphic Unit		Description	Range of Thickness (m)	Occurrence
Quaternary	Alluvium		Clay, silts, sand, gravel, floodplain alluvium.	0 - 25	Continuous alluvium confined to present day stream and creek channels of the Phillips Creek and Isaac River.
Tertiary	Clay		Clay, clayey sand, sandy clay, sand.	4 - 45	Covers Project area with regular distribution; individual lenses are discontinuous and lensoidal.
	Basal Sand/Gravel		Sand.	0 - 3	Irregular distribution generally observed where Tertiary sediments are thickest. Not reported within underground mining footprint.
	Duaringa Formation		Mudstone, sandstone, conglomerate, siltstone.	~ 20	Extensive outside of the underground mining footprint to the southeast.
Permian	Fort Cooper Coal Measures (FCCM)	Burngrove Formation	Sandstone, siltstone, mudstone, carbonaceous shale and coal.	Up to 400	Present beneath eastern portion of underground mining footprint.
		Fairhill Formation			
	Moranbah Coal Measures (MCM)	MacMillan Formation	Sandstone, conglomerate, claystone, siltstone, coal. Contains target coal seam – D14/24.	250 – 350	Present beneath entire underground mining footprint.
		German Creek Formation			
Early to Middle Permian	Back Creek Group		Sandstone, siltstone, carbonaceous shale, minor coal.	-	Underlies entire Project area. Outcrops west of Saraji Mine and extends under mined areas to the east.

The stratigraphic units are described in more detail below.

5.2.3.1 Quaternary sediments

The 1:100,000 surface geology map (Figure 19) indicates that Quaternary sediments are confined to the present day channels of Phillips Creek and the Isaac River. The Quaternary sediments comprise irregular sequences of unconsolidated clay, silt, sand, and gravel which are variable in thickness.

Quaternary sediments surrounding the Project Area have been reported to have a maximum thickness of 25 m at Phillips Creek (AGE, 2007).

An assessment of the alluvium (3D Environmental, 2023), identified in the field at Boomerang Creek, Plumtree Creek, and the former Hughes Creek, and along Phillips Creek was conducted. The hand auger holes, and logged sediments are summarised in Table 18. The location of these augur holes is included in Figure 28.

Table 18 Non-perennial creek alluvium and Philips Creek alluvium

Site	Creek	Depth interval	Description	Comment
2_AU1	Phillips	0 – 0.75 m	Coarse river sand	Moist to wet
		0.75 – 1.15 m	Coarse river sand mixed with silty clay and clay loam	Water table in clayey sand at 1.15 mbGL[9]
3_AU1	Phillips	0 – 1 m	Coarse river sand	Moist at 1 mbGL
		1 – 1.1 m	Coarse gravel	Base of river sand
		1.1 – 1.6 m	Fine to medium clayey sand	Moist
		1.6 – 2.1 m	Orange brown fine sandy clay with some mottling	Moist clay
		2.1 – 2.3 m	Light brown / grey plastic clay	Moist
		2.3 – 2.7 m	Orange brown clayey sand	Wet to moist
		2.7 – 2.8 m	Coarse gravel bed	
4_AU1	Phillips	0 – 0.3 m	Coarse river sand	
		0.3 – 0.5 m	Coarse gravel bed at base of river sand	Dense tree roots at 0.5 m
		0.5 – 0.95 m	Fine sandy clay with orange grey mottling	Moist
		0.95 – 1.6 m	Strongly mottled grey brown sandy clay	Moist to very moist
		1.6 – 1.7 m	Grey to orange decomposed sandstone	Base of alluvium
6_AU1	One Mile	0 – 0.3 m	Dark brown clayey sand with orange mottling	
		0.3 – 0.75 m	Grey brown clayey sand	Moist to wet
		0.75 – 1. 75 m	Grey brown sandy clay with mottling	Moist to wet
		1.75 – 2 m	Grey to brown clayey sand with minor gravel and orange mottling	Tree roots at 2 mbGL
		2 – 2.5 m	Grey brown clay with mottling and gravel fragments	
		2.5 – 2.6 m	Grey to brown gravelly / clayey sand with mottling	
9_AU1	Plumtree	0 – 0.5 m	Medium to coarse grained river sand	
		0.5 – 1 m	Grey to brown sandy clay transitioning to fine sand at 1 m	
		1 – 1.6 m	Grey to orange fine clayey sand with iron staining and mottling	
		1.6 – 2 m	Sand and gravel in grey clay matrix with mottling	Top of decomposed bedrock Moist

[9] mbGL – metres below ground level

Site	Creek	Depth interval	Description	Comment
		2 – 2.25 m	Dense clay with some gravel and iron mottling	Coarse tree roots at 2 mbGL
		2.25 – 2.5 m	Dense grey clay	
10_AU1	Boomerang	0 – 1 m	Medium to coarse river sand	Gravel horizon at 1 mbGL
		1 – 1.25 m	Grey brown gravelly clay with mottling	Dense roots at 1.2 mbGL
		1.25 – 1.5 m	Fine grey clayey sand and gravel	Moist to very moist
		1.5 – 1.6 m	Yellow fine river sand with clay nodules	Dry Hole terminated on weathered sandstone bedrock
11_AU1	Boomerang	0 – 0.5 m	Coarse river sand	Minor tree roots
		0.5 – 1.6 m	Grey to brown medium to coarse clayey sand	Moist Medium to coarse tree roots
		1.6 – 2.25 m	Brown to yellow, fine river sand	Dry
		2.25 – 2.6 m	Brown medium to coarse clayey sand Decomposed sandstone bedrock with clay nodules and ironstone mottling	Medium to coarse tree roots in bedrock
12_AU1	Boomerang	0 – 0.4 m	Free draining dry river sand	Fine tree roots at 0.4 mbGL
		0.4 – 0.5 m	Grey brown cemented sand	
		0.5 – 2.5 m	Dry river sand	Dry
13_AU1	Boomerang	0 – 1 m	Grey brown clay loam with minor orange mottling	
		1 – 1.5 m	Orange to brown silty loam with minor mottling	
		1.5 – 2.9 m	Orange to brown iron stained fine river sand	Dry
		2.9 – 3.0 m	Grey to brown clayey sand	Medium to coarse tree roots at 3 mbGL
		3 – 3.75 m	Grey to brown clayey sand with mottling	Contains weathered sandstone fragments
		3.75 – 3.8 m	Weathered sandstone	

The shallow augur hole program identified:

- Thin heterogenous alluvium within the creeks with varying moisture content
- Shallow bedrock below the non-perennial creeks
- Perched water on the clay-rich sediments
- Limited effective storage in the river sand (i.e., dry due to drainage from the sand)
- The deepest alluvium within the Project footprint was recorded in Augur 13_AU1 hole, some 3.75 m deep. This depth was adopted for the modelling (Section 4.3.8).

Project Alluvium data

Saraji Mine installed five new monitoring bores during 2019 (GHD, 2023). A summary of these alluvium bores is included in Table 21.

Table 19 Saraji Mine alluvium monitoring bores

Bore ID	Depth (m)	Screen (mbGL)	Lithology	Comment
MB38 / MB19SRM01A[10]	8.5	5.5 – 8.5	Sand, gravel, and clay	Water level at 7.39 mbTOC[11] Drilled on 28/07/2019
MB20SRM01A / MB20SRM01A_HY	10.5	7.2 – 10.2	Sand, gravel, and clay	Dry Drilled on 16/10/2019
MB20SRM04A	12	6.5 – 9.5	Silty gravel	Bore was developed using a bailer because of the low water volume within the bore and slow recharge Water level was 9.12 mbTOC Saline groundwater Drilled 05/10/2019
MB20SRM05A / MB20SRM05A_PZ	24	6.5 – 9.5	Sand and gravel	Dry Drilled 02/10/2019
MB20SRM06A / MB20SRM06A_PZ	9.75	2 - 6	Sand, gravel, and clay	MB20SRM06A was not completed and is to be replaced Water level was 6.10 mbTOC Drilled 02/10/2019

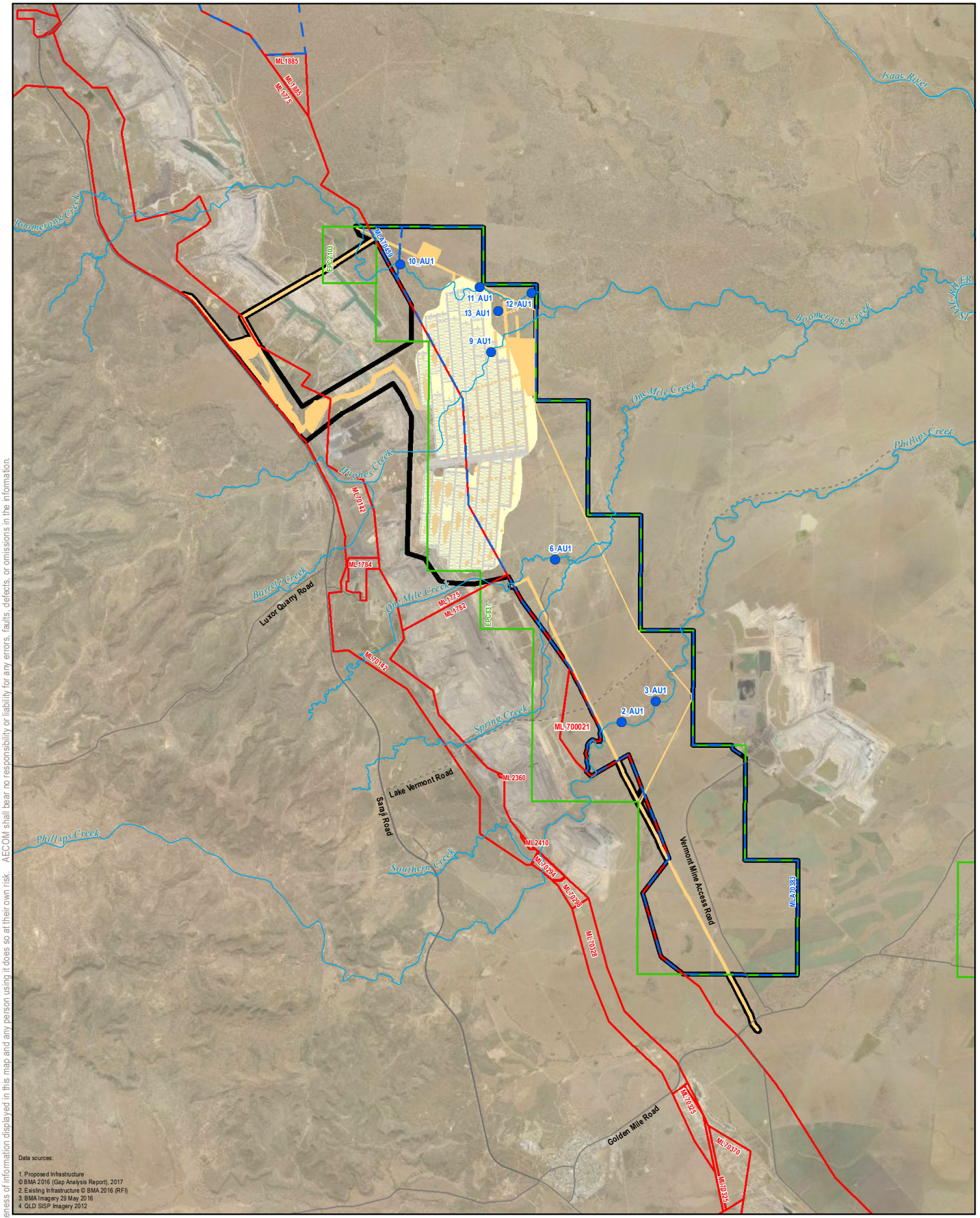
The location of these alluvium monitoring bores is included in Figure 29.

The mapped (extrapolated) alluvium, using the available site-specific data, is included in Figure 27.

NOTE: Due to BMA data management systems, bores have multiple names, this has led to misinterpretation of available monitoring and sampling data for the respective location. The data associated with the various bore identifications are combined to form a complete monitoring record at the respective location. Figures and tables have been updated to reflect the multiple monitoring bore names, and include the following:

- MB38 / MB19SRM01A / MB19SRM01A_HY
- MB39 / MB19SRM03P / MB19SRM03P_HY
- MB40 / MB19SRM02T / MB19SRM02T_HY
- MB19SRM04P / MB19SRM04P_HY
- MB20SRM01A / MB20SRM01 / MB20SRM01_PZ
- MB20SRM05A / MB20SRM05A_PZ
- MB20SRM06A / MB20SRM06A_PZ.

[10] Bores with two identifying names are as a result of BMA data management, which required two identification names. Tables and text in this report include both names whilst only one of the names is shown on the maps for ease of reading
[11] mbTOC – meters below top of casing



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Auger Sites

N

Figure 28
Auger Hole Locations

Groundwater Technical Report
Saraji East Mining Lease Project

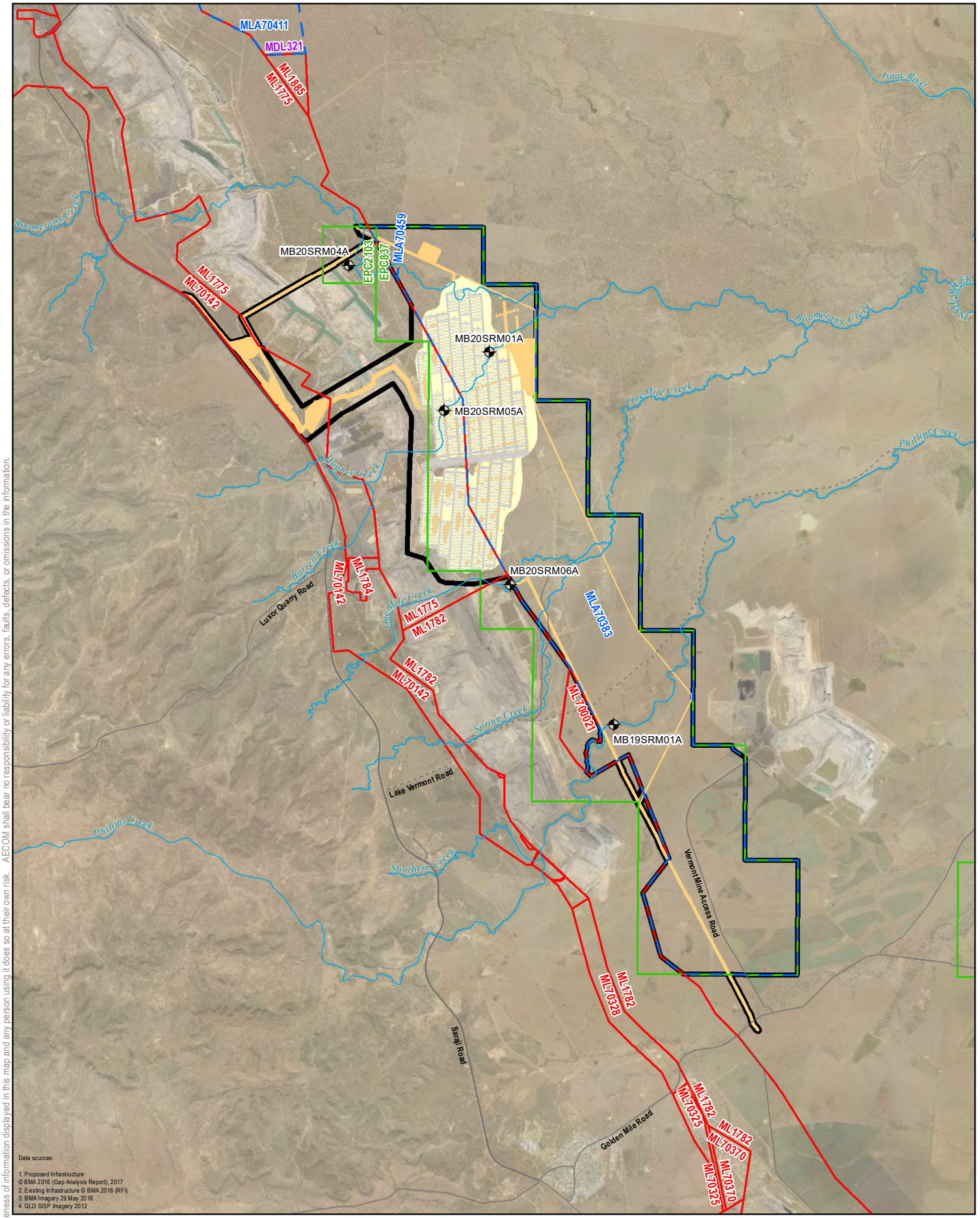
0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G434_v2_A4P.mxd



LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Alluvium Bores

N

Figure 29
Saraji Mine new alluvium monitoring bores

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G435_v2_A4P.mxd

The drilling results for these five alluvium bores indicated:

- Bedrock was not intersected within MB19SRM01A, adjacent to Phillips Creek. Bore collapsed at 8.5 mbGL within sandy clay with gravel, the end of hole.
- MB20SRM01A (MB20SRM01_PZ), adjacent to Plumtree Creek, intersected dry coarse grained alluvium sand.
- MB20SRM04A, adjacent to Boomerang Creek, was screened across silty gravel above clay and weathered sandstone at 9 mbGL. The bore was drilled dry, but seepage was measured after development.
- MB20SRM05A (MB20SRM05A_PZ) on Hughes Creek intersected thick clay with dry alluvium sands 6 to 9 mbGL.
- Shallow alluvium sand above clay was intersected adjacent to One Mile Creek within MB20SRM06A (MB20SRM06A_PZ).

The site-specific drilling data confirmed that the alluvium comprise irregular sequences of unconsolidated clay, silt, sand, and gravel which are variable in thickness.

5.2.3.2 Tertiary sediments

Tertiary sediments within the Project Area comprise dominantly of 'tight' clay overlying an irregular / discontinuous basal unit comprising sand and gravel. Geological cross-sections (Figure 23 to Figure 26) indicate that the Tertiary sediments reach a maximum thickness of approximately 45 m across the underground mine footprint whilst AGE (2011) indicates that the Tertiary sediments are up to 57 m thick in the western portion of the Saraji Mine. The Tertiary sequence is defined by an unconformable boundary with the underlying Permian sequence which characterises the Permian topography prior to deposition of the Tertiary sediments.

Clay unit

The Tertiary clay unit comprises a predominantly clay matrix with intercalation of clay and sand lithologies and is the dominant Tertiary lithology present across the Project Area. At least seven depositional phases are evident in the Tertiary sediments in the Bowen Basin, generally as truncating, fining upward, sequences. Weathering of the sediments is evident in at least three periods of laterisation with associated mottling and concretionary structure (AGE, 2011).

Basal sand/gravel unit

A basal sand and gravel sequence is associated with the base of the Tertiary sediments. Comprising medium to coarse grained sands and fine gravels, the sequence has a maximum thickness of approximately three metres where present and can be locally continuous. JBT (2014) suggests that the basal sand and gravels represent the presence of a laterally discontinuous paleo-channel system assumed to be related to a proto-Phillips Creek system.

Duaringa formation

The Duaringa Formation, which is mapped towards the south and north of the underground mining footprint (Figure 30) contains mudstone and siltstone (i.e., low permeability argillaceous strata). The Duaringa Formation has not been logged within the underground mining footprint.

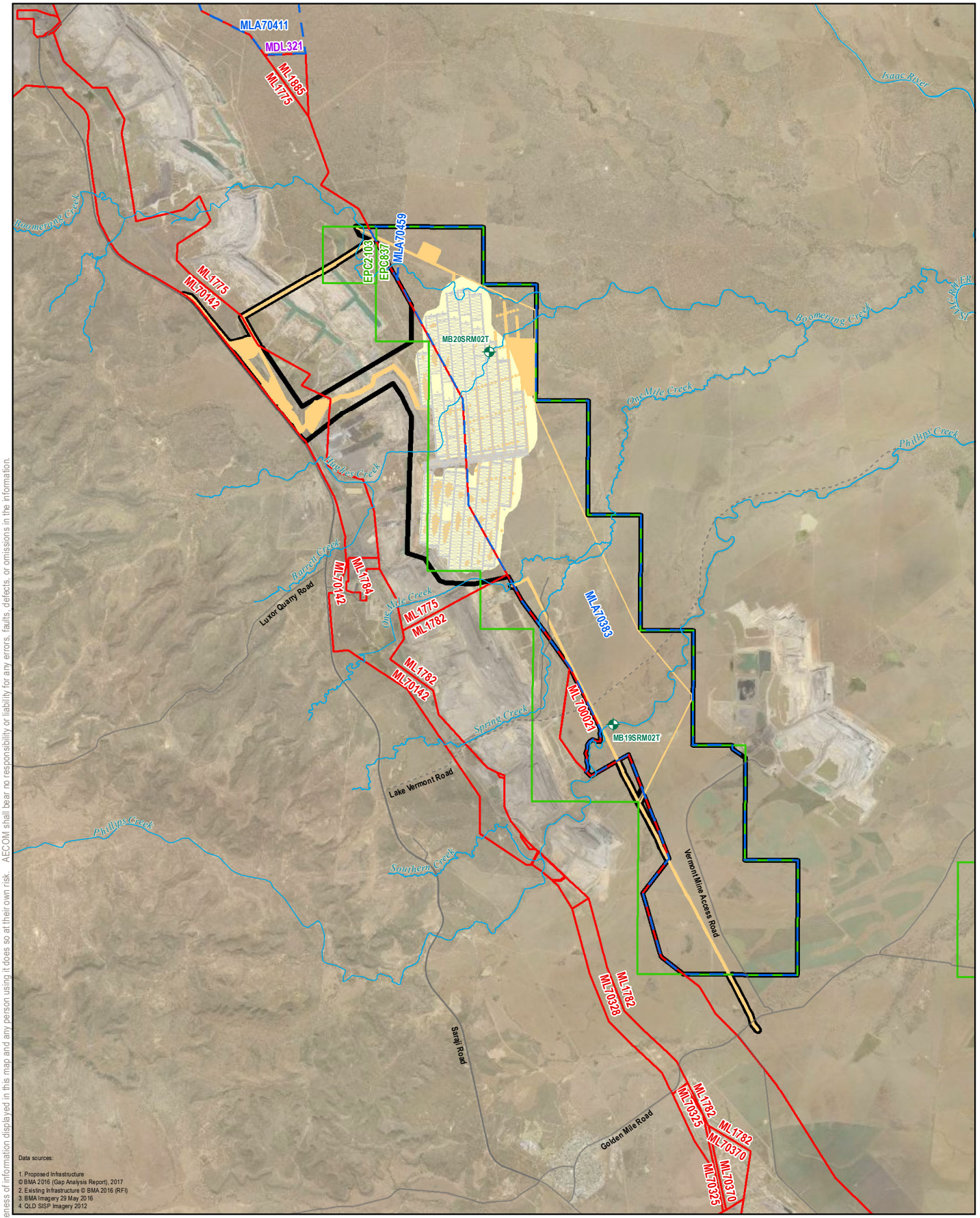
Project Tertiary data

Saraji Mine installed a series of monitoring bores during 2019 (GHD, 2023), including two Tertiary bores. A summary of these Tertiary bores are included in Table 20.

Table 20 Saraji Mine Tertiary monitoring bores

Bore ID	Depth (m)	Screen (mbGL)	Lithology	Comment
MB40 / MB19SRM02T	27	14 - 20	Clay and gravel	Water level at 17.36 mbTOC Drilled 27/07/2019
MB20SRM02T	36.5	27.5 – 36.5	Sandstone	Water level at 23.56 mbTOC Permian sediments and Tertiary age sediments intersected Drilled 18/10/2019

The location of these Tertiary monitoring bores is included in Figure 30.



LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Tertiary Bores

N

Figure 30
Saraji Mine new Tertiary monitoring bores

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 1

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G436_v2_A4P.mxd

MB40 / MB19SRM02T, constructed adjacent to alluvium monitoring bore MB38 / MB19SRM01A on Phillips Creek, intersected clay and sandy clay below the alluvium. A zone of basal gravels and clay were intersected above sandstone. The Tertiary sediments were screened between 14 and 20 mbGL, with water measured within the screen (unconfined) at 17.36 mbTOC. The saturated Tertiary sediments are separated from the perched discontinuous alluvium water, some 10 m difference in water levels. This is consistent with the conceptual model derived during the EIS.

Monitoring bore MB20SRM02T was drilled on Plumtree Creek, adjacent to MB20SRM01A (MB20SRM01_PZ). Clayey sand and clay was intersected below the alluvium logged within MB20SRM01A (MB20SRM01_PZ). No basal gravels were intersected as this bore intersected Permian coal and sandstone below 24.5 mbGL.

5.2.3.3 Permian strata

The Permian coal bearing strata within the Project Area comprise the Fort Cooper Coal Measures (FCCM) and the underlying Moranbah Coal Measures (MCM).

The coal measures comprise sandstone, siltstone, claystone, mudstone and coal. Coal seams of interest within the MCM include the P seam, Harrow Creek Upper (H16) seam, Harrow Creek Lower (H15 and H19) seams, Dysart Upper (D52) seam and Dysart Lower (D14, D24) seam. Other seams are present but are generally too thin or discontinuous to be of economic value within the Project area. The target coal seam of the underground workings is the Dysart Lower (D14 / D24) seam.

The Dysart Lower seam (D24 and D14) is located 17 m to 35 m below the Dysart Upper seam (D52). The D24 seam depth of cover ranges from 120 m at western to maximum of 780 m at eastern limit of MLA 70838 and the seam is typically seven metres thick where coalesced towards the northern end of the MLA 70383. The seam thins to the north and progressively splits to the south into the D14/D142/D291 plys with thicknesses ranging from 2 m to 5.8 m. Figure 31 outlines the Saraji seam correlation present across the Project Area.

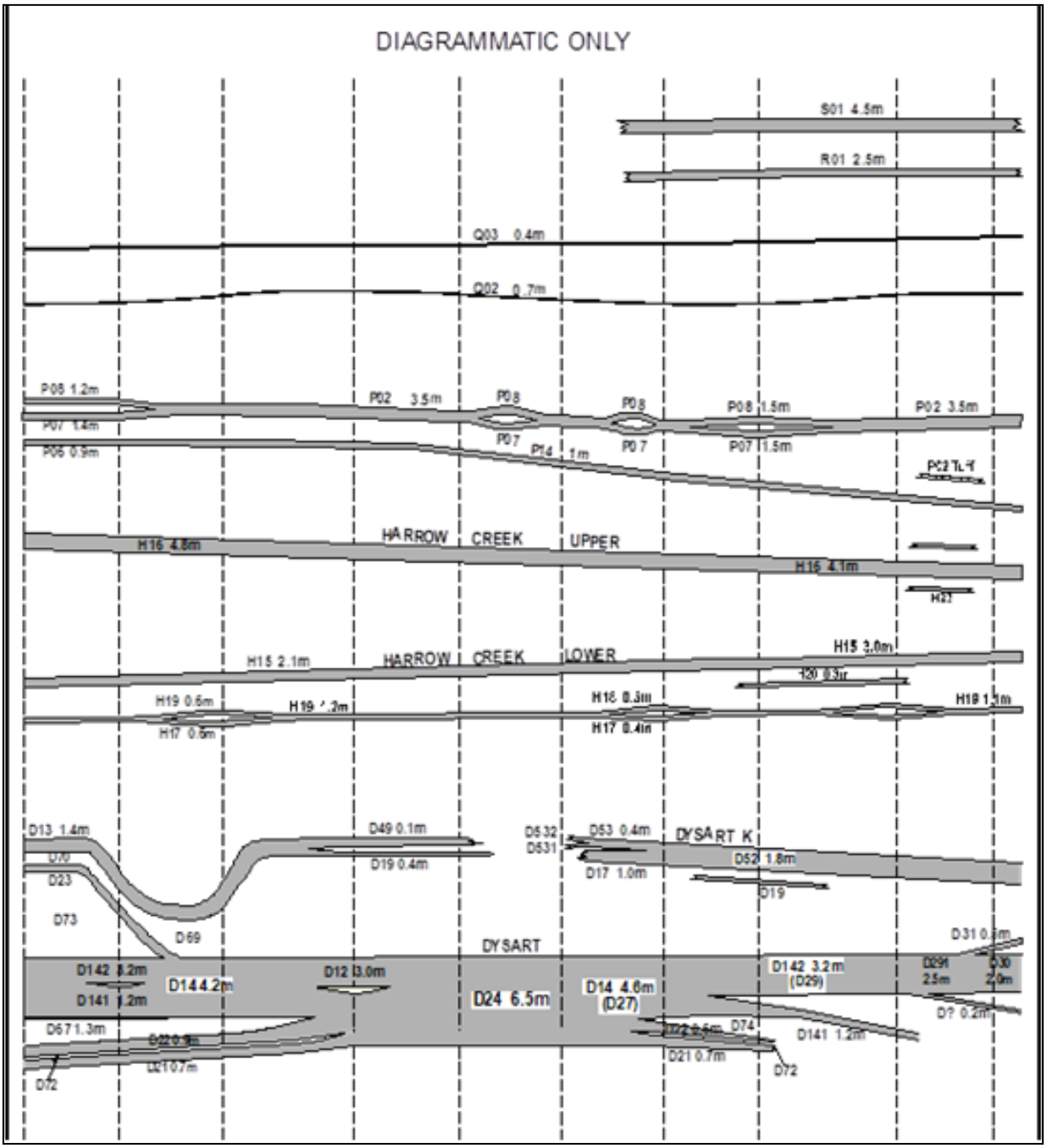


Figure 31 Saraji seam correlation

5.3 Groundwater resources

5.3.1 Groundwater monitoring network

The historic and existing monitoring bores in the vicinity of the Project included:

- Two landholder bores
- Ten single pipe monitoring bores
- Seven monitoring locations comprising three nested groundwater piezometers (i.e., 21 monitoring points in total)
- Eight vibrating wire piezometers (VWPs) located within three holes.

These bores provided detailed groundwater resource data for assessment of the Project. The monitoring bore locations are shown in Figure 32 and construction details are summarised in Table 21. The historic nested bores and VWPs are included in Figure 33.

With the exception of the landholder monitoring bores (MB31 and MB32); all monitoring locations were drilled and constructed between 2011 and 2019.

The two landholder monitoring bores (MB31 and MB32) and single (stand) pipe monitoring bores (MB33, MB34, MB35, MB36 and MB37) are required to be monitored as part of the Saraji Mine EA conditions. Groundwater levels and water quality have been measured on a quarterly basis within all seven of these EA bores since July 2011. It is noted that MB31 and MB32 also contain additional monitoring data which dates back to 2008. Available data for the Saraji Mine monitoring bores, compiled for DESI, include data up until 2023 (**Appendix A**).

The monitoring records for the nested (individual standpipe bores constructed adjacent to one another, screened in different hydrostratigraphic units) groundwater monitoring bores and VWPs are variable and can be summarised as follows:

- Nested groundwater monitoring bores PZ09A and PZ10A were drilled ‘dry’ into Tertiary sediments and have not been monitored since 2012.
- All other nested groundwater monitoring bores (Table 21) contain sporadic monitoring data (water levels and quality) measured between November 2011 and March 2012.
- Records of VWP are available for the period June 2011 to December 2011.

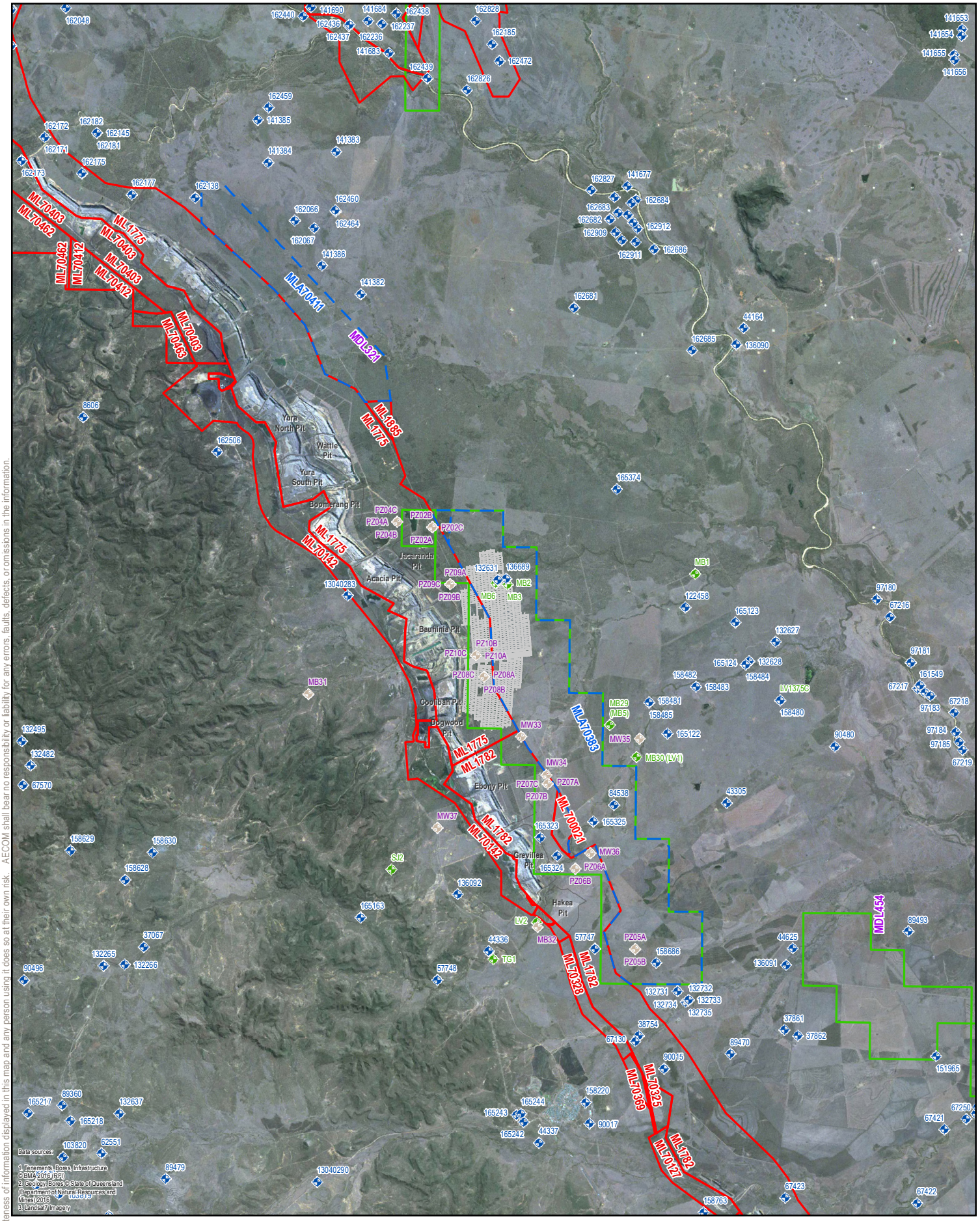
Table 21 Groundwater Monitoring Bores

Bore ID	Easting (GDA94)	Northing (GDA94)	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Purpose
Single Pipe Groundwater Monitoring Bores							
MB35 (RN158010)	642646	7520110	34.5	Fair Hill Formation	18.41 (166.87 mAHD)	-	Compliance
MB36 (RN158011)	640150	7514283	32.0	Fair Hill Formation	17.96 (178.97 mAHD)	0.09	Compliance
MB37 (RN158012)	632389	7515571	42.5	Back Creek Group	12.80 (221.86 mAHD)	0.02	Reference / background
MB34 (RN158013)	637926	7518269	107.0	Moranbah Coal Measures	23.10 (172.51 mAHD)	0.05	Compliance
MB33 (RN158014)	636640	7520199	37.5	Moranbah Coal Measures	21.28 (172.83 mAHD)	0.08	Compliance
MB38 / MB19SRM01A (RN165894)	639919	7515681	8.5	Alluvium	Dry	-	Compliance

Bore ID	Easting (GDA94)	Northing (GDA94)	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Purpose
MB39 / MB19SRM03P (RN169278)	639904	7515697	91.5	Permian	18.09	0.009 – 0.2	Compliance
MB40 / MB19SRM02T (RN 169277)	639913	7515688	27.0	Tertiary	18.0	0.001 – 0.016	Compliance
MB19SRM04P / MB19SRM04P_HY	637059.895	7511041.104	208.74	Permian	20	0.011 – 0.7	Catchment scale Monitoring / Management
MB20SRM01A / MB20SRM01_PZ	635922	7527665	10.5	Alluvium	Dry	-	
MB20SRM02T	635914	7527670	36.5	Tertiary	23.5	0.05 – 0.075	
MB20SRM03P	635907	7527677	242.7	Permian	50.5	0.005 – 0.015	
MB20SRM04A	631397	7530470	12.0	Alluvium	9	0.05 – 0.1	
MB20SRM05A / MB20SRM05A_PZ	634476	7525798	24.0	Alluvium	Dry	-	
MB20SRM06A / MB20SRM06A_PZ	636482	7520008	9.75	Alluvium	6.10	?	
MB20SRM07P	641362	7507960	177.0	Permian	38	0.05 – 0.1	
Landholder Monitoring Bores							
MB31	625942	7522560	44.23	Coal	7 – 22 (variable due to use)	-	Reference / background
MB32	637595	7510716	19.52	Alluvium	11 - 14	-	Reference / background
Nested Groundwater Bores							
PZ02A	632013.15	7530682.68	26	Tertiary - Regolith	-	-	Historic monitoring bore - nest
PZ02B	631930.75	7530683.38	170	Sandstone	-	-	
PZ02C	632013.15	7530682.68	278	Dysart D24	-	-	
PZ04A	630233.34	7530952.35	30	Tertiary - Regolith	-	-	Historic monitoring bore - nest
PZ04B	630233.34	7530952.35	66	Harrow Creek H16	-	-	
PZ04C	630233.34	7530952.35	180	Coal D47	-	-	
PZ07A	637881.99	7517644.04	14	Tertiary - Claystone	-	-	Historic monitoring bore - nest
PZ07B	637881.99	7517644.04	198	Sandstone	-	-	
PZ07C	637881.99	7517644.04	303	Harrow Creek H16	-	-	
PZ09A	632905.13	7527785.31	-	Tertiary - Clay	Dry	-	Historic monitoring bore - nest
PZ09B	632905.13	7527785.31	75	Harrow Creek H16	-	-	

Bore ID	Easting (GDA94)	Northing (GDA94)	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Purpose
PZ09C	632905.13	7527785.31	195	Dysart D24	-	-	
PZ10A	634233.26	7524164.41	-	Tertiary - Regolith	Dry	-	Historic monitoring bore - nest
PZ10B	634233.26	7524164.41	70	Harrow Creek H16	-	-	
PZ10C	634233.26	7524164.41	184	Dysart D24	-	-	
Vibrating Wire Piezometers							
PZ05A	642219.84	7509222.83	203	Harrow Creek H16	168.8 mAHD	-	2 VWPs in one borehole
PZ05B	642219.84	7509222.83	239	Coal D52	166.3 mAHD	-	
PZ06A	639263.48	7513335.58	40.5	Sandstone	185.9 mAHD	-	3 VWPs in one borehole
PZ06B	639263.48	7513335.58	78.5	Harrow Creek H16	179.6 mAHD	-	
PZ06C	639263.48	7513335.58	167	Coal D142	183.4 mAHD	-	
PZ08A	634645.96	7523075.77	38.5	Coal P07	177.6 mAHD	-	3 VWPs in one borehole
PZ08B	634645.96	7523075.77	65	Harrow Creek H16	173.6 mAHD	-	
PZ08C	634645.96	7523075.77	180	Dysart D24	-	-	

Notes:
MB – Monitoring Bore
– No data



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Existing Open-Cut Extent
- Registered Bore
- Saraji Monitoring Bores
- Census Bore

Data sources:
1. Tenements \ Bores \ Infrastructure © BMA 2016 / RPI
2. Geology \ Bores © State of Queensland Department of Natural Resources and Mines) 2016
3. Landsat 7 Imagery

N

Figure 32
Groundwater Bores

Groundwater Technical Report
Saraji East Mining Lease Project

0 2 4 8
Kilometres

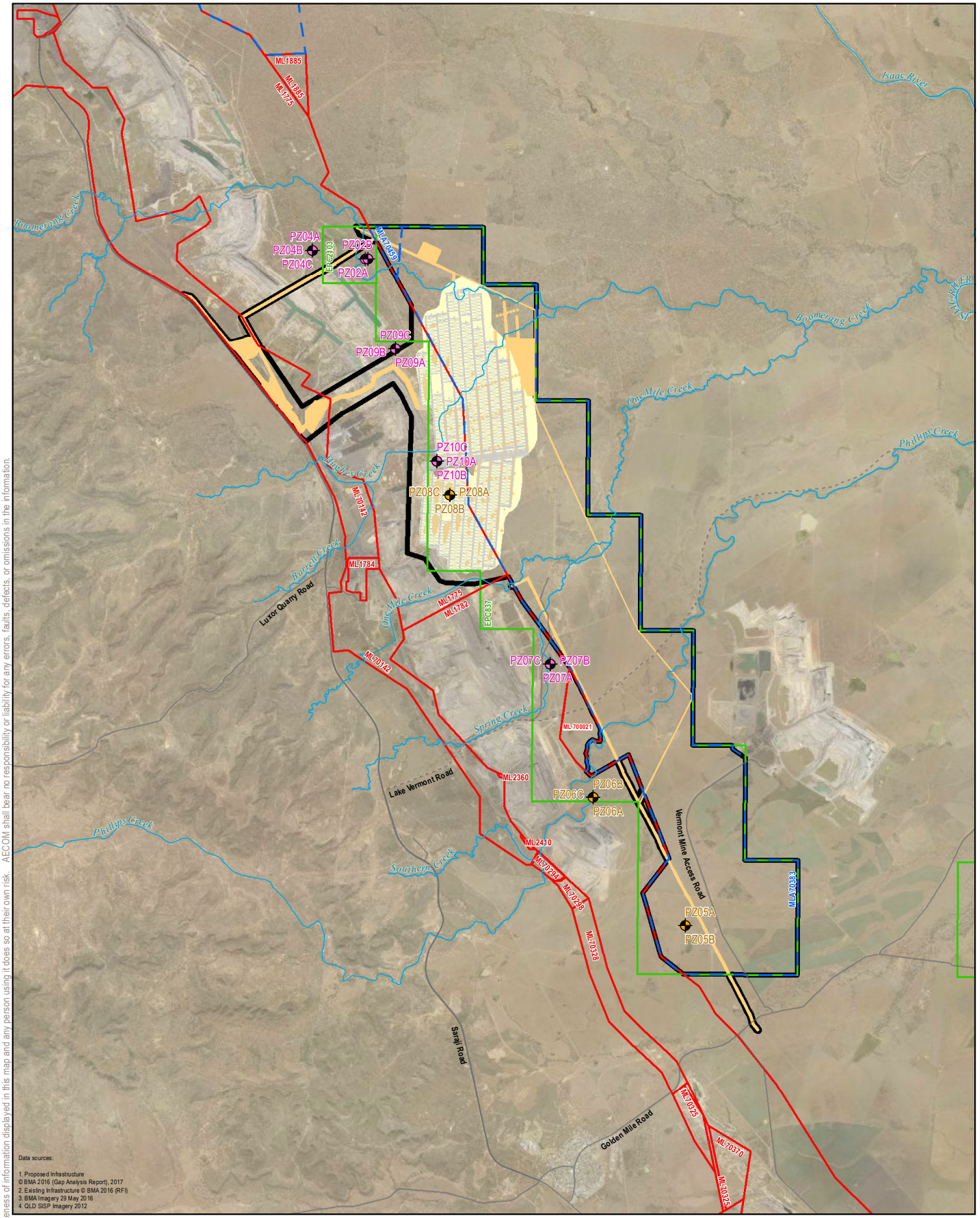
Scale: 1:250,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 19/07/2023 VERSION: 3

Filename: \\na.aecomnet.com\lfs\APAC\Brisbane-AUBNE1\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G186_v3_A4P.mxd



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Vibrating Wire Piezometers
- Nested Groundwater Bores

N

Figure 33
Historic nested piezometers and VWPs

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G437_v2_A4P.mxd

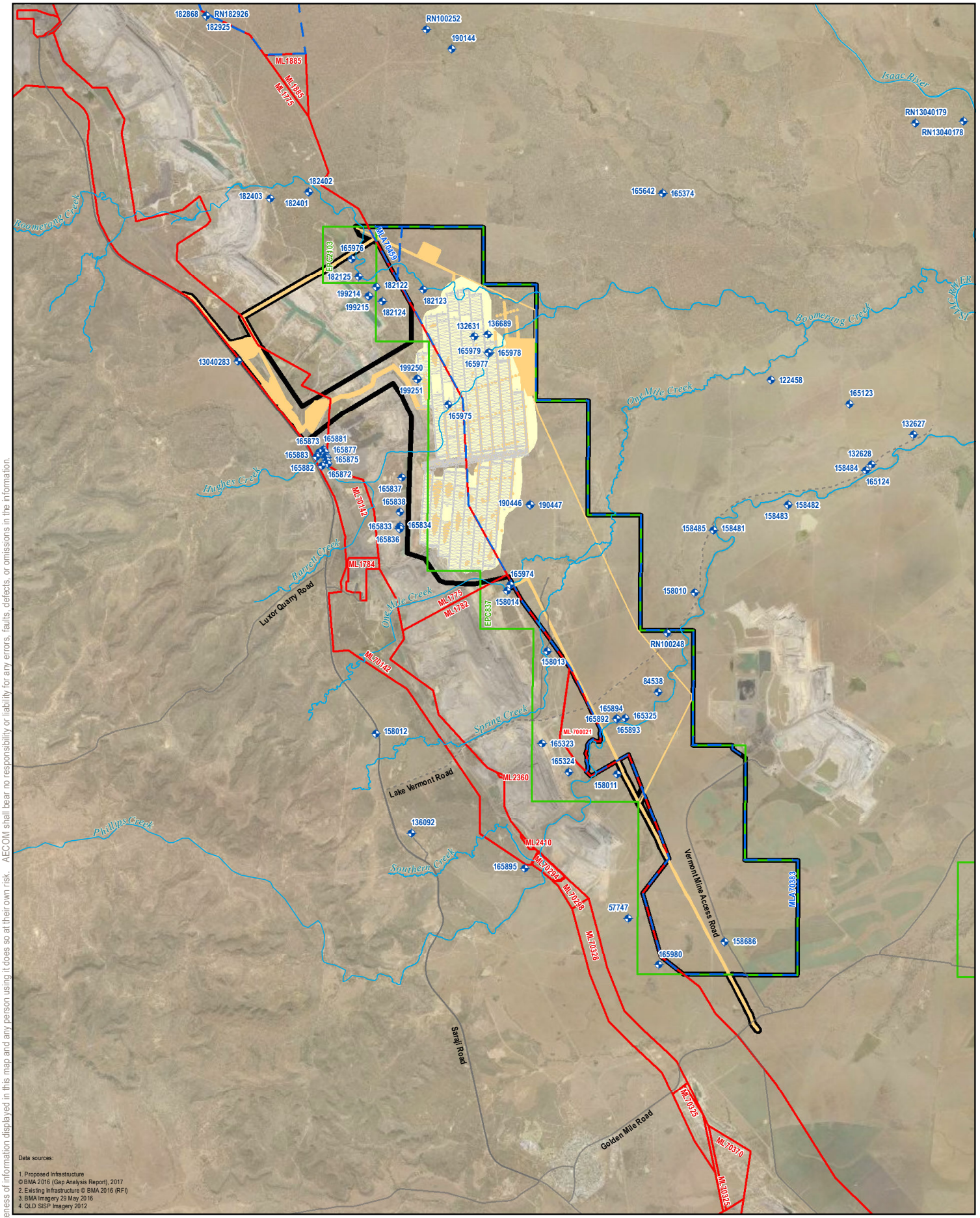
5.3.2 Registered groundwater bores

A search of the Department of Regional Development, Manufacturing and Water (DRDMW) Groundwater Database (GWDB) was undertaken during January 2023 (updated May 2023) to identify registered groundwater bores within and adjacent to the underground mining footprint. The search identified 90 registered groundwater bores within and adjacent to the existing Saraji Mine (Figure 34).

Of the 90 registered bores identified along strike and down dip of the underground mine footprint:

- Seven are described as being abandoned or destroyed
- Eleven were drilled dry
- Six water supply bores
- One petroleum and gas well
- Six are VWPs.

The remaining 59 bores are mine monitoring bores. Registered bore details as recorded in the DRDMW GWDB are summarised in Table 22. For the purposes of this report, the seven bores described as being abandoned and destroyed were excluded from any further discussion in this report as they are not considered to be potential useable/impacted bores.



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Registered Bore

N

Figure 34
Registered Bores Along Strike and Down Dip of Saraji Mine

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G438_v1_A4P.mxd

Table 22 Registered groundwater bores

Registered Number (RN)	Easting	Northing	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
Registered Groundwater Bores							
158014	636496	7519991	37.5	MCM	21.3	0.08	MB33 / Saraji Mine
158013	637781	7518065	107.0	MCM	23.1	0.05	MB34 / Saraji Mine
158012	632271	7515395	41.4	Back Creek Group	12.8	0.02	MB37 / Saraji Mine
158011	640035	7514095	32.0	Fair Hill Formation	17.96	0.09	MB36 / Saraji Mine
158010	642528	7519939	34.5	Fair Hill Formation	18.41	0.09	MB35 / Saraji Mine
165978	*635945*	*7527652*	*10.5*	*Quaternary*	*Dry*		*MB20SRM01A(MB20SRM01_PZ)*
165979	635904	7527647	36.5	Tertiary	23.5	0.05 – 0.075	MB20SRM02T
165977	635885	7527652	242.0	Back Creek Group	50.5	0.005 – 0.015	MB20SRM03P
165976	631494	7530679	12.5	Quaternary	9	0.05 – 0.1	MB20SRM04A
165975	*634596*	*7525982*	*24.0*	*Quaternary*	*Dry*		*MB20SRM05A/ MB20SRM05A_PZ*
165974	636599	7520190	9.75	Quaternary	6.10		MB20SRM06A / MB20SRM06A_PZ
165894	640032	7515860	8.5	Quaternary	8.1		Saraji Mine monitoring
165892	640018	7515876	91.5	MCM	12.2	0.3	Saraji Mine monitoring
165893	640026	7515867	27	Tertiary	19		Saraji Mine monitoring
165325	*640296*	*7515897*	*18.5*	*Quaternary*	*Dry*		*Piezo 3*
84538	641354	7516737	109.7	Open hole 27.4 to 109.7 mbGL	18.3	0.67	
165323	*637620*	*7515091*	*15*	*Quaternary*	*Dry*		*Piezo 1*
165324	*638481*	*7514161*	*15*	*Quaternary*	*Dry*		*Piezo 2*
136092	**633416**	**7512196**	**22**	**Back Creek Group**	**12**	**1.10**	**Water supply**
165895	637063	7511046	42.5	Back Creek Group	12.7	0.2	Mine monitoring
190446	637223	7522750	33.8	FCCM	25.7	0.04	SRMMB12_01 / Mine monitoring
190447	637251	7522750	232.8	MCM		0.5	SRMMB12_03 / Mine monitoring

Registered Number (RN)	Easting	Northing	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
57747	**640392**	**7509441**	**126.5**	**Back Creek Group**		**4.42**	**Squirrel Bore / Water supply**
165980	641365	7507960	177.0	Back Creek Group	38	0.2	MB20SRM07P
182125	631724	7530111	28.5	Tertiary	11.2	0.01	BH01
182122	632287	7529754	32	Tertiary	10.5	0.01	BH03
182124	632484	7529311	38.0	Tertiary	11.5	0.01	BH02
182123	633800	7529686	34.0	Tertiary	10.1	0.01	BH04
132631	**635440**	**7528179**	**328.0**	**Back Creek Group**	**31**	**15**	**Water supply**
136689	635868	7528234	328.0	Duaringa Formation	31	15	Duplicate of RN132631
13040283	627834	7527375	68.5	Back Creek Group	38.14		NAP Isaac River Site 12 / DRDMW monitoring
165837	633101	7523636	42	Spoil	23.8	1	BH05
165838	633043	7522522	77.0	Spoil, bedrock at 66 mbGL	49	0.33	BH06
165833	633038	7522086	54.0	Clay, gravel	39.8	0.02	BH01
165834	633043	7522043	60.0	Clay, sand, gravel		0.13	BH02
165836	633024	7521999	54.0	Spoil, bedrock at 45.5 mbGL	36.5	0.01	BH04A
165835	633045	7521986	54.0	Spoil, bedrock at 53.5 mbGL	38.3	0.2	BH03
165881	*630581*	*7524539*	*17.0*	*Quaternary*	*Dry*		*MP07D*
165873	630457	7524462	10.0	Quaternary	4.5	0.23	MP10
165877	630632	7524461	15.0	Quaternary	9.5	0.14	MP06
165883	630353	7524308	7.0	Quaternary	2.6		MP09
165876	630672	7524328	18.0	Quaternary	10.2		MP01D
165850	630648	7524297	23.0	Quaternary	10.5		MP05D
165875	630692	7524283	18.0	Quaternary	10.5	0.01	MP02D
165874	630671	7524261	14.0	Quaternary	10.1		MP03D
165851	630698	7524184	18.0	Quaternary	9.8		MP04D
165872	630732	7524084	14.5	Quaternary	7.7		MP07
165882	630536	7524019	12.0	Sandstone	5		MP08
158686	643499	7508708	210.0	Coal	60	0.13	MW9P
122458	**644983**	**7526770**	**50.5**	**Back Creek Group**	**26**	**1.88**	**Water supply**

Registered Number (RN)	Easting	Northing	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
165123	647515	7526007	136.0	Rangal Coal Measures			LV2372R / VWP Mine monitoring
132627	**649564**	**7525028**	**70.0**	**Duaringa Formation**	**30**	**0.95**	**Water supply**
132628	**648220**	**7524052**	**120.0**	**Duaringa Formation**	**77**	**0.76**	**Water supply**
158484	648038	7523875	19.0	Quaternary			LV2370 / Mine monitoring
165124	648038	7523864	82.0	Rangal Coal Measures			LV2375W / VWP Mine monitoring
158482	645525	7522752	147.0	Rangal Coal Measures			LV2218 / VWP Mine monitoring
158483	*645525*	*7522751*	*20.0*	*Quaternary (clay)*	*Dry*		*LV2369 / Mine monitoring*
158481	643132	7521949	102.0	Rangal Coal Measures			LV2226 / VWP Mine monitoring
158485	*643132*	*7521943*	*22.0*	*Quaternary (clay)*	*Dry*		*LV2371 / Mine monitoring*
199088	626405	7541912	41.0	Permian siltstone	35	0.0	Mine monitoring
199089	626402	7541905	265.0	Permian coal		2.0	Mine monitoring
199090	626412	7541903	183.0	Permian coal		1.1	Mine monitoring
100291	626431	7542882	524.1	German Creek Coal Measures	17.16		Petroleum or gas bore
141382	628490	7542693	52.0		18.36	0.02	MB5
182363	631318	7542814	83.0	Blackwater Group			Mine monitoring
182362	631743	7543062	65.0	Sandstone	30	0.17	Mine monitoring
182364	633262	7543161	56.0	Blackwater Group	38	0.08	Mine monitoring
182365	634668	7541867	60.0	Blackwater Group			Mine monitoring
162681	*639329*	*7542012*	*10.0*	*Isaac River Alluvium*	*Dry*		*IF3835P (GW06S)*
165640	639334	7542009	203.0	Fort Cooper Coal Measures			IF3836P (GW06D) / VWP Mine monitoring
182925	626827	7538493	42.0	Blackwater Group		0.20	PDNMB05_02 / Mine monitoring
182868	626828	7538498	81.0	Blackwater Group			PBMMB05-03 / Mine monitoring
182630	*629971*	*7539627*	*7.0*	*Quaternary*	*Dry*		*EDS_MB02 / Mine monitoring*

Registered Number (RN)	Easting	Northing	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
190144	*634716*	*7537427*	*10.0*	*Quaternary*	*Dry*		*EDS_MB01 / Mine monitoring*
182403	628880	7532630	30.5	Back Creek Group	11.5	0.20	Mine monitoring
182401	630100	7532833	167.0	Back Creek Group	14.6	0.20	Mine monitoring
182402	630114	7532835	10.0	Quaternary	6.5	0.1	Mine monitoring
165374	641498	7532790	42.5	Duaringa Formation	20	0.14	VE3831P (GW12S) / mine monitoring
165642	641492	7532790	520.0	Rangal Coal Measures			VE3832P (GW12D) / VWP mine monitoring
199214	632035	7529483	40	Tertiary	26.5	0.02	Mine monitoring
199215	632044	7529474	115	MCM	34	0.02	Mine monitoring
199250	633605	7526818	186	MCM	138	0.15	Mine monitoring
199251	633605	7526803	38	Tertiary	27.11	0.02	Mine monitoring

Blanks – no data
Italics represent dry bores.
Bold represents water supply bores.
Abandoned and destroyed bores:
RN100248
RN182406
RN182926
RN100252
RN13040179
RN13040178
RN13040177

It is noted that several large yielding water supply bores, constructed within the Back Creek Group, have been identified using the data included on the GWDB bore cards. The drillers logs for these bores indicated:

- RN136092 had a yield of 1.1 L/s (within the Back Creek Group some 4 km to the west of Saraji Mine)
- RN57747 had a yield of 4.42 L/s (within the Moranbah Coal Measures south of Saraji Mine)
- RN132631 had a yield of 15 L/s (down dip of Saraji Mine within the Fort Cooper Coal Measures)
- RN122458 had a yield of 1.88 L/s (10 km down dip of Saraji Mine within the Rewan Group).

Plate 2 presents the location of these water supply bores in relation to Saraji Mine.

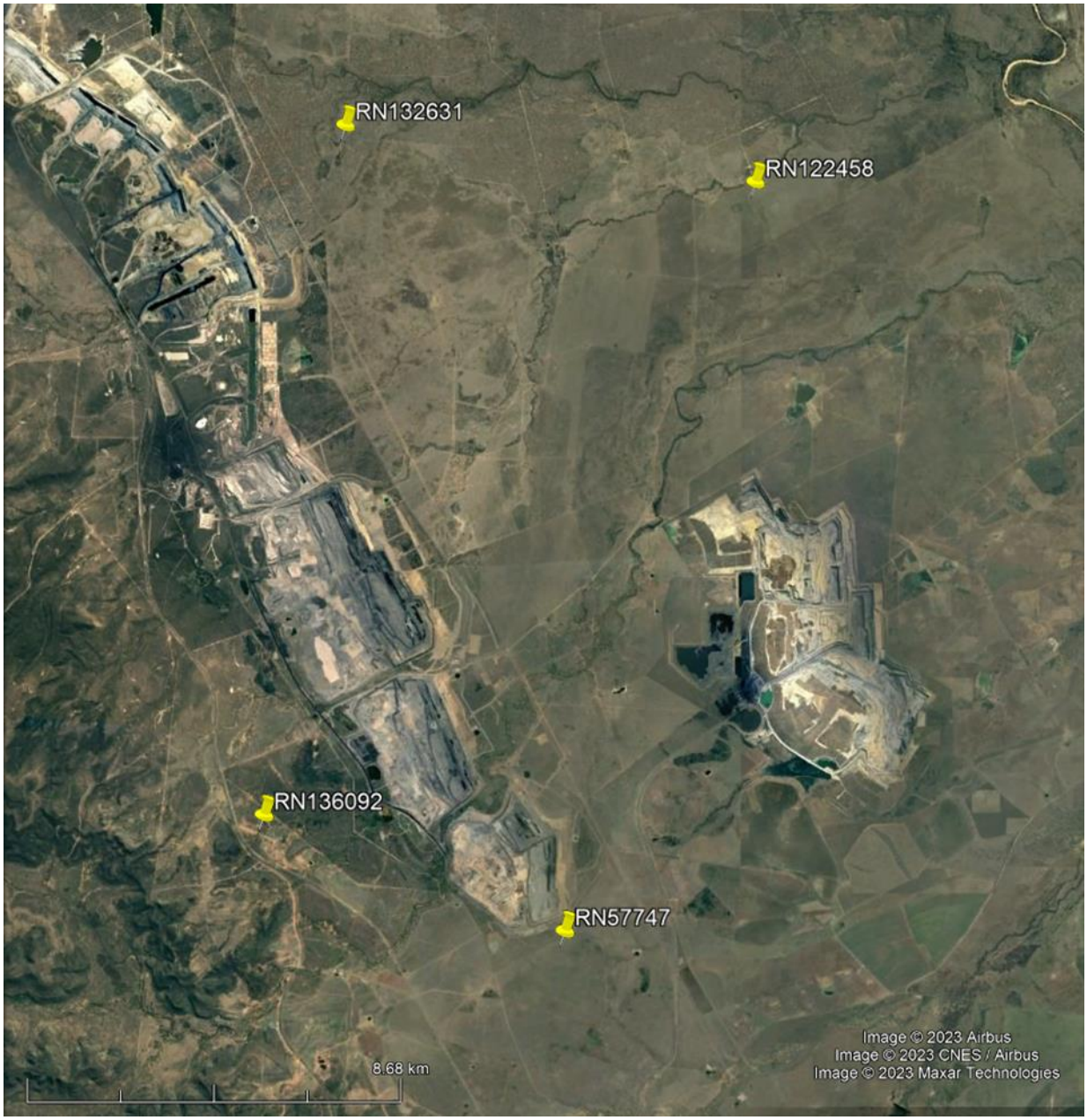


Plate 2 Water supply bore locations

The bore cards for these bores indicate:

- RN136092 intersected gravel and sand and course-grained sandstone and is 22 m deep. It is considered that the groundwater intersected within this bore is Quaternary age alluvium and not Back Creek Group.
- RN57747 was drilled before 1972 into basalt, coal, and sandstone to a depth of 126.5 m. Measured to 70.1 m in 1973. As Back Creek Group comprises quartzose to lithic sandstone, siltstone, mudstone, carbonaceous shale, calcareous sandstone and siltstone, conglomerate, coal, limestone and sandy coquinite. This bore may intersect younger Tertiary basalt and Back Creek Group, but based on location and mining targets along strike it is more likely to intersect Moranbah Coal Measures.
- RN132631 was drilled to 328 m below surface, intersecting groundwater at 321 to 328 m within fractured sandstone. Based on depth and lithology logged it is considered that this bore was drilled into a fault or fracture zone within the Fair Hill Formation of the Fort Copper Coal Measures.
- RN122458 was drilled to 50.5 m below surface, intersecting groundwater within fractured shale. Based on the location of the bore and the lithology logged it is considered that this bore intersected fractured Rewan Group sediments.

Thus, the groundwater yields attributed to the Back Creek Group in the bore cards are considered to be inaccurate and that the Back Creek Group sediments have limited groundwater potential, as included in the model (basement aquitard).

Potential impacts on surrounding registered bores are included in Section 6.8.1. None of these Back Creek Group water supply bores are predicted to be impacted by the Project.

5.3.3 Bore census

A bore census was undertaken in the Project Area in 2007, which identified 12 unregistered landholder bores which were not at that time listed on the GWDB. Two of the identified landholder bores (MB31 and MB32) were subsequently monitored as part of the Saraji Mine monitoring program (Section 5.3.1).

A summary of available information for each of the bores identified during the bore census is presented in Table 23. The location of these bore census bores are included in Figure 35.

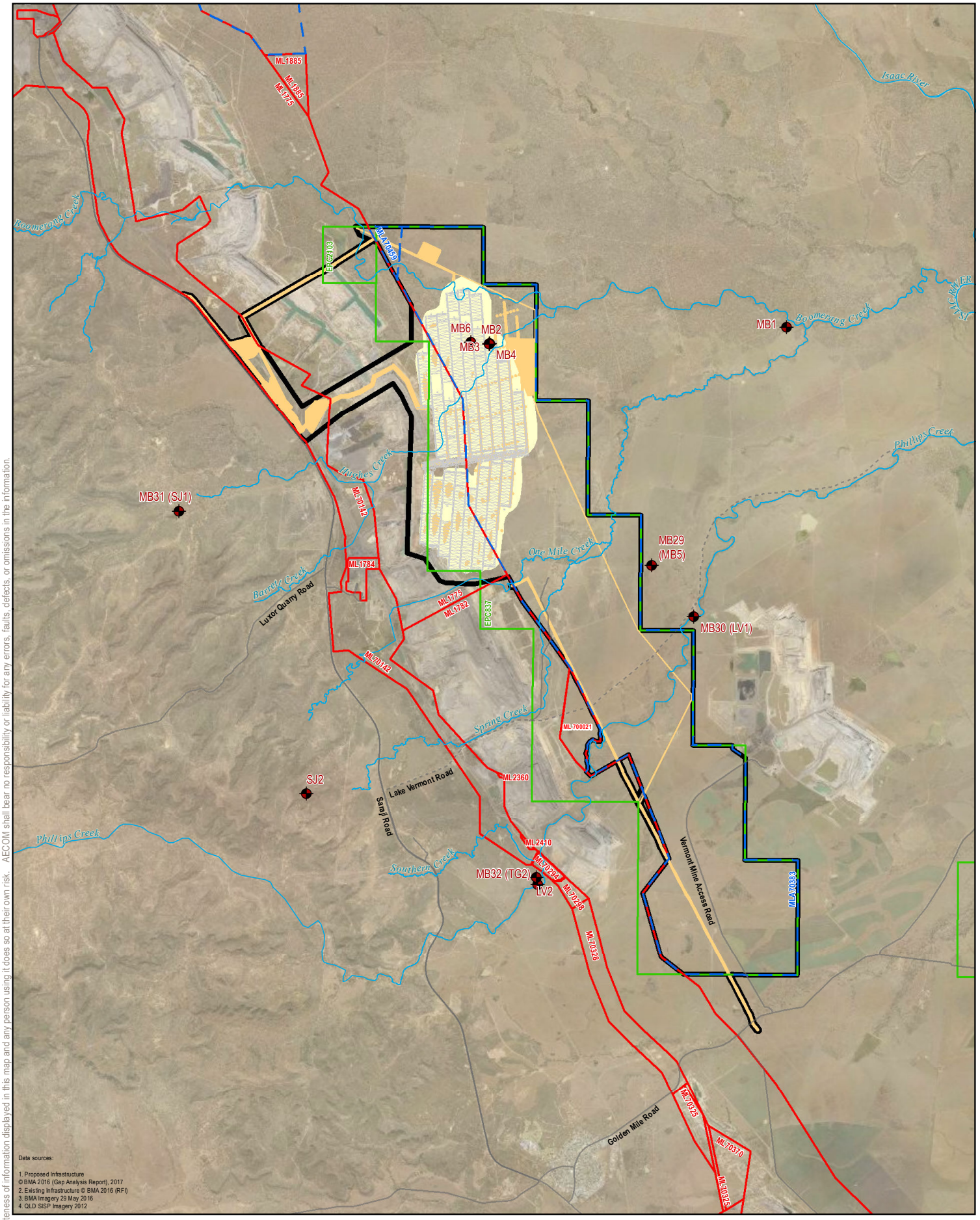
Table 23 Bore census bores

Registered Number	Latitude	Longitude	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
Unregistered	625942	7522560	44.23	Back Creek Group	7.85 (217.19 mAHD)	-	MB31 (SJ1)
Unregistered	637479	7510539	19.52	Phillips Creek Alluvium	10.4 (197.73 mAHD)	-	MB32 (TG2)
Unregistered	641146	7520803	-	Unknown	-	-	MB29 (MB5)
Unregistered	642497	7519163	>100	Coal	23.77	-	MB30 (LV1)
Unregistered	645477	7528481	79.4	Unknown	20.63	-	MB1
Unregistered*	635924	7527947	60.94	Unknown	22.86	-	MB2
Unregistered*	635935	7527947	50	Unknown	23.82	-	MB3
Unregistered*	635924	7527936	27.1	Unknown	23.53	-	MB4
RN132631?	635327	7527997	-	Unknown	-	-	MB6
Unregistered	637429.6	7510772	-	Unknown	-	-	LV2
Unregistered	630045	7513471	-	Unknown	-	-	SJ2
Unregistered	656437	7508703	15.06	Unknown	9.42	-	TG1

*MB2, MB3, and MB4 identified during the bore census are located in the vicinity of RN136689 and RN132631, which are considered to be the same bore based on the bore card details. MB2, MB3, and MB4 were all, however, measured to be markedly shallower than these two registered bores (total drill depth 328 m).

Based on drill dates and depths included in the bore cards for registered bores in proximity to the bore census bores, only MB6 may be an existing registered bore, RN132631.

Although these bores have not been registered or validated since the bore census, they have been included in the Project impact assessment.



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Unregistered Bores

N

Figure 35
Bore census bores

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G439_v2_A4P.mxd

5.3.4 Existing hydrogeological understanding

The following description of the existing groundwater regime(s) for the Project Area is based on a review of previous groundwater investigations (Section 4.1) and data obtained from the following sources:

- DRDMW GWDB
- Exploration drilling across the Project Area
- Data from the Saraji Mine and Saraji East Mine Lease groundwater monitoring network including groundwater level measurements and groundwater quality sampling.

An aquifer is defined as a groundwater bearing formation permeable to transmit and yield water in useable quantities.

There are three aquifer systems and one aquitard within the Project Area. These aquifers and aquitard are, based on the groundwater level data (step vertical gradients) and aquifer hydraulic properties, have limited hydraulic connection. The aquitard is formed by the Permian overburden and interburden (i.e. shale, mudstone, siltstone, and sandstone).

The three hydrostratigraphic units are associated with the following geological strata:

- Quaternary alluvium
- Tertiary sediments
- Coal seams contained within the Permian coal measures.

This section details the physical and chemical characteristics of these hydrostratigraphic units within the context of the prevailing regional hydrogeological regime.

5.3.5 Quaternary alluvium

5.3.5.1 Occurrence

Quaternary alluvium is not mapped within the footprint of the proposed underground mine (Figure 19**).** Quaternary alluvium is recognised to occur as historic channels associated with the present-day course of Phillips Creek. The alluvium aquifer is unconfined with a maximum thickness of 25 m adjacent to Phillips Creek. No alluvium is mapped on geological maps in association with the non-perennial creeks, including the former Hughes Creek, which drains across the underground mining footprint. Alluvium extent, derived from site-specific bore logs and auger holes, is included in Figure 27.

The Quaternary alluvium associated with Phillips Creek is considered to have limited groundwater potential for the following reasons:

- A review of DRDMW bore cards and site data indicates that several bores have been drilled near Phillips Creek and most of these bores did not intersect groundwater, (i.e. the drilling results indicate limited or no sustainable groundwater resources associated with the alluvium).
    - Three hand augur bores (Table 18) results indicate discontinuous saturated alluvium.
    - Only one bore (MB32) within the alluvium sediments of Phillips Creek (Figure 32), has been reported to contain water during all groundwater monitoring events.
    - Monitoring bore MB38 (MB19SRM01A), monitored monthly during 2020, was always dry as included in Table 24 (i.e., no effective recharge or groundwater storage capacity occurs in the alluvium in places, resulting in sporadic discontinuous groundwater resource).
- Phillips Creek is ephemeral and does not provide a permanent or continuous recharge source to the alluvium. As recognised in MB38 (MB19SRM01A), surface water – groundwater interaction along Phillips Creek is variable and not a continuous losing or gaining surface water system.

Table 24 MB38 / MB19SRM01A groundwater level monthly monitoring records for January 2020 to February 2021

Registered Number	Date	Depth-to-water (mbGL)
MB38 (MB19SRM01A)	30/01/2020	169276, no samples taken; bore is dry
	14/02/2020	bore is dry
	18/03/2020	dry
	21/04/2020	dry
	19/05/2020	dry
	17/06/2020	bore dry
	1/07/2020	bore dry
	17/08/2020	bore dry
	16/09/2020	bore dry
	18/11/2020	bore dry
	9/12/2020	bore dry
	13/01/2021	bore dry
	17/02/2021	dry

Hand augur bores and recently installed (2019 and 2020) groundwater monitoring bores, as detailed in Section 5.2.3.1, indicate the limited alluvium along the non-perennial creeks (Boomerang Creek, Plumtree Creek, One Mile Creek, and Hughes Creek).

These drilling results indicate:

- Thin moist to dry alluvium within these creeks
- Shallow bedrock below the non-perennial creeks
- Limited effective storage in the river sand (i.e., dry due to drainage from the sand)
- The deepest alluvium within the Project footprint was 3.75 m deep BGL.

The extent of the alluvium mapped for assessment in this groundwater study, based on the site data, is included in Figure 27.

5.3.5.2 Groundwater recharge, discharge, and flow

The alluvium aquifers are, based on the groundwater level response to rainfall and associated surface water flow in MB32 (Figure 39 and Figure 40), primarily recharged during creek flow events. As all creeks are ephemeral, and can be dry throughout the year (Table 24) recharge to the alluvium is likely to occur by the following mechanisms:

- Discontinuous recharge from surface water flow, ponding, or flooding
- Infiltration of direct rainfall and overland flow where permeable river sand alluvium deposits are exposed, and no substantial clay barriers occur in the shallow sub-surface.

Available hydrological data suggests that water infiltrates/drains from the alluvium relatively quickly after rainfall events (i.e., limited effective storage as the sands were dry). Based on the deep water levels within the underlying Tertiary and Permian age sediments (some 20 mbGL) and the perched alluvium water level (6 to 10 mbGL), as included in Table 21, limited vertical hydraulic connection is identified (i.e., steep vertical gradient and > 10 m separation).

Based on these site-specific data, it is conceptualised that the Quaternary alluvium does not contain permanent groundwater as recharge to the alluvium migrates downstream / downgradient within the creeks more readily than into the underlying bedrock and older sediments.

Discharge from the alluvium is likely to include the following mechanisms:

- Discharge to Phillips Creek during or after flow events as base flow. Limited effective storage (recognised due to the dry bores in the alluvium) results in the alluvium dewatering under gravity.
- Evapotranspiration from vegetation growing in the creek beds and along the banks.

- Minor stream loss and recharge to the underlying formations where the creeks intersects more permeable bedrock or sediments.

Groundwater flow is considered to mimic topography and is limited to the alluvium within or immediately adjacent to the creeks.

It is also considered that discontinuous perched water may occur within the alluvium, which does not readily flow. This can occur in more porous sand surrounded by clay-rich sediments. This is considered to occur due to highly saline alluvium water being reported within the Project (Section 5.3.9).

5.3.5.3 Hydraulic parameters

More extensive alluvium systems occur outside the Project Area, associated with ephemeral water courses such as the Isaac River (approximately 15 km to the east of the underground mining footprint as included in Figure 17).

Based on available information from the nearby Caval Ridge Mine, Quaternary alluvium deposits associated with creeks and main river tributaries could be expected to have a bulk hydraulic conductivity of approximately 0.1 m/day (URS, 2009).

For the alluvium intersected within the five alluvium monitoring bores installed at the Saraji Mine during 2020 (GHD, 2023), the bore construction included development. Each monitoring bore was developed by airlifting after the grout had been allowed to cure. The purpose of development was to remove drilling fines, foreign materials and to enhance hydraulic connectivity with the surrounding aquifer.

Site-specific aquifer hydraulic information compiled during the bore development included:

- Development on bore MB20SRM06A (MB20SRM06A_PZ) was not completed as BMA decided plug and abandon this bore and to redrill at this location at a later date.
- MB20SRM04A was developed using a bailer because of the low water volume within the bore and slow recharge. The estimated yield for this bore was 0.05 to 0.1 L/s (4 to 9 m^3/day).
- MB38 (MB19SRM01A) had an estimated yield of 0.0008 L/s (0.07 m^3/day).
    - This bore has been recorded dry since installation, the estimate yield is based on aquifer testing within a similar unsaturated zone
- MB20SRM01A (MB20SRM01_PZ) and MB20SRM05A (MB20SRM05A_PZ) were dry and could not be developed.

These results indicate little or no groundwater yield capacity within the alluvium, when saturated.

Eleven (11) standpipes were installed at the Hughes Creek / Hughes Creek diversion at Saraji Mine (SRK, 2019). These registered monitoring bores, included in Table 22 and on Figure 34, were installed in an area altered by mining activities. The drilling did intersect fill, mine spoil, natural alluvium, and weathered sedimentary rocks. The Hughes Creek alluvium comprised moist dark brown clay to sandy clay, overlying wet orange sand to silty sand.

Falling and rising head permeability tests (slug tests) were conducted to obtain estimates of hydraulic conductivity of the alluvium. These estimates are summarised in Table 25.

Table 25 Hughes Creek / Hughes Creek diversion alluvium permeability estimates

Bore ID	Screened interval (mbGL)	Hydraulic Conductivity (m/day)	Airlift yield (L/s)
P01D	13.6 – 17: Sand with trace silt, clayey sand, sandy clay 17 – 17.3: Residual sandy silty clay	0.19	0.014
P02D	13.2 – 17: Sand with trace silt, clayey sand, sandy silty clay	1.9	≤ 0.01
P03D	10.9 – 12: Sand with trace silt 12 – 14.1: Sandy clay and fall-in	2.4	≤ 0.01
P04D	12 – 15.5: Gravelly sand with trace silt, sandy clay with gravel, clayey sand with gravel 15.5 – 18.3: Sandy cay with trace gravel	0.64	≤ 0.01
P05D	13.5 – 14: Sandy clay	0.16	≤ 0.01

Bore ID	Screened interval (mbGL)	Hydraulic Conductivity (m/day)	Airlift yield (L/s)
	14 – 21: No returns (assumed alluvium, residual soils and fall-in)		
P07D	12.6 – 15: Gravelly sand 15-16.5: Silty clay with trace sand	> 9	0.18
MP06	11.8 – 15: Clay with sand, sandy clay	> 9	0.13
MP07	8.4 – 11.5: Sand with clay	1.6	≤ 0.01
MP08	2.7 – 12.1: Weathered siltstone	0.09	≤ 0.01
MP09	3.4 – 5.4: Sandy silty clay, sand with trace silt, clayey sand	> 9	0.09
MP10	5.3 – 8: Clay with trace sand 8 – 8.8: Weathered sandstone	> 9	0.2

These bores interested a mix of heterogeneous fill, alluvium, and regolith, no marked groundwater potential was evident based on the airlift yields.

5.3.6 Tertiary sediments

5.3.6.1 Occurrence

The Tertiary sediments maintain permanent groundwater resources particularly within the deeper sequences and the basal unit. The primary groundwater bearing strata of this unit is the basal sand/gravel unit, where it is locally extensive. The basal sand/gravel unit is, however, recognised to be discontinuous.

Observations from the open-cut pits at Saraji Mine indicate that groundwater discharges slowly from the Tertiary sediments and at the boundary (unconformable contact) between the Tertiary age sediments and the underlying Permian strata. Based on these observations, the Tertiary sediments are considered to contain a series of poorly connected water-bearing horizons of low to moderate permeability, with drainage from the upper to lower horizons delayed by lower permeability horizons.

Groundwater ingress rates to the Saraji Mine open-cut pits are very low, resulting in damp pit walls. Evaporation rates are higher than the seepage such that this groundwater does not report directly or require management in the pits.

Groundwater is typically intersected near the base of the Tertiary sediments in the Project Area between 13 m (PZ05) and 35 m (PZ02) (AGE, 2011). Based on bore logs reviewed, the sandy lenses and/or basal sand/gravel units are the primary storage for groundwater. The depth and occurrence of groundwater within the Tertiary sediments is considered variable and dependent on the extent and location of these porous, sandy layers within the sequence.

Groundwater levels within the Tertiary sediments from monitoring bores near the Project Area are reported to be at depths shallower than the recorded water strikes from drilling and installation. This indicates that the aquifer is confined to semi-confined because of the clayey sediments in the upper Tertiary sequence.

MB40 (MB19SRM02T) was constructed adjacent to Phillips Creek (Figure 30). This bore intersected clay and sandy clay below the alluvium. A zone of basal gravels and clay were intersected above bedrock sandstone. The Tertiary sediments were screened between 14 and 20 mbGL (above the sandstone), with water measured within the screen (unconfined) at 17.36 mbTOC. This indicates that the Tertiary sediments are also unconfined in places.

5.3.6.2 Groundwater recharge, discharge and flow

Recharge to the Tertiary aquifers is considered to be the result of the following:

- Direct infiltration of rainfall and/or surface water runoff where the sediments subcrop or outcrop at the surface
- Leakage from overlying alluvium, where present.

Primary discharge mechanisms in the Tertiary sediments are likely to include the following:

- Throughflow into underlying and/or adjacent aquifers such as the coal seams (possible hydraulic connection based on depth-to-water measurements)
- Evapotranspiration
- Groundwater extraction (including local mine dewatering).

Based on depth-to-water measurements for the two Tertiary monitoring bores at Saraji Mine, MB40 / MB19SRM02T, the direction of groundwater flow within the Tertiary sediments is expected to reflect topography, from elevated areas in the west towards lower areas towards the east.

It is noted that the recharge and discharge within the area related to monitoring bore MB40 (MB19SRM02T) are limited as evident in the depth-to-water measurements since 2020 (Figure 36). The water level fluctuation (< 1 m) is not considered to be a direct influence of rainfall variation shown in Figure 36).

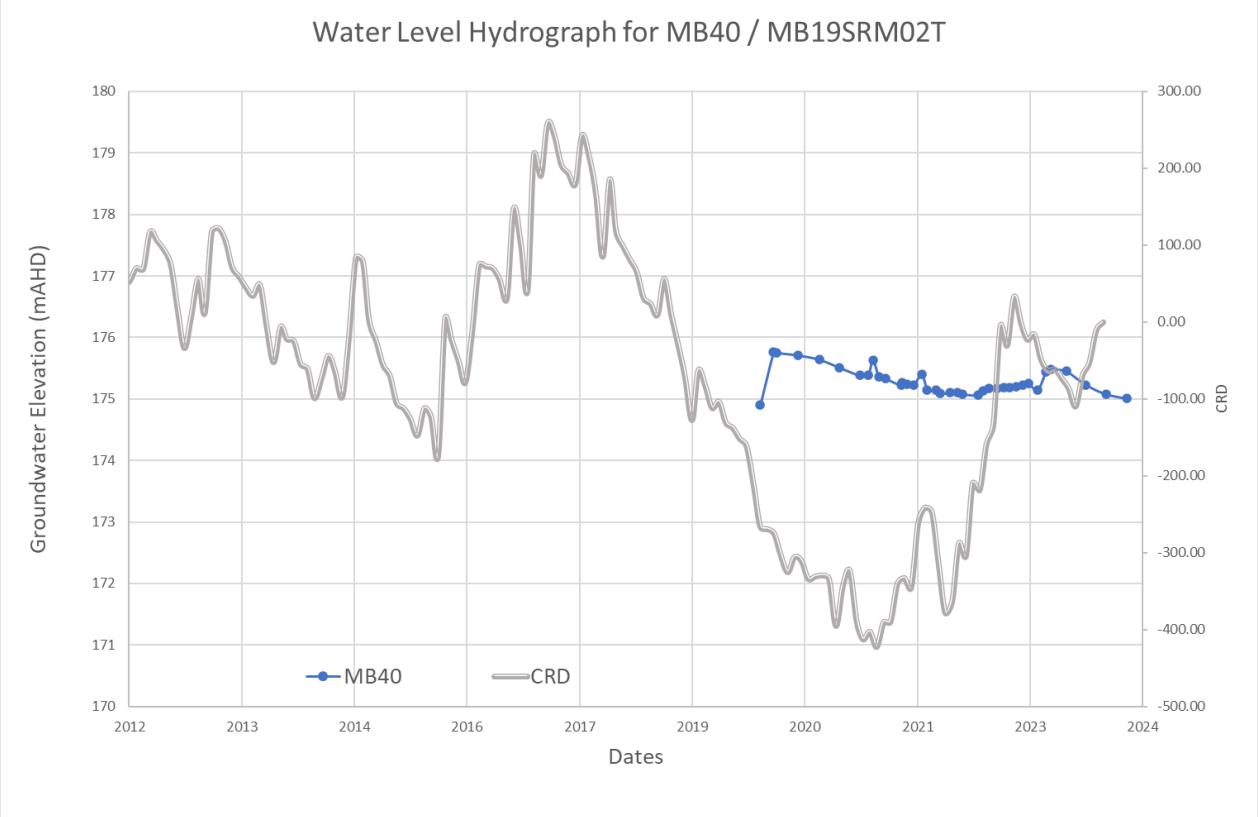


Figure 36 MB40 / MB19SRM02T hydrograph for 2020/21

5.3.6.3 Hydraulic parameters

As the extent and nature of the Tertiary sediments are highly variable, the porosity and permeability of the aquifer is also likely to be highly variable. As a result, usable yields of groundwater are only expected to occur within the higher permeable sand and gravel lenses near the base of the sequence.

Rising head permeability tests were undertaken by AGE (2011) at groundwater monitoring bores PZ02A, PZ04A, and PZ07A. These tests were conducted to assess the permeability of the Tertiary sediments at each location. The tests allowed for groundwater to be removed from each bore via airlift techniques; the rate of water level recovery for each well was then measured via groundwater level loggers installed in each well. Additionally, manual water level readings were measured prior to, and at regular intervals, for each test.

Results of these tests indicated a permeability range for the Tertiary unit between 0.01 m/day and 0.002 m/day (2 to 3 orders of magnitude lower than the alluvium).

Site-specific aquifer hydraulic information compiled during the bore development included:

- Development on bore MB20SRM02T resulted in an estimated yield of 0.001 to 0.016 L/s (0.09 to 1.4 m^3/day).

5.3.7 Permian sediments

5.3.7.1 Occurrence

Permian sediments in the Project Area include the Fort Cooper Coal Measures (FCCM) and MCM. While the Permian sediments do not outcrop in the underground mining footprint, they subcrop under the Tertiary sediments Figure 20 depicts the extent of mapped Permian sediments (i.e. basement geology).

As is the case throughout much of the Bowen Basin, the individual coal seams are typically regarded as the main water bearing units within the Permian coal measures. Groundwater movement and storage occurs within the coal seam cleats and fissures and within open fractures that intersect the seams. The coal seams are often the first unit where useable volumes of groundwater are encountered during drilling along the western edge of the Bowen Basin and, therefore, the coal seams may provide locally sufficient groundwater supplies where yields and quality are sufficient (typically for cattle stock watering or industrial purposes as included in Section 5.4).

Other sediments in the coal overburden and interburden are relatively impermeable and generally form aquitards, except where fractured or faulted. It is recognised from the VWPs constructed in the FCCM (JBT, 2014) that the interburden units which over- and under-lie the coal seams act as effective aquitards. These aquitards have very low vertical hydraulic conductivity resulting in marked differences in piezometric pressures between the different coal seams and interburden (i.e. a leaky aquitard would result in all bores having the same/similar piezometric levels).

Permian sediments may, therefore, be categorised into the following hydrogeological units:

- Hydraulically ‘tight’ and hence very low yielding sandstone, siltstone, mudstone, carbonaceous shale, and claystone that comprise most of the Permian overburden and interburden sediments.
- Low to moderately permeable coal seams which are the main water bearing strata within the Permian coal measures.

5.3.7.2 Groundwater recharge, discharge and flow

Groundwater monitoring bores constructed to intersect the Permian sediments have water levels, which are higher in elevation than the horizon at which the water was first intersected. This indicates that groundwater within the Permian sediments is confined.

Groundwater recharge to the Permian sediments is likely to occur via the following mechanisms:

- Direct infiltration from overland flow and rainfall in areas where the Permian sediments subcrop (thin soil cover) or outcrop at the surface.
- Downward seepage and/or throughflow from adjacent or overlying Tertiary and Quaternary sediments in places where no substantial clay unit is present.

Discharge mechanisms of the Permian sediments are likely to include the following:

- Throughflow into adjacent coal seams or seepage into underlying aquifers (via structural discontinuities).
- Downgradient Permian strata outcrop areas.
- Groundwater extraction from regional / local mine dewatering activities.
- Groundwater flow within the Permian deposits is expected to generally be down-dip.

The geological cross-section in Section 5.2.2.1 suggest that the Permian sediments are relatively undisturbed and groundwater within the sediments is, therefore, unlikely to be influenced by faulting (i.e. mounding or lows in the groundwater flow patterns are not expected or identified, which can result from alteration of sediments due to fault throws).

5.3.7.3 Hydraulic parameters

Hydraulic parameters for the Permian sediments were derived from the following three sources:

- Rising head permeability tests were undertaken by AGE (2011) at groundwater monitoring bores PZ02B&C, PZ04B&C, PZ07B, PZ09B, and PZ10B&C using the same methodology as described in Section 5.3.6.3.
- Packer tests which were undertaken on eight geotechnical boreholes by Mining One (2011).

- Stress and permeability testing which was undertaken by Multiphase Technologies (2011).

The results of the permeability testing is summarised in Table 26.

Table 26 Permeability Test Results

Geological Unit	Test Method	Hydraulic Conductivity (m/day)		
		Minimum	Maximum	Average
Harrow Creek	Slug	4.3×10^{-5}	0.026	0.007
	Packer	-	-	0.016
	Stress & perm	5.8×10^{-5}	0.32	0.039
Dysart	Slug	4.3×10^{-5}	0.0046	0.0023
	Packer	-	-	0.0095
	Stress & perm	5.8×10^{-4}	0.1	0.012
Permian Interburden	Slug	-	-	-
	Packer	-	-	0.16
	Stress & perm	-	-	-

Notes: "-" not tested or no result provided Source: AGE (2011).

Table 26 shows that the coal seam aquifers within the Project Area generally exhibit low to moderate hydraulic conductivity. Overall, results show that the deeper Dysart seam is slightly less permeable (less than one order of magnitude) than the overlying Harrow Creek seam.

The hydraulic conductivity data, as determined during the field tests, indicates a reducing hydraulic conductivity of the coal with depth. Based on the decrease in permeability with depth, exponential equations for the coal seams were derived as detailed in Section 4.3.8.1.

It is recognised from Table 26 that packer tests performed across Permian interburden yielded hydraulic conductivity values comparable to the coal seams which contrasts with the conceptual understanding that the Permian interburden is typically tight and less permeable than the coal seams. The higher hydraulic conductivity results for the packer tests across the Permian interburden suggest that the interburden material can be locally permeable but are not expected to be laterally continuous (AGE, 2011).

SLR, as part of the predictive model calibration (SLR, 2023), assessed the Permian coal and interburden hydraulic parameters across several Bowen Basin mines and available Bowen Basin data. These data allowed for the recognition of the change in hydraulic parameters with depth. Figure 37 shows the decreasing permeability trend in the interburden, which allowed for the calculation of the following regression equations:

- Interburden (Rangal Coal Measures and FCCM): $HC = HC_0 \times e^{(-0.018 \times depth)}$
- Interburden (MCM): $HC = HC_0 \times -2.1^{depth}$.

Where: HC is horizontal hydraulic conductivity at specific depth; HC_0 is horizontal hydraulic conductivity at depth of 0 m (intercept of the curve); depth is depth of the floor of the layer (thickness of the cover material); and slope is a term representing slope of the formula (steepness of the curve).

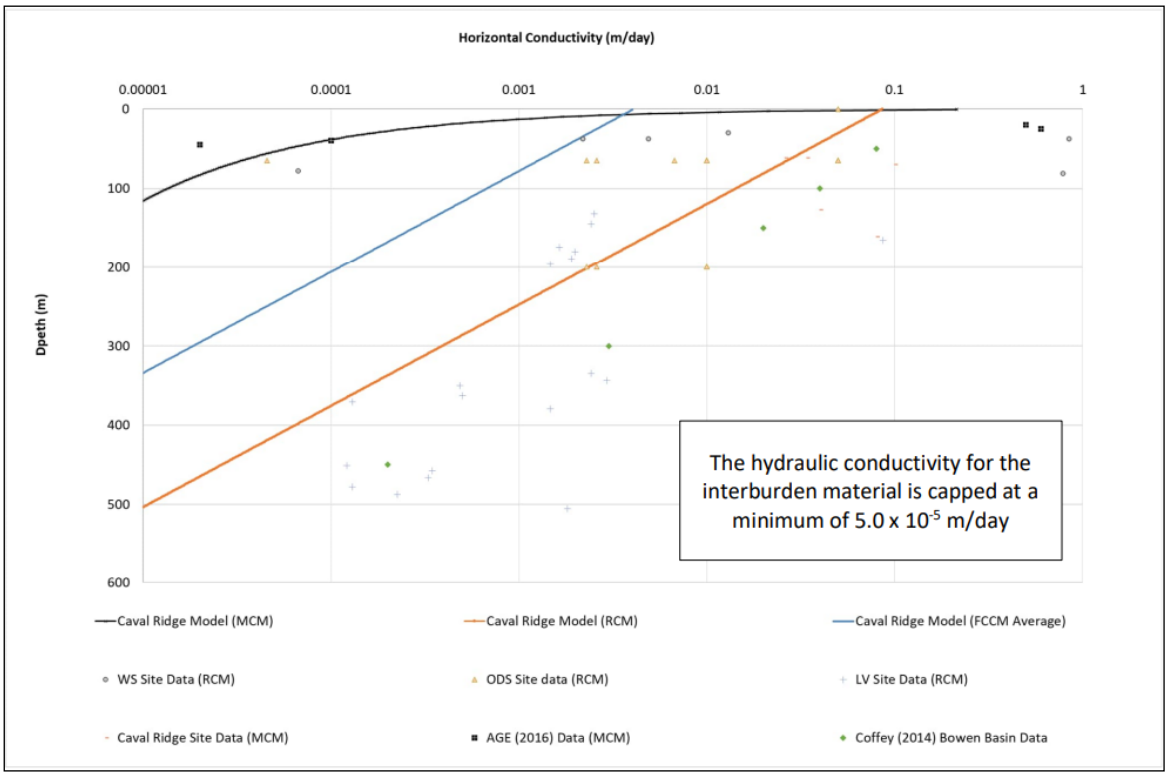


Figure 37 Hydraulic Conductivity vs Depth – Interburden data

The available interburden hydraulic parameters for the interburden within the Project Area indicates a power equation relationship, based on the range of data with depth.

The coal seam data from the Olive Downs site, the Winchester South site, the Lake Vermont North site, and Bowen Basin data, presented in Figure 38, indicates the coal horizontal conductivity - depth relationship.

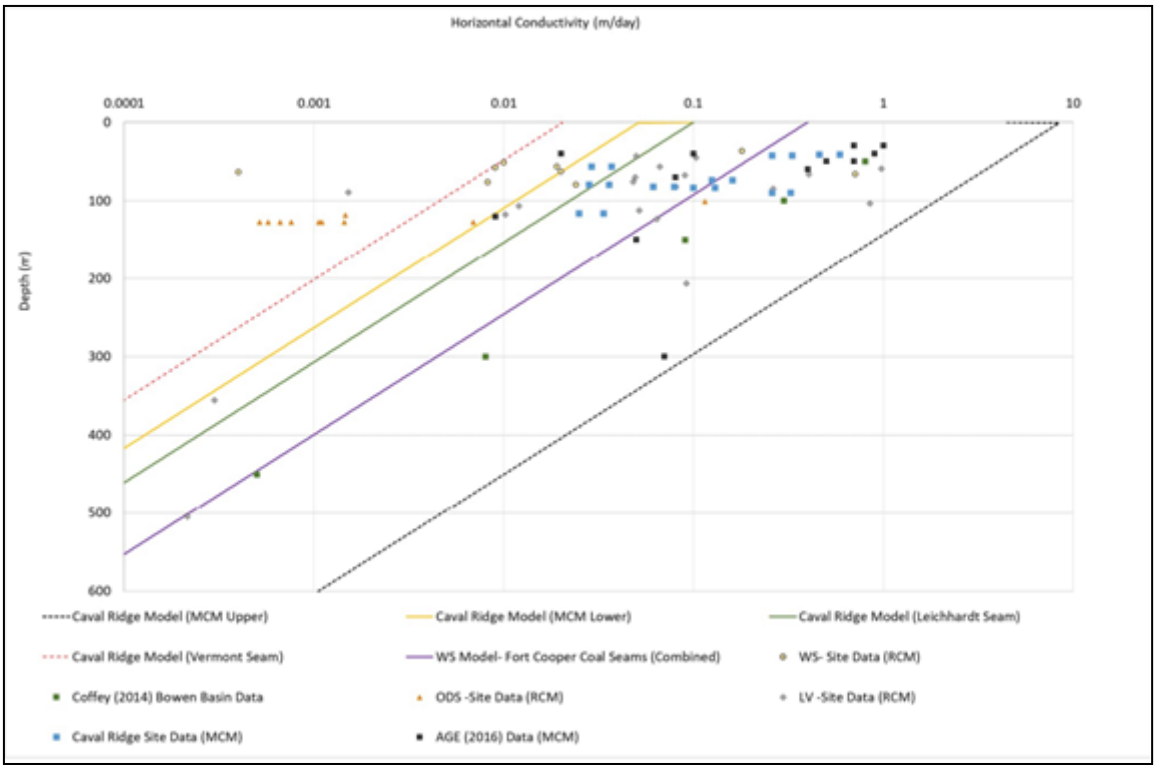


Figure 38 Hydraulic Conductivity vs Depth – coal data

The hydraulic conductivity of the coal seam layers decreases with depth according to the following equation:

- $HC = HC_0 \times e^{(-0.015 \times depth)}$.

Figure 38 also shows the coal horizontal conductivity against depth relationship for the Leichhardt and the Vermont Seam of the Rangal Coal Measures.

5.3.8 Groundwater level data

Groundwater level data was compiled from the various bores identified in Sections 5.3.1, 5.3.2, and 5.2.3.

5.3.8.1 Quaternary groundwater levels

Due to the sporadic, discontinuous, and seasonal nature of the Quaternary alluvium groundwater level data is limited, as included in Section 5.3.5.1.

For this unit depth-to-water measurement data includes:

- Seven bores (158484, 162681, 162685, 165323, 165324, 165325, 165326) with no water level data
- Twenty bores (MB38 (MB19SRM01A), MB20SRM01A (MB20SRM01_PZ), MB20SRM05A (MB20SRM05A_PZ), 165325, 165323, 165324, 165881, 165877, 165883, 165876, 165850, 165875, 165874, 165851, 165872, 158483, 158485, 162681, 182630, 190144) which were drilled dry
    - Monitoring bore MB38 (MB19SRM01A) has been monitored monthly since December 2019 and has been dry at all times (Gauge, 2021)
- Five bores (MB20SRM04A, MB20SRM06A (MB20SRM06A_PZ), 165833, 165873, 182402) with a single recorded water level measurement
    - The registered bores 165833, 165873, and 182402 has only one measurement on their bore cards
    - Monitoring bore MB20SRM04A was drilled dry and was measured once during development with a bailer
    - Monitoring bore MB20SRM06A (MB20SRM06A_PZ) was measured once before this bore could not be successfully completed as a monitoring bore (collapsed / lost bore, which will be replaced in the future).
- One bore (MB32) with transient water level data.

Bore MB32 is a historic stock watering bore (used for stock watering until 2007) identified during a bore census. This bore is located upstream of the Saraji Mine on Phillips Creek (Figure 32).

The available groundwater level data for MB32 shows fluctuations over an approximately 6 m range (Figure 39). Groundwater levels within MB32 readily correlates with the CRD due to rainfall leading to surface water flow and recharge from Phillips Creek (i.e., not solely recharged from rainfall).

It is noted that the alluvium monitoring bore reflects the wet and dry climate conditions (Figure 39) and thus does not include an EA Condition related to water level fluctuation (Section 5.3.10 Table 46).

Background monitoring bore MB32 does not have an associated water level fluctuation EA condition as the water level change in MB32 relates to surface water in Phillips Creek and not solely groundwater related.

Groundwater monitoring data (depth-to-water measurements) review (Gauge, 2021) indicated that groundwater levels have gradually declined since 2017 in reference bore MB32. This decline trend (using depth-to-water data) is not readily identifiable when groundwater data is converted to mAHD.

The CRD data indicates decreased monthly rainfall between 2019 and 2021. The reduce rainfall resulted in reduced flow within Phillips Creek during this period. The water level data indicates the effective storage within the alluvium, at MB32, does not readily discharge to the creek (i.e., minimal baseflow component from groundwater in the Phillips Creek at MB32).

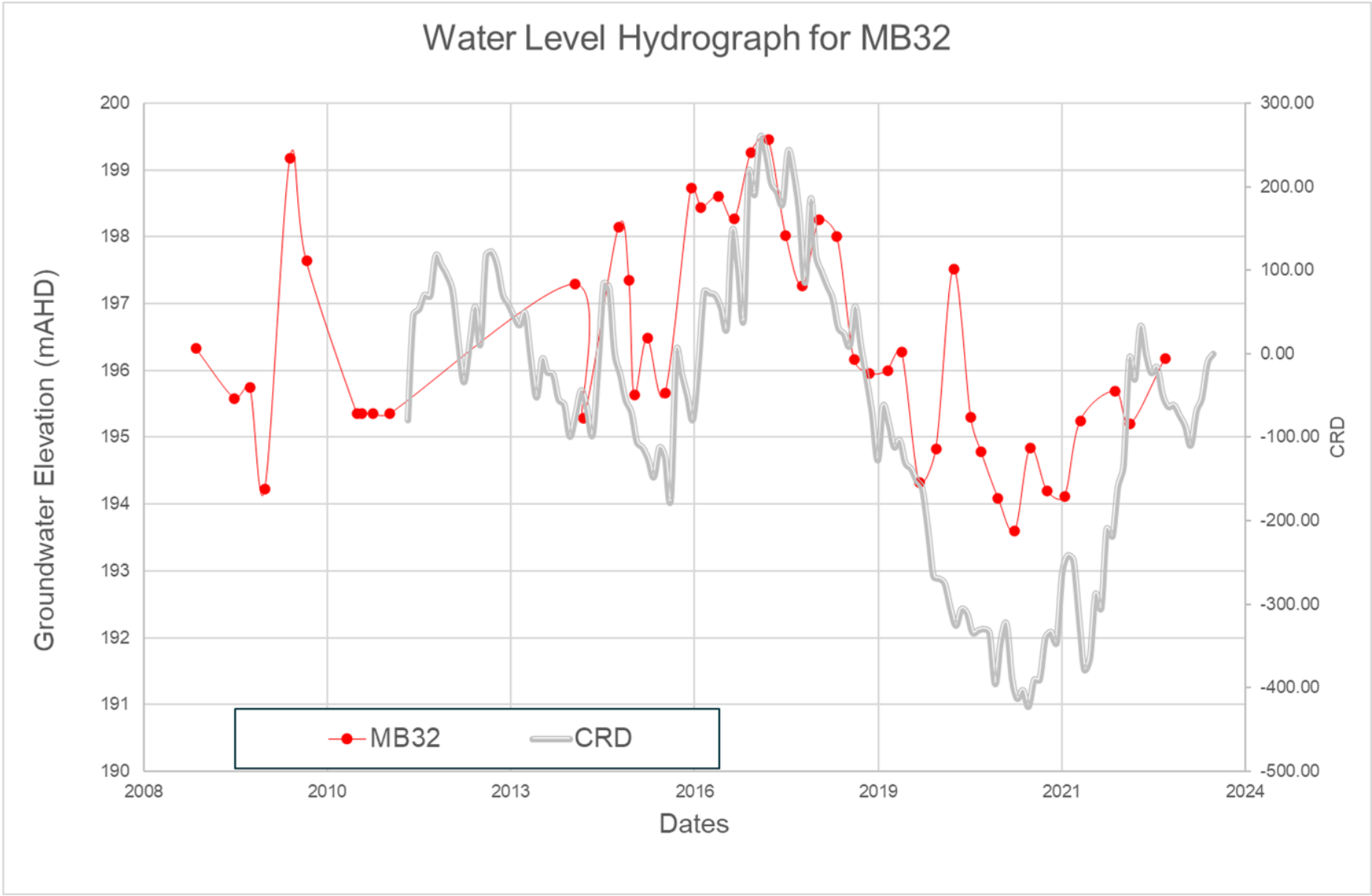


Figure 39 MB32 hydrograph

An assessment of transient (long-term) groundwater level data in all other monitoring bores, across wet and dry seasons, indicated limited natural fluctuation. Figure 40 presents the hydrographs and the CRD curve.

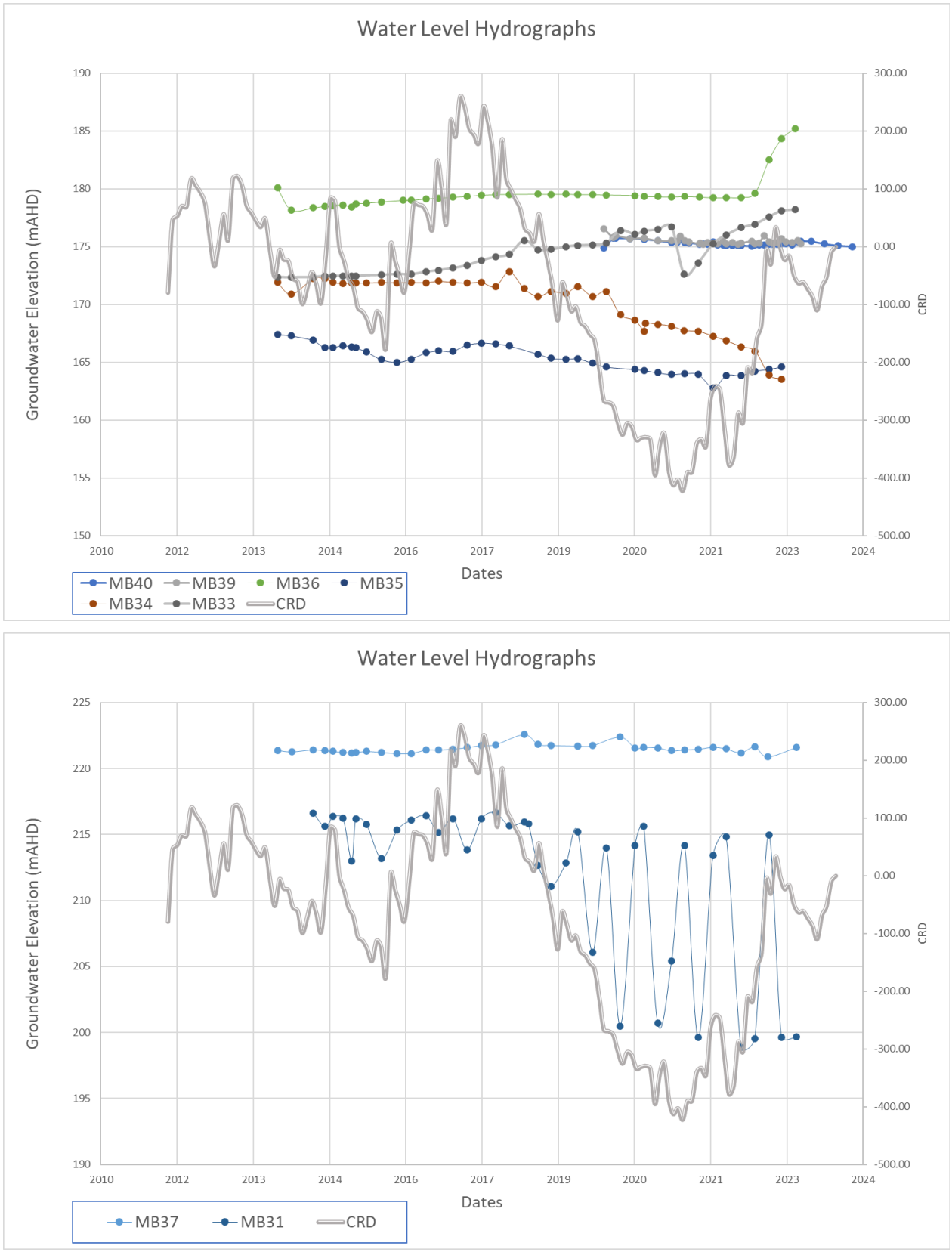
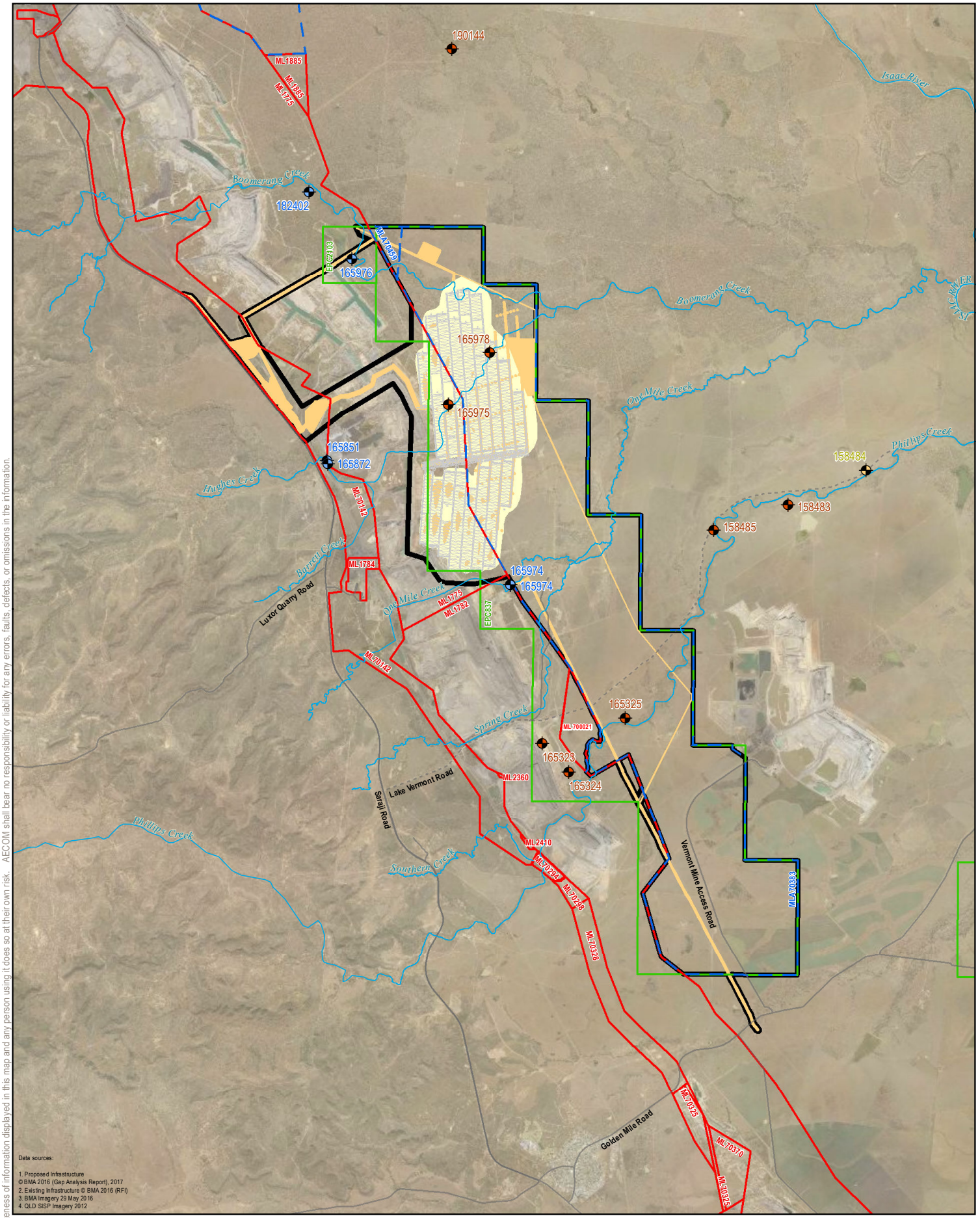


Figure 40 Groundwater levels in Saraji Mine monitoring bores and the CRD

Alluvium groundwater flow pattern

Available groundwater level data for all the alluvium bores identified in Table 22 was compiled to identify current groundwater flow pattern(s) within the alluvium. Based on the large number of dry bores, as included in Figure 41, discontinuous nature, and the separate alluvium deposits (within and immediately adjacent several creeks), no accurate groundwater flow patterns could be derived. Groundwater flow is envisaged to mimic topography and drain downstream when (if) ever fully saturated.



LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road

Alluvium bore saturation status

- Dry
- Water level measured
- No water level measured

N

Figure 41
Alluvium bores and saturation status

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

5.3.8.2 Tertiary groundwater levels

BMA drilled several bores into the Tertiary sediments as part of their historic groundwater monitoring program. Bores PZ02A, PZ04A, and PZ07A were constructed as standpipe monitoring bores within the Tertiary sediments. PZ09A and PZ10A were also drilled to intersect Tertiary sediments but both were drilled dry. PZ07A was contaminated with bentonite and not used for monitoring.

Groundwater level measurements, compiled during 2011 and 2012, indicate variable groundwater levels across the Project Area (Figure 42). Tertiary monitoring bores generally became dry during the monitoring period as a result of sampling, indicating limited sustainable yields.

Tertiary groundwater levels measured in PZ02A (sample depth 26 mbgl) and PZ04A (sample depth 21 mbgl) indicate that groundwater levels are generally greater than 20 mbgl (Table 28 and Figure 42).

Table 27 Historic Tertiary groundwater level measurements

Bore Name	Easting	Northing	Elevation^	Depth-to-water (mbGL)	Water level (mAHD)	Date
PZ02A	632019.46	7530674.7	200 mAHD	19.0	181.0	Sept 2011
				19.87	180.13	Nov 2011
				Dry	Dry	Jan 2012
				Dry	Dry	Mar 2012
PZ04A	630242.09	7530952	207 mAHD	22.0	185.0	Sept 2011
				20.3	186.7	Nov 2011
				23.0	184.0	Jan 2012
				19.91	187.09	Mar 2012

^Estimated from Google Earth

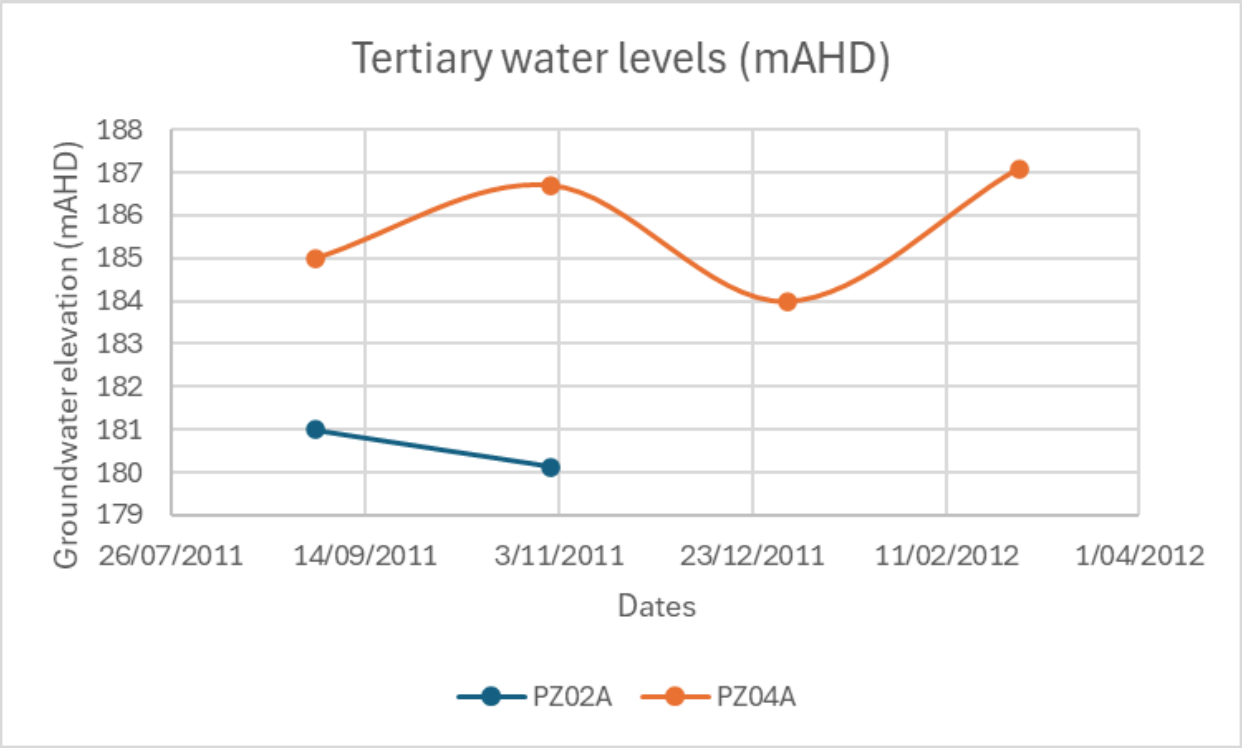


Figure 42 Historic Tertiary groundwater level data

Recent measurements

Groundwater level monitoring occurs within MB40 / MB19SRM02T, a monitoring bore intersecting the Tertiary gravel, clay, and silt. This monitoring bore is 21 m deep and located on Phillips Creek (Figure 32). The groundwater level measurements, monthly during 2020/21, is included in Figure 36.

The longer term groundwater level data within MB40 / MB19SRM02T has been relatively stable (Figure 36), with ~ 1 m fluctuation, indicating no marked response to recharge or discharge.

MB40/ MB19SRM02T is compliant with the water level trigger set at >2 m fluctuation in the Saraji Mine EA Conditions (Section 5.3.10).

Tertiary groundwater flow pattern

Available groundwater level data for all the Tertiary bores identified in Table 22 was compiled to evaluate current groundwater flow patterns within the Tertiary age sediments.

The Tertiary groundwater level data is included in Table 28 and the spatial location of bores in the Tertiary are shown on Figure 44, this figure also presents the resultant groundwater flow pattern within the Tertiary.

Table 28 Available Tertiary groundwater level data

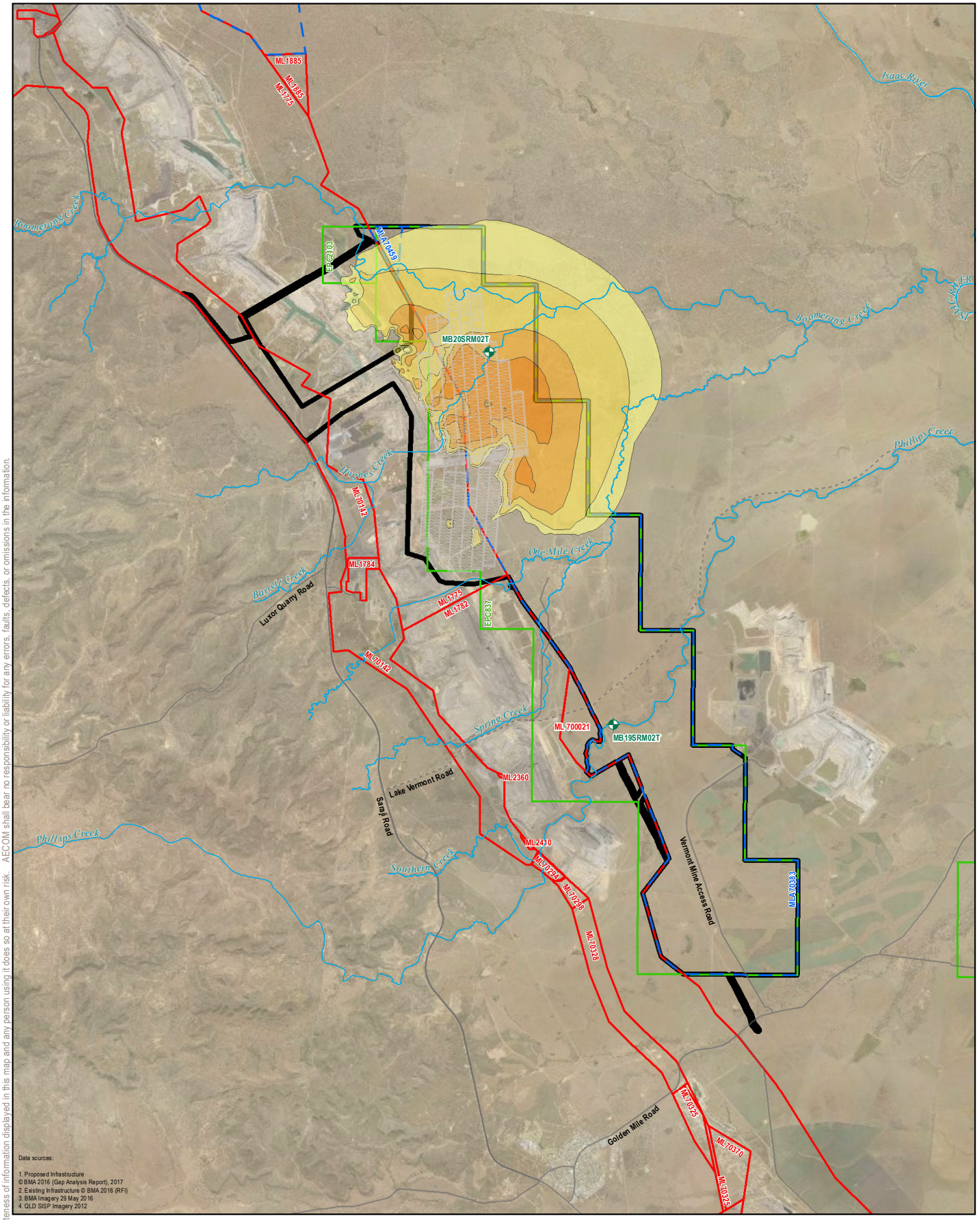
Registered Bore	Easting	Northing	Depth-to-water (mbGL)	Elevation* (mAHD)	Water level elevation (mAHD)
165979	635904	7527647	23.5	190	166.5
165893	640026	7515867	19	196	177
182125	631724	7530111	11.2	199	187.8
182122	632287	7529754	10.5	201	190.5
182124	632484	7529311	11.5	197	185.5
182123	633800	7529686	10.1	193	182.9
199214	632035	7526803	26.5	183	156.5
199251	633605	7526803	27.11	201	173.89

Table note: *Ground elevation estimated on Google Earth

Groundwater flow is recognised to be elevated in the north due to possible artificial recharge from existing mine waste and water storage infrastructure. Groundwater flow is recognised to mimic surface water flow from west to east across the Project Area.

Flow back towards the west is, based on limited data, recognised due to RN19924, which is located adjacent to the Saraji Mine open-cut pits (i.e., the lowest groundwater elevation, 156.5 mAHD, influences the contouring).

Note: Monitoring at PZ02A and PZ04A discontinued in 2012, when the groundwater monitoring bore network was revised to reflect the groundwater monitoring conditions included in the mine's approval conditions.



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Tertiary Bores
- Tertiary Drawdown Contours (m)
  - 1
  - 2
  - 5
  - 10
  - 20

N

Figure 43
Tertiary Bores and Groundwater Flow Patterns

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 1

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G440_v1_A4P.mxd

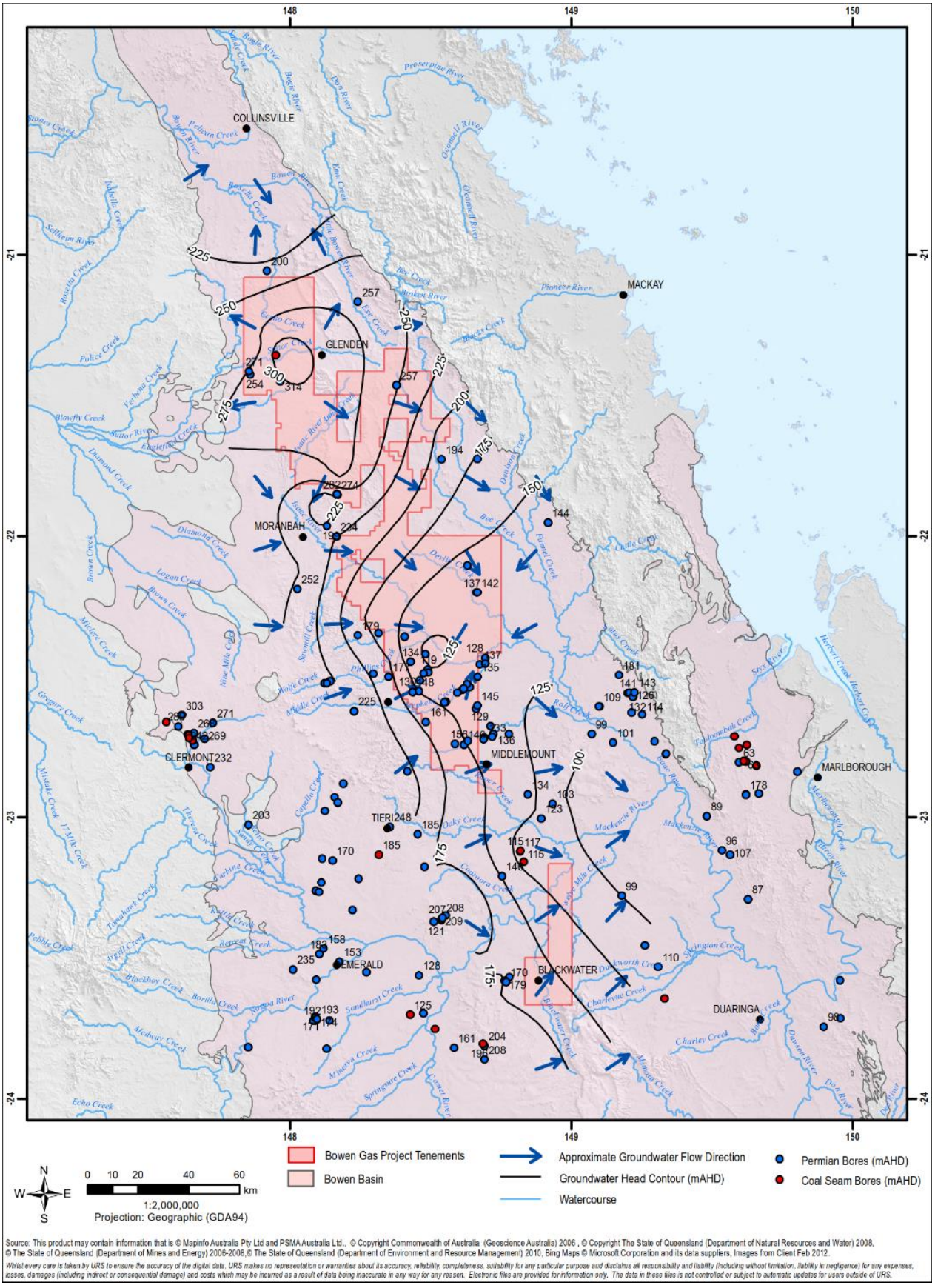
5.3.8.3 Permian groundwater levels

Groundwater monitoring bores and VWPs have been constructed within the Harrow Creek (H16) and Dysart (D14 / D24) coal seam. These historic monitoring bores include:

- Harrow Creek – PZ02B, PZ04B, PZ05A, PZ06B, PZ07C, PZ08B, PZ09B, and PZ10B
- Dysart – PZ02C, PZ04C, PZ05B, PZ06C, PZ07B, PZ08C, PZ09C, and PZ10C.

Groundwater levels measured in the monitoring bores ranged from 27 mbGL (PZ02B) to 64.5 mbGL (PZ07C) for the Harrow Creek H16 seam and from 20.8 mbGL (PZ06C) to 65.2 mbGL (PZ09C) for the Dysart Lower (D14 / D24) seam.

The potentiometric surface (groundwater elevation) of the Permian sequences indicates a gradient from around 185 mAHD in the north-west to around 170 mAHD in the south-east across the Project Area. This is similar to the regional groundwater contours generated for the Permian coal seams across the entire Bowen Basin, Figure 44 (Arrow, 2012).



Source: This product may contain information that is © Mapinfo Australia Pty Ltd and PSMA Australia Ltd., © Copyright Commonwealth of Australia (Geoscience Australia) 2006 , © Copyright The State of Queensland (Department of Natural Resources and Water) 2008, © The State of Queensland (Department of Mines and Energy) 2006-2008,© The State of Queensland (Department of Environment and Resource Management) 2010, Bing Maps © Microsoft Corporation and its data suppliers, Images from Client Feb 2012.
Whilst every care is taken by URS to ensure the accuracy of the digital data, URS makes no representation or warranties about its accuracy, reliability, completeness, suitability for any particular purpose and disclaims all responsibility and liability (including without limitation, liability in negligence) for any expenses, losses, damages (including indirect or consequential damage) and costs which may be incurred as a result of data being inaccurate in any way for any reason. Electronic files are provided for information only. The data in these files is not controlled or subject to automatic updates for users outside of URS.

Figure 44 Average groundwater level contours across the Bowen Basin. Source: Arrow (2012)

The regional groundwater flow pattern across the Project Area indicates flow from north-west to south-east. There is a groundwater low indicated on the regional groundwater flow pattern in this area. It is considered that this low could be a result of abstraction or faulting.

Groundwater levels for the Permian coal seam bores and Permian interburden sediments are presented in Figure 45.

Overall, Permian groundwater levels indicate no marked seasonal fluctuation (response to dry and wet seasons) and no influence of mining (even though the mining at Saraji Mine has been operating since 1974).

The Saraji Mine monitoring includes the following Permian groundwater monitoring bores:

- MB31 an upgradient reference bore screened within coal (unknown seam)
- MB37 an upgradient reference bore located on coal measures sub-crop
- MB33 a compliance monitoring bore within Permian overburden down gradient of the mine
- MB34 a compliance monitoring bore within Permian interburden
- MB35 a compliance monitoring bore within Permian overburden underlying Phillips Creek alluvium
- MB36 a compliance monitoring bore within Permian overburden
- MB39 (MB19SRM03P) a compliance monitoring bore within Permian coal (seam S01).

The layout of these bores is included in Plate 3. The hydrographs of the water level data for these bores are included in Figure 45.

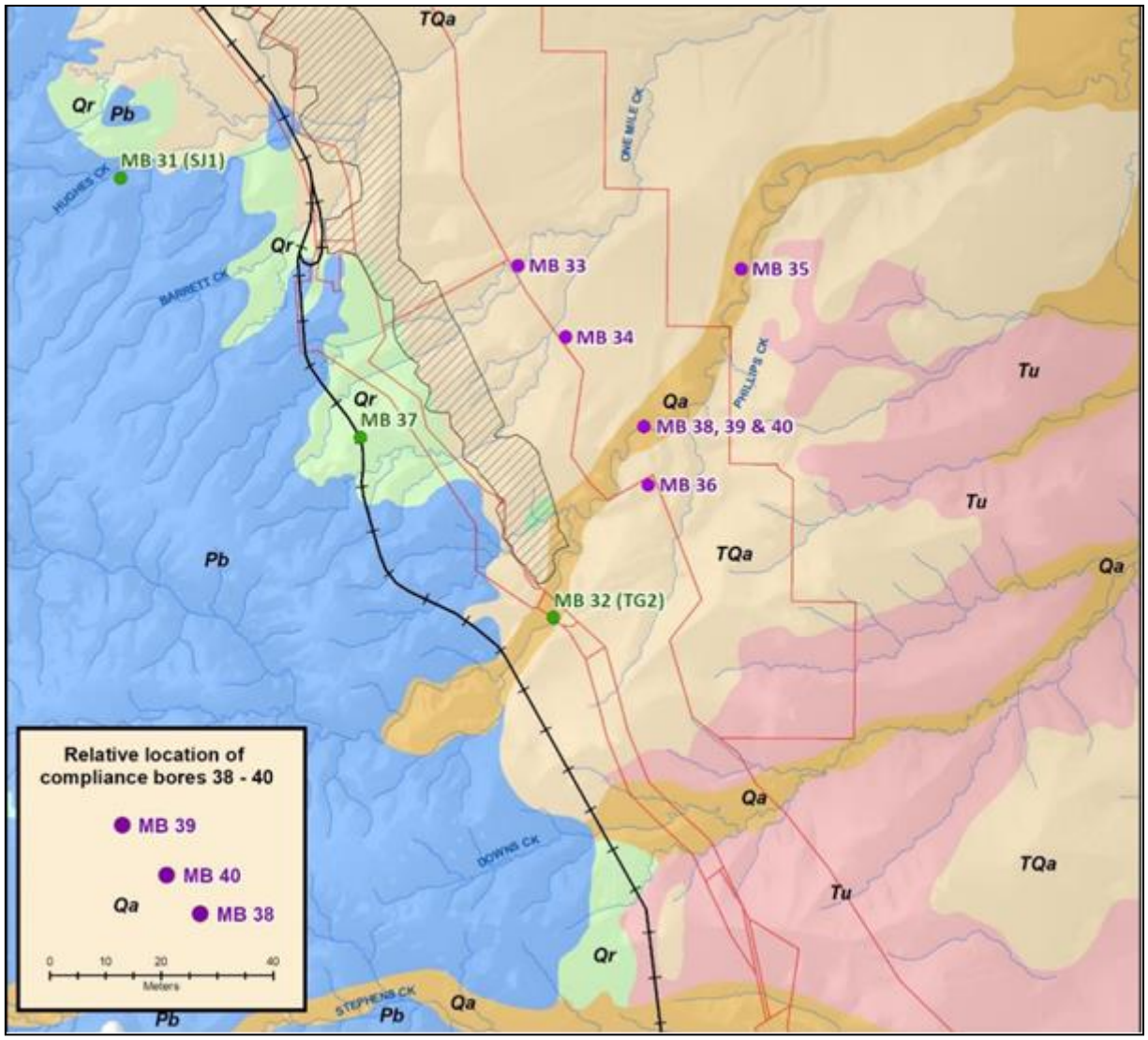
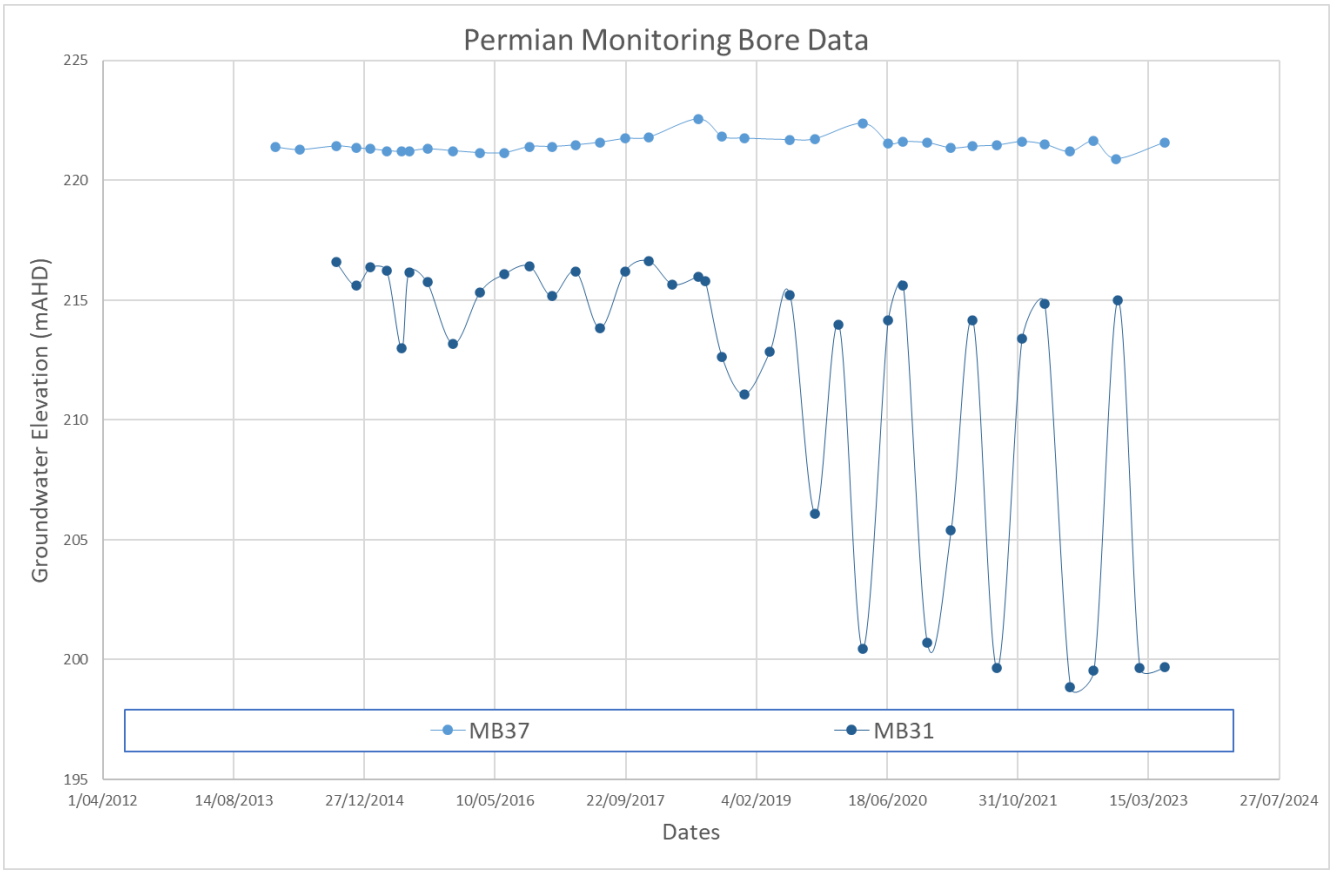


Plate 3 Saraji Mine groundwater monitoring bore network (Gauge, 2021)



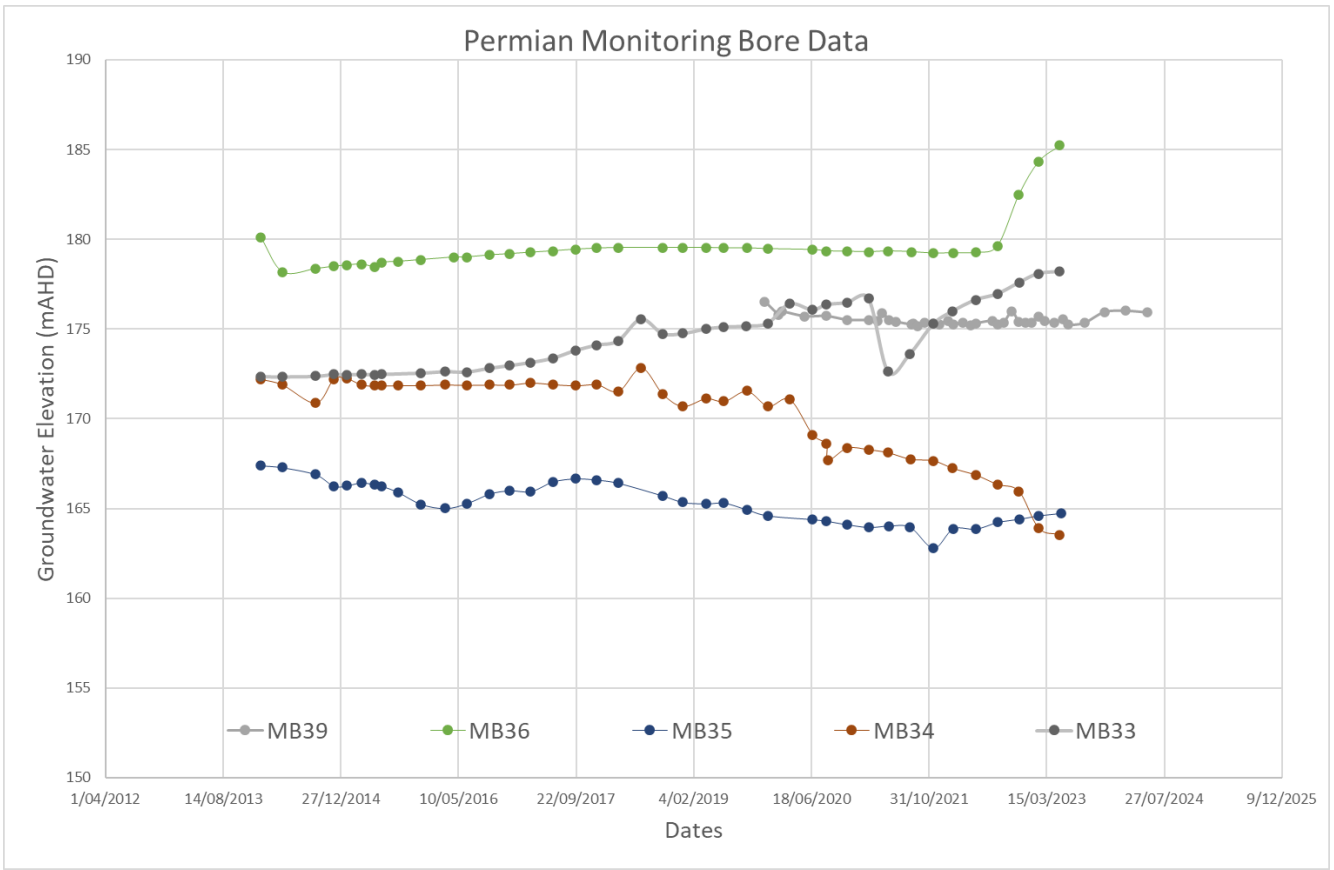


Figure 45 Permian monitoring bore water level hydrographs

The most recent groundwater monitoring assessment confirms no dewatering / declining groundwater level trends within the Permian sediments down gradient of the open-cut mine pits (which have been in operation since 1974). These data indicate:

- Little or no hydraulic connection between the mine target coal and overburden intersected within the open-cut pits
- Low groundwater transmissivity and permeability, which reduces the impact of mine dewatering on Permian over burden, interburden, and coal
- Groundwater levels in MB31 (are influenced by flow in Hughes Creek and/or possible landowner pumping (MB31 is a water supply bore).

Permian groundwater level fluctuation

The Saraji Mine EA condition water level trigger for these bores is “fluctuations in excess of 2 m from background” (Section 5.3.10 Table 46). Considering the water level triggers for Permian monitoring bores at Saraji Mine, which include MB33, MB34, MB35, MB36, and MB39 (MB19SRM03P), the following is observed:

- MB33 indicates a long-term increase in groundwater level of ~ 6 m from 2014 to 2023 in the Permian overburden away from the mining activities
- MB34 in the Permian interburden away from the mining activities, indicates a 9 m decrease in groundwater level between 2014 and 2023, where the rate of decline increased from mid-2019.
    - Figure 80 presents the monitoring bore locations in relation to faults and alluvium mapped at SEMLP. Figure 80 shows that MB34 is in proximity to the main fault mapped across the SEMLP footprint, as such the fault, noting limited drawdown in the Permian overburden and adjacent to the Saraji Mine open cut workings, is considered to possibly facilitate disconnected increased mine dewatering impacts.
- MB35, located in the Permian overburden underlying Phillips Creek alluvium, is relatively stable over time with the hydrograph indicating a muted groundwater level response to wet and dry conditions over time
- MB36 indicates more recent increased groundwater recharge, with groundwater levels rising from background (178 mAHD) to 185 mAHD between 2022 and 2023. This monitoring bore, like MB33, is in the Permian overburden away from the mining activities.
- MB39 (MB19SRM03P), located in the Permian coal seam S01, is relatively stable over time.

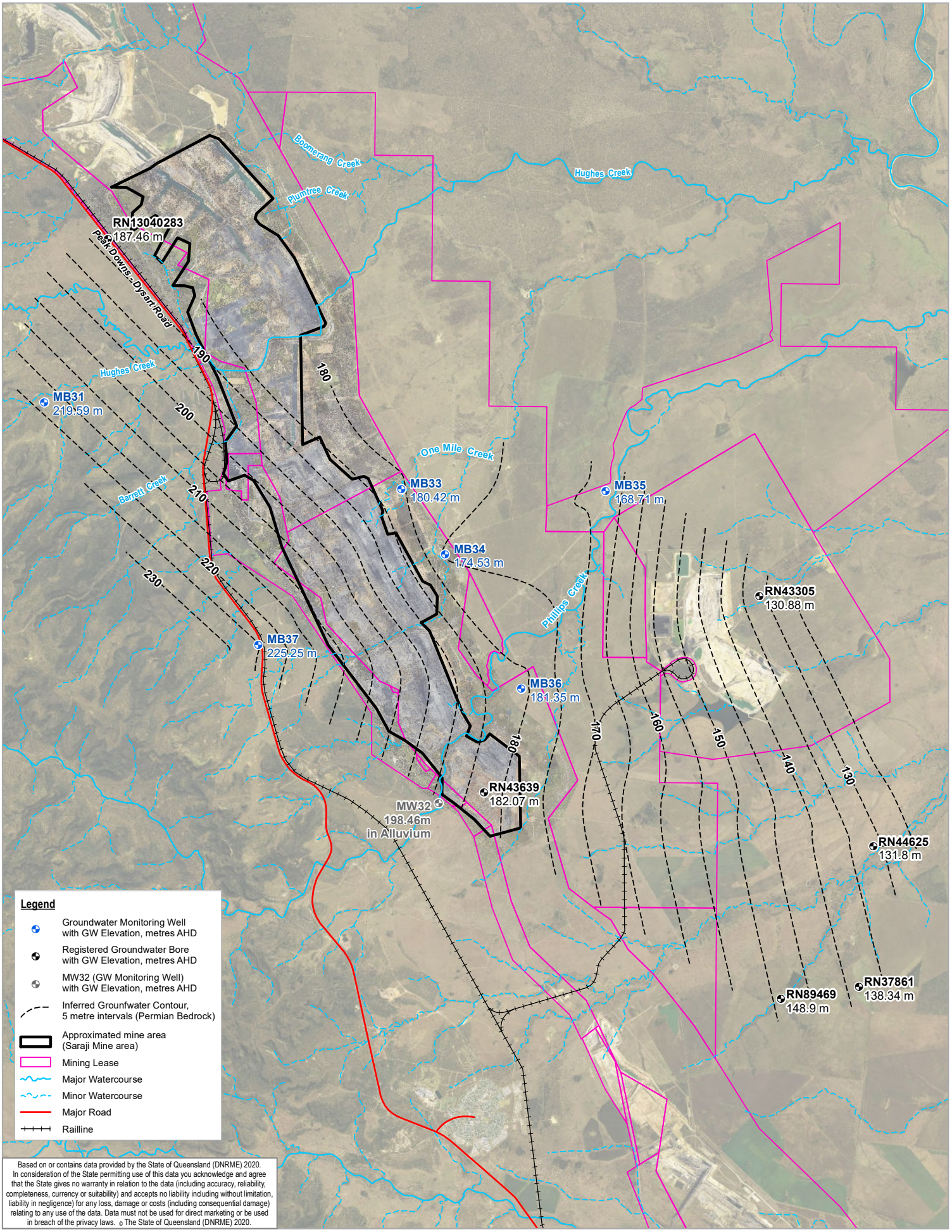
The transient groundwater level data does not readily indicate the direct or indirect impact of mining on these bores, rather the data indicates complex water level fluctuation related to wet and dry climate conditions and mining activities. Based on these water level data trends, the **adopting of a 2 m per year fluctuation trigger, as per the Saraji Mine EA conditions, is not considered suitable for the Permian groundwater monitoring bores across the Project**.

Recommendations in Section 7.5.2.4 regarding groundwater level triggers include consideration of the groundwater model predictions (rate and extent of drawdown).

Permian groundwater flow pattern

A groundwater elevation contour plan was generated from local groundwater level data at Saraji Mine and Lake Vermont Mine (GHD, 2020). This data (compiled from monitoring bores within different Permian age sediments) indicates a general groundwater flow southwest to northeast across the area (Figure 46).

This flow direction does not readily indicate the influence of the mining but is consistent with the surface water drainage flow direction.



Based on or contains data provided by the State of Queensland (DNRME) 2020. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws. © The State of Queensland (DNRME) 2020.

1:100,000 (Paper Size A3)

0 0.5 1 1.5 2 2.5 3 3.5

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

BHP Billiton Ltd
Saraji Mine

Groundwater Levels and Flow (Permian Bedrock)

Project No. 41-31665
Revision No. 0
Date 17 Jan 2020

FIGURE 46

G:\41\31665\GIS\Maps\MXD\41-31665-013_SarajiMineGWdec2017_revB.mxd
Print date: 17 Jan 2020 - 17:02

Data source: Client Supplied: Aerial Ortho Imagery (April 2018); Base Imagery: Google Earth (May 2017, extracted May 2018); DNRME: mine lease boundaries, road, rail, watercourses (2017); GHD: groundwater modelling, mine extent (May 2018). Created by: jvancooten

Vertical gradients

Groundwater levels measured in the nested bores PZ02, PZ04, PZ07, PZ09, PZ10 and VWPs PZ05, PZ06, and PZ08 were assessed to determine vertical groundwater gradients across the Project Area. Representative groundwater data and nested bore details are included in Table 29.

Table 29 Vertical groundwater level assessment (Aug /Sept 2011 data)

Bore	Monitoring Point	Depth (mbGL)	Unit	Water Level (mAHD)	Comment
PZ02	PZ02A	26	Tertiary	181.78	Downwards gradient. Marked water level separation between units.
	PZ02B	170	Permian interburden	173.78	
	PZ02C	278	Dysart D24	170.78	
PZ04	PZ04A	30	Tertiary	187.92	Downwards gradient. Marked water level separation between coal seams.
	PZ04B	66	H16	186.81	
	PZ04C	180	Dysart (D47)	166.81	
PZ05	PZ05A	203	H16	168.43	Downwards gradient. Minor water level separation between coal seams.
	PZ05B	239	Dysart (D52)	166.43	
PZ06	PZ06A	40.5	Permian overburden	184.39	Downwards gradient between overburden and H16 seam. Upwards gradient between H16 seam and D142 seam. Marked water level separation between units.
	PZ06B	78.5	H16	179.08	
	PZ06C	167	Dysart (D142)	182.62	
PZ08	PZ08A	38.5	P07 coal	177.70	Downwards gradient. Marked water level separation between coal seams.
	PZ08B	65	H16	173.25	
	PZ08C	180	Dysart (D24)	No Data	
PZ09	PZ09A		Tertiary	Dry	Downward gradient. Marked water level separation between coal seams.
	PZ09B	75	H16	165.69	
	PZ09C	195	Dysart (D24)	133.02	
PZ10	PZ10A		Tertiary	Dry	Downwards gradient. Marked water level separation between coal seams.
	PZ10B	70	H16	177.52	
	PZ10C	184	Dysart (D24)	159.33	

Overall, the 2011 nest piezometer groundwater level data shows that there are distinct differences in groundwater levels between the Tertiary sediments and Permian sediments, and between the Permian interburden/overburden sediments and Permian coal seams. The vertical hydraulic gradients were recognised to be predominantly downwards.

The latest groundwater monitoring data assessment report (Gauge 2021) plus BMA monitoring team provided groundwater level data for the nested monitoring bores, MB38 / MB19SRM01A (alluvium), MB40 / MB19SRM02T (Tertiary), and MB39 / MB19SRM03P (MCM coal) (Figure 47).

This data indicates varying vertical gradient (direction and separation) over time within the Tertiary and Permian sediments. The alluvium is always dry.

Comparing the available groundwater elevation data, the vertical groundwater gradient is mainly upward from the MCM coal (MB39 / MB19SRM03P) to the Tertiary sediments (MB40 / MB19SRM02T) (Table 30).

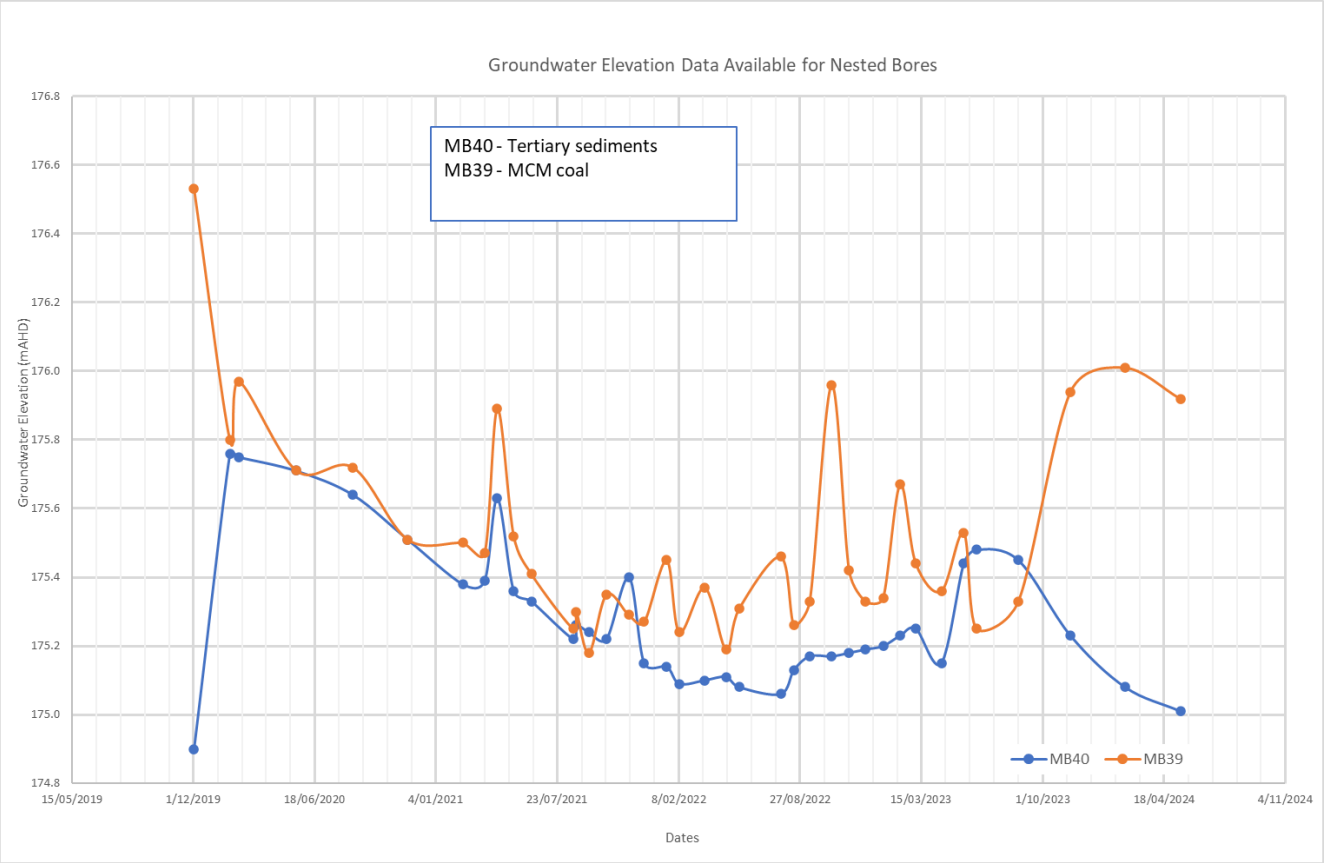


Figure 47 Nested monitoring bore hydrographs

Table 30 Vertical groundwater level assessment

Bore	SWL[12] February 2020	SWL February 2021	SWL February 2022	SWL February 2023
MB38 / MB19SRM01A (Alluvium)	Dry	Dry	Dry	Dry
MB40 / MB19SRM02T (Tertiary)	175.75	175.38	175.09	175.23
MB39 / MB19SRM03P (Permian)	175.97	175.5	175.24	175.67

Groundwater level data is available for February at each bore over the four years included in Table 30. The difference in groundwater elevation each year indicates higher groundwater elevation in the MCM coal seam measured in MB39 (MB19SRM03P) than the Tertiary monitoring bore MB40 (MB19SRM02T). The vertical gradient is upwards from the Permian to the Tertiary at these nested bores.

5.3.8.4 Dewatering as a result of existing mining

Those monitoring bores which contain several years of monitoring data (i.e., MB31 to MB37) discussed in Section 5.3.8 and in Figure 45 do not readily indicate declining trends in groundwater levels as a result of mining despite some bores being located within close vicinity (and down dip) to existing Saraji Mine open-cut pits, (i.e., MB32 is located approximately 600 m from existing pits whilst MB33 is located some 1,500 m away and indicates a water level increase over time).

The lack of uniform, large extent groundwater level decline within the long-term groundwater monitoring bores suggests that these bores have not been impacted by mine dewatering (i.e., induced flow is not evident).

Given that Saraji Mine has been operating since 1974, the absence of a downwards groundwater level trends indicates that the zone of influence resulting from mine dewatering has not yet extended to those bores and is considered restricted to the immediate vicinity of the pits due to the low permeability of the sediments. It is

[12] Standing water level (SWL) in mAHD

considered that these long term Saraji Mine activities have not markedly impacted on the regional groundwater resources.

5.3.9 Groundwater quality

5.3.9.1 Quaternary deposits

Groundwater quality of alluvium associated with creeks and river systems within the Isaac-Connors sub-catchment are considered to be moderately to highly variable, ranging from fresh to very saline (URS, 2012).

The groundwater monitoring bores across the area reported to be screened through the alluvium are dry, except for bore MB32. Available water quality data for MB32 was compiled by Gauge (2021) to provide an indication of the groundwater quality associated with saturated alluvium adjacent to the Project Area (Table 31).

Table 31 shows that groundwater associated with the alluvium is generally brackish and bicarbonate dominant (Plate 4). Elevated major ions were reported during 2015/16, these major ion concentrations have since reported below the Fitzroy River groundwater zone 34 (the closest groundwater zone to the Project) scheduled groundwater WQOs (refer to Section 3.3.3).

The concentrations of total dissolved solids (TDS) indicate that the water is not suitable for drinking but can be used for livestock watering.

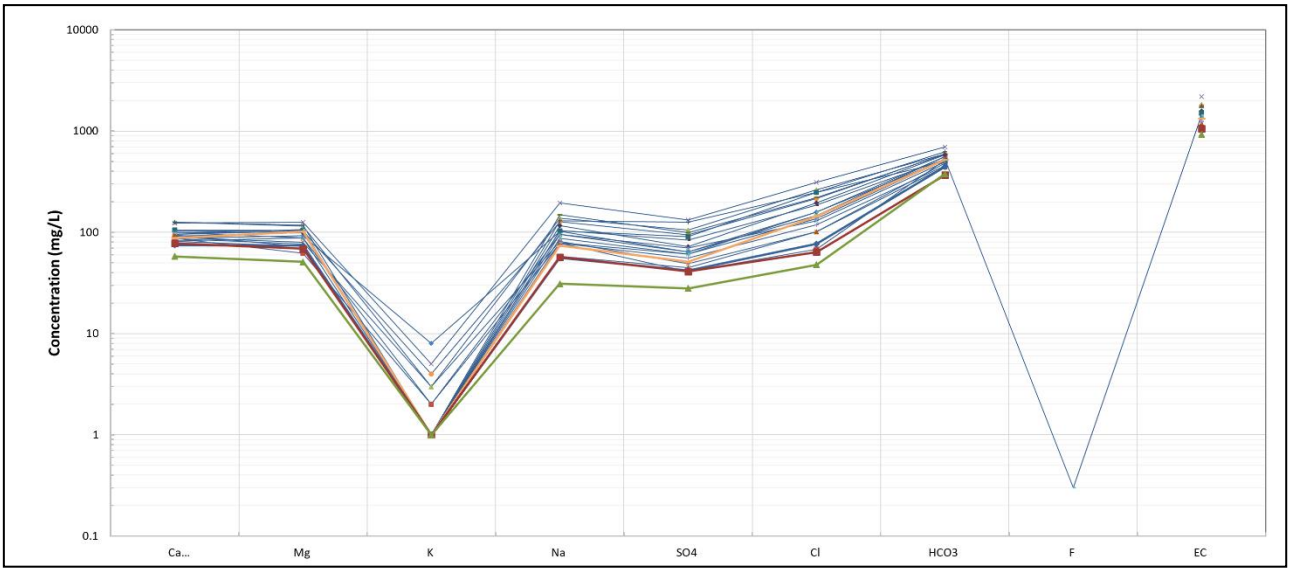


Plate 4 MB32 Schoeller diagram (2016 to 2021 data)

The Piper plot (Plate 5) of the MB32 2016 to 2021 data indicates the water is sodium – chloride + bicarbonate type water.

Groundwater quality from the monitoring bore MB20SRM04A, screened in the alluvium, were compared to the Zone 34 WQOs (Table 32). These data indicate exceedances including Total Iron, which is not readily representative of groundwater (dissolved iron concentrations are at or below limit of reporting).

These alluvium data, MB20SRM04A compared to MB32, indicate marked variation due to the disconnected nature, and differing recharge mechanisms across the alluvium groundwater unit. The discontinuous (spatially and saturated) nature of the alluvium and where groundwater is intersected it is in isolated “pockets’ of water which are not readily recharged or discharged from the alluvium, leading to long residence times and thus high salinity (MB20SRM04A Table 32). The surface water recharge to MB32 facilitates lower salinity (Table 31).

It is recognised that suitable triggers are required for each alluvium monitoring bore rather than for the entire alluvium hydrostratigraphic unit. Thus, the adopting or assumption of baseline WQOs for this unit is not suitable.

Based on the DES (2021), the Project will compile sufficient baseline groundwater quality from the new and proposed groundwater monitoring bores (alluvium and other units) to allow for the statistical assessment of groundwater quality to develop relevant analytes and associated triggers.

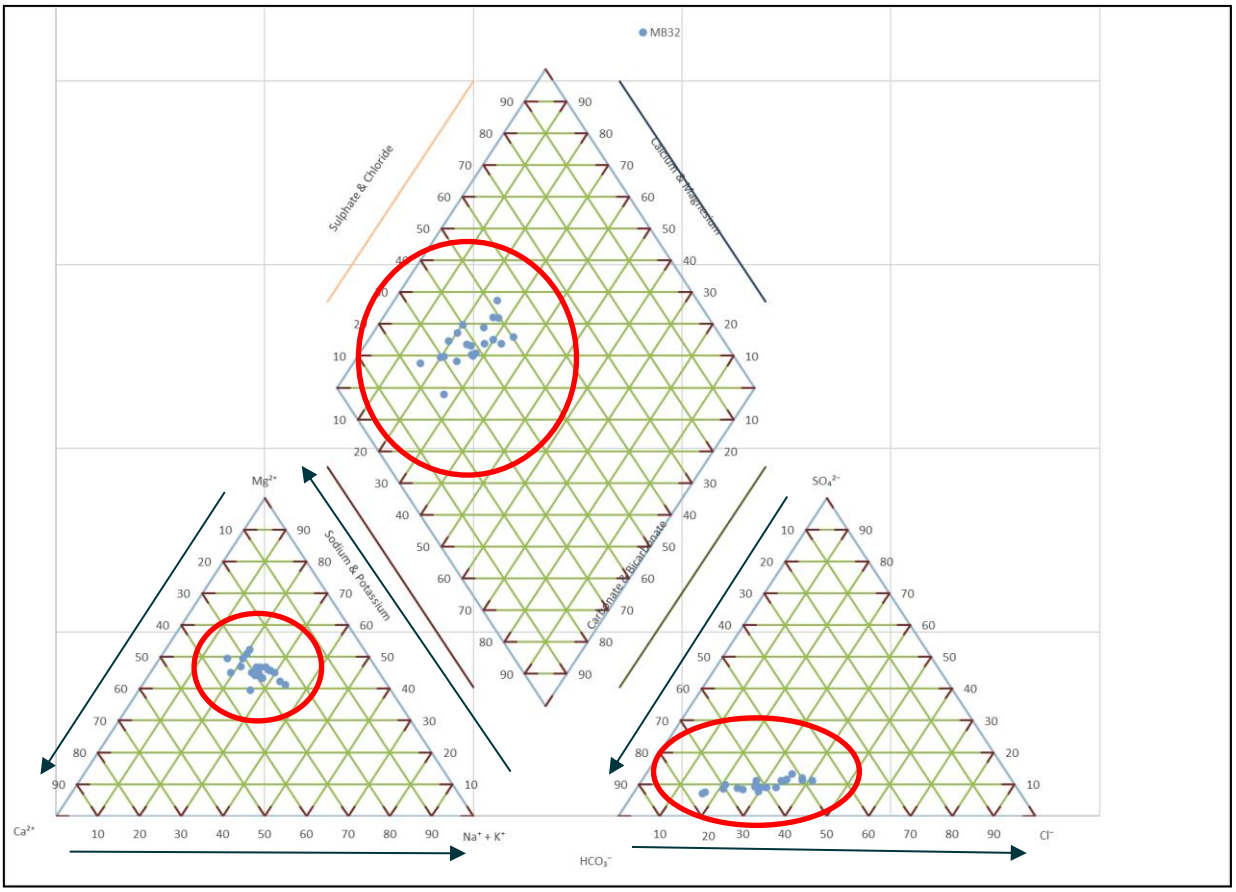


Plate 5 MB32 Piper plot (2016 to 2021 data)

Table 31 Alluvium groundwater quality - MB32 (Gauge, 2021 and GHD, 2021)

Site	Date	pH	EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
									diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units	µ S/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																					
Zone 34	Shallow 80th	7.1-8.1	8910	-	-	878	318	3185	215	389	1500	-	-	-	-	246	-	5.3	-	-	-
MB32	14/12/2009	6.98	1440	649	< 1	422	21	51	73	74	47	< 1	5	0.5	<1	25	0.05			< 20	< 50
MB32	29/04/2010	7.34	996	552	< 1	423	26	40	80	65	41	0.5	5	0.5	<1	70	0.05			< 20	< 50
MB32	27/07/2010	7.06	1098	637	0.5	497	24	55	71	78	61	0.5	5	0.5	<1	25	0.05	<0.01	0.06	< 20	< 50
MB32	29/04/2011	7.28	1080	606	0.5	471	21	42	87	64	38	1	5	1	< 1	340	0.05	< 0.01	0.37	< 20	< 50
MB32	25/05/2011	7.28	1080	606	0.5	471	21	42	87	64	38	1	5	1	< 1	2950	0.05	< 0.01	0.06	< 20	< 50
MB32	25/07/2011	7.48	867	606	0.5	471	21	42	87	64	38	1				2950		< 0.01		< 20	< 50
MB32	24/10/2011	6.95	997	609	83	517	23	50	83	70	48	0.5	5	0.5	< 1	25	0.05	< 0.01	0.05	< 20	< 50
MB32	20/06/2012	7.67	773	3000	0.5	940	32	780	69	89	55	1.4	5	0.5	1			< 0.005	4.4	< 10	< 100
MB32	25/07/2012	6.8	1690	690	0.5	500	32	83	95	82	56	1.1	5	0.5	< 1		0.05	< 0.005	0.44	< 10	< 100
MB32	24/10/2012	7.57	1401	790	0.5	540	32	91	80	72	53	1	24	0.5	< 1	25	0.05	< 0.005	0.067	< 10	< 100
MB32	22/01/2013	7.15	2276	860	0.5	650	59	140	86	94	90	1	5	0.5	< 1	21	0.05	< 0.005	0.065	< 10	< 100
MB32	24/07/2013	6.65	2437	1100	0.5	560	42	140	110	97	77	1.3	5	0.5	< 1		0.05	< 0.005	0.24	< 10	< 100
MB32	22/10/2013	8.22	1430	930	0.5	488	67	202	105	111	75	1	50	0.5	1	650	0.05			10	50
MB32	21/01/2014	8.18	1672	1100	29	436	82	219	79	113	107	1	5	0.5	0.5	1260	0.05			10	50
MB32	22/04/2014	8.21	1622	940	0.5	586	91	218	117	111	106	1	5	0.5	0.5	25	0.05			10	50
MB32	29/07/2014	8	1540	856	0.5	563	62	182	91	102	94	1	5	0.5	0.5	25	0.05			10	50
MB32	10/09/2014	7.518	1562	797	18	485	52	193	104	104	83	2	5	0.5	0.5	60	0.05			10	50
MB32	25/11/2014	7.518	1611	882	0.5	646	59	182	98	106	108	2	5	0.5	0.5	25	0.05			10	50
MB32	24/03/2015	7.504	1695	961	0.5	611	91	212	110	101	119	1	5	0.5	0.5	25	0.05			10	50
MB32	19/05/2015	7.63	1946	1100	0.5	661	136	263	119	118	154	1	5	0.5	0.5	80	0.05			10	50
MB32	16/06/2015	7.765	1655	918	0.5	596	68	221	108	103	101	1	5	0.5	0.5	25	0.05			10	50
MB32	26/08/2015	7.16	1638	660	0.5	602	63	204	96	97	95	1	5	0.5	0.5	2490	0.05			10	50
MB32	2/12/2015	7.04	1833	16800	0.5	678	66	242	107	110	108	2	5	0.5	0.5	50	0.05			10	50
MB32	21/04/2016	7.65	1380	781	0.5	575	60	148	89	66	93	2	5	0.5	0.5	25	0.05			10	50
MB32	13/06/2016	7.29	1396	940	0.5	521	55	155	89	96	92	1	5	0.5	0.5	25	0.05			10	50
MB32	19/09/2016	7.28	1223	660	0.5	482	49	101	89	80	81	3	5	0.5	0.5	25	0.05			10	50
MB32	13/12/2016	7.25	1437	788	0.5	559	64	147	82	88	95	2	5	0.5	0.5	25	0.05	0.27	0.06	10	50
MB32	13/03/2017	7.13	1470	845	0.5	561	64	158	87	93	102	8	5	0.5	0.5	25	0.05	0.24	0.09	10	50
MB32	15/06/2017	7.6	1138	601	0.5	517	41	68	87	62	78	2	5	0.5	0.5	50	0.05	0.21	0.02	10	50
MB32	19/09/2017	7.57	1843	1090	0.5	595	105	264	126	115	138	3	5	0.5	0.5	60	0.05	0.21	0.03	10	50
MB32	19/12/2017	7.52	2180	1350	0.5	701	133	311	123	126	195	5	5	0.5	0.5	260	0.05	0.18	0.05	10	50
MB32	20/03/2018	7.54	1399	824	0.5	519	61	136	81	73	87	1	5	0.5	0.5	25	0.05	0.17	0.05	10	50
MB32	25/06/2018	7.117	1776	1100	0.5	598	94	215	95	103	127	4	5	0.5	0.5	290	0.05	0.18	0.04	10	50
MB32	25/09/2018	7.03	1980	1100	0.5	625	126	247	126	117	130	1	5	0.5	0.5	250	0.05	0.09	0.03	10	50
MB32	19/12/2018	7.33	1480	859	0.5	535	66	179	108	105	79	1	5	0.5	0.5	50	0.05	0.07	0.05	10	50
MB32	27/03/2019	6.76	1593	920	0.5	530	84	186	98	101	104	1	5	0.5	0.5	50	0.05	0.1	0.04	10	50
MB32	12/06/2019	7.18	1769	997	1	589	99	221	102	104	150	1	10	1	1	980	0.05	0.07	0.01	10	50
MB32	16/09/2019	6.94	1626	904	0.5	583	72	195	92	99	116	1	5	0.5	0.5	25	0.05			10	50
MB32	16/12/2019	6.95	1558	957	0.5	498	91	247	105	104	103	1	5	0.5	0.5	1500	0.05	0.03		10	50
MB32	20/03/2020	6.96	1236	679	0.5	447	45	101	94	72	58	1	5	0.5	0.5	360	0.05	0.14	0.03	10	50
MB32	22/06/2020	7.13	1375	756	0.5	496	70	130	99	88	95	1	5	0.5	0.5	1270	0.05	0.07	<0.01	10	50
MB32	18/08/2020	7.22	1400	721	0.5	453	56	119	86	77	78	1	5	0.5	0.5	430	0.05	0.04	0.01	10	50
MB32	18/11/2020	7.06	1524	926	0.5	523	61	158	98	106	79	1	5	0.5	0.5	130	0.05	0.06	0.05	10	50
MB32	17/02/2021	7.09	1341	877	0.5	522	51	144	88	102	74	0.5	5	0.5	0.5	80	0.05	0.1	0.05	10	50
MB32	11/05/2021	7.14		609	0.5	444	42	77	75	74	56	0.5	5	1	0.5	25	0.05			10	50
MB32	11/08/2021	8.39	1060	671	26	368	41	64	78	69	57	<1	<10	<1	<1	6410	0.1			<20	<50
MB32	16/11/2021	8.02	928	546	<1	378	28	48	58	51	31	1	<10	<1	<1	17400	0.1	0.01	<0.01	<20	70

Blanks – no analysis

Table 32 Alluvium groundwater quality – MB20SRM04A (Gauge, 2021)

Site	In-situ pH	In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
								diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
	pH units	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																				
Zone 34	7.1-8.1	8,910	-	-	878	318	3,185	215	389	1,500	-	-	-	-	246	-	5.30	-	-	-
ANZECC Stock	6.0 - 9.0	5,970	4,000			1,000		1,000				5,000	-	500.00	-	2.00				
NHMRC Drinking Water (2022)	6.5 - 8.5	895	600			500	250			180		200	3.00	10.00	300	1.00	11.30			
MB20SRM04A	7.62	21,400	14,700	<1	907	1,620	6,980	236	402	4,220	72	6,650	<1	6.00	12,400	0.30	0.07	0.79	<20	2,310

A single sample result was available for MB20SRM04A installed in October 2019.

5.3.9.2 Tertiary sediments

Tertiary groundwater quality was determined from historic Saraji Mine monitoring bores PZ02A and PZ04A. A representative sample could not be collected from bore PZ07A (screened in the Tertiary sediments), due to bentonite ingress into the screened zone in that bore.

Table 33 summarises the groundwater quality of samples from the Tertiary sediments as collected from historic monitoring bores PZ02A and PZ04A. It is noted that only one sample per bore was collected in 2011.

Table 33 Tertiary groundwater quality (Oct/Nov 2011 data)

Parameter	Unit	LOR	PZ02A (31/10/2011)	PZ04A (18/11/2011)	Livestock Guidelines (2000)
pH	pH unit	0.01	6.7	8.1	-
EC	µS/cm	1	22,000	9,000	
TDS	mg/L	5	18,000	6,300	4,000
Alkalinity (total)	mg/L	1	490	81	-
Sulphate	mg/L SO_4	1	1,700	44	1,000 – 2,000
Chloride	mg/L Cl	1	8,800	3,700	-
Fluoride	mg/L F	0.1	0.44	0.12	1,000
Calcium	mg/L Ca	0.5	370	230	-
Magnesium	mg/L Mg	0.5	730	110	-
Sodium	mg/L Na	0.5	5,100	1,600	-
Potassium	mg/L K	0.5	110	19	-
Metals (dissolved / total)					
Aluminium	mg/L Al	0.01	0.049 / 0.15	0.02 / 0.11	5
Antimony	mg/L Sb	0.001	0.001 / <0.001	<0.001 / 0.002	-
Arsenic	mg/L As	0.001	0.002 / 0.002	<0.001 / 0.001	0.5
Molybdenum	mg/L Mo	0.001	0.002 / 0.002	0.003 / 0.006	0.15
Selenium	mg/L Se	0.001	<0.001 / <0.001	<0.001 / <0.001	0.02
Silver	mg/L Ag	0.001	<0.001 / <0.001	<0.001 <0.001	-
Iron	mg/L Fe	0.01	1.72 / 2.56	0.014 / 1.0	-
Mercury	mg/L Hg	0.0001	<0.0001 / <0.0001	<0.0001 / <0.0001	0.002
Nutrients					
Nitrite	mg/L NO_2	0.01	< 0.01	< 0.01	30
Nitrate	mg/L NO_3	0.1	< 0.1	< 0.1	400
Nitrate + Nitrite	mg/L N	-	< 0.1	< 0.1	-
Orthophosphate	mg/L PO_4	0.005	0.01	< 0.005	-
Total Petroleum Hydrocarbons					
$C_6 – C_9$	µg/L	10	< 10	< 10	-
$C_{10} – C_{14}$	µg/L	50	< 50	140	-
$C_{15} – C_{28}$	µg/L	100	< 100	890	-

Parameter	Unit	LOR	PZ02A (31/10/2011)	PZ04A (18/11/2011)	Livestock Guidelines (2000)
C_{29} – C_{36}	µg/L	100	< 100	180	-
BTEX	µg/L	1 - 2	< LOR	< LOR	1 - 25

LOR – Limit of Reporting Source: AGE (2011)

Table 33 indicates that the Tertiary groundwater ranges from slightly acidic to slightly alkaline and is dominated by sodium and chloride with TDS in excess of 6,000 mg/L. This means the water is brackish to saline and exceeds the livestock guideline level for cattle. A relatively high sulphate level was recorded in PZ02A; however, this was still within the range for livestock.
Metal concentrations for all parameters analysed were either below the laboratory detection limit or below relevant guideline levels.

Total petroleum hydrocarbon (TPH) concentrations were below the laboratory detection limits in PZ02A but reported levels between 140 micrograms per litre (µg/L) and 890 µg/L for the C_{10}–C_{36} fractions analysed. It is possible that the source for these hydrocarbon fractions might be oil based lubricant used whilst drilling the borehole and not hydrocarbon contamination from within the aquifer. Interference from naturally occurring organic matter is also a potential source of the hydrocarbons detected in the water samples. Aromatic (BTEX) hydrocarbons were below the limit of detection in both monitoring bores.

Additional sampling events have reported that these two Tertiary monitoring bores contain insufficient groundwater to collect additional samples.

Post 2020 results

Monitoring bore, MB40 / MB19SRM02T, intersects the Tertiary gravel, clay and silt, adjacent to Phillips Creek. The latest major ion data for 2020 and 2021 is included in Plate 7, the Schoeller diagram for MB40/ MB19SRM02T. The groundwater is sodium – bicarbonate dominant. The Piper plot of the data (Plate 6) indicates a mixed consistent water type within MB40/ MB19SRM02T.

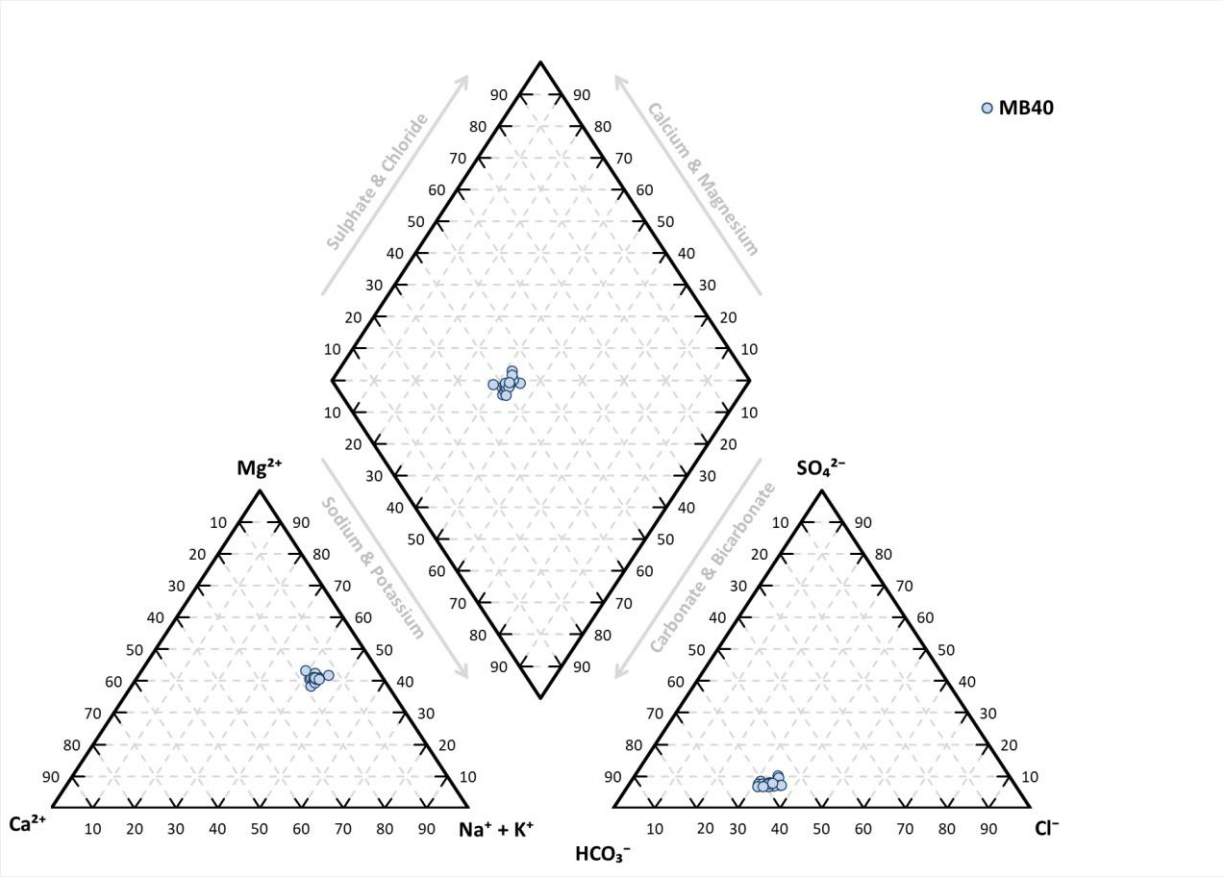
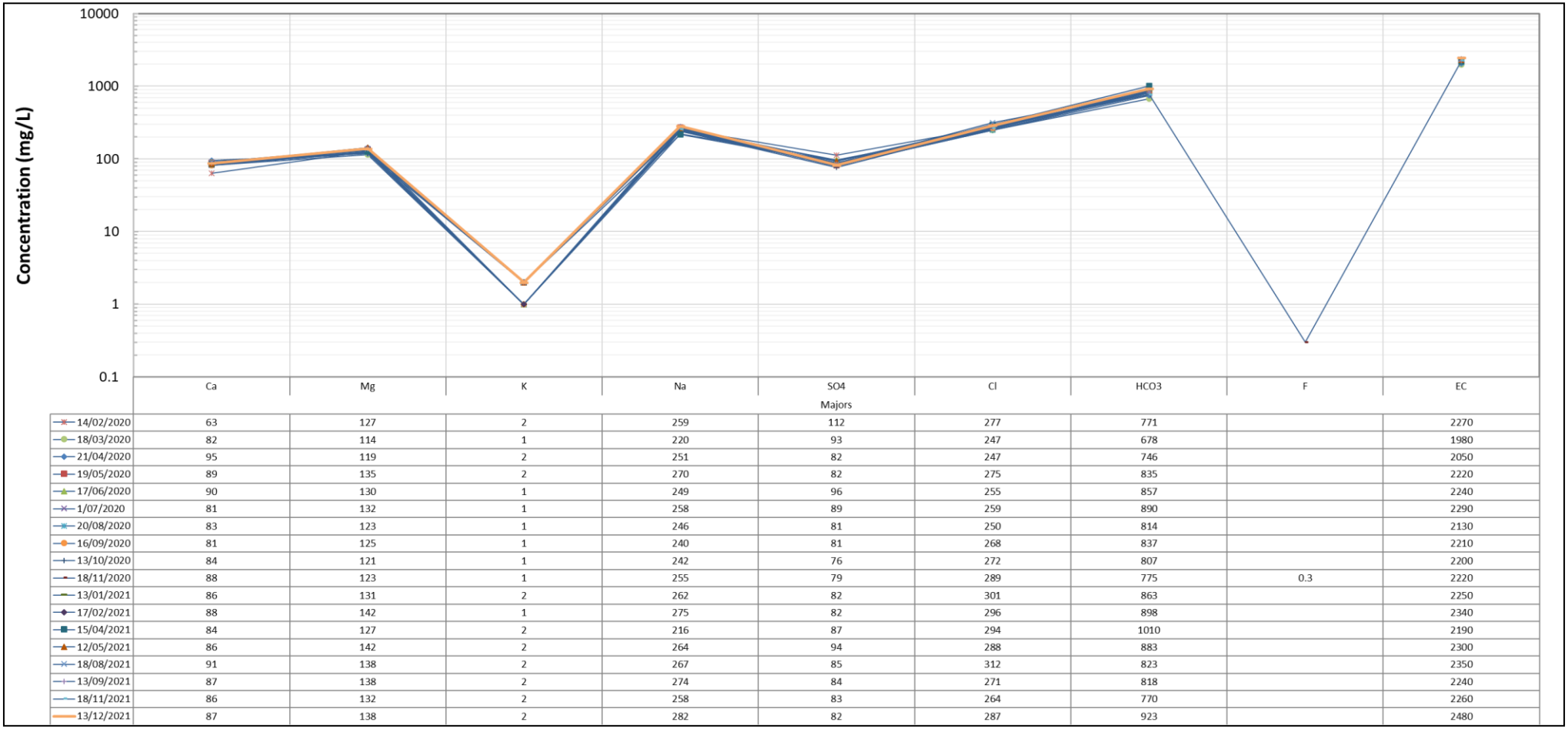


Plate 6 MB40 / MB19SRM02T Piper plot 2020 and 2021 data



	Ca	Mg	K	Na	SO4	Cl	HCO3	F	EC
	Majors								
14/02/2020	63	127	2	259	112	277	771		2270
18/03/2020	82	114	1	220	93	247	678		1980
21/04/2020	95	119	2	251	82	247	746		2050
19/05/2020	89	135	2	270	82	275	835		2220
17/06/2020	90	130	1	249	96	255	857		2240
1/07/2020	81	132	1	258	89	259	890		2290
20/08/2020	83	123	1	246	81	250	814		2130
16/09/2020	81	125	1	240	81	268	837		2210
13/10/2020	84	121	1	242	76	272	807		2200
18/11/2020	88	123	1	255	79	289	775	0.3	2220
13/01/2021	86	131	2	262	82	301	863		2250
17/02/2021	88	142	1	275	82	296	898		2340
15/04/2021	84	127	2	216	87	294	1010		2190
12/05/2021	86	142	2	264	94	288	883		2300
18/08/2021	91	138	2	267	85	312	823		2350
13/09/2021	87	138	2	274	84	271	818		2240
18/11/2021	86	132	2	258	83	264	770		2260
13/12/2021	87	138	2	282	82	287	923		2480

Plate 7 MB40 / MB19SRM02T Schoeller diagram for 2020 and 2021 data

The groundwater in the Tertiary deposits, adjacent to Phillips Creek show elevated bicarbonate concentrations (678 to 1,010 mg/L) with Electrical conductivity ranging from 1,980 to 2,480 µS/cm, supporting the primary aquifer recharge mechanism of infiltration of precipitation and of surface water flows.

Comparison to guidelines

Groundwater quality data for Tertiary monitoring bore MB40**/** MB19SRM02T is included in Table 34 and compared to the EA condition trigger levels (as detailed in Section 5.3.10, Table 46). This comparison indicates that the monthly groundwater quality data for 2020 complies with the trigger values derived in the EA.

Note: Metal concentrations are presented as either dissolved or total, depending on the source of data. Dissolved metals are representative of groundwater, however, WQOs often use the same values for surface water, where total metals are more representative of the water quality (i.e., dependent on colloidal particles within the water).

It is noted that the Saraji Mine EA Conditions (Section 5.3.10) Table 12 Groundwater Contaminant Trigger Levels for metals are not specified (neither total or dissolved or both are stipulated).

This EA condition has led to compilation of both total and dissolved metal results over time. The water quality tables presented in this technical report include for both total and dissolved metal results depending on bore and sample date. Consideration, when assessing these results, should include the different metal results provided.

It is confirmed that Saraji Mine groundwater monitoring currently reports dissolved metal concentrations, which is used for assessing EA condition compliance.

The 2020 MB40 / MB19SRM02T water quality also exceeds the deeper Fitzroy Basin Groundwater Zone 34 WQOs as discussed in Section 3.3.3. Table 35 indicates the water quality in MB40 / MB19SRM02T has elevated bicarbonate compared to the guidelines.

Groundwater quality compiled for MB19SRM02T / MB40 and a single sample from MB20SRM02T, included in Table 46, indicate that the Tertiary groundwater in comparison to the Fitzroy Zone 34 guidelines contains naturally elevated bicarbonate and total iron concentrations. It is noted that dissolved iron concentrations are all below LOR at 25 µg/L.

The water quality compiled for MB40 (MB19SRM20T), within the SEMLP footprint, is considered baseline quality of the Tertiary prior to any mining at the proposed Project.

Table 34 MB40 / MB19SRM02T 2020 groundwater quality data and EA trigger levels (Gauge, 2021 and GHD, 2021)

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Trigger Levels		6.5	8.5	8,910				318						55	9	13	700	0.6			20	100
MB40	30/01/2020	7.38		2100	1230	1	683	115	252	81	114	224	1	13000	2	3	16600	0.2			20	50
MB40	14/02/2020	7.85		2270	1320	1	771	112	277	63	127	259	2	7760	1	3	7220	0.1		0.01	20	100
MB40	18/03/2020	7.70		1980	1170	1	678	93	247	82	114	220	1	1940	1	1	1620	0.1	0.77	0.01	20	50
MB40	21/04/2020	7.73		2050	1260	1	746	82	247	95	119	251	2	2260	2	1	1610	0.1	0.89	0.02	20	50
MB40	19/05/2020	7.52		2220	1280	1	835	82	275	89	135	270	2	1120	4	1	850	0.1	0.62	0.01	20	50
MB40	17/06/2020	7.64		2240	1230	1	857	96	255	90	130	249	1	680	1	1	390	0.1	0.43	0.02	20	50
MB40	1/07/2020	7.92		2290	1330	1	890	89	259	81	132	258	1	1970	1	1	1600	0.1	0.5	0.02	20	50
MB40	20/08/2020	7.83		2130	1230	1	814	81	250	83	123	246	1	320	1	1	200	0.1	0.81	0.02	20	50
MB40	16/09/2020	7.52		2210	1270	1	837	81	268	81	125	240	1	360	1	1	240	0.1	0.8	0.02	20	50
MB40	13/10/2020	7.96		2200	1240	1	807	76	272	84	121	242	1	310	2	1	220	0.1	0.88	0.02	20	50
MB40	18/11/2020	7.65		2220	1360	1	775	79	289	88	123	255	1	1180	3	1	1360	0.1	0.74	0.01	20	50
MB40	9/12/2020	7.72		2460	1450	1	855	85	338	82	136	290	2	5240	2	2	4220	0.1	0.58	0.02	20	50

Table 35 MB40 / MB19SRM02T 2020 groundwater quality data and Fitzroy Zone 34 guidelines (Gauge, 2021 and GHD, 2021)

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16000		-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
MB40	30/01/2020	7.38		2250	1230	0.5	683	115	252	81	114	224	1	5	3	0.5	250	0.05			10	50
MB40	14/02/2020	7.37		2990	1320	0.5	771	112	277	63	127	259	2	5	0.5	0.5	25	0.05		0.01		50
MB40	18/03/2020	7.2		2230	1170	0.5	678	93	247	82	114	220	1	5	0.5	0.5	25	0.05	0.77	0.01		50
MB40	21/04/2020	7.05		2150	1260	0.5	746	82	247	95	119	251	2	5	4	0.5	25	0.05	0.89	0.02		50
MB40	19/05/2020	6.96		2160	1280	0.5	835	82	275	89	135	270	2	5	3	1	25	0.05	0.62	0.01		50
MB40	17/06/2020	7.07		2420	1230	0.5	857	96	255	90	130	249	1	5	1	0.5	25	0.05	0.43	0.02		50
MB40	01/07/2020	7.2		2020	1330	0.5	890	89	259	81	132	258	1	5	1	0.5	25	0.05	0.5	0.02		50
MB40	20/08/2020	7.83		2409	1230	0.5	814	81	250	83	123	246	1	5	1	0.5	25	0.05	0.81	0.02		50
MB40	16/09/2020	7.03		2395	1270	0.5	837	81	268	81	125	240	1	5	1	1	25	0.05	0.8	0.02		50
MB40	13/10/2020	6.94		2463	1240	0.5	807	76	272	84	121	242	1	5	2	0.5	25	0.05	0.88	0.02		50
MB40	18/11/2020	6.96		2530	1360	0.5	775	79	289	88	123	255	1	5	3	0.5	290	0.05	0.74	0.01		50
MB40	09/12/2020	6.99		2630	1450	0.5	855	85	338	82	136	290	2	5	2	0.5	25	0.05	0.58	0.02		50

Table 36 MB19SRM02T (MB40) and MB20SRM02T Tertiary groundwater quality data and Fitzroy Zone 34 guidelines (Gauge, 2021 and GHD, 2021)

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Diss	Diss	Diss	Diss	Diss		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	**Deep 80th**	**7.4**	**8.03**	**16000**		-	**650**	**398**	**5905**	**442**	**491**	**2565**	-	-	-	-	**140.00**	-	**14.92**	-	-	-
MB19SRM02T	2/12/2019	7.62		2,190	1,220	700.0	700	135	252	74	115	244	2		1.00	2.00		0.10	0.43	0.02	20.00	50.00
MB19SRM02T	30/01/2020	7.38		2,250	1,230	0.5	683	115	252	81	114	224	1	5.00	3.00	0.50		0.05			10.00	50.00
MB19SRM02T	14/02/2020	7.37		2,990	1,320	0.5	771	112	277	63	127	259	2	5.00	0.50	0.50	25.00	0.05		0.01		50.00
MB19SRM02T	18/03/2020	7.2		2,230	1,170	0.5	678	93	247	82	114	220	1	5.00	0.50	0.50	25.00	0.05	0.77	0.01		50.00
MB19SRM02T	21/04/2020	7.05		2,150	1,260	0.5	746	82	247	95	119	251	2	5.00	4.00	0.50	25.00	0.05	0.89	0.02		50.00
MB19SRM02T	19/05/2020	6.96		2,160	1,280	0.5	835	82	275	89	135	270	2	5.00	3.00	1.00	25.00	0.05	0.62	0.01		50.00
MB19SRM02T	17/06/2020	7.07		2,420	1,230	0.5	857	96	255	90	130	249	1	5.00	1.00	0.50	25.00	0.05	0.43	0.02		50.00
MB19SRM02T	1/07/2020	7.2		2,020	1,330	0.5	890	89	259	81	132	258	1	5.00	1.00	0.50	25.00	0.05	0.50	0.02		50.00
MB19SRM02T	20/08/2020	7.83		2,409	1,230	0.5	814	81	250	83	123	246	1	5.00	1.00	0.50	25.00	0.05	0.81	0.02		50.00
MB19SRM02T	16/09/2020	7.03		2,395	1,270	0.5	837	81	268	81	125	240	1	5.00	1.00	1.00	25.00	0.05	0.80	0.02		50.00
MB19SRM02T	13/10/2020	6.94		2,463	1,240	0.5	807	76	272	84	121	242	1	5.00	2.00	0.50	25.00	0.05	0.88	0.02		50.00
MB19SRM02T	18/11/2020	6.96		2,530	1,360	0.5	775	79	289	88	123	255	1	5.00	3.00	0.50	290.00	0.05	0.74	0.01		50.00
MB19SRM02T	9/12/2020	6.99		2,630	1,450	0.5	855	85	338	82	136	290	2	5.00	2.00	0.50	25.00	0.05	0.58	0.02		50.00
MB19SRM02T	13/01/2021	7.08		2,428	1,390	0.5	863	82	301	86	131	262	2	5.00	3.00	0.50	25.00	0.05	0.43	0.03	10.00	50.00
MB19SRM02T	17/02/2021	6.89		2,510	1,450	0.5	898	82	296	88	142	275	1	5.00	1.00	0.50	25.00	0.05	0.23	0.02	10.00	50.00
MB19SRM02T	25/03/2021	7.05		2,220	1,390	0.5	889	86	286	83	137	266	1	5.00	3.00	0.50	25.00	0.05	0.30	0.02	10.00	50.00
MB19SRM02T	15/04/2021	7.12		2,190	1,480	0.5	1010	87	294	84	127	216	2	5.00	9.00	0.50	25.00	0.05			10.00	50.00
MB19SRM02T	12/05/2021	7.04		2,300	1,380	0.5	883	94	288	86	142	264	2	5.00	4.00	0.50	25.00	0.05			10.00	50.00
Site	**Date**	**pH**		**EC**	**TDS**	**CO3**	**HC03**	**SO4**	**Cl-**	**Ca**	**Mg**	**Na**	**K**	**Al**	**Sb**	**As**	**Fe**	**Hg**	**NO3**	**P**	**C6-C9**	**C10-C36**
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	**Deep 80th**	**7.4**	**8.03**	**16000**		-	**650**	**398**	**5905**	**442**	**491**	**2565**	-	-	-	-	**140.00**	-	**14.92**	-	-	-
MB19SRM02T	10/06/2021	7.81		2,380	1,400	902.0	902	88	312	91	127	249	2	380.00	27.00	1.00	340.00	0.10			20.00	50.00
MB19SRM02T	18/08/2021	7.64		2,350	1,370	823.0	823	85	312	91	138	267	2	900.00	3.00	1.00	640.00	0.10	0.15	0.01	20.00	50.00
MB19SRM02T	23/08/2021	7.89		2,400	1,480	853.0	853	107	298	101	148	308	2	30.00	2.00	1.00	50.00	0.10			20.00	50.00
MB19SRM02T	13/09/2021	7.53		2,240	1,390	818.0	818	84	271	87	138	274	2	1670.00	2.00	1.00	1090.00	0.10			20.00	50.00
MB19SRM02T	12/10/2021	8.34		2,210	1,370	860.0	887	89	287	85	131	258	2	130.00	6.00	1.00	130.00	0.10			20.00	50.00
MB19SRM02T	18/11/2021	8.05		2,260	1,350	770.0	770	83	264	86	132	258	2	360.00	2.00	1.00	230.00	0.10	0.57	0.02	20.00	50.00
MB19SRM02T	13/12/2021	8.02		2,480	1,430	923.0	923	82	287	87	138	282	2	380.00	2.00	1.00	260.00	0.10	0.20	0.02	20.00	50.00
MB19SRM02T	19/01/2022	7.26		2,360	1,360	916.0	916	80	281	86	138	273	1	120.00	2.00	1.00	110.00	0.10			20.00	50.00
Site	**Date**	**pH**		**EC**	**TDS**	**CO3**	**HC03**	**SO4**	**Cl-**	**Ca**	**Mg**	**Na**	**K**	**Al**	**Sb**	**As**	**Fe**	**Hg**	**NO3**	**P**	**C6-C9**	**C10-C36**
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	**Deep 80th**	**7.4**	**8.03**	**16000**		-	**650**	**398**	**5905**	**442**	**491**	**2565**	-	-	-	-	**140.00**	-	**14.92**	-	-	-
MB20SRM02T	20/10/2019	8.52		3,990	2,520	47.0	686	383	724	48	55	837	20	3740.00	1.00	7.00	4500.00	0.10	0.01		20.00	50.00

5.3.9.3 Permian hydrostratigraphic units

Representative samples of the Permian coal seam aquifers were collected from historic groundwater monitoring bores PZ02B, PZ04B, and PZ09B for the Harrow Creek Upper (H16) Coal Seam and from PZ04C, PZ09C, and PZ10C for the Dysart Lower Coal Seam, Table 37 and Table 38 provide summaries of the water quality results.

The analyses indicate that the groundwater quality within the Permian coal seams:

- Is slightly acidic to alkaline
- Is sodium - chloride dominant
- Has highly variability salinity, with TDS concentrations ranging from 3,300 mg/L to 20,000 mg/L.

The coal seam groundwater is brackish to saline and typically not suitable for stock watering.

Metal concentrations for all parameters analysed were either below the laboratory limit of detection or the relevant guideline level. TPH concentrations were mostly below the laboratory detection limits but reported detectable levels between 25 µg/L and 1,100 µg/L for C_6–C_{35} fractions analysed in bores PZ09B and PZ10C. It is possible that the source for these hydrocarbon fractions is oil based lubricant used whilst drilling the borehole and not hydrocarbon contamination from within the aquifer. Similarly, aromatic (BTEX) hydrocarbons were mostly below the laboratory detection limits in both monitoring bores, except for detectable levels reported for toluene between 2 µg/L and 4 µg/L in bores PZ09B and PZ10C. Interference from naturally occurring organic matter is also a potential source of the hydrocarbons detected in the water samples.

Table 37 Harrow coal seam groundwater quality (AGE, 2011)

Analyte	Unit	LOR	PZ02B (31/10/11)	PZ04B (18/11/11)	PZ09B (1/11/11)	Livestock Guidelines (2000)
pH Value	pH Unit	0.01	7.6	6.7	8.1	-
Electrical Conductivity	µS/cm	1	14,000	27,000	20,000	-
Total Dissolved Solids	mg/L	5	**9,600**	**20,000**	**15,000**	4,000
Major Ions						
Total Alkalinity	mg/L	1	35	590	420	-
Sulphate	mg/L	1	49	1,900	1,500	1,000-2,000
Chloride	mg/L	1	4,900	9,100	6,700	-
Fluoride	mg/L	0.1	0.14	0.44	0.2	1,000
Calcium	mg/L	0.5	310	400	320	
Magnesium	mg/L	0.5	120	740	500	-
Sodium	mg/L	0.5	2,900	5,200	4700	-
Potassium	mg/L	0.5	9.1	130	17	-
Trace Metals (dissolved / total)						
Aluminium	mg/L	0.01	0.013/0.08	0.05/0.15	<0.01/0.038	5
Antimony	mg/L	0.001	<0.001/<0.001	0.001/<0.001	0.001/<0.001	-
Arsenic	mg/L	0.001	0.004/0.004	0.003/0.003	0.001/<0.001	0.5
Molybdenum	mg/L	0.001	0.008/0.009	0.002/0.002	<0.001/0.002	0.15
Selenium	mg/L	0.001	<0.001/<0.001	<0.001/<0.001	<0.001/<0.001	0.02
Silver	mg/L	0.001	<0.001/<0.001	<0.001/<0.001	<0.001/<0.001	-
Iron	mg/L	0.01	0.75/1.1	1.7/2.5	0.028/0.29)	-

Analyte	Unit	LOR	PZ02B (31/10/11)	PZ04B (18/11/11)	PZ09B (1/11/11)	Livestock Guidelines (2000)
Mercury	mg/L	0.0001	<0.0001/<0.0001	<0.0001/<0.0001	<0.0001/<0.0001	0.002
Nutrients						
Nitrite	mg/L	0.01	<0.01	<0.01	<0.01	30
Nitrate	mg/L	0.1	<0.005	<0.1	<0.005	400
Nitrate + Nitrite	mg/L	-	<0.005	<0.1	<0.005	-
Reactive Phosphorous	mg/L	0.005	<0.005	<0.005	<0.005	-
Total Petroleum Hydrocarbons						
C_6 - C_9 Fraction	µg/L	10	<10	<10	28	-
C_{10} - C_{14} Fraction	µg/L	50	<50	<50	<50	-
C_{15} - C_{36} Fraction	µg/L	100	<100	<100	<100	-
C_{29} - C_{36} Fraction	µg/L	100	<100	<100	<100	-
BTEX[1]	µg/L	1-2	<LOR	<LOR	4 (Toluene)	1-25

Table note **bold** represents exceedance of the TDS guideline value

Table 38 Dysart coal seam groundwater quality

Analyte	Unit	LOR	PZ04C (18/11/11)	PZ09C (1/11/11)	PZ10C (1/11/11)	Livestock Guidelines (2000)
pH Value	pH Unit	0.01	7.6	8.25	9.0	-
Electrical Conductivity	µS/cm	1	23,000	8,122	5,500	-
Total Dissolved Solids	mg/L	5	**18,000**	3,420	3,300	4,000
Major Ions						
Total Alkalinity	mg/L	1	270	201	220	-
Sulphate	mg/L	1	1,200	52	60	1,000-2,000
Chloride	mg/L	1	7,900	7,880	1,600	-
Fluoride	mg/L	0.1	0.18	0.44	0.4	1,000
Calcium	mg/L	0.5	350	32	29	
Magnesium	mg/L	0.5	520	27	25	-
Sodium	mg/L	0.5	4,400	0.45	1200	-
Potassium	mg/L	0.5	92	8.9	9.8	-
Trace Metals (dissolved / total)						
Aluminium	mg/L	0.01	0.048/0.12	0.022/0.57	0.026/0.59	5
Antimony	mg/L	0.001	<0.001/<0.001	<0.001/<0.001	<0.001/<0.001	-
Arsenic	mg/L	0.001	<0.001/<0.001	<0.001/0.001	<0.001/0.001	0.5
Molybdenum	mg/L	0.001	<0.001/<0.001	0.034/0.040	0.034/0.040	0.15
Selenium	mg/L	0.001	<0.001/<0.001	<0.001/<0.001	<0.001/<0.001	0.02
Silver	mg/L	0.001	<0.001/<0.001	<0.001/<0.001	<0.001/<0.001	-

Analyte	Unit	LOR	PZ04C (18/11/11)	PZ09C (1/11/11)	PZ10C (1/11/11)	Livestock Guidelines (2000)
Iron	mg/L	0.01	0.4/0.65	0.13/1.9	0.012/2.0	-
Mercury	mg/L	0.0001	<0.0001/<0.0001	<0.0001/<0.0001	<0.0001/<0.0001	0.002
Nutrients						
Nitrite	mg/L	0.01	<0.01	<0.025	<0.025	30
Nitrate	mg/L	0.1	<0.1	<0.025	<0.025	400
Nitrate + Nitrite	mg/L	-	<0.1	<0.025	<0.025	-
Reactive Phosphorous	mg/L	0.005	<0.007	0.01	0.01	-
Total Petroleum Hydrocarbons						
C_6 - C_9 Fraction	µg/L	10	<10	-	25	-
C_{10} - C_{14} Fraction	µg/L	50	<50	-	<50	-
C_{15} - C_{36} Fraction	µg/L	100	<100	-	1100	-
C_{29} - C_{36} Fraction	µg/L	100	<100	-	490	-
BTEX[1]	µg/L	1-2	<LOR	-	2 (Toluene)	1-25

Table note **bold** represents exceedance of the TDS guideline value

Permian groundwater monitoring (GHD, 2021)

Groundwater in the Permian is typically characterised by sodium-chloride major ion chemistry, however in close proximity to Phillips Creek the groundwater has a sodium-bicarbonate chemistry (MB35) and lower TDS concentrations. This supports the concept that the Permian bedrock is also recharged from the overlying strata, particularly along creek lines.

The groundwater is brackish to saline, which is indicative of longer residence times of the groundwater and overall lower hydraulic conductivity in comparison to the overlying alluvium deposits. The MCM (MB33 and MB34) is characterised by the highest EC values, ranging between 16,000 and 31,000 µS/cm, and is considered to be of poor quality and unsuitable for stock (AGE 2007).

Up gradient to the west, the EC of the Back Creek Group is lower, and ranges from 2,500 to 14,800 µS/cm (MB31 and MB37), which reflects the proximity of the unit to outcropping strata and recharge areas to the west.

Down-gradient to the east, the EC of the Fair Hill Formation ranges from 2,500 to 16,000 µS/cm (MB36) away from the influences of the recharge area along Phillips Creek.

In close proximity to Phillips Creek, the infiltration of surface water through the overlying Quaternary and Tertiary/Quaternary deposits results in a zone of comparatively fresher groundwater within the Permian, in the order of 1,000 to 2,000 µS/cm (MB35).

Saraji EA monitoring bores

Seven monitoring bores, MB31 to MB37, form part of the existing groundwater monitoring network. All these bores, except MB32 (alluvium), provide ongoing hydrochemistry data for the Permian interburden/overburden strata across and adjacent to the Saraji Mine. Available hydrochemical data for these Permian bores was compiled by Gauge (2021) and assessed by GHD (2021) and shown in Appendix A.

The latest annual groundwater monitoring report (Gauge, 2021) indicates the following:

- Groundwater quality parameters monitored include pH, electrical conductivity (EC), total dissolved solids (TDS), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), carbonate (CO_3),

Bicarbonate (HCO_3), chloride (Cl), sulphate (SO_4), reactive phosphorus (P), nitrate (NO_3), aluminium (Al), iron (Fe), arsenic (As), mercury (Hg), antimony (Sb), and petroleum hydrocarbons.

- Bores MB33 and MB34 have the highest salinities, with an EC range of 17,400 µS/cm to 31,000 µS/cm associated with deeper Permian interburden indicating increased salinity with depth due to slow movement and interaction with Permian sediments.
- The lowest salinities occur within the Phillips Creek bores MB32 (alluvium) and MB35 (Fairhill Formation directly below alluvium) with EC concentrations less than 2,500 µS/cm. The salinity values in MB35 suggest this bore is likely to receive recharge from the overlying alluvium.
- All bores have TDS concentrations greater than 500 mg/L, which exceeds the drinking water guideline.
- Sulphate concentrations in MB31, MB33, and MB37 are greater than the cattle stock watering guideline (1,000 mg/L SO_4).
- Total metals in groundwater samples are less than the ANZECC stock water guidelines.
- Concentrations of nitrate are all below guideline values.
- Orthophosphate (reactive phosphate) concentrations are highest in MB31, a bore located within farming land up gradient of Saraji Mine.
- Low levels of hydrocarbons are still being measured in MB34, considered to have been contaminated during construction.

These ongoing groundwater monitoring results are comparable with the initial baseline data and indicate little or no measurable impact due to mine operations.

Baseline Permian water quality prior to the Project

Available groundwater quality for Permian bore with EA condition trigger levels (Section 5.3.10) were compiled and compared to the relevant bore trigger levels, allowing for the establishment of baseline groundwater quality prior to mining at the Project.

Table 39 includes the groundwater quality data for MB33 from 2013 to 2022. This data indicates, as with the Tertiary groundwater data, that the groundwater complies with the trigger levels.

Table 40, Table 41, Table 42, and Table 43 includes the groundwater quality data for MB34, MB35, MB36, and MB39 (MB19SRM03P). This data indicates that the groundwater includes outliers (possible erroneous measurements or naturally occurring concentrations outside the adopted percentile for the water quality triggers) but no increasing trends (i.e., no indications of deterioration of chemistry over time).

Groundwater quality for the new Permian monitoring bores are included in Table 44 and compared to the Fitzroy Zone 34 guidelines.

Table 39 MB33 groundwater quality data compared to EA trigger levels (Gauge, 2021 and GHD, 2021)

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Diss	Diss	Diss	Diss	Diss		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	25,170				2,580						55	9	13	1,600	0.6			20	100
MB33	24/07/2013	7.44		7,330	17,000	0.5	750		6,700	280	570	5,300	130	5	0.5			0.05				
MB33	21/10/2013	8.24		22,900	16,100	0.5	705	2,240	7,120	285	638	4,510	130	5	0.5	0.5	25	0.05			10	50
MB33	20/01/2014	6.34		26,140	16,500	0.5	580	2,420	7,020	249	627	4,550	145	5	0.5	0.5	25	0.05			10	50
MB33	22/04/2014	7.89		24,980	15,100	0.5	735	2,390	7,420	301	570	4,390	118	5	0.5	1	1,350	0.05			10	50
MB33	29/07/2014	7.79		21,300	16,900	0.5	718	2,150	7,560	240	601	4,920	141	10	0.5	1	910	0.05			10	1,680
MB33	9/09/2014	6.737		24,033		0.5	618	2,410	7,600	318	618	4,470	119	5	0.5	0.5	890	0.05			10	140
MB33	25/11/2014	6.657		24,466	14,900	0.5	794	2,580	7,880	332	599	5,230	106	5	0.5	3	700	0.05			10	130
MB33	20/01/2015	6.838		25,400	17,700	0.5	787	2,550	8,190	345	621	4,760	111	5	0.5	0.5	880	0.05			10	50
MB33	24/03/2015	6.729		24,267	16,800	0.5	821	2,410	7,910	360	563	4,930	99	5	0.5	0.5	760	0.05			10	340
MB33	19/05/2015	6.981		24,233	16,400	0.5	801	2,920	7,580	354	575	4,530	90	5	0.5	1	1,510	0.05			10	50
MB33	16/06/2015	6.826		24,000	16,800	0.5	829	2,580	7,920	352	525	4,330	87	5	0.5	2	1,740	0.05			10	50
MB33	2/12/2015	6.65		23,667	15,700	0.5	865	2,480	6,720	338	530	4,100	88	5	0.5	1	1,200	0.05			10	50
MB33	14/03/2016	7.6		23,900	16,400	0.5	804	2,360	7,290	298	571	4,630	110	5	0.5	0.5	25	0.05			10	50
MB33	13/06/2016	7.95		23,900	15,500	0.5	736	2,400	7,270	335	623	4,980	123	5	0.5	2	60	0.05			10	50
MB33	19/09/2016	7.6		24,100	16,500	0.5	740	2,370	7,680	322	595	4,760	116	5	0.5	1	25	0.05	0.01	0.01	10	50
MB33	13/12/2016	7.4		24,700	17,100	0.5	853	2,370	7,530	291	510	4,330	86	5	0.5	0.5	25	0.05	0.005	0.01	10	50
MB33	13/03/2017	7.62		24,100	16,600	0.5	771	2,460	7,580	318	574	4,650	118	5	0.5	1	25	0.05	0.005	0.01	10	50
MB33	15/06/2017	7.05		23,600	16,200	0.5	823	2,310	7,360	298	588	4,650	111	5	0.5	1	1,210	0.05	0.12	0.01	10	50
MB33	19/09/2017	6.82		23,700	16,700	0.5	780	2,350	7,430	327	596	4,670	116	5	0.5	1	1,200	0.05	0.07	0.01	10	50
MB33	19/12/2017	6.7		23,800	17,100	0.5	789	2,320	7,320	285	532	4,470	111	5	0.5	2	1,160	0.05	0.05	0.01	10	50
MB33	19/03/2018	6.731		23,600	16,000	0.5	770	2,480	7,140	286	514	4,340	124	5	0.5	2	840	0.05	0.05	0.01	10	
MB33	25/06/2018	6.656		23,600	16,700	0.5	768	2,440	7,370	271	554	4,440	120	5	0.5	1	1,100	0.05	0.03	0.01	10	50
MB33	25/09/2018	6.73		24,001	16,600	0.5	795	2,340	6,940	283	518	4,290	113	5	0.5	1	1,020	0.05	0.03	0.01	10	50
MB33	19/12/2018	6.93		22,900	16,200	0.5	766	2,330	7,210	305	528	4,420	114	5	0.5	0.5	1,070	0.05	0.03	0.01	10	50
MB33	27/03/2019	6.62		22,941	15,600	0.5	783	2,230	7,230	296	543	4,480	113	5	0.5	0.5	1,020	0.05	0.04	0.01	10	50
MB33	12/06/2019	6.67		23,055	15,800	1	769	2,240	7,410	271	531	4,370	109	10	1	1	1,000	0.05	0.02	0.01	10	50
MB33	16/09/2019	6.46		23,166	16,900	0.5	786	2,020	7,050	285	517	4,580	114	5	0.5	0.5	1,030	0.05			10	50
MB33	16/12/2019	6.52		22,596	16,100	0.5	708	2,260	7,240	293	579	4,640	119	5	0.5	1	850	0.05	0.005	0.01	10	50
MB33	17/03/2020	6.69		23,528	15,600	0.5	739	2,480	6,980	300	597	4,730	126	5	0.5	0.5	360	0.05	0.04	0.01	10	140
MB33	22/06/2020	6.62		23,668	15,000	0.5	884	2,180	7,190	279	511	4,180	96	20	0.5	6	5,830	0.05	0.005	0.01	30	50
MB33	19/08/2020	6.56		24,865	15,800	0.5	740	2,240	6,820	259	520	4,440	112	5	0.5	0.5	830	0.05	0.005	0.01	10	50
MB33	17/11/2020	6.6		23,370	14,700	0.5	747	2,210	7,020	265	522	4,450	117	5	0.5	1	780	0.05	0.005	0.01	10	50
MB33	16/02/2021	6.51		23,957	15,500	0.5	884	1,970	7,270	269	538	4,470	116	25	2.5	5	900	0.05	0.005	0.01	10	50
MB33	10/05/2021	6.65			15,100	0.5	750	2,200	6,940	252	539	4,450	119	5	0.5	1	960	0.05			10	50
MB33	10/08/2021	6.98			16,100	0.5	758	2,160	7,090	319	530	4,500	121	20	2	1	610	0.05			10	50
MB33	18/11/2021	7.44			15,900	0.5	713	2,190	7,180	264	547	4,390	114	30	1	2	960	0.05	0.01	0.01	10	50
MB33	8/02/2022	7.41																				

Table 40 MB34 groundwater quality data compared to EA trigger levels (GHD, 2021)

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
MB34										diss	diss	diss	diss	Diss	Diss	Diss	Diss	Diss		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	29,720				398						55	9	13	700	0.6			20	100
MB34	24/07/2013				18,000	23	15		8,900	650	94	6200	42	5	0.5		25	0.05				
MB34	21/10/2013		8.86	25,200	17,500	14	13	343	8,860	672	170	4940	45	5	0.5	1	25	0.05			20	50
MB34	20/01/2014	7.04		29,440	18,900	0.5	30	259	9,020	835	127	5020	49	5	0.5	0.5	25	0.05			10	50
MB34	22/04/2014		8.72	28,540	18,300	10	16	280	9,720	801	131	4670	40	5	0.5	0.5	25	0.05			10	50
MB34	30/07/2014	7.84		25,200	21,100	0.5	23	266	9,810	764	189	5640	44	5	0.5	0.5	25	0.05			30	340
MB34	10/09/2014		8.891	27,433	15,700	0.5	32	434	9,720	690	274	5050	46	5	0.5	0.5	25	0.05			10	50
MB34	25/11/2014	7.624		28,500	19,900	0.5	62	558	10,500	622	350	5760	30	5	1	1	70	0.05			10	50
MB34	20/01/2015	8.175		28,766	19,700	0.5	20	368	10,600	733	249	5280	37	5	0.5	0.5	25	0.05			10	50
MB34	24/03/2015	7.81		28,033	18,000	0.5	41	402	10,500	822	267	5560	31	5	0.5	0.5	25	0.05			10	50
MB34	19/05/2015		9.041	28,200	17,800	9	17	428	9,800	860	240	4950	29	5	0.5	0.5	25	0.05			20	50
MB34	16/06/2015	7.178		27,500	18,400	0.5	32	366	10,500	840	216	4790	28	5	0.5	1	120	0.05			10	110
MB34	26/08/2015	8.47		27,000	19,200	0.5	15	320	10,200	737	212	4550	26	5	0.5	0.5	25	0.05			10	50
MB34	2/12/2015	7.84		27,333	17,900	0.5	31	340	8,660	814	234	4610	28	5	0.5	0.5	25	0.05			10	50
MB34	14/03/2016	7.93		27,200	17,800	0.5	60	373	9,440	798	145	5560	41	5	0.5	0.5	120	0.05			10	50
MB34	13/06/2016	7.74		27,700	18,400	0.5	48	276	9,410	835	293	5340	30	5	0.5	1	280	0.05			10	50
MB34	19/09/2016	7.82		27,100	19,200	0.5	85	393	9,630	894	125	5320	45	5	0.5	0.5	130	0.05	0.005	0.01	10	110
MB34	13/12/2016	7.6		28,400	20,800	0.5	53	248	9,890	750	283	5330	25	5	0.5	0.5	110	0.05	0.04	0.01	10	50
MB34	13/03/2017	7.66		28,100	18,800	0.5	61	223	10,100	809	278	5310	28	5	0.5	0.5	90	0.05	0.005	0.01	10	50
MB34	15/06/2017	7.72		27,900	18,600	0.5	99	257	10,200	782	260	5690	32	5	0.5	0.5	130	0.05	0.01	0.01	10	50
MB34	19/09/2017	6.86		27,300	19,400	0.5	212	299	10,200	986	189	5240	39	5	0.5	0.5	500	0.05	0.02	0.01	10	110
MB34	19/12/2017	7.26		28,100	21,100	0.5	131	180	10,000	804	286	5160	27	5	0.5	2	1060	0.05	0.005	0.01	10	50
MB34	20/03/2018	7.583		28,000	18,900	0.5	141	142	9,790	760	292	5120	25	5	0.5	0.5	960	0.05	0.005	0.01	10	130
MB34	25/06/2018	7.453		28,100	20,400	0.5	138	101	10,100	678	298	5160	26	20	0.5	1	90	0.05	0.04	0.02	10	50
MB34	25/09/2018	7.33		28,212	17,200	0.5	163	82	9,470	713	293	5010	24	20	0.5	7	360	0.05	0.01	0.08	10	50
MB34	19/12/2018	7.48		27,700	21,700	0.5	156	74	10,200	790	299	5090	25	5	0.5	4	70	0.05	0.005	0.02	10	50
MB34	27/03/2019	7.52		27,556	18,600	0.5	156	60	10,200	734	307	5220	23	5	0.5	3	400	0.05	0.01	0.02	10	50
MB34	12/06/2019	7.26		27,942	18,600	1	153	55	10,400	693	304	5310	24	10	1	1	50	0.05	0.01	0.01	10	50
MB34	17/09/2019	7.08		27,964	20,000	0.5	167	46	10,000	727	325	5560	26	5	0.5	0.5	50	0.05			10	130
MB34	16/12/2019	7.11		27,784	16,900	0.5	160	8	18,900	716	354	5760	26	5	0.5	0.5	25	0.05	0.01	0.01	10	110
MB34	17/03/2020	7.22		28,818	19,500	0.5	172	48	9,970	732	355	5720	27	5	0.5	0.5	60	0.05	0.02	0.02	10	140
MB34	22/06/2020	6.96		28,825	18,600	0.5	221	138	10,100	703	357	5430	28	5	0.5	0.5	250	0.05	0.005	0.01	20	50
MB34	19/08/2020	7.21		30,756	19,400	0.5	180	54	10,000	722	345	5840	26	5	0.5	0.5	100	0.05	0.03	0.01	10	
MB34	17/11/2020	7.13		29,029	18,900	0.5	164	54	10,200	707	320	4860	26	5	0.5	0.5	25	0.05	0.005	0.01	10	50
MB34	16/02/2021	6.97		30,148	19,700	0.5	185	46	10,400	643	323	5310	25	25	2.5	2.5	190	0.05	0.005	0.02	10	50
MB34	10/05/2021	7.21			19,400	0.5	276	68	10,200	628	348	5550	23	5	0.5	0.5	25	0.05			30	220
MB34	12/08/2021	7.84		27,900	20,700	1	171	25	10,000	642	355	5430	24		5	5					20	110
MB34	18/11/2021	7.83		27,700	19,200	1	200	23	10,100	680	363	5510	25		5	5			0.01	0.01	40	130

Table 41 MB35 groundwater quality data compared to EA trigger levels (GHD, 2021)

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
MB35										diss	diss	diss	diss	Diss	Diss	Diss	Diss	Diss		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	16,000				398						55	9	13	1,700	0.6			20	100
MB35	25/07/2013				690	0.5	560		70	46	76	110	1.5	5	0.5		25	0.05				
MB35	21/10/2013	8.38		1,220	859	22	505	35	101	49	80	115	2	5	0.5	0.5	25	0.05			10	50
MB35	20/01/2014	6.45		1,479	672	94	400	35	105	24	82	127	2	5	0.5	0.5	600	0.05			10	50
MB35	22/04/2014	8.09		1,309	669	0.5	520	35	94	50	81	121	1	5	0.5	1	25	0.05			10	50
MB35	29/07/2014	7.87		1,260	731	0.5	505	36	100	49	79	116	2	5	0.5	1	25	0.05			10	50
MB35	10/09/2014	7		1,829	1,010	91	595	81	174	57	94	226	3	5	0.5	2	25	0.05			10	50
MB35	25/11/2014	6.865		1,824	942	0.5	707	78	151	57	94	241	2	5	0.5	2	60	0.05			10	50
MB35	20/01/2015	6.974		2,047	1,050	32	701	103	212	60	100	313	3	5	0.5	2	25	0.05			10	50
MB35	24/03/2015	6.946		1,857	1,020	0.5	734	85	180	61	91	234	2	5	0.5	2	25	0.05			10	50
MB35	19/05/2015	7.007		1,672	907	0.5	635	66	141	57	82	164	2	5	0.5	1	60	0.05			10	50
MB35	16/06/2015	7.043		1,837	987	0.5	674	93	185	59	83	218	2	5	0.5	2	100	0.05			10	50
MB35	26/08/2015	7.11		1,367	801	0.5	578	48	128	51	75	142	2	5	0.5	1	25	0.05			10	50
MB35	2/12/2015	7.76		1,397	862	29	591	51	112	53	78	138	2	5	0.5	1	25	0.05			10	50
MB35	14/03/2016	7.8		2,050	1,160	0.5	769	123	217	56	95	291	3	5	0.5	2	25	0.05			10	50
MB35	13/06/2016	8.26		1,330	889	27	532	48	120	52	87	153	2	5	0.5	2	25	0.05			10	50
MB35	19/09/2016	7.68		1,340	718	24	525	48	104	55	86	152	2	5	0.5	2	25	0.05	0.005	0.02	10	50
MB35	13/12/2016	7.46		1,337	731	0.5	574	46	103	48	75	132	1	5	0.5	2	25	0.05	0.005	0.01	10	50
MB35	13/03/2017	6.8		1,502	835	0.5	625	74	131	53	84	176	2	5	0.5	2	60	0.05	0.01	0.02	10	50
MB35	15/06/2017	7.6		1,334	729	0.5	600	48	100	47	75	129	1	5	0.5	2	25	0.05	0.005	0.01	10	50
MB35	19/09/2017	7.01		1,343	746	0.5	556	46	108	56	86	146	2	5	0.5	1	60	0.05	0.02	0.01	10	50
MB35	19/12/2017	7.24		1,364	772	0.5	570	48	110	53	82	151	2	5	0.5	2	25	0.05	0.005	0.01	10	50
MB35	20/03/2018	6.939		1,990	1,140	0.5	737	104	190	55	85	261	2	5	0.5	2	1,490	0.05	0.005	0.01	10	50
MB35	25/06/2018	7.056		2,120	1,360	0.5	742	118	228	53	93	289	3	10	0.5	2	1,510	0.05	0.005	0.01	10	50
MB35	25/09/2018	7.06		2,050	1,130	0.5	673	105	188	60	92	277	2	5	0.5	4	3,180	0.05	0.005	0.01	10	50
MB35	19/12/2018	7.35		2,050	1,160	0.5	742	110	238	63	93	304	2	5	0.5	3	1,020	0.05	0.005	0.01	10	50
MB35	27/03/2019	6.97		1,602	886	0.5	613	66	144	54	84	178	2	5	0.5	2	2,280	0.05	0.01	0.01	10	50
MB35	12/06/2019	7.06		1,909	1,120	1	717	104	200	59	95	266	3	10	1	1	50	0.05	0.01	0.01	10	50
MB35	17/09/2019	6.96		1,981	1,140	0.5	749	101	200	56	88	277	2	5	0.5	2	430	0.05			10	50
MB35	16/12/2019	7.73		1,513	827	0.5	560	20	126	56	90	178	2	5	0.5	2	25	0.05	0.005	0.01	10	50
MB35	17/03/2020	6.69		2,070	1,180	0.5	705	123	194	62	93	285	2	5	0.5	2	25	0.05	0.005	0.01	10	50
MB35	22/06/2020	6.94		1,988	1,140	0.5	748	107	190	66	100	269	2	5	0.5	2	25	0.05	0.005	0.01	40	50
MB35	20/08/2020	7		1,546	785	0.5	524	48	119	51	81	151	2	5	0.5	3	300	0.05	0.005	0.01	10	50
MB35	18/11/2020	6.9		1,529	858	0.5	544	60	127	53	84	165	2	5	0.5	0.5	100	0.05	0.02	0.01	10	50
MB35	16/02/2021	6.93		2,156	1,240	0.5	740	116	219	56	96	293	2	5	0.5	2	120	0.05	0.005	0.01	10	50
MB35	12/05/2021	7			1,130	0.5	708	116	198	54	95	269	2	5	0.5	3	70	0.05			10	50
MB35	11/08/2021		8.54	1,680	976		505	75	139	64	86	198	2		1	3		0.1			10	180
MB35	18/11/2021	7.98		1,800	1,070	0.5	607	94	174	53	92	242	2		1	4		0.1	0.02	0.01	10	50

Table 42 MB36 groundwater quality data compared to EA trigger levels (GHD, 2021)

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
MB36										diss	diss	diss	diss	Diss	Diss	Diss	Diss	Diss		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	16,000				477						55	9	13	2,600	0.6			20	100
MB36	25/07/2013				4,800	0.5	750		1,600	190	210	1,200	9	5	0.5		560	0.05				
MB36	22/10/2013	8.02		6,990	4,610	0.5	565	435	1,660	192	223	1,040	7	5	0.5	0.5	1,500	0.05			10	50
MB36	20/01/2014	6.4		7,893	4,650	0.5	474	440	1,640	158	214	1,050	7	5	0.5	0.5	60	0.05			10	50
MB36	22/04/2014	7.98		7,579	4,220	0.5	665	493	2,140	204	234	1,140	5	5	0.5	1	610	0.05			10	50
MB36	29/07/2014	7.82		6,850	4,850	0.5	646	422	1,730	187	235	1,110	6	5	0.5	1	700	0.05			10	50
MB36	10/09/2014	6.742		10,150		0.5	354	362	3,500	312	347	1,440	9	5	0.5	3	1,080	0.05			10	50
MB36	25/11/2014	6.656		10,003	6,140	0.5	468	360	3,180	303	324	1,430	8	5	0.5	3	1,020	0.05			10	50
MB36	20/01/2015	6.879		10,790	6,830	0.5	389	404	3,860	344	368	1,680	8	5	0.5	2	570	0.05			10	50
MB36	24/03/2015	6.807		10,517	6,720	0.5	399	369	3,720	459	345	1,480	6	5	0.5	2	950	0.05			10	310
MB36	19/05/2015	6.841		9,953	6,140	0.5	471	512	3,200	386	295	1,280	6	5	0.5	3	1,170	0.05			10	50
MB36	16/06/2015	6.847		10,327	6,520	0.5	424	429	3,620	398	297	1,320	6	5	0.5	1	25	0.05			10	50
MB36	26/08/2015	7.59		7,743	4,990	0.5	622	467	2,340	245	224	1,060	6	5	0.5	1	25	0.05			10	50
MB36	2/12/2015	7.37		8,677	5,350	0.5	630	440	2,410	303	246	1,100	6	5	0.5	1	200	0.05			10	50
MB36	21/04/2016	7.8		8,480	5,470	0.5	600	412	1,900	227	248	1,170	6	5	0.5	0.5	25	0.05			10	50
MB36	13/06/2016	7.58		7,890	4,630	0.5	645	444	1,840	271	266	1,240	6	5	0.5	1	70	0.05			10	50
MB36	19/09/2016	7.5		7,830	5,000	0.5	636	439	2,160	256	254	1,210	6	5	0.5	0.5	25	0.05	0.03	0.01	10	50
MB36	13/12/2016	7.44		8,080	5,260	0.5	681	443	2,280	241	239	1,160	6	5	0.5	0.5	70	0.05	0.005	0.01	10	50
MB36	13/03/2017	6.74		10,660	6,780	0.5	447	361	3,480	409	335	1,470	7	5	0.5	2	1,640	0.05	0.005	0.01	10	50
MB36	15/06/2017	6.82		8,280	5,190	0.5	681	406	2,460	272	269	1,250	6	5	0.5	1	1,280	0.05	0.005	0.01	10	50
MB36	19/09/2017	7		7,160	4,330	0.5	730	458	1,840	232	239	1,130	5	5	0.5	0.5	880	0.05	0.02	0.01	10	50
MB36	19/12/2017	7.28		7,810	4,760	0.5	687	442	1,980	240	236	1,180	6	5	0.5	1	280	0.05	0.005	0.01	10	50
MB36	20/03/2018	7.195		10,430	7,010	0.5	471	267	3,350	362	292	1,350	7	5	0.5	0.5	2,090	0.05	0.01	0.01	10	50
MB36	25/06/2018	7.056		9,990	7,360	0.5	488	290	3,240	314	304	1,330	6	5	0.5	0.5	1,580	0.05	0.005	0.01	10	50
MB36	25/09/2018	6.9		10,659	6,250	0.5	314	294	3,250	356	310	1,380	6	5	0.5	5	4,440	0.05	0.005	0.01	10	50
MB36	19/12/2018	7.21		10,600	7,700	0.5	464	281	3,630	413	326	1,440	7	5	0.5	0.5	1,730	0.05	0.005	0.01	10	50
MB36	27/03/2019	6.8		8,159	5,220	0.5	664	369	2,470	265	242	1,190	6	5	0.5	0.5	3,450	0.05	0.01	0.01	10	50
MB36	12/06/2019	7.18		8,473	5,180	1	632	337	2,670	258	260	1,230	6	10	1	1	340	0.05	0.01	0.01	10	50
MB36	17/09/2019	6.84		7,855	4,860	0.5	745	334	2,260	222	226	1,130	6	5	0.5	0.5	230	0.05			10	50
MB36	16/12/2019	7.45		7,550	5,160	0.5	685	391	1,880	204	257	1,270	6	5	0.5	0.5	220	0.05	0.005	0.01	10	50
MB36	22/06/2020	6.92		6,714	3,710	0.5	1050	221	1,580	174	209	1,080	8	5	0.5	0.5	25	0.05	0.05	0.08	10	160
MB36	20/08/2020	6.94		7,177	4,020	0.5	905	344	1,580	167	194	1,060	6	5	0.5	0.5	180	0.05	0.005	0.01	10	50
MB36	18/11/2020	6.84		7,410	4,120	0.5	809	416	1,580	166	199	1,050	6	5	0.5	0.5	140	0.05	0.005	0.02	10	50
MB36	16/02/2021	6.75		7,496	4,440	0.5	803	420	1,700	174	213	1,100	5	5	0.5	0.5	260	0.05	0.005	0.01	10	50
MB36	11/05/2021	6.91			5,450	0.5	700	198	2,760	251	270	1,240	6	5	0.5	0.5	25	0.05			10	240
MB36	18/08/2021	7.6		8,670	5,810	1	599	280	3,170	235	267	1,300	6		5	1		0.1	0.01	0.01	10	110
MB36	16/11/2021	7.86		9,880	7,110	1	558	223	3,220	284	311	1,410	7		3	1		0.1	0.01	0.04	10	50

Table 43 MB39 (MB19SRM03P) groundwater quality data compared to EA trigger levels (GHD, 2021)

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
MB39										diss	diss	diss	diss	Diss	Diss	Diss	Diss	Diss		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	16,000				398						55	9	13	700	0.6			20	100
MB39	30/01/2020	7.8		8,050	4,660	0.5	339	99	2,510	67	32	1,580	6	30	16	0.5	25	0.05			10	580
MB39	14/02/2020	7.77		8,290	4,600	20	329	70	2,530	25	34	1,710	6	5	17	0.5	25	0.05		0.01		750
MB39	18/03/2020	7.85		7,930	4,540	0.5	362	70	2,560	51	32	1,680	7	5	47	1	25	0.05				870
MB39	21/04/2020	7.91		7,730	5,180	0.5	361	74	2,550	79	34	1,690	7	40	58	0.5	25	0.05				1020
MB39	19/05/2020	7.68		7,800	4,610	0.5	388	75	2,650	67	36	1,760	7	30	68	1	25	0.05				1070
MB39	17/06/2020	7.77		8,790	4,830	0.5	353	138	2,530	97	35	1,740	7	30	41	0.5	50	0.05				960
MB39	1/07/2020	7.79		8,020	5,280	0.5	324	265	2,890	47	37	1,940	6	30	16	0.5	25	0.05				260
MB39	20/08/2020	8.05		9,864	5,450	0.5	286	281	2,930	103	36	1,940	6	20	4	0.5	100	0.05				140
MB39	16/09/2020	7.58		10,073	5,320	0.5	295	286	3,050	96	35	1,890	6	10	4	0.5	90	0.05				120
MB39	13/10/2020	7.48		9,966	5,450	0.5	295	300	2,940	89	36	1,850	6	10	5	0.5	25	0.05				50
MB39	18/11/2020	7.51		10,371	5,420	0.5	280	300	3,030	64	36	1,960	6	10	2	0.5	90	0.05				50
MB39	9/12/2020	7.52		10,636	5,320	0.5	300	312	3,010	83	42	1,910	7	20	2	0.5	50	0.05				50

Table 44 New Permian monitoring bore groundwater quality data compared to Fitzroy Zone 34 guidelines

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16,000	-	-	650	398	5,905	442	491	2,565	-	-	-	-	140.00	-	14.92	-	-	-
MB19SRM03P	2/12/2019	8.18		8,140	4,700	1	346	90	2,360	52	30	1,540	6	70.00	1.00	1.00	60.00	0.10	0.01	0.01	20	50
MB19SRM03P	30/01/2020	7.8		8,260	4,660	1	339	99	2,510	67	32	1,580	6	260.00	17.00	1.00	400.00	0.10			20	670
MB19SRM03P	14/02/2020	8.42		8,030	4,600	20	329	70	2,530	<1	34	1,710	6	90.00	23.00	1.00	160.00	0.10		0.01	20	810
MB19SRM03P	18/03/2020	8.28		7,890	4,540	1	362	70	2,560	51	32	1,680	7	160.00	58.00	1.00	220.00	0.10	0.01	0.01	20	940
MB19SRM03P	21/04/2020	8.24		7,980	5,180	1	361	74	2,550	79	34	1,690	7	180.00	79.00	1.00	220.00	0.10	0.01	0.01	20	1,010
MB19SRM03P	19/05/2020	8.03		8,370	4,610	1	388	75	2,650	67	36	1,760	7	140.00	87.00	1.00	200.00	0.10	0.02	0.01	20	1,100
MB19SRM03P	17/06/2020	7.95		8,520	4,830	1	353	138	2,530	97	35	1,740	7	120.00	69.00	1.00	180.00	0.10	0.01	0.01	20	930
MB19SRM03P	1/07/2020	8.25		9,470	5,280	1	324	265	2,890	47	37	1,940	6	120.00	32.00	1.00	180.00	0.10	0.01	0.01	20	340
MB19SRM03P	20/08/2020	8.05		9,340	5,450	1	286	281	2,930	103	36	1,940	6	40.00	8.00	1.00	150.00	0.10	0.01	0.01	20	180
MB19SRM03P	16/09/2020	7.83		9,610	5,320	1	295	286	3,050	96	35	1,890	6	50.00	6.00	1.00	190.00	0.10	0.02	0.01	20	50
MB19SRM03P	13/10/2020	8.2		9,630	5,450	1	295	300	2,940	89	36	1,850	6	40.00	6.00	1.00	140.00	0.10	0.01	0.02	20	50
MB19SRM03P	18/11/2020	7.97		9,350	5,420	1	280	300	3,030	64	36	1,960	6	50.00	5.00	1.00	160.00	0.10	0.01	0.01	20	50
MB19SRM03P	9/12/2020	7.97		9,500	5,320	1	300	312	3,010	83	42	1,910	7	80.00	7.00	1.00	150.00	0.10	0.01	0.01	20	50
MB19SRM03P	13/01/2021	7.96		9,280	5,290	1	306	296	2,990	60	35	1,880	6	30.00	6.00	1.00	150.00	0.10	0.01	0.01	20	50
MB19SRM03P	17/02/2021	7.99		9,420	5,470	1	293	296	3,060	75	37	1,920	6	10.00	2.00	1.00	70.00	0.10	0.01	0.01	20	50
MB19SRM03P	25/03/2021	8.1		9,090	5,260	1	386	305	3,000	50	37	1,950	6	50.00	7.00	1.00	190.00	0.10	0.01	0.01	20	50
MB19SRM03P	15/04/2021	8.05		11,000	5,520	1	362	310	3,190	66	36	1,760	6	80.00	12.00	1.00	250.00	0.10			20	50
MB19SRM03P	12/05/2021	8.19		9,130	5,370	1	289	307	2,980	97	37	1,900	6	40.00	6.00	1.00	140.00	0.10			20	110
MB19SRM03P	10/06/2021	8.1		9,300	5,150	1	308	298	3,000	83	36	1,800	6	30.00	10.00	1.00	190.00	0.10			20	50
MB19SRM03P	18/08/2021	7.83		9,320	5,420	1	275	317	3,540	50	36	1,950	6	40.00	6.00	1.00	170.00	0.10	0.01	0.01	20	50
MB19SRM03P	23/08/2021	7.83		9,260	5,430	1	291	288	2,930	56	38	2,030	6	20.00	11.00	1.00	100.00	0.10			20	50
MB19SRM03P	13/09/2021	7.69		9,290	5,420	1	304	295	2,920	68	37	1,980	6	40.00	16.00	1.00	180.00	0.10			20	50
MB19SRM03P	12/10/2021	8.33		9,600	5,430	14	299	289	3,030	80	36	1,860	6	10.00	17.00	1.00	100.00	0.10			20	50
MB19SRM03P	18/11/2021	8.15		9,410	5,380	1	270	300	2,960	44	38	1,960	6	30.00	8.00	1.00	130.00	0.10	0.08	0.01	20	120
MB19SRM03P	13/12/2021	8.1		10,000	5,620	1	298	299	3,100	35	37	2,020	6	10.00	10.00	1.00	50.00	0.10	0.01	0.01	20	50
MB19SRM03P	19/01/2022	7.4		9,100	5,350	1	314	301	3,080	59	36	1,920	6	860.00	41.00	1.00	2570.00	0.50			20	100

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16,000	-	-	650	398	5,905	442	491	2,565	-	-	-	-	140	-	14.92	-	-	-
MB19SRM04P	4/12/2019	7.38		6,060	3,480	1	505	581	1,260	110	129	978	16	80.00	1.00	2.00	1,050	0.10	0.01	0.01	20	50
MB19SRM04P	14/02/2020	7.94		5,870	3,450	1	491	571	1,300	1	135	1,010	17	820.00	1.00	6.00	3,280	0.10		0.01	20	50
MB19SRM04P	20/05/2020	7.38		5,910	3,700	1	513	534	1,370	119	137	1,070	16	80.00	1.00	3.00	1,280	0.10	0.01	0.01	20	50
MB19SRM04P	18/08/2020	7.54		5,850	3,680	1	510	620	1,340	115	130	1,040	16	90.00	1.00	3.00	1,400	0.10	0.01	0	20	50
MB19SRM04P	18/11/2020	7.38		5,910	3,810	1	482	662	1,370	130	131	1,030	16	30.00	1.00	3.00	2,960	0.10	0.01	0.01	20	50
MB19SRM04P	15/02/2021	7.27		5,940	3,640	1	533	597	1,390	116	130	1,010	16	50.00	1.00	1.00	380	0.10	0.05	0.06	20	50
MB19SRM04P	12/05/2021	7.86		5,770	3,520	1	499	626	1,350	108	128	987	16	520.00	1.00	1.00	1,520	0.10			20	100
MB19SRM04P	12/08/2021		8.41	6,110	3,640	31	414	584	1,350	127	128	1,060	18	260.00	1.00	2.00	2,230	0.10			20	160

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16,000	-	-	650	398	5,905	442	491	2,565	-	-	-	-	140	-	14.92	-	-	-
MB19SRM04P	4/12/2019	7.38		6,060	3,480	<1	505	581	1,260	110	129	978	16	80.00	1.00	2.00	1,050	0.10	0.01	<0.01	<20	<50
MB19SRM04P	14/02/2020	7.94		5,870	3,450	<1	491	571	1,300	<1	135	1,010	17	820.00	1.00	6.00	3,280	0.10		<0.01	<20	<50
MB19SRM04P	20/05/2020	7.38		5,910	3,700	<1	513	534	1,370	119	137	1,070	16	80.00	1.00	3.00	1,280	0.10	<0.01	<0.01	<20	<50
MB19SRM04P	18/08/2020	7.54		5,850	3,680	<1	510	620	1,340	115	130	1,040	16	90.00	1.00	3.00	1,400	0.10	<0.01	<0.01	<20	<50
MB19SRM04P	18/11/2020	7.38		5,910	3,810	<1	482	662	1,370	130	131	1,030	16	30.00	1.00	3.00	2,960	0.10	<0.01	<0.01	<20	<50
MB19SRM04P	15/02/2021	7.27		5,940	3,640	<1	533	597	1,390	116	130	1,010	16	50.00	1.00	1.00	380	0.10	0.05	0.06	<20	<50
MB19SRM04P	12/05/2021	7.86		5,770	3,520	<1	499	626	1,350	108	128	987	16	520.00	1.00	1.00	1,520	0.10			<20	100
MB19SRM04P	12/08/2021		8.41	6,110	3,640	31	414	584	1,350	127	128	1,060	18	260.00	1.00	2.00	2,230	0.10			<20	160

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16,000	-	-	650	398	5,905	442	491	2,565	-	-	-	-	140	-	14.92	-	-	-
MB20SRM03P	26/10/2019		12.2	16,500	5,640	320	<1	80	1,180	14	<1	1,990	504	240	3	6	2,090	0.1	0.05		60	2,000

Site	Date	In-situ pH		In-situ EC	SWL		TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
												diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	(mBGL)	(mRL)	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																								
Zone 34	Deep 80th	7.4	8.03	16,000			-	-	650	398	5,905	442	491	2,565	-	-	-	-	140	-	14.92	-	-	-
MB20SRM07P	27/10/2019	8.43		5,440			2,850	20	152	4	1,580	67	12	1,130	8	30	0.1	1	50	0.1	0.01		<20	<50

5.3.9.4 Stock watering suitability

The groundwater quality data across the site is variable and ranges from brackish to saline. Although the groundwater is generally within the guidelines for livestock, Section 4.3.3.5 of the ANZECC guidelines (2000) states that loss of production and a decline in animal health occurs if stock are exposed to high TDS and saline water for prolonged periods. For beef cattle, this TDS limit is the range of 5,000 mg/L to 10,000 mg/L, see Table 43.

Table 45 Total Dissolved Solids ANZECC 1992 Livestock Drinking Water Quality Guideline

Animal	No Adverse effects	Reluctance to Drink		Loss of production–-short-term tolerance	
	Tolerance Limit	Low	High	Low	High
	mg/l	mg/l		mg/l	
Beef Cattle	<4,000	4,000	5,000	5,000	10,000
Dairy Cattle	<2,500	2,500	4,000	4,000	7,000
Sheep	<5,000	5,000	10,000	10,000	13,000
Horses	<4,000	4,000	6,000	6,000	7,000
Pigs	<4,000	4,000	6,000	6,000	8,000
Poultry	<2,000	2,000	3,000	3,000	4,000

Hart (1974) as presented in ANZECC, 1992.

Given that total dissolved solids for the Tertiary and Permian sediments are generally above 5,000 mg/L, the regional groundwater would generally not be considered suitable for prolonged livestock supply.

5.3.10 Trigger levels

Available water quality data across and adjacent to Saraji Mine was compiled as per the Department of Environment, Science and Innovation (DESI) request after the Department's review of the initial Project EIS submission. These data are included in the water quality monitoring data template in **Appendix A**.

These data allow for the evaluation of data and aid in the compilation of proposed trigger levels for the Project.

The data from the Saraji Mine monitoring bores, used to describe baseline groundwater conditions, have trigger levels, which have been included in the Saraji Mine EA conditions (EPML00862313, dated 10 March 2022). It is considered that the existing Saraji Mine monitoring bores to be included in the SEMLP groundwater monitoring bore network (Section 7.1) will use the same water quality triggers . These triggers are included in Table 46.

Table 46 Groundwater contaminant trigger levels (Table I2)

Quality characteristic	Unit	MB31, MB32, MB37	MB33	MB34	MB35	MB36	MB39	MB40
Water level	RL	Monitored for interpretative reasons only – no triggers apply	Fluctuations in excess of 2 m from background excluding changes from pumping of licenced bores					
pH Value	pH units		6.5 – 8.5					
Electrical Conductivity	µS/cm		25,170	29,720	16,000	16,000	16,000	8,910
Sulphate	mg/L SO_4		2,580	398	398	477	398	318
Iron	mg/L Fe		1.6	0.7	1.7	2.6	0.7	0.7
Aluminium	mg/L Al		0.055					
Arsenic	mg/L As		0.013					
Mercury	mg/L Hg		0.0006					
Antimony	mg/L Sb		0.009					
Molybdenum	mg/L Mo		0.034					
Selenium	mg/L Se		0.020	0.020	0.011	0.011	0.011	0.011
Silver	mg/L Ag		0.0014	0.0013	0.001	0.001	0.0012	0.001
TPH C6-C10	µg/L		20					
TPH C10-C40	µg/L		100					

Table note: The Saraji Mine EA Conditions does not stipulate dissolved and/or total metals

The development of the groundwater contaminant trigger levels for the Saraji Mine is included in the Saraji Mine - Groundwater Contaminant Trigger Levels Report (GHD, 2021).

It is noted, as per Section 5.3.8, that adopting the 2 m per year fluctuation for Permian groundwater monitoring bores is deemed unsuitable for the Project. Groundwater level triggers for the Saraji Mine monitoring bores to be included in the SEMLP groundwater monitoring bore network, MB33 and MB34, are discussed in Section 7.5.2.4.

5.3.10.1 Triggers for new monitoring bores

The monitoring wells, installed in 2019 and 2020, for Saraji Mine catchment scale monitoring plus selected existing Saraji Mine monitoring bores will be included in the Project monitoring bore network. The groundwater monitoring bore network proposed for the Project is included in Section 7.1.2 (Table 60) and Section 7.2.1 (Table 61).

A high-level overview of the methodology adopted for the determination of proposed trigger levels for the proposed Project monitoring bores, which do not already have agreed / authorised water quality trigger levels (i.e., proposed monitoring bores not included in Table 46) are included below.

- Available water quality data was compiled (as included in Appendix **A**)
- The water quality data were reviewed for outliers and screened to remove bias from the dataset
- Statistics were calculated for use in the derivation of contaminant trigger values for each of the new monitoring wells to be included in the Project groundwater monitoring. These include (Table 60)
    - MB20SRM02T, MB20SRM03P, and MB20SRM04A
    - Note: MB38 (MB19SRM01A), MB20SRM01A (MB20SRM01_PZ), and MB20SRM05A (MB20SRM05A_PZ) were dry.
- Environmental values (Section 5.4) were reviewed and WQOs were selected for each hydrostratigraphic unit based on protecting the most sensitive EV applicable to each hydrostratigraphic unit
    - The hydrostratigraphic units include alluvium, Tertiary, and Permian age sediments
- Contaminant trigger values were derived for each new monitoring bore and compliance parameters were based on review of the monitoring data and review of data trends using the DES (2021) monitoring data assessment methodologies.

5.3.10.2 Water quality objectives

To assist with developing interim water quality trigger levels for the monitoring bores with insufficient data. The following WQOs and guidelines were considered:

- Environmental Protection (Water) Policy 2009 (EPP (Water) 2009) Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River) September 2011
    - WQOs for Fitzroy Basin groundwaters according to the chemistry zone 34 (refer plan WQ 1310) and depth category, as per Section 3.3.3 and Figure 3.
- ANZG (2018) freshwater (FW) guidelines at the 95 per cent level of protection, where no regional WQO was defined
- ANZG (2018) unknown level of species protection, where there is no guideline for the 95% level of protection
- In the absence of a published guideline for iron at the 95 per cent species protection level, the draft ANZG (2018) guideline for 95 per cent species protection of 0.7 mg/L has been adopted as the WQO for dissolved iron, as the Saraji Mine trigger study (GHD, 2021).

<u>Alluvium</u>

Groundwater chemistry data for the new alluvium monitoring bore proposed to be included in the Project groundwater monitoring bore network, MB20SRM04A, have been compiled and compared to the Isaac River Sub-basin Environmental Values and Water Quality Objectives Table 14 (shallow) Zone 34 (Table 47).

Only one groundwater sample result is available and as such no proposed trigger levels can yet be proposed for this monitoring bore. As detailed in Section 7.5.4.1, once sufficient groundwater quality data is available (a minimum of 12 sample events) triggers will be developed for MB20SRM04A.

Tertiary

Groundwater chemistry data for new monitoring bore MB20SRM02T, has been compiled and compared to the Isaac River Sub-basin Environmental Values and Water Quality Objectives Table 14 (deep) Zone 34 (Table 48).

Only one groundwater sample result is available and as such no proposed trigger levels can yet be proposed for this monitoring bore. Once sufficient groundwater quality data is available (a minimum of 12 sample events) triggers will be developed for MB20SRM02T.

Permian

Groundwater chemistry data for new monitoring bore MB20SRM03P was compiled and compared to the Isaac River Sub-basin Environmental Values and Water Quality Objectives Table 14 (deep) Zone 34 (Table 49).

Only one groundwater sample result is available and as such no proposed trigger levels can yet be proposed for this monitoring bore. Once sufficient groundwater quality data is available (a minimum of 12 sample events) triggers will be developed for MB20SRM03P.

Interim triggers

It is considered that the water quality triggers developed for Saraji Mine will be adopted in the interim, until sufficient data is available for the new Project monitoring bores (Section 7.2.2).

Table 47 MB20SRM04A alluvium groundwater quality data

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Shallow 80th	7.1	8.1	8910	-	-	878	318	3185	215	389	1500	-	-	-	-	246	-	5.3	-	-	-
MB20SRM04A	14/12/2009	7.62		21400	14700	1	907	1620	6980	236	402	4220	72	6650	1	6	12400	0.3	0.07	0.79	20	2310

Table 48 MB20SRM02T Tertiary groundwater quality data

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16000		-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
MB20SRM02T	20/10/2019	8.52		3,990	2,520	47	686	383	724	48	55	837	20	3,740	1	7	4,500	0	0		20	50

Table 49 MB20SRM02P Permian groundwater quality data

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16000	-	-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
MB20SRM03P	26/10/2019	12.2		16500	5640	320	1	80	1180	14	1	1990	504	240	3	6	2090	0.1	0.05		60	2000

5.3.11 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are defined as ecosystems that require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Richardson et al, 2011).

GDEs can be grouped into three categories in Queensland, based on their type of groundwater reliance:

- Aquatic GDEs
- Terrestrial GDEs
- Subterranean GDEs.

Aquatic GDEs are dependent on the surface expression of groundwater and rely on groundwater after it has been discharged to the surface (i.e., groundwater-fed wetland systems (swamps, lakes and rivers)).

Terrestrial GDEs are dependent on the subsurface expression of groundwater and access subsurface groundwater to meet all or some of its water requirements (i.e., terrestrial vegetation with typically deep-rooted trees).

Subterranean GDEs occur within caves and aquifers. Cave GDEs occur in caves which have some degree of groundwater connectivity. Aquifer GDEs typically occur within the intergranular void space, rock fractures and solution cavities. Aquatic animals that live in groundwater are referred to as stygofauna.

5.3.11.1 Identification of GDEs

The National Atlas of groundwater dependent ecosystems (GDE Atlas) was consulted to identify whether GDEs have been mapped within the area. GDE Atlas comprises maps that show the location of both known and potential GDEs across Australia, as well as ecological and hydrogeological information for each GDE. The database containing the GDE mapping is hosted by BoM and accessible through the BoM website (http:\\www.bom.gov.au).

Where no known aquatic or terrestrial GDEs were mapped within the GDE Atlas, the potential for aquatic or terrestrial GDEs were further assessed by using the Stage 1 assessment approach recommended within the *Australian groundwater-dependent ecosystem toolbox part 1: assessment framework* (GDE Toolbox) (Richardson et al, 2011). The GDE Toolbox Stage 1 assessment relies heavily on the methodology outlined by Eamus et al (2006) for identifying aquatic and terrestrial GDEs. Eamus et al (2006) pose a series of questions to help determine the likelihood of whether an ecosystem is potentially dependent on groundwater. They suggest that an affirmative answer to one or more of these questions means there is potentially a GDE present. The questions are reproduced in Table 22 and Table 23. Where no known subterranean GDEs were mapped within the GDE Atlas; the potential for subterranean GDEs was assessed from a literature review and site specific sampling results.

5.3.11.2 Aquatic GDEs

Aquatic GDEs, as mapped within the GDE Atlas, are shown in Figure 49 and can be summarised as follows:

- No known aquatic GDEs are mapped within the Project Area.
- There is moderate to high potential for aquatic GDEs to exist within those areas of the Saraji Mine which contain open water i.e. tailings dams, evaporation dams and levees.
- There is moderate to high potential for aquatic GDEs to exist along reaches of Phillips Creek to the south of the proposed underground mine and Hughes Creek/Boomerang Creek which overlies the northern portion of the underground mining footprint.

To further assess the likelihood of aquatic GDEs within the Project Area, using project specific data and observations, a series of five questions posed by Eamus, et al (2006) were answered as shown in Table 50.

Table 50 Questions to determine likelihood of aquatic GDEs

Question	Comment
Does a stream/river continue to flow all year, or a floodplain waterhole remains wet all year in dry periods?	No. All creeks in the Project Area are ephemeral with only intermittent flow. As discussed in Section 5.3.5, it is conceptualised that the alluvium will not contain permanent groundwater as recharge to the alluvium seeps downwards into the underlying sediments. None of the creeks in the Project Area have permanent groundwater baseflow that contributes to surface flows (Hydrobiology, 2016).
For estuarine systems, does the salinity drop below that of seawater in the absence of surface water inputs?	Not applicable to the Project.
Does the volume of flow in a stream/river increase downstream in the absence of inflow from a tributary?	No. Creeks flow throughout their length following flood events, water then quickly retreats due to the sandy nature of the creek bed. During retreat, water becomes ponded in areas where clay is present and/or areas which have low elevation. None of the creeks in the Project area are identified as gaining streams (SKM, 2009).
Is the level of water in a wetland/swamp maintained during dry periods?	No. Water levels in tailing dams, evaporation dams and levees (areas identified as moderate to high potential for aquatic GDEs within the GDE Atlas) do maintain permanence throughout the year but are artificial mining features and permanence is related to mining activities.
Is groundwater discharged to the surface for significant periods of time each year at critical times during the lifetime of the dominant vegetation type?	No. There are no springs which have been mapped in the area or which are known to exist within the area. There are no known points where groundwater can be seen naturally discharging to the surface.

Given that the answers to all of the questions in Table 50 are either ‘no’ or ‘not applicable’, those areas mapped as having moderate to high potential for aquatic GDEs in the GDE Atlas, are considered to have low potential for aquatic GDEs when assessed using site specific data for the following reasons: Those areas of the mine which contain open water i.e. tailings dam, evaporation pits and levees only have permanence of water due to them being artificial mining features.

The creeks in the area are ephemeral with only intermittent flows and it is conceptualised that the alluvium associated with the creeks do not contain permanent groundwater.

5.3.11.3 Terrestrial GDEs

Terrestrial GDEs, as mapped within the GDE Atlas, are shown in Figure 50 and can be summarised as follows:

- No known terrestrial GDEs occur within the Project Area.
- There is low to moderate potential for terrestrial GDEs to exist within the footprint of the proposed underground mine workings and surrounds.

To further assess the likelihood of terrestrial GDEs within the Project area, using project specific data and observations, a series of three questions posed by Eamus et al (2006) were answered as shown in Table 51.

Table 51 Questions to determine likelihood of Terrestrial GDEs

Question	Comment
Is groundwater or the capillary fringe above the water table present within the rooting depth of any vegetation?	Unlikely in alluvium. Sections 5.3.5.2 and 5.3.8.1 shows that groundwater is not permanently present in alluvium deposits with the exception of MB32 located to the west of Saraji Mine. Groundwater levels in MB32 vary between 7 mbGL and 14 mbGL. No in Tertiary sediments. Section 5.3.8.2 shows that water levels in Tertiary sediments are greater than 15 mbGL. Froend and Loomes (2004) suggest that groundwater is of reduced importance to vegetation when the water table is at depths greater than 10 m.
Does a proportion of the vegetation remain green and physiologically active (principally, transpiring and fixing carbon, although stem-diameter growth or leaf growth are also good indicators) during extended dry periods?	Not applicable. Previous studies (AECOM, 2024; Hydrobiology, 2023; 3D Environmental, 2023) have shown that the majority of floral assemblages within the area are characterised by drought tolerant species with low physiological sensitivity to water availability and are not considered groundwater dependent. No EPBC Act listed GDEs identified.
Is the level of water in a wetland/swamp maintained during extended dry periods?	No. Water levels in tailing dams, evaporation dams and levees (areas identified as moderate to high potential for terrestrial GDEs within the GDE Atlas) do maintain permanence throughout the year but are artificial mining features and permanence is related to mining activities.

Given the answers to the questions in Table 51, those areas mapped as having moderate potential for terrestrial GDEs in the GDE Atlas, are considered to have low potential for terrestrial GDEs when assessed using site specific data for the following reasons:

- Groundwater levels in Tertiary sediments are generally deeper than 15 mbGL which is at a depth where groundwater has a reduced importance to vegetation (Froend and Loomes, 2004). This depth is also outside the accessible reach for Eucalypt vegetation (Zolfagher et al, 2014).
- Groundwater is generally not permanently present within alluvium and is therefore unlikely to provide a source of water for terrestrial species.
- The majority of floral assemblages within the area are drought tolerant with low sensitivity to water availability.

5.3.11.4 Aquatic and Terrestrial GDE site-specific investigations

A groundwater dependent ecosystem assessment was conducted for the Project (3D Environmental, 2023). The GDE Assessment included the hand auger bores detailed in Section 5.2.3.1 (Table 18).

Based on the results of the field survey, it is concluded that Terrestrial GDEs are present on Phillips Creek, which passes through the central portion of EPC837. Terrestrial GDEs were identified on Hughes Creek mapped as intruding marginally into EPC837. These Terrestrial GDEs host variable groundwater volumes and are seasonally recharged via surface flows and flooding.

No specific impediment to tree water use of Tertiary or Permian groundwater is recognised based on salinity values. However, water held in these aquifers is an unsuitable resource to support GDEs due to the potentiometric surface being generally >17 mbGL, which is significantly below the maximum rooting depth of facultative phreatophytes associated with the major drainage channels across the Project.

Field data indicates that Phillips Creek is highly likely to function as a Terrestrial GDE where groundwater dependence varies on a seasonal basis. The highest degree of groundwater usage would occur post seasonal flooding events, which recharge groundwater in associated alluvium deposits. As included in the conceptual groundwater model (Section 4.3.2) the discontinuous (spatially and saturated) alluvium is not in hydraulic connection with Tertiary and Permian age sediments, as such any

potential drawdown in these older sediments due to the Project is not predicted to result in induced flow from the seasonally (surface water) recharged discontinuous alluvium.

There is no indication that Phillips Creek represents an Aquatic GDE.

Vegetation on Tertiary plains has limited potential for groundwater dependency, due to both the shallow rooted nature of the dominant poplar box and brigalow and the significant depth to the groundwater.

Vegetation fringing One Mile Creek and adjacent woodland does not meet the hydrological criteria (refer to Table 51 for criteria) for a Terrestrial GDE with field assessment confirming that moisture requirements of vegetation are being supported within the unsaturated portion of the soil profile.

Vegetation fringing Hughes Creek does not meet the hydrological or ecological criteria for a Terrestrial GDE. The transition of Hughes Creek into a Terrestrial GDE to the east of the Project is most likely associated with a thickening and widening of creek alluvium eastward toward the Isaac River where there is greater capacity for storage of perched groundwater. Within the Project Site, the alluvium landform hosting Hughes, Boomerang, and Plum Tree creeks is extremely shallow, with outcropping sedimentary basement evident in some channel exposures.

The Boomerang Creek wetland (assessed at Site 13_AU1) is a surface feature and there is no indication of any hydrological linkage between surface water and groundwater. The Boomerang Creek wetland does not meet the hydrological or ecological criteria for either a Terrestrial GDE or Aquatic GDE.

An assessment of predicted groundwater impacts (SLR, 2023) indicated that the risk to GDE's posed by Project is 'Low to Insignificant' and there is no interaction between modelled groundwater drawdown and the Terrestrial GDE identified on Phillips Creek (Figure 48).

The assessment also identified that there are no significant residual impacts predicted to any prescribed environmental matters under relevant state or federal legislation including both MSES and MNES.

5.3.11.5 Subterranean GDEs

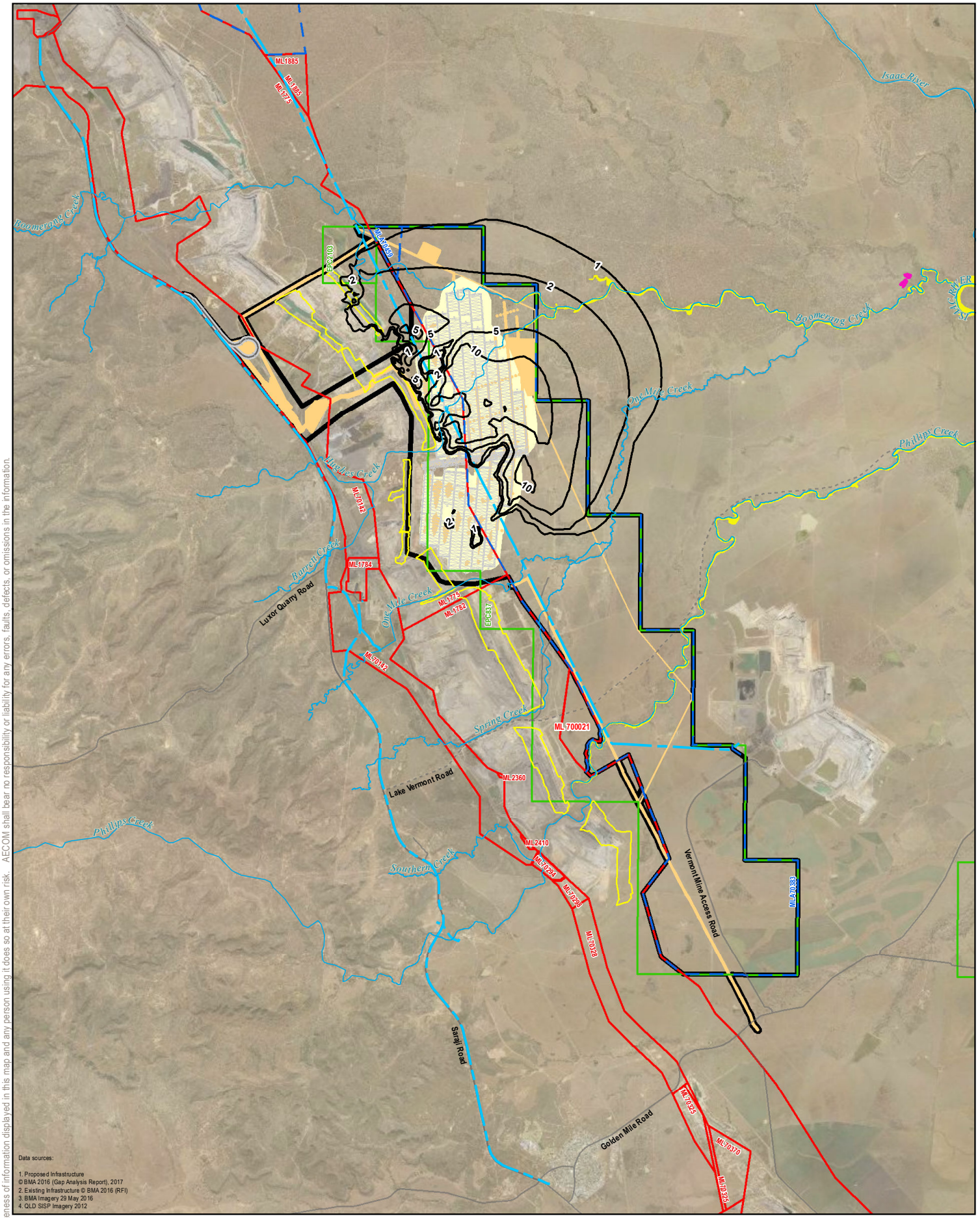
No known or potential subterranean GDEs have been identified within the GDE Atlas for the Project area and surrounds.

5.3.11.6 Stygofauna desktop review

Several previous investigations have been undertaken to assess the suitability of sediments within the Bowen Basin for stygofauna.

4T Consultants (2012) conducted a desktop review to assess the potential for stygofauna within the Bowen Basin. The main findings of the desktop review are summarised below:

- Aquifer type and associated hydraulic conductivity and pore space are the primary determinants for the presence or absence of stygofauna.
- Available information indicated that no stygofauna have been detected in coal seams within the Bowen Basin.
- Most stygofauna identified in the Bowen Basin were found within shallow (<29 mbGL) unconsolidated sediments, such as alluvium, at salinity levels less than 2,000 µS/cm and pH between 6.5 and 8.5.
- For unconsolidated sediment aquifers, stygofauna are more likely to be located where the depth to water is less than 20 m. In fractured rock aquifers, the majority of stygofauna have been located where the depth to water is less than 30 m.
- ALS (2012) suggested that salinity values of less than 5,000 µS/cm were most preferable for stygofauna with the highest number of taxa present where the water table was less than 10 mbGL.



LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Rail Loop
- Water Pipelines
- Tertiary Drawdown Contour
- Active Pits

Areas of Known Potential

- Known / Likely GDE (Type 1)
- High Potential GDE (Type 2)

N

Figure 48
Identified GDEs and Predicted Groundwater Drawdown in the Tertiary Sediments Due to the Project (3D Environmental)

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 1

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G441_v1_A4P.mxd

5.3.11.7 Stygofauna site-specific investigations

Stygofauna sampling was undertaken in seven groundwater monitoring bores screened across Tertiary and Permian sediments during September 2011 (IESA, 2011a) and December 2011 (IESA, 2011b). The details of the monitoring bores are summarised in Table 52 and the location of the bores in Figure 51.

Table 52 Monitoring bores sampled for stygofauna

Hole ID	Sediments Sampled	Easting	Northing	Total Depth (mbGL)	Water Level (mbGL)
SEGT02	Triassic and Permian	633848.57	7523735.93	149.62	28.61
SEGT04	Triassic and Permian	633825.64	7522274.62	138.01	22.40
SEGT10	Triassic and Permian	634355.39	7521627.86	162.30	45.77
PZ002-1	Tertiary	632117.75	7530870.01	26.00	17.44
PZ002-2	Triassic and Permian	632128.05	7530869.92	170.00	34.29
PZ009-1	Tertiary	633009.54	7527950.49	20.00	16.98
PZ00902	Triassic and Permian	632999.17	7527942.83	170.00	33.60

Table note: Bores SEGT02, SEGT04, and SEGT10 were temporary bores, constructed for the stygofauna assessments.

Sampling was undertaken in accordance with *Draft Guidance No. 54A - Sampling methods and survey considerations for subterranean fauna in Western Australia* (WA EPA, 2007). It is noted that this guideline has since been updated.

The two sampling events during September 2011 and December 2011 detected no stygofauna species.

5.3.11.8 Potential for stygofauna

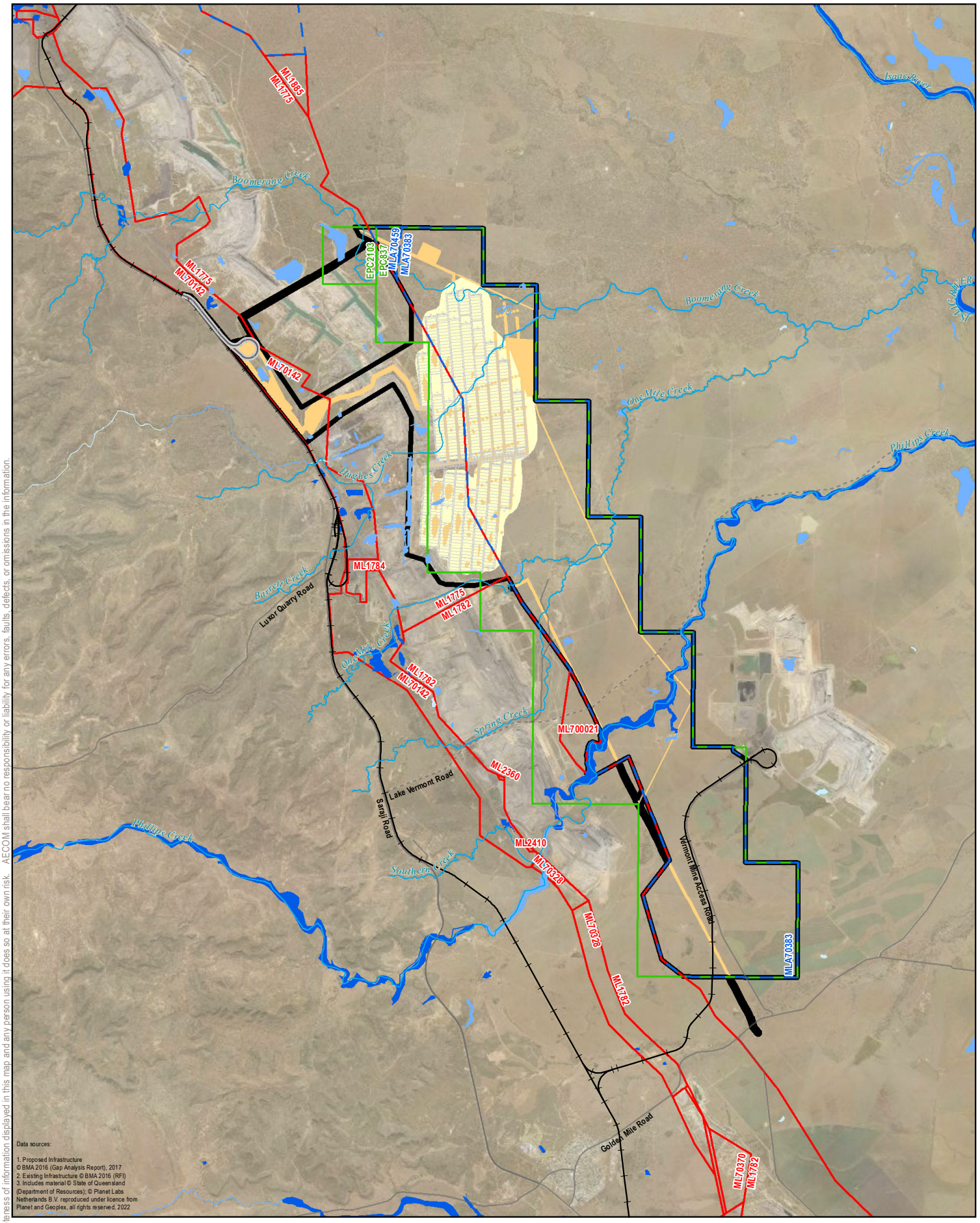
As the alluvium in and adjacent to the Project area is ephemeral, discontinuous, and can be saline it is considered that the alluvium is unlikely to contain sufficient permanent suitable groundwater to support stygofauna populations.

The IESC (2019) Information Guidelines Explanatory Note Assessing groundwater-dependent ecosystems describes water chemistry and aquifer conditions favourable to stygofauna. The potential for subterranean GDEs to exist within the Tertiary and Permian sediments is considered to be low for the following reasons:

- Stygofauna most likely in water with electrical conductivity (EC) less than 5000 mS/cm.
- Site specific sampling of the Tertiary and Permian sediments did not detect any stygofauna taxa.

5.3.12 Springs

No known springs are present within the Project Area. A review of registered springs indicates that the closest springs are greater than 150 km from Saraji Mine (Figure 52).



LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Existing Railway
- Private Access
- Public Road
- Rail Loop

Aquatic Groundwater Dependent Ecosystems

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)
- Low potential GDE (national assessment)

N

Figure 49
Aquatic GDEs
(Source: GDE Atlas)

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

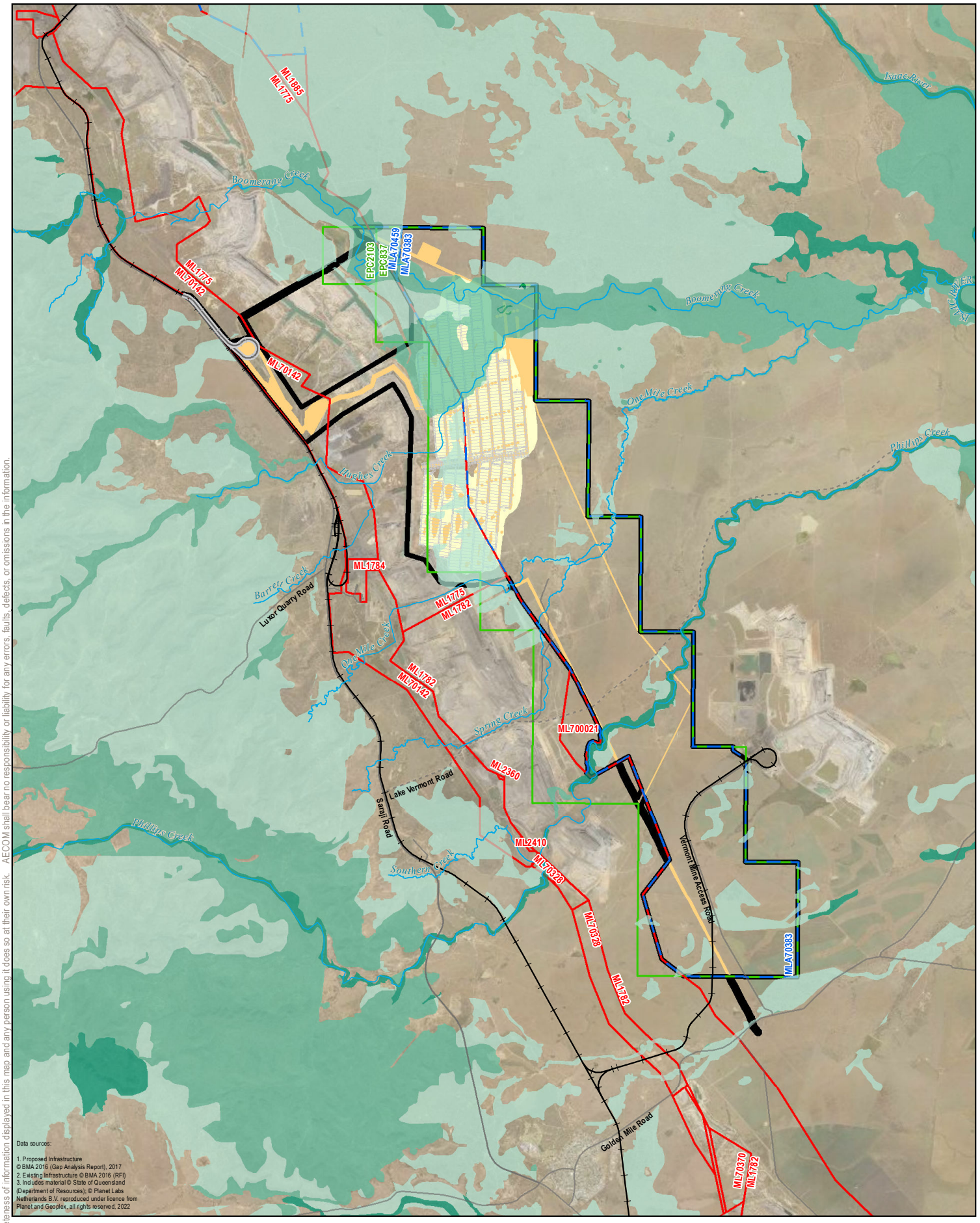
Scale: 1:158,094 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 3

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



Data sources:

1. Proposed Infrastructure © BMA 2016 (Gap Analysis Report), 2017
2. Existing Infrastructure © BMA 2016 (RFI)
3. Includes material © State of Queensland (Department of Resources); © Planet Labs Netherlands B.V. reproduced under licence from Planet and Geoplex, all rights reserved, 2022

LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Existing Railway
- Private Access Road
- Public Road
- Rail Loop

Terrestrial Groundwater Dependent Ecosystems

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)
- Low potential GDE (national assessment)

N

Figure 50
Terrestrial GDEs
(Source: GDE Atlas)

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

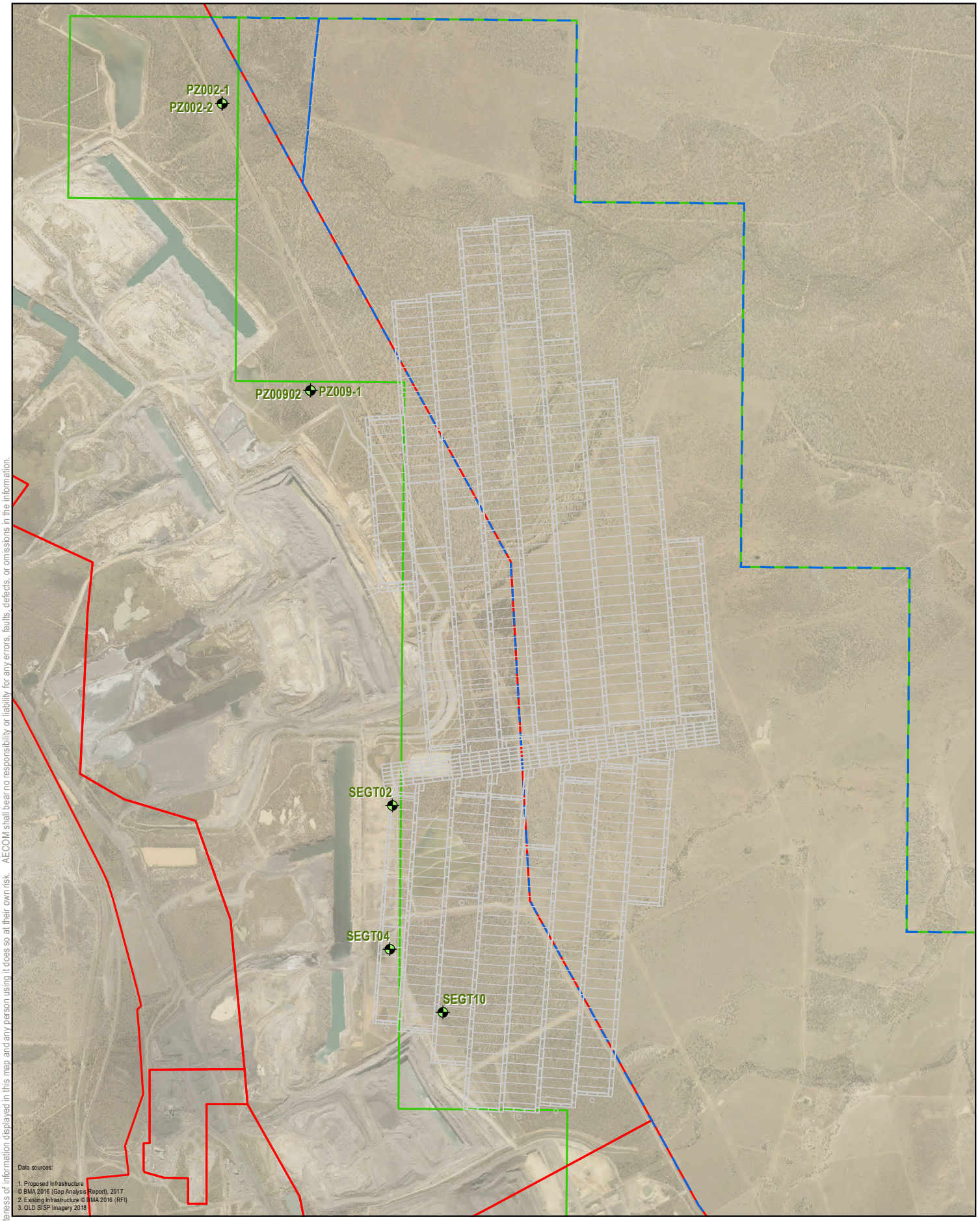
Scale: 1:158,094 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 3

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



Data sources:

1. Proposed Infrastructure © BMA 2016 (Gap Analysis Report), 2017
2. Existing Infrastructure © BMA 2016 (RFI)
3. QLD SISP Imagery 2018

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Stygofauna Sampling Bore

N

Figure 51
Stygofauna Sampling Bores

Groundwater Technical Report
Saraji East Mining Lease Project

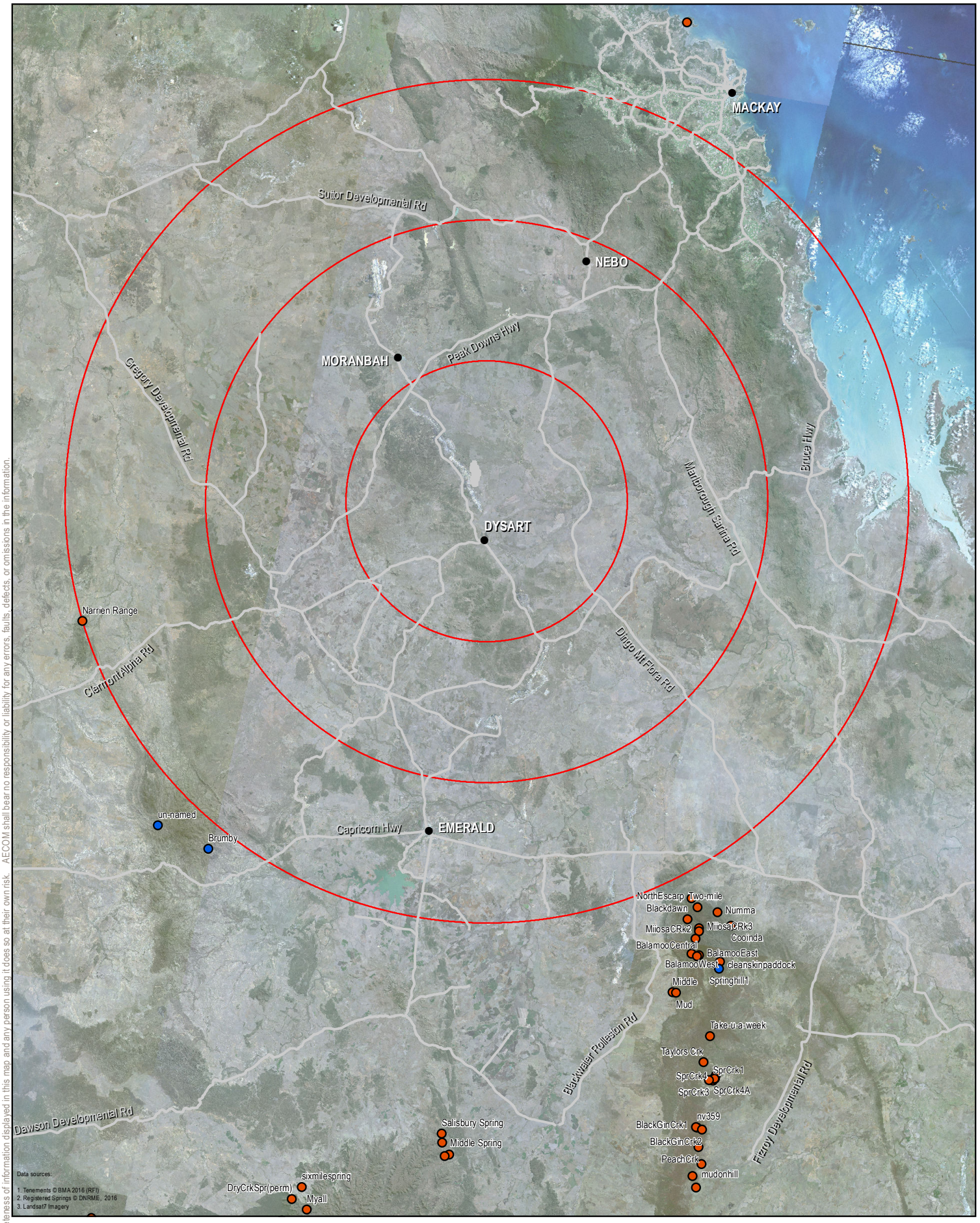
0 0.275 0.55 1.1
Kilometres

Scale: 1:50,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2



AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Locality
- Major Road
- Underground Mine Layout
- 50km concentric circles from Saraji Mine

Registered Springs

- Palustrine
- Riverine

N

Figure 52
Registered Srings

Groundwater Technical Report
Saraji East Mining Lease Project

0 5 10 20
Kilometres

Scale: 1:1,750,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 1

Filename: L:\Secure\Projects\605X\605070311\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G190_v1_A4P.mxd

5.4 Groundwater environmental values

This section identifies and describes groundwater related environmental values in the Project Area as included in groundwater chemistry zone 34 included in the Environmental Protection (Water) Policy 2009 WQ1310 - Fitzroy Basin Groundwater Zones Basin 130 (refer to Section 3.3.3 and Section 5.3.10.1). Groundwater chemistry zone 34[13] (Figure 3) identified the following Isaac Groundwater EVs:

- Aquatic ecosystems
- Irrigation
- Farm supply
- Stock water
- Primary recreation
- Drinking water
- Cultural and Spiritual Values.

The enhancement of groundwater environmental values and the protection of groundwater are required (Section 3.2.3). For the purposes of this EIS assessment the groundwater EVs are those attributes of the groundwater systems within the potential impact area that are sufficiently important to be protected or enhanced.

The Project is located within the Isaac River sub-basin of the Fitzroy Basin as described in Schedule 1 of the EPP (Water and Wetland Biodiversity). Environmental values and water quality objectives for groundwater within the Isaac River sub-basin are provided in the Isaac River Sub-basin Environmental Values and Water Quality Objectives 2011. The environmental values for groundwater to be enhanced or protected in the Project Area are listed Table 53.

Table 53 Environmental values for groundwater

Environmental Value	Definition
Aquatic ecosystems	A community of organisms living within or adjacent to water, including riparian or foreshore area Aquatic ecosystems comprise the animals, plants and micro-organisms that live in water, and the physical and chemical environment and climatic regime in which they interact. It is predominantly the physical components (e.g. light, temperature, mixing, flow, habitat) and chemical components (e.g. organic and inorganic carbon, oxygen, nutrients) of an ecosystem that determine what lives and breeds in it, and therefore the structure of the food web. Biological interactions (e.g. grazing and predation) can also play a part in structuring many aquatic ecosystems.
Irrigation	Suitability of water supply for irrigation, for example, irrigation of crops, pastures, parks, gardens and recreational areas.
Farm water supply/use	Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.
Stock watering	Suitability of water supply for production of healthy livestock.
Primary recreation	Health of humans during recreation which involves direct contact and a high probability of water being swallowed, for example, swimming, surfing, windsurfing, diving and water-skiing. Primary recreational use, of water, means full body contact with the water, including, for example, diving, swimming, surfing, water-skiing and windsurfing (EPP (Water), s. 6).
Drinking water supply	Suitability of raw drinking water supply. This assumes minimal treatment of water is required, for example, coarse screening and/or disinfection.
Cultural and spiritual values	Indigenous and non-indigenous cultural heritage, for example:

[13] The eastern most portion of the Project is assumed to be included within groundwater chemistry zone 34

Environmental Value	Definition
	- custodial, spiritual, cultural and traditional heritage, hunting, gathering and ritual responsibilities - symbols, landmarks and icons (such as waterways, turtles and frogs) - lifestyles (such as agriculture and fishing). Cultural and spiritual values of water, means its aesthetic, historical, scientific, social or other significance, to the present generation or past or future generations (EPP (Water), s. 6).

5.4.1 Aquatic ecosystems

Section 5.3.11, desktop data and site-specific studies, shows that there are no known aquatic or subterranean GDEs identified within the Project, and that there is a low potential for Terrestrial GDEs to be present. 3D Environmental (2023) define the aquatic ecosystems as ecosystems supported by surface expression of groundwater (e.g. spring fed watercourses and associated fringing vegetation).

Field data indicates that Phillips Creek is highly likely to function as a Terrestrial GDE where groundwater dependence varies on a seasonal basis. There is no indication that Phillips Creek represents an Aquatic GDE (no groundwater base flow contributing to gaining streams or surface flows).

The Boomerang Creek wetland does not meet the hydrological or ecological criteria for an Aquatic GDE (the extreme isotopic enrichment of the surface water sample indicates a clear lack of exchange between groundwater and surface water, excluding the site as an Aquatic GDE).

Potential aquatic ecosystem EVs are considered to be supported by shallow perched discontinuous alluvium groundwater. The depth-to-water measured within the Tertiary and Permian hydrostratigraphic units (Section 5.3.8) preclude these units from supporting aquatic ecosystem EVs.

5.4.2 Irrigation

The ANZECC guidelines (2000) states that the threshold salinity tolerances for plants grown in loamy to clayey soils are 600 µS/cm to 7,200 µS/cm. Given that groundwater salinity within Tertiary and Permian sediments is generally greater than 5,000 µS/cm, groundwater would not be considered suitable for irrigation.

A lack of licensed groundwater bores within 15 km of the Project Area also suggests that groundwater is not useable as a source of irrigation water.

Alluvium groundwater quality is potentially suitable for irrigation use, however, no registered bores or water licences for irrigation were identified (Table 22).

5.4.3 Farm water supply/use

The high salinity of the groundwater generally precludes it from being suitable for farm supply uses such as laundry or produce preparation.

5.4.4 Stock watering

The review of DRDMW registered bores and the bore census data indicates that groundwater in the area is used for stock watering.

Although the groundwater is generally within the guidelines for livestock, the ANZECC guidelines (2000) states that loss of production and a decline in animal health occurs if stock are exposed to high salinity water for prolonged periods. For beef cattle, this limit is in range the range of 5,000 mg/L to 10,000 mg/L.

Given the variable salinity levels for groundwater hosted in the Tertiary and Permian units are within this range and there are some cases of salinity greater than 10,000 mg/L, the regional groundwater would generally not be considered suitable for livestock (Section 1.1.1.1).

5.4.5 Primary recreation

This category of environmental value is considered not applicable to groundwater in-situ. There are also no registered groundwater springs in the Project area that could be considered for recreational use.

Groundwater seepage from the alluvium and/or Tertiary units into water courses can provide short duration baseflow into rivers and creeks immediately after heavy rains or flooding, however, after larger flood events suitability of these waters for recreation may be limited by other factors.

This value is more common for surface water features that are accessible for recreational use and visual interaction; however, there is currently no evidence to suggest that groundwater is directly used for recreational or aesthetic purposes in the Project area.

5.4.6 Drinking water

The suitability of water for human consumption is defined in the Australian Drinking Water Guidelines (NHMRC and NRMMC, 2011). The groundwater quality data, as presented in Section 5.3.9, indicates that groundwater is unsuitable for human consumption before treatment due to elevated levels of salinity (Appendix A).

Groundwater resources within the Project area are, therefore, considered to require significant treatment before utilisation for drinking.

The availability of rainwater tanks and the generally low sustainable yield and poor quality of the groundwater bores in the area are also factors that preclude the usage and potential for usage of the groundwater as a drinking water source.

It is noted, however, that alluvium bores LV2 and TG2, located to the west of the Saraji Mine have electrical conductivity concentrations below the Australian Drinking Water Guidelines EC (895 µS/cm or 600 mg/L TDS). These shallow groundwater resource could be suitable for drinking based on salinity off lease. It is noted in Section 5.3.5, however, that the groundwater resources associated with alluvium deposits in the Project area are limited and seasonal.

5.4.7 Cultural and spiritual values

There are no registered groundwater springs or seeps that supply surface water bodies in the Project Area. No springs are known to have Aboriginal and/or non-indigenous cultural heritage associations.

Groundwater is of potential cultural and spiritual significance.

5.4.8 Summary

In summary, the evaluation of groundwater environmental values in the area enveloping the Project indicates that groundwater associated with the Tertiary and Permian sediments are of limited suitability for most uses.

Groundwater associated with the alluvium, which has recorded saturated alluvium with good quality groundwater quality, is sporadic and seasonal and is not considered to provide a sustainable supply in the Project area.

From a hydrogeological perspective. The assessment of available groundwater resources (potential and chemistry) indicates that the only recognised groundwater use within the Project area is stock watering.

5.5 Sustainable and efficient use of groundwater

Based on an assessment of existing water quality data (Section 5.3.9) extracted water is expected to be of poor quality and have high salinity. As a result, extracted water will not be discharged and will instead be used in the CHPP with losses through evaporation.

6.0 Potential impacts

6.1 Overview of potential impacts

A summary of potential impacts of mining activities on the groundwater resources has been compiled based on the proposed mining activities.

6.1.1 Construction phase

As the proposed mining activities will start within the existing open-cut pits (high wall), the construction phase activities include the start of the portal to facilitate access to the longwall mining panels.

This construction will occur within the dewatered Permian sediments immediately adjacent to the high wall, thus no additional groundwater impacts are envisaged during construction.

6.1.2 Operational phase

The principal activities during the operational phase of the underground workings, which may impact groundwater resources, include:

- Pre-mining incidental mine gas dewatering activities
- Dewatering of workings
- Alteration of geology, and associated aquifer hydraulic properties, due to goaf
- The cumulative drawdown of open-cut mining along strike, with the extended down-dip underground mining.

6.1.3 Mine dewatering

Dewatering may be required (dependent on strata permeability, influence of existing mine dewatering, and model predictions) to lower groundwater levels to the base of the proposed workings for safe and efficient operation of the underground mining. As a result, groundwater levels will be drawn down during the operational phase.

Dewatering has the potential to reduce groundwater levels in existing groundwater bores that fall within the cone of influence of the proposed mine and hence has the potential to impact on existing groundwater supplies.

The dewatering impacts, outside the Project footprint (Section 6.2), have been predicted using a regional scale numerical groundwater model.

6.1.3.1 Indirect impacts

The longwall mining may have some indirect dewatering impacts through goaf induced flow, which include:

- Drawdown in the saturated Tertiary and possible seasonally saturated Quaternary-age sediments, above the mined longwall panels
- Additional leakage from the overlying altered (due to goaf) Permian units to the dewatered and depressurised target D coal seam.

6.1.3.2 Creek flow impacts

Mine dewatering can result in drawdown of the coal seam potentiometric surface, which can extend beneath the non-perennial creeks which drain across the Project. Seasonal surface water flows and remnant pools in the creeks may decline as a result of possible induced flow from the surface water to the groundwater, in response to the reduction in groundwater levels below the creeks. This has the potential to increase the frequency or duration of no flow in the creeks. Predictive modelling was conducted to assess this potential impact (Section 6.2). This modelling, detailed in Section 6.3.1 and Section 6.3.2, indicated that there is:

- No predicted loss of water from the alluvium along the extent of Boomerang Creek mapped across the Project footprint.
- No predicted loss of water from the Isaac River alluvium due to the Project.
- No predicted change in surface water flows in the local creeks including Boomerang due to the Project.

- No predicted change to surface water flows in the Isaac River due to the Project.

Note: A conservative approach was adopted in the modelling, where no self-sealing of the subsidence fracturing to surface is included in the simulations. This approach ensures that any change to hydraulic and storage properties in the model remain. Even adopting this approach no impact on alluvium or surface water resources is predicted.

6.1.4 Post closure

It is considered that on completion of the proposed underground workings, the approved Saraji Mine open-cut final voids will be in place (for this Project the void created in the last year of open cut mining will remain open, the remaining open-cut pit will be backfilled with spoil) upon completion of mining.

For the Project assessment the post closure phase considers the potential impacts on groundwater resources related to the Saraji Mine open-cut pits. Groundwater level recovery, with the consideration of the open-cut pits, is considered to be slow (due to low hydraulic properties of the host rock, recharge, and increased evaporation in the open-cut pits). Principally the reduced groundwater levels and alterations to the groundwater regime will be ongoing post closure of the Project due to the Approved Saraji Mine open cut pits.

Closed open-cut pits, referred to as final voids, can gradually fill with water once mine dewatering operations have ceased. Evaporation losses from the final voids are considered to exceed predicted groundwater inflow and hence the final voids are expected to remain mainly dry, except following prolonged heavy rainfall events. In this case, ongoing evaporation from these final voids will essentially act as long-term groundwater extractions from within the mine area, with the potential to permanently reduce local groundwater levels to the base of proposed final voids.

Thus, the long term predictions are for the groundwater to recover within the Project underground mine workings but not within the Saraji Mine area due to the influence of final voids (Section 6.4).

6.2 Predictive modelling

6.2.1 Conceptualisation

The data used to develop the hydrogeological conceptualisation indicates three separate groundwater systems occur within the Project Area; these groundwater systems are associated with the following geological units:

- Seasonal or sporadic alluvium groundwater
- Localised basal sand and gravel at the base of the Tertiary sediments
- Deeper Permian coal seams.

Key understandings from the conceptualisation as discussed in Section 4.3.2 include the following:

- Differences in groundwater levels measured in the Tertiary and deeper Permian aquifers indicate that there is limited hydraulic connection between these groundwater systems.
- Recharge occurs from infiltration from the rainfall and creek flow into the Tertiary and Permian aquifer sub-crop areas. Minor leakage from overlying aquifers may occur but is not evident based on groundwater level data.
- The regional groundwater levels are a subdued reflection of the surface topography except immediately adjacent to the open-cut mine area where localised discharge / seepage into the pits results in the steeper gradients around the pits.
- Regionally groundwater discharge within the deeper aquifers is complex based on the horst and graben structures within the Bowen Basin. Groundwater flow is considered to flow down dip from sub-crop to the east. Groundwater level data indicates lower groundwater levels to the east even though the permeability decreases with depth. It is considered that faulting facilitates more complex groundwater movement to the east of the Project Area.
- Groundwater associated with the alluvium, based on site-specific data (Section 5.3.5) occurs as discontinuous and sporadic resource.

6.2.2 Timing and mining

Transient predictive modelling was used to simulate the proposed Project underground mining as well as mining at other approved and foreseeable mines within the regional model domain. The predictive part of the model started from January 2021 until January 2044, the envisaged life of mine.

The predictive modelling included three model scenarios, which included:

- Project – all approved and foreseeable mining in region including Saraji Mine open-cut pits plus the Project.
- Approved – all approved and foreseeable mining in region including Saraji Mine.
- Null Run – no mining within region.

Mining was simulated by adding drain cells annually at the base of the target coal seam. For the different mining methods, the modelling included:

- A three-year operational window was assumed for mine cells at the Saraji Mine open-cut pits. After which time the drains were removed and then spoil properties were assigned to the model cells.
- The drains within the underground workings remained active during mining and one year following the completion of the underground panel.

The drains in the model had high drain conductance of 100 square metres per day (m^2/day), which allowed for the rapid removal of water from the mine workings.

Predictive modelling results presented were based on the best calibrated model realisation (i.e., the base case model, as discussed in Section 4.4) and uncertainty with respect to the model predictions is investigated in detail in Section 6.6.

6.2.3 Predictive model scenarios water balance

The average flow rates for water transfer into and out of the predictive model for each of the three model scenarios are compiled in Table 54 (Project scenario), Table 55 (Approved scenario), and Table 56 (Null run).

The mass balance error for three scenarios was 0.0 per cent indicating that the model was stable and achieved an accurate numerical solution. All scenarios maintained mass balance errors below 1 per cent for all time steps throughout the simulations. The low error achieved indicates that the predictive model is stable, and the solution achieved is accurate (Barnett et al., 2012).

Table 54 Predictive model Project scenario - water balance

Component	Flow (ML/day)
IN	
Recharge (direct rainfall)	7.43
Evapotranspiration (ET)	0.00
SW-GW interaction – Isaac River	12.45
SW-GW interaction – other rivers*	0.00
Regional groundwater flow	3.05
Drains (mine inflows)	0.00
Storage	36.42
Gas drainage wells	0.00
TOTAL IN	**59.35**
OUT	
Recharge	0.00
Evapotranspiration (ET)	2.82
SW-GW interaction – Isaac River	6.58
SW-GW interaction – other rivers	0.61

Component	Flow (ML/day)
Regional groundwater flow	0.21
Drains (mine inflows)	33.54
Storage	15.57
Gas drainage wells	0.02
TOTAL OUT	**59.35**
IN - OUT	0
Percent Discrepancy	0.01%

Table note: * The other tributaries or drainage lines in the model are set as drains to the groundwater system and so do not result in any recharge

Table 55 Predictive model Approved scenario - water balance

Component	Flow (ML/day)
IN	
Recharge (direct rainfall)	7.53
Evapotranspiration (ET)	0.00
SW-GW interaction – Isaac River	12.45
SW-GW interaction – other rivers*	0.00
Regional groundwater flow	3.05
Drains (mine inflows)	0.00
Storage	36.64
Gas drainage wells	0.00
TOTAL IN	**58.68**
OUT	
Recharge	0.00
Evapotranspiration (ET)	2.82
SW-GW interaction – Isaac River	6.58
SW-GW interaction – other rivers	0.61
Regional groundwater flow	0.21
Drains (mine inflows)	33.10
Storage	15.57
Gas drainage wells	0.00
TOTAL OUT	**58.68**
IN - OUT	0
Percent Discrepancy	0.00%

Table note: * The other tributaries or drainage lines in the model are set as drains to the groundwater system and so do not result in any recharge

Table 56 Predictive model Null run - water balance

Component	Flow (ML/day)
IN	
Recharge (direct rainfall)	4.20
Evapotranspiration (ET)	0.00
SW-GW interaction – Isaac River	7.70
SW-GW interaction – other rivers*	0.00
Regional groundwater flow	2.22
Drains (mine inflows)	0.00
Storage	0.04
Gas drainage wells	0.00
TOTAL IN	**14.15**
OUT	
Recharge	0.00
Evapotranspiration (ET)	3.08
SW-GW interaction – Isaac River	9.83
SW-GW interaction – other rivers	0.76
Regional groundwater flow	0.21
Drains (mine inflows)	0.00
Storage	0.27
Gas drainage wells	0.00
TOTAL OUT	**14.15**
IN - OUT	0
Percent Discrepancy	0.00%

Table note: * The other tributaries or drainage lines in the model are set as drains to the groundwater system and so do not result in any recharge

6.2.4 Groundwater ingress estimates

The predicted inflows for both the Project and the Saraji Mine open-cut pits are presented in Figure 53. These inflow volumes were estimated as time weighted averages of the outflow reporting to the drain cells representing the mine workings at the Project and the Saraji Mine open-cut pits.

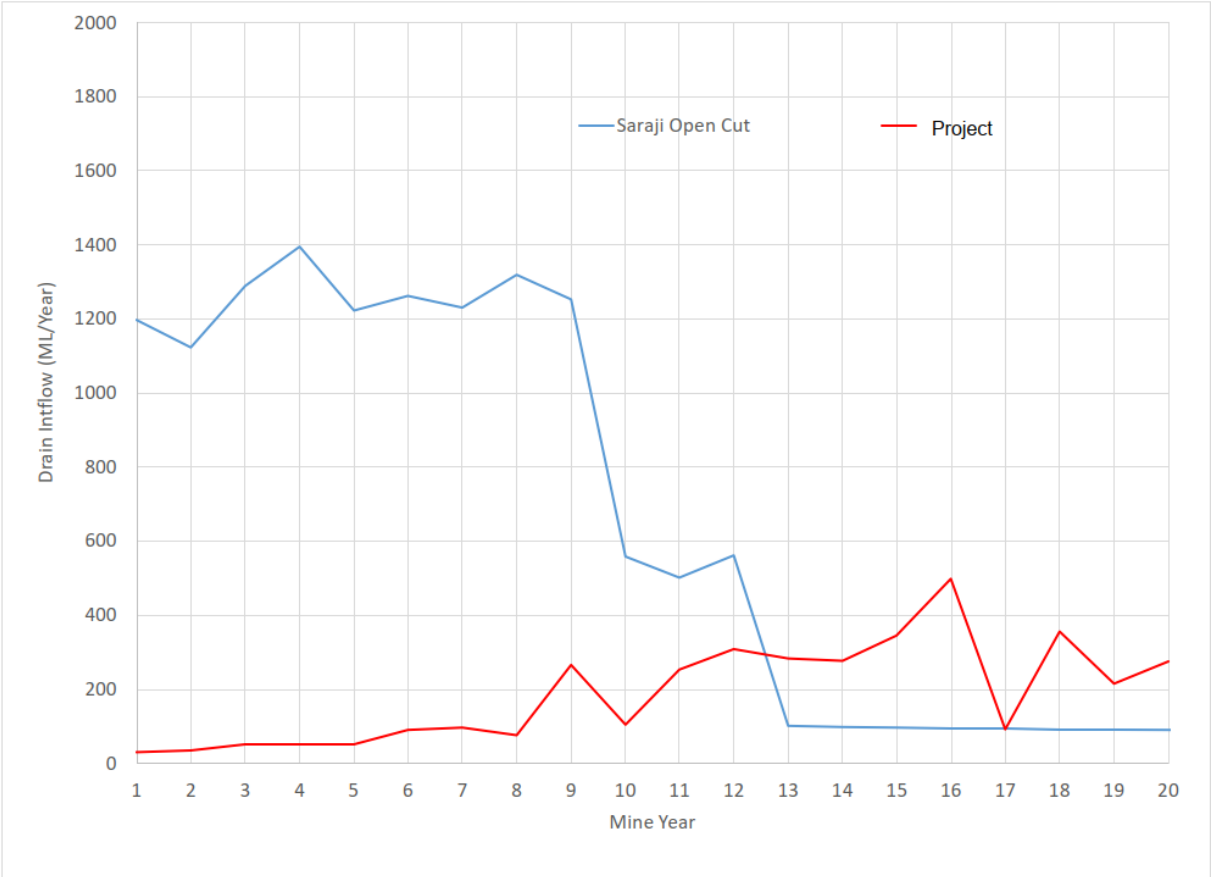


Figure 53 Predicted groundwater inflows (in ML/year)

The inflows at the Project are predicted to reach a maximum peak in mine year 16, of 500 ML/year (1.4 ML/day) in reaction to the mine plan (longwall panels mined during that year). The average inflow rate for the Project is estimated at 183 ML/year (0.5 ML/day).

The base case model includes all the recent model structure updates from site geological information and the changes to the hydraulic properties based on the model calibration (Section 4.4).

The predicted groundwater inflows to the approved Saraji Mine open-cut pits, due to size and strike length, are markedly larger than the predicted Project inflows between years 1 and 9, approximately 1,200 to 1,400 ML/year (3.3 to 3.8 ML/day).

It is noted that mine year 9 is the final year of the approved Saraji Mine open cut mining. The inflows will then decrease gradually and remain at around 100 ML/year (0.3 ML/day) between mine years 13 and 20. This occurs as the Saraji Mine open-cut pits will act as groundwater sinks[14] (as detailed in Section 6.1.4).

6.2.5 Predicted groundwater level changes

Based on the predicted groundwater ingress into the mine workings, groundwater level drawdown was predicted for the Project and Approved model scenarios. This allowed for the evaluation of the additional contribution of the potential impacts of the Project on the groundwater regimes (alluvium, Tertiary, and Permian hydrostratigraphic units).

Note: In the predicted groundwater level figures, the gaps in the water level grids represent unsaturated areas (i.e., where the simulated water level elevation is below the base of cell).

[14] Groundwater levels are influenced by the open-cut pits, which act as groundwater 'sinks' because of water loss through evaporation.

6.2.5.1 Alluvium

The predicted groundwater levels indicate that there is no change to alluvium groundwater levels when comparing the Project to Approved mining scenarios (Figure 54).

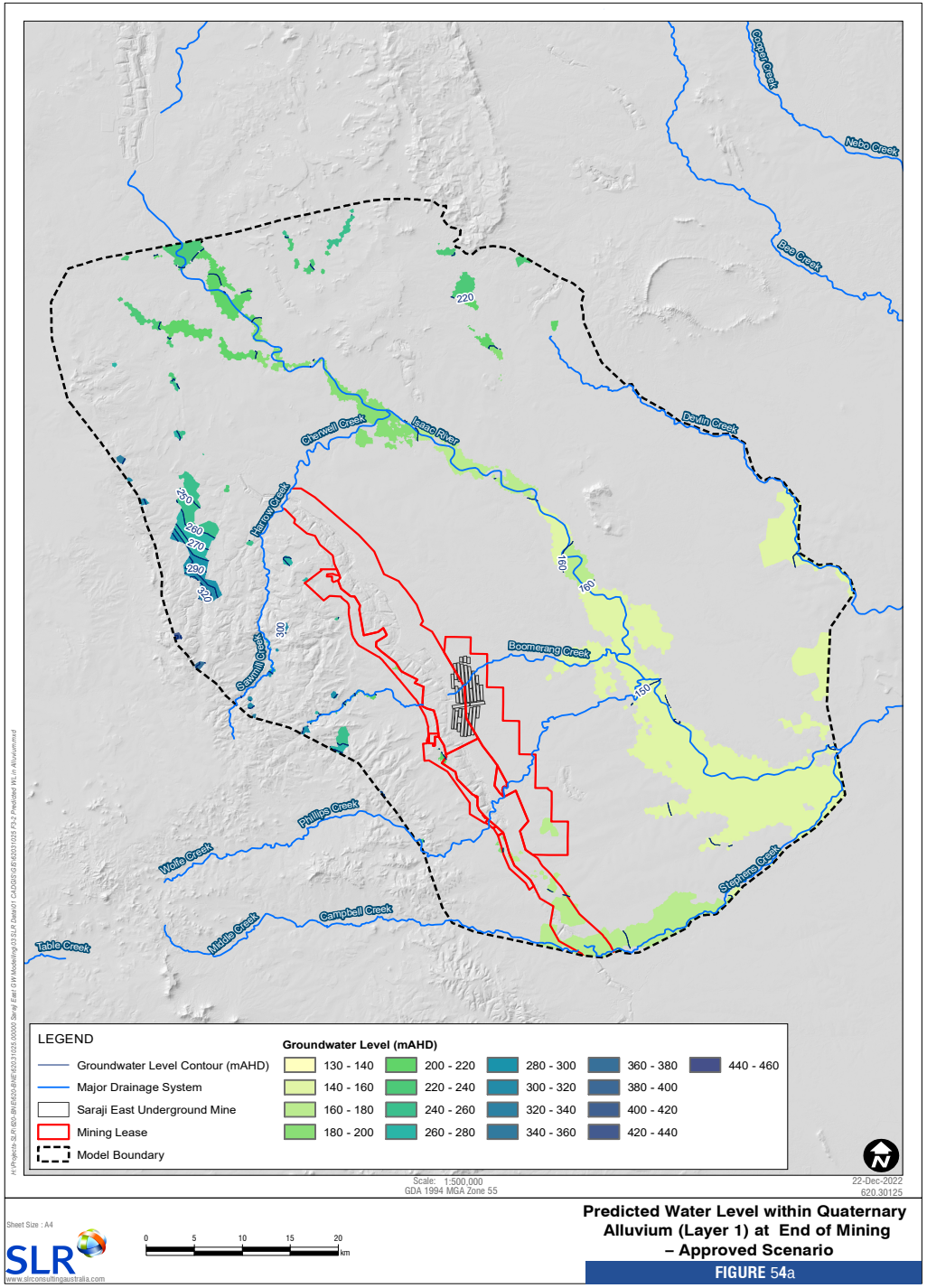
6.2.5.2 Tertiary

The predicted groundwater levels in the Tertiary age units, at the end of mining for the Project and Approved mining scenarios, indicate that dewatering caused by the Project is predicted to be slightly larger (i.e., a slightly larger unsaturated zone within the Project area for the Project scenario to the Approved mining scenario (Figure 55).

6.2.5.3 Permian

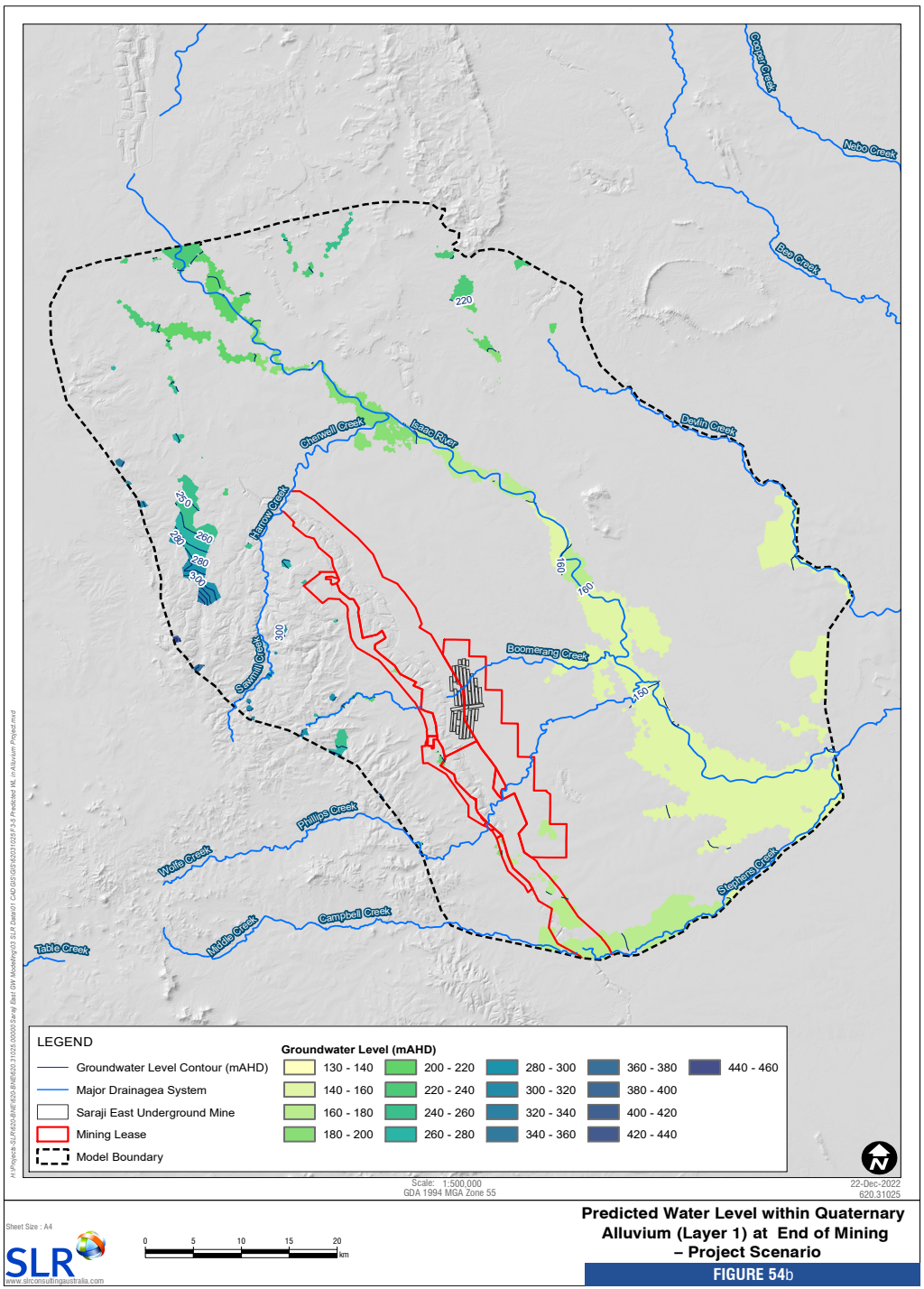
The predicted groundwater levels in the target D coal seam at the end of mining for Project and Approved mining scenarios is included in Figure 56. A regional south-easterly hydraulic gradient is evident across the model for both scenarios, towards the Isaac River. Zones of depressurisation at the Project and surrounding mines are shown to cause localised interruptions to the regional flow gradient.

Figure 54 Predicted Alluvium groundwater level change – Project and Approved predictive model scenarios



Predicted Water Level within Quaternary Alluvium (Layer 1) at End of Mining – Approved Scenario

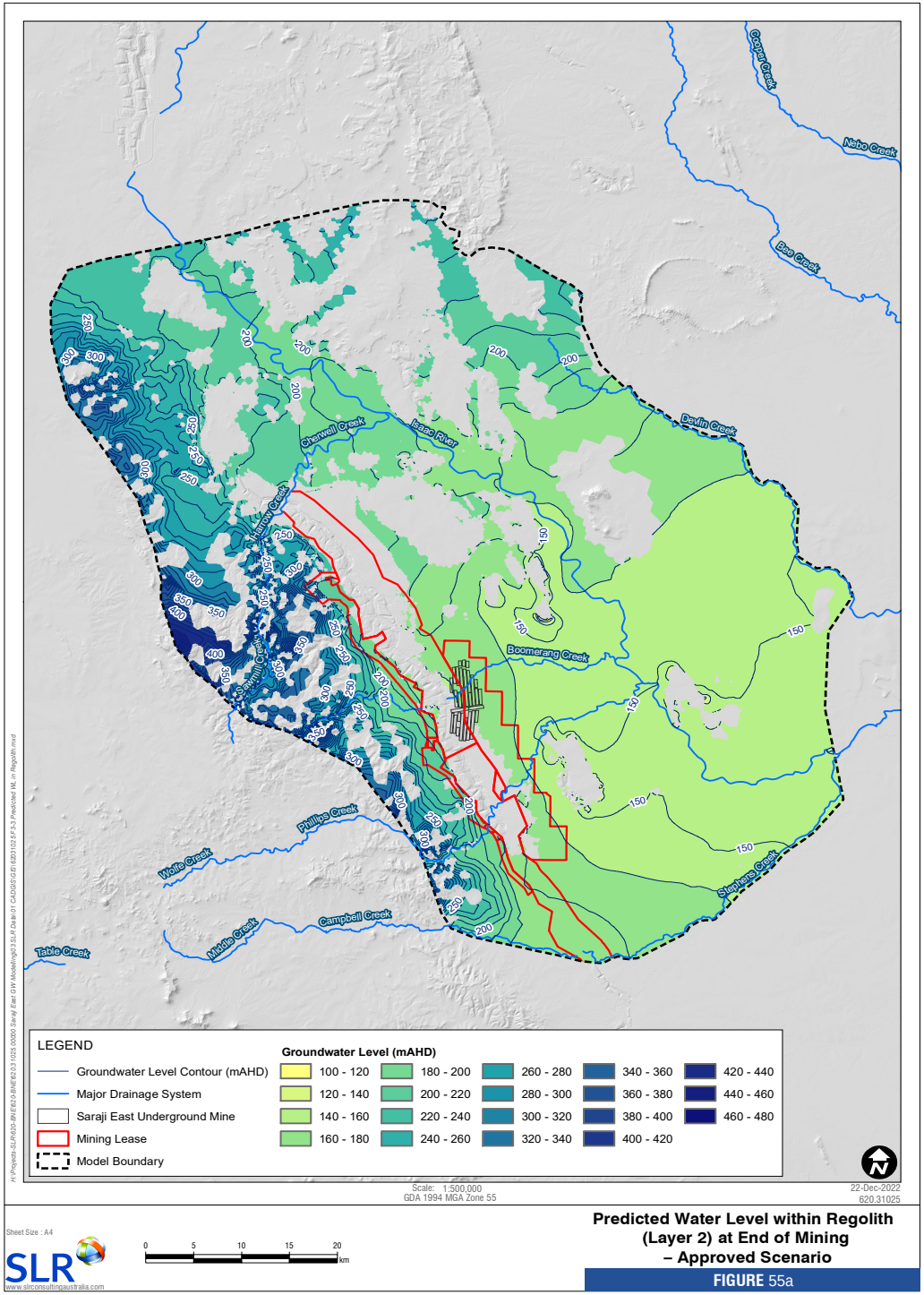
FIGURE 54a



Predicted Water Level within Quaternary Alluvium (Layer 1) at End of Mining – Project Scenario

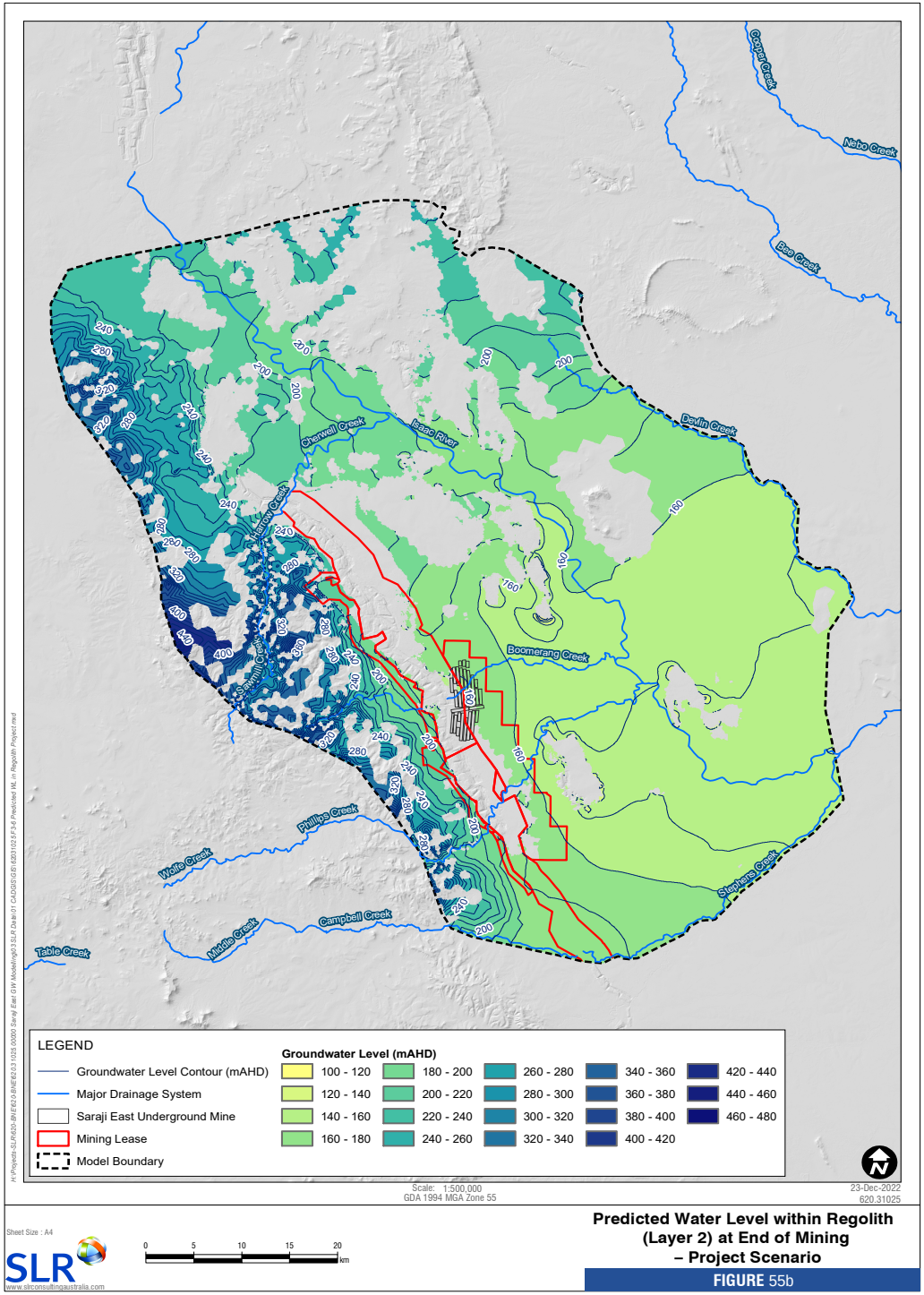
FIGURE 54b

Figure 55 Predicted Tertiary groundwater level change – Project and Approved predictive model scenarios



Predicted Water Level within Regolith (Layer 2) at End of Mining – Approved Scenario

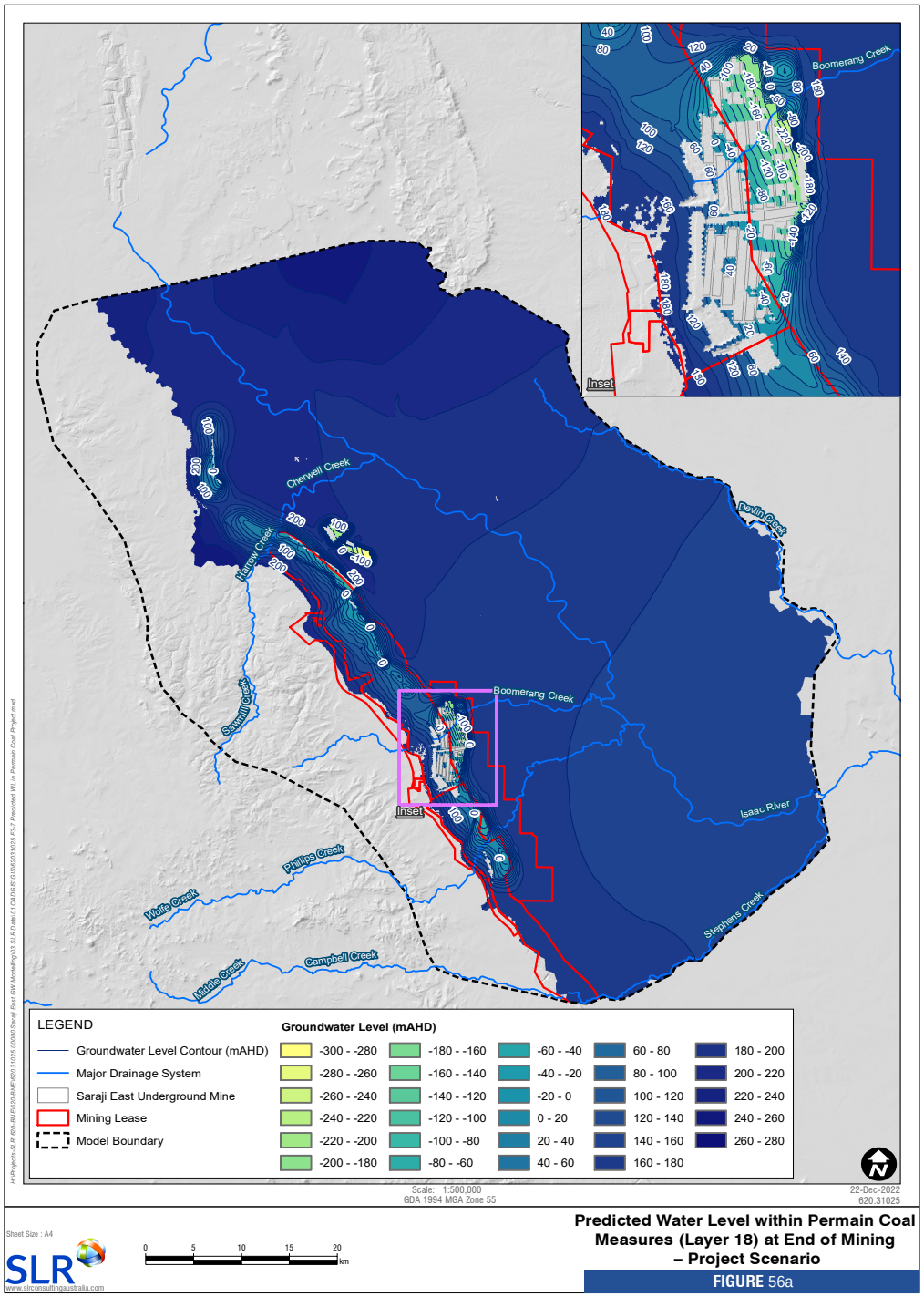
FIGURE 55a



Predicted Water Level within Regolith (Layer 2) at End of Mining – Project Scenario

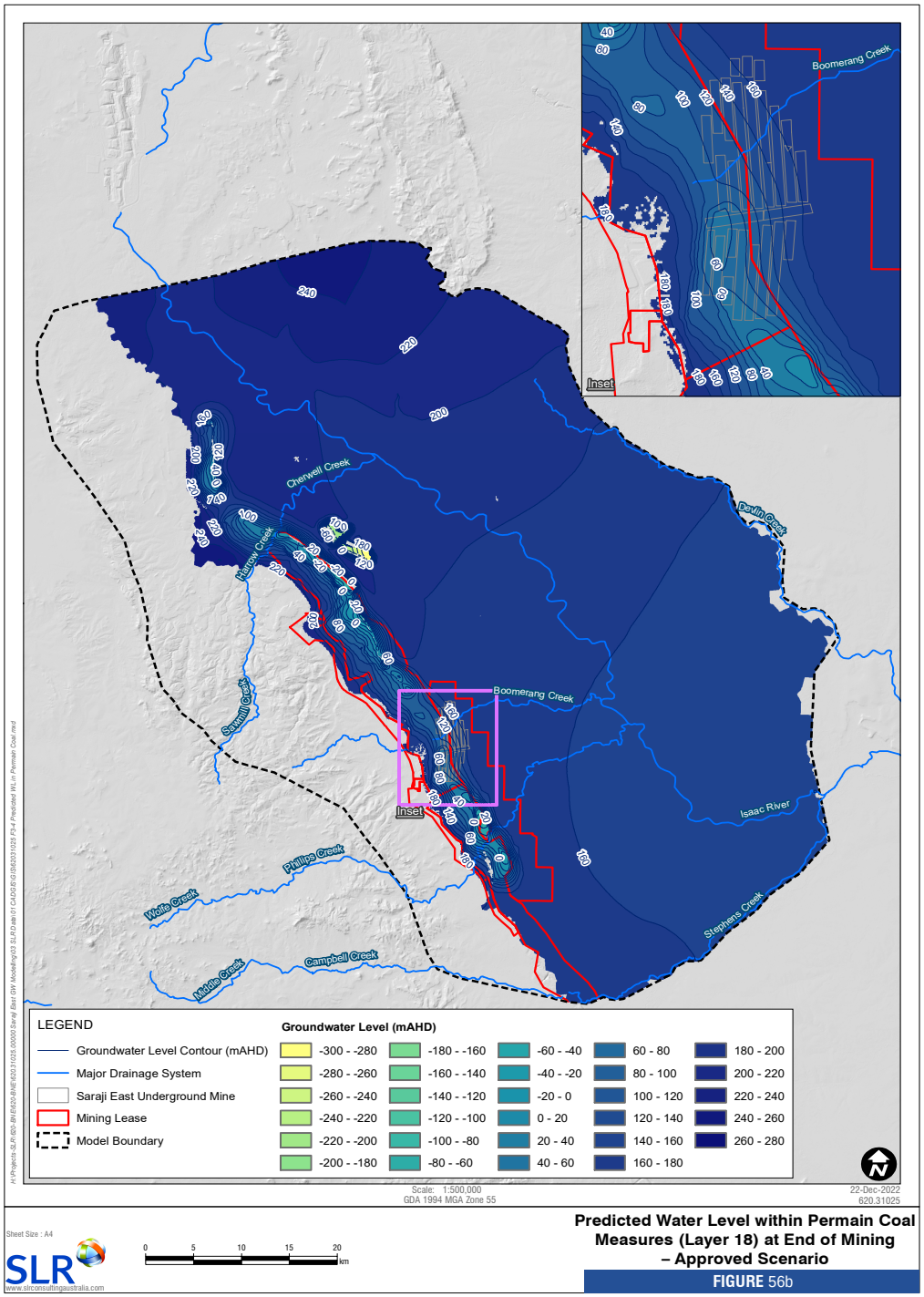
FIGURE 55b

Figure 56 Predicted Target D coal seam groundwater level change - Project and Approved predictive model scenarios



Predicted Water Level within Permain Coal Measures (Layer 18) at End of Mining – Project Scenario

FIGURE 56a



Predicted Water Level within Permain Coal Measures (Layer 18) at End of Mining – Approved Scenario

FIGURE 56b

6.2.6 Maximum incremental drawdown

The process of mining directly removes groundwater and reduces water levels in surrounding hydrostratigraphic units. The extent of the zone affected is dependent on the hydraulic properties of the hydrostratigraphic units (aquifers/aquitards) and is referred to as the zone of drawdown. Groundwater drawdown is greatest at the working coalface and decreases with distance from the mine workings.

In this Section, the maximum incremental drawdown refers to the potential drawdown impact associated with the Project only and was determined by comparing the difference in predicted groundwater levels for the Approved scenario and the Project scenario at matching times (i.e., what additional drawdown is predicted to occur as a result of the Project).

Predicted drawdown figures (Figure 57 to Figure 59) show where maximum incremental drawdown impacts are predicted to exceed 1 m.

6.2.6.1 Alluvium

Figure 57 shows that no incremental drawdown impacts are predicted for the Quaternary alluvium as a result of mining at the Project.

6.2.6.2 Tertiary

The maximum predicted incremental drawdown impacts associated with the Project within the Tertiary age sediments is shown in Figure 58. The incremental drawdown extent within the model Layer 2 is largely confined to the Project footprint or down dip of only the northern panels.

The drawdown predictions are influenced by the distribution of saturated zones in the Tertiary. At the northern panels, 1 m drawdown influence is predicted to extend 4.2 km northeast of the Project mine workings.

6.2.6.3 Permian

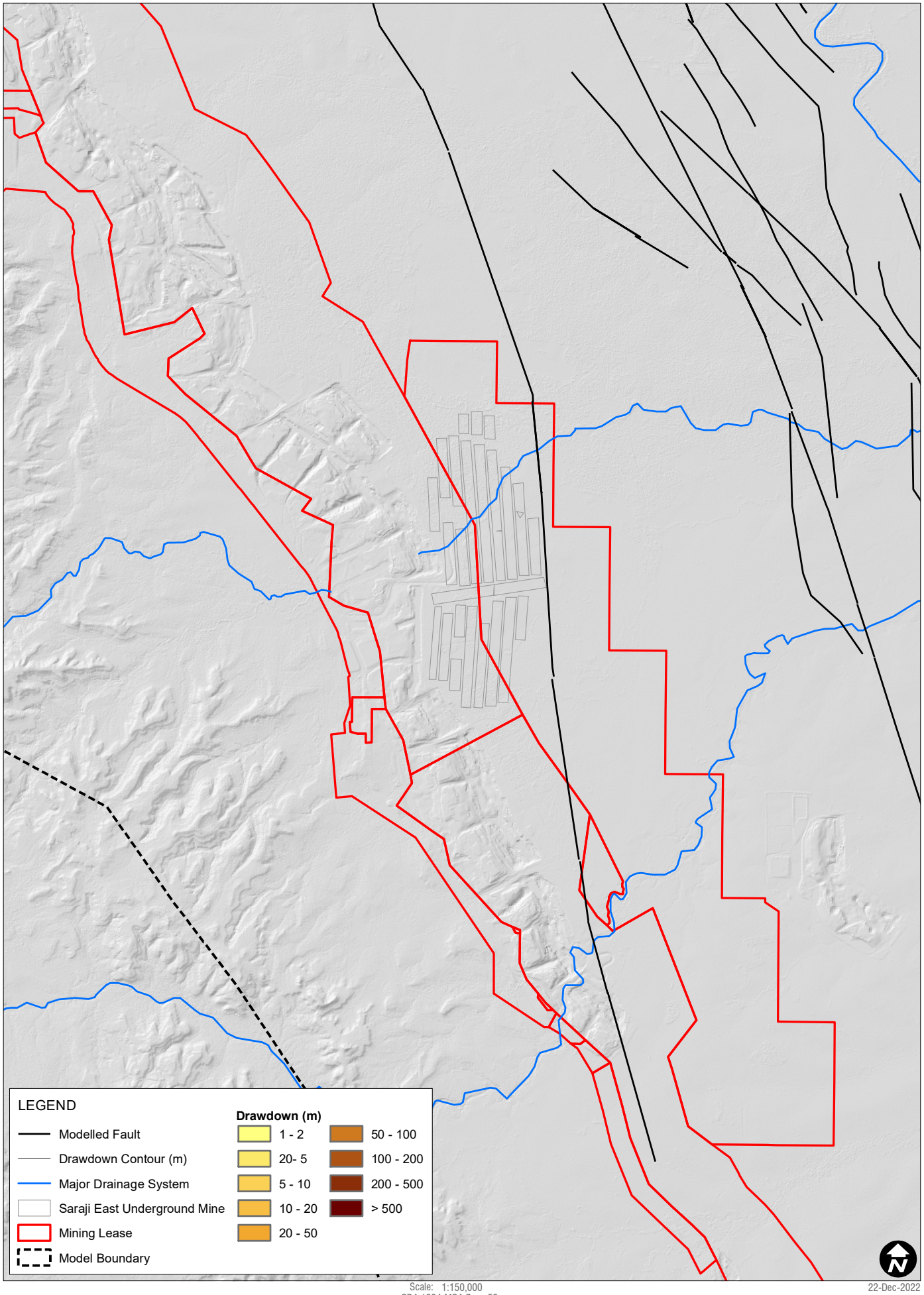
The coal seams of the Moranbah Coal Measures are the primary groundwater bearing strata at the Project and will experience drawdowns as a result of mining. Groundwater level drawdown within the mined coal seams is influenced by unit structure and is confined to unit extents.

Figure 59 shows the maximum predicted incremental drawdown in the target D seam. This figure shows the extent of maximum predicted depressurisation of the Permian aged coal seam due to the Project. This drawdown is limited to the west due to the coal subcrop in this area (i.e., deposition of coal in the western limb of the Bowen Basin).

The extent of maximum predicted incremental drawdown impacts in the Moranbah Coal Measures coal seams are generally elongated along strike in the northwest-southeast direction and extents maximum of 5 km and 8 km northwest and southeast of the Project mine extent, respectively.

The influence of fault adjacent to the Project footprint is evident and it appears that it limits potential drawdown to the east.

It is noted that the drawdown shape in the Tertiary (Figure 58) is different to the Permian (Figure 59) as it is not controlled by strike and fault structures, (i.e., the faults are evident in the more competent Permian bedrock, which do not extend into the younger Tertiary age sediments).



H:\Projects-SLR\620-BNE\620.31025.00000 Saraji East GW Modelling\03 SLR Data\01 CAD\GIS\GIS\620\31025 F3-8 Maximum Incremental DD in Alluvium.mxd

Scale: 1:150,000
GDA 1994 MGA Zone 55

22-Dec-2022
620.31025

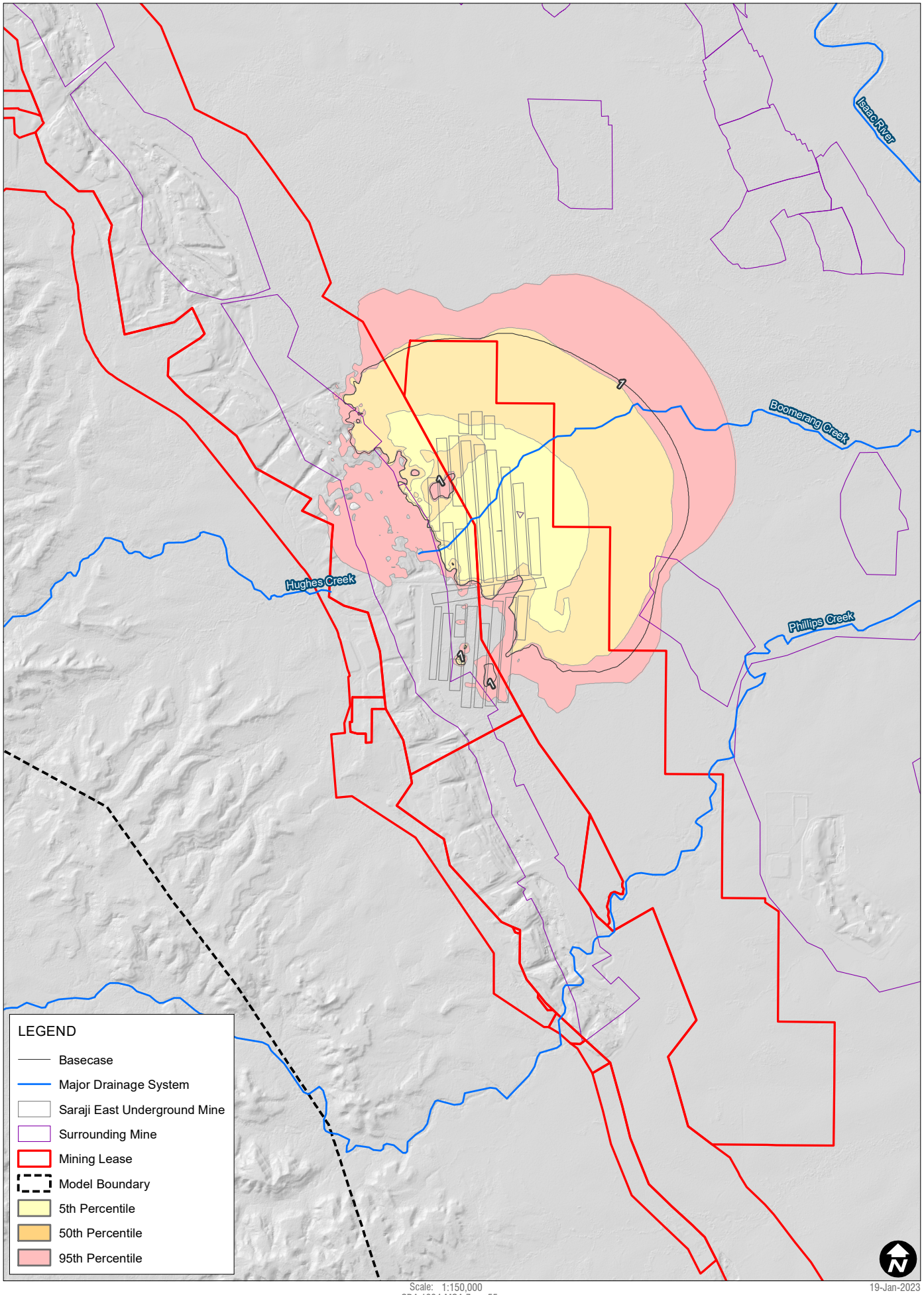
Sheet Size : A4

SLR
www.slrconsultingaustralia.com

0 1 2 3 4 5 km

Maximum Incremental Drawdown in Quaternary Alluvium (Layer 1)

FIGURE 57



H:\Projects-SLR\620-BNE\620.31025.00000 Saraji East GW Modelling\03 SLR Data\01 CAD\GIS\GIS\620\31025 F6-4 Uncertainty in Predicted 1m Maximum Incremental Drawdown in Regolith.mxd

Scale: 1:150,000
GDA 1994 MGA Zone 55

19-Jan-2023
620.31025

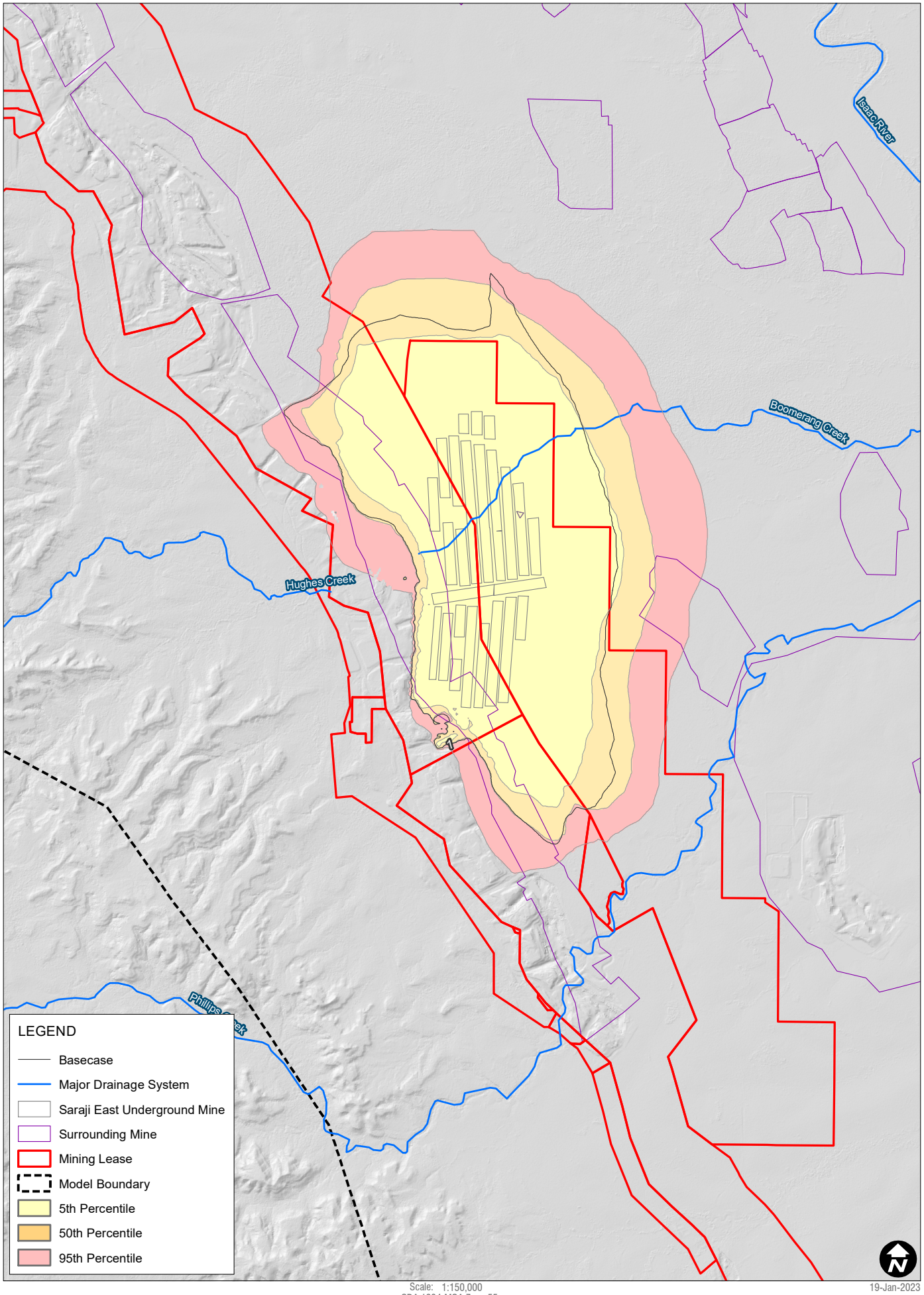
Sheet Size : A4

SLR
www.slrconsultingaustralia.com

0 1 2 3 4 5 km

Uncertainty in Predicted 1 m Maximum Incremental Drawdown in Regolith (Layer 2)

FIGURE 58



Sheet Size : A4

SLR
www.slrconsultingaustralia.com

0 1 2 3 4 5 km

Uncertainty in Predicted 1 m Maximum Incremental Drawdown in D Seam (Layer 18)

FIGURE 59

6.2.7 Cumulative drawdown

The simulated cumulative drawdown presented in this Section show the impacts on different hydrostratigraphic units due to the existing approved mining within the model domain. The simulated cumulative drawdown shows whether the zone of impact from the neighbouring mine operations is predicted to interact with the predicted Project zone of impact in different hydrostratigraphic units (alluvium, Tertiary, and MCM coal seams).

The maximum cumulative drawdowns represent the total impact to modelled groundwater levels resulting from all mining within the model domain. These drawdown predictions are derived by comparing the maximum difference in hydrostratigraphic unit groundwater levels for the Project model scenario with those in the theoretical “no mining” Null Run scenario, for all times during the predictive model period.

Maximum cumulative drawdown predictions covering the entire model domain are provided in Groundwater Modelling Technical Report (SLR, 2023).

The vast majority of these predicted cumulative drawdown impacts are **not** related to the Project but result from existing mining activities represented in the model.

6.2.7.1 Alluvium

There are no cumulative drawdown impacts predicted for the Quaternary alluvium within or adjacent to the Project footprint (Figure 60).

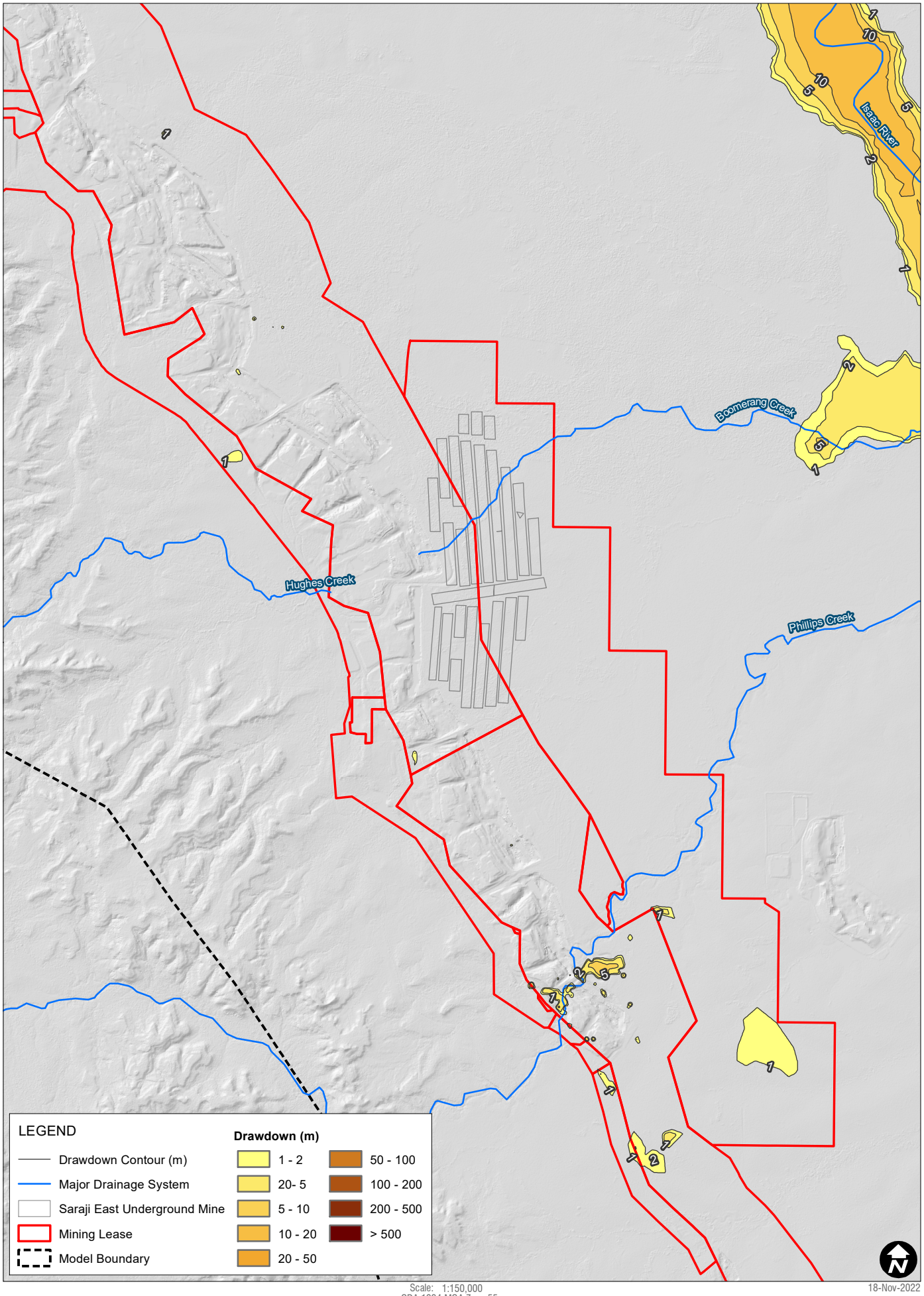
6.2.7.2 Tertiary

Cumulative drawdown impacts within the Tertiary age sediments and basalt can be seen connecting the Project-related drawdown to the drawdown impacts at the Peak Downs Mine and Saraji Mine open-cut pits (Figure 61). These mines, along strike and up dip, are included in Figure 10.

6.2.7.3 Permian

For the Leichhardt and Vermont coal seams of the Rangal Coal Measures, there was no drawdown interaction between the Project and the neighbouring mines since these seams are not present within the Project area.

The maximum predicted cumulative drawdown in the target D seam in the Moranbah Coal Measures, is predicted to interact with zone of impact from the Peak Downs Mine and Saraji Mine open-cut pits (Figure 62). This figure, Figure 62, shows that drawdown is predicted to elongate along the north-south trending fault located adjacent to the Project footprint.



H:\Projects-SLR\620-BNE\620.31025.00000 Saraji East GW Modelling\03 SLR Data\01 CAD\GIS\GIS\620\31025 F3-14 Maximum Cumulative DD in Alluvium.mxd

Scale: 1:150,000
GDA 1994 MGA Zone 55

18-Nov-2022
620.31025

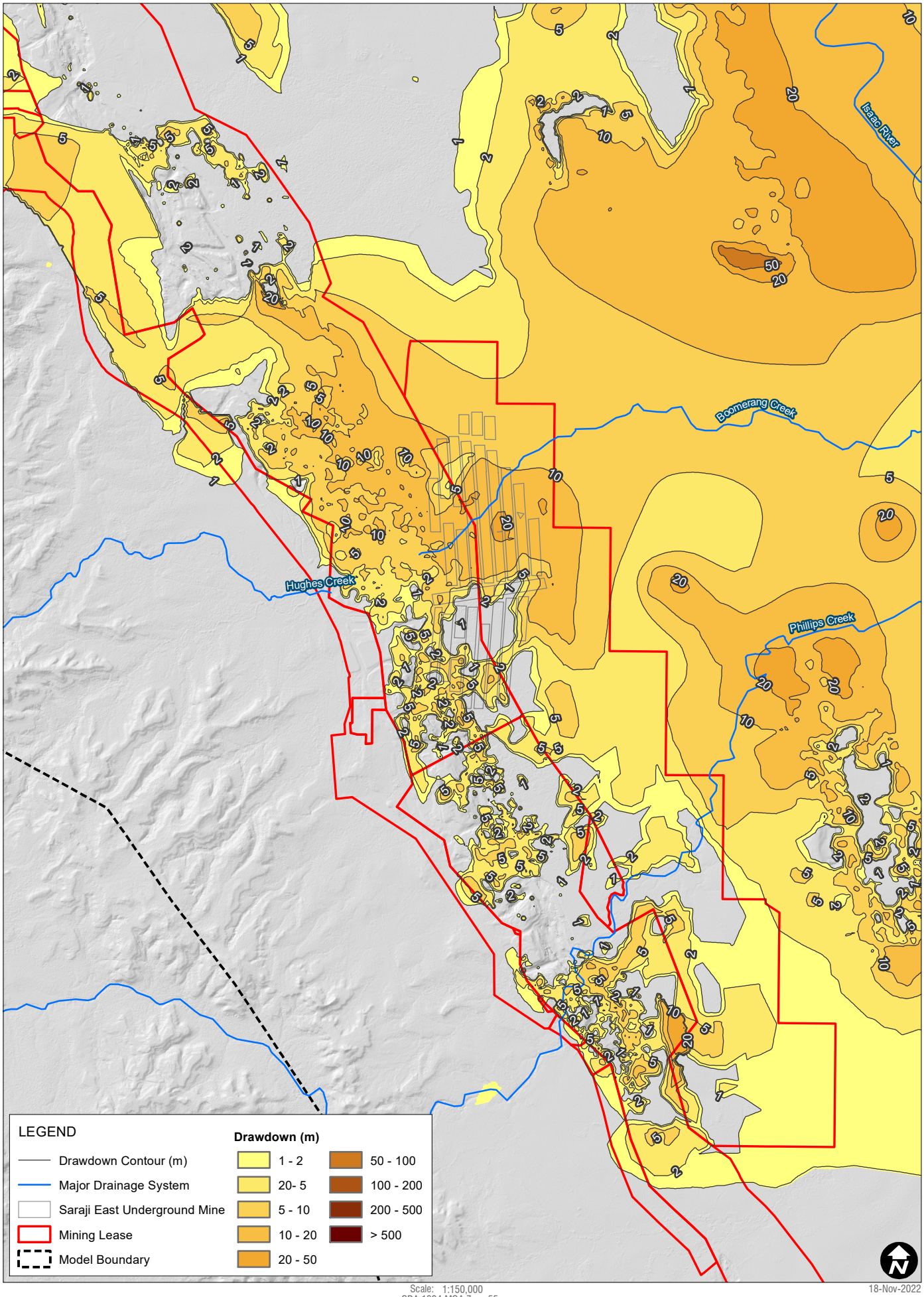
Sheet Size : A4

SLR
www.slrconsultingaustralia.com

0 1 2 3 4 5 km

Maximum Cumulative Drawdown in Quaternary Alluvium (Layer 1)

FIGURE 60



H:\Projects-SLR\620-BNE\620.31025.00000 Saraji East GW Modelling\03 SLR Data\01 CAD\GIS\GIS\620\31025 F3-15 Maximum Cumulative DD in Regolith.mxd

Scale: 1:150,000
GDA 1994 MGA Zone 55

18-Nov-2022
620.31025

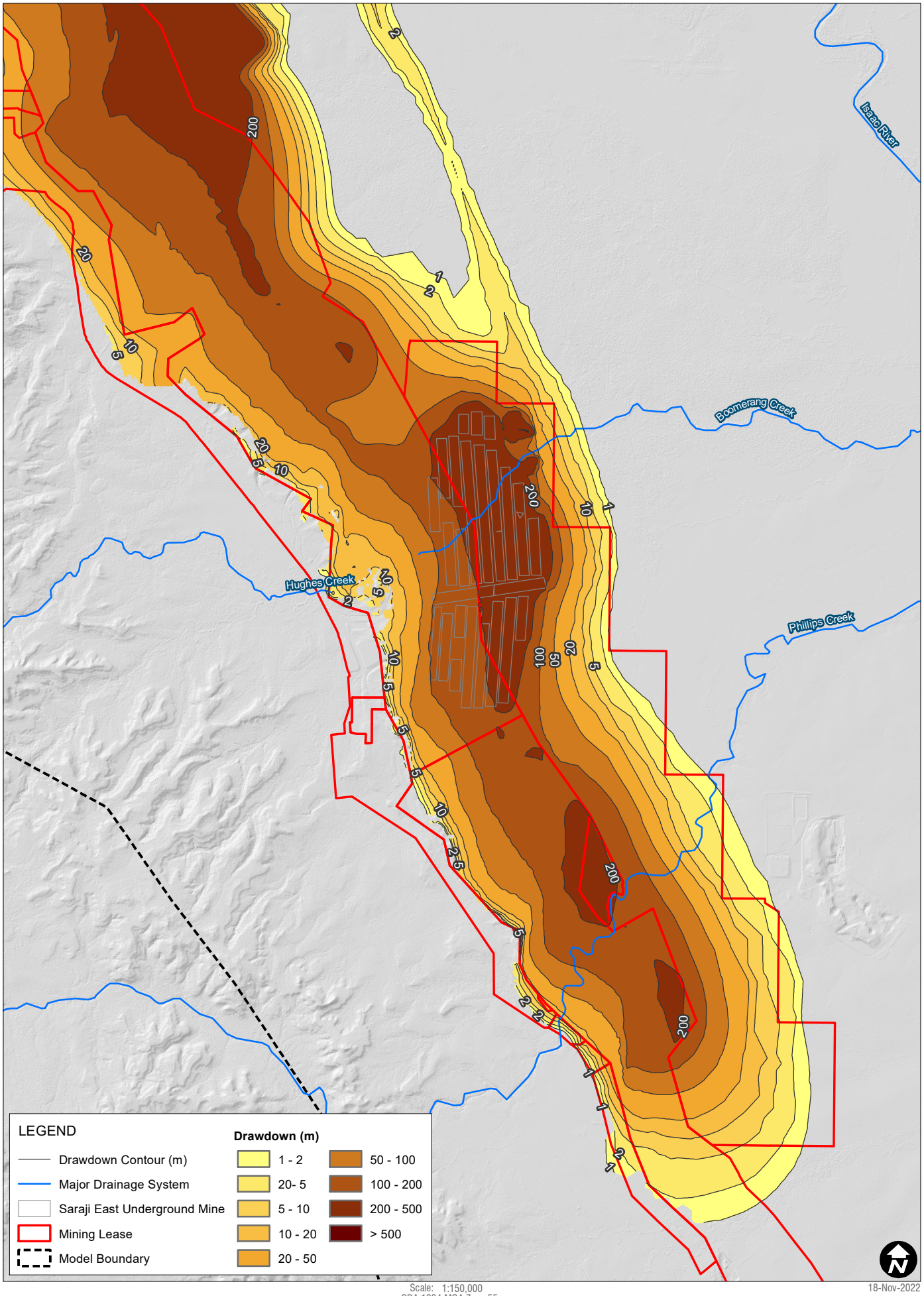
Sheet Size : A4

SLR
www.slrconsultingaustralia.com

0 1 2 3 4 5 km

Maximum Cumulative Drawdown in Regolith (Layer 2)

FIGURE 61



H:\Projects-SLR\620-BNE\620.31025.00000 Saraji East GW Modelling\03 SLR Data\01 CAD\GIS\GIS\620\31025 F3-21 Maximum Cumulative DD in D Seam.mxd

Scale: 1:150,000
GDA 1994 MGA Zone 55

18-Nov-2022
620.31025

Sheet Size : A4

SLR
www.slrconsultingaustralia.com

0 1 2 3 4 5 km

Maximum Cumulative Drawdown in D Seam (Layer 18)

FIGURE 62

6.3 Incidental water impacts

6.3.1 Impacts on alluvium

The change in alluvium water resources was assessed by comparing water budgets for alluvium zones using the Project and Approved model scenarios of the predictive model. Impacts on the alluvium groundwater can occur due to the potential for increased leakage, due to longwall mining.

Predictive modelling indicated:

- Over the extent of Boomerang Creek alluvium mapped across the Project footprint, the predicted loss of water from alluvium as a result of the Project is predicted to be zero.
- With regards to the Project impact on the Isaac River alluvium, the model predicts that the alluvium take due to the Project is also zero.

It is noted that any change in flux below than 0.01 ML/day is beyond the model ability to be able to predict it. Therefore, any flux changes derived from the model that are below 0.01 ML/day are considered to be within the range of model error.

Predicted total groundwater inflows to the Project amount to 183 ML/year on average (between 2022 and 2042). This groundwater extraction is not predicted to result in any groundwater drawdown in the alluvium due to the Project.

6.3.2 Groundwater – surface water interaction

The change in surface water drainage leakage to groundwater due to the Project was assessed by comparing the River cell flow budgets for the Isaac River in the Project scenario against the Approved scenario. This comparison showed that over the life of the Project, the change in the Isaac River net flow attributable to the Project is zero.

Boomerang, Hughes, and Plumtree creeks located within the Project area are all set up with a stage height of 0.0, which means they are simulated as gaining systems (i.e., negative net flow). The predictive model results indicate that there is no change to the estimated net flow for the above creeks as the result of Project.

The predictive modelling, therefore, indicates:

- No change in surface water flows in the local creeks including Boomerang Creek is predicted due to the Project.
- No change is predicted to surface water flows in the Isaac River due to the Project.

Note: A conservative approach was adopted in the modelling, where no self-sealing of the subsidence fracturing to surface is included in the simulations. This approach ensures that any change to hydraulic and storage properties in the model remain. Even adopting this approach no impact on alluvium or surface water resources is predicted.

6.3.2.1 Streamflow impacts

The Project's Hydrology, Hydraulics and Geomorphology Report (Alluvium, 2023) concludes that minor alteration to flow behaviour will be expected due to subsidence, this potential impact/s on streamflow and geomorphology are considered temporary as channels infill and ponded areas slowly accrete (as observed at other longwall operations in the Bowen Basin, the elevated sediment supply overwhelms the pools).

The general effects are a reduction in total flow some 11 per cent to 0.5 per cent reduction depending on the rainfall events. The reduction is more notable for the most frequent and extreme events and a delay in flow associated with the increased attenuation capacity of the subsided landscape. Residual pools will occur in parts of the landscape post-subsidence; this will account for the reduction in flow volume leaving the Project Site. In time, with sediment movement in the system these ponded volumes will decrease (i.e., flow reduction is temporary). The reduction in flows due to the ponding within subsided areas has the potential to impact on water quality downstream through reduced flows and hence less dilution after dry spells. However, impacts on water quality are likely to be minor and on a short temporal scale, as the predicted variation in flow between pre- and post-subsidence environment will keep decreasing over time as pools and channel beds fill in, and ephemeral wetlands slowly accrete.

The ponded water, albeit of short duration, has the potential to increase groundwater recharge over the Project footprint. This increase in shallow groundwater resources will be mitigated by minor remedial drainage works. Subsidence modelling was used to identify future ponding areas. The ponding areas develop gradually over the life-of-mine. The minor remedial drainage works will reduce persistent ponding in the landscape.

Subsidence monitoring will detect areas subject to persistent ponding of overland flow and remedial drainage works will ensure a free-draining landform. Subsidence ponding can be further alleviated through appropriate design and mitigation measures outlined in the Project's Subsidence Management Plan (SMP) (BMA, 2024).

6.4 Recovery modelling

The post-mining recovery modelling included simulation of groundwater level recovery within the Project underground workings. A 2,000-year transient model was created to ascertain post-mining recovery. This recovery model included the Saraji Mine open-cut pits.

All drain cells representing the Project were removed at the end of mining, allowing for the start of the groundwater level recovery in the underground workings and the overlying water-bearing strata.

The underground workings maintained the hydraulic parameters adopted in the model cells to reflect mined-out areas and goaf effects from the prediction model. These parameters allow for enhanced vertical and horizontal hydraulic conductivity in the fractured layers overlying longwall panels and the increased storage in the mined seam.

For the Saraji Mine open-cut pits, all the open cut mine workings where areas were changed to spoil with only the sections of open-cut pits closest to the Project (i.e., areas mined at the final year of the Saraji Mine) were not backfilled and remained as voids. The voids were assigned high horizontal and vertical hydraulic conductivities (1,000 m/day) and storage parameters. This allowed for the simulation of free water movement. No extra recharge or evapotranspiration was applied to the voids, and it was assumed that the voids will be filled through groundwater recovery (as discussed in Section 6.1.4).

Based on two pilot points, located within the northern and southern longwall panels, the groundwater model predicts the groundwater system will reach equilibrium approximately 1,800 years post-mining (Figure 63).

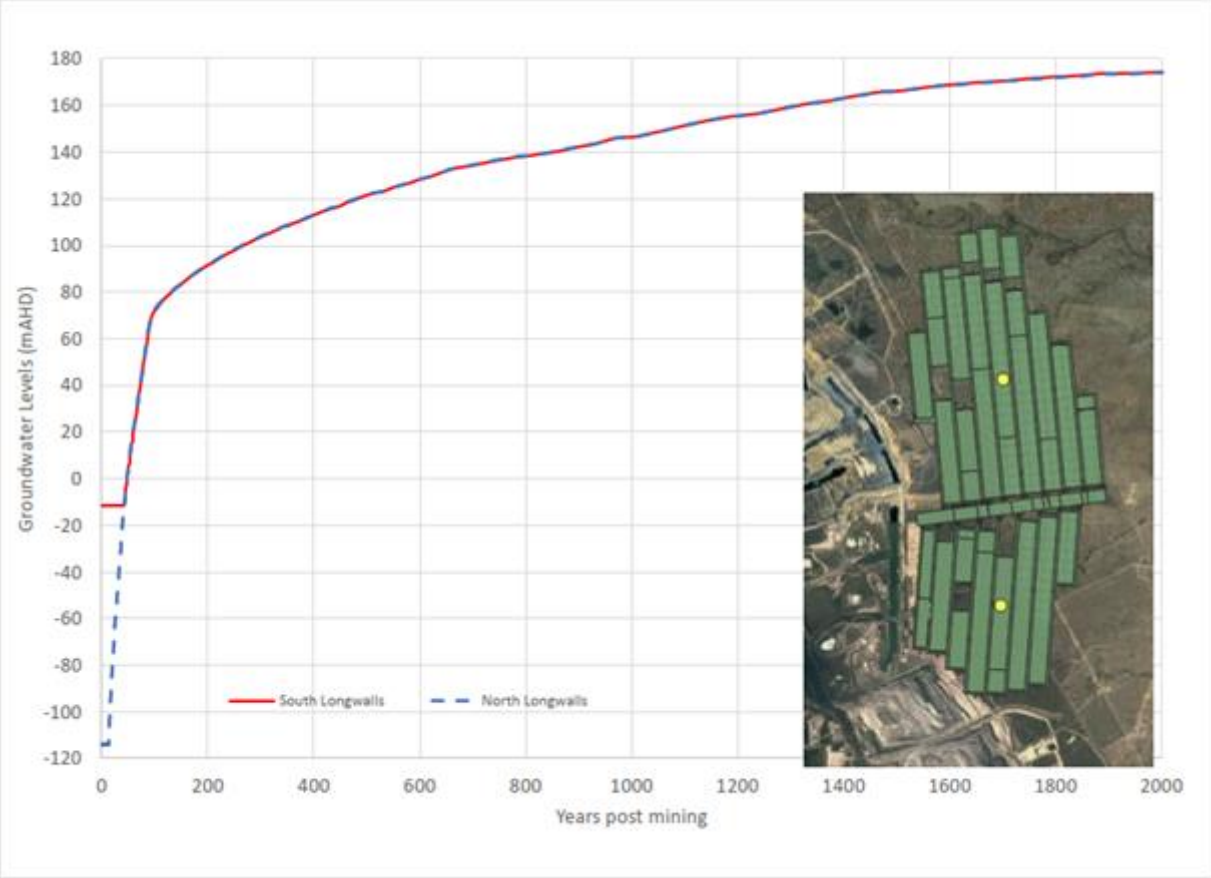


Figure 63 Predicted groundwater level recovery within the underground workings

In both the northern and southern longwall panels (yellow dots in Figure 63), the groundwater level recovers to approximately 176.5 mAHD and stabilises. This groundwater level is approximately 7.0 m above the pre-mining (all open cut and underground mining) groundwater levels, where the pre-mining groundwater level was derived from the steady-state modelling calibration (Section 4.4).

The recovered groundwater levels within the northern and southern longwall panels, stabilise at between 10 to 20 m below ground level. This indicates that the influence of the final voids will be limited, resulting in localised drawdown around the voids.

6.4.1 Final voids

The potential impact of the final voids at the Saraji Mine will depend on the Progressive rehabilitation and closure plans (PRC Plans) to be developed for the Project, which is outside the scope of the Project EIS.

The Saraji Mine transitional PRC Plan submitted (pending approval), which details the closure of the open cut mines, includes an assessment of groundwater interaction with the final voids and predictions of pseudo steady state pit water levels. The hydrogeological study (SLR, 2023b) and the PRC Plan submission was assessed to aid in evaluating the influence of the final voids on groundwater. It is noted that the Saraji Mine transitional PRC Plan does not include for the Project (i.e., the initial Saraji Mine PRCP was compiled prior to the finalisation of the Project EIS submissions).

Final void lakes

The Saraji Mine PRC plan includes the prediction of pit water levels at the end of mining and post closure (rehabilitation). The final void lake levels were included in a Saraji Mine PRC plan groundwater model as part of an iterative modelling approach between the groundwater model and the water balance model. The modelling results identify the residual voids develop as long-term ‘sinks’ with respect to groundwater for all climate change scenarios modelled. Stabilised lake levels in all the final voids are predicted to remain below the recovered groundwater levels (SLR, 2023b).

Consideration of water level predictions at the Coolibah / Dogwood pits, the pits with the highwall access for the Project, have been summarised for consideration of long-term groundwater flow patterns (Figure 4 in Section 4.2).

A dedicated final void water balance model, based on the final closure landform design, was completed for the period 2080 to 2199 (120-years), to understand water balance behaviour (including climate change considerations) within the residual voids over time. The findings for the Coolibah / Dogwood final void was:

- The decant level is 190 mAHD (i.e., level where water could overtop / spill from the void).
- After 2120 pit water levels start to stabilise, with simulated mean inflows of 783 ML/year being very similar to mean outflows of 784 ML/year.
    - This indicates that the mean water balance has reached an equilibrium.
- The long-term final void lake levels range between 7 and 24 m AHD (BMA, 2023).

The numerical groundwater modelling (SLR, 2023b) shows the establishment of sustained inward groundwater flow gradients to all the voids. The groundwater flow patterns are driven by the evaporative discharges from void lakes. The final void water levels stabilise below the modelled groundwater elevations and below the shallow hydrogeological units, (i.e., alluvium and Tertiary).

Therefore, once the final void lakes and groundwater levels have stabilised, the modelling indicates the residual voids will continue to act as groundwater sinks.

Coolibah / Dogwood final void groundwater

Groundwater modelling, considering wet, base, and dry climate conditions, indicated that groundwater ingress represents 5 per cent to 13 per cent of the total volumetric inflow to each final void based on the water balance model predictions. The majority of the groundwater ingress comes via the spoil. Based on the depth of the water within the voids, driven by evaporation (Section 5.1.4), groundwater from the hydrostratigraphic units within the highwall flow into the final voids resulting in localised groundwater drawdown.

The post-mining groundwater elevations, contours, and drawdown for the target D seam is included in Figure 64. The predicted groundwater levels across the Project footprint, based on the Saraji Mine recovery predictions, are around 140 m AHD.

Groundwater levels within the Project are predicted, considering Saraji Mine open cuts and the SEMLP underground workings, to recover to 176.5 m AHD in the long term (Figure 63), this is >100 m above the pit water levels of between 7 to 24 m AHD.

This comparison of groundwater recovery levels in the Project and long-term levels associated with the Saraji Mine post-closure indicates groundwater flow will be towards the deep water levels within the final void where the Coolibah / Dogwood final void (predicted to be 7 to 24 m AHD).

Future groundwater modelling envisaged for the PRC Plan for SEMLP and/or revisions of the Saraji Mine PRC Plan will allow for the reassessment of cumulative groundwater recovery of these two mines, plus the use of particle tracking to show groundwater flow patterns adjacent and into the final voids.

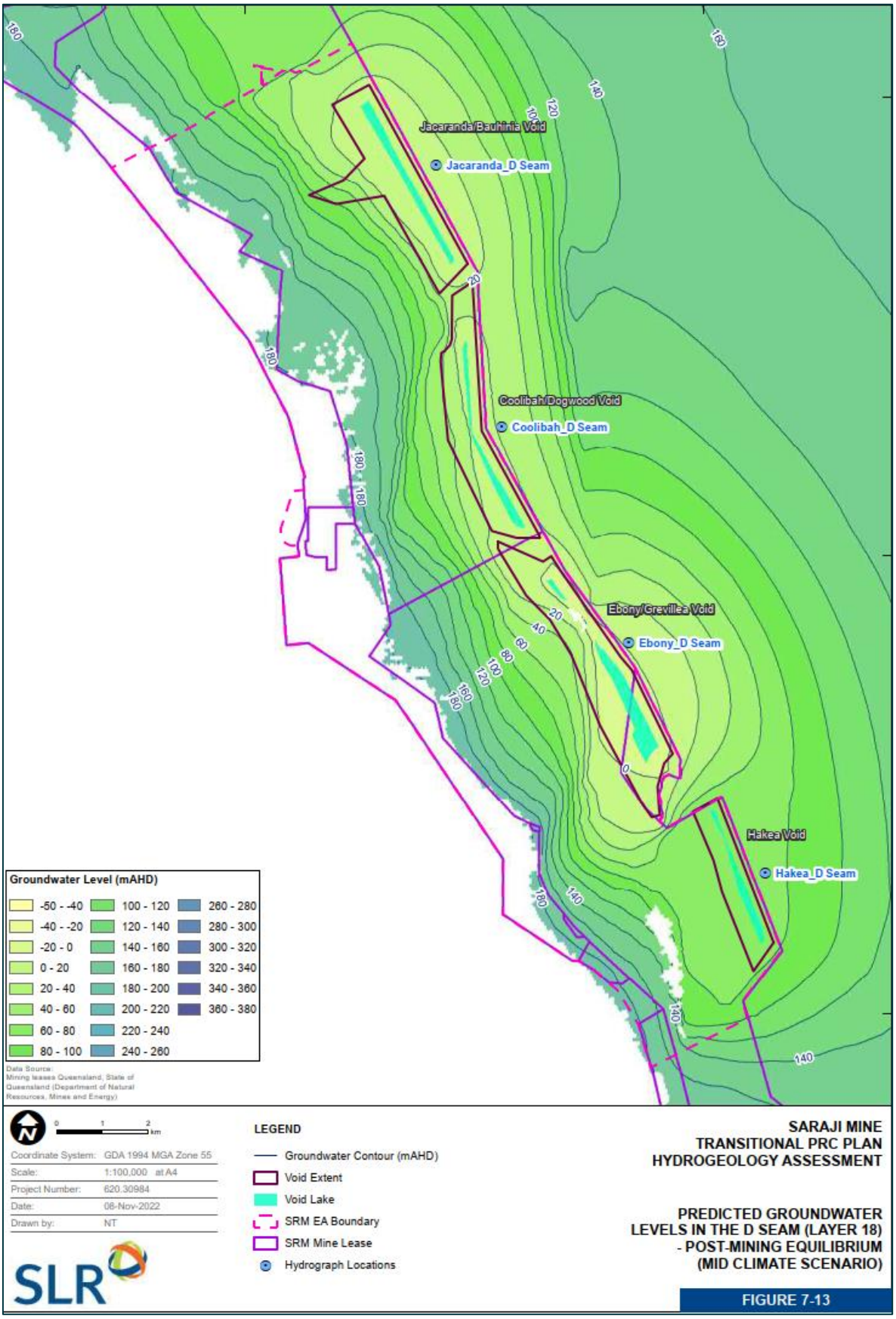


Figure 64 Predicted groundwater levels in the D seam at Saraji Mine (SLR, 2023b)

6.5 Sensitivity analysis

6.5.1 Calibration identifiability

Identifiability describes a parameters capability to be constrained by the model calibration. Identifiability values range from zero to one. As identifiability approaches one, the parameter is increasingly able to be constrained. Likewise, as values approach zero the parameter is increasingly unable to be constrained by the calibration and uncertainty of model results is not reduced through calibration.

Estimates of parameter identifiability for the model calibrated parameters was conducted (as detailed in Groundwater Modelling Technical Report (SLR, 2023)). The parameters included:

- Horizontal hydraulic conductivity
- Anisotropy
- Storage - specific yield and specific storage
- Recharge.

The calibration process was successful in constraining the horizonal hydraulic conductivity. Notably, the horizontal hydraulic conductivity of the Rewan Group, Leichhardt Seam, Vermont Seam, MCM D Seam and Q Seam units (high identifiability values above 0.80).

The horizontal hydraulic conductivity of most of the faults were not constrained well during calibration, relative to their surrounding unit. The exception to this is the Isaac fault zone, which has been constrained during the calibration.

Identifiability of anisotropy in the weathered Permian, RCM interburden, FCCM interburden and MCM interburden have high identifiability values indicating these can be constrained and reduce model uncertainty. All other zones feature low values (≤ 0.40) and are less constrained by calibration.

Specific yield for the regolith (Tertiary), Rewan Group, and Isaac fault zone was highly identifiable, whilst other zones in the model domain have low identifiability. The specific storage of D seam appears to be the most identifiable parameters among the zones.

The recharge zones for all the zones except the Isaac River channel, were constrained by the calibration. Note that the stream channel alluvium represents a narrow zone along the Isaac River, with a small area relative to the other recharge zones. It is, therefore, considered less impactful to model predictions.

6.5.2 Prediction identifiability

Prediction identifiability describes parameters capability on influencing the model predictions. To calculate the prediction identifiability the groundwater model was run once per each parameter. The predictions included in the analysis were the Project only inflows and maximum incremental drawdowns.

As identifiability approaches one, the parameter is increasingly able to change model predictions. On the contrary, as values approach zero the parameter is increasingly unable to change model predictions.

The Murray Darling Basin Modelling Guidelines (MDBC, 2000) recommends classifying sensitivity by the resultant changes (or contribution) to the model calibration and predictions. According to this process models can be classified as one of the four main types:

- Type I: Insignificant changes to calibration (low identifiability) and prediction (low uncertainty contribution
- Type II: Significant changes to calibration (high identifiability) – insignificant changes to predictions (low uncertainty contribution)
- Type III: Significant changes to calibration (high identifiability) – significant changes to predictions (high uncertainty contribution)
- Type IV: Insignificant changes to calibration (low identifiability) – significant changes to predictions (high uncertainty contribution).

Types I-III are of less concern, as these Types have an insignificant impact on model predictions or constrained by calibration. Type IV is classed as ‘a cause for concern’ as non-uniqueness in a model

input might allow a range of valid calibrations but the choice of value impacts significantly on a prediction (MDBC, 2000).

To classify the sensitivity contribution to the model calibration and predictions for each model parameter, the calibration and prediction identifiability were compared against each other for each parameter.

Figure 65 presents the relationship between the identifiability of the Project inflows and the identifiability of the calibration. Sensitivity classifications for the sensitivity types have been assigned based on the range of the identifiability.

The results show that the key parameters that require further work to reduce their influence on predictive uncertainty in relation to groundwater inflows include:

- The specific yield of the MCM interburden (i.e., interburden above the target D coal seam)
- The anisotropy of the fault to the east of the Project.

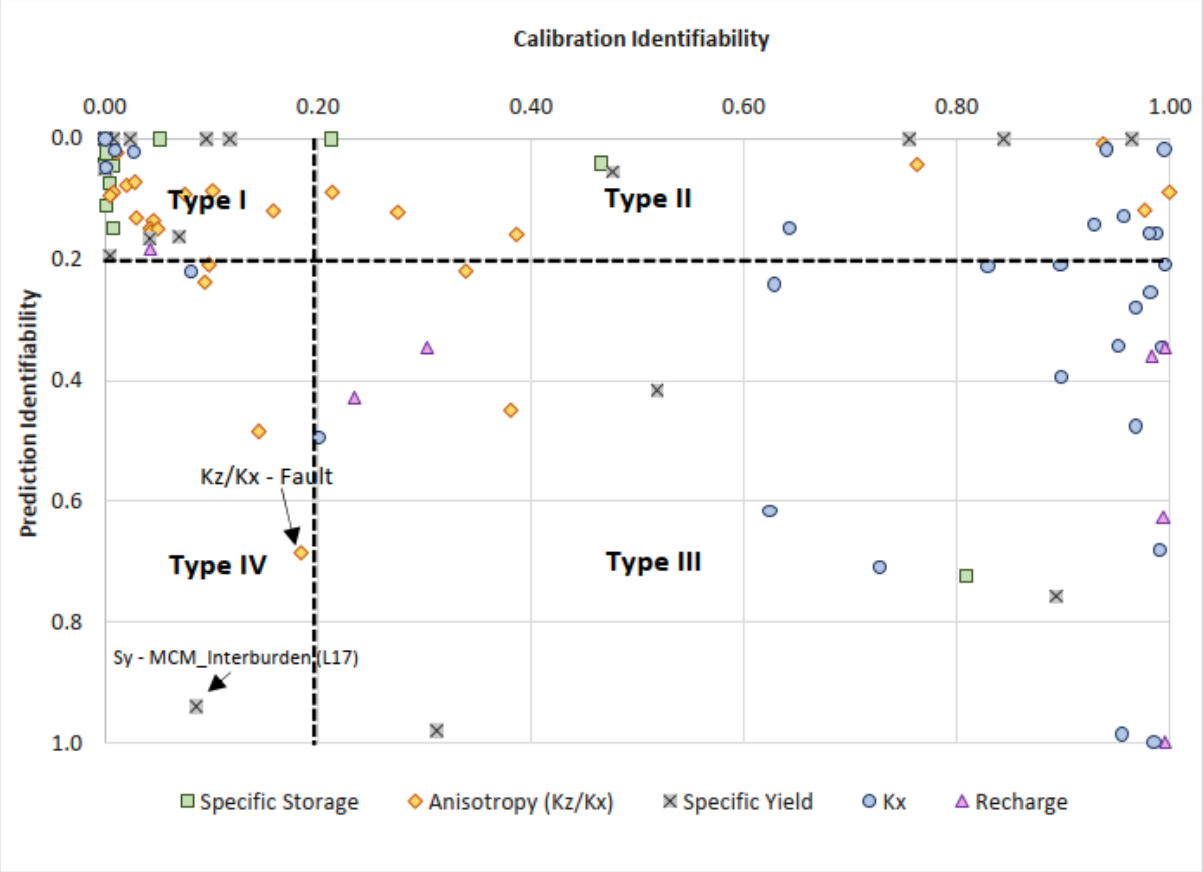


Figure 65 Uncertainty contribution (predicted mine inflow) versus identifiability

Figure 66 presents the relationship between identifiability of the maximum predicted drawdown and the identifiability of the calibration. Sensitivity classifications for the sensitivity types have been assigned based on the range of the posterior predictions. The results show that the key parameter that require further work to reduce its influence on predictive uncertainty in relation to the maximum drawdown extent are:

- The specific storage of the MCM interburden (i.e., interburden above the target D coal seam)
- The anisotropy and specific yield of the fault to the east of the Project.

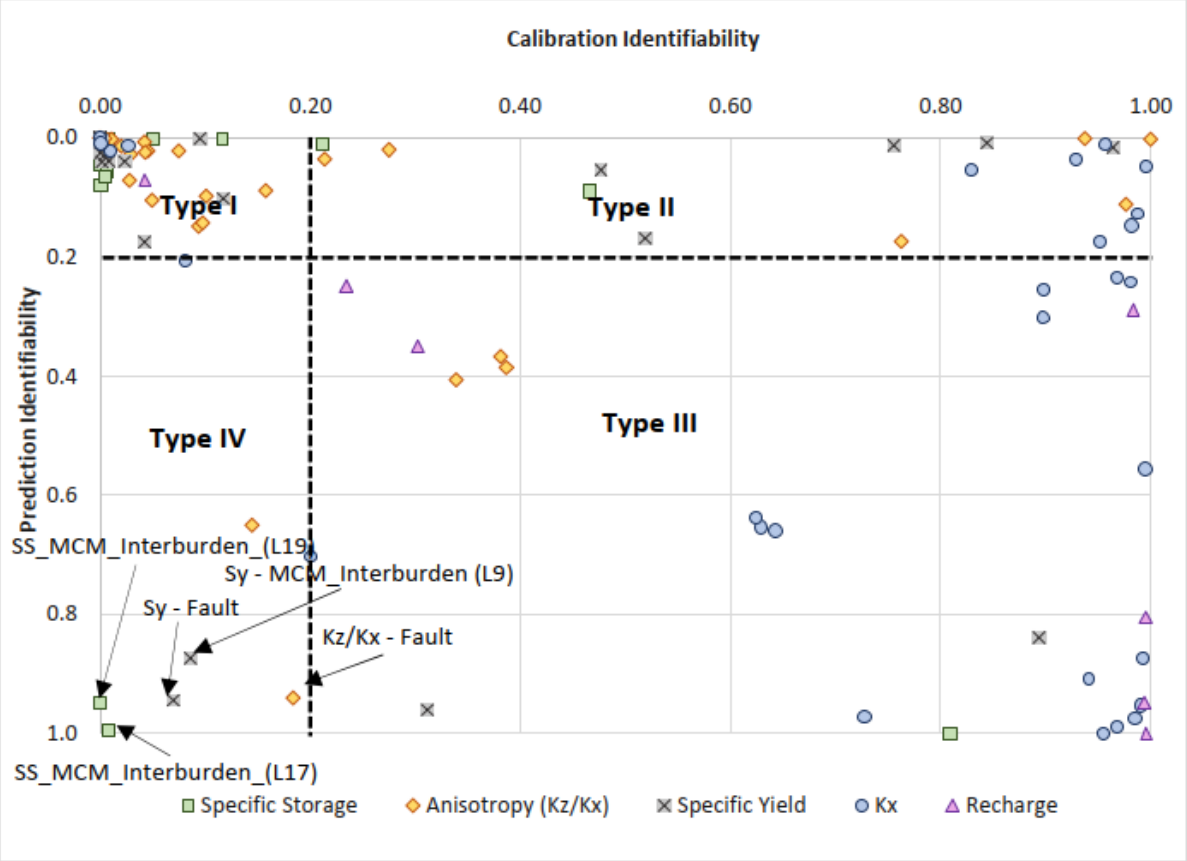


Figure 66 Uncertainty contribution (maximum incremental drawdown) versus identifiability

6.6 Prediction uncertainty

A Type 3 Monte Carlo uncertainty analysis (IESC, 2018) was undertaken to estimate the uncertainty in the potential impacts predicted by the model. This uncertainty analysis method generates numerous alternative sets of model input parameters to the groundwater flow model (referred to as realisations). Each set of input parameters are used to run the model for each realisation. The results are then aggregating for statistical analysis.

The first step in Monte Carlo analysis is to define the parameter distribution and range. For the Project, the parameters are assumed to be log-normally distributed around the optimum value derived from the calibration and the standard deviation attributed to the Log10 of parameter is 0.5. The distribution for each parameter were checked and constrained such that upper or lower ranges do not go beyond ranges in literature for physical constraints.

A total of 550 model realisations were generated, each having differing values of key parameters. The realisations were run, and calibration quality was assessed.

Of the 550 model runs, 95 model runs were accepted as sufficiently calibrated, with SRMS values ranging between 5.9 per cent and 7.9 per cent. These were used in all model scenarios (Project and Approved) and statistically analysed for uncertainty analysis.

Table 57 and Table 58 (Recharge) show the parameter ranges explored during the uncertainty analysis simulation.

Parameters were assumed to possess a log-Normal distribution. The Latin Hypercube Sampling (LHS) method was used to create near-random realisations from parameter distribution. The generated random numbers derived from LHS approach is distributed sufficiently across the parameter space even at the small sample size.

The parameter distributions for prior (i.e. from the 550 model realisations) and posterior (i.e. from 95 accepted realisations) are detailed in Groundwater Modelling Technical Report (SLR, 2023).

As commented in Table 12, a review of the parameter distribution indicated that the horizontal hydraulic conductivity of Alluvium for the base case is at the upper range of parameter distribution. Figure 67

presents the parameter distribution of horizontal hydraulic conductivity of Alluvium from the uncertainty analyses and the value used in the base case scenario. As Figure 67 shows, the majority of realisations are centred around the 10 m/day with a few of realisations up to 50 m/day. This indicates that although 54 m/day used in the base case is considered to be extreme, the uncertainty analysis results are based on a more probable value (i.e., 10 m/day). In addition, the sensitivity analysis in Section 6.5 indicates the horizontal hydraulic conductivity of Alluvium is considered to be Type I meaning that it will not have significant influence on the modelling predictions.

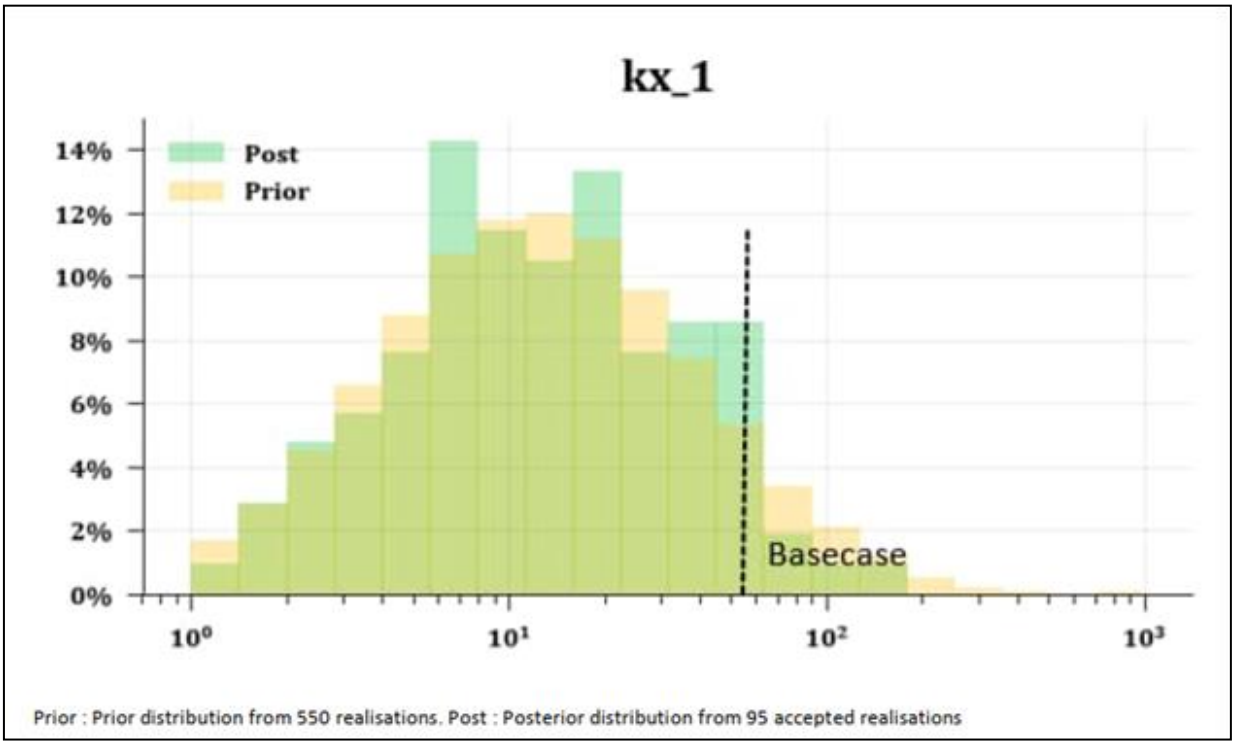


Figure 67 Horizontal hydraulic conductivity of Alluvium parameter distribution

Table 57 Uncertainty parameter range

Zone	Layer-unit	Horizontal hydraulic conductivity (m/day)		Anisotropy		Specific yield (Sy)		Specific storage (SS)	
		Mean (Log10)	Constraint	Mean (Log10)	Constraint	Mean (Log10)	Constraint	Mean (Log10)	Constraint
1	Layer 1 - Alluvium	1.74	No constraint	-0.55	<1.0	-1.38	<0.20	-5.21	<1 x 10^{-5}
2	Layer 1 - Regolith	0.66	<K_x Alluvium	-1.40	<1.0	-1.44	<Sy Alluvium; <0.05	-5.26	<SS Alluvium; <1 x 10^{-5}
3	Layer 1 - Weathered Permian	-0.46	<K_x Alluvium	-0.38	<1.0	-2.01	<Sy Alluvium; <0.05	-6.81	<SS Alluvium; <1 x 10^{-5}
4	Layer 1 - Duaringa Formation	0.25	<K_x Alluvium	-0.43	<1.0	-1.68	<Sy Alluvium; <0.05	-6.40	<SS Alluvium; <1 x 10^{-5}
5	Layer 1/2 - Tertiary Basalt	0.44	<K_x Alluvium	-1.02	<1.0	-1.47	<Sy Alluvium; <0.05	-5.91	<SS Alluvium; <1 x 10^{-5}
6	Layer 2 - Regolith	-0.45	<K_x Alluvium	-0.82	<1.0	-1.56	<Sy Alluvium; <0.05	-6.75	<SS Alluvium; <1 x 10^{-5}
7	Layer 3-19-Faults_zone1	-0.27	No constraint	-1.51	<1.0	-1.41	<Sy Alluvium; <0.05	-5.20	<SS Alluvium; <1 x 10^{-5}
8	Layer 3- Rewan	-2.32	<K_x Alluvium	-1.00	<1.0	-1.55	<Sy Alluvium; <0.05	-6.46	<SS Alluvium; <1 x 10^{-5}
9	Layer 4 - RCM O/B	-2.06	<K_x Alluvium	-0.82	<1.0	-2.11	<Sy Alluvium; <0.02	-5.33	<SS Alluvium; <1 x 10^{-5}
10	Layer 5 - Leichhardt Seam	-0.96	<K_x Alluvium	-2.83	<1.0	-3.08	<Sy Alluvium; <0.02	-6.33	<SS Alluvium; <1 x 10^{-5}
11	Layer 6 - RCM I/B	-3.03	<K_x Alluvium	-0.24	<1.0	-2.63	<Sy Alluvium; <0.02	-6.42	<SS Alluvium; <1 x 10^{-5}
12	Layer 7 - Vermont Seam	-1.69	<K_x Alluvium	-1.58	<1.0	-2.72	<Sy Alluvium; <0.02	-5.51	<SS Alluvium; <1 x 10^{-5}
13	Layer 8 - RCM U/B	-2.08	<K_x Alluvium	-2.88	<1.0	-3.00	<Sy Alluvium; <0.02	-5.80	<SS Alluvium; <1 x 10^{-5}
14	Layer 9 - FCCM O/B	-2.13	<K_x Alluvium	-0.22	<1.0	-2.27	<Sy Alluvium; <0.02	-6.91	<SS Alluvium; <1 x 10^{-5}
15	Layer 10 - FCCM Seam	-2.37	<K_x Alluvium	-0.71	<1.0	-2.25	<Sy Alluvium; <0.02	-5.50	<SS Alluvium; <1 x 10^{-5}
16	Layer 11 - FCCM U/B	0.33	<K_x Alluvium	-2.46	<1.0	-2.88	<Sy Alluvium; <0.02	-5.72	<SS Alluvium; <1 x 10^{-5}
17	Layer 12 - Q Seam	-1.19	<K_x Alluvium	-1.18	<1.0	-2.41	<Sy Alluvium; <0.02	-5.32	<SS Alluvium; <1 x 10^{-5}
18	Layer 13 - MCM U/B	0.45	<K_x Alluvium	-0.59	<1.0	-2.13	<Sy Alluvium; <0.02	-5.76	<SS Alluvium; <1 x 10^{-5}

Zone	Layer-unit	Horizontal hydraulic conductivity (m/day)		Anisotropy		Specific yield (Sy)		Specific storage (SS)	
		Mean (Log10)	Constraint	Mean (Log10)	Constraint	Mean (Log10)	Constraint	Mean (Log10)	Constraint
19	Layer 14 - P Seam	0.93	<K_x Alluvium	-1.44	<1.0	-3.01	<Sy Alluvium; <0.02	-5.05	<SS Alluvium; <1 x 10^{-5}
20	Layer 15 -MCM I/B	-0.10	<K_x Alluvium	-0.57	<1.0	-2.89	<Sy Alluvium; <0.02	-5.84	<SS Alluvium; <1 x 10^{-5}
21	Layer 16 - H Seam	-1.07	<K_x Alluvium	-2.25	<1.0	-3.25	<Sy Alluvium; <0.02	-7.00	<SS Alluvium; <1 x 10^{-5}
22	Layer 17 - MCM I/B	-0.67	<K_x Alluvium	-1.05	<1.0	-2.49	<Sy Alluvium; <0.02	-5.47	<SS Alluvium; <1 x 10^{-5}
23	Layer 18 - D Seam	-1.29	<K_x Alluvium	-0.73	<1.0	-3.66	<Sy Alluvium; <0.02	-5.01	<SS Alluvium; <1 x 10^{-5}
24	Layer 19 - MCM U/B	-0.60	<K_x Alluvium	-2.76	<1.0	-2.41	<Sy Alluvium; <0.02	-5.46	<SS Alluvium; <1 x 10^{-5}
25	Layer 3-19 - Faults zone 2	0.18	No constraint	-1.30	<1.0	-2.62	<Sy Alluvium; <0.05	-6.15	<SS Alluvium; <1 x 10^{-5}
26	Layer 7 - Faults zone 3	-0.04	No constraint	-2.94	<1.0	-2.59	<Sy Alluvium; <0.05	-6.22	<SS Alluvium; <1 x 10^{-5}
27	Layer 8 - Faults zone 4	0.10	No constraint	-1.52	<1.0	-1.95	<Sy Alluvium; <0.05	-5.75	<SS Alluvium; <1 x 10^{-5}
28	Layer 3-7 Faults zone 5	-3.23	No constraint	-2.58	<1.0	-2.39	<Sy Alluvium; <0.05	-5.80	<SS Alluvium; <1 x 10^{-5}

Standard deviation = 0.5 order of magnitude for all units.

O/B = Overburden. I/B = Interburden. U/B = Underburden. RCM = Rangal Coal Measures. FCCM = Fort Cooper Coal Measures. MCM = Moranbah Coal Measures.

Table 58 Uncertainty range for recharge rates

Zone	Unit	Mean % of rainfall	Constraints
1	Other Alluvium	0.12	No constraint
2	Regolith	0.01	<Other Alluvium
3	Weathered Permian	0,09	<Other Alluvium
4	Duaringa Formation	0.03	<Other Alluvium
5	Tertiary Basalt	0.37	No constraint
6	Alluvium Isaac River channel	0.05	No constraint
7	Alluvium Isaac River	0.22	No constraint

6.6.1 Fault approach

Geological faults, fractures in the rock whee the rock has been displaced parallel to the plane of movement, are mapped within and adjacent to SEMLP. These geological structures can, depending on the nature of the fault (i.e., filled, or open) plus the amount of displacement on the fault can influence groundwater flow.

The faults, acting as barriers or preferential flow pathways, can influence groundwater ingress and groundwater drawdown at SEMLP. To best include faults and assess potential impacts on groundwater, the nature of the faulting was assessed through model calibration and uncertainty analysis.

As per industry best practice, if the nature of a fault, or other hydraulic feature, is unknown, then the parameterisation of the fault should be sufficiently large to capture all plausible conceptualisations. This is the practice employed within the SLR (2023) modelling, and development of the calibrated ensemble; in particular, the allowed parameter ranges during calibration allowed representation of the fault as a full barrier, full conduit, and all possibilities in between (as included in Table 57).

Calibration of the hydraulic conductivity of the fault is allowed during the calibration process based upon the calibration dataset and its sensitivity to fault hydraulic conductivities. Where insensitive, the calibrated range in conductivities will then remain large; therefore, incorporating the conceptual uncertainty within the numerical uncertainty of the model results.

The Project's Groundwater Modelling Technical Report (SLR, 2023) provides the ranges in conductivities for the different fault zones within the model (lines 25 to 28 of Table 57). The range in values within the ensemble varies by orders of magnitude and as such the predictive uncertainty captures the uncertainty in the conceptualisation on the nature of the faults.

In this sense, the predictive results incorporate the possibility of faults being barriers, conduits, and / or both. The modelling approach is recognised to assess the fault/s influence on groundwater ingress and drawdown.

6.6.2 Uncertainty results

6.6.2.1 Groundwater ingress

Figure 68 shows the predicted inflows for the Project and different percentiles including 10th, 33rd, 50th, 67th, and 90th prediction bounds.

Based on the IESC (2018) guidelines these percentiles represent the likelihood of exceedance, where:

- <10th percentile indicates it is very likely the outcome is larger than this value
- 10th – 33rd indicates it is likely that the outcome is larger than this value
- 33rd - 67th indicate it is as likely as not that the outcome is larger or smaller than this value
- 67th - 90th indicates it is unlikely that the outcome is larger than this value
- > 90th percentile indicates it is very unlikely the outcome is larger than this value.

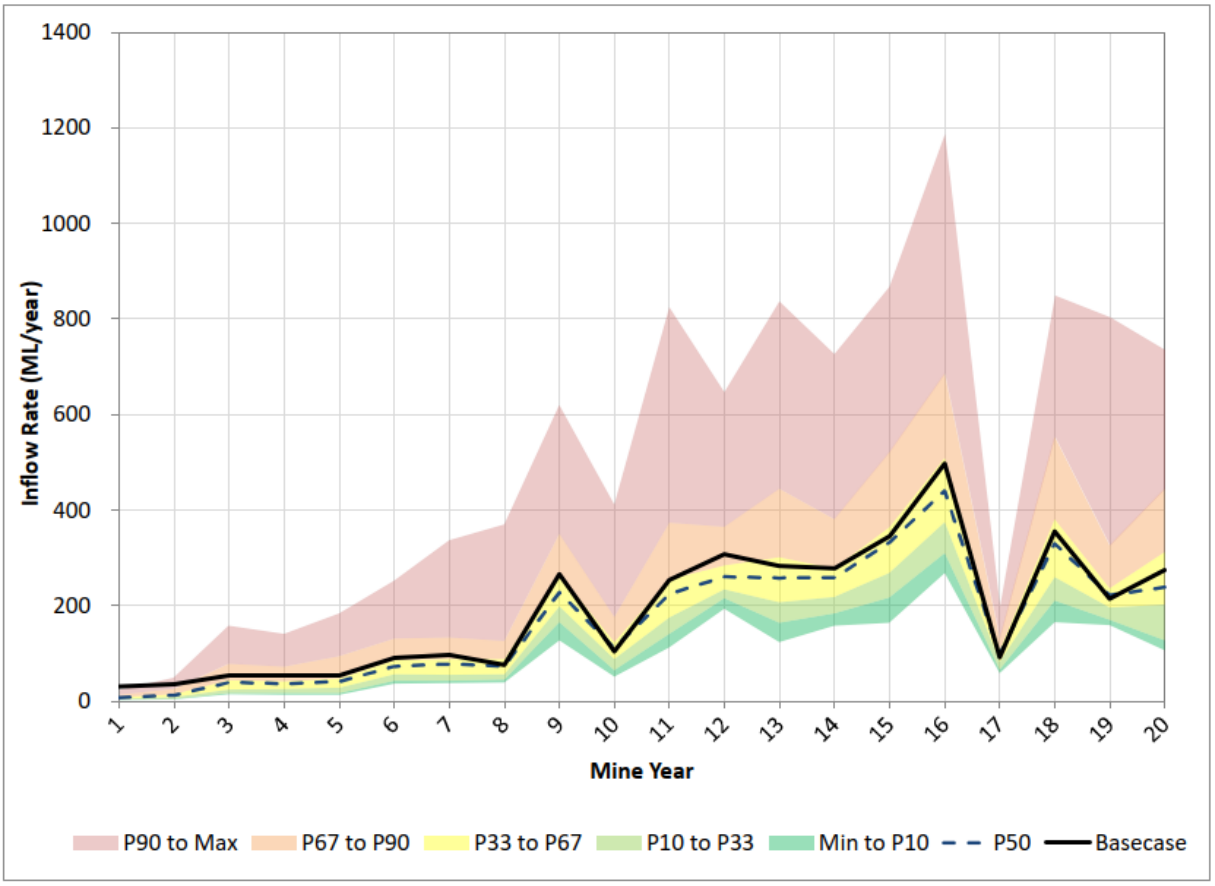


Figure 68 Mine ingress uncertainty

The bounds in Figure 68 indicate the uncertainty within the predicted inflow rate. The bounds show that the calibrated model generally match the 67th percentile, where the range 33th– 67th percentile indicates a outcome would be similar to the prediction (not larger or smaller).

The average inflows for the 10th to 90th percentiles are 111.4 ML/year (0.31 ML/day) and 271.5 ML/year (0.74 ML/day), respectively.

6.6.2.2 Groundwater level drawdown

To illustrate the level of uncertainty in the extent of predicted drawdown, the 1 m drawdown due to Project was compared to 5th, 50th, and 95th percentiles maximum drawdown from the uncertainty analysis.

The 5th, 50th, and 95th percentiles maximum drawdowns in Alluvium do not indicate that the Project will impact on the alluvium. Even the most unlikely percentile, the 95th percentile, did not predict any drawdown in the alluvium due to the Project.

Figure 69 shows the uncertainty in the extent of predicted 1 m maximum incremental drawdown in the Tertiary age units. The 5th, 50th, and 95th percentiles maximum drawdowns are localised around the northern longwall panels at the Project.

With respect to the 95th percentile (most unlikely), the drawdown extends approximately 5 km northeast of the Project.

The uncertainty in the extent of predicted 1 m maximum incremental drawdown in the target D Seam, indicates that the 95th percentile drawdown extends between 10 and 12 km to the northwest and southeast of the Project (Figure 70).

6.6.3 Uncertainty on influence on Alluvium and Surface Water

The uncertainty analysis results showed that even for the 95th percentile (most unlikely) prediction, the take from the Isaac River and Boomerang Creek alluvium due to Project were predicted to below 0.01 ML/day and considered to be in the range of model errors (as included in Section 6.3.1).

The uncertainty analysis also indicates that there is no change to the net flow of Isaac River and local creeks as the result of Project.

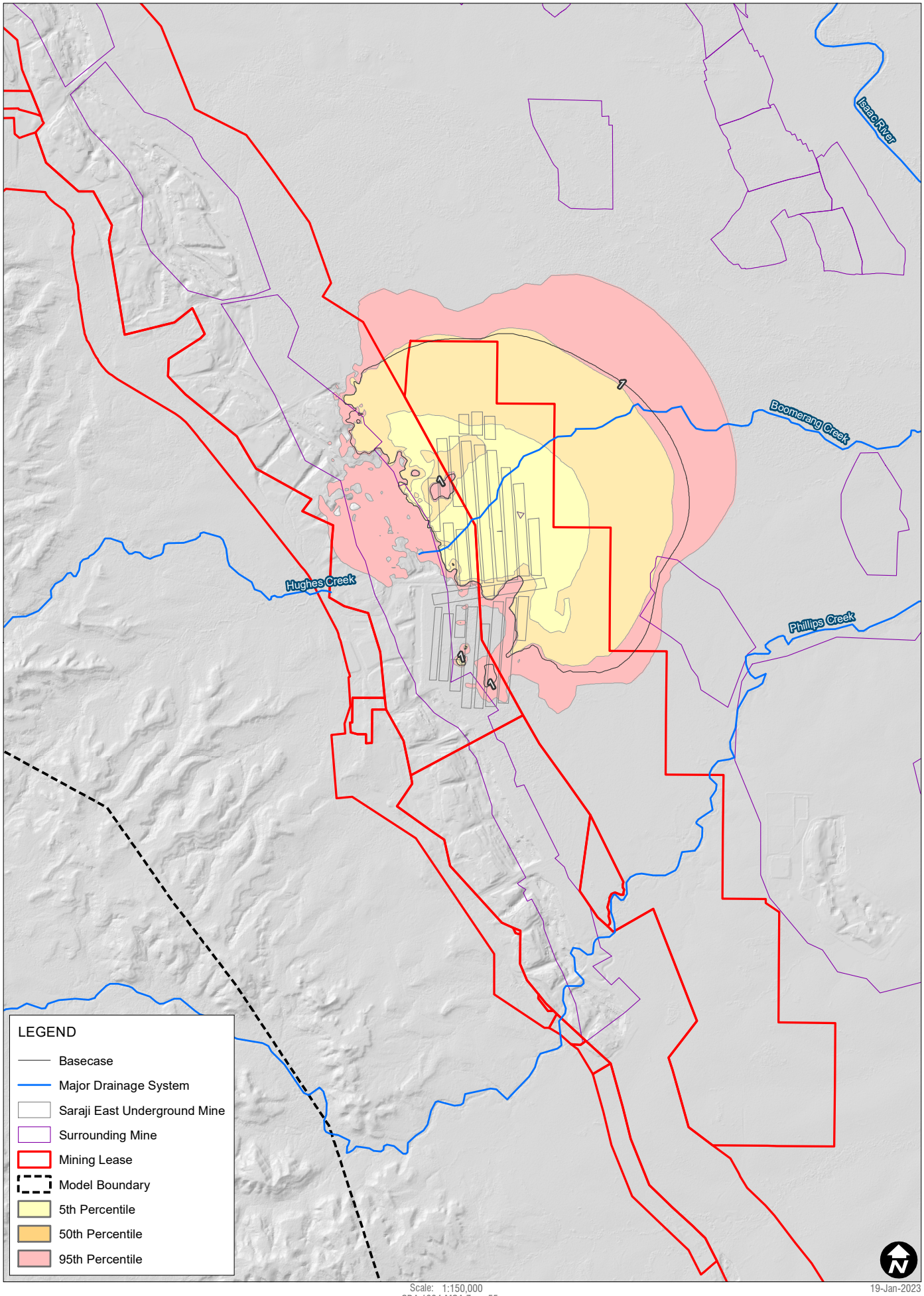
6.6.4 Uncertainty number of realisations

65 realisations were selected as calibrated realisations and used for uncertainty analysis. The predictive model was run using the 65 parameters sets. The results from the predictive model were used to conduct statistical analyses to assess if additional realisations were likely to provide results that would significantly change the reported predictive results. The 95 per cent confidence interval was calculated for the mine inflows and the maximum drawdown.

Figure 71 and Figure 72 show the 95 per cent confidence intervals of the median and maximum drawdown and predicted inflows, as well as the variance of the median and maximum drawdown and predicted inflows as more realisations are added to the uncertainty analysis.

For example, the 95 per cent confidence interval for the maximum drawdown is calculated by first estimating the maximum drawdown for each realisation and then calculating the 95 per cent confidence interval of the maximum drawdowns as each realisation is added to the dataset. As shown in Figure 71 and Figure 72 additional realisations will not significantly increase or decrease the confidence intervals of predictions of mine inflows and maximum drawdowns.

Therefore, the results from the 65 realisations are considered sufficient for the estimation of uncertainty with respect to inflows and other prediction variables.



Scale: 1:150,000
GDA 1994 MGA Zone 55

19-Jan-2023
620.31025

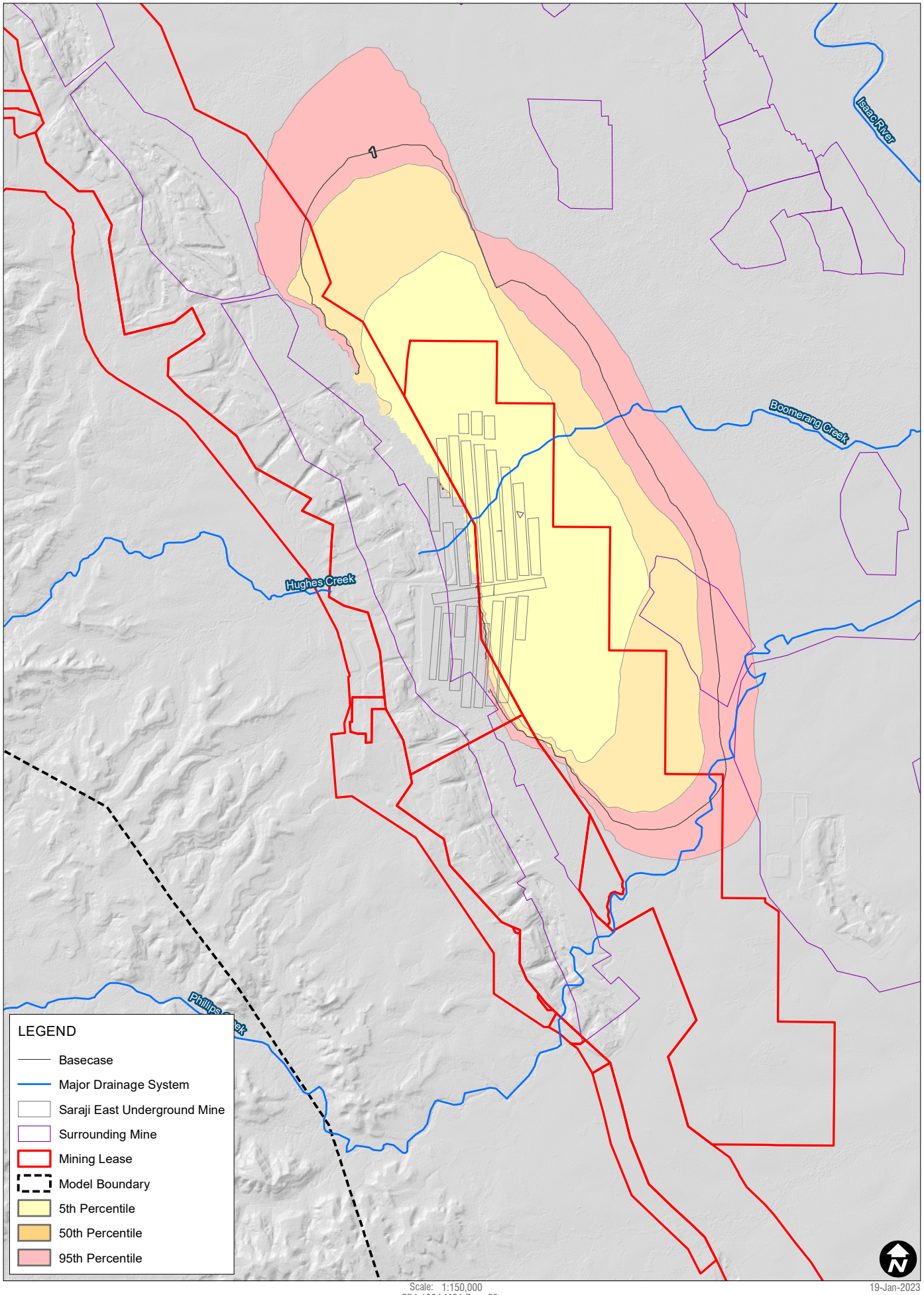
Sheet Size : A4

SLR
www.slrconsultingaustralia.com

0 1 2 3 4 5 km

Uncertainty in Predicted 1 m Maximum Incremental Drawdown in Regolith (Layer 2)

FIGURE 69



H:\Projects-SLR\620-BNE\620.31025.00000 Saraji East GW Modelling\03 SLR Data\01 CAD\GIS\GIS\620\31025 F6-5 Uncertainty in Predicted 1m Maximum Incremental Drawdown in Q Seam.mxd

Scale: 1:150,000
GDA 1994 MGA Zone 55

19-Jan-2023
620.31025

Sheet Size : A4

SLR
www.slrconsultingaustralia.com

0 1 2 3 4 5 km

Uncertainty in Predicted 1 m Maximum Incremental Drawdown in Q Seam (Layer 12)

FIGURE 70

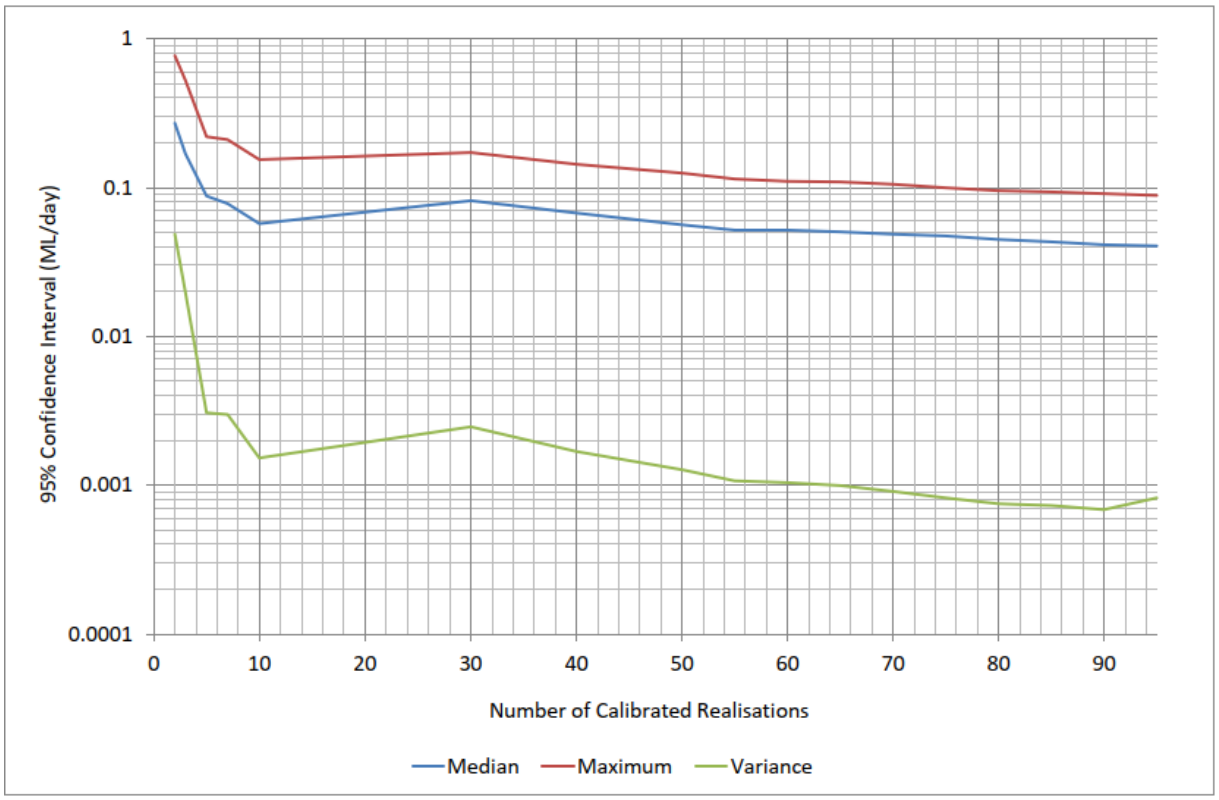


Figure 71 95 % Confidence interval for ingress

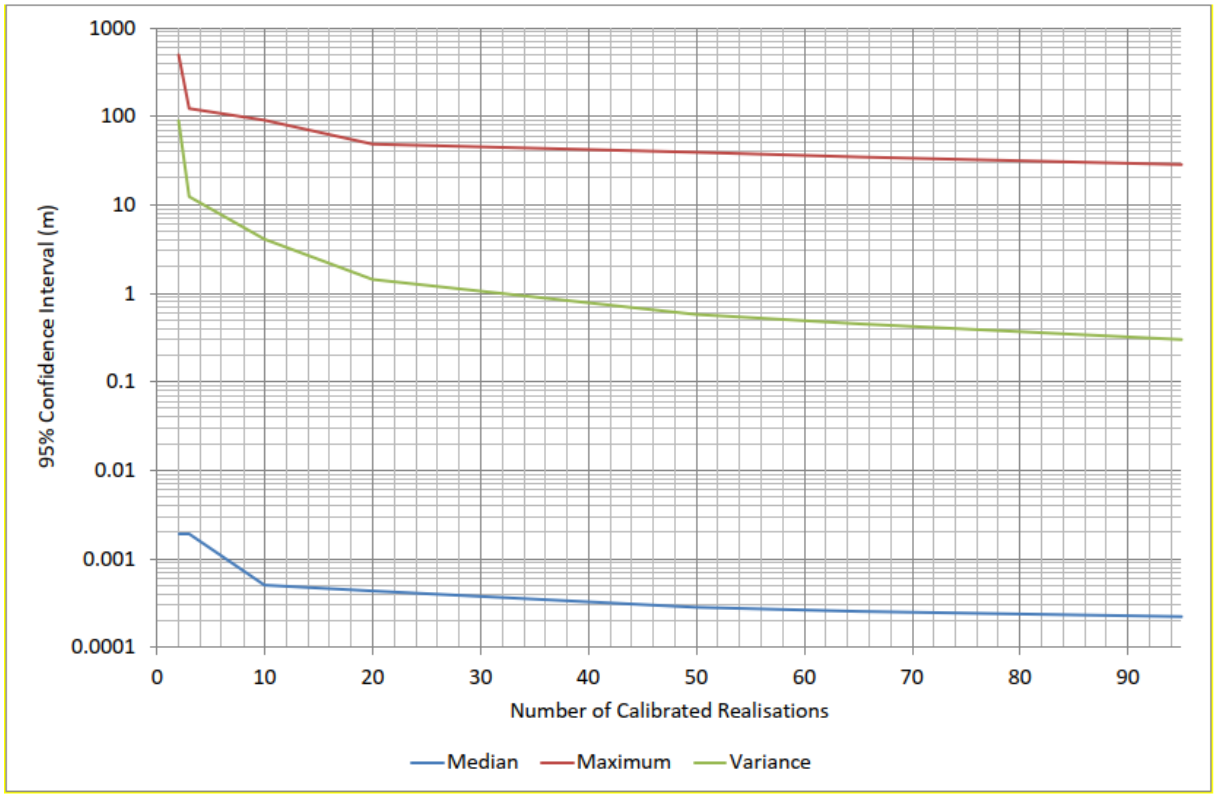


Figure 72 95 % Confidence interval for maximum drawdown

6.7 Predictive modelling conclusions

A numerical groundwater model for the Project was developed using a previously reviewed and accepted numerical groundwater model as the foundation. The numerical groundwater model developed for the Project was reviewed by an independent third party and was deemed to successfully achieved the modelling objectives.

The Project numerical groundwater model covered a large model domain due to extensive historic and approved mining within the Bowen Basin. Existing and approved mines are represented in the model.

The model calibration was undertaken to best match the latest observation datasets. In doing so, new observation data was included in the calibration data set where available. The calibrated model showed an acceptable match between simulated and observed water levels across the model domain and therefore the model parameterisation was considered appropriate for the Project.

The key conclusions from the modelling include:

- Predicted total groundwater inflows to the Project amount to 183 ML/year on average (between 2022 and 2042), reaching a peak inflow of 500 ML/year in 2038.
- No groundwater drawdown is predicted in the alluvium due to the Project.
- Groundwater drawdown in the Tertiary age sediments occurs above the northern longwall panels where the model predicts these sediments are saturated.
- Groundwater drawdown in Permian coal seams is limited to the west due to coal seam sub crops, open cut mining, and extends a maximum of 5 km east and 8 km north and south of the Project footprint.
- No change in surface water flows in the local creeks including Boomerang Creek is predicted due to the Project. Similarly, no change is predicted to surface water flows in the Isaac River due to the Project.

6.7.1 Predictive modelling subsidence uncertainty comments

Modelling of underground mines requires assumptions as to the degree of fracturing above the mined coal seam and the enhancement of permeabilities and storage properties in the fracture zone. As the longwall panel width is broad (320 m) and the cutting height is high (3.6 m), a substantial vertical fracture zone is to be expected. A separate subsidence assessment by Minserve (2022), based on FLAC-3D geotechnical modelling, provided estimates of the degree of subsurface fracturing and surface cracking, as well as estimates of enhanced permeabilities and porosities. These predictions were used to assess potential impacts on alluvium and surface water systems. The uncertainty analysis (Section 6.6) allowed for the evaluation of possible impacts across a range of aquifer parameters. This approach adequately addresses the variation in rock strength considered in the Subsidence modelling (Minserve, 2022) and peer review (Cartledge, 2022).

The alteration of rock parameters due to longwall mining was adopted in the groundwater model, based on the Minserve predictions (Minserve, 2022). The fracture zone, as detailed in Section 4.3.8.4.1, is taken to merge with the cracking zone for D-seam depths of cover less than 300 m, giving continuous vertical connectivity over most of the southern panels and the western half of the northern panels.

As surface cracks are assumed not to heal in the groundwater model, and to be pervasive over the mining footprint, the simulated effects of fracturing/cracking are highly conservative (in the opinion of the groundwater model peer reviewer (HydroAlgorithmics, 2023)). The approach to increase the hydraulic conductivity in the fracture zone during the uncertainty analysis adds to the degree of conservatism.

The conclusions derived in Section 6.7, therefore, include consideration of possible impacts on alluvium groundwater resources and surface water across a range of aquifer (rock parameter) parameters and conclude that:

- There is no discernible drawdown in the alluvium at any level of probability.
- No material impacts on Isaac River or the overlying Boomerang Creek are anticipated at any level of probability.

6.8 Impact assessment

6.8.1 Impacts on groundwater levels

To assess the potential impacts of the Project on groundwater levels the predictive model was used to assess drawdown within selected monitoring bores, both for the Approved and Project model scenarios (as discussed in Section 4.4.6).

The selected monitoring bores, allowing for an assessment of groundwater level change overtime in all three hydrostratigraphic units, included:

- Alluvium monitoring bore – MB20SRM04A
- Tertiary monitoring bores – MB40 **/** MB19SRM02T, MB20SRM02T[15]
- Permian monitoring bores – MB33, MB39 (MB19SRM03P), MB35, MB36, MB34, MB20SRM07P, MB20SRM03P, MB19SRM04P / MB19SRM04P_HY.

The location (Figure 32) and details of these monitoring bores are included in Section 5.3.

Groundwater level simulated within the numerical model included water levels from 1988 to 2096, where:

- 1988 to 2007 was derived from the warm-up model (the transient warm-up model was built to incorporate pre-2008 mining activities and their impacts on groundwater levels around the Project)
- 2007 to 2021 calibration model data
- 2021 to 2044 mining at the Project (noting mining ceases in 2042 and impacts are simulated for 2 additional years to assess goaf impacts)
- Saraji Mine open-cut pits simultaneous mining for 9 years
- 50 years of recovery post-mining.

The groundwater level changes over time were the same for both the Approved and Project model scenarios for MB40 (MB19SRM02T), MB39 (MB19SRM03P), MB36, MB35, MB34, MB20SRM07P, and MB19SRM04P (MB19SRM04P_HY) (Figure 73**).** This indicates the Project is not predicted to impact on groundwater resources intersected within these monitoring bores along strike and along Phillips Creek.

Monitoring bore MB33, located adjacent to the southern longwall panels and down dip of Ebony Pit (Figure 32), is 37.5 m deep. The predicted groundwater level drawdown at this location is included in Figure 74. The Project is predicted to alter the groundwater level within this area by some 23 m compared to the Approved mining, in 2096. The increased depth of mining in the Project will draw the groundwater levels within the target coal seam, resulting in the additional 23 m drawdown in the area. It is noted that monitoring bore MB33 will run dry during both the Approved and Project mining.

Groundwater level predictions down dip of the Project, within the area containing monitoring bores MB20SRM03P and MB20SRM02T, are included in Figure 75. Drawdown predictions at MB20SRM03P indicates groundwater levels will be drawn down to the base of the target D seam, some 400 m below current groundwater levels. The Approved mining is predicted to have an impact on the D seam water levels down dip of Saraji Mine, some 10 m in 2096. The groundwater level will be impacted during the Project, with groundwater levels recovering over time post-mining. Monitoring bore MB20SRM03P is 242.7 m deep and intersects FCCM and MCM coal seams above the target D seam.

Monitoring bore MB20SRM02T, screened across Tertiary and Permian age sediments down dip of the mining (Approved and Project). Drawdown in the Tertiary and FCCM, due to surrounding approved mining, is recognised to reduce groundwater levels in this area (some 3 m in 2096). The indirect impacts of the Project, resulting in induced flow from the overlying sediments to the dewatered mine workings, is predicted to increase the drawdown in these sediments to 10 m in 2096, an increase of 7 m.

[15] MB20SRM02T is recognised to be screened across both Tertiary and Permian sediments



Figure 73 Predicted groundwater level – no change between Approved and Project scenarios

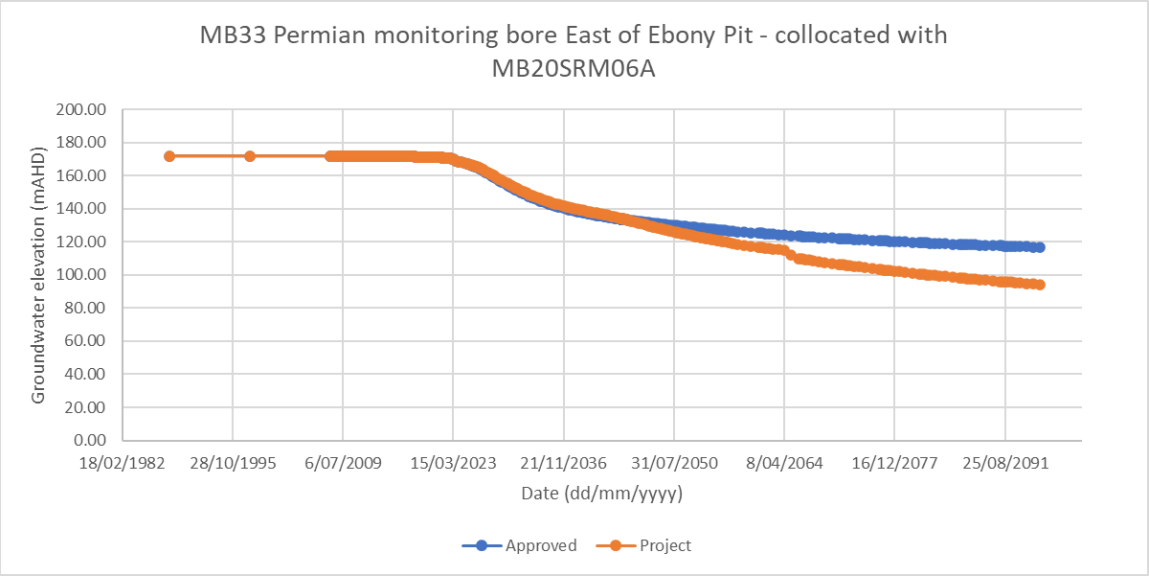


Figure 74 MB33 water level drawdown – Approved and Project mine scenarios

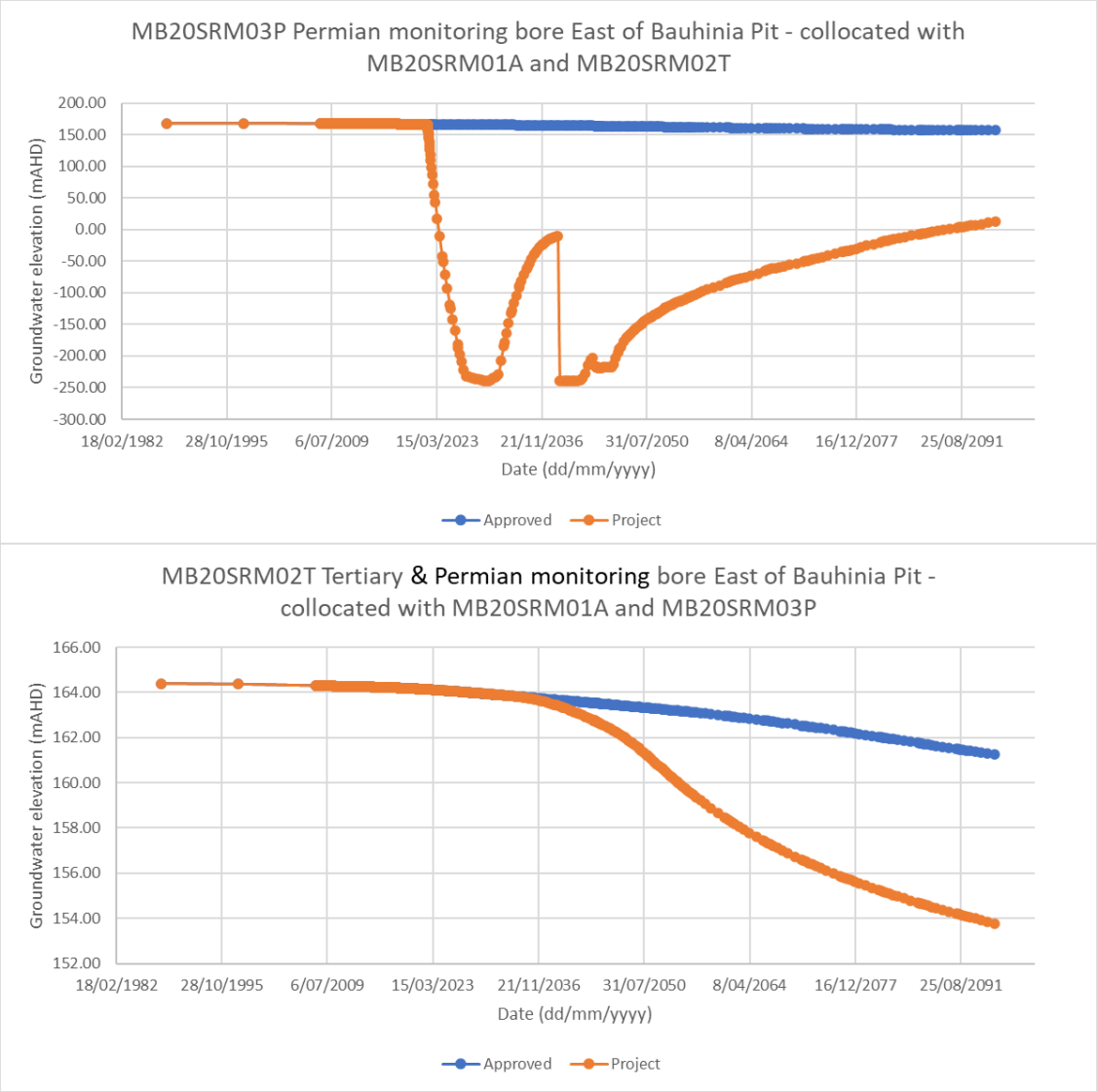


Figure 75 Down dip water level drawdown – Approved and Project mine scenarios

Groundwater level predictions for the Alluvium monitoring bore MB20SRM04A indicates that there is no predicted impact on the alluvium screened within the bore (across silty gravel some 6 to 9 metres below surface). The predicted groundwater levels within the alluvium containing MB20SRM04A, along strike from the Project and immediately adjacent to the Jacaranda Pit, not predicted to be impacted in either the Approved or Project model scenarios Figure 76. This is consistent with the predictive modelling (Section 6.2).

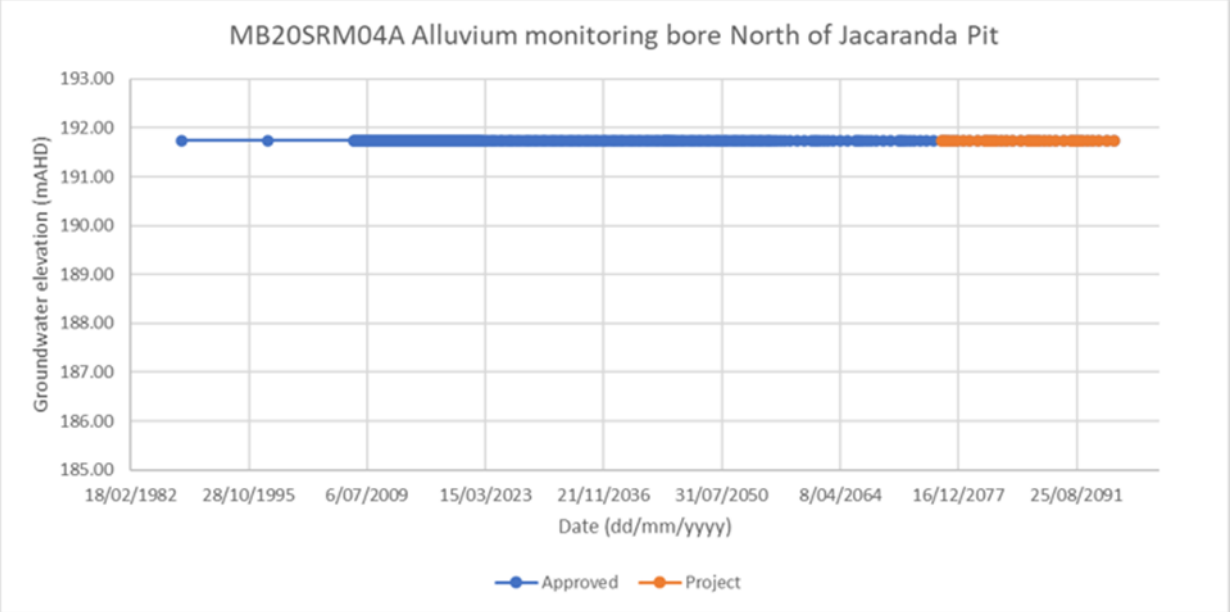


Figure 76 MB20SRM04A – Approved and Project mine scenarios

It is noted that the stable water level for the hydrograph presented in Figure 76 shows no change in predicted water level over time.

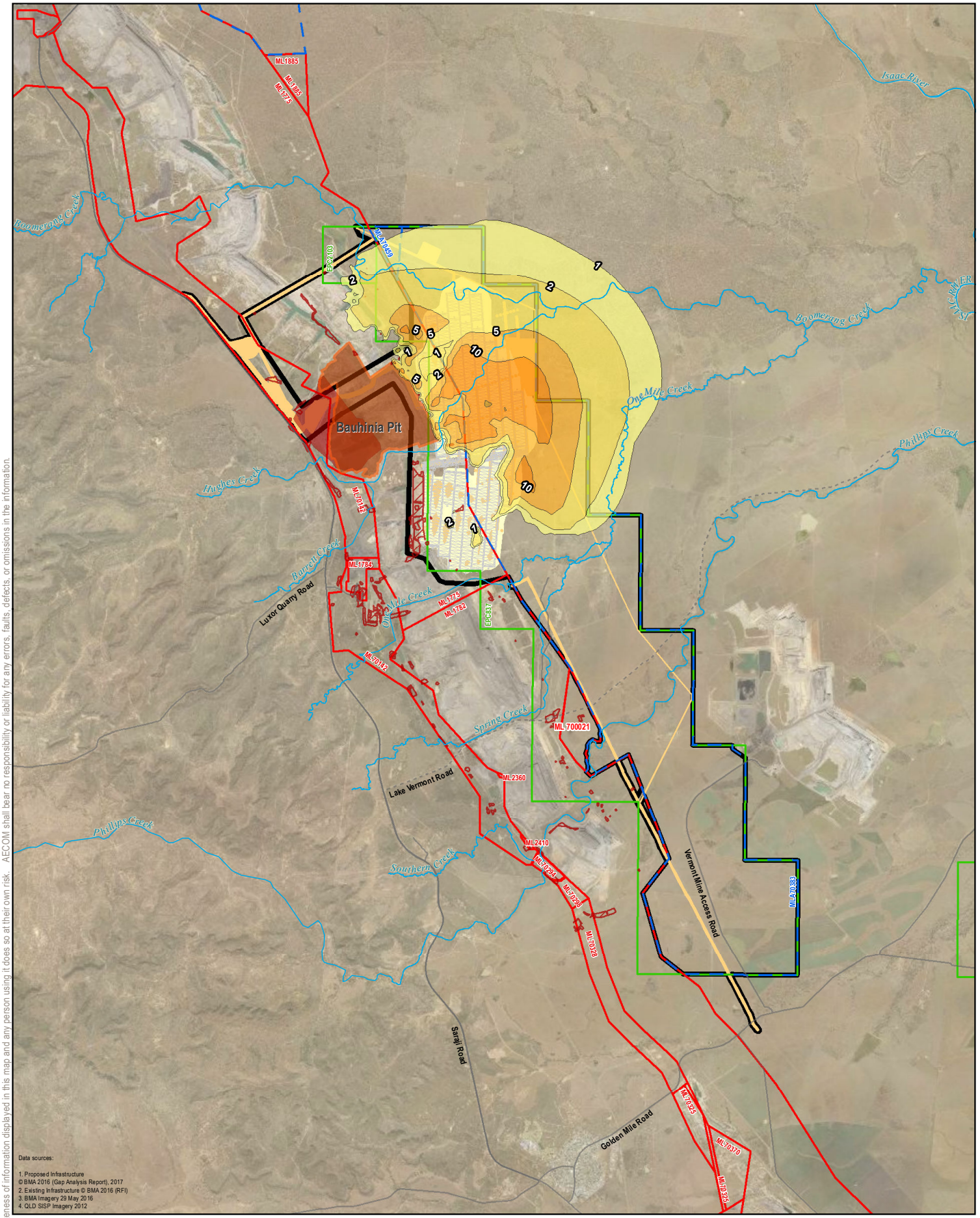
6.8.2 Impacts on Saraji Mine infrastructure

Mine water and waste storage facilities within Saraji Mine are included in Figure 77. No drawdown due to Project in Alluvium is predicted (Figure 54 and Figure 57).

The predicted drawdown within the Tertiary sediments, which can underly the mine water and waste facilities was added to Figure 77 (similar to Figure 48, which considers GDEs).

The predicted drawdown within the Tertiary age sediments, due to Project, does not extend up dip into the Saraji Mine, thus no impact on Saraji Mine water and waste storage facilities is predicted.

No drawdown in the footwall sediments, the Back Creek Group, is predicted to occur as such no drawdown impacts are predicted for any mine water and waste storage facilities located on the Back Creek Group.



Data sources:

1. Proposed Infrastructure
© BMA 2016 (Gap Analysis Report), 2017
2. Existing Infrastructure © BMA 2016 (RFI)
3. BMA Imagery 29 May 2016
4. QLD SISP Imagery 2012

LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Active Pits, Industrial areas and Laydown areas
- Bauhinia Pit
- Tailings and dump footprint

Tertiary Drawdown Contours (m)

- 1
- 2
- 5
- 10
- 20

N

Figure 77
Tertiary Drawdown Predictions and Saraji Mine Water and Waste Storage Facilities
Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G442_v1_A4P.mxd

6.8.3 Impacts on existing groundwater users

Figure 78 shows the location of existing registered bores plus additional bores identified during the bore census in relation to the predicted maximum incremental drawdown in the Tertiary and target D seam, where the predicted maximum incremental drawdown refers to the potential drawdown impact associated with the Project. These predicted maximum incremental drawdown contours are included in Figure 58 and Figure 59.

The predicted drawdown of groundwater levels due to the Project were assessed using the bore thresholds as defined in the Water Act to evaluate potential impacts on neighbouring groundwater bores. Figure 78 shows that there are 24 groundwater bores within the 1 – 2 m predicted maximum incremental drawdown contours for the Tertiary and target D seam units. These groundwater bores include:

- 20 registered bores
- 4 unregistered bores.

Bore details are provided in Table 59.

Of the 24 bores predicted to be impacted, none are identified as potential ‘make-good’ bores for a combination of the following reasons:

- No water supply bores, recognised in Table 22, are located within the Project drawdown zones
- Alluvium bores are either dry or not predicted to be impacted
- They are all located on BMA owned land
- The majority of the bores are for mine monitoring purposes
- Deep bores are screened within the Back Creek Group, which is located below the target D seam and not predicted to be impacted.

It is noted that four unregistered bores, identified during the bore census (Section 5.3.3) are within the predicted Project drawdown zones (refer to Table 21 and Table 22). There is limited data available for these bores, which are located within the BMA lease area. It is unlikely that BMA would require any ‘make-good’ agreements for these bores. Thus, it is unlikely that the Project will have any material impacts on existing groundwater users.

Table 59 Potentially impacted bores located within the predicted maximum incremental drawdown in the Tertiary and target D seam

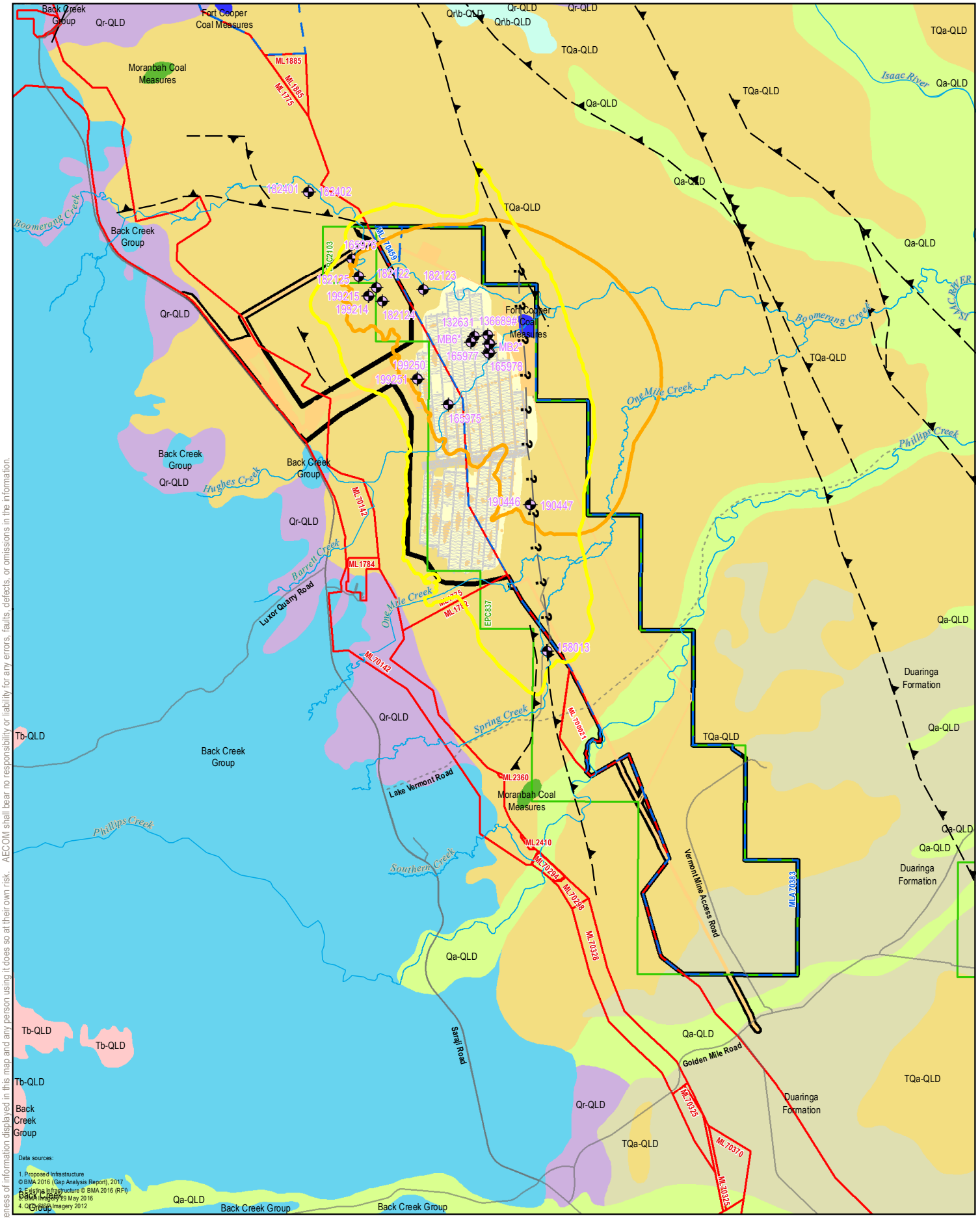
Bore RN	Easting	Northing	Lot/Plan	Land Owner	Depth (mbGL)	Geology	Use	Comment
132631	635440	7528179	10/CNS93	Private Landholder	328	Back Creek Group	Unknown / water supply?	Existing. Screened in Back Creek Group below the MCM and not predicted to be impacted.
136689[#]	635868	7528234	10/CNS93	Private Landholder	328	Duaringa Formation	Unknown / duplicate of 132631?	Existing. Based on depth intersects Back Creek Group below the MCM and not predicted to be impacted.
158013	637781	7518065	1/SP260662	BMA	107	MCM	Monitoring	Existing MB34
182402	630114	7532835	10/SP208611	BMA	10	Quaternary	Monitoring	No drawdown in alluvium due to Project predicted
182401	630100	7532833	10/SP208611	BMA	167	Coal	Monitoring	Screened in Back Creek Group below the MCM and not predicted to be impacted.
165976	631494	7530679	10/SP208611	BMA	12.5	Quaternary	Monitoring	No drawdown in alluvium due to Project predicted
182125	631724	7530111	10/SP208611	BMA	28.5	Tertiary	Monitoring	BH01
182122	632287	7529754	10/SP208611	BMA	32	Tertiary	Monitoring	BH03
199214	632035	7529483	10/SP325345	BMA	40	Tertiary	Monitoring	New monitoring bore 10/2022 in sandstone (EC 27,300 µS/cm)
199215	632044	7529474	10/SP325345	BMA	115	Permian	Monitoring	New monitoring bore 10/2022 in coal (EC 15,500 µS/cm)
182124	632484	7529311	10/SP208611	BMA	38	Tertiary	Monitoring	BH02
182123	633800	7529686	10/CNS93	BMA	34	Tertiary	Monitoring	BH04 on Boomerang Creek
199250	633605	7526818	7/CNS144	BMA	186	Permian	Monitoring	MB 102_02 New monitoring bore 11/2022 in coal and sandstone (EC 13,170 µS/cm)
199251	633605	7526803	7/CNS144	BMA	38	Tertiary	Monitoring	MB 102_01 New monitoring bore 11/2022 in sandstone (EC 18,950 µS/cm)

Bore RN	Easting	Northing	Lot/Plan	Land Owner	Depth (mbGL)	Geology	Use	Comment
165977	635885	7527652	10/CNS93	BMA	242	Permian	Monitoring	MB20SRM03P – drawdown of 400 m predicted as per Figure 75
165978	635945	7527652	10/CNS93	BMA	10.5	Quaternary	Monitoring	MB20SRM01A (MB20SRM01_PZ) – dry alluvium bore on Hughes Creek
165979	635904	7527647	10/CNS93	BMA	36.5	Tertiary	Monitoring	MB20SRM02T – drawdown of 7 m predicted as per Figure 75.
165975	634596	7525982	7/CNS144	BMA	24	Quaternary	Monitoring	MB20SRM05A / MB20SRM05A_PZ – dry alluvium bore on Hughes Creek
190446	637223	7522750	101/SP310393	BMA	33.8	FCCM	Monitoring	SRMMB12_01
190447	637251	7522750	101/SP310393	BMA	232.8	MCM	Monitoring	SRMMB12_03
MB2*	635924	7527947	9/CNS98	BMA	60.94	Unknown	Unknown	Identified during Bore Census
MB3*	635935	7527947	9/CNS98	BMA	50	Unknown	Unknown	Identified during Bore Census
MB4*	635924	7527936	9/CNS98	BMA	27.1	Unknown	Unknown	Identified during Bore Census
MB6*	635327	7527997	10/CNS93	BMA	-	Unknown	Equipped	Identified during Bore Census

Table notes:

[#] Formation determined from geological log from adjacent bore RN132631

* Bore has no registered number



LEGEND

- Project Site
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Watercourse
- Private Access Road
- Public Road
- Potentially impacted bores
- Maximum drawdown in the D-Seam
- Maximum drawdown in the Tertiary Layer
- Fault
- Inferred Fault

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- Qrlb-QLD (Qrlb)
- TQa-QLD (TQa)
- Tb-QLD (Tb)

Figure 78
Bores located within the predicted maximum incremental drawdown in the Tertiary and target D seam
Groundwater Technical Report
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:158,094 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 3

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G445_v3_A4P.mxd

6.8.4 Cumulative impacts

Cumulative impact assessments are highly specific to the impact under analysis and may consider, for example, the following (Franks et al, 2010):

- Multiple areas of groundwater abstraction (e.g. adjacent mining operations)
- Overlapping cones of drawdown
- Dewatering discharge locations
- Distributions of ecosystems around the project
- Catchment-scale groundwater levels.

6.8.4.1 Local scale cumulative drawdown

The results of the predictive modelling, considering the Approved Saraji Mine and the Project, shows the following:

- Additional ingress because of proposed underground operations is 161 ML/year (0.4 ML/day) based on the model water balance data in Section 6.2.3.
    - Groundwater outflow from the model mostly occurs via drain cells, used to simulate the open cut and underground mining activity in the model. Table 54 and Table 55 show that the Project (Project model scenario) resulted in an increase in the average drain outflow (33.5 ML/day from 33.1 ML/day predicted for the Approved model scenario.
- Groundwater drawdown contours will extend further to the east and north.
    - The additional drawdown predicted to occur as a result of the Project, the maximum incremental drawdown, was determined by comparing the difference in predicted groundwater levels for the Approved model scenario and the Project model scenario at matching times (Section 6.2.6).

Mapping of the maximum incremental drawdown in the Tertiary (Figure 58) and the target D seam (Figure 59). The drawdown predicted within Tertiary (Figure 58) extends to the east and is different to the predicted drawdown in the target D seam (Figure 59), which extends along strike and is influenced fault structures. The drawdown indicates that the faults are located within the more competent Permian bedrock and do not extend into the younger Tertiary age sediments.

6.8.4.2 Regional model scale cumulative drawdown

The maximum cumulative drawdown predictions indicate the potential impacts on the Tertiary and target D seam (no drawdown in the alluvium due to the Project is predicted) due to the existing approved mining within the model domain. The simulated cumulative drawdown shows whether the zone of impact from all the neighbouring mine operations within the model is predicted to interact with the predicted Project zone of impact in the Tertiary and the target D seam (as detailed in Section 6.2.7).

The maximum cumulative drawdowns represent the total impact to modelled groundwater levels resulting from all mining within the model domain. These drawdown predictions are derived by comparing the maximum difference in hydrostratigraphic unit groundwater levels for the Project model scenario with those in the theoretical “no mining” Null Run scenario, for all times during the predictive model period.

The evaluation of cumulative impacts on the regional model scale indicated:

- The vast majority of these predicted cumulative drawdown impacts are not related to the Project but result from existing mining activities represented in the model.
- There are no cumulative drawdown impacts predicted for the Quaternary alluvium within or adjacent to the Project footprint.

Cumulative drawdown impacts within the Tertiary (Figure 61)

- indicate that the Project-related drawdown extends and interacts with the drawdown associated with the Peak Downs Mine and Saraji Mine open-cut pits.

The maximum predicted cumulative drawdown in the target D seam is predicted to interact with zone of impact from the Peak Downs Mine and Saraji Mine open-cut pits (Figure 62)

- This cumulative drawdown is predicted to elongate along the north-south trending fault located adjacent to the Project footprint.

6.8.4.3 Distributions of ecosystems around the Project

Based on site-specific field data, it is concluded that:

- Terrestrial GDEs are present on Phillips Creek and were identified on Hughes Creek mapped as intruding marginally into EPC837. These Terrestrial GDEs host variable groundwater volumes associated with the alluvium and are seasonally recharged via surface flows and flooding.
- No specific impediment to tree water use of Tertiary or Permian groundwater is recognised based on salinity values.
- There is no indication that Phillips Creek represents an Aquatic GDE.
- Vegetation on Tertiary plains has limited potential for groundwater dependency, due to both the shallow rooted nature of the dominant vegetation and the depth to the groundwater table.
- Vegetation fringing One Mile Creek and adjacent woodland are being supported within the unsaturated portion of the soil profile.
- Vegetation fringing Hughes Creek does not meet the hydrological or ecological criteria for a Terrestrial GDE.
- Within the Project Site, the alluvium landform hosting Hughes, Boomerang, and Plum Tree creeks is extremely shallow.
- The Boomerang Creek wetland is a surface feature and there is no indication of any surface water and groundwater interaction.
- The assessment identified that there are no significant residual impacts predicted to any prescribed environmental matters under relevant state or federal legislation including both MSES and MNES.

The assessment of predicted groundwater impacts were assessed and indicate that the potential risk to GDE's posed by Project is 'Low to Insignificant'.

6.8.4.4 Catchment-scale groundwater levels

Long term groundwater levels are predicted to be influenced by the Saraji Mine final voids, which act as groundwater 'sinks' because of water loss through evaporation. This maintenance of a pseudo-steady pit water level will maintain cones of drawdown immediately around the final voids.

6.8.5 Impacts on groundwater quality

During mining, a cone of depression will develop around the underground mining footprint due to incidental mine gas management (coal seam groundwater extraction) and mine dewatering. This will result in localised groundwater flow into the underground workings. The risk of water contained in the underground panels (a blend of groundwater from different strata) impacting on groundwater quality, away from the underground workings is, therefore, limited.

Due to the poor water quality (i.e. high salinity) groundwater within the Project Area, it is unlikely that there will be a marked alteration in water quality due to blending / mixing within the cone of depression predicted to envelop the underground workings. It is noted, based on available groundwater level and water quality data, that induced flow potential is limited.

The mixing of groundwater types from the three different hydrostratigraphic units (Tertiary, and Permian), if it occurs, would not markedly impact upon any existing groundwater environmental values.

6.8.6 Potential environmental impacts

The potential environmental impacts of the proposed Project are considered low as:

- The surface water system in the Project Area is ephemeral and limited surface water – groundwater interaction is evident, particularly related to GDEs
- The Quaternary age alluvium is thin, discontinuous and sporadic across the Project footprint. The thicker saturated (in places) alluvium associated with the Phillips Creek are located outside the predicted drawdown resulting from the Project

- The clay-rich Tertiary sediments have low recharge potential and low permeability resulting in insufficient yield and low usage potential
- The predicted drawdown within the target D seam is predicted to elongate along strike and does not extend to the Isaac River to the east. The Project is not predicted to impact on the Isaac River or associated alluvium groundwater resources
- The groundwater quality in the three hydrostratigraphic units present within the Project Area is not suitable for drinking, too deep for terrestrial ecosystems, and is often too saline for livestock watering
- The surface water systems are separated from the predicted impacted groundwater resources by low permeable sediments, which reduce the potential for the Project to impact on the alluvium and surface water flows.

Summary

The proposed underground mine is predicted to have long term locally contained impacts on the quantity and quality of groundwater resources on the Project area. These impacts include:

- Localised drawdown due to mining of underground panels
- Blending (mixing of groundwater from the different hydrostratigraphic units) within the underground mine footprint.

To protect against unexpected impacts and ensure ongoing validation of the predictive modelling in the vicinity of the proposed underground workings, it is considered that ongoing groundwater monitoring during and after the Project development be conducted.

The groundwater monitoring approach, including adaptive management and the instigation of further investigations, is detailed in Section 7.0.

7.0 Mitigation measures

7.1 Groundwater monitoring bore network

In summary, the impacts that require ongoing monitoring include:

- Shallow Quaternary age alluvium groundwater levels and quality
- Tertiary groundwater levels and quality
- Permian coal seam target D seam groundwater levels and quality.

Based on the predictive modelling, which allowed for the assessment of additional groundwater drawdown due to the Project (Section 6.2.6), no impact on the existing Saraji Mine water and waste storage facilities is predicted. As these mine water and waste storage facilities are up dip or on Back Creek Group sediments, the drawdown associated with the Project will not extend to these facilities. As such, no Project related groundwater monitoring is proposed for the existing Saraji Mine water and waste storage facilities.

7.1.1 Groundwater Monitoring Plan

A Groundwater Monitoring Program (GMP) will be developed to ensure an appropriate level of detail and scale. The purpose of the GMP will be to monitor the magnitude and distribution of actual changes to groundwater resources in response to the Approved and Project mining and to provide early detection of any unforeseen impacts to groundwater levels, groundwater ingress, or groundwater quality.

The selected groundwater monitoring bore network, to be included in GMP, will monitor potential effects of the proposed Project on overlying and underlying hydrostratigraphic units, so that informed management decisions can be made.

The fundamental components of the GMP are as follows:

- The monitoring bore network and subsequent monitoring program will be developed and established prior to the commencement of the Project underground mining.
    - Baseline seasonal trends for groundwater levels and quality will continue to be collected for the monitoring bores installed in 2019 and 2020.
    - Data from Saraji Mine groundwater bores will be used, as included in this EIS report, to detail the current groundwater quality prior to the Project commencement.
    - This groundwater quality data will be used as comparison with the groundwater quality data compiled during the Project (construction and operation) to assess potential impacts or alteration.
- Where appropriate, groundwater level and quality data from existing monitoring bores will be incorporated into the monitoring data compiled in the GMP.
    - As some drawdown impacts are predicted for registered bores, representative private bores (or new sentinel sites) are likely to also be incorporated into the monitoring bore network.
- Site-specific groundwater quality will be monitored to determine additional bore specific trigger levels, evaluate spatial and temporal trends, and gauge whether water quality objectives are being protected or enhanced.
    - An objective of the GMP will be to detect possible water quality change trends, which could materially change water quality (i.e., no longer able to meet WQOs or current use) due to the Project.
- There are no local springs or aquatic GDEs to monitor.

7.1.1.1 Cumulative impact considerations

The GMP will include, based on the mines up dip and along strike of the Project are all owned and operated by BMA, opportunities to combine groundwater monitoring data, refine the regional Bowen Basin groundwater models and model predictions, and assess mining operations to evaluate potential cumulative impacts.

The more regional groundwater monitoring, which allows BMA to detect and monitor potential groundwater related cumulative impacts, will assist in developing mine operation and closure plans to avoid, minimise, or mitigate pre- and post-closure impacts.

7.1.2 Existing monitoring bores

A summary of the current groundwater monitoring bores, and the relevant hydrostratigraphic unit, to be included in Project GMP is included in Table 60. Figure 79 shows the location of these existing monitoring bores.

Table 60 Existing groundwater monitoring bores for the Project

Bore ID	Easting (GDA94)	Northing (GDA94)	Monitoring Period	Elevation (mAHD)	Depth (mbgl) / screen depths	Geology	Purpose	Location
MB34	637926	7518269	2013 -ongoing	195.9	107.0 99.5 to 105.5 mbgl	Moranbah Coal Measures interburden Model Layer 13	Validate model predictions	Along strike from Project underground on One Mile Creek
MB33	636640	7520199	2013 - ongoing	194.8	37.5 30 to 36 mbgl	Moranbah Coal Measures Q seam Model Layer 12	Validate model predictions (Figure 74)	Along strike between Project underground and Philipps Creek
MB38 / MB19SRM01A	639919	7515681	2019 - ongoing	194.41	8.5 5.5 to 8.5 mbgl	Alluvium Model Layer 1	Validate dry alluvium	On Phillips Creek
MB20SRM04A	631397	7530470	2019 - ongoing	194.95	12.0 6.5 to 9.5 mbgl	Alluvium Model Layer 1	Validate no impact on alluvium	Along strike from Project underground
MB20SRM01A / MB20SRM01 / MB20SRM01_PZ	635922	7527665	2019 - ongoing	186.42	10.5 7.2 to 10.2 mbgl	Alluvium Model Layer 1	Validate dry alluvium	On Plumtree Creek
MB20SRM05A/ MB20SRM05A_PZ	634476	7525798	2019 - ongoing	191.43	24.0 6.5 to 9.5 mbgl	Alluvium Model Layer 1	Validate dry alluvium	On Hughes Creek
MB20SRM02T	635914	7527670	2019 - ongoing	186.61	36.5 27.5 to 36.5 mbgl	Tertiary Model Layer 2	Validate model predictions (Figure 75)	Above the Project
MB20SRM03P	635907	7527677	2019 - ongoing	185.87	242.7 231 to 237 mbgl	Moranbah Coal Measures P seam Model Layer 14 & 15	Validate model predictions (Figure 75)	Above the Project



Data sources:
1. Tenements © BMA 2016 (RFI)
2. Geology © State of Queensland (Department of Natural Resources and Mines) 2016

LEGEND

- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Existing Open-Cut Extent
- Fault
- Existing Bore

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- German Creek Formation (Pbd)
- MacMillan Formation (Pbn)
- Moranbah Coal Measures (Pwb)
- Peak Range Volcanics (Tp)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- Qr\b-QLD (Qr\b)
- TQa-QLD (TQa)
- Tb-QLD (Tb)

Figure 79
Existing Groundwater Monitoring Bores to be Included in the Project GMP
Groundwater Technical Report
Saraji East Mining Lease Project

0 1 2 4
Kilometres

Scale: 1:200,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

7.1.3 Existing water level monitoring

Groundwater level measurements are collected manually from monitoring wells located across the site. Manual readings are procured during each monitoring event (prior to any sampling).

Historic data indicates automated readings via dedicated level logger have been used. It is recommended that these be reinstated and that these loggers are programmed to collect static water level (SWL) measurements at least once a week.

7.2 Additional groundwater monitoring requirements

The existing groundwater monitoring network will be augmented near the proposed underground mine (and over time) to ensure the following:

- The determination of groundwater level responses to mine activities within the Project Area. The comparison of water level decline will allow for the identification of groundwater resources, which may be unduly affected by mine dewatering; unduly affected is where drawdown is projected to be greater than the model predictions.
- The extent and magnitude of drawdown in each hydrostratigraphic unit near the proposed underground workings is adequately monitored for comparison to modelled projections over time.
- The identification and management of any potential impacts on surface water.
- The groundwater monitoring network will, during operations, act as an early warning system for potential drawdown impacts. The monitoring bore network augmentation will ensure the replacement of monitoring points that are lost during mining, and the groundwater monitoring program is to be modified in response to mine activities change (i.e. operations or closure).

7.2.1 New groundwater monitoring bores

To ensure the collection of representative groundwater monitoring data, allow for the assessment of the potential predicted impacts of the Project on local groundwater resources, and consider the existing groundwater monitoring bore network, additional monitoring bores are required prior to the Project mining activities. These new monitoring bores are detailed in Table 61 and shown in Figure 80.

Table 61 New Project monitoring bores

Recommended bore	Easting	Northing	Model Layer	Target
SEMLP1T	637628	7528964	Model Layer 2	Tertiary sediments adjacent to Boomerang Creek, within the mapped fault
SEMLP1P	637735	7528962	Model Layer 18	Target D seam, adjacent to Boomerang Creek, and within the mapped fault (Figure 20).
SEMLP2T	637672	7523955	Model Layer 2	Tertiary sediments, within the inferred fault (Figure 22)
SEMLP2P	637863	7524055	Model Layer 18	Target D seam, within the inferred fault (Figure 22)

These proposed bores are to be located down dip of the Project underground mine panels and along the inferred fault, as discussed in Section 5.2.2 and included on Figure 80.

These monitoring bores will allow for:

- The verification of drawdown within the Tertiary and target D seam
- The assessment of the fault (and possible refinement of the model)
- The evaluation of the fault in terms of influence on drawdown (i.e., groundwater level change due to compartmentalisation, elongation along fault, or across the fault)
- Assessment of vertical gradients and potential induced flow (from Tertiary to Permian)
- Evaluation of potential blending of groundwater quality
- Recovery (post-closure).

7.2.2 Bore design and drilling

All monitoring bores are to be drilled using a water bore drilling rig, using mud-rotary, air-percussion or other appropriate techniques. The groundwater monitoring bores are to be designed in accordance with the Minimum Construction Requirements for Water Bores in Australia, 4th Edition (National Uniform Drillers Licensing Committee, 2020) or as current.

Consideration must be given to casing and annular seal requirements to ensure that no pathway is provided for the movement of water between hydrostratigraphic units (i.e. the bore does not act as a connecting pathway).

7.3 Groundwater monitoring bore network assessment

The proposed groundwater monitoring bore locations are illustrated in Figure 80, whilst the overview of the groundwater monitoring program is shown in Figure 81.

The groundwater monitoring bore network, both existing and proposed bores, is summarised in Table 62.

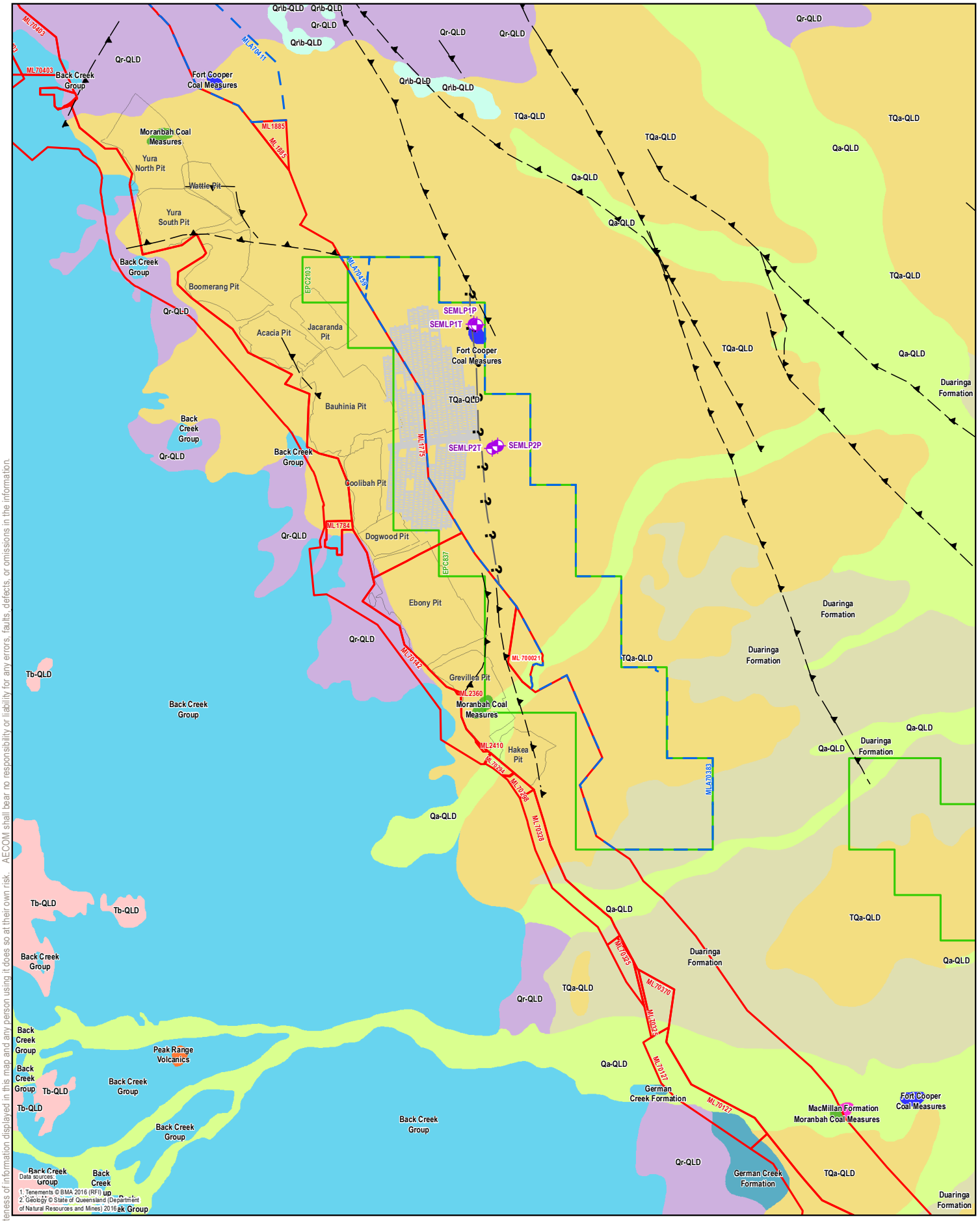


Figure 80
Proposed Monitoring Bores

Groundwater Technical Report
Saraji East Mining Lease Project

BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 2

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

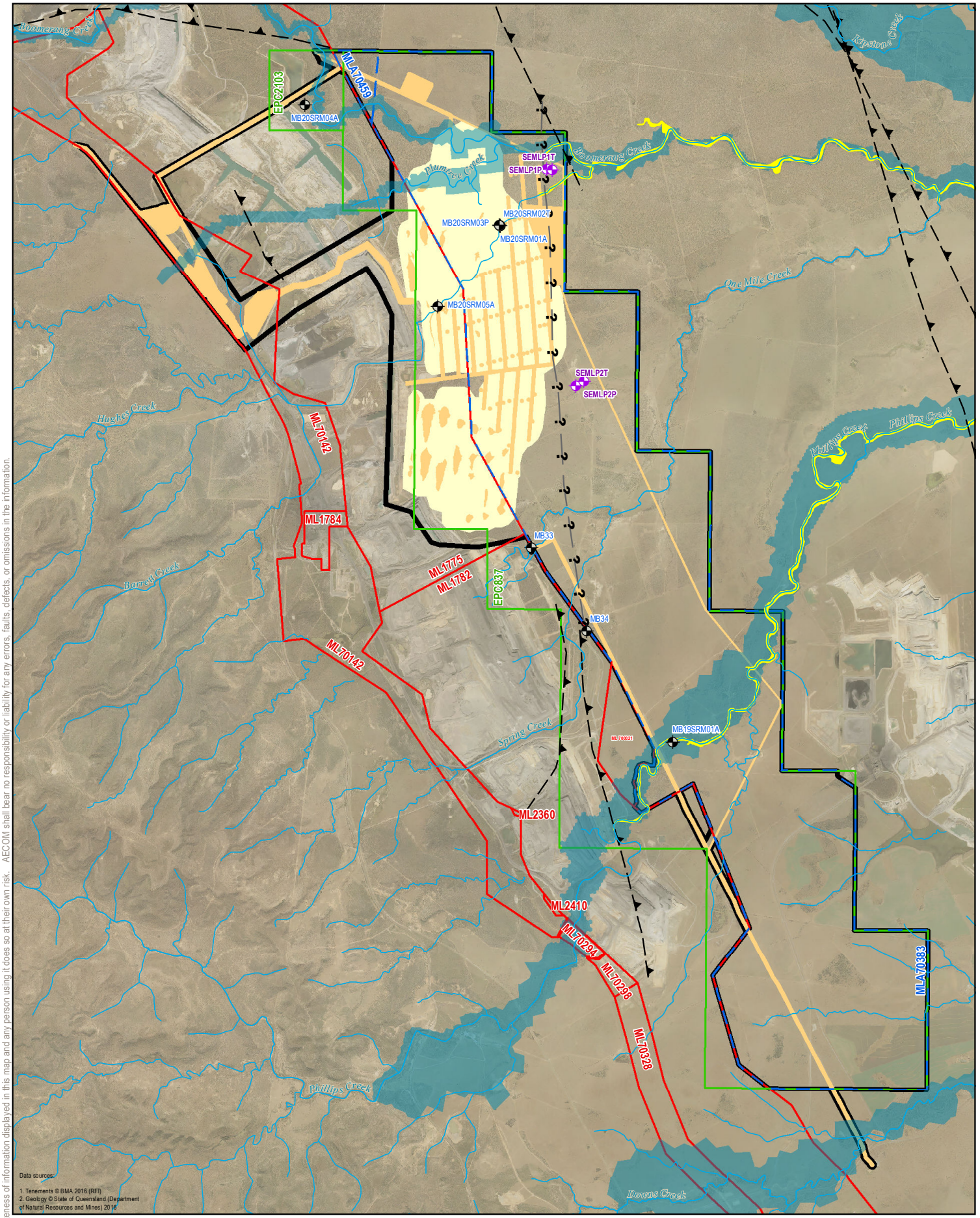
Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G201_v2_A4P.mxd

Table 62 SEMLP Groundwater monitoring bore network summary

Bore ID	Easting (GDA94)	Northing (GDA94)	Monitoring Period	Elevation (mAHD)	Depth (m)	Geology	Purpose	Location
Existing								
MB34	637926	7518269	2013 - ongoing	195.9	107.0	Moranbah Coal Measures interburden	• Validate model predictions (Figure 73) • Assess dewatering trend (9 m decline over time) - located on possible fault leading to preferential drawdown	Along strike from Project underground on One Mile Creek
MB33	636640	7520199	2013 - ongoing	194.8	37.5	Moranbah Coal Measures Q seam	• Validate model predictions (Figure 74) • Assess groundwater recharge, influence of cracking and ponding • Predicted to go dry	Along strike between Project underground workings and One Mile Creek and Philipps Creek
MB38 / MB19SRM01A / MB19SRM01A_HY	639919	7515681	2019 - ongoing	194.41	8.5	Alluvium	• Validate water level (dry /wet) condition of alluvium • No impact predicted – validate no impact due to the Project noting Saraji Mine Grevillea Pit expansion impacts likely	On Phillips Creek
MB20SRM04A	631397	7530470	2019 - ongoing	194.95	12.0	Alluvium	• Validate no impact on alluvium upstream on Boomerang Creek of the Project (Figure 76)	Along strike and up dip of Project underground
MB20SRM01A (MB20SRM01_PZ)	635922	7527665	2019 - ongoing	186.42	10.5	Alluvium	• Validate dry alluvium • Assess groundwater recharge, influence of cracking and ponding • Predicted to remain dry	On Plumtree Creek
MB20SRM05A / MB20SRM05A_PZ	634476	7525798	2019 - ongoing	191.43	24.0	Alluvium	• Validate dry alluvium • Assess groundwater recharge, influence of cracking and ponding	On Hughes Creek

Bore ID	Easting (GDA94)	Northing (GDA94)	Monitoring Period	Elevation (mAHD)	Depth (m)	Geology	Purpose	Location
							• Predicted to remain dry	
MB20SRM02T	635914	7527670	2019 - ongoing	186.61	36.5	Tertiary	• Validate model predictions (Figure 75) • Assess groundwater recharge, influence of cracking and ponding	Above the Project
MB20SRM03P	635907	7527677	2019 - ongoing	185.87	242.7	Moranbah Coal Measures P seam	• Validate model predictions (Figure 75) • Assess rate and fluctuation of groundwater level as per predictions in response to mine plan	Above the Project
Proposed								
SEMLP1T	637628	7528964	-	TBC	TBC	Tertiary	Tertiary sediments adjacent to Boomerang Creek, within the mapped fault	
SEMLP1P	637735	7528962	-	TBC	TBC	D seam	Target D seam, adjacent to Boomerang Creek, and within the mapped fault (Figure 20).	
SEMLP2T	637672	7523955	-	TBC	TBC	Tertiary	Tertiary sediments, down dip of the Project and adjacent to the inferred fault (Figure 22). Assess fault barrier or preferential drawdown	
SEMLP2P	637863	7524055	-	TBC	TBC	D seam	Target D seam, down dip of the Project and adjacent to the inferred fault (Figure 22). Assess fault barrier or preferential drawdown	

Table note: TBC – to be confirmed.



LEGEND

- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- Alluvium extent
- Existing Bores
- Proposed Bores
- Fault
- Inferred Fault

Areas of Known Potential

- Known / Likely GDE (Type 1)

Figure 81
Proposed Monitoring Program Overview

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:114,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 0

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\F-1 Groundwater Technical Report\60507031_G454_v0_A4P_RePathed.mxd

7.3.1 Groundwater level change over time

To assess the longevity of these selected groundwater monitoring bores predictions of groundwater level change over time within each of the monitoring bores was conducted using the predictive groundwater model. The modelling allowed for:

- The prediction of maximum drawdown within each of the hydrostratigraphic units screened within the monitoring bores.
- The prediction of changes in groundwater level over time, using the calibration water level data from 2008 to 2024 and prediction data to 2501.
- Evaluation of groundwater level against the top and bottom elevations of the hydrostratigraphic unit monitored at each monitoring bore location.

A summary of the groundwater model predictions for each of the monitoring bores is included in Table 63.

7.3.1.1 Comment and recommendations

The cumulative drawdown predictions for each groundwater monitoring bore selected for the SEMLP, as included in Table 63, indicate there may be need to modify the groundwater monitoring bore network over time, to ensure assessment of impacts, validation of groundwater modelling, and to allow for informed decision making regarding management and mitigation measures.

The groundwater level predictions for the SEMLP groundwater monitoring bore network indicates:

- MB34 (an existing Saraji Mine EA monitoring bore)
  - This bore is predicted to run dry in 2032.
  - It is not recommended to drill this bore deeper as the MCM interburden at this location is predicted to run dry in 2036.
  - A replacement monitoring bore is recommended, to be installed into the MCM interburden adjacent to MB35 (Figure 46) in 2032 (in agreement with Saraji Mine).
- MB33 (an existing Saraji Mine EA monitoring bore)
  - This bore is predicted to run dry in 2029.
  - Not recommended to be drilled deeper as the unit will run dry.
  - It is considered that SEMLP2P will provide MCM groundwater monitoring, further down dip, in proximity to this bore (Figure 80).
  - Based on SEMLP2P and predicted poor groundwater recovery it is not considered necessary to replace MB33 once it runs dry.
- No longevity risks are recognised with regards to the alluvium monitoring bores (MB19SRM01A, MB20SRM04A, MB20SRM01A (MB20SRM01_PZ), and MB20SRM05A (MB20SRM05A_PZ))
- Long term groundwater monitoring can be conducted at MB20SRM02T, MB20SRM03P, SEMLP1T, SEMLP1P, SEMLP2T, and SEMLP2P.

Table 63 Groundwater level prediction summary

Bore ID and Target unit	Bore depth	Screen depth / Screen interval	Model Layer and depth	Predicted drawdown and timing
MB34 MCM interburden	107 mbgl	96.4 to 90.4 mAHD	Layer 13 99 to 94 mAHD	The groundwater level will decline below the screened section of the bore in 2032 and below the bottom of the MCM interburden in 2036 Groundwater level recovery above the bottom unit elevation in 2156 and is predicted to recovery to within the screened section in 2351
MB33 MCM Q seam	37.5 mbgl	164.8 to 158.8 mAHD	Layer 12 170 to 115 mAHD	The groundwater level will decline below the screened section of the bore in 2029 and below the bottom of the MCM Q seam in 2070 Groundwater level recovery above the bottom unit elevation is predicted after 2401. The groundwater level is not predicted to recovery to within the screened section
Alluvium bores • MB19SRM01A, • MB20SRM04A • MB20SRM01A (MB20SRM01_PZ) • MB20SRM05A (MB20SRM05A_PZ)	 • 8.5 mbgl • 12 mbgl • 8.5 mbgl • 24 mbgl	 • 188.91 and 185.91 mAHD • 188.45 and 185.45 mAHD • 179.22 and 176.22 mAHD • 184.93 and 181.93 mAHD	Layer 1	No drawdown is predicted
MB20SRM02T Tertiary sediments	36.5 mbgl	159.11 to 150.11 mAHD	Layer 2 184 to 150 mAHD	The groundwater level will decline below the screened section and the bottom of the Tertiary after 2141 Groundwater level recovery above the bottom unit elevation is not predicted
MB20SRM03P MCM P seam	242 mbgl	- 45 to – 51.13 mAHD	Layer 14 and 15 -46 to -42 mAHD	The groundwater level is not predicted to decline below the screened section or the bottom of the P seam.
Proposed SEMLP1T Tertiary sediments	-	140 to 134 mAHD	Layer 2 176 to 134 mAHD	The groundwater level is not predicted to decline below the screened section or the bottom of the Tertiary unit.

Bore ID and Target unit	Bore depth	Screen depth / Screen interval	Model Layer and depth	Predicted drawdown and timing
Proposed SEMLP1P MCM D seam	-	-525 to -531 mAHD	Layer 18 -524 to -531 mAHD	The groundwater level is not predicted to decline below the screened section or the bottom of the D seam.
Proposed SEMLP2T Tertiary sediments	-	157 to 151 mAHD	Layer 2 183 to 151 mAHD	The groundwater level is predicted to decline below the screened section and the bottom of the Tertiary after 2085 Will allow for model validation
Proposed SEMLP2P MCM D seam	-	-307 to -301 mAHD	Layer 18 -292 to -301 mAHD	The groundwater level is not predicted to decline below the screened section or the bottom of the D seam.

- to be determined

7.4 Surface cracking

The groundwater assessment, using predictive groundwater modelling and uncertainty analysis, identified that there is no discernible drawdown in the alluvium and no material impacts on surface water creeks are anticipated at any level of probability.

The assessment assessed the scenario of continuous vertical connectivity (cracks from surface and cracks upward from the goaf) over the shallowest panels (<300 m deep) which will experience the largest subsidence. In addition, the surface cracks were assumed not to heal in the groundwater model, and to be pervasive over the mining footprint, thus the simulated effects of fracturing/cracking (upward from the goaf and downward from the surface subsidence) are highly conservative.

Although the alteration of the overlying geological units, due to longwall mining, have been assessed through a range of differing model layer parameters in the uncertainty analysis, BMA have included a subsidence monitoring program to actively manage surface cracks, thus reducing the potential for surface water – groundwater interaction.

The Project's Subsidence Management Plan (BMA, 2024) includes the monitoring proposed to be undertaken as part of subsidence management. The SMP includes surface crack repairs. Monitoring of the Project area, including waterways within the Project area, will occur during the operational phase of the Project to identify cracks and assess the type/amount of work needed to repair individual surface cracks. Cracks obscured by alluvial sediment within waterways may not be able to be identified visually, however, any adverse environmental impacts that occur as a result of these cracks will be identified through other forms of monitoring (e.g. streamflow monitoring, groundwater monitoring, erosion monitoring, riparian vegetation monitoring, etc).

Surface assessment above the longwall panels will be conducted to identify smaller cracks (e.g. less than 50 mm) to determine if repair is required or if the safety and environmental risks associated with the smaller cracks are negligible. Areas disturbed by surface crack repair works will be monitored to ensure that they re-establish vegetation and achieve rehabilitation completion criteria.

7.4.1 Current understanding

For longwalls, such as the Project and Broadmeadow Mine in the Bowen basin, with large width to depth ratios cracking is expected at the surface. Open cracking may be parallel and close to the panel edges (longitudinal fractures) or parallel to the face line (arcuate fractures) (Plate 8).

BMA have adopted the following approach at Broadmeadow Mine (Broadmeadow Subsidence Management Plan BRM-PLN-0016):

- Subsidence cracks in the landscape will be managed according to erosion risk and likelihood of self-repair / healing. Mechanical ripping and disturbance within the landscape will be limited and targeted to those areas of high erosion risk and low probability of self-repair.
- The basis for this approach is to minimise the risk of secondary erosion issues developing from land and vegetation disturbance associated with ripping and ploughing.

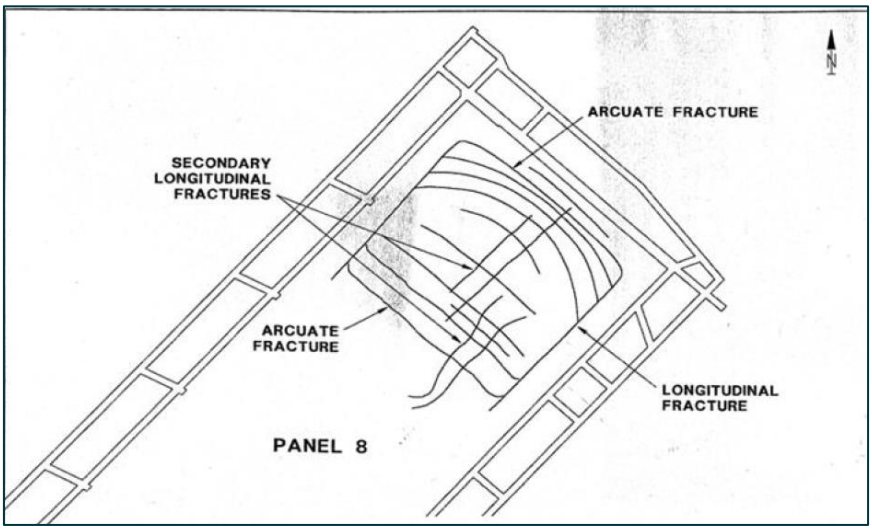


Plate 8 Longwall cracking (after ACARP, 2000).

7.5 Groundwater monitoring and sampling program

This section describes the groundwater monitoring program attributes that will guide implementation before, during, and after the proposed mining activities. In accordance with an adaptive management approach, these monitoring attributes will be modified on an on-going basis to ensure optimal understanding of the groundwater regimes and the envisaged mining impacts.

7.5.1 Parameters

It is important that a rigorous sampling protocol is followed to ensure that representative parameters are measured, and that due diligence is maintained in tracking of the samples and the results. Appropriate quality assurance and quality control (QA/QC) of samples and procedures will be implemented. All groundwater monitoring, water level measurements and sample collection, storage and transportation is to be undertaken in accordance with the procedures outlined by the DES Monitoring and Sampling Manual (2018) and the Murray Darling Basin Groundwater Quality Sampling Guidelines (1997).

The parameter suite for analysis for each groundwater sample is likely to include, but not limited to the following:

- pH, Electrical Conductivity, and turbidity (field and laboratory determinations)
- Total Dissolved Solids (laboratory analysis)
- Anions - carbonate, bicarbonate, chloride, sulphate, fluoride (laboratory analysis)
- Cations - calcium, magnesium, sodium, potassium (laboratory analysis)
- Dissolved and total metals - aluminium, antimony, arsenic, iron, manganese, molybdenum, selenium, silver, mercury (laboratory analysis)
- Nutrients - nitrate, nitrite, phosphorus, ammonia
- Total petroleum hydrocarbons (TPH)
  - TPH $C_6 – C_{10}$
  - TPH $>C_{10} - C_{40}$.

7.5.2 Groundwater level monitoring

Groundwater level monitoring is the key parameter for assessing changes to the groundwater regime, particularly as the ‘make good’ agreements with landholders are typically predicated on a water level change.

7.5.2.1 Frequency and duration

At a minimum, groundwater levels within the groundwater monitoring network are reviewed annually. Most of the groundwater monitoring bores will have permanent groundwater level monitoring devices (automated water level loggers) installed. These data loggers compile water level data at a minimum weekly interval, with the data being downloaded and assessed on a regular basis (during groundwater sampling events).

Groundwater level monitoring is to continue through operations and post closure at selected representative groundwater monitoring points (providing representative assessment of groundwater level changes in the various hydrostratigraphic units).

During post closure it is envisaged that the groundwater level data will provide recovery data, which will be compared to long-term model predictions (Section 6.4).

The details of the monitoring bores, units to be monitored and monitoring frequency details for each of the mine phases, are included in Table 64.

Table 64 Mining phases and monitoring details

Mining Phase	Groundwater Level	Frequency	Groundwater Quality	Frequency	Monitoring points
Operations	Automated loggers	Weekly	Every 3 months	During Project mining	Table 60 and Table 61

Mining Phase	Groundwater Level	Frequency	Groundwater Quality	Frequency	Monitoring points
Post closure	Automated loggers	Weekly	Every 6 months	For first 10 years after closure	To be determined

7.5.2.2 Instrumentation and control

Groundwater levels will be measured manually with an electronic water level probe each time a bore is visited. The probe is to be decontaminated between bores.

Automated water level monitoring devices are to be installed in the monitoring bores. This will comprise automated water level loggers. A barometric pressure automated monitoring device will be required, noting that confined aquifers require barometric post-correction regardless of if a vented or non-vented pressure sensor is used.

It is recommended that a barometric pressure automated monitoring device be suspended above high water level in one well on site. The approximate site compensation coverage for one device is 30 km. The barometric pressure automated monitoring device records ambient barometric fluctuations over time and allows for accurate barometric compensation of the data files from the automated water level monitoring devices across the Project.

7.5.2.3 Groundwater level indicators

Changes in quantity of groundwater (or availability of groundwater), flow volumes in hydrostratigraphic units, and interaction between groundwater and surface water features are primarily determined based on groundwater level/pressure levels and related changes in these levels.

Mining-induced changes in groundwater levels can be caused by the removal of groundwater from a hydrostratigraphic unit, changes in groundwater balances (due to land cover changes including backfilling), and pressure effects due to mine dewatering and depressurisation.

The primary indicator for groundwater quantity is, therefore, defined as the temporal change to groundwater level/pressure in a defined hydrostratigraphic unit at an established monitoring location.

As a result, groundwater levels will be assessed against the background data which has been collected to date. Comparison to established baseline conditions will be used to assess for mine related influences.

7.5.2.4 Groundwater level triggers

The transient groundwater level data, presented in Section 5.3.8, does not readily indicate the direct or indirect impact of mining on these bores, rather the data indicates complex response to wet and dry climate conditions in the different hydrostratigraphic units. The adopting of a simple 2 m per year fluctuation, as included in the Saraji Mine EA (Section 5.3.10) is not considered suitable for the Permian monitoring bores, based on these water level data trends, for the Project.

It is considered that the groundwater level monitoring data, proposed in Section 7.5.2 across the groundwater monitoring bores proposed (Table 61), be derived based on impact assessment and consideration of groundwater model predictions. The groundwater level predictions, considering surrounding projects and the Project, are included in Section 6.8.1.

Based on the groundwater resource/s assessment, the potential indirect impacts of the SEMLP underground mining, and the groundwater model predictions (Section 7.3.1), the following groundwater level triggers have been compiled:

- No groundwater level triggers are included for the Permian units directly impacted by mining. This absence of water level trigger is based on the assessment that no sensitive receptor/s will be impacted by the resultant mining related drawdown.
    - No groundwater level triggers have been proposed for MB33, MB34, MB20SRM03P, SEMLP1P, and SEMLP2P.
- For shallow (surficial sediments) monitoring bores the investigation trigger is the 2 m per year variation (as included for Saraji Mine in Section 5.3.8). These surficial sediments are more readily influenced by seasonal changing climatic conditions. The trigger, noting several Saraji Mine monitoring bores increased more than 2 m, is set as a decline in water level more than 2 m within a year.

  - The 2 m per year variation trigger is derived for MB38 (MB19SRM01A), MB20SRM04A, MB20SRM01A (MB20SRM01_PZ), and MB20SRM05A (MB20SRM05A_PZ).
- For the Tertiary monitoring bores, MB20SRM02T, SEMLP1T, and SEMLP2T, the maximum predicted drawdown (in mAHD) from the model at these locations will be the investigation triggers.
  - MB20SRM02T trigger level of 150 mAHD
  - SEMLP1T trigger level 148 mAHD
  - SEMLP2T trigger level of 151 mAHD.

Approach

The transient groundwater level monitoring data, will be corrected for barometric pressure, calculated in mAHD, and compiled into hydrographs. The groundwater level data trends will be compared, rate and amount of drawdown over time, to predictive modelling at regular intervals.

Groundwater level drawdown reaching water level triggers will instigate investigation, as per Section 7.5.5.

7.5.3 Groundwater quality monitoring

Groundwater samples have and will be obtained from the representative groundwater monitoring points, which have allowed for establishing representative groundwater chemistry concentrations and trends prior to the Project.

The groundwater units monitored on site, based on the potential for mine activities to impact on these units, include:

- Quaternary alluvium
- Tertiary sediments
- Permian non-coal bearing strata
- Permian target coal seam.

7.5.3.1 Methods

The low-flow sampling method is to be adopted so as to minimise the volume of purge water to be managed while ensuring that samples collected are representative of the groundwater unit.

Groundwater samples are collected when field parameters have stabilised as per Table 65.

Table 65 Field parameter stabilisation criteria prior to sampling

Measurement	Variability[1]	Recording
pH	± 0.1 pH unit	Continuous readings until stabilised, i.e. three to five consecutive readings within the variability range
Temperature	± 0.2°C	
Electrical Conductivity	± 5%	
Dissolved oxygen	± 10 %	
Redox potential (Eh)	± 10 mV	

[1] EPA Guidelines: Regulatory Monitoring and Testing - Groundwater Sampling June 2007 (Johnston, 2007).

Groundwater sampling is to be undertaken in accordance with the most recent edition of the DES Water Quality Sampling Manual, which allows for the collection of repeatable representative groundwater data.

Groundwater samples are to be analysed for the parameters listed in Section 7.5.1.

7.5.3.2 Quality assurance / quality control sampling

Field monitoring equipment, such as electrical conductivity and pH meters, are to be calibrated daily during sampling events using appropriately ranged and preserved calibration solutions.

Quality assurance / quality control (QA/QC) laboratory samples are to be collected at one duplicate sample for every ten groundwater samples collected, or if less than ten samples in a sampling event, one duplicate sample per batch.

The duplicate sample is sent to the primary analytical laboratory; all external laboratories will be National Association of Testing Authorities (NATA) accredited for the analytical procedures they are performing. Duplicate samples are to be analysed for the full suite of parameters for which the primary sample is analysed.

Collected samples are to be transported under chilled conditions to the laboratory without compromising the sample holding limits (where possible).

7.5.4 Data analysis process

Different methods exist for the assessment of groundwater monitoring data, one of which is the use of statistical tests for the development of indicator parameter limits. It is recognised that alternative methods exist, however, statistics honour natural data variability and facilitate tracking of quality and quantity trends. The groundwater level thresholds will be based on predictive groundwater modelling.

7.5.4.1 Hydrochemistry

Once sufficient (statistical) groundwater dataset is available (a minimum of 18 sets of data within a 24 month period) and assessment of statistical trends for representative parameters within each new proposed groundwater monitoring bore will be derived.

Trends can be identified, and follow-up investigations initiated per the established approach outlined in Section 7.5.5. The intent of the investigative follow-up is to identify natural exceptions to the proposed trigger levels and contaminant limits and facilitate revision of the targets as per the adaptive management approach (i.e. an assessment of potential for environmental harm will be conducted and if it is found that the trigger levels are exceeded due to natural conditions (not mine related) then the limits are to be re-evaluated).

7.5.4.2 Water level

It is recognised that drawdown, as a result of mine dewatering or depressurisation, can impact on groundwater resources and potentially cause environmental harm.

To identify potential drawdown impacts the monitoring points will act as early warning and model prediction validation points, when assessing underground mine drawdown impacts.

The monitoring points will act as early warning bores for impacts beyond those predicted.

7.5.5 Investigation and response processes

The administering authority will be notified within 24 hours of becoming aware of any water quality or water level trigger exceedance.

7.5.5.1 Hydrochemistry

First step

Should any agreed groundwater quality trigger levels be exceeded, an investigation will be undertaken within 28 days of detection to determine if the exceedance is a result of:

- mining activities authorised under the Project EA
- Natural variation
- Neighbouring land use resulting in groundwater impacts.

Second step

If the investigation determines that the exceedance was the result of Project mining, then investigations will be undertaken to establish whether environmental harm has occurred or may occur.

This will include:

- The relevant monitoring point(s) will be resampled, and the samples analysed for major cations and anions, and selected dissolved metals
- If elevated concentrations (above trigger levels) are recorded on three consecutive sampling events then an investigation into cause, optimum response, and the potential for environmental harm will be conducted.

The results of the investigations will result in the development of appropriate responses.

7.5.5.2 Water levels

If groundwater levels decline in excess of the trigger levels defined through predictive modelling is identified, an investigation will be instigated within 28 days of detection.

The investigation will aim at determining if the fluctuations in groundwater levels are a result of:

- Mining activities authorised under the Project EA
- Pumping from licensed bores
- Seasonal variation
- Neighbouring land use resulting in groundwater impacts.

If the water level trigger exceedance is as a result of authorised Project mining activities, then BMA will notify the administering authority within 28 days and provide the following:

- Details of whether actual environmental harm has occurred or is likely to occur
- Any proposed mitigation measures required to address the affected groundwater resource
- Proposed actions to reduce the potential for environmental harm.

7.5.6 Groundwater TARPs

Once sufficient baseline data has been compiled, water level and water quality, for the new and proposed Project groundwater monitoring bores (Section 7.2.2) then the site-specific groundwater Trigger Action Response Plans (TARP) will be finalised.

Draft groundwater TARPs have been compiled and presented below in Table 66.

Table 66 Draft Groundwater Trigger Action Response Plan

Aspect	Normal state	Trigger 1	Trigger 2	Action
Groundwater quality	Groundwater quality within historic range for all parameters	Trigger: • Groundwater quality concentrations outside of the adopted trigger value for at least one parameter for more than three consecutive monitoring rounds. Response: • Repeat sampling. • Identify any potential contributing factors. • Investigate the source for the change in groundwater quality and whether it was caused by mining related activities.	Trigger: • Groundwater quality concentrations trending outside of the adopted trigger values for at least one parameter, for more than 12 months. Response: • Increase investigations to determine if the source for the change in groundwater quality is mining related. • Undertake additional monitoring until water quality improves or source/cause is identified.	Trigger 1: • Notify BMA management and DESI. Trigger 2: • Inform regulators of findings and mitigation measures.
Groundwater level	Groundwater level change within historical range or groundwater model predictions, based on climatic variation and mine plan / schedule.	Triggers: • Refer to Section 7.5.2.4, groundwater level triggers are exceeded on three (3) consecutive occasions, where the triggers include: - No groundwater level triggers are included for the Permian units (no sensitive receptors identified relating to drawdown). - For shallow aquifers the investigation trigger is a decline >2 m in a year. - For the Tertiary monitoring bores, the trigger is the maximum predicted drawdown in the Tertiary at the bore locations. Response: • Identify any potential contributing factors. • Investigate the source for the change in groundwater level and whether it was caused by mining related activities. • Use the monitoring water level data and recalibrate the predictive groundwater model to re-evaluate potential impacts,	Trigger: • Groundwater levels do not recover after six months (water level or rate of drawdown). • Investigation into Trigger 1 identifies that change in groundwater level is due to mining-related activity. Response: • Implement appropriate mitigation and management measures, which may include advice from independent groundwater specialists. • Undertake additional monitoring of mitigation and management measures. • Review of hydrogeological modelling predictions.	Trigger 1: • Notify BMA management and DESI. Trigger 2: • Inform regulators of findings and mitigation measures.

Aspect	Normal state	Trigger 1	Trigger 2	Action
		risks for environmental harm, and the need for mitigation		
Groundwater inflows	Groundwater inflows consistent with modelled predictions	Trigger: • Groundwater inflow volume exceeds predictions by more than 10 per cent for three consecutive monitoring events. Response: • Review monitoring/inflow estimation methodology and validate inflow data. • Identify any potential contributing factors. • Investigate the source for the change in groundwater inflows and whether it is sourced from aquifers or a contribution from seepage through spoils.	Trigger: • Groundwater inflow volume exceeds predictions by more than 20% for three consecutive months. Response: • Review water balance for associated groundwater pit, including consideration of seepage through spoils. • Implement appropriate mitigation and management measures, which may include advice from independent groundwater specialists. • Undertake additional monitoring of mitigation and management measures. • Review of hydrogeological modelling predictions.	Trigger 1: • Notify BMA management and DESI. Trigger 2: • Inform regulators of findings and mitigation measures.
Downstream water users - surface water users and groundwater users	No complaints from downstream water users regarding loss of surface water or groundwater availability (quality and/or quantity)	Trigger: • Complaint/s from downstream water user/s regarding loss of water (surface and / or groundwater) availability (quality and/or quantity). Response: • Implement Complaints Management Protocol. • Review of relevant historical monitoring results (water quality and/or flow). • Identification of any potential contributing factors. • Investigate whether the change in water availability is due to mining-related activity. • Provide feedback to complainant.	Trigger: • Investigation into Trigger 1 identifies that change in downstream water availability is due to mining-related activity. Response: • Implement appropriate mitigation and management measures, which may include advice from independent water resource specialists. • Undertake additional monitoring of mitigation and management measures. • Provide compensatory water supply to any landowner whose water supply has been adversely and directly impacted.	Trigger 1: Notify BMA management and DESI. Trigger 2: • Inform regulators of findings and mitigation measures.

(Modified Glencore 2024)

7.6 Data reporting

All documentation and information related to groundwater level and groundwater quality monitoring will be kept in a secure archive, and readily available to scrutinise against regulatory criteria and trigger levels. All calibration records, laboratory chain-of-custody forms, photographs, laboratory certificates, and laboratory reports should be up-to-date and archived. A dedicated groundwater monitoring database will be developed and maintained on at least a monthly basis to ensure compliance conditions are met and any impacts are detected as soon as practicably possible.

The groundwater monitoring program will be reviewed annually by a suitably qualified hydrogeologist to identify unforeseen potential impacts, update the monitoring schedule, and factor in any changes to the mine plan that could influence groundwater impacts.

7.7 Post-mining period

A post-mining monitoring program will be developed by BMA. The program will be customised to address recovery of actual groundwater drawdown impacts observed during operation of the underground mine.

7.8 Future modelling

In case of future use of the Project model, updates could be conducted to further refine the model if it was deemed that an increase in model confidence level was required. However, the applicability of this would be dependent on the purpose of the future modelling and availability of data to inform future changes. As it stands, the current model is deemed fit for purpose for the Project impact assessment.

Fitness for Purpose of Model Comment

The groundwater model, based on the Project and used on numerous other mining activities within the Bowen Basin, is recognised (regulators and peer review) to be fit for purpose given the predicted risk to groundwater resources. Noting that the groundwater resources associated with alluvium and other hydrostratigraphic units do not allow for widespread groundwater use and are recognised not to provide a significant / useable freshwater resource (i.e., the alluvium at the Project is not a groundwater target like it is in other basins, such as the Condamine Alluvium in the Surat Basin).

In this context, this groundwater model is considered appropriate. In addition, the model is not uncalibrated and includes 282 transient calibration points across the regional Bowen Basin scale model domain (refer to the Projects Groundwater Modelling Technical Report Response to Comments letter (SLR, 2024)). Figure 2-9 of the Project's Groundwater Modelling Technical Report (SLR, 2023) provides a spatial distribution of calibration residuals. Figure 16 shows the location of the bores used in calibration as well as a spatial distribution of calibration error at each of those bores.

A review of the groundwater model against the Murray-Darling Basin Commission (MDBC) Groundwater Flow Modelling Guideline, issued in 2001, and guidelines issued by the National Water Commission (NWC) in June 2012 (Barnett et al., 2012) concludes that the groundwater model is "fit for purpose", where the purpose was defined by the model objectives, which include:

- Estimate the groundwater inflow to the Project mine workings as a function of mine position and timing.
- Simulate and predict the extent of groundwater level drawdown due to the Project.
- Identify areas of potential environmental risk, where groundwater impact management measures may be necessary.

The peer reviewer (HydroAlgorithmics, 2023) is of the opinion that the documented groundwater modelling is best practice and concludes that the model is fit for purpose, where the purpose is defined by the objectives in the bullets above.

8.0 Residual impacts

Potential impacts to groundwater because of the Project have been considered in detail as part of this groundwater assessment. Residual impacts are anticipated in the short to medium term. These concern groundwater flow and height and are relative to the duration of dewatering. Beyond closure, groundwater aquifers will continue to flow into the Saraji Mine final voids until a steady state is achieved. During this period the loss of water from the Tertiary and Permian aquifers are not expected to have a significant impact on beneficial use or natural ecosystem values. This is based on the fact that Saraji Mine has been operating since the 1970s and groundwater resources adjacent to the mine do not indicate material impact to groundwater levels or yields.

8.1 Simulated drawdown hydrographs

The groundwater model was used to provide a prediction of long-term groundwater level variation and recovery, as included in Section 6.2, Section 6.4, and Section 6.7.1. For this long-term prediction, it was assumed that all Saraji Mine open-cut operations will cease at the end of 2031 (when the open-cut pits reach the ML boundaries) and all underground mining will cease at the end of 2042; this in line with the current open-cut approvals and the proposed Project life of mine.

Groundwater recovery was predicted in the model, using pilot points within the model in both the north and south longwall panel areas (Figure 63), such that groundwater level time series hydrographs were generated to show groundwater rebound. The post-mining modelling, included for increased permeability in the underground goaf and open-cut backfill, natural low recharge across the model domain and evaporative losses from the final open-cut voids.

As presented in Figure 63, it is predicted that there be marked recovery of groundwater levels for the first 100 years following cessation of underground mining, followed by slow recovery. Predictive modelling indicates the groundwater system will reach equilibrium approximately 1,800 years post-mining due to:

- Recovery is slowed drawdown because of on-going extraction (through evaporation) from the open-cut final voids
- The marked groundwater rebound is considered to occur within the goaf and underground workings until water reaches the open-cut final voids
- Limited rainfall recharge over the region
- The long term mine dewatering (since 1974) has resulted in groundwater being removed from storage which needs to be replaced
- High evaporation (due to large final void areas) is expected to remain after 2031 (across the approximately 22.5 km strike length of the open-cut mine)
- Low permeability within the sediments surrounding the open-cut pits.

A hydrograph showing the drawdown and recovery pattern for the target D seam at the location of monitoring bore MB20SRM03P, located within the Project footprint is shown in Figure 82.

Groundwater is predicted to rebound following cessation of mining in 2042, but the rate of recovery is influenced by the natural limited groundwater resources and mechanisms plus the final voids in the Saraji Mine open-cut pits.

During the slow recovery to equilibrium, approximately 1,800 years post-mining, deeper groundwater levels are recognised as residual impacts which will reduce available drawdown (water column within neighbouring bores within the zone of influence of the Project). Reduced available drawdown can reduce the bore capacity (extraction volumes and bore yields).

It is noted from the assessment of the impacts on existing groundwater bores (Section 6.8.3) concluded that, based on the existing bores that could potentially be impacted by decreased water levels, it is unlikely that the Project will have any material impacts on existing groundwater users.

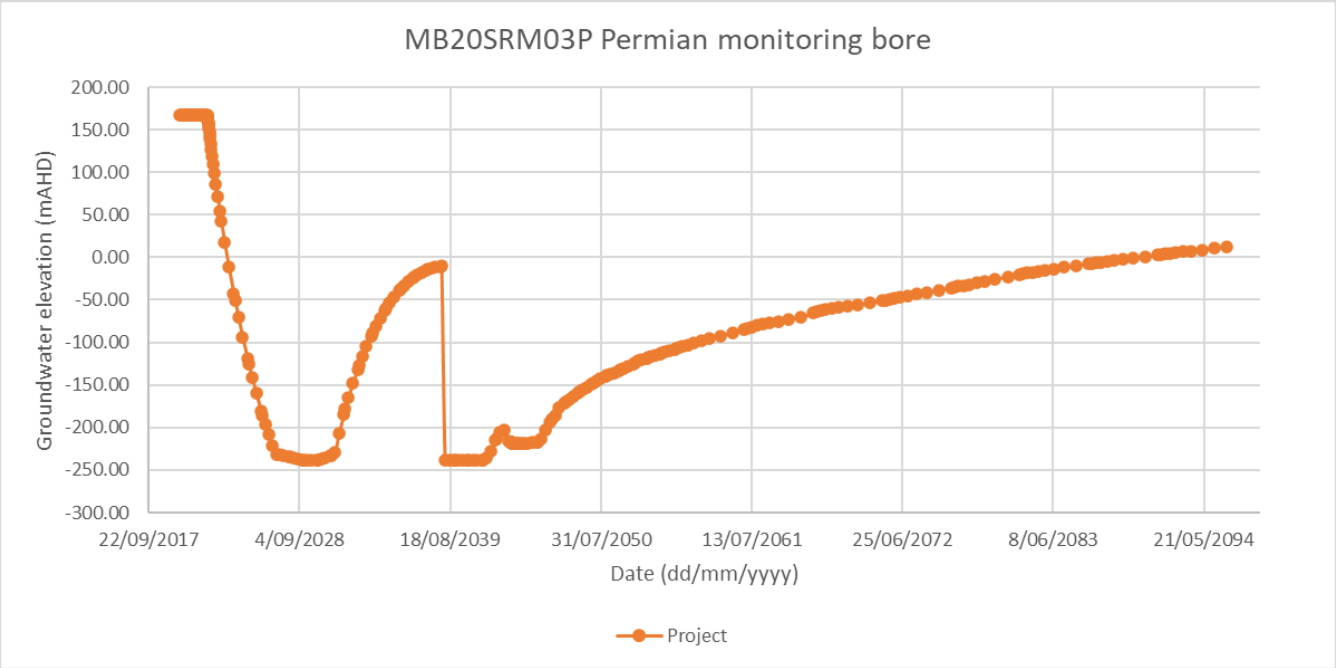


Figure 82 Simulated hydrograph for MB20SRM03P

9.0 Summary and conclusions

9.1 Introduction and methodology

A groundwater environmental assessment has been compiled to evaluate potential impacts associated with the proposed underground mining associated with the Project.

The groundwater study includes predictive groundwater modelling to evaluate the potential impacts of the proposed underground mining activities on groundwater resources. This groundwater technical report was compiled for inclusion in the EIS submission.

Predictive groundwater modelling was conducted to assess the potential impacts of the proposed longwall mining. The modelling looked at mine dewatering impacts (groundwater ingress and groundwater level drawdown) considering the approved mining within the regional model with and without the Project. Predictive simulations, including an evaluation of groundwater level drawdown, the prediction of groundwater ingress, and an evaluation of groundwater level recovery was conducted using the predictive model.

9.2 Geology and groundwater occurrence

The Project is located on the western limb of the geological Bowen Basin and is underlain by Quaternary and Tertiary sediments, which overlie the Permian strata, which hosts the target D seam. The sediments across the Project are generally undisturbed and gently dip approximately 8 degrees to the east. The Permian unit includes less weathered to fresh overburden, which comprises sandstone, siltstone, claystone, mudstone, coal, coal parting materials and sub-coal (under burden) strata. The Permian rocks form a regular layered sedimentary sequence while the Tertiary materials are more complex and irregular. Infilled alluvium channels associated with the present-day creek courses are locally superimposed on the Tertiary sediments.

The alluvium comprises irregular sequences of unconsolidated clay, silt, sand, and gravel. The alluvium deposits are variable in thickness, linear, irregular, and lensoidal, being discontinuous as evidenced in the bedrock outcrop within the creeks. The alluvium aquifer is not a permanent source of groundwater in the non-perennial creeks which drain across the Project. The alluvium associated with the larger Phillips Creek includes monitoring bores, which contain groundwater in places. The records of dry bores indicate the alluvium have limited storage and thus do not readily store groundwater, are non-continuous (the coarse grained more permeable sediments are not continuous down the length of the creeks) and have variable groundwater quality (ranging from fresh to saline).

The Tertiary aged sediments in the Project Area consists of lensoidal sand deposits separated by a low permeability clay-rich matrix. Medium to coarse grained sands and fine gravels occur is places at the base of the Tertiary sediments. The Tertiary sediments maintain permanent groundwater particularly within the deeper basal sediments, these basal sands are locally extensive and discontinuous. Minor groundwater ingress into the Saraji Mine pits indicates that the Tertiary sediments comprise a series of poorly connected low to moderate permeability aquifers. Tertiary groundwater quality ranges from slightly acidic to slightly alkaline and is dominated by sodium and chloride with TDS more than 6,000 mg/L. This means the water is brackish to saline and exceeds the recommended level for cattle.

The Permian overburden/interburden sediments comprise sandstone, siltstone, and shale. The Permian coal seams comprise the main groundwater units, where the cleats and fractures within the coal provide enhanced groundwater potential. Permian coal seam groundwater ranges from slightly acidic to alkaline and is dominated by sodium and chloride with TDS levels ranging from 3,300 mg/L to 20,000 mg/L. The coal seam water is brackish to saline and typically not suitable for stock watering.

9.3 Environmental values

The Project is situated within the Isaac River sub-basin of the Fitzroy Basin. The land use surrounding the Project is predominantly coal mining and cattle grazing.

The groundwater quality data across the site is variable and ranges from brackish to saline. Although the groundwater is generally within the guidelines for livestock, Section 4.3.3.5 of the ANZECC guidelines (2000) states that loss of production and a decline in animal health occurs if stock are exposed to high TDS and saline water for prolonged periods. For beef cattle, this TDS limit is in range the range of 5,000 mg/L to 10,000 mg/L.

Given that TDS for the Tertiary and Permian sediments are generally above 5,000 mg/L, the regional groundwater would generally not be considered suitable for livestock.

Terrestrial GDEs, along the Phillips Creek and to the east of the Project lease area along Hughes Creek, are not predicted to be impacted by the Project as they are associated with the alluvium. There are no known aquatic GDEs. No known springs are present within the Project Area.

From a hydrogeological perspective, the assessment of available groundwater resources (potential and chemistry) indicates that the only recognised groundwater use within the Project area is stock watering.

9.4 Mining alteration

Mining

Groundwater impacts from the approved open-cut operations and the Project underground mining was modelled by SLR in 2023. Given that the underground mine and open-cut mine are intrinsically linked through drawdown contour overlap, operational scheduling overlap and proximity, impacts from underground mining were assessed by simulating continuous operation of the open-cut and underground mining operations. This approach means that drawdown contours and impacts from underground mining were considered as cumulative impacts with the Saraji Mine open-cut mining.

The predictive groundwater modelling also included a no mining within the region model scenario. This scenario aided in the evaluation of predicted cumulative drawdown impacts.

Longwall mining impacts

To estimate mine impacts and estimates of groundwater ingress from underground longwall mining activities, aquifer alteration due to mining (longwall goaf) was taken into consideration. Longwall mining results in collapse and alteration of the overlying rock strata. The collapse propagates upwards from the extracted seam until the tensile strength of the rock is sufficient to hold up the overburden without failure. Where propagation extends to the land surface, subsidence of the land surface occurs.

Subsidence modelling simulated the effect of bed separation, opening of joints and the formation of new cracks in the originally intact overburden rock mass. Changes in stress and the induced deformation in the surrounding rock mass associated with rock fracture and bedding plane separation were predicted. These predictions included:

- When overburden thickness is less than 300 m above the target D coal seam, the subsidence modelling results show continual volumetric strain and rock mass damage in the overburden strata extending from longwall edge to the surface.
- When the overburden thickness is more than 300 m, the results indicate that the fractured zone extends to above 30 m to 50 m above the Harrow Creek seam with the overlying units undamaged.

In the Groundwater Assessment, the groundwater modelling assumed that any change to hydraulic conductivity and storage properties of the units predicted to be affected by subsidence persisted for the duration of model simulation, (i.e., there is no ‘self-sealing’ of subsidence fracturing over time). This approach is considered to be conservative given that the overlying Tertiary sediments, particularly those at the surface zone, swell and self-seal over time, and therefore any surface cracks fill with sediments reducing their hydrological effect over time. This phenomenon is recognised in the Bowen Basin, as evident at the Goonyella Broadmeadow Riverside Mine complex, where water ponding occurs above subsided areas.

This approach ensures that any change to hydraulic and storage properties in the model remain. Even adopting this approach no impact on alluvium or surface water resources is predicted.

9.5 Potential impacts

Predictive modelling of groundwater level drawdown in the alluvium, Tertiary, and the target D seam, as a result of the Project, indicated:

- No impact on alluvium groundwater resources is predicted due to the Project.
- The drawdown predictions are influenced by the distribution of saturated zones in the Tertiary. At the northern panels, 1 m drawdown influence is predicted to extend 4.2 km northeast of the Project mine workings.

- The extent of maximum predicted incremental drawdown impacts in the Moranbah Coal Measures coal seams are generally elongated along strike in the northwest-southeast direction and extents maximum of 5 km and 8 km northwest and southeast of the Project mine extent, respectively.

The inflows at the Project are predicted to reach a maximum peak in mine year 16, of 500 ML/year (1.4 ML/day). The average inflow rate for the Project is estimated at 183 ML/year (0.5 ML/day). This impact is not considered to be significant due to the absence of privately owned bores in the drawdown areas.

Impacts of the mine dewatering associated with the proposed underground workings, considered in connection with the approved Saraji Mine open-cut operations, are considered low for the following reasons:

- Surface water creeks in the area are ephemeral and groundwater levels (more than 17 m below surface) are below the level that would provide baseflow to existing alluvium or to root zone of plants.
- Groundwater level drawdown will occur predominantly within the Permian coal seams, which are separated from surficial groundwater regimes by clay-rich Tertiary cover, Permian age aquitard interburden, and are not expected to impact surface ecosystems.

It is unlikely that a significant dewatering impact will occur on the non-perennial creeks, which drain across the Project. No Project related impact to Phillips Creek is predicted.

The potential environmental impacts of the Project are considered low as:

- The surface water system at the Project is ephemeral
- The alluvium is of limited extent, discontinuous and dry in the majority of bores
- Tertiary sediments often have insufficient yield/low recharge potential indicating low permeability and low potential for usage
- The Project is not predicted to impact on the Isaac River to the east
- Groundwater quality is not suitable for drinking, too deep for Terrestrial ecosystems at the Project footprint, and is often too saline for livestock watering
- The surface water systems are separated from the predicted impacted groundwater resources by low permeable self-sealing Tertiary sediments, which reduce the potential for the Project to impact on surface water flows.

Only one landholder water supply bore is located within the predicted drawdown as a result of the Project. This registered bore, RN132631 (duplicate RN136689) is 328 m deep and is complete within the Fort Cooper Coal Measures. No predicted induced drawdown, from the Fort Copper Coal Measures to the target Moranbah Coal Measures, due to interbedded low permeable aquitards is predicted as a result of the Project.

9.6 Uncertainty

To verify or validate the predictions, a Type 3 Monte Carlo uncertainty analysis (IESC, 2018) was undertaken to estimate the uncertainty in the potential impacts predicted by the model. This uncertainty analysis method generates numerous alternative sets of model input parameters to the groundwater flow model.

Predictions

Modelling of underground mines requires assumptions as to the degree of fracturing above the mined coal seam and the enhancement of permeabilities and storage properties in the fracture zone. As the longwall panel width is broad (320 m) and the cutting height is high (3.6 m), a substantial vertical fracture zone is to be expected. A separate subsidence assessment by Minserve (2022), based on FLAC-3D geotechnical modelling, provided estimates of the degree of subsurface fracturing and surface cracking, as well as estimates of enhanced permeabilities and porosities. These predictions were used to assess potential impacts on alluvium and surface water systems. The uncertainty analysis (Section 6.6) allowed for the evaluation of possible impacts across a range of aquifer parameters.

The alteration of rock parameters due to longwall mining was adopted in the groundwater model, based on the subsidence model predictions. The fracture zone is taken to merge with the cracking zone for D-

seam depths of cover less than 300 m, giving continuous vertical connectivity over most of the southern panels and the western half of the northern panels.

As surface cracks are assumed not to heal in the groundwater model, and to be pervasive over the mining footprint, the simulated effects of fracturing/cracking are highly conservative (HyrdoAlgorithmics, 2023). The approach to increase the hydraulic conductivity in the fracture zone during the uncertainty analysis adds to the degree of conservatism.

The conclusions derived in Section 6.7, therefore, include consideration of possible impacts on alluvium groundwater resources and surface water across a range of aquifer (rock parameter) parameters and conclude that:

- There is no discernible drawdown in the alluvium at any level of probability.
- No material impacts on Isaac River or the overlying Boomerang Creek are anticipated at any level of probability.

Faulting

As faults can act as barriers or conduits to groundwater flow, which can influence ingress and groundwater drawdown, the nature of the faulting was assessed through model calibration and uncertainty analysis.

As per industry best practice, if the nature of a fault, or other hydraulic feature, is unknown, then the parameterisation of the fault should be sufficiently large to capture all plausible conceptualisations. This is the practice employed within the groundwater modelling, and development of the calibrated ensemble; in particular, the allowed parameter ranges during calibration allowed representation of the fault as a full barrier, full conduit, and all possibilities in between.

Calibration of the hydraulic conductivity of the fault was allowed during the calibration process and in the numerical uncertainty assessment of the model.

The predictive results incorporate the possibility of faults being barriers, conduits, and / or both. This modelling approach allowed for the assessment of the fault/s influence on groundwater ingress and drawdown.

9.7 Surface cracking

The groundwater assessment, using predictive groundwater modelling and uncertainty analysis, identified that there is no discernible drawdown in the alluvium and no material impacts on surface water creeks are anticipated at any level of probability.

The assessment assessed the scenario of continuous vertical connectivity (cracks from surface and cracks upward from the goaf) over the shallowest panels (< 300 m deep) which will experience the largest subsidence. In addition, the surface cracks were assumed not to heal in the groundwater model, and to be pervasive over the mining footprint, thus the simulated effects of fracturing/cracking are highly conservative.

Although the alteration of the overlying geological units, due to longwall mining, have been assessed through a range of differing model layer parameters in the uncertainty analysis, BMA have included a subsidence monitoring program to actively manage surface cracks, thus reducing the potential for surface water – groundwater interaction.

9.8 Long-term groundwater levels

Groundwater levels within the Project are predicted to recover to 176.5 mAHD in the long term (Figure 63), the simple comparison of groundwater recovery levels in the Project and long-term levels associated with the Saraji Mine post-closure indicates groundwater flow will be towards the final void where the Coolibah / Dogwood final void water level is predicted to be 7 to 24 mAHD, which is > 100 m lower than surrounding recovered groundwater levels.

Long term groundwater levels are therefore predicted to be influenced by the Saraji Mine final voids, which act as groundwater ‘sinks’ because of water loss through evaporation. This generation of deep water levels below the alluvium and Tertiary age sediments and within the target coal seams, results in localised cones of drawdown immediately around the final voids.

9.9 Management measures

A GMP will be developed for the Project, which will allow for the validation of model predictions and allow for the instigation of investigations into potential for environmental harm should groundwater monitoring results differ from predictions.

To ensure the collection of representative groundwater monitoring data, allow for the assessment of the potential predicted impacts of the Project on local groundwater resources, and consider the existing groundwater monitoring bore network, additional monitoring bores are recommended prior to the Project mining activities. The augmentation of the existing proposed groundwater monitoring bores is detailed in Section 7.2.

The assessment indicates significant, long term impacts on groundwater would not result from the Project.

9.9.1 TARPS

Preliminary site-specific groundwater triggers have been compiled to assist in mitigating and managing potential Project impacts on the groundwater resources (see Section 7.5.6).

References

3D Environmental, 2023. Saraji East Mining Lease Project - Groundwater Dependent Ecosystem Assessment, July 2023. Prepared for AECOM Australia Pty Ltd.

4T Consultants, 2012. Desktop Assessment Likelihood of Stygofauna Occurrence in the Bowen Basin, ref. R_20120922_Stygofauna_238_Final, dated October 2012.

ACARP, 2000. The influence of subsidence cracking on Longwall Extension, Report C5016.

AECOM, 2016. Saraji Open-Cut Extension Project – Groundwater Technical Report.

AECOM, 2024. Saraji East Mining Lease Project – Terrestrial Ecology Technical Report.

AGE, 2007. Report on Hydrogeological Regime and Impact Assessment Saraji Mine, Project No. G1387, December 2007.

AGE, 2011. Report on Saraji East Project Groundwater Impact Assessment, Project No. G1549, December 2011.

AGE, 2012a. Review of Groundwater Monitoring Data – Saraji Mine, dated December 2012.

AGE, 2012b. Australian Groundwater & Environmental Consultants Memorandum – Predicted Inflows and Drawdown Extents – Saraji East Underground Mine, ref. G1549, dated 24 February 2012.

AGE, 2013. Annual Review of Groundwater Data and Monitoring Network – 2031 - Saraji Mine.

Alluvium, 2023. Saraji East Mining Lease Project - Hydrology, Hydraulics and Geomorphology Report.

ALS, 2012. ALS Stygofauna Pilot Study at The Range, report prepared for ELP Muddy Boots.

ANZECC & ARMCANZ, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Arrow, 2012. Arrow Bowen Gas Project EIS Chapter 14 Groundwater.

Barnett, B. et al, 2012. Australian Groundwater Modelling Guidelines, June 2012.

BMA, 2013. Progressive Rehabilitation and Closure Plan Saraji Mine Status: DRAFT Version: 1.0 (1 April 2023) Business Owner: Saraji Mine Document ID # BMA-SRM-PRCP-v1

BMA, 2024. Saraji East Mining Lease Project – Subsidence Management Plan.

Cartledge, 2022. Saraji East Mining Lease Project – Subsidence Modelling Peer Review.

Commonwealth of Australia, 2015. Information Guidelines for the Independent Expert Scientific Committee Advice on Coal Seam Gas and Large Coal Mining Development Proposals.

Department of the Environment and Heritage (DEHP), 2009. Monitoring and Sampling Manual 2009, Version 2, July 2013 format edits.

Department of the Environment and Heritage (DEHP), 2013. Isaac River Sub-basin Environmental Values and Water Quality Objectives.

Department of the Environmental and Heritage (DEHP), 2017. Terms of reference for an environmental impact statement (EIS) - Environmental Protection Act 1994 - Saraji East Mining Lease Project - Proposed by BM Alliance Coal Operations Pty Ltd - May 2017.

Department of Resources (DOR), 2021. Guideline *Environmental Protection Act 1994* Requirements for site-specific and amendment applications—underground water rights, Version 1.03 dated 26 April 2021

Department of Environment and Science (DES), 2018. Monitoring and Sampling Manual: Environmental Protection (Water) Policy. Brisbane

Department of Environment and Science (DES), 2021. Using monitoring data to assess groundwater quality and potential environmental impacts. Version 2.), Queensland Government, Brisbane.

Dickens, J.M., and Malone, E.J., 1973. Geology of the Bowen Basin, Queensland. Department of Minerals and Energy Bureau of Mineral Resources, Geology and Geophysics, Bulletin 130.

Doherty et al, 1994. PEST Model-Independent Parameter Estimation https://www.epa.gov/sites/production/files/documents/PESTMAN.PDF

Eamus. D, Froend. R, Loomes. R, Hose. G and Murray. B, 2006. 'A functional methodology for determining the groundwater regime needed to maintain health of groundwater-dependent vegetation', Australian Journal of Botany 54(2): 97-114.

Franks, J.M., Breteton, D., Moran, C.J., Sarker, T. & Cohen, T., 2010. Cumulative Impacts- A Good Practice Guide for the Australian Coal Mining Industry. Centre for Social Responsibility in Mining & Centre for Water in the Minerals Industry, Sustainable Minerals Institute, The University of Queensland.

Froend, R. and R. Loomes., 2004. Approach to Determination of Ecological Water Requirements of Groundwater Dependent Ecosystems in Western Australia – A report of the Department of Environment, Edith Cowan University. Perth.

Gauge, 2015. Annual Groundwater Monitoring Report Saraji Coal Mine June 2015 Gauge Industrial and Environmental Version 1.0 dated 25 June 2015.

Gauge, 2016. Annual Groundwater Monitoring Report Saraji Coal Mine September 2016 Gauge Industrial and Environmental Version 1.0 dated 15 December 2016.

Gauge, 2021. Annual Groundwater Monitoring Report Saraji Coal Mine2021 Gauge Industrial and Environmental Version 1.0 dated 21 March 2022.

GEOGas, 2011. Gas Reservoir Assessment Saraji East Project, May 2011.

GEOGas, 2016. Conceptual Study for Gas Drainage Planning at Saraji East – BHP Billiton Coal, September 2016.

GEONET Consulting Group, 2022. Subsidence over longwall panels revised longwall panel layout Saraji East Underground Mine, February 2022.

GHD, 2020. BHP Saraji Mine – Groundwater Contaminant Trigger Levels Report, Draft undated.

GHD, 2021. BHP Saraji Mine – Groundwater Contaminant Trigger Levels Report, June 2022

GHD, 2023. BHP Pty Ltd BHP BMA Saraji Groundwater Well Installation draft report, dated April 2023.

Glencore. 2024. United Wambo Joint Venture Groundwater Management Plan, Number: UWOC-1689771511-370 Approved Version 6.0

HydroAlgorithmics, 2023. Saraji East Mining Lease Project – Groundwater Model Peer Review – June 2023.

Hydrobiology, 2016. 2014/2015 Receiving Environment Monitoring Program Annual Report – Saraji Mine – February 2016.

Hydrobiology, 2023. Saraji East Mining Lease Project – Aquatic Ecology Technical Report.

IESA, 2011a. Saraji East Mine Stygofauna Survey Report, September 2011.

IESA, 2011b. Environmental Monitoring Saraji East Project Quarterly Stygofauna Service Records and Data Reporting.

IESA, 2012. Environmental Monitoring Saraji East Mine Monthly Service Records and Data Reporting, ref doc. SJIEMar12.

IESC, 2018, Uncertainty analysis – Guidance for groundwater modelling within a risk management framework.

JBT, 2014. Lake Vermont Northern Extension Groundwater Impact Assessment report prepared by JBT Consulting for AARC on behalf of Bowen Basin Coal Pty Ltd, ref. JBT01-036-001, August 2014.

Johnston, 2007. EPA Guidelines: Regulatory Monitoring and Testing – Groundwater Sampling. June 2007.

Kendorski, 1993. Effect of High-Extraction Coal Mining on Surface and Ground Waters, 12th Conference on Groundwater Control in Mining, 3-5 August 1993.

Murray-Darling Basin Commission (MDBC), 1997. Murray-Darling Basin Groundwater Quality Sampling Guidelines Issue 3 of Technical report

MDBC (Middlemis, H., Merrick, N., and Ross, J.), 2000. Murray-Darling Basin Commission – Groundwater Flow Modelling Guideline. Report for MDBC.

Mining One, 2011. BMA Saraji East Extension: Packer test Program, ref. 1597_G\2813, dated 27 July 2011.

Minserve, 2022. Saraji East Mining Lease Project. Subsidence over Longwall Panels – Saraji East Underground Mine, April 2022. Prepared for AECOM Australia Pty Ltd.

NHMRC & ARCMANZ, 2011. “Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy”. National Health and Medical Research Council, 2011, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra. Updated October 2017.

National Water Commission, 2012. Minimum Construction Requirements for Water Bores in Australia, third edition.

National Uniform Drillers Licensing Committee, 2020. Minimum Construction Requirements

for Water Bores in Australia, fourth edition.

Richardson S, et al 2011. Australian groundwater-dependent ecosystem toolbox part 1: assessment framework, Waterlines report, National Water Commission, Canberra.

SKM, 2009. Isaac Connors Groundwater Project – Part B: Assessment of Groundwater Dependent Ecosystems, January 2009.

SLR, 2023. Groundwater modelling technical report, SLR Ref: 620.31025.00000-R01, Version 2.0.

SLR, 2023b. SARAJI MINE Transitional PRC Plan Hydrogeology SLR Ref: 620.30984.00000-R01 Version No: -v5.0 February 2023

SLR, 2024. Saraji East Mining Lease Plan –SEMLP Groundwater Modelling Technical Report Response to Comments, Appendix F-1a, May 2024

SRK, 2019. Hughes Creek, Ramps 2 and 3 TSF seepage investigation. Project memo dated 10 June 2019.

URS, 2009. Caval Ridge Groundwater Impact Assessment.

URS, 2012. Report Groundwater Impact Assessment Bowen Gas Project, Ref. 42626960, November 2012.

URS, 2014. Groundwater Chapter for the Dysart Coal Mine Project prepared for Bengal Coal Pty Ltd, ref. 42627233/GW dated 10 February 2014.

Weber, K. and Stewart, M. 2004. “A Critical Analysis of the cumulative rainfall departure concept”. Ground Water, 42 (6-7) pp 935-938.

Western Australia Environmental Protection Authority (WA EPA), 2007. Guidance for the Assessment of Environmental Factors Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia No: 54a, Environmental Protection Authority, Perth.

Zolfaghar Sepideh, Villalobos-Vega Randol, Cleverly James, Zeppel Melanie, Rumman Rizwana, Eamus Derek, 2014. The influence of depth-to-groundwater on structure and productivity of Eucalyptus woodlands. Australian Journal of Botany 62, 428-437.

Appendix A

Water Quality Data

DES - Major ions

DO NOT change column headings. Values in the Data column must be a number. This data is used for Piper plots in Power BI. Cells can be blank

Monitoring Point	Date	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Chloride (mg/L)	Sulfate as SO4 (mg/L)	Bicarbonate Alkalinity as CaCO3 (mg/L)	Total Alkalinity as CaCO3 (mg/L)	Hydroxide Alkalinity as CaCO3 (mg/L)	Carbonate Alkalinity as CaCO3 (mg/L)
PZ00A	6/06/2019	452	1010	5050	22	8590	1490	446	446	<1	<1
PZ00A	3/12/2019	427	971	4690	14	9010		552	552	<1	<1
PZ00A	14/02/2020	335	942	4700	21	9120	1720	547	547	<1	<1
PZ00A	19/05/2020	459	1070	5350	24	9320		584	584	<1	<1
PZ00A	17/08/2020	505	1060	5240	16	9840	1740	572	572	<1	<1
PZ00A	16/11/2020	456	1010	5130	15	9740		529	529	<1	<1
PZ00B	6/06/2019	324	917	4930	19	8390	1460	34	534	<1	<1
PZ00B	2/12/2019	330	783	4130	19	7780		584	584	<1	<1
PZ00B	14/02/2020	252	796	4300	17	8170	1410	576	576	<1	<1
PZ00B	19/05/2020	330	816	4610	17	8410		603	603	<1	<1
PZ00B	17/08/2020	334	778	4280	18	8190	1450	610	610	<1	<1
PZ00B	16/11/2020	336	803	4550	18	8320		577	577	<1	<1
PZ00D	6/06/2019	92	164	1110	18	1850	336	269	269	<1	<1
PZ00D	3/12/2019	230	488	2920	40	5500		456	456	<1	<1
PZ00D	14/02/2020	286	650	3950	490	7400	1180	514	514	<1	<1
PZ00D	18/05/2020	294	614	3880	46	7230		526	526	<1	<1
PZ00D	17/08/2020	351	711	4380	54	8140	1470	549	549	<1	<1
PZ00D	16/11/2020	352	742	4680	56	8370		536	536	<1	<1
PZ02A	31/10/2011	370	730	5100	110	8800	1700		490		
PZ02B	31/10/2011	310	120	0.14	9.1	4900	49		35		
PZ02C											
PZ04A	18/11/2011	230	110	1600	19	3700	44		81		
PZO4B	18/11/2011	400	740	5200	130	9100	1900		590		
PZ04C	18/11/2011	350	520	4400	92	7900	1200		270		
PZ05A											
PZ05B											
PZ0BC											
PZ06A											
PZ06B											
PZ06C											
PZ07A	1/11/2011										
PZ07B											
PZ07C											
PZ08A											
PZ08B											
PZ08C											
PZ09A	1/11/2011										
PZ09B	1/11/2011	320	500	0.2	1.7	6700	1500		420		
PZ09C	1/11/2011	32	27	0.45	8.9	1880	52		201		
PZ10A	1/11/2011										
PZ10B	1/11/2011										
PZ10C	1/11/2011	29	25	0.4	9.8	1600	60		220		
MB31	26/10/2009		195	1260		1490	1190	641	641	<1	<1
MB31	14/12/2009	140	203	1270	57	1400	1160	505	505	<1	<1
MB31	29/04/2010	81	99	907	39	840	656	649	649	<1	<1
MB31	27/07/2010	66	113	1030	37	932	665	729	729	<1	<1
MB31	24/01/2011	29	72	852	35	797	478	732	753	<1	21
MB31	29/04/2011	62	81	806	36	723	551	725	725	<1	<1
MB31	25/05/2011	62	81	806	36	723	551	725	725	<1	<1
MB31	25/07/2011	62	81	806	36	723	551	725	725	<1	<1
MB31	25/10/2011	74	88	838	38	726	600	723	761	<1	38
MB31	21/06/2012	86	77	55	1.4	78	32	<5	500	<5	50
MB31	24/07/2012	68	87	920	53	720	490	<5	1000	<5	1000
MB31	26/10/2012	63	77	780	48	550	360	790	840	<5	45
MB31	22/01/2013	70	90	870	61	930	630	1100	1200	<5	29
MB31	22/04/2013	79	100	970	82	970	650	120	1300	<5	1200
MB31	25/07/2013	72	97	970	72	860	520	1200	1300	<5	99
MB31	21/01/2014	92	119	95	1060	947	662	1180	1320	<1	136
MB31	23/04/2014	93	107	1030	91	1170	770	1410	1540	<1	131
MB31	10/09/2014	273	324	1530	77	2390	1560	458	458	<1	<1
MB31	25/11/2014	266	330	1690	73	2430	1480	515	515	<1	<1
MB31	20/01/2015	299	344	1720	83	2660	1730	494	494	<1	<1
MB31	24/03/2015	266	301	1470	61	2440	1610	526	526	<1	<1
MB31	19/05/2015	247	276	1340	57	1970	1880	524	524	<1	<1

MB31	16/06/2015	262	267	1340	57	2460	1710	524	524	<1	<1
MB31	25/08/2015	265	288	1400	58	2300	1510	508	508	<1	<1
MB31	2/12/2015	185	210	1140	49	1830	1280	621	621	<1	<1
MB31	14/03/2016	194	243	1340	56	1680	1280	590	590	<1	<1
MB31	13/06/2016	300	332	1580	70	1920	1570	488	488	<1	<1
MB31	19/09/2016	89	108	834	37	869		584	584	<1	<1
MB31	13/12/2016	84	102	776	33	892		610	610	<1	<1
MB31	15/03/2017	184	214	1240	54	1610		591	591	<1	<1
MB31	15/06/2017	83	102	740	31	917		586	586	<1	<1
MB31	19/09/2017	100	118	819	37	995		535	535	<1	<1
MB31	19/12/2017	144	164	1070	45	1270		546	546	<1	<1
MB31	20/03/2018	283	299	1490	75	2540		483	483	<1	<1
MB31	25/06/2018	264	314	1500	67	2510		484	484	<1	<1
MB31	23/07/2018	195	234	1250	52	1830		519	519	<1	<1
MB31	25/09/2018	194	214	1220	50	1590		552	552	<1	<1
MB31	27/03/2019	296	316	1500	64	2660		476	476	<1	<1
MB31	12/06/2019	172	207	1170	44	1530		538	538	<1	<1
MB31	12/06/2019	171	208	1160	45	1510		540	540	<1	<1
MB31	16/09/2019	149	163	982	44	1380		540	540	<1	<1
MB31	16/12/2019	196	219	1200	51	1750		484	484	<1	<1
MB31	16/03/2020	203	199	1160	47	1520		508	508	<1	<1
MB31	22/06/2020	163	184	1070	44	1330		486	486	<1	<1
MB31	18/08/2020	152	184	1090	42	1360	977	502	502	<1	<1
MB31	18/11/2020	138	148	946	40	1220		477	477	<1	<1
MB32	14/12/2009	73	74	47	<1	51	21	422	422	<1	<1
MB32	29/04/2010	80	65	41	<1	40	26	423	423	<1	<1
MB32	27/07/2010	71	78	61	<1	55	24	497	497	<1	<1
MB32	29/04/2011	87	64	38	<1	42	21	471	471	<1	<1
MB32	25/05/2011	87	64	38	<1	42	21	471	471	<1	<1
MB32	25/07/2011	87	64	38	<1	42	21	471	471	<1	<1
MB32	24/10/2011	83	70	40	<1	50	23	517	517	<1	<1
MB32	20/06/2012	69	89	910	51	780	500	<5	940	<5	940
MB32	25/07/2012	95	82	1.1	56	83	32	<5	500	<5	500
MB32	24/10/2012	80	72	53	1	91	32	540	540	<5	<5
MB32	22/01/2013	86	94	90	1	140	59	650	650	<5	<5
MB32	24/07/2013	110	97	77	1.3	140	42	560	560	<5	<5
MB32	22/10/2013	105	111	75	1	202	67	488	488	<1	<1
MB32	22/10/2013	105	111	1	75	202	67	488	488	<1	<1
MB32	22/10/2013	105	111	75	7	202	67	488	488	<1	<1
MB32	21/01/2014	79	113	107	1	219	82	436	465	<1	29
MB32	21/01/2014	79	113	1	107	219	82	436	465	<1	29
MB32	21/01/2014	79	113	107	1	219	82	436	465	<1	29
MB32	22/04/2014	117	111	106	1	218	91	586	586	<1	<1
MB32	29/07/2014	91	102	94	1	182	62	563	563	<1	<1
MB32	29/07/2014	91	102	94	1	182	62	563	563	<1	<1
MB32	10/09/2014	104	104	83	2	193	52	488	488	<1	18
MB32	25/11/2014	98	106	108	2	172	59	646	646	<1	<1
MB32	24/03/2015	110	101	119	1	212	91	611	611	<1	<1
MB32	19/05/2015	119	118	154	1	263	136	661	661	<1	<1
MB32	16/06/2015	108	103	101	1	221	68	596	596	<1	<1
MB32	26/08/2015	96	97	95	1	204	63	602	602	<1	<1
MB32	2/12/2015	107	110	108	2	242	66	678	678	<1	<1
MB32	21/04/2016	89	66	93	2	148	60	575	575	<1	<1
MB32	13/06/2016	89	96	92	1	155	55	521	521	<1	<1
MB32	19/09/2016	89	80	81	3	101		482	482	<1	<1
MB32	13/12/2016	82	88	95	2	147		559	559	<1	<1
MB32	13/03/2017	87	93	102	8	158		561	561	<1	<1
MB32	15/06/2017	87	62	78	2	68		517	517	<1	<1
MB32	19/09/2017	126	115	138	3	264		595	595	<1	<1
MB32	19/12/2017	123	126	195	5	311		701	701	<1	<1
MB32	20/03/2018	81	73	87	1	136		519	519	<1	<1
MB32	25/06/2018	95	103	127	4	215		598	598	<1	<1
MB32	25/09/2018	126	117	130	1	247		625	625	<1	<1
MB32	27/03/2019	98	101	104	1	186		530	530	<1	<1
MB32	12/06/2019	102	104	150	1	221		589	589	<1	<1
MB32	16/09/2019	92	99	116	1	195		583	583	<1	<1
MB32	16/12/2019	105	104	103	1	247		498	498	<1	<1
MB32	20/03/2020	94	72	58	1	101		447	447	<1	<1

MB32	22/06/2020	99	88	95	1	130		496	496	<1	<1
MB32	18/08/2020	86	77	78	1	119	56	453	453	<1	<1
MB32	18/11/2020	98	106	79	1	158		523	523	<1	<1
MB33	24/07/2013	280	570	5300	130	6700		750	750	<5	<5
MB33	21/10/2013	285	638	4510	130	7120	2240	705	705	<1	<1
MB33	20/01/2014	249	627	4550	145	7020	2420	580	580	<1	<1
MB33	22/04/2014	301	570	4390	118	7420	2390	735	735	<1	<1
MB33	29/07/2014	240	601	4920	141	7560	2150	718	718	<1	<1
MB33	9/09/2014	318	618	4470	119	7600	2410	618	618	<1	<1
MB33	25/11/2014	332	599	5230	106	7880	2580	794	794	<1	<1
MB33	20/01/2015	345	621	4760	111	8190	2550	787	787	<1	<1
MB33	24/03/2015	360	563	4930	99	7910	2410	821	821	<1	<1
MB33	19/05/2015	354	575	4530	90	7580	2920	801	801	<1	<1
MB33	16/06/2015	352	525	4330	87	7920	2580	829	829	<1	<1
MB33	2/12/2015	338	530	4100	88	6720	2480	865	865	<1	<1
MB33	14/03/2016	298	571	4630	110	7290	2360	804	804	<1	<1
MB33	13/06/2016	335	623	4980	123	7270	2400	736	736	<1	<1
MB33	19/09/2016	322	595	4760	116	7680		740	740	<1	<1
MB33	13/12/2016	291	510	4330	86	7530		853	853	<1	<1
MB33	13/03/2017	318	574	4650	118	7580		771	771	<1	<1
MB33	15/06/2017	298	588	4650	111	7360		823	823	<1	<1
MB33	19/09/2017	327	596	4670	116	7430		780	780	<1	<1
MB33	19/12/2017	285	532	4470	111	7320		789	789	<1	<1
MB33	19/03/2018	286	514	4340	124	7140		770	770	<1	<1
MB33	25/06/2018	271	554	4440	120	7370		768	768	<1	<1
MB33	25/09/2018	283	518	4290	113	6940		795	795	<1	<1
MB33	27/03/2019	296	543	4480	113	7230		783	783	<1	<1
MB33	12/06/2019	271	531	4370	109	7410		769	769	<1	<1
MB33	16/09/2019	285	517	4580	114	7050		786	786	<1	<1
MB33	16/12/2019	293	579	4640	119	7240		708	708	<1	<1
MB33	17/03/2020	300	597	4730	126	6980		739	739	<1	<1
MB33	22/06/2020	279	511	4180	96	7190		884	884	<1	<1
MB33	19/08/2020	259	520	4440	112	6820	2240	740	740	<1	<1
MB33	17/11/2020	265	522	4450	117	7020		747	747	<1	<1
MB34	24/07/2013	650	94	6200	42	8900		15	38	<5	23
MB34	21/10/2013	672	170	4940	45	8860	343	13	26	<1	14
MB34	20/01/2014	835	127	5020	49	9020	259	30	30	<1	<1
MB34	22/04/2014	801	131	4670	40	9720	280	16	26	<1	10
MB34	30/07/2014	764	189	5640	44	9810	266	23	23	<1	<1
MB34	10/09/2014	690	274	5050	46	9720	434	32	32	<1	<1
MB34	25/11/2014	622	350	5760	30	10500	558	62	62	<1	<1
MB34	20/01/2015	733	249	5280	37	10600	368	20	20	<1	<1
MB34	24/03/2015	822	267	5560	31	10500	402	41	41	<1	<1
MB34	19/05/2015	860	240	4950	29	9800	428	17	26	<1	9
MB34	16/06/2015	840	216	4790	28	10500	366	32	32	<1	<1
MB34	26/08/2015	737	212	4550	26	10200	320	15	15	<1	<1
MB34	2/12/2015	814	234	4610	28	8660	340	31	31	<1	<1
MB34	14/03/2016	798	145	5560	41	9440	373	60	60	<1	<1
MB34	13/06/2016	835	293	5340	30	9410	276	48	48	<1	<1
MB34	19/09/2016	894	125	5320	45	9630		85	85	<1	<1
MB34	13/12/2016	750	283	5330	25	9890		53	53	<1	<1
MB34	13/03/2017	809	278	5310	28	10100		61	61	<1	<1
MB34	15/06/2017	782	260	5690	32	10200		99	99	<1	<1
MB34	19/09/2017	986	189	5240	39	10200		212	212	<1	<1
MB34	19/12/2017	804	286	5160	27	10000		131	131	<1	<1
MB34	20/03/2018	760	292	5120	25	9790		141	141	<1	<1
MB34	25/06/2018	678	298	5160	26	10100		138	138	<1	<1
MB34	25/09/2018	713	293	5010	24	9470		163	163	<1	<1
MB34	27/03/2019	734	307	5220	23	10200		156	156	<1	<1
MB34	12/06/2019	693	304	5310	24	10400		153	153	<1	<1
MB34	17/09/2019	727	325	5560	26	10000		167	167	<1	<1
MB34	16/12/2019	716	354	5760	26	18900		160	160	<1	<1
MB34	17/03/2020	732	355	5720	27	9970		172	172	<1	<1
MB34	22/06/2020	703	357	5430	28	10100		221	221	<1	<1
MB34	19/08/2020	722	345	5840	26	10000	54	180	180	<1	<1
MB34	17/11/2020	707	320	4860	26	10200		164	164	<1	<1
MB35	25/07/2013	46	76	110	1.5	70		560	560	<5	<5
MB35	21/10/2013	49	80	115	2	101	35	505	526	<1	22

MB35	20/01/2014	24	82	127	2	105	35	400	494	<1	94
MB35	22/04/2014	50	81	121	1	94	35	520	520	<1	<1
MB35	29/07/2014	49	79	116	2	100	36	505	505	<1	<1
MB35	10/09/2014	57	94	226	3	174	81	595	686	<1	97
MB35	25/11/2014	57	94	241	2	151	78	707	707	<1	<1
MB35	20/01/2015	60	100	313	3	212	103	701	733	<1	32
MB35	24/03/2015	61	91	234	2	180	85	734	734	<1	<1
MB35	19/05/2015	57	82	164	2	141	66	635	635	<1	<1
MB35	16/06/2015	59	83	218	2	185	93	674	674	<1	<1
MB35	26/08/2015	51	75	142	2	128	48	578	578	<1	<1
MB35	2/12/2015	53	78	138	2	112	51	591	620	<1	29
MB35	14/03/2016	56	95	291	3	217	123	769	769	<1	<1
MB35	13/06/2016	52	87	153	2	120	48	532	558	<1	27
MB35	19/09/2016	55	86	152	2	104		525	549	<1	24
MB35	13/12/2016	48	75	132	1	103		574	574	<1	<1
MB35	13/03/2017	53	84	176	2	131		625	625	<1	<1
MB35	15/06/2017	47	75	129	1	100		600	600	<1	<1
MB35	19/09/2017	56	86	146	2	108		556	556	<1	<1
MB35	19/12/2017	53	82	151	2	110		570	570	<1	<1
MB35	20/03/2018	55	85	261	2	190		737	737	<1	<1
MB35	25/06/2018	53	93	289	3	228		742	742	<1	<1
MB35	25/09/2018	60	92	277	2	188		673	673	<1	67
MB35	27/03/2019	54	84	178	2	144		613	613	<1	<1
MB35	12/06/2019	59	95	266	3	200		717	717	<1	<1
MB35	17/09/2019	56	88	277	2	200		749	749	<1	<1
MB35	16/12/2019	56	90	178	2	126		560	560	<1	<1
MB35	17/03/2020	62	93	285	2	194		705	705	<1	<1
MB35	22/06/2020	66	100	269	2	190		748	748	<1	<1
MB35	20/08/2020	51	81	151	2	119	48	524	524	<1	<1
MB35	18/11/2020	53	84	165	2	127		544	544	<1	<1
MB36	25/07/2013	190	210	1200	9	1600		750	750	<5	<5
MB36	22/10/2013	192	223	1040	7	1660	435	565	565	<1	<1
MB36	20/01/2014	158	214	1050	7	1640	440	474	474	<1	<1
MB36	22/04/2014	204	234	1140	5	2140	493	665	665	<1	<1
MB36	29/07/2014	187	235	1110	6	1730	422	646	646	<1	<1
MB36	10/09/2014	312	347	1440	9	3500	362	354	354	<1	<1
MB36	25/11/2014	303	324	1430	8	3180	360	468	468	<1	<1
MB36	20/01/2015	344	368	1680	8	3860	404	389	389	<1	<1
MB36	24/03/2015	459	345	1480	6	3720	369	399	399	<1	<1
MB36	19/05/2015	386	295	1280	6	3200	512	471	471	<1	<1
MB36	16/06/2015	398	297	1320	6	3620	429	424	424	<1	<1
MB36	26/08/2015	245	224	1060	6	2340	467	622	622	<1	<1
MB36	2/12/2015	303	246	1100	6	2410	440	630	630	<1	<1
MB36	21/04/2016	227	248	1170	6	1900	412	600	600	<1	<1
MB36	13/06/2016	271	266	1240	6	1840	444	645	645	<1	<1
MB36	19/09/2016	256	254	1210	6	2160		636	636	<1	<1
MB36	13/12/2016	241	239	1160	6	2280		681	681	<1	<1
MB36	13/03/2017	409	335	1470	7	3480		447	447	<1	<1
MB36	15/06/2017	272	269	1250	6	2460		681	681	<1	<1
MB36	19/09/2017	232	239	1130	5	1840		730	730	<1	<1
MB36	19/12/2017	240	236	1180	6	1980		687	687	<1	<1
MB36	20/03/2018	362	292	1350	7	3350		471	471	<1	<1
MB36	25/06/2018	314	304	1330	6	3240		488	488	<1	<1
MB36	25/09/2018	356	310	1380	6	3250		314	314	<1	<1
MB36	27/03/2019	265	242	1190	6	2470		664	664	<1	<1
MB36	12/06/2019	258	260	1230	6	2670		632	632	<1	<1
MB36	17/09/2019	222	226	1130	6	2260		745	745	<1	<1
MB36	16/12/2019	204	257	1270	6	1880		685	685	<1	<1
MB36	22/06/2020	174	209	1080	8	1580		1050	1050	<1	<1
MB36	20/08/2020	167	194	1060	6	1580	344	905	905	<1	<1
MB36	18/11/2020	166	199	1050	6	1580		809	809	<1	<1
MB37	24/07/2013	470	200	2700	21	3400		110	110	<5	<5
MB37	22/10/2013	605	243	2670	28	4230	1920	111	111	<1	<1
MB37	21/01/2014	571	226	2550	24	4190	2130	108	108	<1	<1
MB37	23/04/2014	584	220	2450	19	4070	2300	98	98	<1	<1
MB37	29/07/2014	520	215	2630	22	4250	1950	96	96	<1	<1
MB37	10/09/2014	555	239	2610	29	4420	2080	177	177	<1	<1
MB37	25/11/2014	545	234	2480	23	4320	1870	133	133	<1	<1

MB37	20/01/2015	530	230	2720	23	4450	2220	116	116	<1	<1
MB37	24/03/2015	575	216	2480	16	4390	1950	121	121	<1	<1
MB37	19/05/2015	526	206	2300	18	4180	2310	117	117	<1	<1
MB37	16/06/2015	540	198	2330	17	4470	2250	112	112	<1	<1
MB37	25/08/2015	451	178	2180	18	4040	2110	90	90	<1	<1
MB37	2/12/2015	499	193	2180	18	3750	2100	120	120	<1	<1
MB37	14/03/2016	450	194	2430	20	3990	2000	85	85	<1	<1
MB37	13/06/2016	516	208	2580	22	4060	1990	90	90	<1	<1
MB37	19/09/2016	490	204	2560	20	3910		95	95	<1	<1
MB37	13/12/2016	416	174	2170	17	3880		94	94	<1	<1
MB37	13/03/2017	476	192	2470	21	4010		89	89	<1	<1
MB37	15/06/2017	471	200	2490	19	3880		119	119	<1	<1
MB37	19/09/2017	524	210	2580	21	4160		100	100	<1	<1
MB37	19/12/2017	512	196	2490	19	4060		138	138	<1	<1
MB37	25/06/2018	463	219	2450	19	4330		279	279	<1	<1
MB37	25/09/2018	529	207	2400	18	4080		287	287	<1	<1
MB37	12/06/2019	508	217	2500	18	4330		380	380	<1	<1
MB37	16/09/2019	496	184	2270	18	4190		278	278	<1	<1
MB37	16/03/2020	515	200	2440	19	3940		343	343	<1	<1
MB37	22/06/2020	542	218	2550	19	4270		443	443	<1	<1
MB37	18/08/2020	421	194	2450	19	4060	1800	207	207	<1	<1
MB37	18/11/2020	455	187	2470	20	3980		188	188	<1	<1
MB39	14/02/2020	25	34	1710	6	2530	70	329	349	<1	20
MB39	18/03/2020	51	32	1680	7	2560		362	362	<1	<1
MB39	21/04/2020	79	34	1690	7	2550	74	361	361	<1	<1
MB39	19/05/2020	67	36	1760	7	2650		388	388	<1	<1
MB39	17/06/2020	97	35	1740	7	2530		353	353	<1	<1
MB39	1/07/2020	47	37	1940	6	2890		324	324	<1	<1
MB39	20/08/2020	103	36	1940	6	2930	281	286	286	<1	<1
MB39	16/09/2020	96	35	1890	6	3050		295	295	<1	<1
MB39	13/10/2020	89	36	1850	6	2940		295	295	<1	<1
MB39	18/11/2020	64	36	1960	6	3030		280	280	<1	<1
MB40	14/02/2020	63	127	259	2	277	112	771	771	<1	<1
MB40	18/03/2020	82	114	220	1	247		678	678	<1	<1
MB40	21/04/2020	95	119	251	2	247	82	746	746	<1	<1
MB40	19/05/2020	89	135	270	2	275		835	835	<1	<1
MB40	17/06/2020	90	130	249	1	255		857	857	<1	<1
MB40	1/07/2020	81	132	258	1	259		890	890	<1	<1
MB40	20/08/2020	83	123	246	1	250	81	814	814	<1	<1
MB40	16/09/2020	81	125	240	1	268		837	837	<1	<1
MB40	13/10/2020	84	121	242	1	272		807	807	<1	<1
MB40	18/11/2020	88	123	255	1	289		775	775	<1	<1
MB19SRM02T	2/12/2019	74	115	244	2	252		700	700	<1	<1
MB19SRM02T	30/01/2020	81	114	224	1	252		683	683	<1	<1
MB19SRM03P	2/12/2019	52	30	1540	6	2360		346	346	<1	<1
MB19SRM03P	30/01/2020	67	32	1580	6	2510		339	339	<1	<1
MB19SRM04P	4/12/2019	110	129	978	16	1260		505	505	<1	<1
MB19SRM04P	14/02/2020	94	135	1010	17	1300	571	491	491	<1	<1
MB19SRM04P	20/05/2020	119	137	1070	16	1370		513	513	<1	<1
MB19SRM04P	18/08/2020	115	130	1040	16	1340	620	510	510	<1	<1
MB19SRM04P	18/11/2020	130	131	1030	16	1370		482	482	<1	<1
MB20SRM03P	26/10/2019	14	<1	1990	504	1180		<1	3350	3030	320
MB20SRM07P	27/10/2019	67	12	1130	8	1580		152	172	<1	20
MB01P_R01	11/01/2020	531	480	2270	12	5380		351	351	<1	<1
MB02P	10/01/2020	402	474	1610	7	4340		408	408	<1	<1
2013MP06	11/10/2018	584	768	3180	38	6770	2360	762	762	<1	<1
2013MP06	30/10/2018	607	813	3220	41	6540		889	889	<1	<1
2013MP06	15/01/2019	595	824	3210	40	6110		854	854	<1	<1
2013MP06	27/03/2019	592	829	3220	40	6340		872	872	<1	<1
2013MP06	16/04/2019	360	521	2150	31	4030		584	584	<1	<1
2013MP06	28/05/2019	535	752	3060	39	5930		830	830	<1	<1
2013MP06	4/07/2019	682	913	3460	45	5880		901	901	<1	<1
2013MP06	22/07/2019	582	835	3160	40	6190		928	928	<1	<1
2013MP06	24/09/2019	591	839	3320	38	6550		868	868	<1	<1
2013MP06	3/12/2019	521	781	2990	41	5650		913	913	<1	<1
2013MP06	14/02/2020	498	809	3220	40	6110	2220	864	864	<1	<1
2013MP06	20/05/2020	399	587	2540	31	4760		685	685	<1	<1
2013MP06	19/08/2020	535	748	2970	37	5850	2120	883	883	<1	<1

2013MP06	19/11/2020	617	874	3520	42	6520		864	864	<1	<1
2016BH05	11/10/2018	213	156	1760	56	2000	1290	338	354	<1	16
2016BH05	28/05/2019	199	197	1870	55	1900		630	630	<1	<1
2016BH05	4/07/2019	214	225	1900	66	1880		741	741	<1	<1
2016BH05	22/07/2019	184	214	1750	58	2180		739	739	<1	<1
2016BH05	12/08/2019	129	214	1770	60	2300		706	706	<1	<1
2016BH05	24/09/2019	197	190	1780	54	1790		621	621	<1	<1
2016BH05	3/12/2019	192	194	1540	51	1600		606	606	<1	<1
2016BH05	13/02/2020	164	218	1790	54	1680	1840	608	608	<1	<1
2016BH05	20/05/2020	198	233	1860	54	1740		693	693	<1	<1
2016BH05	19/08/2020	191	213	1780	56	1810	1870	632	632	<1	<1
2016BH05	19/11/2020	220	231	1770	56	1680		613	613	<1	<1
2016BH08	11/10/2018	263	434	3770	108	5950	3140	335	348	<1	13
2016BH08	30/10/2018	247	468	3910	114	5760		316	316	<1	<1
2016BH08	15/01/2019	269	527	4160	117	5760		332	332	<1	<1
2016BH08	27/03/2019	288	547	4160	119	6120		285	285	<1	<1
2016BH08	16/04/2019	280	578	4340	125	6160		271	271	<1	<1
2016BH08	28/05/2019	322	571	4440	125	6240		279	279	<1	<1
2016BH08	4/07/2019	342	593	4420	139	5940		288	288	<1	<1
2016BH08	22/07/2019	293	567	4120	121	6050		402	402	<1	<1
2016BH08	24/09/2019	332	585	4310	120	6350		398	398	<1	<1
2016BH08	3/12/2019	304	580	4090	123	5700		384	384	<1	<1
2016BH08	13/02/2020	309	616	4300	118	6260	3680	444	444	<1	<1
2016BH08	20/05/2020	346	661	4780	122	6380		475	475	<1	<1
2016BH08	18/08/2020	336	655	4440	124	6320	3980	567	567	<1	<1
2016BH08	17/11/2020	358	708	4810	132	6680		587	587	<1	<1
2019MP01_D	4/07/2019	86	70	514	11	590		216	216	<1	<1
2019MP01_D	22/07/2019	75	67	488	10	597		226	226	<1	<1
2019MP01_D	13/08/2019	54	69	458	10	615		237	237	<1	<1
2019MP01_D	23/09/2019	84	77	524	10	669		210	210	<1	<1
2019MP01_D	3/12/2019	97	86	528	11	644		197	197	<1	<1
2019MP01_D	13/02/2020	95	89	542	11	719	611	190	190	<1	<1
2019MP01-D	20/05/2020	106	95	575	11	730		215	215	<1	<1
2019MP01-D	19/08/2020	115	103	587	12	776	710	190	190	<1	<1
2019MP01-D	17/11/2020	130	108	606	12	802		191	191	<1	<1
2019MP02_D	4/07/2019	523	495	931	32	1950		36	36	<1	<1
2019MP02_D	22/07/2019	478	466	915	29	1970		49	49	<1	<1
2019MP02_D	13/08/2019	311	460	844	28	1970		40	40	<1	<1
2019MP02_D	23/09/2019	458	465	917	28	2150		40	40	<1	<1
2019MP02_D	3/12/2019	452	464	911	30	2080		64	64	<1	<1
2019MP02_D	13/02/2020	428	451	901	28	2220	1890	48	48	<1	<1
2019MP02-D	20/05/2020	444	443	1020	28	2240		94	94	<1	<1
2019MP02-D	19/08/2020	406	405	879	26	2190	1930	61	61	<1	<1
2019MP02-D	17/11/2020	441	408	991	29	2190		77	77	<1	<1
2019MP03_D	4/07/2019	454	447	1120	31	1940		258	258	<1	<1
2019MP03_D	22/07/2019	410	420	1050	27	1950		276	276	<1	<1
2019MP03_D	13/08/2019	284	407	924	25	2000		282	282	<1	<1
2019MP03_D	23/09/2019	415	428	1020	27	2180		230	230	<1	<1
2019MP03_D	3/12/2019	417	421	988	28	2000		261	261	<1	<1
2019MP03_D	13/02/2020	422	414	1020	28	2240	1680	297	297	<1	<1
2019MP03-D	20/05/2020	394	425	1210	29	2240		262	262	<1	<1
2019MP03-D	19/08/2020	424	416	1150	29	2310	1870	279	279	<1	<1
2019MP03-D	17/11/2020	451	410	1110	31	2330		260	260	<1	<1
2019MP04_D	4/07/2019	336	75	260	36	714		387	387	<1	<1
2019MP04_D	22/07/2019	328	76	244	32	778		397	397	<1	<1
2019MP04_D	13/08/2019	230	79	232	31	768		400	400	<1	<1
2019MP04_D	23/09/2019	365	87	262	34	913		358	358	<1	<1
2019MP04_D	3/12/2019	416	89	260	34	909		337	337	<1	<1
2019MP04_D	13/02/2020	366	96	274	34	946	371	330	330	<1	<1
2019MP04-D	20/05/2020	480	110	308	34	1050		362	362	<1	<1
2019MP04-D	19/08/2020	501	111	305	36	1120	506	328	328	<1	<1
2019MP04-D	17/11/2020	593	120	318	37	1250		332	332	<1	<1
2019MP05_D	4/07/2019	356	431	1220	17	2380		262	262	<1	<1
2019MP05_D	22/07/2019	302	401	1180	14	2240		242	242	<1	<1
2019MP05_D	13/08/2019	202	384	1050	13	2320		279	279	<1	<1
2019MP05_D	24/09/2019	284	381	1160	13	2320		236	236	<1	<1
2019MP05_D	3/12/2019	339	447	1160	16	2450		300	300	<1	<1
2019MP05_D	13/02/2020	237	337	1060	11	2190	1310	220	220	<1	<1

2019MP05-D	20/05/2020	266	369	1140	12	1980		245	245	<1	<1
2019MP05-D	19/08/2020	259	349	1110	12	2060	1380	237	237	<1	<1
2019MP05-D	17/11/2020	278	358	1130	13	2160		228	228	<1	<1
2019MP06	4/07/2019	399	726	1370	38	2920		661	661	<1	<1
2019MP06	22/07/2019	318	650	1190	30	3000		669	669	<1	<1
2019MP06	12/08/2019	391	796	2910	37	6260		979	979	<1	<1
2019MP06	13/08/2019	256	566	1290	33	3220		725	725	<1	<1
2019MP06	23/09/2019	400	574	1500	34	3360		652	652	<1	<1
2019MP06	3/12/2019	379	621	1340	34	3080		643	643	<1	<1
2019MP06	13/02/2020	333	585	1460	33	3370	1580	615	615	<1	<1
2019MP06	20/05/2020	386	684	1420	32	3350		649	649	<1	<1
2019MP06	19/08/2020	376	631	1470	34	3290	1680	672	672	<1	<1
2019MP06	17/11/2020	399	630	1480	34	3400		618	618	<1	<1
2019MP07	4/07/2019	505	339	1890	35	2260		520	520	<1	<1
2019MP07	22/07/2019	428	375	1860	39	2780		511	511	<1	<1
2019MP07	13/08/2019	289	326	1580	34	2280		517	517	<1	<1
2019MP07	23/09/2019	429	386	1780	38	2450		471	471	<1	<1
2019MP07	3/12/2019	417	346	1660	37	2280		464	464	<1	<1
2019MP07	13/02/2020	359	376	1690	37	2240	2710	436	436	<1	<1
2019MP07	20/05/2020	403	488	2310	53	3680		533	533	<1	<1
2019MP07	19/08/2020	421	382	1890	40	2700	2610	499	499	<1	<1
2019MP07	17/11/2020	461	359	1780	38	2320		446	446	<1	<1
2019MP07_D	4/07/2019	698	741	2870	57	4910		775	775	<1	<1
2019MP07_D	22/07/2019	562	657	2610	46	5010		825	825	<1	<1
2019MP07_D	13/08/2019	385	620	2340	46	5000		818	818	<1	<1
2019MP07_D	23/09/2019	569	662	2650	47	5230		747	747	<1	<1
2019MP07_D	3/12/2019	540	643	2470	49	4630		727	727	<1	<1
2019MP07_D	13/02/2020	480	642	2520	46	5000	2230	708	708	<1	<1
2019MP07-D	20/05/2020	558	706	2840	50	5140		763	763	<1	<1
2019MP07-D	19/08/2020	527	665	2720	50	5110	2340	738	738	<1	<1
2019MP08	4/07/2019	278	526	3400	88	4520		739	739	<1	<1
2019MP08	22/07/2019	253	476	3060	82	4700		789	789	<1	<1
2019MP08	12/08/2019	152	411	2640	69	4180		796	796	<1	<1
2019MP08	12/08/2019	207	531	3690	116	5760		467	467	<1	<1
2019MP08	24/09/2019	251	444	3030	80	4600		737	737	<1	<1
2019MP08	4/12/2019	216	441	2930	76	4200		704	704	<1	<1
2019MP08	14/02/2020	199	437	2910	74	4210	2120	710	710	<1	<1
2019MP08	19/05/2020	267	419	2820	78	4090		751	751	<1	<1
2019MP08	18/08/2020	243	415	2780	78	4110	2050	718	718	<1	<1
2019MP09	28/05/2019	1100	719	1830	86	5050		678	678	<1	<1
2019MP09	4/07/2019	1250	725	1860	100	4680		721	721	<1	<1
2019MP09	22/07/2019	1160	751	1860	97	5270		779	779	<1	<1
2019MP09	12/08/2019	753	686	1750	96	5140		758	758	<1	<1
2019MP09	24/09/2019	1180	816	1970	106	6100		781	781	<1	<1
2019MP09	4/12/2019	990	637	1860	105	4560		616	616	<1	<1
2019MP09	13/02/2020	1190	832	2110	130	5550	2020	684	684	<1	<1
2019MP09	19/05/2020	1280	970	2230	130	6630		760	760	<1	<1
2019MP09	18/08/2020	1190	883	2090	144	6080	2220	795	795	<1	<1
2019MP10	28/05/2019	649	631	1950	52	3950		644	644	<1	<1
2019MP10	4/07/2019	658	621	1900	56	3770		688	688	<1	<1
2019MP10	22/07/2019	577	587	1800	49	3800		731	731	<1	<1
2019MP10	12/08/2019	391	564	1720	47	3980		728	728	<1	<1
2019MP10	24/09/2019	557	584	1960	48	4010		676	676	<1	<1
2019MP10	3/12/2019	514	565	1800	49	3550		681	681	<1	<1
2019MP10	13/02/2020	398	479	1600	39	3240	1590	557	557	<1	<1
2019MP10	20/05/2020	514	587	2050	46	3800		702	702	<1	<1
2019MP10	18/08/2020	494	540	2000	46	3580	2160	687	687	<1	<1
2019MP10	17/11/2020	526	589	2180	52	4220		656	656	<1	<1

DES - Monitoring Points

DO NOT change column headings. Latitude and longitude must be added as decimal degrees. Only enter relevant data, columns can be left blank.

Monitoring Point	Type	Group	Basin	Stream	latitude	longitude	Surface RL (m)	Install Date	Depth (m)	Screened Section (m)
MB31	Landholder Monitoring Bore				-22.400	148.224	221.9		44.23	
MB32	Landholder Monitoring Bore				-22.506	148.336	208		19.52	
MB33	Single Pipe Groundwater Monitoring Bore				-22.4189	148.32761	194.8		37.5	30 - 36
MB34	Single Pipe Groundwater Monitoring Bore				-22.43625	148.3402	195.9		107	99.5 - 105.5
MB35	Single Pipe Groundwater Monitoring Bore				-22.4192	148.3859	184.6		34.5	27 - 33
MB36	Single Pipe Groundwater Monitoring Bore				-22.472	148.3622	197.8		32	24.5 - 30.5
MB37	Single Pipe Groundwater Monitoring Bore				-22.461	148.2867	234.8		42.5	1.7 - 42.5
MB39					-22.45769451	148.3608086			91.5	
MB40					-22.45777514	148.360887089			21	
MB19SRM01A	Borehole with Well Piezometer				-22.45946648	148.3598619	194.34	29/07/2019	8.5	5.2-8.3
MB19SRM02T	Borehole with Well Piezometer				-22.4593992	148.3598078	194.41	29/07/2019	27	14-20
MB19SRM03P	Borehole with Well Piezometer				-22.45931864	148.3597215	194.3	27/07/2019	91.5	84.4-90.2
MB20SRM07P	Borehole with Well Piezometer				-22.5290747	148.374569	208.77	26/10/2019	177	164.8-170.5
MB20SRM04A	Borehole with Well Piezometer				-22.32657073	148.275841871	194.95	5/10/2019	12	6.4-9.5
MB20SRM01A	Borehole with Well Piezometer				-22.35155234	148.3199976	186.42	16/10/2019	10.5	7.5-10.5
MB20SRM02T	Borehole with Well Piezometer				-22.35150866	148.3199263	186.61	19/10/2019	36.5	27.4-36.50
MB20SRM03P	Borehole with Well Piezometer				-22.35144148	148.3198577	186.74	18/10/2019	240	230.9-236.8
MB20SRM05A	Borehole with Well Piezometer				-22.36853122	148.3061208	191.99	3/10/2019	24	6.5-9.5
MB20SRM03P	Borehole with Well Piezometer				-22.35144148	148.3198577	186.74	18/10/2019	240	237-230.8
MB19SRM04P	Borehole with Well Piezometer				-22.50160118	148.332483202	208.74	4/08/2019	42	35.8-42
SEMLPMB1	Proposed bore - deleted by MB20SRM01A, MB20SRM02T, MB20SRM03P				-22.3543	148.3193	208.74	4/08/2019	42	35.8-42
SEMLPMB2	Proposed coal VWP for along strike drawdown				-22.32438	148.3114				
SEMLPMB3	Proposed VWP for coal MB20SRM3P				-22.3647	148.345				
SEMLPMB4	Proposed VWP for coal				-22.3915	148.341				
PZ02A	Nested Groundwater Monitoring				-22.3246	148.2818			26	
PZ02B	Nested Groundwater Monitoring				-22.3246	148.281			170	
PZ02C	Nested Groundwater Monitoring				-22.3246	148.2818			279	
PZ04A	Nested Groundwater Monitoring				-22.3223	148.2645			30	
PZ04B	Nested Groundwater Monitoring				-22.3223	148.2645			66	
PZ04C	Nested Groundwater Monitoring				-22.3223	148.2645			180	
PZ05A	Vibrating Wire Piezometers				-22.5176	148.3838	197.23		303	203 -
PZ05B	Vibrating Wire Piezometers				-22.5176	148.3838	197.23		303	239 -
PZ06A	Vibrating Wire Piezometers				-22.4807	148.3537	230.42		199	40.5 -
PZ06B	Vibrating Wire Piezometers				-22.4807	148.3537	230.42		199	78.5 -
PZ06C	Vibrating Wire Piezometers				-22.4807	148.3537	230.42		199	167 -
PZ07A	Nested Groundwater Monitoring				-22.4419	148.3399			14	
PZ07B	Nested Groundwater Monitoring				-22.4419	148.3399			198	
PZ07C	Nested Groundwater Monitoring				-22.4419	148.3399			303	
PZ08A	Vibrating Wire Piezometers				-22.3931	148.308	205.2		189	38.5 -
PZ08B	Vibrating Wire Piezometers				-22.3931	148.308	205.2		189	65 -
PZO8C	Vibrating Wire Piezometers				-22.3931	148.308			180	
PZ09A	Nested Groundwater Monitoring				-22.3507	148.2907				
PZ09B	Nested Groundwater Monitoring				-22.3507	148.2907			75	
PZ09C	Nested Groundwater Monitoring				-22.3507	148.2907			195	
PZ10A	Nested Groundwater Monitoring				-22.3833	148.3039				
PZ10B	Nested Groundwater Monitoring				-22.3833	148.3039			70	
PZ10C	Nested Groundwater Monitoring				-22.3833	148.30392			184	
2016MP06										
2016BH05										
2016BH08										
2019MP01_D					22.38379095	148.268289	209.59		18.00	
2019MP02_D					22.38415149	148.2683855	209.28		18.00	
2019MP03_D					22.38436955	148.2683379	209.09		14.10	
2019MP04_D					22.38510267	148.268495120	208.58		18.30	
2019MP05_D					22.38401643	148.267986042	209.89		23.00	
2019MP06					22.38262102	148.2678549	209.28		16.00	
2019MP07					22.38596978	148.268957541	206.24		13.50	
2019MP07_D					22.38190586	148.2673657	208.89		17.00	
2019MP08					22.38648231	148.2670653	201.64		12.10	
2019MP09					22.38391744	148.265286	200.61		6.50	
2019MP10					22.38260745	148.2662435	203.67		10.00	

DES - Raw Data

DO NOT change column headings. Values in the Data columns must be a number. If < is entered in a cell it will be treated as a blank in Power BI. Column can be added if indicator is not present. Column can be deleted if no data.

Monitoring Point	Date	Aluminium - Dissolved (µg/L)	Antimony - Dissolved (µg/L)	Arsenic - Dissolved (µg/L)	Boron - Dissolved (µg/L)	Electrical Conductivity (µS/cm)	Cadmium - Dissolved (µg/L)	Chromium - Dissolved (µg/L)	Cobalt - Dissolved (µg/L)	Copper - Dissolved (µg/L)	Lead - Dissolved (µg/L)	Manganese - Dissolved (µg/L)	Molybdenum - Dissolved (µg/L)	Nickel - Dissolved (µg/L)	pH (pH Units)	Selenium - Dissolved (µg/L)	Uranium - Dissolved (µg/L)	Vanadium - Dissolved (µg/L)	Zinc - Dissolved (µg/L)	Sulfate (mg/L)	Mercury-Dissolved (mg/L)	Free Cyanide (mg/L)	Weak Acid Dissociable Cyanide (mg/L)	Fluoride (mg/L)
PZ00A	6/06/2019	<50	<5	<5	1090	23900	<0.5	<5	<5	13	<5	101	<5	27	7.54	<50	<5	1490	889		<0.1			
PZ00A	3/12/2019	<10	<1	<1		28800							2		7.27	10					<0.1			
PZ00A	14/02/2020	<10	1	<1	1000	27800	<0.1	<1	1	2	<1	136	3	4	7.83	<10	4	1720	<5		<0.1			
PZ00A	19/05/2020	<50	<5	<5	1080	27600	<0.5	<5	<5	<5	<5	236	<5	10	7.23	<50	6		123		<0.1			
PZ00A	17/08/2020	<50	<5	<5	1350	28100	<0.5	<5	<5	<5	<5	172	<5	<5	7.31	<50	<5	1740	48		<0.1			
PZ00A	16/11/2020	<10	<1	1	740	27500	0.1	<1	2	18	<1	106	4	5	7.23	<10	3		98		<0.1			0.3
PZ00A	17/02/2021	<50	<5	<5	1000	28800	<0.5	<5	<5	<5	<5	104	6	10	7.2	<50	<5	<50	87	1640	<0.1			
PZ00A	10/05/2021	<10	<1	<1	1080	29100	0.1	<1	1	4	<1	88	1	6	7.62	<10	4	<10	25	1690	<0.1			
PZ00A	9/08/2021	<50	<5	<5	1220	29000	<0.5	<5	<5	<5	<5	80	<5	<5	8.12	<50	<5	<50	<25	1770	<0.1			
PZ00A	17/11/2021	<50	<5	<5	1090	29100	<0.5	<5	<5	<5	<5	<5	10	18	7.65	<50	<5	<50	<25	1600	<0.1			
PZ00B	6/06/2019	<50	<5	<5	1430	23900	<0.5	<5	<5	<5	<5	45	<5	9	7.17	<50	6	1460	<25		<0.1			
PZ00B	2/12/2019	<10	<1	<1		25400							1		7.39	<10					<0.1			
PZ00B	14/02/2020	<10	<1	<1	1630	25000	<0.1	<1	<1	<1	<1	7	1	7	7.91	<10	6	1410	<5		<0.1			
PZ00B	19/05/2020	<10	<1	<1	1290	24800	<0.1	<1	1	<1	<1	12	8	9	7.17	<10	7		15		<0.1			
PZ00B	17/08/2020	<10	<1	<1	1470	23900	0.1	<1	2	1	<1	35	<1	10	7.3	<10	12	1450	13		<0.1			
PZ00B	16/11/2020	<10	<1	<1	1150	24100	<0.1	<1	<1	3	<1	9	1	10	7.26	<10	11		62		<0.1			0.4
PZ00B	17/02/2021	<50	<5	<5	1430	24600	<0.5	<5	<5	<5	<5	10	<5	16	7.32	<50	9	<50	<25	1390	<0.1			
PZ00B	10/05/2021	<10	<1	<1	1360	24400	<0.1	2	1	2	<1	8	2	8	7.75	<10	8	<10	11	1440	<0.1			
PZ00B	9/08/2021	<10	<1	<1	1300	24700	<0.1	6	<1	3	<1	4	<1	8	8.17	<10	11	<10	<5	1480	<0.1			
PZ00B	17/11/2021	<10	<1	<1	1330	24800	<0.1	3	3	8	<1	58	1	14	7.79	<10	9	<10	16	1360	<0.1			
PZ00C	6/06/2019	<50	<5	<5	1440	25900	<0.5	<5	<5	<5	<5	901	<5	5	7.06	<50	8	1460	<25		<0.1			
PZ00C	2/12/2019	<10	<1	<1		28100							<1		7.03	<10					<0.1			
PZ00C	17/01/2020	<10	2	<1	1110	24300	<0.1	<1	42	1	<1	1940	1	23	7.32	<10	12		20		<0.1			
PZ00C	19/05/2020	<50	<5	<5	1310	27100	<0.5	<5	42	<5	<5	2640	<5	35	7.02	<50	14		44		<0.1			
PZ00C	17/08/2020	<50	<5	<5	1890	27300	<0.5	<5	31	<5	<5	1540	<5	19	7.13	<50	16	1540	<25		<0.1			
PZ00C	16/11/2020	<10	<1	2	1000	25200	<0.1	<1	38	2	<1	2660	3	80	7.2	<10	15		45		<0.1			0.3
PZ00D	6/06/2019	20	<1	<1	210	6710	<0.1	<1	<1	<1	<1	45	3	10	7.23	<10	<1	336	22		<0.1			
PZ00D	3/12/2019	<10	<1	1		18400							2		7.23	<10					<0.1			
PZ00D	14/02/2020	<10	<1	<1	1360	22500	<0.1	<1	18	<1	<1	1620	1	8	7.81	<10	4	1180	8		<0.1			
PZ00D	18/05/2020	<10	<1	<1	1080	21300	<0.1	1	23	<1	<1	1820	2	20	7.15	<10	5		12		<0.1			
PZ00D	17/08/2020	<10	<1	1	1410	24200	<0.1	<1	39	<1	<1	2010	<1	12	7.24	<10	6	1470	8		<0.1			
PZ00D	16/11/2020	<10	<1	2	1060	24100	<0.1	<1	38	2	<1	1810	2	16	7.1	<10	6		66		<0.1			0.3
PZ00D	17/02/2021	<50	<5	<5	1330	24700	<0.5	<5	40	<5	<5	2050	<5	23	7.13	<50	<5	<50	40	1390	<0.1			
PZ00D	10/05/2021	<10	2	2	1540	24900	<0.1	<1	40	<1	<1	2030	<1	10	7.66	<10	6	<10	6	1460	<0.1			
PZ00D	9/08/2021	<10	2	2	1280	24800	<0.1	10	43	<1	<1	2270	1	13	8.23	<10	6	<10	9	1460	<0.1			
PZ00D	17/11/2021	<10	1	2	1270	25100	<0.1	1	40	5	<1	2060	1	16	7.62	<10	5	<10	46	1380	<0.1			
PZ02A	31/10/2011	49	<1	2		22000							2		6.7	<1								0.44
PZ02B	31/10/2011	13	<1	4		14000							8		7.6	<1								0.14
PZ02C																								
PZ04A	18/11/2011	20	2	1		9000							3		8.1	<1								0.12
PZ04B	18/11/2011	50	<1	3		27000							2		6.7	<1								0.44
PZ04C	18/11/2011	48	<1	<1		23000							<1		7.6	<1								0.18
PZ05A																								
PZ05B																								
PZ06A																								
PZ06B																								
PZ06C																								
PZ07A	1/11/2011																							
PZ07B																								
PZ07C																								
PZ08A																								
PZ08B																								
PZ08C																								
PZ09A	1/11/2011																							
PZ09B	1/11/2011	<10	<1	<1		20000							<1		8.1	<1								0.2
PZ09C	1/11/2011	22	<1	1		8122							34		8.25	<1								0.44
PZ10A	1/11/2011																							
PZ10B	1/11/2011																							
PZ10C	1/11/2011	26	<1	1		5500							38		9	<1								0.4
MB31	26/10/2009	<10	<1			7330									7.44					1190				
MB31	14/12/2009	<10	<1			7640									7.65					1160				
MB31	29/04/2010	<10	<1			4940									7.33					656				
MB31	27/07/2010	<10	<1			4940									7.45					665				
MB31	24/01/2011	<10	<1			3990									7.14					478				
MB31	29/04/2011	100	<1			4500									7.65					551				
MB31	25/05/2011	100	<1			4500									7.65					551				
MB31	25/07/2011					4388									8					551				
MB31	25/10/2011	<10	<1			3961									8.61					600				
MB31	21/06/2012	<10000	<1000			2521									8.13					32				
MB31	24/07/2012	<10000	<1000			5358									9.64					490				
MB31	26/10/2012	<10	<1			5882									9.25					360				
MB31	22/01/2013	10	<1			7498									8.25					630				
MB31	22/04/2013	<10	<1			6500									8.25					650				
MB31	25/07/2013	<10000	<1000			7477									9.28					520				
MB31	21/01/2014		<1			6570									8.54					662	<0.0001			
MB31	23/04/2014	<10	<1			7130									8.48					775	<0.0001			
MB31	10/09/2014	<10	<1			9380									7.33					1560	<0.0001			
MB31	25/11/2014	<10	<1			8030									7.57					1480	<0.0001			
MB31	20/01/2015	10	<1	<1		9980							<1		7.97	<10				1730	<0.0001			
MB31	24/03/2015	10	<1	<1		9340							<1		8.17	<10				1610	<0.0001			
MB31	19/05/2015	<10	<1	<1		9140							1		7.52	<10				1880	<0.0001			
MB31	16/06/2015	20	<1	<1		9340							<1		7.45	<10				1710	<0.0001			
MB31	25/08/2015	20	<1	<1		9160							<1		7.11	<10				1510	<0.0001			
MB31	2/12/2015	<10	<1	<1		7550							2		7.69	<10				1280	<0.0001			
MB31	14/03/2016	<10	<1	<1		844							3		7.83	<10				1280	<0.0001			
MB31	13/06/2016	<10	<1	<1		9660							1		7.57	<10				1570	<0.0001			
MB31	19/09/2016	<10				4570							4		8.01						<0.1			
MB31	13/12/2016	<10				4790							4		7.55						<0.1			
MB31	15/03/2017	<10				7520							3		8.06						<0.1			
MB31	15/06/2017	<10				4590							4		7.64						<0.1			
MB31	19/09/2017	<10				4710							4		7.53						<0.1			
MB31	19/12/2017	<10	<1	<1		6290							5		7.61	<10					<0.1			
MB31	20/03/2018	<10	<1	<1		10100							1		6.99	<10					<0.1			
MB31	25/06/2018	<10				9940							2		6.98						<0.1			
MB31	23/07/2018	<10	<1	<1		8460							2		7.44	<10					<0.1			
MB31	25/09/2018	<10	<1	<1		7220							3		7.41	<10					<0.1			
MB31	27/03/2019	<10	<1	<1		10200							1		7.66	<10					<0.1			
MB31	12/06/2019	<10	<1	<1		7080							3		7.5	<10					<0.1			
MB31	12/06/2019	<10	<1	<1		7060							3		7.65	<10					<0.1			
MB31	16/09/2019	<10			800	6520		<1				137	3		7.61						<0.1			
MB31	16/12/2019	<10	<1	<1		7450							2		7.02	<10					<0.1			
MB31	16/03/2020	<10	<1	<1	830	7160		<1				156	2		7.34	<10					<0.1			
MB31	22/06/2020	<10	<1	<1	680	6160	0.7	<1	<1	<1	<1	136	4	5	7.39	<10	1		40		<0.1			
MB31	18/08/2020	<10	<1	<1	740	6460	0.8	<1	<1	4	<1	117	2	2	7.6	<10	2		36	977	<0.1			
MB31	18/11/2020	<10	<1	<1	690	5740	0.3	<1	<1	6	<1	117	2	2	7.59	<10	1		44		<0.1			1.4
MB31	17/02/2021	10	1	1	760	5780	0.3	<1	<1	<1	1	120	3	1	7.58	<10	1	<10	20	809	<0.0001			
MB31	11/05/2021	10	1	1	920	6800	0.3	<1	<1	2	<1	162	3	1	7.93	<10	<1	<10	22	1050	<0.0001			
MB31	11/08/2021	10	1	1	700	6790	0.2	<1	<1	1	<1	172	2	1	8.31	<10	1	<10	27	981	<0.0001			
MB31	16/11/2021	10	1	1	790	8110	0.2	<1	<1	3	<1	201	2	2	7.75	<10	1	<10	26	1240	<0.0001			
MB31	10/02/2022	480	<1	3																				
MB32	14/12/2009	<10	<1			1440									6.98					21	<0.0001			
MB32	29/04/2010	<10	<1			996									7.34					26	<0.0001			
MB32	27/07/2010	<10	<1			1098									7.06					24	<0.0001			
MB32	29/04/2011	<10	<1			1080									7.28					21	<0.0001			
MB32	25/05/2011	<10	<1			1080									7.28					21	<0.0001			
MB32	25/07/2011					867									7.48					21				
MB32	24/10/2011	<10	<1			997									6.95					23	<0.0001			
MB32	20/06/2012	<10000	<1000			773									7.67					500	<0.05			
MB32	25/07/2012	<10000	<1000			1690									8.8					32	<0.05			
MB32	24/10/2012	24	<1			1401									7.57					32	<0.0005			
MB32	22/01/2013	<10	<1			2276									7.15					59	<0.00005			
MB32	24/07/2013	<10000	<1000			2437									6.65					42	<0.05			
MB32	22/10/2013	<10	<1			1713									7.37					67	<0.001			
MB32	22/10/2013	<1	<1			1430							1		8.22	<10				67	<0.0001			
MB32	22/10/2013	<10	<1	1		1430							1		8.22	<10				67	<0.0001			
MB32	21/01/2014	<10	<1			1672									8.18					82	<0.0001			
MB32	21/01/2014	<1	<1			1560							<1		8.41	<10				82	<0.0001			
MB32	21/01/2014	<10	<1	<1		1560							<1		8.41	<10				82	<0.0001			
MB32	22/04/2014	<10	<1	<1		1740							<1		8.21	<10				91	<0.0001			
MB32	29/07/2014	<10	<1	<1		1540							<1		8	<10				62	<0.0001			
MB32	29/07/2014	<10	<1	<1		1540							<1		8	<10				62	<0.0001			
MB32	10/09/2014	<10	<1	<1		1550							<1		7.78	<10				52	<0.0001			
MB32	25/11/2014	<10	<1	<1		1570							<1		8.14	<10				59	<0.0001			
MB32	24/03/2015	<10	<1	<1		1700							<1		8.25	<1				91	<0.0001			
MB32	19/05/2015	<10	<1	<1		1980							<1		7098	<1				136	<0.0001			
MB32	16/06/2015	<10	<1	<1		1650							<1		8	<1				68	<0.0001			
MB32	26/08/2015	<10	<1	<1		1640							<1		7.57	<1				63	<0.0001			
MB32	2/12/2015	<10	<1	<1		1720							<1		7.79	<1				66	<0.0001			
MB32	21/04/2016	<10	<1	<1		1380							<1		7.62	<10				60	<0.0001			
MB32	13/06/2016	<10	<1	<1		1390							<1		7.79	<10				55	<0.0001			
MB32	19/09/2016	<10				1190							1		8.08						<0.1			
MB32	13/12/2016	<10				1430							1		7.77						<0.1			
MB32	13/03/2017	<10				1450							1		8.11						<0.1			
MB32	15/06/2017	<10				1090							1		7.7						<0.1			
MB32	19/09/2017	<10				1840							<1		7.86						<0.1			
MB32	19/12/2017	<10	<1	<1		2190							2		8	<10					<0.1			
MB32	20/03/2018	<10	<1	<1		1390							<1		7.49	<10					<0.1			
MB32	25/06/2018	<10	<1	<1		1770							1		7.4	<10					<0.1			
MB32	25/09/2018	<10	<1	<1		1780							<1		7.5	<10					<0.1			
MB32	27/03/2019	<10	<1	<1		1550							<1		7.98	<10					<0.1			
MB32	12/06/2019	<10	<1	<1		1710							1		7.72	<10					<0.1			
MB32	16/09/2019	<10			230	1580		<1				11	1		7.74						<0.1			
MB32	16/12/2019	<10	<1	<1		1520							<1		7.43	<10					<0.1			
MB32	20/03/2020	<10	<1	<1	80	1180	<0.1	<1	<1	<1	<1	36	1	1	8.13	<10	2		<5		<0.1			
MB32	22/06/2020	<10	<1	<1	140	1310	<0.1	<1	<1	<1	<1	38	<1	7	7.66	<10	2		<5		<0.1			
MB32	18/08/2020	<10	<1	<1	120	1230	<0.1	<1	<1	<1	<1	16	<1	<1	7.85	<10	2		<5		<0.1			
MB32	18/11/2020	<10	<1	<1	110	1450	<0.1	<1	<1	<1	<1	12	<1	1	7.64	<10	3		<5		<0.1			0.3
MB32	17/02/2021	<10	<1	<1	120	1330	<0.1	<1	<1	<1	<1	8	<1	<1	7.7	<10	3	<10	<5	51	<0.1			
MB32	11/05/2021	<10	1	<1	100	1040	<0.1	<1	<1	<1	<1	16	<1	2	8.14	<10	2	<10	<5	42	<0.1			
MB32	11/08/2021	<10	<1	<1	60	1060	<0.1	<1	<1	<1	<1	25	<1	<1	8.39	<10	2	<10	<5	41	<0.1			
MB32	16/11/2021	<10	<1	<1	80	928	<0.1	<1	<1	<1	<1	30	<1	1	8.02	<10	1	<10	<5	28	<0.1			
MB33	24/07/2013	<10000	<1000																		<5			
MB33	21/10/2013	<10	<1	<1		22900							72		8.24	<10				2240	<0.1			
MB33	20/01/2014	<10	<1	<1		24100							52		7.79	<10				2420	<0.1			
MB33	22/04/2014	<10	<1	1		24300							<1		7.32	<10				2390	<0.1			

MB33	29/07/2014	<10	<1	1		21300							1		7.59	<10				2150	<0.1				
MB33	9/09/2014	<50	<5	<5		18700							<5		8.09	<50				2410	<0.1				
MB33	25/11/2014	<10	<1	3		17400							2		7.89	<10				2580	<0.1				
MB33	20/01/2015	<50	<5	<5		25400							<5		8.01	<50				2550	<0.1				
MB33	24/03/2015	<50	<5	<5		24800							<5		7.66	<50				2410	<0.1				
MB33	19/05/2015	<10	<1	1		24100							1		7.18	<10				2920	<0.1				
MB33	16/06/2015	<10	<1	2		24000							1		7.48	<10				2580	<0.1				
MB33	2/12/2015	<10	<1	1		21600							1		7.57	<10				2480	<0.1				
MB33	14/03/2016	<10	<1	<1		24900							<1		8.08	<10				2360	<0.1				
MB33	13/06/2016	<10	<1	2		24200							1		8.03	<10				2400	<0.1				
MB33	19/09/2016	<10				23700							1		8.11						<0.1				
MB33	13/12/2016	<50				24400							<5		7.72						<0.1				
MB33	13/03/2017	<10				23900							<1		8.17						<0.1				
MB33	15/06/2017	<10				23600							1		7.2						<0.1				
MB33	19/09/2017	<10				23000							<1		7.24						<0.1				
MB33	19/12/2017	<10	<1	2		24800							2		7.4	<10					<0.1				
MB33	19/03/2018	<10	<1	2		23400							1		7.13	<10					<0.1				
MB33	25/06/2018	<10	<1	1		23100							1		7.01	<10					<0.1				
MB33	25/09/2018	<10	<1	1		21200							<1		7.16	<10					<0.1				
MB33	27/03/2019	<10	<1	1		23300							1		7.73	<10					<0.1				
MB33	12/06/2019	<10	<1	1		22600							1		7.3	<10					<0.1				
MB33	16/09/2019	<10			2110	22600		<1				837	<1		7.36						<0.5				
MB33	16/12/2019	<10	<1	1		23200							1		6.92	<10					<0.1				
MB33	17/03/2020	<50	<5	<5	1720	22200		<5				909	<5		7.1	<50					<0.1				
MB33	22/06/2020	20	<1	6	610	23100	<0.1	<1	<1	<1	<1	688	<1	6	7.26	<10	2		5		<0.1				
MB33	19/08/2020	<10	<1	<1	1960	22200	<0.1	<1	<1	<1	<1	855	<1	2	7.46	<10	4		<5	2240	<0.1				
MB33	17/11/2020	<10	<1	1	1480	22000	<0.1	<1	<1	<1	<1	773	<1	<1	7.28	<10	4		10		<0.1				0.4
MB33	16/02/2021	<50	<5	<5	1860	22400	<0.5	<5	<5	<5	<5	773	<5	<5	7.31	<50	<5	<50	<25	1970	<0.1				
MB33	10/05/2021	<10	<1	1	2180	22400	<0.1	<1	<1	<1	<1	834	<1	<1	7.68	<10	4	<10	<5	2200	<0.1				
MB33	10/08/2021	<10	1	1	1760	22900	<0.1	12	<1	<1	<1	942	<1	<1	8.22	<10	4	<10	<5	2160	<0.1				
MB33	18/11/2021	<10	<1	<1	1700	23200	<0.1	<1	1	<1	<1	866	<1	<1	7.59	<10	4	<10	<5	2190	<0.1				
MB34	24/07/2013	<10000	<1000			25200							2		8.86	<10				343	<0.05				
MB34	21/10/2013	<10	<1	1		25200							2		8.86	<10				343	<0.0001				
MB34	20/01/2014	<10	<1	<1		27500							2		7.67	<10				259	<0.0001				
MB34	22/04/2014	<10	<1	<1		27800							44		8.72	<10				280	<0.0001				
MB34	30/07/2014	<50	<5	<5		252							41		7.84	<50				266	<0.0001				
MB34	10/09/2014	<50	<5	<5		23400							50		8.86	<50				434	<0.0001				
MB34	25/11/2014	<10	<1	<1		28500							46		7.73	<10				558	<0.0001				
MB34	20/01/2015	<50	<5	<5		28500							26		7.63	<50				368	<0.0001				
MB34	24/03/2015	<50	<5	<5		27200							26		7.5	<50				402	<0.0001				
MB34	19/05/2015	<10	<1	<1		27700							34		8.63	<10				428	<0.0001				
MB34	16/06/2015	<10	<1	<1		27700							32		7.5	<10				366	<0.0001				
MB34	26/08/2015	<10	<1	<1		26400							30		7.75	<10				320	<0.0001				
MB34	2/12/2015	<10	<1	<1		25100							24		7.55	<10				340	<0.0001				
MB34	14/03/2016	<10	<1	<1		28300							15		7.69	<10				373	<0.0001				
MB34	13/06/2016	<10	<1	<1		28000							14		7.63	<10				276	<0.0001				
MB34	19/09/2016	<10				26600							4		7.8						<0.1				
MB34	13/12/2016	<10				28100							4		7.4						<0.1				
MB34	13/03/2017	<10				28000							2		7.72						<0.1				
MB34	15/06/2017	<50				27900							<5		7.51						<0.1				
MB34	19/09/2017	<10				26300							4		7.32						<0.1				
MB34	19/12/2017	<10	<1	2		29300							1		7.62	<10					<0.1				
MB34	20/03/2018	<50	<5	<5		28000							<5		7.27	<50					<0.1				
MB34	25/06/2018	20	<1	1		27900							<1		7.42	<10					<0.1				
MB34	25/09/2018	20	<1	7		25200							<1		7.54	<10					<0.1				
MB34	27/03/2019	<10	<1	3		28200							2		7.83	<10					<0.1				
MB34	12/06/2019	<10	<1	<1		27600							1		7.48	<10					<0.1				
MB34	17/09/2019	<10			500	27500		<5				20	<5		7.67						<0.5				
MB34	16/12/2019	<50	<5	<5	190	28800							<5		7.25	<50					<0.1				
MB34	17/03/2020	<50	<5	<5		27600		<5				36	<5		7.57	<50					<0.1				
MB34	22/06/2020	<10	<1	<1	280	28000	<0.1	<1	<1	<1	<1	91	8	5	7.51	<10	<1		5		<0.1				
MB34	19/08/2020	<50	<5	<5	260	28500	<0.5	<5	<5	<5	<5	39	<5	<5	7.59	<50	<5		<25	54	<0.1				
MB34	17/11/2020	<50	<5	<5	130	27300	<0.5	<5	<5	<5	<5	30	<5	<5	7.54	<50	<5		<25		<0.1				0.2
MB34	16/02/2021	<50	<5	<5	250	27700	<0.5	<5	<5	<5	<5	79	<5	<5	7.56	<50	<5	<50	<25	46	<0.1				
MB34	10/05/2021	<10	<1	<1	230	28200	<0.1	1	<1	<1	<1	25	2	<1	7.83	<10	<1	<10	5	68	<0.1				
MB34	12/08/2021	<50	<5	<5	220	27900	<0.5	<5	<5	<5	<5	38	<5	<5	7.84	<50	<5	<50	<25	25	<0.1				
MB34	18/11/2021	<10	<5	<5	210	27700	<0.5	<5	<5	<5	<5	49	<5	<5	7.83	<50	<5	<50	<25	23	<0.1				
MB35	25/07/2013	<10000	<1000																		<0.05				
MB35	21/10/2013	<10	<1	<1		1220							1		8.38	<10				35	<0.0001				
MB35	20/01/2014	<10	<1	<1		1170							1		8.75	<10				35	<0.0001				
MB35	22/04/2014	<10	<1	1		1280							1		8.09	<10				35	<0.0001				
MB35	29/07/2014	<10	<1	1		1260							2		7.87	<10				36	<0.0001				
MB35	10/09/2014	<10	<1	2		1780							5		7.5	<10				81	<0.0001				
MB35	25/11/2014	<10	<1	2		1710							5		7.81	<10				78	<0.0001				
MB35	20/01/2015	<10	<1	2		1940							6		8.38	<10				103	<0.0001				
MB35	24/03/2015	<10	<1	2		1840							5		8318	<10				85	<0.0001				
MB35	19/05/2015	<10	<1	1		1520							3		7.79	<10				66	<0.0001				
MB35	16/06/2015	<10	<1	2		1780							5		7.61	<10				93	<0.0001				
MB35	26/08/2015	<10	<1	1		1410							3		7.64	<10				48	<0.0001				
MB35	2/12/2015	<10	<1	1		1320							3		8.35	<10				51	<0.0001				
MB35	14/03/2016	<10	<1	2		2100							7		8.58	<10				123	<0.0001				
MB35	13/06/2016	<10	<1	2		1340							2		8.4	<10				48	<0.0001				
MB35	19/09/2016	<10				1300							2		8.36						<0.1				
MB35	13/12/2016	<10				1320							2		7.93						<0.1				
MB35	13/03/2017	<10				1480							3		7.92						<0.1				
MB35	15/06/2017	<10				1310							2		7.93						<0.1				
MB35	19/09/2017	<10				1340							2		7.43						<0.1				
MB35	19/12/2017	<10	<1	2		1380							2		7.97	<10					<0.1				
MB35	20/03/2018	<10	<1	2		1970							5		7.38	<10					<0.1				
MB35	13/12/2016	<10				1320							2		7.93						<0.1				
MB35	13/03/2017	<10				1480							3		7.92						<0.1				
MB35	15/06/2017	<10				1310							2		7.93						<0.1				
MB35	19/09/2017	<10				1340							2		7.43						<0.1				
MB35	19/12/2017	<10	<1	2		1380							2		7.97	<10					<0.1				
MB35	25/06/2018	10	<1	2		2090							4		7.37	<10					<0.1				
MB35	25/09/2018	<10	<1	4		1880							5		8.61	<10					<0.1				
MB35	27/03/2019	<10	<1	2		1530							3		8.03	<10					<0.1				
MB35	12/06/2019	<10	<1	<1		1890							5		7.66	<10					<0.1				
MB35	17/09/2019	<10			310	1940		<1				422	5		7.77						<0.1				
MB35	16/12/2019	<10	<1	2		1410							3		7.96	<10					<0.1				
MB35	17/03/2020	<10	<1	2	290	1980		<1				397	4		7.57	<10					<0.1				
MB35	22/06/2020	<10	<1	2	280	1940	<0.1	<1	<1	<1	<1	359	6	6	7.6	<10	1		17		<0.1				
MB35	20/08/2020	<10	<1	3	160	1350	<0.1	<1	<1	<1	<1	200	2	3	7.79	<10	2		5	48	<0.1				
MB35	18/11/2020	<10	<1	<1	170	1430	<0.1	<1	<1	<1	<1	212	2	2	7.58	<10	1		12		<0.1				0.4
MB35	16/02/2021	<10	<1	2	330	2000	<0.1	<1	<1	<1	<1	406	6	4	7.73	<10	<1	<10	<5	116	<0.1				
MB35	12/05/2021	<10	<1	3	360	1900	<0.1	<1	<1	<1	<1	426	6	<1	8	<10	<1	<10	<5	116	<0.1				
MB35	11/08/2021	<10	<1	2	180	1680	<0.1	<1	<1	<1	<1	334	4	1	8.54	<10	1	<10	<5	75	<0.1				
MB35	18/11/2021	<10	<1	2	250	1800	<0.1	<1	1	<1	<1	370	5	1	7.98	<10	1	<10	<5	94	<0.1				
MB36	25/07/2013	<10000	<1000																		<0.05				
MB36	22/10/2013	<10	<1	<1		6990							<1		8.02	<10				435	<0.0001				
MB36	20/01/2014	<10	<1	<1		7370							<1		8.13	<10				440	<0.0001				
MB36	22/04/2014	<10	<1	1		7480							<1		7.98	<10				493	<0.0001				
MB36	29/07/2014	<10	<1	1		6850							1		7.82	<10				422	<0.0001				
MB36	10/09/2014	<10	<1	3		10300							<1		7.28	<10				362	<0.0001				
MB36	25/11/2014	<10	<1	3		7930							<1		7.71	<10				360	<0.0001				
MB36	20/01/2015	<10	<1	2		10800							<1		7.94	<10				404	<0.0001				
MB36	24/03/2015	<10	<1	2		10500							<1		7.93	<10				369	<0.0001				
MB36	19/05/2015	<10	<1	3		9850							<1		7.53	<10				512	<0.0001				
MB36	42171	<10	<1	1		10300							1		7.49	<10				429	<0.0001				
MB36	26/08/2015	<10	<1	1		7850							<1		7.81	<10				467	<0.0001				
MB36	2/12/2015	<10	<1	1		7720							<1		7.87	<10				440	<0.0001				
MB36	21/04/2016	<10	<1	<1		8520							<1		7.75	<10				412	<0.0001				
MB36	13/06/2016	<10	<1	1		7880							<1		8	<10				444	<0.0001				
MB36	19/09/2016	<10				7630							<1		8						<0.1				
MB36	13/12/2016	<10				7980							<1		7.8						<0.1				
MB36	13/03/2017	<10				10600							<1		7.88						<0.1				
MB36	15/06/2017	<10				8170							<1		7.41						<0.1				
MB36	19/09/2017	<10				7180							<1		7.42						<0.1				
MB36	19/12/2017	<10	<1	1		8000							1		7.92	<10					<0.1				
MB36	20/03/2018	<10	<1	<1		10400							<1		7.18	<10					<0.1				
MB36	25/06/2018	<10	<1	<1		9980							<1		7.2	<10					<0.1				
MB36	25/09/2018	<10	<1	5		9350							<1		7.95	<10					<0.1				
MB36	27/03/2019	<10	<1	1		8220							<1		7.84	<10					<0.1				
MB36	12/06/2019	<10	<1	<1		8370							1		7.74	<10					<0.1				
MB36	17/09/2019	<10			260	7700		<1				163	<1		7.63						<0.1				
MB36	16/12/2019	<10	<1	<1		7690							<1		7.72	<10					<0.1				
MB36	22/06/2020	<10	<1	<1	210	6550	<0.1	<1	<1	<1	<1	142	<1	2	7.6	<10	<1		<5		<0.1				
MB36	20/08/2020	<10	<1	<1	230	6540	<0.1	<1	<1	<1	<1	151	<1	<1	7.73	<10	<1		5	344	<0.1				
MB36	18/11/2020	<10	<1	<1	200	6580	<0.1	2	<1	<1	<1	156	<1	1	7.59	<10	<1		6		<0.1				0.3
MB37	24/07/2013	<10000	<1000																		<0.05				
MB37	22/10/2013	<10	<1	1		13300							1		8.15	<10				1920	<0.0001				
MB37	21/01/2014	<50	<5	<5		14800							41		8.2	<50				2130	<0.0001				
MB37	23/04/2014	<10	<1	<1		14200							<1		7.86	<10				2300	<0.0001				
MB37	29/07/2014	<10	<1	<1		12900							2		7.84	<10				1950	<0.0001				
MB37	10/09/2014	<50	<5	<5		14600							<5		7.78	<50				2080	<0.0001				
MB37	25/11/2014	<10	<1	<1		11200							<1		7.84	<10				1870	<0.0001				
MB37	20/01/2015	<10	<1	<1		14300							<1		7.85	<10				2220	<0.0001				
MB37	24/03/2015	<10	<1	<1		13900							<1		7.8	<10				1950	<0.0001				
MB37	19/05/2015	<10	<1	<1		14200							<1		7.56	<10				2310	<0.0001				
MB37	16/06/2015	<10	<1	<1		14300							<1		7.62	<10				2250	<0.0001				
MB37	25/08/2015	<10	<1	<1		13300							3		7.73	<10				2110	<0.0001				
MB37	2/12/2015	<10	<1	<1		12700							<1		7.79	<10				2100	<0.0001				
MB37	14/03/2016	<10	<1	<1		14200							3		7.91	<10				2000	<0.0001				
MB37	13/06/2016	<10	<1	<1		13500							3		7.91	<10				1990	<0.0001				
MB37	19/09/2016	<10				13200							2		7.88						<0.1				
MB37	13/12/2016	<10				13700							2		7.67						<0.1				
MB37	13/03/2017	<10				13800							2		7.73						<0.1				
MB37	15/06/2017	<10				13400							<1		7.57						<0.1				
MB37	19/09/2017	<10				13500							1		7.62						<0.1				
MB37	19/12/2017	<10	<1	<1		14200							<1		8	<10					<0.1				
MB37	25/06/2018	40	<1	6		14400							<1		7.73	<10					<0.1				
MB37	25/09/2018	20	<1	17		12900							<1		7.86	<10					<0.1				
MB37	12/06/2019	<10	<1	<1		13800							<1		7.77	<10					<0.1				
MB37	16/09/2019	<10			180	13600		<1				137	<1		7.94						<0.1				
MB37	16/03/2020	40	<1	6	130	13500		1				209	<1		7.87	<10					<0.1				
MB37	22/06/2020	50	<1	5	150	14400	<0.1	<1	<1	<1	<1	158	<1	1	8.03	<10	<1		10		<0.5				
MB37	18/08/2020	<10	<1	<1	180	13500	<0.1	3	<1	<1	<1	64	<1	2	8.02	<10	<1		<5		<0.1				
MB37	18/11/2020	<10	<1	2	130	13500	<0.1	1	<1	<1	<1	64	<1	<1	7.9	<10	<1		10		<0.1				<0.1
MB37	17/02/2021	<10	1	1	160	14100	<0.1	<1	<1	<1	<1	96	<1	1	7.96	<10	<1	<10	<5	1770	<0.1				

MB37	11/05/2021	<10	1	1	180	13800	<0.1	<1	<1	<1	<1	120	<1	<1	8.11	<10	<1	<10	<5	1800	<0.1				
MB37	11/08/2021	<10	2	1	70	14200	<0.1	9	<1	<1	<1	144	<1	<1	8.08	<10	<1	<10	<5	1740	<0.1				
MB37	16/11/2021	<10	26	1	120	13000	<0.1	2	<1	2	<1	73	<1	2	8.25	<10	<1	<10	24	1600	<0.1				
MB39	14/02/2020	<10	17	<1	330	8030	<0.1	<1	<1	<1	<1	9	<1	<1	8.42	<10	<1		<5	70	<0.1				
MB39	18/03/2020	<10	47	1	370	7890	<0.1	<1	<1	<1	<1	52	<1	<1	8.28	<10	<1		<5		<0.1				
MB39	21/04/2020	40	58	<1	300	7980	<0.1	<1	<1	<1	<1	74	<1	1	8.24	<10	<1		11	74	<0.1				
MB39	19/05/2020	30	68	1	360	8370	<0.1	<1	<1	<1	<1	80	<1	1	8.03	<10	<1		<5		<0.1				
MB39	17/06/2020	30	41	<1	400	8520	<0.1	<1	<1	<1	<1	114	<1	2	7.95	<10	<1		<5		<0.1				
MB39	1/07/2020	30	16	<1	350	9470	<0.1	<1	<1	<1	<1	176	<1	<1	8.25	<10	<1		<5		<0.1				
MB39	20/08/2020	20	4	<1	400	9340	<0.1	<1	<1	<1	<1	177	<1	<1	8.05	<10	<1		<5	281	<0.1				
MB39	16/09/2020	10	4	<1	540	9610	<0.1	<1	<1	<1	<1	183	<1	<1	7.83	<10	<1		<5		<0.1				0.1
MB39	13/10/2020	10	5	<1	410	9630	<0.1	<1	<1	<1	<1	176	<1	<1	8.2	<10	<1		<5		<0.1				0.1
MB39	18/11/2020	10	2	<1	380	9350	<0.1	<1	<1	<1	<1	152	<1	<1	7.97	<10	<1		<5		<0.1				0.1
MB40	14/02/2020	<10	<1	<1	200	2270	<0.1	<1	2	<1	<1	141	2	1	7.85	<10	13		<5	112	<0.1				
MB40	18/03/2020	<10	<1	<1	170	1980	<0.1	<1	<1	<1	<1	16	3	<1	7.7	<10	6		<5		<0.1				
MB40	21/04/2020	<10	4	<1	130	2050	<0.1	<1	<1	<1	<1	7	<1	<1	7.73	<10	10		<5	82	<0.1				
MB40	19/05/2020	<10	3	1	160	2220	<0.1	<1	<1	<1	<1	62	<1	<1	7.52	<10	9		6		<0.1				
MB40	17/06/2020	<10	1	<1	220	2240	<0.1	<1	<1	<1	<1	19	1	<1	7.64	<10	13		<5		<0.1				
MB40	1/07/2020	<10	1	<1	210	2290	<0.1	<1	<1	<1	<1	25	2	<1	7.92	<10	14		<5		<0.1				
MB40	20/08/2020	<10	1	<1	190	2130	<0.1	<1	<1	<1	<1	7	<1	<1	7.83	<10	11		<5	81	<0.1				
MB40	16/09/2020	<10	1	1	150	2210	<0.1	<1	<1	<1	<1	9	1	<1	7.52	<10	9		<5		<0.1				0.3
MB40	13/10/2020	<10	2	<1	190	2200	<0.1	<1	<1	<1	<1	7	1	<1	7.96	<10	6		<5		<0.1				0.3
MB40	18/11/2020	<10	3	<1	200	2220	<0.1	<1	<1	<1	<1	24	<1	2	7.65	<10	9		<5		<0.1				0.3
MB19SRM02T	2/12/2019	<10	<1	<1		2190							2		7.62	<10					<0.1				
MB19SRM02T	30/01/2020	<10			150	2100	<0.1	<1				58	1		7.38						<0.1				
MB19SRM02T	14/02/2020	<10	<1	<1	200	2270	<0.1	<1	<1	<1	<1	141	2	1	7.85	<10	13	<10	<5	112	<0.1				
MB19SRM02T	18/03/2020	<10	<1	<1	170	1980	<0.1	<1	2	<1	<1	16	3	<1	7.7	<10	6	7	<10	<5	93	<0.1			
MB19SRM02T	21/04/2020	<10	4	<1	130	2050	<0.1	<1	<1	<1	<1	7	<1	<1	7.73	<10	10	<10	<5	82	<0.1				
MB19SRM02T	19/05/2020	<10	3	1	160	2220	<0.1	<1	<1	<1	<1	62	<1	<1	7.52	<10	9	<10	6	82	<0.1				
MB19SRM02T	17/06/2020	<10	1	<1	220	2240	<0.1	<1	<1	<1	<1	19	1	<1	7.64	<10	13	<10	<5	96	<0.1				
MB19SRM02T	1/07/2020	<10	1	<1	210	2290	<0.1	<1	<1	<1	<1	25	2	<1	7.92	<10	14	<10	<5	89	<0.1				
MB19SRM02T	20/08/2020	<10	1	<1	190	2130	<0.1	<1	<1	<1	<1	7	<1	<1	7.83	<10	11	<10	<5	81	<0.1				
MB19SRM02T	16/09/2020	<10	1	<1	150	2210	<0.1	<1	<1	<1	<1	9	1	<1	7.52	<10	9	<10	<5	81	<0.1				
MB19SRM02T	13/10/2020	<10	2	<1	190	2200	<0.1	<1	<1	<1	<1	7	1	<1	7.96	<10	6	<10	<5	76	<0.1				
MB19SRM02T	18/11/2020	<10	3	<1	200	2220	<0.1	<1	<1	<1	<1	24	<1	2	7.65	<10	9	<10	<5	79	<0.1				
MB19SRM02T	9/12/2020	<10	2	<1	270	2460	<0.1	2	<1	1	<1	46	3	10	7.72	<10	10	<10	12	85	<0.1				
MB19SRM02T	13/01/2021	<10	3	<1	240	2250	<0.1	<1	3	<1	<1	73	2	1	7.85	<10	10	<10	17	82	<0.1				
MB19SRM02T	17/02/2021	<10	1	<1	240	2340	<0.1	<1	<1	<1	<1	29	2	8	7.62	<10	14	<10	8	82	<0.1				
MB19SRM02T	25/03/2021	<10	3	<1	260	2220	<0.1	<1	<1	3	<1	16	2	<1	7.75	<10	11	<10	31	86	<0.1				
MB19SRM02T	15/04/2021	<10	9	<1	190	2190	<0.1	<1	<1	3	<1	3	<1	1	8.2	<10	9	<10	20	87	<0.1				
MB19SRM02T	12/05/2021	<10	4	<1	280	2300	<0.1	<1	<1	2	<1	35	2	<1	7.97	<10	13	<10	12	94	<0.1				
MB19SRM02T	10/06/2021	<10	24	<1	200	2380	<0.1	<1	<1	<1	<1	66	2	3	7.81	<10	11	<10	<5	88	<0.1				
MB19SRM02T	18/08/2021	<10	3	<1	280	2350	<0.1	2	1	<1	<1	70	2	5	7.64	<10	12	<10	16	85	<0.1				
MB19SRM02T	23/08/2021	<10	4	1	270	2400	<0.1	4	1	<1	<1	178	2	6	7.89	<10	13	<10	26	107	<0.1				
MB19SRM02T	13/09/2021	<10	1	1	250	2240	<0.1	<1	2	<1	<1	42	<1	<1	7.53	<10	13	10	15	84	<0.1				
MB19SRM02T	12/10/2021	<10	4	<1	180	2210	<0.1	<1	2	<1	2	2	<1	2	8.34	<10	12	<10	14	89	<0.1				
MB19SRM02T	18/11/2021	<10	1	<1	200	2280	<0.1	<1	5	<1	<1	10	1	<1	8.05	<10	12	<10	16	83	<0.1				
MB19SRM02T	13/12/2021	<10	2	<1	250	2480	<0.1	<1	5	<1	8	2	2	8.02	<10	12	<10	21	82	<0.1					
MB19SRM02T	19/01/2022	<10	<1	1	300	2360	<0.1	<1	<1	2	<1	45	1	<1	7.26	<10	12	<10	<5	80	<0.1				
MB19SRM03P	2/12/2019	30	<1	<1		8140							<1		8.18	<10					<0.1				
MB19SRM03P	30/01/2020	30			350	8260	<0.1	<1				56	<1		7.8						<0.1				
MB19SRM03P	14/02/2020	<10	17	<1	330	8030	<0.1	<1	<1	<1	<1	9	<1	<1	8.42	<10	<1	<10	<5	70	<0.1				
MB19SRM03P	18/03/2020	<10	10	1	370	7890	<0.1	<1	<1	<1	<1	52	<1	<1	8.28	<10	<1	<10	<5	70	<0.1				
MB19SRM03P	21/04/2020	40	58	<1	300	7980	<0.1	<1	<1	<1	<1	74	<1	1	8.24	<10	<1	<10	11	74	<0.1				
MB19SRM03P	19/05/2020	30	68	1	360	8370	<0.1	<1	<1	<1	<1	80	<1	1	8.03	<10	<1	<10	<5	75	<0.1				
MB19SRM03P	17/06/2020	30	41	<1	400	8520	<0.1	<1	<1	<1	<1	114	<1	2	7.95	<10	<1	<10	<5	138	<0.1				
MB19SRM03P	1/07/2020	30	16	<1	350	9470	<0.1	<1	<1	<1	<1	176	<1	<1	8.25	<10	<1	<10	<5	265	<0.1				
MB19SRM03P	20/08/2020	20	4	<1	400	9340	<0.1	<1	<1	<1	<1	177	<1	<1	8.05	<10	<1	<10	<5	281	<0.1				
MB19SRM03P	16/09/2020	10	4	<1	540	9610	<0.1	<1	<1	<1	<1	183	<1	<1	7.83	<10	<1	<10	<5	286	<0.1				
MB19SRM03P	13/10/2020	10	5	<1	410	9630	<0.1	<1	<1	<1	<1	176	<1	<1	8.2	<10	<1	<10	<5	300	<0.1				
MB19SRM03P	18/11/2020	10	2	<1	380	9350	<0.1	<1	<1	<1	<1	152	<1	<1	7.97	<10	<1	<10	<5	300	<0.1				
MB19SRM03P	9/12/2020	20	2	<1	460	9500	<0.1	<1	<1	<1	<1	167	27	6	7.97	<10	<1	<10	<5	312	<0.1				
MB19SRM03P	13/01/2021	10	2	<1	410	9280	<0.1	<1	<1	<1	<1	160	1	<1	7.96	<10	<1	<10	<5	296	<0.1				
MB19SRM03P	17/02/2021	30	3	<1	390	9420	<0.1	<1	<1	<1	<1	161	<1	2	7.99	<10	<1	<10	9	296	<0.1				
MB19SRM03P	25/03/2021	<10	2	<1	480	9090	<0.1	<1	<1	<1	<1	147	<1	<1	8.1	<10	<1	<10	9	305	<0.1				
MB19SRM03P	15/04/2021	20	3	<1	360	11000	<0.1	<1	<1	<1	<1	144	<1	<1	8.05	<10	<1	<10	<5	310	<0.1				
MB19SRM03P	12/05/2021	<10	3	<1	460	9130	<0.1	<1	<1	<1	<1	140	<1	<1	8.19	<10	<1	<10	8	307	<0.1				
MB19SRM03P	10/06/2021	<10	7	<1	420	9300	<0.1	<1	<1	1	<1	225	4	4	8.1	<10	<1	<10	<5	298	<0.1				
MB19SRM03P	18/08/2021	<10	2	<1	460	9320	<0.1	<1	<1	<1	<1	149	<1	2	7.83	<10	<1	<10	<5	317	<0.1				
MB19SRM03P	23/08/2021	<10	9	<1	440	9260	<0.1	<1	<1	<1	<1	135	<1	<1	7.83	<10	<1	<10	<5	288	<0.1				
MB19SRM03P	13/09/2021	<10	5	<1	460	9290	<0.1	<1	<1	<1	<1	151	<1	<1	7.69	<10	<1	<10	<5	295	<0.1				
MB19SRM03P	12/10/2021	<10	8	<1	340	9600	<0.1	<1	<1	<1	<1	144	1	<1	8.33	<10	<1	<10	19	289	<0.1				
MB19SRM03P	18/11/2021	<10	4	<1	380	9410	<0.1	<1	1	<1	<1	144	<1	<1	8.15	<10	<1	<10	<5	300	<0.1				
MB19SRM03P	13/12/2021	<10	9	<1	420	10000	<0.1	<1	<1	<1	<1	134	<1	<1	8.1	<10	<1	<10	<5	299	<0.1				
MB19SRM03P	19/01/2022	10	4	<1	430	9100	<0.1	<1	<1	<1	<1	134	<1	<1	7.4	<10	<1	<10	<5	301	<0.1				
MB19SRM04P	4/12/2019	<10	<1	<1		6060							3		7.38	<10					<0.1				
MB19SRM04P	14/02/2020	<10	<1	1	390	5870	<0.1	<1	4	<1	<1	94	2	2	7.94	<10	<1		<5	571	<0.1				
MB19SRM04P	20/05/2020	<10	<1	3	430	5910	<0.1	<1	6	<1	<1	271	2	5	7.38	<10	2		<5		<0.1				
MB19SRM04P	18/08/2020	<10	<1	3	460	5850	<0.1	<1	6	<1	<1	270	2	4	7.54	<10	2		<5	620	<0.1				
MB19SRM04P	18/11/2020	<10	<1	3	420	5910	<0.1	<1	4	<1	<1	246	1	5	7.38	<10	2		<5		<0.1				0.5
MB19SRM04P	15/02/2021	<10	<1	<1	450	5940	<0.1	<1	<1	<1	<1	267	<1	2	7.27	<10	<1	<10	26	597	<0.1				
MB19SRM04P	12/05/2021	<10	<1	2	520	5770	<0.1	<1	<1	<1	<1	163	<1	<1	7.86	<10	<1	<10	<5	626	<0.1				
MB19SRM04P	12/08/2021	<10	<1	1	400	6110	<0.1	3	<1	<1	<1	200	<1	<1	8.41	<10	<1	<10	<5	584	<0.1				
MB205RM03P	26/10/2019	250			130	16500	<0.1	16				<1	112		12.2						<0.1				0.5
MB205RM07P	27/10/2019	10			50	5440	<0.1	3				15	5		8.43						<0.1				0.1
MB01P_R01	11/01/2020	<10			280	15600	<0.1	<1				100	7		7.37						<0.1				0.1
MB02P	10/01/2020	<10			420	12800	<0.1	<1				432	<1		7.86						<0.1				0.5
2013MP06	11/10/2018	40	<1	<1		21500							2		7.83	<10				2360	<0.1				
2013MP06	30/10/2018	30	<1	<1		21500		<1		3			2		7.55	<10	55		12		<0.1				
2013MP06	15/01/2019	<10			1060	21000	0.2	<1				5000	3		7.29						<0.1				
2013MP06	27/03/2019	<10			1170	19100	0.2	<1				5250	3		7.38						<0.1				
2013MP06	16/04/2019	<10			820	13400	<0.1	<1				1960	4		8.12						<0.1				
2013MP06	28/05/2019	<10			1240	18800	0.2	<1				5100	3		7.24						<0.1				
2013MP06	4/07/2019	<10			1060	20000	0.2	<1				3420	2		7.33						<0.1				
2013MP06	22/07/2019	<10	<1	<1	1070	20200	0.2	<1	7	1	<1	4540	2	17	7.03	<10	44		9		<0.1				
2013MP06	24/09/2019	<10			1060	19800	0.1	<1				1730	2		7.23						<0.1				
2013MP06	3/12/2019	50	<1	<1		20500							2		7.36	<10					<0.1				
2013MP06	14/02/2020	<10	<1	<1	1380	20300	<0.1	<1	6	<1	<1	2960	2	13	7.82	<10	45		<5	2220	<0.1				
2013MP06	20/05/2020	<10	<1	<1	780	15500	<0.1	<1	2	<1	<1	1030	3	13	7.22	<10	18		<5		<0.1				
2013MP06	19/08/2020	<10	<1	<1	1060	18800	0.3	<1	2	2	<1	2480	2	18	7.44	<10	43		31	2120	<0.1				
2013MP06	19/11/2020	<10	<1	<1	840	21000	0.2	<1	6	2	<1	2300	2	21	7.34	<10	57		16		<0.1				0.3
2013MP08	18/02/2021	<10	<1	<1	820	16200	<0.1	<1	2	4	<1	1370	2	14	7.33	<10	35	<10	10	1630	<0.1				
2013MP06	12/05/2021	<10	1	<1	710	13400	<0.1	<1	1	3	<1	1640	2	10	7.75	<10	18	<10	9	1270	<0.1				
2013MP06	11/08/2021	<10	<1	<1	530	13000	0.1	<1	4	1	<1	3400	2	13	8.12	<10	28	<10	10	1200	<0.1				
2013MP06	18/11/2021	<10	<1	<1	310	2820	<0.1	1	<1	6	<1	67	3	5	8.12	<10	4	<10	<5	193	<0.1				
2016BH05	11/10/2018	30	<1	3		8560							26		8.46	<10				1290	<0.1				
2016BH05	28/05/2019	40			1050	9460	<0.1	<1				1370	21		7.65						<0.1				
2016BH05	4/07/2019	<10			1190	9350	<0.1	<1				1260	8		7.75						<0.1				
2016BH05	22/07/2019	<10	<1	1	1060	10000	<0.1	<1	1	<1	1130	6	10	7.43	<10	7			22		<0.1				
2016BH05	12/08/2019	<10	<1	2		10600						14		8.14	<10						<0.1				
2016BH05	24/09/2019	10			1000	8770	<0.1	<1				1680	38		7.47						<0.1				
2016BH05	3/12/2019	20	<1	4		9060							38		7.63	<10					<0.1				
2016BH05	13/02/2020	<10	<1	2	1140	9260	<0.1	<1	1	<1	<1	1640	18	8	8.13	<10	8		<5	1840	<0.1				
2016BH05	20/05/2020	10	<1	3	1060	9590	<0.1	<1	2	<1	<1	1830	10	9	7.46	<10	9		10		<0.1				
2016BH05	19/08/2020	<10	<1	3	1140	9310	<0.1	<1	1	<1	<1	1670	14	9	7.67	<10	9		7	1870	<0.1				
2016BH05	19/11/2020	<10	<1	7	820	9130	<0.1	<1	4	1	<1	2540	25	17	7.43	<10	16		20		<0.1				0.6
2016BH05	18/02/2021	<10	<1	3	520	7090	<0.1	<1	11	<1	<1	1930	10	15	7.45	<10	10	<10	19	2970	<0.1				
2016BH05	13/05/2021	<10	<1	1	580	6400	<0.1	<1	<1	<1	<1	951	5	1	8.04	<10	7	<10	<5	2780	<0.1				
2016BH05	11/08/2021	<10	<1	7	690	8870	<0.1	<1	14	<1	<1	3070	10	25	8.39	<10	13	<10	15	2400	<0.1				
2016BH05	17/11/2021	<10	<1	6	530	6490	<0.1	<1	8	3	<1	1300	10	15	7.89	<10	9	<10	10	2850	<0.1				
2016BH08	11/10/2018	<10	<1	3		20900							3		8.35	<10				3140	<0.1				
2016BH08	30/10/2018	<10	<1	4		20700		<1		<1			3		6.97	<10	4		764		<0.1				
2016BH08	15/01/2019	<10			2520	21300	0.3	<1				3150	3		6.89						<0.1				
2016BH08	27/03/2019	<10			2460	20300	0.4	1				2620	2		6.72						<0.1				
2016BH08	16/04/2019	<10			2420	21200	0.7	<1				2410	2		7.83						<0.1				
2016BH08	28/05/2019	<10			2650	22000	1.5	<1				3110	2		6.73						<0.1				
2016BH08	4/07/2019	<10			2550	21900	0.3	<1				3830	2		6.81						<0.1				
2016BH08	22/07/2019	<10	<1	<1	2260	21700	<0.1	<1	196	<1	<1	3180	2	322	6.68	<10	6		343		<0.1				
2016BH08	24/09/2019	<10			2440	20700	0.2	<1				3810	2		6.83						<0.1				
2016BH08	3/12/2019	<10	<1	<1		22600							3		7.08	<10					<0.1				
2016BH08	13/02/2020	<10	<1	1	2720	23200	0.4	<1	191	<1	<1	3560	4	299	7.74	<10	12		489	3680	<0.1				
2016BH08	20/05/2020	10	<1	3	2020	22900	<0.1	<1	259	<1	<1	4050	3	418	6.96	<10	12		494		<0.1				
2016BH08	18/08/2020	<10	<1	1	2300	22900	<0.1	<1	7	<1	<1	5180	2	28	7.22	<10	15		21	3980	<0.1				
2016BH08	17/11/2020	<10	<1	1	1560	23100	<0.1	<1	11	<1	<1	4590	3	23	7.18	<10	16		52		<0.1				0.8
2016BH08	18/02/2021	<50	<5	<5	1780	23200	<0.5	<5	144	<5	<5	5040	<5	226	7.07	<10	8	<50	116	4300	<0.1				
2016BH08	11/05/2021	<10	<1	<1	2730	23200	0.1	<1	128	<1	<1	4180	2	109	7.56	<10	12	<10	73	4500	<0.1				
2016BH08	11/08/2021	<10	7	1	2320	23400	<0.1	7	35	1	<1	5010	2	56	8	<10	13	<10	61	4490	<0.1				
2016BH08	17/11/2021	<10	<1	3	2130	23200	0.3	2	363	5	<1	4380	4	595	7.52	<10	9	<10	1050	4250	<0.1				
2019MP01_D	4/07/2019	<10			200	3050	<0.1	<1				111	<1		6.55						<0.1				
2019MP01_D	22/07/2019	<10	<1	<1	220	3030	<0.1	<1	2	<1	<1	400	<1	5	6.35	<10	<1		69		<0.1				
2019MP01_D	13/08/2019	<10	<1	<1		3140							<1		7.06	<10					<0.1				
2019MP01_D	23/09/2019	<10			220	3080	<0.1	<1				578	<1		6.39						<0.1				
2019MP01_D	3/12/2019	50	<1	<1		3620							<1		6.68	<10					<0.1				
2019MP01_D	13/02/2020	<10	<1	<1	150	3640	<0.1	<1	2	<1	<1	385	<1	4	6.92	<10	<1		6	611	<0.1				
2019MP01_D	20/05/2020	<10	<1	<1	160	3630	<0.1	<1	7	<1	<1	674	<1	5	6.47	<10	<1		8		<0.1				
2019MP01_D	19/08/2020	<10	<1	<1	240	3850	<0.1	<1	8	<1	<1	653	<1	6	6.42	<10	<1		15	710	<0.1				
2019MP01_D	17/11/2020	<10	<1	<1	210	3880	<0.1	<1	8	<1	<1	613	<1	6	6.31	<10	<1		26		<0.1				0.1
2019MP02_D	4/07/2019	<10			190	8660	1	<1				3620	<1		5.63						<0.1				
2019MP02_D	22/07/2019	<10	<1	<1	190	8630	0.6	<1	87	2	1	2600	<1	82	5.59	<10	<1		54		<0.1				
2019MP02_D	13/08/2019	<10	<1	<1		8640							<1		5.98	<10					<0.1				
2019MP02_D	23/09/2019	<10			190	8160	1	<1				3230	<1		5.52						<0.1				
2019MP02_D	3/12/2019	<10	<1	<1		8920							<1		6.08	<10					<0.1				
2019MP02_D	13/02/2020	<10	<1	<1	130	8780	0.9	<1	88	1	<1	2770	<1	95	6.24	<10	<1		42	1890	<0.1				
2019MP02_D	20/05/2020	<10	<1	<1	120	8860	0.5	<1	85	<1	<1	2450	<1	80	6.1	<10	<1		42		<0.1				
2019MP02_D	19/08/2020	<10	<1	<1	140	8600	0.4	<1	88	<1	<1	2750	<1	92	5.78	<10	<1		44	1930	<0.1				
2019MP02_D	17/11/2020	<10	<1	<1	140	8520	0.6	<1	94	9	<1	2380	<1	91	5.8	<10	<1		68		<0.1				<0.1
2019MP03_D	4/07/2019	<10			400	8740	0.3	<1				11300	<1		6.59						<0.1				
2019MP03_D	22/07/2019	<10	<1	<1	370	8730	0.3	<1	5	1	<1	8200	<1	28	6.48	<10	2		22		<0.1				
2019MP03_D	13/08/2019	<10	<1	<1	

2019MP03_D	20/05/2020	<10	<1	<1	360	9270	<0.1	<1	46	<1	<1	7700	<1	28	6.57	<10	2		8		<0.1			
2019MP03_D	19/08/2020	20	<1	<1	440	9080	0.2	<1	65	<1	<1	9870	<1	35	6.66	<10	4		15	1870	<0.1			
2019MP03_D	17/11/2020	<10	<1	<1	420	9150	<0.1	<1	75	3	<1	10000	<1	36	6.58	<10	2		22		<0.1			0.2
2019MP03_D	16/02/2021	<10	<1	<1	400	9390	0.1	<1	78	<1	<1	12600	<1	39	6.66	<10	2	<10	23	1710	<0.1			
2019MP03_D	11/05/2021	<10	<1	<1	540	9000	<0.1	<1	26	2	<1	6430	<1	27	7.53	<10	4	<10	18	1590	<0.1			
2019MP03_D	10/08/2021	<10	<1	<1	370	9810	<0.1	2	132	2	<1	14500	<1	51	7.35	<10	1	<10	9	1760	<0.1			
2019MP03_D	17/11/2021	<10	<1	<1	370	9830	0.1	2	53	3	<1	6950	<1	46	7.35	<10	1	<10	21	1850	<0.1			
2019MP04_D	4/07/2019	<10			350	3100	<0.1	3				25	<1		7.52						<0.1			
2019MP04_D	22/07/2019	<10	<1	<1	300	3280	<0.1	<1	<1	<1	<1	6	<1	<1	7.08	<10	<1		24		<0.1			
2019MP04_D	13/08/2019	<10	<1	<1		3500							<1		7.65	<10					<0.1			
2019MP04_D	23/09/2019	<10			290	3480		<1				15	<1		7.01						<0.1			
2019MP04_D	3/12/2019	30	<1	<1		4050							<1		7.43	<10					<0.1			
2019MP04_D	13/02/2020	<10	<1	<1	270	3960	<0.1	<1	<1	<1	<1	4	<1	1	7.57	<10	1		<5	371	<0.1			
2019MP04_D	20/05/2020	<10	<1	<1	250	4400	<0.1	<1	<1	<1	<1	9	<1	2	7.09	<10	<1		<5		<0.1			
2019MP04_D	19/08/2020	<10	<1	<1	280	4600	<0.1	<1	<1	<1	<1	11	<1	4	7.16	<10	1		<5	506	<0.1			
2019MP04_D	17/11/2020	<10	<1	<1	280	4920	<0.1	<1	<1	<1	<1	17	<1	2	7.06	<10	<1		9		<0.1			0.2
2019MP04_D	17/02/2021	<10	<1	<1	300	4580	<0.1	<1	<1	<1	<1	27	<1	7	7.3	<10	1	<10	20	543	<0.1			
2019MP04_D	12/05/2021	<10	<1	<1	230	5080	<0.1	<1	<1	2	<1	19	<1	1	7.78	<10	<1	<10	17	688	<0.1			
2019MP04_D	10/08/2021	<10	<1	<1	270	5680	<0.1	<1	<1	<1	<1	18	<1	5	7.93	<10	1	<10	<5	764	<0.1			
2019MP04_D	29/11/2021	<10	<1	<1	280	6390	<0.1	<1	<1	<1	<1	11	<1	2	7.64	<10	1	<10	8	883	<0.1			
2019MP05_D	4/07/2019	<10			420	9200	0.1	<1				3270	<1		6.66						<0.1			
2019MP05_D	22/07/2019	<10	<1	<1	390	8720	0.1	<1	20	1	<1	2800	<1	23	6.42	<10	5		43		<0.1			
2019MP05_D	13/08/2019	<10	<1	<1		8880							<1		7	<10					<0.1			
2019MP05_D	24/09/2019	<10			410	8160	0.2	<1				2600	<1		6.38						<0.1			
2019MP05_D	3/12/2019	<10	<1	<1		9750							<1		6.74	<10					<0.1			
2019MP05_D	13/02/2020	<10	<1	<1	460	8340	0.2	<1	12	<1	<1	1740	<1	15	6.85	<10	3	1310	12		<0.1			
2019MP05_D	20/05/2020	<10	<1	<1	400	8350	<0.1	<1	14	<1	<1	2210	<1	20	6.43	<10	4		20		<0.1			
2019MP05_D	19/08/2020	<10	<1	<1	450	8080	0.1	<1	14	<1	<1	2240	<1	23	6.5	<10	5	1380	26		<0.1			
2019MP05_D	17/11/2020	<10	<1	<1	410	8200	<0.1	<1	15	2	<1	2140	<1	20	6.3	<10	4		51		<0.1			0.2
2019MP05_D	16/02/2021	<10	<1	<1	440	8030	<0.1	2	16	<1	<1	2720	<1	28	6.51	<10	4	<10	76	1230	<0.1			
2019MP05_D	11/05/2021	<10	<1	<1	590	9440	<0.1	<1	7	1	<1	684	<1	10	7.32	<10	8	<10	14	1570	<0.1			
2019MP05_D	10/08/2021	<10	<1	<1	490	9000	<0.1	3	14	6	<1	2080	<1	21	7.55	<10	6	<10	20	1440	<0.1			
2019MP05_D	29/11/2021	<10	<1	<1	600	9610	<0.1	<1	8	1	<1	734	<1	10	7.11	<10	9	<10	18	1530	<0.1			
2019MP06	4/07/2019	<10			930	10800	<0.1	<1				85	2		7.51						<0.1			
2019MP06	22/07/2019	<10	<1	<1	1020	10700	<0.1	<1	<1	<1	<1	67	2	2	7.24	<10	10		19		<0.1			
2019MP06	12/08/2019	<50	<5	<5		20800							<5		7.71	<50					<0.1			
2019MP06	13/08/2019	<10	<1	<1		11700							1		7.84	<10					0.1			
2019MP06	23/09/2019	<10			870	11300	<0.1	<1				40	<1		7.16						<0.1			
2019MP06	3/12/2019	10	<1	<1		11800							1		7.5	<10					<0.1			
2019MP06	13/02/2020	<10	<1	<1	980	11800	<0.1	<1	<1	<1	<1	39	1	2	7.85	<10	16	1580	<5		<0.1			
2019MP06	20/05/2020	<10	<1	<1	800	11700	<0.1	<1	2	<1	<1	209	<1	4	7.21	<10	11		6		<0.1			
2019MP06	19/08/2020	<10	<1	<1	890	11400	<0.1	<1	<1	<1	<1	80	<1	4	7.41	<10	14	1680	6		<0.1			
2019MP06	17/11/2020	<10	<1	<1	750	11700	<0.1	<1	1	<1	<1	84	<1	4	7.23	<10	13		6		<0.1			0.5
2019MP06	16/02/2021	<10	<1	<1	860	12400	<0.1	<1	1	<1	<1	72	1	3	7.21	<10	16	<10	6	1580	<0.1			
2019MP06	11/05/2021	<10	2	<1	1420	10600	<0.1	<1	2	2	<1	38	2	4	7.96	<10	16	<10	22	1430	<0.1			
2019MP06	10/08/2021	<10	<1	<1	980	12300	<0.1	<1	1	7	<1	85	1	3	8.18	<10	18	<10	<5	1580	<0.1			
2019MP06	17/11/2021	<10	<1	<1	960	11500	<0.1	<1	2	3	<1	112	1	4	7.88	<10	16	<10	14	1480	<0.1			
2019MP07	4/07/2019	<10			700	10600	<0.1	<1				5110	3		7.33						<0.1			
2019MP07	22/07/2019	<10	<1	<1	610	11500	0.1	<1	15	<1	<1	2410	2	24	7.05	20	18		22		<0.1			
2019MP07	13/08/2019	<10	<1	<1		11100							3		7.74	20					<0.1			
2019MP07	23/09/2019	<10			610	10500	<0.1	<1				4260	3		7.02						<0.1			
2019MP07	3/12/2019	<10	<1	<1		11200							2		7.24	10					<0.1			
2019MP07	13/02/2020	<10	<1	<1	610	10900	<0.1	<1	6	<1	<1	1840	2	19	7.81	<10	18	2710	<5		<0.1			
2019MP07	20/05/2020	<10	<1	<1	740	13900	<0.1	<1	15	<1	<1	3120	3	25	7.26	30	11		9		<0.1			
2019MP07	19/08/2020	<10	<1	1	670	11400	<0.1	<1	19	<1	<1	3730	1	24	7.4	10	23	2610	10		<0.1			
2019MP07	17/11/2020	<10	<1	<1	550	10700	<0.1	<1	17	54	<1	3120	2	25	7.17	<10	23		78		<0.1			0.4
2019MP07	18/02/2021	<10	<1	<1	580	11100	<0.1	<1	16	<1	<1	3840	2	26	7.31	<10	23	<10	15	2710	<0.1			
2019MP07	11/05/2021	<10	<1	<1	790	12700	<0.1	<1	10	<1	<1	4730	2	21	7.86	20	20	<10	10	2780	<0.1			
2019MP07	10/08/2021	<10	<1	<1	510	10800	<0.1	<1	12	<1	<1	3820	2	21	8.24	<10	23	<10	8	2800	<0.1			
2019MP07	17/11/2021	<10	<1	<1	510	11000	<0.1	<1	9	<1	<1	3880	2	24	7.79	<10	22	<10	17	2660	<0.1			
2019MP07_D	4/07/2019	<10			1130	17200	<0.1	<1				54	1		7.27						<0.1			
2019MP07_D	22/07/2019	<10	<1	<1	1220	17000	<0.1	<1	<1	1	<1	50	<1	6	7.05	<10	20		6		<0.1			
2019MP07_D	13/08/2019	<10	<1	<1		17300							1		7.83	<10					<0.1			
2019MP07_D	23/09/2019	<10			1350	16000	<0.1	<1				42	1		7.09						<0.1			
2019MP07_D	3/12/2019	<10	<1	<1		17500							<1		7.3	<10					<0.1			
2019MP07_D	13/02/2020	<10	<1	<1	1300	17500	0.2	<1	<1	1	<1	12	1	6	7.82	<10	24	2230	<5		<0.1			
2019MP07_D	20/05/2020	<10	<1	<1	1130	17600	<0.1	<1	<1	1	<1	45	<1	7	7.14	<10	27		<5		<0.1			
2019MP07_D	19/08/2020	<10	<1	<1	1300	17000	0.2	<1	<1	<1	<1	49	<1	8	7.5	<10	29	2340	6		<0.1			
2019MP07_D	19/11/2020	<10	<1	<1	1060	17500	<0.1	<1	<1	<1	<1	46	1	8	7.32	<10	26	<10	7	5280	<0.1			
2019MP07_D	16/02/2021	<10	<1	<1	1170	17900	<0.1	<1	<1	<1	<1	47	1	6	7.18	<10	30	<10	18	5430	<0.1			
2019MP07_D	12/05/2021	<10	<1	<1	1140	17600	<0.1	<1	<1	<1	<1	52	1	6	7.78	<10	28	<10	6	5290	<0.1			
2019MP07_D	10/08/2021	<10	<1	<1	1170	17900	<0.1	<1	<1	2	<1	58	1	6	7.98	<10	36	<10	<5	5320	<0.1			
2019MP07_D	17/11/2021	<10	<1	<1	980	18100	<0.1	2	<1	2	<1	55	2	8	7.82	<10	35	<10	6	5290	<0.1			
2019MP08	4/07/2019	<10			1490	17000	<0.1	<1				112	2		7.35						0.2			
2019MP08	22/07/2019	<10	<1	<1	1330	17100	<0.1	<1	<1	2	<1	33	1	4	7.15	<10	26		87		0.2			
2019MP08	12/08/2019	<10	<1	<1		15400							3		7.9	<10					<0.1			
2019MP08	12/08/2019	<10	<1	<1		22400							2		7.6	<10					<0.1			
2019MP08	24/09/2019	<10			1430	15200	<0.1	<1				25	2		7.23						<0.1			
2019MP08	4/12/2019	<10	<1	<1		16800							1		7.49	<10					<0.1			
2019MP08	14/02/2020	<10	<1	<1	1410	15900	<0.1	<1	<1	<1	<1	14	1	3	7.98	<10	28	2120	<5		<0.1			
2019MP08	19/05/2020	<10	<1	1	1130	14900	<0.1	<1	<1	<1	<1	173	2	6	7.27	<10	24		<5		<0.1			
2019MP08	18/08/2020	<10	<1	1	1350	14600	<0.1	<1	<1	<1	<1	44	<1	6	7.53	<10	30	2050	10		<0.1			
2019MP08	19/11/2020	<10	<1	1	1080	13700	<0.1	<1	<1	<1	<1	16	1	5	7.41	<10	26	<10	10	1910	<0.1			
2019MP08	18/02/2021	<10	<1	1	1190	13600	<0.1	<1	<1	<1	<1	8	2	8	7.3	<10	27	<10	10	1760	<0.1			
2019MP08	12/05/2021	<10	<1	2	1030	12800	<0.1	1	<1	<1	<1	3	1	3	7.92	<10	20	<10	5	1740	<0.1			
2019MP08	10/08/2021	<10	<1	<1	1350	14000	<0.1	1	<1	3	<1	26	1	4	8.32	<10	28	<10	7	1890	<0.1			
2019MP08	17/11/2021	<10	2	2	1080	13400	0.2	<1	<1	5	<1	31	2	6	7.93	<10	26	<10	47	1800	<0.1			
2019MP09	28/05/2019	<10			490	15700	0.1	<1				2250	15		7.13						<0.1			
2019MP09	4/07/2019	<10			510	15900	0.2	<1				2230	7		7.25						<0.1			
2019MP09	22/07/2019	<10	<1	<1	520	17100	0.2	<1	7	1	<1	2500	4	21	6.92	<10	113		17		<0.1			
2019MP09	12/08/2019	<10	<1	2		16600							8		7.63	<10					<0.1			
2019MP09	24/09/2019	<10			600	16600	0.1	<1				2790	2		7.01						<0.1			
2019MP09	4/12/2019	<10	<1	3		16300							6		7.31	<10					<0.1			
2019MP09	13/02/2020	<50	<5	<5	450	18000	<0.5	<5	11	<5	<5	3780	<5	18	7.72	<50	91	2020	<25		<0.1			
2019MP09	19/05/2020	<10	<1	<1	460	20300	0.2	<1	12	1	<1	4170	3	23	7.01	<10	138		9		<0.1			
2019MP09	18/08/2020	<10	<1	<1	770	18900	<0.1	<1	14	<1	<1	4600	1	24	7.16	<10	135	2220	8		<0.1			
2019MP09	19/11/2020	<10	<1	<1	560	18700	<0.1	<1	15	<1	<1	4420	2	23	7.27	<10	122	<10	12	2360	<0.1			
2019MP09	18/02/2021	<10	<1	<1	700	20900	<0.1	<1	17	<1	<1	5680	2	24	7.23	<10	147	<10	13	2440	<0.1			
2019MP09	12/05/2021	<10	<1	1	680	19700	<0.1	<1	9	<1	<1	5830	1	31	7.68	<10	116	<10	9	2420	<0.1			
2019MP09	10/08/2021	<10	<1	<1	600	20500	<0.1	<1	20	<1	<1	7680	2	16	7.74	<10	139	<10	7	2610	<0.1			
2019MP09	17/11/2021	<10	<1	<1	490	20100	<0.1	1	10	2	<1	5530	3	18	7.73	<10	99	<10	8	2340	<0.1			
2019MP10	28/05/2019	<10			650	13600	<0.1	<1				1	<1		7.17						0.4			
2019MP10	4/07/2019	<10			660	13800	<0.1	<1				3	<1		7.31						0.2			
2019MP10	22/07/2019	<10	<1	<1	600	13600	<0.1	<1	<1	<1	<1	2	<1	2	7.08	<10	25		<5		<0.1			
2019MP10	12/08/2019	<10	<1	<1		13700							1		7.78	<10					<0.1			
2019MP10	24/09/2019	<10			610	12800	<0.1	<1				7	<1		7.14						<0.1			
2019MP10	3/12/2019	<10	<1	<1		13900							<1		7.39	<10					<0.1			
2019MP10	13/02/2020	<10	<1	<1	480	11600	<0.1	<1	<1	<1	<1	9	<1	2	7.89	<10	24	1590	<5		<0.1			
2019MP10	20/05/2020	<10	<1	<1	590	13900	<0.1	<1	<1	<1	<1	22	<1	4	7.19	<10	26		<5		<0.1			
2019MP10	18/08/2020	<10	<1	<1	720	13300	<0.1	<1	<1	<1	<1	30	<1	3	7.39	<10	25	2160	<5		<0.1			
2019MP10	17/11/2020	<10	<1	<1	630	14500	<0.1	<1	9	<1	<1	186	<1	17	7.2	<10	25		23		<0.1			0.3
2019MP10	15/02/2021	<10	<1	<1	700	14900	<0.1	<1	<1	<1	<1	25	<1	3	7.31	<10	31	<10	<5	1950	<0.1			
2019MP10	12/05/2021	<10	<1	<1	940	14500	<0.1	<1	<1	2	<1	24	<1	3	7.89	<10	40	<10	5	2080	<0.1			
2019MP10	10/08/2021	<10	<1	<1	780	14900	<0.1	1	<1	2	<1	30	<1	3	8.08	<10	36	<10	<5	2080	<0.1			
2019MP10	17/11/2021	<10	<1	<1	710	15000	<0.1	<1	<1	4	<1	52	<1	4	7.81	<10	33	<10	7	2020	<0.1			

Permian

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		*µS/cm*	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16,000	-	-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
MB19SRM03P	2/12/2019	8.18		8,140	4,700	1	346	90	2,360	52	30	1,540	6	70	1	1	60	0	0	0	20	50
MB19SRM03P	30/01/2020	7.8		8,260	4,660	1	339	99	2,510	67	32	1,580	6	260	17	1	400	0			20	670
MB19SRM03P	14/02/2020	8.42		8,030	4,600	20	329	70	2,530	<1	34	1,710	6	90	23	1	160	0		0	20	810
MB19SRM03P	18/03/2020	8.28		7,890	4,540	1	362	70	2,560	51	32	1,680	7	160	58	1	220	0	0	0	20	940
MB19SRM03P	21/04/2020	8.24		7,980	5,180	1	361	74	2,550	79	34	1,690	7	180	79	1	220	0	0	0	20	1,010
MB19SRM03P	19/05/2020	8.03		8,370	4,610	1	388	75	2,650	67	36	1,760	7	140	87	1	200	0	0	0	20	1,100
MB19SRM03P	17/06/2020	7.95		8,520	4,830	1	353	138	2,530	97	35	1,740	7	120	69	1	180	0	0	0	20	930
MB19SRM03P	1/07/2020	8.25		9,470	5,280	1	324	265	2,890	47	37	1,940	6	120	32	1	180	0	0	0	20	340
MB19SRM03P	20/08/2020	8.05		9,340	5,450	1	286	281	2,930	103	36	1,940	6	40	8	1	150	0	0	0	20	180
MB19SRM03P	16/09/2020	7.83		9,610	5,320	1	295	286	3,050	96	35	1,890	6	50	6	1	190	0	0	0	20	50
MB19SRM03P	13/10/2020	8.2		9,630	5,450	1	295	300	2,940	89	36	1,850	6	40	6	1	140	0	0	0	20	50
MB19SRM03P	18/11/2020	7.97		9,350	5,420	1	280	300	3,030	64	36	1,960	6	50	5	1	160	0	0	0	20	50
MB19SRM03P	9/12/2020	7.97		9,500	5,320	1	300	312	3,010	83	42	1,910	7	80	7	1	150	0	0	0	20	50
MB19SRM03P	13/01/2021	7.96		9,280	5,290	1	306	296	2,990	60	35	1,880	6	30	6	1	150	0	0	0	20	50
MB19SRM03P	17/02/2021	7.99		9,420	5,470	1	293	296	3,060	75	37	1,920	6	10	2	1	70	0	0	0	20	50
MB19SRM03P	25/03/2021	8.1		9,090	5,260	1	386	305	3,000	50	37	1,950	6	50	7	1	190	0	0	0	20	50
MB19SRM03P	15/04/2021	8.05		11,000	5,520	1	362	310	3,190	66	36	1,760	6	80	12	1	250	0			20	50
MB19SRM03P	12/05/2021	8.19		9,130	5,370	1	289	307	2,980	97	37	1,900	6	40	6	1	140	0			20	110
MB19SRM03P	10/06/2021	8.1		9,300	5,150	1	308	298	3,000	83	36	1,800	6	30	10	1	190	0			20	50
MB19SRM03P	18/08/2021	7.83		9,320	5,420	1	275	317	3,540	50	36	1,950	6	40	6	1	170	0	0	0	20	50
MB19SRM03P	23/08/2021	7.83		9,260	5,430	1	291	288	2,930	56	38	2,030	6	20	11	1	100	0			20	50
MB19SRM03P	13/09/2021	7.69		9,290	5,420	1	304	295	2,920	68	37	1,980	6	40	16	1	180	0			20	50
MB19SRM03P	12/10/2021	8.33		9,600	5,430	14	299	289	3,030	80	36	1,860	6	10	17	1	100	0			20	50
MB19SRM03P	18/11/2021	8.15		9,410	5,380	1	270	300	2,960	44	38	1,960	6	30	8	1	130	0	0	0	20	120
MB19SRM03P	13/12/2021	8.1		10,000	5,620	1	298	299	3,100	35	37	2,020	6	10	10	1	50	0	0	0	20	50
MB19SRM03P	19/01/2022	7.4		9,100	5,350	1	314	301	3,080	59	36	1,920	6	860	41	1	2570	1			20	100
MB19SRM03P	9/02/2022																					

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		*µS/cm*	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16000	-	-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
MB19SRM04P	4/12/2019	7.38		6060	3480	1	505	581	1260	110	129	978	16	80	1	2	1050	0.1	0.01	0.01	20	50
MB19SRM04P	14/02/2020	7.94		5870	3450	1	491	571	1300	1	135	1010	17	820	1	6	3280	0.1		0.01	20	50
MB19SRM04P	20/05/2020	7.38		5910	3700	1	513	534	1370	119	137	1070	16	80	1	3	1280	0.1	0.01	0.01	20	50
MB19SRM04P	18/08/2020	7.54		5850	3680	1	510	620	1340	115	130	1040	16	90	1	3	1400	0.1	0.01	0.01	20	50
MB19SRM04P	18/11/2020	7.38		5910	3810	1	482	662	1370	130	131	1030	16	30	1	3	2960	0.1	0.01	0.01	20	50
MB19SRM04P	15/02/2021	7.27		5940	3640	1	533	597	1390	116	130	1010	16	50	1	1	380	0.1	0.05	0.06	20	50
MB19SRM04P	12/05/2021	7.86		5770	3520	1	499	626	1350	108	128	987	16	520	1	1	1520	0.1			20	100
MB19SRM04P	12/08/2021	8.41		6110	3640	31	414	584	1350	127	128	1060	18	260	1	2	2230	0.1			20	160

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		*µS/cm*	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16000	-	-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
MB20SRM03P	26/10/2019	12.2		16500	5640	320	1	80	1180	14	1	1990	504	240	3	6	2090	0.1	0.05		60	2000

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		*µS/cm*	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16000	-	-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
MB20SRM07P	27/10/2019	8.43		5440	2850	20	152	4	1580	67	12	1130	8	30	0.1	1	50	0.1	0.01		20	<50

Site	Date	In-situ pH	In-situ EC	SWL		TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
											diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units	µS/cm	(mBGL)	(mRL)	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																							
Zone 34	Shallow 80th	7.1-8.1	8910			-	-	878	318	3185	215	389	1500	-	-	-	-	246	-	5.3	-	-	-
Zone 34	Deep 80th	7.4 - 8.03	16000			-	-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
EA Trigger Levels																							
ANZECC Stock		6.0 - 9.0	5970			4000			1000		1000				5000	-	500	-	2				
C Drinking Water (2022)		6.5 - 8.5	895			600			500	250			180		200	3	10	300	1	11.3			
MB31	26/10/2009	7.44	7330			4890	<1	641	1190	1490		195	1260				1						
MB31	14/12/2009	7.65	7640			4870	<1	505	1160	1400	140	203	1270	57			1						
MB31	29/04/2010	7.33	4940			2920	<1	649	656	840	81	99	907	39			1						
MB31	27/07/2010	7.45	4940			3120	<1	729	665	932	66	113	1030	37			1						
MB31	24/01/2011	7.14	3990			2560	21	732	478	797	29	72	852	35			1						
MB31	29/04/2011	7.65	4500			2740	<1	725	551	723	62	81	806	36			1						
MB31	25/05/2011	7.65	4500			2740	<1	725	551	723	62	81	806	36			1						
MB31	25/07/2011	8	4388			2740	<1	725	551	723	62	81	806	36									
MB31	25/10/2011	8.61	3961			2740	38	723	600	726	74	88	838	38			1						
MB31	21/06/2012	8.13	2521			710	500	< 5	32	78	86	77	55	1.4			1000						
MB31	24/07/2012	9.64	5358			2900	1000	< 5	490	720	68	87	920	53			1000						
MB31	26/10/2012	9.25	5882			2500	45	790	360	550	63	77	780	48			1						
MB31	22/01/2013	8.25	7468			2900	29	1100	630	930	70	90	870	61			2						
MB31	22/04/2013	8.25	6500			3300	1200	120	650	970	79	100	970	82			1						
MB31	25/07/2013	9.28	7477			3300	99	1200	520	860	72	97	970	72			2000						
MB31	21/01/2014	8.54	6570			3530	136	1180	662	947	92	119	95	1060	80	1	2	340	0.1			20	570
MB31	23/04/2014	8.48	7130			3640	131	1410	770	1170	93	107	1030	91	10	1	1	60	0.1			50	20
MB31	10/09/2014	7.33	9380			5810	1	458	1560	2390	273	324	1530	77	10	1	1	11800	0.1			20	100
MB31	25/11/2014	7.57	8030			6640	1	515	1480	2430	266	330	1690	73	470	1	1	3920	0.1			20	50
MB31	20/01/2015	7.97	9980			6920	1	494	1730	2660	299	344	1720	83	540	1	1	4130	0.1			20	50
MB31	24/03/2015	8.17	9340			6510	1	526	1610	2440	266	301	1470	61	210	5	5	2840	0.1			20	50
MB31	19/05/2015	7.52	9140			6260	1	524	1880	1970	247	276	1340	57	640	1	1	2500	0.1			20	50
MB31	16/06/2015	7.45	9340			6420	1	524	1710	2460	262	267	1340	57	200	1	1	2360	0.1			20	50
MB31	25/08/2015	7.11	9160			6700	1	508	1510	2300	265	288	1400	58	490	1	1	2520	0.1			20	50
MB31	2/12/2015	7.69	7550			5140	1	621	1280	1830	185	210	1140	49	10	1	1	1050	0.1			20	50
MB31	14/03/2016	7.83	8440			4860	1	590	1280	1680	194	243	1340	56	10	1	1	980	0.1			20	50
MB31	13/06/2016	7.57	9660			6660	1	488	1570	1920	300	332	1580	70	10	1	1	1840	0.1			20	50
MB31	19/09/2016	8.01	4570			2590	1	584	585	869	89	108	834	37	10	1	1	360	0.1	<0.01	<0.01	20	50
MB31	13/12/2016	7.55	4790			3020	1	610	622	892	84	102	776	33	10	1	1	180	0.1	0.09	<0.01	20	50
MB31	15/03/2017	8.06	7520			4810	1	591	1170	1610	184	214	1240	54	10	1	1	60	0.1	1.08	0.02	20	50
MB31	15/06/2017	7.64	4590			2750	1	586	632	917	83	102	740	31	10	1	1	200	0.1	0.11	<0.01	20	50
MB31	19/09/2017	7.53	4710			2800	1	535	608	995	100	118	819	37	10	1	1	130	0.1	0.16	<0.01	20	50
MB31	19/12/2017	7.61	6290			3670	1	546	860	1270	144	164	1070	45	10	1	1	80	0.1	1.42	<0.01	20	50
MB31	20/03/2018	6.99	10100			7210	1	483	1750	2540	283	299	1490	75	700	1	1	1210	0.1	<0.01	<0.01	20	50
MB31	25/06/2018	6.98	9940			7240	1	484	1620	2510	264	314	1500	67	10	1	1	1340	0.1	0.31	<0.01		
MB31	23/07/2018	7.44	8460			5480	1	519	1220	1830	195	234	1250	52	10	1	1	470	0.1	1.47	<0.01	20	50
MB31	25/09/2018	7.41	7220			5230	1	552	1230	1590	194	214	1220	50	10	1	1	320	0.1	4.22	<0.01	20	50
MB31	19/12/2018	7.15	6660			4170	1	538	992	1400	169	182	1120	46	10	1	1	300	0.1	2.2	<0.01	20	50
MB31	27/03/2019	7.66	10200			7220	1	476	1670	2660	296	316	1500	64	20	1	1	1450	0.1	0.18	<0.01	20	50
MB31	12/06/2019	7.5	7080			4740	1	538	1060	1530	172	207	1170	44	10	1	1	50	0.1	2.15	<0.01	20	50
MB31	16/09/2019	7.61	6520			4330	1	540	910	1380	149	163	982	44	10	1	1	470	0.1			20	50
MB31	16/12/2019	7.02	7450			5200	1	484	1180	1750	196	219	1200	51	10	1	1	300	0.1	0.53	<0.01	20	50
MB31	16/03/2020	7.34	7160			4910	1	508	1190	1520	203	199	1160	47	20	1	2	2930	0.1	1.63	<0.01	20	50
MB31	22/06/2020	7.39	6160			3980	1	486	855	1330	163	184	1070	44	10	1	1	380	0.1	<0.01	<0.01	20	50
MB31	18/08/2020	7.6	6460			4420	1	502	977	1360	152	184	1090	42	10	1	1	400	0.1	0.94	<0.01	20	50
MB31	18/11/2020	7.59	5740			3610	1	477	879	1220	138	148	946	40	10	1	1	360	0.1	<0.01	<0.01	20	50
MB31	17/02/2021	7.58	5780			3790	1	515	809	1240	130	156	959	41	10	1	1	580	0.1	<0.01	<0.01	20	50
MB31	11/05/2021	7.93	6800			4860	1	497	1050	1490	181	196	1050	48	10	1	1	490	0.1			20	50
MB31	11/08/2021	8.31	6790			4430	10	453	981	1360	161	175	1050	46	10	1	1	410	0.1			20	50
MB31	16/11/2021	7.75	8110			5590	1	450	1240	1770	214	238	1260	52	10	1	2	5830	0.1	0.01	<0.01	20	50
MB31	10/02/2022														480	<1	3	17400					

Site	Date	In-situ pH		In-situ EC	SWL		TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
												diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	(mBGL)	(mRL)	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	25,170						2,580						55	9	13	1600	0.6			20	100
MB33	24/07/2013	7.44		7330			17000	5	750		6700	280	570	5300	130									
MB33	21/10/2013	7.65		7640			16100	1	705	2240	7120	285	638	4510	130	10	1	2	1480	0.1			20	50
MB33	20/01/2014	7.33		4940			16500	1	580	2420	7020	249	627	4550	145	10	1	1	1430	0.1			20	50
MB33	22/04/2014	7.45		4940			15100	1	735	2390	7420	301	570	4390	118	50	5	5	1410	0.1			20	20
MB33	29/07/2014	7.14		3990			16900	1	718	2150	7560	240	601	4920	141	2340	6	5	7510	0.1			20	1680
MB33	9/09/2014	7.65		4500				1	618	2410	7600	318	618	4470	119	140	1	3	1310	0.1			20	120
MB33	25/11/2014	7.65		4500			14900	1	794	2580	7880	332	599	5230	106	130	1	3	910	0.1			20	130
MB33	20/01/2015	8		4388			17700	1	787	2550	8190	345	621	4760	111	250	1	4	1890	0.1			20	50
MB33	24/03/2015	8.61		3961			16800	1	821	2410	7910	360	563	4930	99	1670	5	7	5000	0.1			20	340
MB33	19/05/2015	8.13		2521			16400	1	801	2920	7580	354	575	4530	90	170	1	2	1790	0.1			20	50
MB33	16/06/2015	9.64		5358			16800	1	829	2580	7920	352	525	4330	87	920	1	2	2790	0.1			20	50
MB33	2/12/2015	9.25		5882			15700	1	865	2480	6720	338	530	4100	88	100	1	2	1400	0.1			20	50
MB33	14/03/2016	8.25		7468			16400	1	804	2360	7290	298	571	4630	110	80	1	1	790	0.1			20	50
MB33	13/06/2016	8.25		6500			15500	1	736	2400	7270	335	623	4980	123	20	1	1	630	0.1			20	50
MB33	19/09/2016	9.28		7477			16500	1	740	2370	7680	322	595	4760	116	50	1	2	420	0.1	0.01	0.01	20	50
MB33	13/12/2016	8.54		6570			17100	1	853	2370	7530	291	510	4330	86	200	1	1	1200	0.1	0.01	0.01	20	50
MB33	13/03/2017	8.48		7130			16600	1	771	2460	7580	318	574	4650	118	70	1	1	710	0.1	0.01	0.01	20	50
MB33	15/06/2017	7.33		9380			16200	1	823	2310	7360	298	588	4650	111	20	1	2	2230	0.1	0.12	0.01	20	50
MB33	19/09/2017	7.57		8030			16700	1	780	2350	7430	327	596	4670	116	100	1	3	2540	0.1	0.07	0.01	20	50
MB33	19/12/2017	7.97		9980			17100	1	789	2320	7320	285	532	4470	111	70	1	3	2420	0.1	0.05	0.01	20	50
MB33	19/03/2018	8.17		9340			16000	1	770	2480	7140	286	514	4340	124	110	1	2	2320	0.1	0.05	0.01	20	760
MB33	25/06/2018	7.52		9140			16700	1	768	2440	7370	271	554	4440	120	50	1	5	3380	0.1	0.03	0.01	20	50
MB33	25/09/2018	7.45		9340			16600	1	795	2340	6940	283	518	4290	113	70	1	3	2330	0.1	0.03	0.01	20	50
MB33	19/12/2018	7.11		9160			16200	1	766	2330	7210	305	528	4420	114	60	1	3	2410	0.1	0.03	0.01	20	50
MB33	27/03/2019	7.69		7550			15600	1	783	2230	7230	296	543	4480	113	50	1	4	2810	0.1	0.04	0.01	20	50
MB33	12/06/2019	7.83		8440			15800	1	769	2240	7410	271	531	4370	109	90	1	4	3390	0.1	0.02	0.01	20	50
MB33	16/09/2019	7.57		9660			16900	1	786	2020	7050	285	517	4580	114	120	1	5	3580	0.5			20	50
MB33	16/12/2019	8.01		4570			16100	1	708	2260	7240	293	579	4640	119	30	1	1	850	0.1	0.01	0.01	20	50
MB33	17/03/2020	7.55		4790			15600	1	739	2480	6980	300	597	4730	126	380	1	5	3540	0.1	0.04	0.01	20	50
MB33	22/06/2020	8.06		7520			15000	1	884	2180	7190	279	511	4180	96	360	1	8	12000	0.1	0.01	0.01	40	50
MB33	19/08/2020	7.64		4590			15800	1	740	2240	6820	259	520	4440	112	10	1	2	1580	0.1	0.01	0.01	20	50
MB33	17/11/2020	7.53		4710			14700	1	747	2210	7020	265	522	4450	117	20	1	2	1800	0.1	0.01	0.01	20	50
MB33	16/02/2021	7.61		6290			15500	1	884	1970	7270	269	538	4470	116	50	5	5	460	0.1	0.01	0.01	20	50
MB33	10/05/2021	6.99		10100			15100	1	750	2200	6940	252	539	4450	119	150	1	2	1310	0.1			20	50
MB33	10/08/2021	6.98		9940			16100	1	758	2160	7090	319	530	4500	121	20	2	1	610	0.1			20	50
MB33	18/11/2021	7.44		8460			15900	1	713	2190	7180	264	547	4390	114	30	1	2	960	0.1	0.01	0.01	20	50
MB33	8/02/2022	7.41		7220																				

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
MB34										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	29,720				398						55	9	13	700	0.6			20	100
MB34	24/07/2013				18,000	23	15		8,900	650	94	6200	42									
MB34	21/10/2013	8.86		25,200	17,500	14	13	343	8,860	672	170	4940	45	450	1	1	250	0.1			20	50
MB34	20/01/2014	7.67		27,500	18,900	1	30	259	9,020	835	127	5020	49	540	1	1	150	0.1			20	50
MB34	22/04/2014	8.72		27,800	18,300	10	16	280	9,720	801	131	4670	40	50	5	5	260	0.1			50	20
MB34	30/07/2014	7.84		25,200	21,100	1	23	266	9,810	764	189	5640	44	1640	5	5	1820	0.1			30	420
MB34	10/09/2014	8.86		23,400	15,700	1	32	434	9,720	690	274	5050	46	50	5	5	550	0.1			20	50
MB34	25/11/2014	7.73		28,500	19,900	1	62	558	10,500	622	350	5760	30	70	1	2	310	0.1			20	50
MB34	20/01/2015	7.63		28,500	19,700	1	20	368	10,600	733	249	5280	37	110	1	3	380	0.1			20	50
MB34	24/03/2015	7.5		27,200	18,000	1	41	402	10,500	822	267	5560	31	190	5	5	640	0.1			20	50
MB34	19/05/2015	8.63		27,700	17,800	9	17	428	9,800	860	240	4950	29	360	2	3	1050	0.1			20	50
MB34	16/06/2015	7.5		27,700	18,400	1	32	366	10,500	840	216	4790	28	190	2	1	700	0.1			20	200
MB34	26/08/2015	7.75		26,400	19,200	1	15	320	10,200	737	212	4550	26	710	21	21	1070	0.1			20	50
MB34	2/12/2015	7.55		25,100	17,900	1	31	340	8,660	814	234	4610	28	150	1	2	380	0.1			20	50
MB34	14/03/2016	7.69		28,300	17,800	1	60	373	9,440	798	145	5560	41	270	1	1	720	0.1			20	50
MB34	13/06/2016	7.63		28,000	18,400	1	48	276	9,410	835	293	5340	30	220	1	1	650	0.1			20	50
MB34	19/09/2016	7.8		26,600	19,200	1	85	393	9,630	894	125	5320	45	130	1	1	500	0.1	0.01	0.01	20	130
MB34	13/12/2016	7.4		28,100	20,800	1	53	248	9,890	750	283	5330	25	200	1	2	660	0.1	0.04	0.01	20	110
MB34	13/03/2017	7.72		28,000	18,800	1	61	223	10,100	809	278	5310	28	440	2	1	1140	0.1	0.01	0.01	20	50
MB34	15/06/2017	7.51		27,900	18,600	1	99	257	10,200	782	260	5690	32	80	5	5	580	0.1	0.01	0.01	20	50
MB34	19/09/2017	7.32		26,300	19,400	1	212	299	10,200	986	189	5240	39	50	2	1	670	0.1	0.02	0.01	20	120
MB34	19/12/2017	7.62		29,300	21,100	1	131	180	10,000	804	286	5160	27	100	1	3	2470	0.1	0.01	0.01	20	50
MB34	20/03/2018	7.27		28,000	18,900	1	141	142	9,790	760	292	5120	25	580	1	3	2320	0.1	0.01	0.01	20	130
MB34	25/06/2018	7.42		27,900	20,400	1	138	101	10,100	678	298	5160	26	90	1	2	330	0.1	0.04	0.02	20	50
MB34	25/09/2018	7.54		25,200	17,200	1	163	82	9,470	713	293	5010	24	330	1	9	2580	0.1	0.01	0.08	20	50
MB34	19/12/2018	7.48		27,700	21,700	1	156	74	10,200	790	299	5090	25	210	2	4	1310	0.1	0.01	0.02	20	50
MB34	27/03/2019	7.83		28,200	18,600	1	156	60	10,200	734	307	5220	23	170	1	3	1800	0.1	0.01	0.02	20	50
MB34	12/06/2019	7.48		27,600	18,600	1	153	55	10,400	693	304	5310	24	90	1	2	200	0.1	0.01	0.01	20	50
MB34	17/09/2019	7.67		27,500	20,000	1	167	46	10,000	727	325	5560	26	60	5	5	160	0.5			20	120
MB34	16/12/2019	7.25		28,800	16,900	1	160	78	18,900	716	354	5760	26	90	1	1	150	0.1	0.01	0.01	20	110
MB34	17/03/2020	7.57		27,600	19,500	1	172	48	9,970	732	355	5720	27	230	1	1	570	0.1	0.02	0.02	20	170
MB34	22/06/2020	7.51		28,000	18,600	1	221	138	10,100	703	357	5430	28	110	1	4	2970	0.1	0.01	0.01	40	50
MB34	19/08/2020	7.59		28,500	19,400	1	180	54	10,000	722	345	5840	26	230	5	5	940	0.1	0.03	0.01	20	760
MB34	17/11/2020	7.54		27,300	18,900	1	164	54	10,200	707	320	4860	26	70	1	1	200		0.01	0.01	20	50
MB34	16/02/2021	7.56		27,700	19,700	1	185	46	10,400	643	323	5310	25	110	5	5	250		0.01	0.02	20	50
MB34	10/05/2021	7.83		28,200	19,400	1	276	68	10,200	628	348	5550	23	710	5	5	1070				20	230
MB34	12/08/2021	7.84		27,900	20,700	1	171	25	10,000	642	355	5430	24	200	5	5	450				20	110
MB34	18/11/2021	7.83		27,700	19,200	1	200	23	10,100	680	363	5510	25	150	5	5	430		0.01	0.01	40	130

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
MB35										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	16,000				398						55	9	13	1700	0.6			20	100
MB35	25/07/2013				690	<5	560		70	46	76	110	1.5									
MB35	21/10/2013	8.38		1,220	859	22	505	35	101	49	80	115	2	130	1	1	50	0.1			20	50
MB35	20/01/2014	8.75		1,170	672	94	400	35	105	24	82	127	2	10	1	1	50	0.1			20	50
MB35	22/04/2014	8.09		1,280	669	1	520	35	94	50	81	121	1	10	1	1	50	0.1			50	50
MB35	29/07/2014	7.87		1,260	731	1	505	36	100	49	79	116	2	10	1	1	50	0.1			20	50
MB35	10/09/2014	7.5		1,780	1010	91	595	81	174	57	94	226	3	1400	1	2	2190	0.1			20	50
MB35	25/11/2014	7.81		1,710	942	1	707	78	151	57	94	241	2	310	1	2	200	0.1			20	50
MB35	20/01/2015	8.38		1,940	1050	32	701	103	212	60	100	313	3	320	1	3	250	0.1			20	50
MB35	24/03/2015	8.18		1,840	1020	1	734	85	180	61	91	234	2	510	1	2	250	0.1			20	50
MB35	19/05/2015	7.79		1,520	907	1	635	66	141	57	82	164	2	230	1	2	180	0.1			20	50
MB35	16/06/2015	7.61		1,780	987	1	674	93	185	59	83	218	2	380	1	2	320	0.1			20	50
MB35	26/08/2015	7.64		1,410	801	1	578	48	128	51	75	142	2	310	1	2	930	0.1			20	50
MB35	2/12/2015	8.35		1,320	862	29	591	51	112	53	78	138	2	30	1	1	70	0.1			20	50
MB35	14/03/2016	8.28		2,100	1160	1	769	123	217	56	95	291	3	480	1	2	440	0.1			20	50
MB35	13/06/2016	8.4		1,340	889	27	532	48	120	52	87	153	2	170	1	2	140	0.1			20	50
MB35	19/09/2016	8.36		1,300	718	24	525	48	104	55	86	152	2	130	1	2	120	0.1	0.01	0.02	20	50
MB35	13/12/2016	7.93		1,320	731	1	574	46	103	48	75	132	1	50	1	2	120	0.1	0.01	0.01	20	50
MB35	13/03/2017	7.92		1,480	835	1	625	74	131	53	84	176	2	160	1	2	280	0.1	0.01	0.02	20	50
MB35	15/06/2017	7.93		1,310	729	1	600	48	100	47	75	129	1	320	1	5	3890	0.1	0.01	0.01	20	50
MB35	19/09/2017	7.43		1,340	746	1	556	46	108	56	86	146	2	50	1	2	80	0.1	0.02	<0.01	20	50
MB35	19/12/2017	7.97		1,380	772	1	570	48	110	53	82	151	2	50	1	2	80	0.1	0.01	0.01	20	50
MB35	20/03/2018	7.38		1,970	1140	1	737	104	190	55	85	261	2	580	1	4	2020	0.1	0.01	0.01	20	50
MB35	25/06/2018	7.37		2,090	1360	1	742	118	228	53	93	289	3	200	1	4	1880	0.1	0.01	0.01	20	50
MB35	25/09/2018	8.61		1,880	1130	67	673	105	188	60	92	277	2	550	1	6	4090	0.1	0.01	0.01	20	50
MB35	19/12/2018	7.35		2,050	1160	1	742	110	238	63	93	304	2	50	1	4	1160	0.1	0.01	0.01	20	50
MB35	27/03/2019	8.03		1,530	886	1	613	66	144	54	84	178	2	140	1	5	2760	0.1	0.01	0.01	20	50
MB35	12/06/2019	7.66		1,890	1120	1	717	104	200	59	95	266	3	50	1	2	100	0.1	0.01	0.01	20	50
MB35	17/09/2019	7.77		1,940	1140	1	749	101	200	56	88	277	2	260	1	4	660	0.1			20	50
MB35	16/12/2019	7.96		1,410	827	1	560	60	126	56	90	178	2	120	1	4	290	0.1	0.01	0.01	20	50
MB35	17/03/2020	7.57		1,980	1180	1	705	123	194	62	93	285	2	100	1	5	150	0.1	0.01	0.01	20	50
MB35	22/06/2020	7.6		1,940	1140	1	748	107	190	66	100	269	2	450	1	5	500	0.1	0.01	0.01	40	50
MB35	20/08/2020	7.79		1,350	785	1	524	48	119	51	81	151	2	10	1	3	310	0.1	0.01	0.01	20	50
MB35	18/11/2020	7.58		1,430	858	1	544	60	127	53	84	165	2	20	1	1	140	0.1	0.02	0.01	20	50
MB35	16/02/2021	7.73		2,000	1240	1	740	116	219	56	96	293	2	60	1	5	150	0.1	0.01	0.01	20	50
MB35	12/05/2021	8		1,900	1130	1	708	116	198	54	95	269	2	160	1	4	220	0.1			20	50
MB35	11/08/2021	8.54		1,680	976	66	505	75	139	64	86	198	2	240	1	3	500	0.1			20	180
MB35	18/11/2021	7.98		1,800	1070	1	607	94	174	53	92	242	2	70	1	4	220	0.1	0.02	0.01	20	50

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
MB36										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		*µS/cm*	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	16,000				477						55	9	13	2600	0.6			20	100
MB36	25/07/2013				4800	5	750		1600	190	210	1200	9									
MB36	22/10/2013	8.02		6,990	4610	1	565	435	1660	192	223	1040	7	20	1	1	760	0.1			20	50
MB36	20/01/2014	8.13		7,370	4650	1	474	440	1640	158	214	1050	7	10	1	1	630	0.1			20	50
MB36	22/04/2014	7.98		7,480	4220	1	665	493	2140	204	234	1140	5	10	1	1	630	0.1			50	20
MB36	29/07/2014	7.82		6,850	4850	1	646	422	1730	187	235	1110	6	10	1	1	600	0.1			20	50
MB36	10/09/2014	7.28		10,300		1	354	362	3500	312	347	1440	9	310	1	3	1740	0.1			20	50
MB36	25/11/2014	7.71		7,930	6140	1	468	360	3180	303	324	1430	8	880	1	3	2210	0.1			20	50
MB36	20/01/2015	7.94		10,800	6830	1	389	404	3860	344	368	1680	8	480	1	3	1670	0.1			20	60
MB36	24/03/2015	7.93		10,500	6720	1	399	369	3720	459	345	1480	6	460	5	5	1960	0.1			20	380
MB36	19/05/2015	7.53		9,850	6140	1	471	512	3200	386	295	1280	6	530	1	3	1990	0.1			20	50
MB36	16/06/2015	7.49		10,300	6520	1	424	429	3620	398	297	1320	6	600	1	3	2210	0.1			20	50
MB36	26/08/2015	7.81		7,850	4990	1	622	467	2340	245	224	1060	6	100	1	2	720	0.1			20	50
MB36	2/12/2015	7.87		7,720	5350	1	630	440	2410	303	246	1100	6	140	1	2	740	0.1			20	50
MB36	21/04/2016	7.75		8,520	5470	1	600	412	1900	227	248	1170	6	120	1	1	450	0.1			20	50
MB36	13/06/2016	8		7,880	4630	1	645	444	1840	271	266	1240	6	60	1	1	590	0.1			20	50
MB36	19/09/2016	8		7,630	5000	1	636	439	2160	256	254	1210	6	50	1	1	300	0.1	0.03	0.01	20	50
MB36	13/12/2016	7.8		7,980	5260	1	681	443	2280	241	239	1160	6	80	1	1	670	0.1	0.01	0.01	20	50
MB36	13/03/2017	7.88		10,600	6780	1	447	361	3480	409	335	1470	7	340	1	2	2360	0.1	0.01	0.01	20	50
MB36	15/06/2017	7.41		8,170	5190	1	681	406	2460	272	269	1250	6	70	1	1	1470	0.1	0.01	0.01	20	50
MB36	19/09/2017	7.42		7,180	4330	1	730	458	1840	232	239	1130	5	10	1	1	970	0.1	0.02	0.01	20	50
MB36	19/12/2017	7.92		8,000	4760	1	687	442	1980	240	236	1180	6	30	1	1	580	0.1	0.01	0.01	20	50
MB36	20/03/2018	7.18		10,400	7010	1	471	267	3350	362	292	1350	7	210	1	2	3910	0.1	0.01	0.01	20	50
MB36	25/06/2018	7.2		9,980	7360	1	488	290	3240	314	304	1330	6	220	1	1	2130	0.1	0.01	0.01	20	50
MB36	25/09/2018	7.95		9,350	6250	1	314	294	3250	356	310	1380	6	350	1	6	6040	0.1	0.01	0.01	20	50
MB36	19/12/2018	7.21		10,600	7700	1	464	281	3630	413	326	1440	7	190	1	2	2290	0.1	0.01	0.01	20	50
MB36	27/03/2019	7.84		8,220	5220	1	664	369	2470	265	242	1190	6	180	1	2	5370	0.1	0.01	0.01	20	50
MB36	12/06/2019	7.74		8,370	5180	1	632	337	2670	258	260	1230	6	90	1	1	1080	0.1	0.01	0.01	20	50
MB36	17/09/2019	7.63		7,700	4860	1	745	334	2260	222	226	1130	6	40	1	1	680	0.1			20	50
MB36	16/12/2019	7.72		7,690	5160	1	685	391	1880	204	257	1270	6	70	1	1	680	0.1	0.01	0.01	20	50
MB36	22/06/2020	7.6		6,550	3710	1	1050	221	1580	174	209	1080	8	480	2	1	1040	0.1	0.05	0.08	20	140
MB36	20/08/2020	7.71		6,540	4020	1	905	344	1580	167	194	1060	6	20	1	1	190	0.1	0.01	0.01	20	50
MB36	18/11/2020	7.59		6,580	4120	1	809	416	1580	166	199	1050	6	20	1	1	180	0.1	0.01	0.02	20	50
MB36	16/02/2021	7.57		6,920	4440	1	803	420	1700	174	213	1100	5	30	1	1	280	0.1	0.01	0.01	20	50
MB36	11/05/2021	7.85		8,550	5450	1	700	198	2760	251	270	1240	6	30	1	1	90	0.1			20	250
MB36	18/08/2021	7.6		8,670	5810	1	599	280	3170	235	267	1300	6	40	5	1	180	0.1	0.01	0.01	20	110
MB36	16/11/2021	7.86		9,880	7110	1	558	223	3220	284	311	1410	7	90	3	1	430	0.1	0.01	0.04	20	50

Site	Date	In-situ pH		In-situ EC	SWL		TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
												diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	(mBGL)	(mRL)	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																								
Zone 34	Shallow 80th	7.1	8.1	8910			-	-	878	318	3185	215	389	1500	-	-	-	-	246	-	5.3	-	-	-
Zone 34	Deep 80th	7.4	8.03	16000			-	-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
EA Trigger Levels		6.5	8.5																					
ANZECC Stock		6	9	5970			4000			1000		1000				5000	-	500	-	2				
C Drinking Water (2022)		6.5	8.5	895			600			500	250			180		200	3	10	300	1	11.3			
MB37	24/07/2013						9600	<5	110		3400	470	200	2700	21									
MB37	22/10/2013	8.15		13300			9650	<1	111	1920	4230	605	243	2670	28	10	1	1	1750	0.1			<20	<50
MB37	21/01/2014	8.2		14800			9030	<1	108	2130	4190	571	226	2550	24	10	1	1	1360	0.1			<20	<50
MB37	23/04/2014	7.86		14200			9580	<1	98	2300	4070	584	220	2450	19	10	1	1	1490	0.1			<50	<20
MB37	29/07/2014	7.84		12900			10100	<1	96	1950	4250	520	215	2630	22	640	3	1	2820	0.1			<20	1900
MB37	10/09/2014	7.78		14600				<1	177	2080	4420	555	239	2610	29	60	1	1	1010	0.1			<20	<50
MB37	25/11/2014	7.84		11200			10000	<1	133	1870	4320	545	234	2480	23	130	1	1	930	0.1			<20	<50
MB37	20/01/2015	7.85		14300			9950	<1	116	2220	4450	530	230	2720	23	70	1	1	610	0.1			<20	<50
MB37	24/03/2015	7.8		13900			9290	<1	121	1950	4390	575	216	2480	16	140	5	5	1070	0.1			<20	<50
MB37	19/05/2015	7.56		14200			9380	<1	117	2310	4180	526	206	2300	18	80	1	1	980	0.1			<20	<50
MB37	16/06/2015	7.62		14300			9730	<1	112	2250	4470	540	198	2330	17	250	1	1	960	0.1			<20	<50
MB37	25/08/2015	7.73		13300			9670	<1	90	2110	4040	451	178	2180	18	350	1	1	1930	0.1			<20	<50
MB37	2/12/2015	7.79		12700			9180	<1	120	2100	3750	499	193	2180	18	20	1	1	500	0.1			<20	<50
MB37	14/03/2016	7.91		14200			9300	<1	85	2000	3990	450	194	2430	20	30	1	1	170	0.1			<20	<50
MB37	13/06/2016	7.91		13500			7820	<1	90	1990	4060	516	208	2580	22	30	1	1	320	0.1			<20	120
MB37	19/09/2016	7.88		13200			9200	<1	95	2060	3910	490	204	2560	20	200	1	1	810	0.1	<0.01	0.01	<20	<50
MB37	13/12/2016	7.67		13700			9180	<1	94	2020	3880	416	174	2170	17	90	1	1	370	0.1	<0.01	<0.01	<20	120
MB37	13/03/2017	7.73		13800			8760	<1	89	2010	4010	476	192	2470	21	510	1	1	1340	0.1	<0.01	0.01	<20	170
MB37	15/06/2017	7.57		13400			8710	<1	119	1940	3880	471	200	2490	19	40	1	1	410	0.1	<0.01	<0.01	<20	<50
MB37	19/09/2017	7.62		13500			8860	<1	100	1980	4160	524	210	2580	21	20	1	1	250	0.1	<0.01	<0.01	<20	<50
MB37	19/12/2017	8		14200			9650	<1	138	2030	4060	512	196	2490	19	100	1	1	620	0.1	<0.01	<0.01	<20	<50
MB37	25/06/2018	7.73		14400			10100	<1	279	1800	4330	463	219	2450	19	140	1	7	2280	0.1	<0.01	0.13	<20	<50
MB37	25/09/2018	7.86		12900			9020	<1	287	1870	4080	529	207	2400	18	110	1	19	1390	0.1	<0.01	0.39	<20	<50
MB37	19/12/2018	7.58		13800			8620	<1	302	1780	4090	470	221	2590	17	70	1	10	1700	0.1	<0.01	0.2	<20	<50
MB37	12/06/2019	7.77		13800			9500	<1	380	1680	4330	508	217	2500	18	60	1	1	3230	0.1	<0.01	<0.01	<20	<50
MB37	16/09/2019	7.94		13600			9770	<1	278	1660	4190	496	184	2270	18	60	1	1	400	0.1			<20	<50
MB37	16/03/2020	7.87		13500			9480	<1	343	1860	3940	515	200	2440	19	90	1	7	780	0.1	<0.01	0.65	<20	<50
MB37	22/06/2020	8.03		14400			9570	<1	443	1610	4270	542	218	2550	19	160	1	10	710	0.1	<0.01	0.45	<50	<50
MB37	18/08/2020	8.02		13500			9140	<1	207	1800	4060	421	194	2450	19	280	1	1	760	0.1	<0.01	<0.01	<20	310
MB37	18/11/2020	7.9		13500			9030	<1	188	1750	3980	455	187	2470	20	30	1	2	320	0.1	<0.01	0.1	<20	200
MB37	17/02/2021	7.96		14100			9540	<1	263	1770	4220	515	205	2500	19	20	1	1	100	0.1	<0.01	<0.01	<20	<50
MB37	11/05/2021	8.11		13800			9510	<1	304	1800	4140	489	210	2450	19	50	1	1	430	0.1			<20	340
MB37	11/08/2021	8.08		14200			9830	<1	338	1740	4080	527	194	2430	19	60	3	1	270	0.1			<20	550
MB37	16/11/2021	8.25		13000			9000	<1	308	1600	3760	433	185	2330	32	120	31	1	710	0.1	0.01	0.04	<20	560
MB37	10/02/2022																							

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
MB39										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		*µS/cm*	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
EA Trigger Levels		6.5	8.5	16,000				398						55	9	13	700	0.6			20	100
MB39	30/01/2020	7.8		8,260	4,660	1	339	99	2,510	67	32	1,580	6	260	17	1	400	0.1			20	670
MB39	14/02/2020	8.42		8,030	4,600	20	329	70	2,530	25	34	1,710	6	90	23	1	160	0.1		0.01	20	810
MB39	18/03/2020	8.28		7,890	4,540	1	362	70	2,560	51	32	1,680	7	160	58	1	220	0.1	0.01	0.01	20	940
MB39	21/04/2020	8.24		7,980	5,180	1	361	74	2,550	79	34	1,690	7	180	79	1	220	0.1	0.01	0.01	20	1010
MB39	19/05/2020	8.03		8,370	4,610	1	388	75	2,650	67	36	1,760	7	140	87	1	200	0.1	0.02	0.01	20	1100
MB39	17/06/2020	7.95		8,520	4,830	1	353	138	2,530	97	35	1,740	7	120	69	1	180	0.1	0.01	0.01	20	930
MB39	1/07/2020	8.25		9,470	5,280	1	324	265	2,890	47	37	1,940	6	120	32	1	180	0.1	0.01	0.01	20	340
MB39	20/08/2020	8.05		9,340	5,450	1	286	281	2,930	103	36	1,940	6	40	8	1	150	0.1	0.01	0.01	20	180
MB39	16/09/2020	7.83		9,610	5,320	1	295	286	3,050	96	35	1,890	6	50	6	1	190	0.1	0.02	0.01	20	50
MB39	13/10/2020	8.2		9,630	5,450	1	295	300	2,940	89	36	1,850	6	40	6	1	140	0.1	0.01	0.02	20	50
MB39	18/11/2020	7.97		9,350	5,420	1	280	300	3,030	64	36	1,960	6	50	5	1	160	0.1	0.01	0.01	20	50
MB39	9/12/2020	7.97		9,500	5,320	1	300	312	3,010	83	42	1,910	7	80	7	1	150	0.1	0.01	0.01	20	50

Quaternary

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		*µS/cm*	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Shallow 80th	7.1	8.1	8910	-	-	878	318	3185	215	389	1500	-	-	-	-	246	-	5.3	-	-	-
MB20SRM04A	14/12/2009	7.62		21400	14700	1	907	1620	6980	236	402	4220	72	6650	1	6	12400	0.3	0.07	0.79	20	2310

Site	Date	In-situ pH	In-situ EC	SWL		TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
											diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units	µS/cm	(mBGL)	(mRL)	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																							
Zone 34	Shallow 80th	7.1-8.1	8910			-	-	878	318	3185	215	389	1500	-	-	-	-	246	-	5.3	-	-	-
Zone 34	Deep 80th	7.4 - 8.03	16000			-	-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
Trigger Levels																							
NZECC Stock		6.0 - 9.0	5970			4000			1000		1000				5000	-	500	-	2				
Drinking Water (2022)		6.5 - 8.5	895			600			500	250			180		200	3	10	300	1	11.3			
MB32	14/12/2009	6.98	1440			649	< 1	422	21	51	73	74	47	< 1			< 1					< 20	< 50
MB32	29/04/2010	7.34	996			552	< 1	423	26	40	80	65	41	< 1			1					< 20	< 50
MB32	27/07/2010	7.06	1098			637	< 1	497	24	55	71	78	61	< 1			< 1			< 0.01	0.06	< 20	< 50
MB32	24/01/2011																						
MB32	29/04/2011	7.28	1080			606	< 1	471	21	42	87	64	38	1			< 1			< 0.01	0.37	< 20	< 50
MB32	25/05/2011	7.28	1080			606	< 1	471	21	42	87	64	38	1			< 1			< 0.01	0.06	< 20	< 50
MB32	25/07/2011	7.48	867			606	< 1	471	21	42	87	64	38	1						< 0.01		< 20	< 50
MB32	24/10/2011	6.95	997			609	< 1	517	23	50	83	70	48	< 1			< 1			< 0.01	0.05	< 20	< 50
MB32	20/06/2012	7.67	773			3000	< 5	940	500	780	69	89	910	51			1			< 0.005	4.4	< 10	< 100
MB32	25/07/2012	6.8	1690			690	< 5	500	32	83	95	82	56	1.1			< 1			< 0.005	0.44	< 10	< 100
MB32	24/10/2012	7.57	1401			790	< 5	540	32	91	80	72	53	1			< 1			< 0.005	0.067	< 10	< 100
MB32	22/01/2013	7.15	2276			860	< 5	650	59	140	86	94	90	1			< 1			< 0.005	0.065	< 10	< 100
MB32	22/04/203																						
MB32	24/07/2013	6.65	2437			1100	< 5	560	42	140	110	97	77	1.3			< 1			< 0.005	0.24	< 10	< 100
MB32	22/10/2013	7.37	1713			930	< 1	488	67	202	105	111	75	1	50	< 1	< 1	390	< 1			< 20	< 50
MB32	21/01/2014	8.18	1672			1100	29	436	82	219	79	113	107	1	100	< 1	< 1	1070	< 0.1			< 20	< 50
MB32	22/04/2014		1622			940	< 1	586	91	218	117	111	106	1	70	< 1	< 1	690	< 0.1			< 20	< 20
MB32	29/07/2014			10.71		856	< 1	563	62	182	91	102	94	1	150	< 1	< 1	1160	< 0.1			< 20	< 50
MB32	10/09/2014	7.518	1562	12.72		797	18	485	52	193	104	104	83	2	<10	< 1	< 1	390	< 0.1			< 20	< 50
MB32	25/11/2014	7.518	1611			882	< 1	646	59	182	98	106	108	2	30	< 1	< 1	320	< 0.1			< 20	< 50
MB32	20/01/2015																						
MB32	24/03/2015	7.504	1695	9.85		961	< 1	611	91	212	110	101	119	1	90	< 1	< 1	1100	< 0.1			< 20	< 50
MB32	19/05/2015	7.63	1946	10.65		1100	< 1	661	136	263	119	118	154	1	10	< 1	< 1	850	< 0.1			< 20	< 50
MB32	16/06/2015	7.77	1655	12.37		918	< 1	596	68	221	108	103	101	1	50	< 1	< 1	110	< 0.1			< 20	< 50
MB32	26/08/2015	7.16	1638	11.52		660	< 1	482	49	101	89	80	81	3	20	< 1	< 1	80	< 0.1	0.23		< 20	< 50
MB32	2/12/2015	7.04	1833	12.34		16800	< 1	829	2580	7920	352	525	4330	87	920	< 1	2	2970	< 0.1			< 20	< 50
MB32	21/04/2016	7.65	1380	9.27		18300	10	16	280	9720	801	131	4670	40	< 50	< 5	< 5	< 260	< 0.1			< 50	< 20
MB32	13/06/2016	7.29	1396	9.56		940	< 1	586	91	218	117	111	106	1	70	< 1	< 1	690	< 0.1			< 50	< 20
MB32	19/09/2016	7.28	1223	9.39		6150	< 1	465	506	3220	386	295	1260	6	560	< 1	3	1980	< 0.1			< 20	< 50
MB32	13/12/2016	7.77	1430	9.73		788	<1	559	64	147	82	88	95	2	10	< 1	< 1	110	< 0.1	0.27	0.06	<20	<50
MB32	13/03/2017	8.11	1450	8.74		845	<1	561	64	158	87	93	102	8	30	< 1	< 1	220	< 0.1	0.24	0.09	<20	<50
MB32	15/06/2017	7.7	1090	8.55		601	<1	517	41	68	87	62	78	2	< 10	< 1	< 1	90	< 0.1	0.21	0.02	<20	<50
MB32	19/09/2017	7.86	1840	9.98		1090	<1	595	105	264	126	115	138	3	80	< 1	< 1	1940	< 0.1	0.21	0.03	<20	<50
MB32	19/12/2017	8	2190	10.74		1350	<1	701	133	311	123	126	195	5	40	< 1	< 1	2040	< 0.1	0.18	0.05	<20	<50
MB32	20/03/2018	7.49	1390	9.75		824	<1	519	61	136	81	73	87	1	700	< 1	< 1	1760	< 0.1	0.17	0.05	<20	<50
MB32	25/06/2018	7.4	1770	10		1100	<1	598	94	215	95	103	127	4	1280	< 1	2	4930	< 0.1	0.18	0.04	<20	<50
MB32	25/09/2018	7.5	1780	11.84		1100	<1	625	126	247	126	117	130	1	150	< 1	< 1	1390	< 0.1	0.09	0.03	<20	<50
MB32	19/12/2018	7.33	1480	12.05		859	<1	535	66	179	108	105	79	1	3260	< 1	3	9950	< 0.1	0.07	0.05	<20	<50
MB32	27/03/2019	7.98	1550	12		920	<1	530	84	186	98	101	104	1	1960	< 1	2	50	< 0.1	0.1	0.04	<20	<50
MB32	12/06/2019	7.72	1710	11.73		997	<1	589	99	221	102	104	150	1	80	< 1	< 1	2250	< 0.1	0.07	0.01	<20	<50
MB32	16/09/2019	7.74	1580	13.68		904	<1	583	72	195	92	99	116	1	310	< 1	< 1	1170	< 0.1			<20	<50
MB32	20/03/2020	8.13	1180	10.48		679	<1	447	45	101	94	72	58	1	1210	< 1	1	3490	< 0.1	0.14	0.03	<20	<50
MB32	22/06/2020	7.66	1310	12.7		756	<1	496	70	130	99	88	95	1	240	< 1	1	3520	< 0.1	0.07	<0.01	<20	<50
MB32	18/08/2020	7.85	1230	12.12		721	<1	453	56	119	86	77	78	1	480	< 1	1	2880	< 0.1	0.04	0.01	<20	<50
MB32	18/11/2020	7.64	1450	12.81		926	<1	523	61	158	98	106	79	1	2090	< 1	2	6620	< 0.1	0.06	0.05	<20	<50
MB32	17/02/2021	7.7	1330	13.3		877	<1	522	51	144	88	102	74	<1	50	<1	<1	670	<0.1	0.1	0.05	<20	<50
MB32	11/05/2021	8.14	1040	12.06		609	<1	444	42	77	75	74	56	<1	1750	<1	2	4420	<0.1			<20	<50
MB32	11/08/2021	8.39	1060	12.7		671	26	368	41	64	78	69	57	<1	1940	<1	2	6410	<0.1			<20	<50
MB32	16/11/2021	8.02	928	12.78		546	<1	378	28	48	58	51	31	1	480	<1	3	17400	<0.1	0.01	<0.01	<20	70

Tertiary

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	**Deep 80th**	**7.4**	**8.03**	**16000**		**-**	**650**	**398**	**5905**	**442**	**491**	**2565**	**-**	**-**	**-**	**-**	**140**	**-**	**14.92**	**-**	**-**	**-**
MB19SRM02T	2/12/2019	7.62		2,190	1,220	700	700	135	252	74	115	244	2	2,120	1	2	1900	0	0	0	20	50
MB19SRM02T	30/01/2020	7.38		2,100	1,230	683	683	115	252	81	114	224	1	13,000	2	3	16600	0			20	50
MB19SRM02T	14/02/2020	7.85		2,270	1,320	771	771	112	277	1	127	259	2	7,760	1	3	7220	0		0	20	100
MB19SRM02T	18/03/2020	7.70		1,980	1,170	678	678	93	247	82	114	220	1	1,940	1	1	1620	0	1	0	20	50
MB19SRM02T	21/04/2020	7.73		2,050	1,260	746	746	82	247	95	119	251	2	2,260	2	1	1610	0	1	0	20	50
MB19SRM02T	19/05/2020	7.52		2,220	1,280	835	835	82	275	89	135	270	2	1,120	4	1	850	0	1	0	20	50
MB19SRM02T	17/06/2020	7.64		2,240	1,230	857	857	96	255	90	130	249	1	680	1	1	390	0	0	0	20	50
MB19SRM02T	1/07/2020	7.92		2,290	1,330	890	890	89	259	81	132	258	1	1,970	1	1	1600	0	1	0	20	50
MB19SRM02T	20/08/2020	7.83		2,130	1,230	814	814	81	250	83	123	246	1	320	1	1	200	0	1	0	20	50
MB19SRM02T	16/09/2020	7.52		2,210	1,270	837	837	81	268	81	125	240	1	360	1	1	240	0	1	0	20	50
MB19SRM02T	13/10/2020	7.96		2,200	1,240	807	807	76	272	84	121	242	1	310	2	1	220000	0	1	0	20	50
MB19SRM02T	18/11/2020	7.65		2,220	1,360	775	775	79	289	88	123	255	1	1,180	3	1	1360	0	1	0	20	50
MB19SRM02T	44174.49306	7.72		2,460	1,450	855	855	85	338	82	136	290	2	5,240	2	20	4220	0	1	0	20	50
MB19SRM02T	13/01/2021	7.85		2,250	1,390	863	863	82	301	86	131	262	2	1,400	3	1	940	0	0	0	20	50
MB19SRM02T	17/02/2021	7.62		2,340	1,450	898	898	82	296	88	142	275	1	320	1	1	180	0	0	0	20	50
MB19SRM02T	25/03/2021	7.75		2,220	1,390	889	889	86	286	83	137	266	1	860	5	1	680	0	0	0	20	50
MB19SRM02T	15/04/2021	8.2		2,190	1,480	1,010	1010	87	294	84	127	216	2	80	9	1	70	0			20	50
MB19SRM02T	12/05/2021	7.97		2,300	1,380	883	883	94	288	86	142	264	2	400	4	1	320	0			20	50
MB19SRM02T	10/06/2021	7.81		2,380	1,400	902	902	88	312	91	127	249	2	380	27	1	340	0			20	50
MB19SRM02T	18/08/2021	7.64		2,350	1,370	823	823	85	312	91	138	267	2	900	3	1	640	0	0	0	20	50
MB19SRM02T	23/08/2021	7.89		2,400	1,480	853	853	107	298	101	148	308	2	30	2	1	50	0			20	50
MB19SRM02T	13/09/2021	7.53		2,240	1,390	818	818	84	271	87	138	274	2	1,670	2	1	1090	0			20	50
MB19SRM02T	12/10/2021	8.34		2,210	1,370	860	887	89	287	85	131	258	2	130	6	1	130	0			20	50
MB19SRM02T	18/11/2021	8.05		2,260	1,350	770	770	83	264	86	132	258	2	360	2	1	230	0	1	0	20	50
MB19SRM02T	13/12/2021	8.02		2,480	1,430	923	923	82	287	87	138	282	2	380	2	1	260	0	0	0	20	50
MB19SRM02T	19/01/2022	7.26		2,360	1,360	916	916	80	281	86	138	273	1	120	2	1	110	0			20	50
Site	**Date**	**pH**		**EC**	**TDS**	**CO3**	**HC03**	**SO4**	**Cl-**	**Ca**	**Mg**	**Na**	**K**	**Al**	**Sb**	**As**	**Fe**	**Hg**	**NO3**	**P**	**C6-C9**	**C10-C36**
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	**Deep 80th**	**7.4**	**8.03**	**16000**		**-**	**650**	**398**	**5905**	**442**	**491**	**2565**	**-**	**-**	**-**	**-**	**140**	**-**	**14.92**	**-**	**-**	**-**
MB20SRM02T	20/10/2019	8.52		3,990	2,520	47	686	383	724	48	55	837	20	3,740	1	7	4500	0.1	0		20	50

Site	Date	pH		EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		*µS/cm*	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Guidelines (Fitzroy)																						
Zone 34	Deep 80th	7.4	8.03	16000		-	650	398	5905	442	491	2565	-	-	-	-	140	-	14.92	-	-	-
MB20SRM02T	20/10/2019	8.52		3,990	2,520	47	686	383	724	48	55	837	20	3,740	1	7	4,500	0	0		20	50

Site	Date	In-situ pH		In-situ EC	TDS	CO3	HC03	SO4	Cl-	Ca	Mg	Na	K	Al	Sb	As	Fe	Hg	NO3	P	C6-C9	C10-C36
										diss	diss	diss	diss	Total	Total	Total	Total	Total		react		(sum)
		pH units		*µS/cm*	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l
Trigger Levels		6.5	8.5	8,910				318						55	9	13	700	0.6			20	100
MB40	30/01/2020	7.38		2100	1230	1	683	115	252	81	114	224	1	13000	2	3	16600	0.2			20	50
MB40	14/02/2020	7.85		2270	1320	1	771	112	277	63	127	259	2	7760	1	3	7220	0.1		0.01	20	100
MB40	18/03/2020	7.70		1980	1170	1	678	93	247	82	114	220	1	1940	1	1	1620	0.1	0.77	0.01	20	50
MB40	21/04/2020	7.73		2050	1260	1	746	82	247	95	119	251	2	2260	2	1	1610	0.1	0.89	0.02	20	50
MB40	19/05/2020	7.52		2220	1280	1	835	82	275	89	135	270	2	1120	4	1	850	0.1	0.62	0.01	20	50
MB40	17/06/2020	7.64		2240	1230	1	857	96	255	90	130	249	1	680	1	1	390	0.1	0.43	0.02	20	50
MB40	1/07/2020	7.92		2290	1330	1	890	89	259	81	132	258	1	1970	1	1	1600	0.1	0.5	0.02	20	50
MB40	20/08/2020	7.83		2130	1230	1	814	81	250	83	123	246	1	320	1	1	200	0.1	0.81	0.02	20	50
MB40	16/09/2020	7.52		2210	1270	1	837	81	268	81	125	240	1	360	1	1	240	0.1	0.8	0.02	20	50
MB40	13/10/2020	7.96		2200	1240	1	807	76	272	84	121	242	1	310	2	1	220	0.1	0.88	0.02	20	50
MB40	18/11/2020	7.65		2220	1360	1	775	79	289	88	123	255	1	1180	3	1	1360	0.1	0.74	0.01	20	50
MB40	9/12/2020	7.72		2460	1450	1	855	85	338	82	136	290	2	5240	2	2	4220	0.1	0.58	0.02	20	50