2018
Annual Review

BULGA
COAL

GLENCORE

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
10 Kings Road
New Lambton NSW 2305 Australia
(PO Box 447 New Lambton NSW 2305 Australia)
T: +61 2 4037 3200
E: newcastleau@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Bulga Coal Management Pty Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.12687-R01-v1.0	21 March 2019	Nathan Archer (SLR)	Adam Williams (SLR) Bulga Coal E&C Team	Adam Williams (SLR)

Cover photograph: Wedgetail chick nesting at Bulga Coal's offset property, Condran.

Name of Operation	Bulga Coal
Name of Operator	Bulga Coal Management Pty Ltd
Development consent / project approval #	Bulga Underground Operations DA 376-8-2003 Bulga Open Cut SSD-4960 Bulga Open Cut DA 41-03-99
Name of holder of development consent / project approval	Bulga Coal Management Pty Ltd
Mining lease #	ML 1494, ML 1547,ML 1674, ML 1717, MLA 525, AUTH 447, AUTH 450, EL 5277, EL 5461, EL 8315
Name of holder of mining lease	Saxonvale Coal Pty Ltd; Saxonvale Coal Pty Ltd and Nippon Steel Australia Pty Ltd; and Bulga Coal Management Pty Ltd
Water licence #	20BL168475, 20BL169347, 20BL169514, 20BL172658, 20BL172673.
Name of holder of water licence	Bulga Coal Management, Saxonvale Coal Pty Ltd, Beltana Highwall Mining Pty Ltd
MOP/RMP start date	29 May 2018 (Bulga Open Cut) 29 May 2018 (Bulga Underground Operations)
MOP/RMP end date	31 December 2023 (Bulga Open Cut) 31 December 2023 (Bulga Underground Operations)
Annual Review start date	1 January 2018
Annual Review end date	31 December 2018

I, Ralph Northey, certify that this audit report is a true and accurate record of the compliance status of Bulga Coal for the period 1 January 2018 to 31 December 2018 and that I am authorised to make this statement on behalf of Bulga Coal Management Pty Ltd.

Note.

a) The Annual Review is an 'environmental audit' for the purposes of section 122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.

b) The Crimes Act 1900 contains other offences relating to false and misleading information: section 192G (Intention to defraud by false or misleading statement—maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/information/documents—maximum penalty 2 years imprisonment or $22,000, or both).

Name of authorised reporting officer	Ralph Northey
Title of authorised reporting officer	Environment and Community Manager
Signature of authorised reporting officer	R Northey
Date	26-3-19

CONTENTS

1 STATEMENT OF COMPLIANCE 1

2 INTRODUCTION 4

2.1 Mine Operations 4

2.2 Mine Contacts 4

3 APPROVALS 6

3.1 Development Consent/s and Commonwealth Approvals 6

3.2 Mining Tenements 7

3.3 Licences 8

4 OPERATIONS SUMMARY 11

4.1 Mining Operations 11

4.2 Other Operations 16

4.3 Next Reporting Period 18

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW 21

6 ENVIRONMENTAL MANAGEMENT PERFORMANCE 22

6.1 Meteorology 22

6.2 Noise 25

6.3 Blasting 29

6.4 Air Quality 31

6.5 Mine Subsidence 38

6.6 Flora and Fauna (Remnant Vegetation) 40

6.7 Biodiversity Offsets 43

6.8 Weeds and Pests 52

6.9 Archaeology and Heritage 52

6.10 Visual and Lighting 56

6.11 Spontaneous Combustion 57

6.12 Bushfire 57

6.13 Methane Drainage, Mine Ventilation and Greenhouse Gas Emissions 58

6.14 Hydrocarbon Management 60

6.15 Public Safety 63

7 WATER MANAGEMENT 65

CONTENTS

7.1 Water Management 65
7.2 Surface Water 67
7.3 Erosion and Sedimentation 73
7.4 Groundwater 73

8 REHABILITATION 77
8.1 Post Rehabilitation Land Use 77
8.2 Rehabilitation Performance during the Reporting Period 77
8.3 Buildings 85
8.4 DPE-RR Sign-Off on Rehabilitation 85
8.5 Variations from Proposed MOP Activities 85
8.6 Rehabilitation Monitoring, Trials and Research 86
8.7 Key Issues that may Affect Rehabilitation 88
8.8 Actions for the Next Reporting Period 89

9 COMMUNITY 90
9.1 Community Engagement 90
9.2 Community Sponsorship and Donations 92
9.3 Community Complaints 96
9.4 Community Feedback 96

10 INDEPENDENT AUDIT 98
10.1 2018 Independent Environmental Audit 98
10.2 2015 Independent Environmental Audit 98

11 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD 100
11.1 Air Quality 100
11.2 EPL 563 Condition O1.1 – Failure to Carry out Operations in a Competent Manner 102
11.3 Aboriginal Cultural Heritage 102
11.4 Administrative Non-Compliances 103

12 ACTIVITIES TO BE COMPLETED IN THE NEXT REPORTING PERIOD 104

13 REFERENCES 105

CONTENTS
DOCUMENT REFERENCES

TABLES

Table 1 Summary Statement of Compliance for Major Approvals 1
Table 2 Summary of Non-Compliances 1
Table 3 Compliance Status Categories 3
Table 4 Contacts for Bulga Coal 4
Table 5 Development Consents and Commonwealth Approvals 6
Table 6 Mining Tenements 7
Table 7 Bulga Coal Licences 9
Table 8 Production and Waste Summary for Bulga Underground Operations 12
Table 9 Bulga Open Cut Mining Fleet 15
Table 10 Production and Waste Summary for the Bulga Open Cut 16
Table 11 Action required from 2017 Annual Review 21
Table 12 Summary of Attended Noise Monitoring Data – 2018 25
Table 13 2018 Sound Power Testing 27
Table 14 Overall Sound Power Results 2016 - 2018 and Comparison to Modelled Levels 27
Table 15 Private Property Amenity Impact Assessment Criteria 29
Table 16 Infrastructure Impact Assessment Criteria 29
Table 17 Heritage Impact Assessment Criteria 29
Table 18 2018 Private Property Overpressure and Vibration Monitoring Results 30
Table 19 2018 Infrastructure Vibration Monitoring Results 30
Table 20 Summary of Dust Deposition Monitoring Results – 2018 Annual Average 31
Table 21 Summary of High Volume Air Sampling Results – 2018 Annual Average 32
Table 22 Summary of High Volume Air Sampling Results – 2018 Maximum 24 Hour Average and Number of Exceedance 33
Table 23 Summary of TEOM and BA Monitoring Results – 2018 Annual Average 33
Table 24 Summary of TEOM PM_{10} Results – 2018 Maximum 24 Hour Average and Number of Exceedances 33
Table 25 Observed Subsidence Impacts from Blakefield South Longwall 1B 38
Table 26 Comparison between the Maximum Observed and Maximum Predicted Total Subsidence Parameters for the Monitoring Lines due to the Extraction of Blakefield South Longwall 1B 39
Table 27 Bulga Coal Greenhouse Gas Emissions (Scope 1 and 2 Direct Emissions) 59
Table 28 Comparison of 2018 Scope 1 and 2 Greenhouse Gas Data against Bulga Optimisation Project maximum Annual Predictions 60
Table 29 Hydrocarbon Monitoring Sites 61
Table 30 Ecological Investigation Levels (ANZECC) Adopted for Natural Waters (Surface and Groundwater) at Bulga Open Cut 61
Table 31 Trigger Levels for Onsite Dirty Water Dams 62
Table 32 Bulga Coal 2018 Water Balance 65
Table 33 Water Take 2017-2018 66
Table 34 20BL169347 and 20BL168475 Compliance Table 66
Table 35 Summary of Surface Water Monitoring Results – 2018 Annual Averages 67
Table 36 Comparison of Surface Water Monitoring Results (2018) against Background (2013 Bulga Optimisation Project EIS) 70
Table 37 Summary of Groundwater Monitoring Results – 2018 Annual Averages 74

CONTENTS

Table 38 Rehabilitation Status at Bulga Coal 78
Table 39 Maintenance Activities on Rehabilitated Land for Bulga Open Cut 80
Table 40 Maintenance Activities on Rehabilitated Land for Bulga Underground Operations 84
Table 41 Bulga Coal MOP Rehabilitation Predictions against 2018 Data 85
Table 42 Summary of Complaints by Issue 2015 – 2018 96
Table 43 Non-Compliance Finding and Proposed Actions 98
Table 44 Eastern Emplacement Area PM_{10} Non-Compliances 101
Table 45 Administrative Non-Compliances 103
Table 46 Bulga Underground Operations Proposed Activities in 2019 104
Table 47 Bulga Open Cut Proposed Activities in 2019 104

FIGURES

Figure 1 Bulga Coal Locality and Licences 2018 5
Figure 2 Bulga Underground Operations Summary of Operations 2018 13
Figure 3 Bulga Open Cut Summary of Operations 2018 14
Figure 4 Bulga Underground Proposed Operations 2019 19
Figure 5 Bulga Open Cut Proposed Operations 2019 20
Figure 6 Bulga Coal Environmental Monitoring Locations 2018 23
Figure 7 Bulga Coal Water Monitoring Locations 2018 24
Figure 8 2018 Pollution rose for EPA Point 9 (D7 in Todoroski Air Sciences (2019)) E-SAMPLER PM_{10} data 35
Figure 9 2018 Pollution rose for EPA Point 10 (D6 in Todoroski Air Sciences (2019)) E-SAMPLER PM_{10} data 36
Figure 10 Mushroom Composting Facility (D4) Sampling Results 2018 – 13 hour PM_{10} Averages 37
Figure 11 Ecological and Rehabilitation Monitoring Locations 2018 41
Figure 12 Wollombi Brook Brickmans Bridge Gauging Station 210135 (Upstream) 68
Figure 13 Wollombi Brook – Bulga Gauging Station (210028) (Downstream) 69
Figure 14 Long Term Surface Water EC Results 71
Figure 15 Long Term Surface Water pH Results 72
Figure 16 Long Term Surface Water TSS Results 72
Figure 17 Bulga Open Cut Rehabilitation and Disturbance 2018 82
Figure 18 Bulga Underground Operations Rehabilitation and Disturbance 2018 83
Figure 19 Community Survey Results (Issues of concern from existing operations) 97

PHOTOS

Photo 1 Loders Creek Grinding Groove Photographic Monitoring – 2017 view from Photo Point 4 54
Photo 2 Loders Creek Grinding Groove Photographic Monitoring – 2018 view from Photo Point 4 55
Photo 3 Location of identified archaeological sites (April 2018) 56
Photo 4 Community Barbeques in Bulga and Broke 91
Photo 5 Annual Stakeholder Meeting 92

CONTENTS

Photo 6 Broke School students and teachers using the furniture purchased with funding by Bulga Coal 93
Photo 7 Broke Village Fair 93
Photo 8 Cool Burn, McNamara Park 94
Photo 9 Community Yoga Classes 94

APPENDICES

Appendix A EPBC Approval 2012/6637 Compliance Table
Appendix B Long-term noise trends for Bulga Coal (Global Acoustics, 2019)
Appendix C Monitoring Data Review and Analysis at Bulga Complex 2018 (Todoroski, 2019)
Appendix D Annual Groundwater Report for Blakefield South
Appendix E Completion Criteria Checklist
Appendix F Annual Review Plan

1 Statement of Compliance

The Bulga Coal Complex (Bulga Coal) includes the Bulga Open Cut and the Bulga Underground Operations. During the reporting period Bulga Open Cut operated under development consents DA 41-03-99 and SSD-4960, while Bulga Underground Operations operated under DA 376-8-2003. Both sites operate under Environment Protection Licence (EPL) 563 and several mining and exploration leases.

Table 1 outlines compliance against major approvals. Where non-compliances have been identified, they are listed in **Table 2** and detailed in later sections of this report. **Table 3** describes the status of non-compliance.

Table 1 Summary Statement of Compliance for Major Approvals

Licence	Were all conditions of the Licence complied with?
DA 41-03-99	No
DA SSD-4960	No
DA 376-8-2003	No
EPBC 2002/773	Yes
EPBC 2012/6637	No (Refer **Appendix A**)
ML 1494	Yes
ML 1547	Yes
ML 1674	Yes
ML 1717	Yes
EPL 563	Yes
EL 5277	Yes
EL 5461	Yes
EL 8315	Yes
AUTH 447	Yes
AUTH 450	No

Table 2 Summary of Non-Compliances

Approval/Licence	Condition	Condition Summary	Compliance Status	Comment	Date	Section of this report
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality and Dust Monitoring	Non-Compliant	Exceedance in PM_{10} concentration (24-hour average) at Mitchell Line Road TEOM	19/03/18 02/04/18 15/04/18 19/07/18 20/07/18 28/07/18 04/08/18 19/09/18 06/11/18 21/11/18 22/11/18 23/11/18 25/11/18	Section 6.4 and 11
DA SSD-4960	Schedule 3, Condition 16	Air Quality Criteria				
DA 376-8-2003	Schedule 4, Condition 22	Air Quality Criteria				

Approval/Licence	Condition	Condition Summary	Compliance Status	Comment	Date	Section of this report
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality and Dust Monitoring	Non-Compliant	Exceedance in PM_{10} concentration (24-hour average) at Hill Street TEOM	19/03/18 21/11/18 22/11/18 23/11/18	Section 6.4 and 11
DA SSD-4960	Schedule 3, Condition 16	Air Quality Criteria				
DA 376-8-2003	Schedule 4, Condition 22	Air Quality Criteria				
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality and Dust Monitoring	Non-Compliant	Exceedance in PM_{10} concentration (24-hour average) at Dawtry / Cobcroft Road TEOM	19/03/18 15/04/18 21/11/18 22/11/18 23/11/18	Section 6.4 and 11
DA SSD-4960	Schedule 3, Condition 16	Air Quality Criteria				
DA 376-8-2003	Schedule 4, Condition 22	Air Quality Criteria				
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality and Dust Monitoring	Non-Compliant	Exceedance in PM_{10} concentration (24-hour average) at Putty Road TEOM	19/03/18 15/04/18 21/11/18 22/11/18 23/11/18	Section 6.4 and 11
DA SSD-4960	Schedule 3, Condition 16	Air Quality Criteria				
DA 376-8-2003	Schedule 4, Condition 22	Air Quality Criteria				
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality and Dust Monitoring	Non-Compliant	Exceedance in PM_{10} concentration (24-hour average) at D10 HVAS	22/11/18	Section 6.4 and 11
DA SSD-4960	Schedule 3, Condition 16	Air Quality Criteria				
DA 376-8-2003	Schedule 4, Condition 22	Air Quality Criteria				
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality and Dust Monitoring	Non-Compliant	Exceedance in PM_{10} concentration (24-hour average) at Dawtrey HVAS	22/11/18	Section 6.4 and 11
DA SSD-4960	Schedule 3, Condition 16	Air Quality Criteria				
DA 376-8-2003	Schedule 4, Condition 22	Air Quality Criteria				
Eastern Emplacement Area Air Quality Management Framework (EEAAQMF)	Section 4.2 of the EEAAQMF	Air Quality Criteria	Non-Compliant	Exceedance in PM_{10} concentration (13-hour average) at Mushroom Composting Facility TEOM	16/02/18 13/04/18 04/05/18 19/07/18 20/07/18 15/08/18 19/09/18 02/11/18 22/11/18	Section 6.4 and 11.2

Approval/Licence	Condition	Condition Summary	Compliance Status	Comment	Date	Section of this report
EPL 563	O1.1	Monitoring	Non-Compliant	Failure to carry out activities in a competent manner	03/11/18	Section 6.4 and 11
EPL 563	M2.1	Monitoring	Non-Compliant	Failure of E-SAMPLER	Various	Section 11
EPBC 2012/6637	Condition 2	Biodiversity	Non-compliant	Conservation covenant not finalised by 3 December 2017	06/09/18	Appendix A
EPBC 2012/6637	Condition 9	Reporting	Non-compliant	2017 Annual Review not on website by 31 March 2018	04/04/18	Appendix A
AUTH450	Condition 7	Reporting	Non-compliant	Failure to submit annual report on Community Consultation	27/01/18	Section 11

Table 3 Compliance Status Categories

Risk Level	Colour Code	Description
High	Non-Compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	Non-Compliant	Non-compliance with potential for serious environmental consequences, but is unlikely to occur; or potential for moderate environmental consequences, but is likely to occur
Low	Non-Compliant	Non-compliance with potential for moderate environmental consequences, but is unlikely to occur; or potential for low environmental consequences, but is likely to occur
Administrative non-compliance	Non-Compliant	Non-compliance which does not result in any risk of environmental harm

Section 6 of this report details the environmental management performance of Bulga Coal. Non-compliances are discussed in **Section 11**.

2 Introduction

2.1 Mine Operations

Bulga Coal is located approximately 12 kilometres (km) southwest of Singleton, and 2 km from the townships of Broke and Bulga in the Upper Hunter Valley of New South Wales (NSW) (refer **Figure 1**). Bulga Coal comprises two coal mining operations, being Bulga Open Cut and Bulga Underground Operations. The Coal Handling and Preparation Plant (CHPP) and rail loading facility are located in the north-east corner of the site and service both operations. In May 2018, Bulga Underground Operations ceased mining and the mine was sealed in July 2018.

Bulga Coal is managed by Bulga Coal Management Pty Ltd on behalf of the Bulga Joint Venture. Bulga Coal Management Pty Ltd is owned by Oakbridge Pty Ltd, which is the majority shareholder (87.5%) of the Bulga Joint Venture. Glencore is the majority shareholder of Oakbridge Pty Ltd.

This report details the environmental management performance of Bulga Coal over the period 1 January 2018 to 31 December 2018. It has been prepared in accordance with the NSW Government *Annual Review Guideline* (October 2015), and satisfies:

- Schedule 6, Condition 4 of Bulga Underground Operations Development Consent DA 376-8-2003;
- Schedule 2, Condition 9.1 of Bulga Open Cut Development Consent DA 41-03-99;
- Schedule 5, Condition 4 of Bulga Optimisation Project Development Consent SSD-4960; and
- the requirement for Environmental Management Reports or Rehabilitation Reports required under various mining tenements.

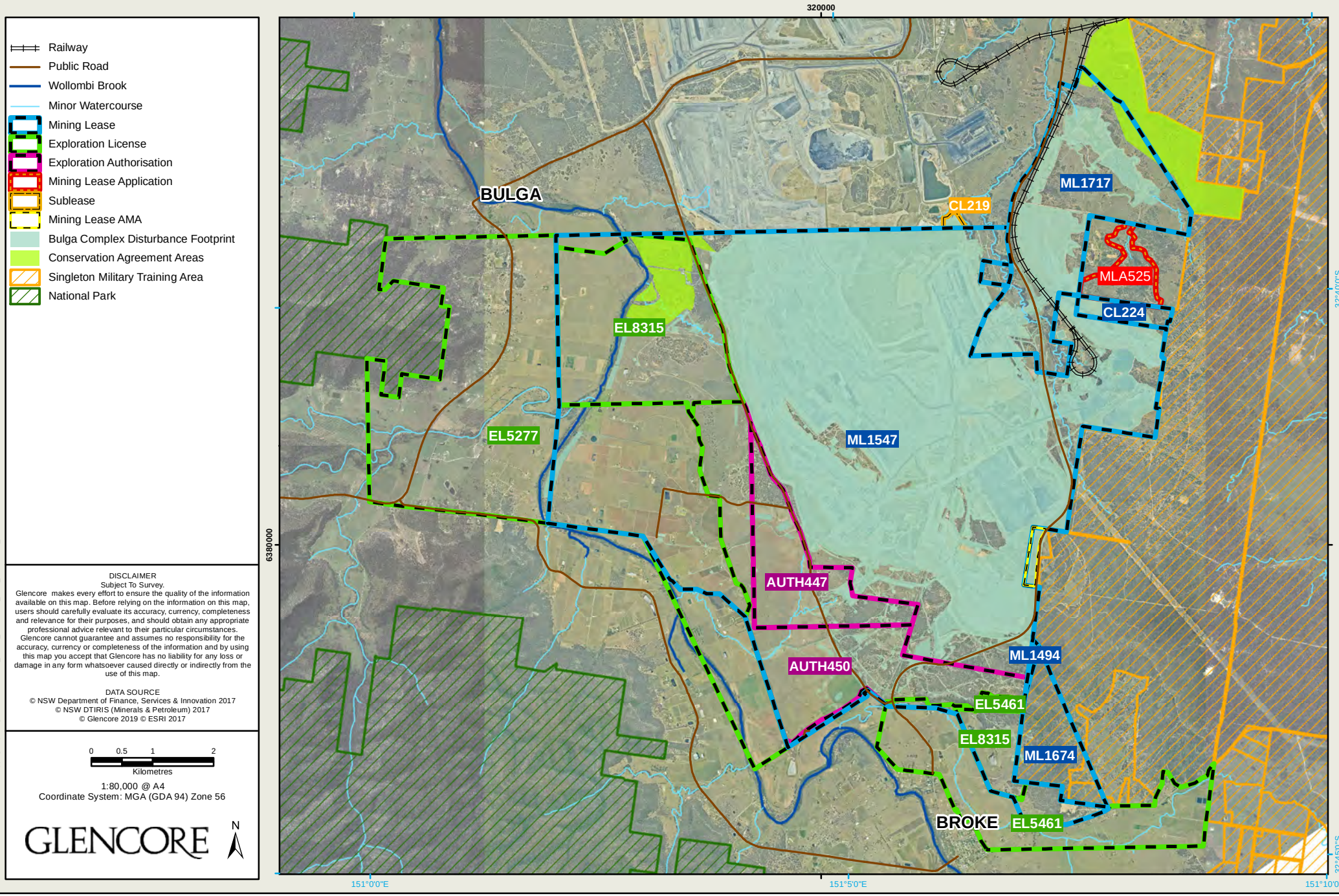
2.2 Mine Contacts

The contact details for the personnel responsible for environmental management and community relations at Bulga Coal are provided in **Table 4**.

Table 4 Contacts for Bulga Coal

Contact	Position	Contact Details
Ralph Northey	Bulga Coal Environment and Community Manager	T: 02 6570 2539
		E: Ralph.Northey@glencore.com.au
Geoff Kelly	Bulga Coal Operations Manager	T: 02 6570 2400
		E: Geoff.Kelly@glencore.com.au

FIGURE 1 - BULGA COAL LOCALITY & LICENCES 2018



DISCLAIMER
Subject To Survey.
Glencore makes every effort to ensure the quality of the information available on this map. Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

DATA SOURCE
© NSW Department of Finance, Services & Innovation 2017
© NSW DTIRIS (Minerals & Petroleum) 2017
© Glencore 2019 © ESRI 2017

0 0.5 1 2
Kilometres

1:80,000 @ A4
Coordinate System: MGA (GDA 94) Zone 56

GLENCORE

N

Ref: \\AUSYDSRVC5960\BulkISMapping\Reporting\AEMR\2018\2018_AEMR_FIGURE01_BCC_LOCATION_LICENSES.mxd

3 Approvals

3.1 Development Consent/s and Commonwealth Approvals

Bulga Coal operates under three development consents; the Bulga Underground Operations DA 376-8-2003, Bulga Open Cut DA 41-03-99 and SSD-4960. Approval SSD-4960 superseded DA 41-03-99 at the granting of the Bulga Optimisation Project. DA 41-03-99 is in the process of being relinquished in accordance with the requirements of Schedule 2, Condition 9 of SSD-4960. On 15 November 2018, the Department of Planning and Environment (DPE) approved an extended deadline of 30 June 2019 for the surrender of DA 41-03-99.

In July 2018, Bulga Open Cut submitted an application to modify SSD-4960 (Mod 2). Mod 2 was approved by DPE on 30 August 2018. The modification amended Schedule 3, Condition 47 (b) allowing an additional nine months (1 September 2019) to complete rehabilitation of the outer face of the Noise and Visual Bund.

Bulga Coal is currently preparing a third modification (Mod 3) to SSD-4960. SSD-4960 Mod 3 will include:

- Mining within the current approved project boundary;
- Relocation of approximately 30 million cubic meters of existing tailings within the Deep Pit to allow mining of the underlying coal;
- Mining of an additional 64 million tonnes of coal;
- Disturbance of an additional 21 hectares (ha) of vegetation; and
- Extension of the open cut mine life by 4 years to 2039.

Bulga Coal also operates in accordance with two Commonwealth approvals issued by the Department of the Environment and Energy (DEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Details of the development consents and Commonwealth approvals are provided in **Table 5**.

Table 5 Development Consents and Commonwealth Approvals

Consent	Details	Expiry Date
DA 376-8-2003	Bulga Coal Continued Underground Operations	23 February 2031
	Mod 1 – Drift relocation (11 April 2006)	
	Mod 2 – Increase CHPP throughput (25 October 2006)	
	Mod 3 – Longwall realignment (1 October 2007)	
	Mod 4 – Methane Abatement and Gas-fired Power Plant (14 July 2010)	
	Mod 5 – Blakefield North Longwall Modification and Gas Fired Power Plant (18 October 2013)	
	Mod 6 – Modification to noise criteria, flora and fauna criteria, and independent auditing (8 December 2016)	
DA 41-03-99	Bulga Coal Surface Operations	23 December 2020[1]
	Mod 1 – Time of commencement (approved 15 February 2001)	
	Mod 2 – Office extension (approved 11 January 2008)	
	Mod 3 – Surface facilities and CHPP dam (approved 5 November 2008)	

Consent	Details	Expiry Date
	Mod 4 – CHPP dam (approved 2 November 2009)	
	Mod 5 – Noise Conditions (approved 24 May 2010)	
	Mod 6 – Rail Refuelling Facility (approved 2 July 2011)	
	Mod 7 – Western limit extension (approved 15 March 2013)	
	Mod 8 – Sediment Dam (approved 14 March 2014)	
SSD-4960	Bulga Optimisation Project (1 December 2014)	31 December 2035
	Mod 1 – Eastern Emplacement Area and Tailings Storage (17 January 2017)	
	Mod 2 – Noise and Amenity Bund (30 August 2018)	
EPBC 2002/773	Commonwealth Land Consent (as varied 25 October 2015)	31 December 2034
	Mod 2002/773 – Commonwealth Land Subsidence Management Plan (SMP) Submission Schedule	
EPBC 2012/6637	Bulga Open Cut (as varied 5 January 2016)	31 December 2036

1 - DA 41-03-99 has been superseded by SSD-4960 and is due to be surrendered by 30 June 2019.

3.2 Mining Tenements

Mining operations at Bulga Coal are undertaken within Mining Lease (ML) 1494, ML 1547, ML 1674, ML 1717, Coal Lease (CL) 224 and a sublease within Mount Thorley Operations (CL 219). Bulga Coal has approval to undertake exploration activities in accordance with Exploration Lease (EL) 5277, EL 5461, EL 8315, Authorisations (AUTH) 447 and AUTH 450.

In 2016 Bulga Coal submitted a Mining Lease Application (MLA) to Department of Planning and Environment – Resources Regulator (DPE-RR). MLA 525 is located in the north-eastern portion of the site and is being sought to enable Bulga Coal to undertake mining activities associated with the Eastern Emplacement Area Modification (SSD-4960 Mod 1). The proposed instrument of grant for MLA 525 was received on 18 October 2018.

On 22 August 2018, Bulga Coal varied ML 1547 to add an Ancillary Mining Activity condition (AMA 1004).

Mining tenements are summarised in **Table 6** and are shown on **Figure 1**.

Table 6 Mining Tenements

Tenement	Details	Expiry Date
ML 1494	Saxonvale Coal Pty Ltd and Nippon Steel and Sumitomo Metal Australia Pty Ltd	20 September 2027
ML 1547	Bulga Coal Management Pty Ltd	4 April 2025
ML 1674	Bulga Coal Management Pty Ltd	22 March 2033
ML 1717	Bulga Coal Management Pty Ltd	15 September 2036
MLA 525	Bulga Coal Management Pty Ltd	-
Subleases within CL 219	Sublease to Bulga Coal within the Mount Thorley Operations CL 219 (to be relinquished and re-applied for in 2019)	14 October 2018
CL 224	Saxonvale Coal Pty Ltd	23 December 2023
EL 5277	Saxonvale Coal Pty Ltd	7 April 2021
EL 5461	Saxonvale Coal Pty Ltd and Nippon Steel and Sumitomo Metal Australia Pty Ltd	2 April 2018[1]

Tenement	Details	Expiry Date
EL 8315	Saxonvale Coal Pty Ltd	13 October 2019
AUTH 447	Saxonvale Coal Pty Ltd	2 September 2022
AUTH 450	Saxonvale Coal Pty Ltd	30 December 2018[1]

1 – Renewal sought

3.2.1 Mining Operations Plan Status

During 2018, Bulga Coal operated in accordance with approved Mining Operations Plans (MOPs).

From January 2018 to May 2018, Bulga Open Cut operated in accordance with the *Bulga Open Cut Mining Operations Plan: December 2014 - December 2021.* In May 2018, Bulga Open Cut submitted a new MOP to the DPE-RR to incorporate the additional activities approved by SSD-4960 Mod 1. The *Bulga Open Cut Mining Operations Plan: 29 May 2018 – 31 December 2023* was approved by DPE-RR on 13 June 2018.

From January 2018 to May 2018, Bulga Underground Operations operated in accordance with the *Bulga Underground Operations MOP: July 2015 to 30 June 2021*. Bulga Underground Operations also submitted a new MOP in May 2018, detailing the planned cessation of underground mining in mid-2018 and continued operation of Blakefield North pre-drainage and power generation. The *Bulga Underground Operations – Mining Operations Plan: 29 May 2018 – 31 December 2023* was approved by DPE-RR on 13 June 2018.

3.2.2 Subsidence Management Plan Status

Secondary extraction by Bulga Underground Operations during 2018 was undertaken in accordance with the approved *Blakefield South Longwalls 1 – 6 Subsidence Management Plan* (SMP). Extraction of Blakefield South Longwall 1B commenced on 9 February 2018 and was completed on 3 May 2018.

Bulga Underground Operations comprises the Blakefield South Mine, along with the approved but not yet commenced Blakefield North Mine. Following completion of Blakefield South Longwall 1B, underground mining has ceased and Bulga Underground Operations was sealed in July 2018.

3.3 Licences

The licences held by Bulga Coal are detailed in **Table 7**. Bulga Coal does not hold any surface water licences for mining purposes. The only surface water drawn for mining purposes is supplied from the Mount Thorley Water Supply Joint Venture. The scheme is operated by Singleton Council.

On 14 November 2018 a variation to EPL 563 was issued, this included:

- revision to the boundary with the Mount Thorley Mine;
- updating the licence to reflect the operation of the flares and three engines at the gas fired power station and onsite sewage treatment plant;
- removing the waste table and adding a general condition preventing any waste to be received at the Premises unless authorised by the EPL;
- adding a condition requiring that blast monitoring results be included with the Annual Return;
- removing the special condition requiring an updated plan of the Premises;

- small administrative changes; and
- draft conditions relating to irrigation of effluent were removed and blast conditions revised following a submission from Bulga Coal on 11 October 2018.

EPL 563 was also varied on 17 December 2018 to include a condition requiring Bulga Coal to calculate and comply with an hourly discharge volume limit at Hunter River Salinity Trading Salinity discharge points.

Table 7 Bulga Coal Licences

Licence	Details
Environmental Protection Licence (EPL)	
EPL 563	For scheduled activities: Coal works; Crushing, grinding or separating; and Mining for coal. Renewed annually on 20 July.
Water Licences	
20BL169347	Mining: Underground workings. Volume licence limit 365ML.
20BL166867	Monitoring (mining bore): GW1 – GW10. Total of 16 bores for monitoring purposes.
20BL167776	Monitoring: P1 – P3, P4A, P4B, P5 – P8 and V3. Licence for total of 9 bores for monitoring purposes.
20BL167777	Monitoring: V1, V2, F1 and F2.
20BL168475	Dewatering (mining): Beltana Longwall 1 Borehole. Volume licence limit 500ML.
20BL169204	Monitoring: Bore – ACARP Project.
20BL169246	Monitoring: Bore – ACARP Project.
20BL169510	Monitoring: WBR50 WBR50A, WBD55, WBD55A, WBD 57, WBD57A, WBD62, WBD62A, WBR15.
20BL169514 (WAL415543)	Dewatering (mining): Beltana MG4. Volume licence limit 500ML.
20BL172658 (WAL41544)	Dewatering (mining): South Bulga MGE1. Volume licence limit 500ML.
20BL172659	Monitoring: WBR180 and WBR181.
20BL172660	Monitoring: WBR182 and WBR183.
20BL172673 (WAL41545)	Dewatering (mining): South Bulga MGE4. Volume licence limit 500ML.
20BL173014	Monitoring: SBD194, SBD196
Radiation/Dangerous Goods Licences	
Radiation Density Gauge Licence RL5061333	Serial No: 4376GK - Nominal Activity: 1850MBq (OEH Reg No: 2036) Serial No: 4412GK - Nominal Activity: 1850MBq (OEH Reg No: 2037) Serial No: 4421GK - Nominal Activity: 1850MBq (OEH Reg No: 2042) Serial No: 6230GK - Nominal Activity: 1850MBq (OEH Reg No: 2047) Serial No: 6218GK - Nominal Activity: 2076MBq (OEH Reg No: 2046) Serial No: 0539/07 - Nominal Activity: 740MBq (OEH Reg No: 2188) Serial No: 0538/07 - Nominal Activity: 740MBq (OEH Reg No: 2187) Serial No: 0538/07 - Nominal Activity: 740MBq (OEH Reg No: 2187) Serial No: 0528/07 - Nominal Activity: 3700MBq (OEH Reg No: 2190) Serial No: 0532/06 - Nominal Activity: 3700MBq (OEH Reg No: 2173) Serial No: 0532/06 - Nominal Activity: 3700MBq (OEH Reg No: 2173)

Licence	Details
	Serial No: OC519 - Nominal Activity: 1850MBq (OEH Reg No: 49314 – 0010)
NDG018992	Dangerous Goods Notification for the storage and handling of hazardous chemicals.
XSTR1000095	Bulga Open Cut License to Store Explosives

3.3.1 Other Approvals

In 2015 Bulga Underground Operations was granted a surface access agreement by the Commonwealth Department of Finance to allow the construction and operation of goaf gas drainage wells on the Singleton Military Training Area for Blakefield South Longwall 7. This agreement was modified in 2016 to include an additional four goaf wells to service Blakefield South Longwall 8. This agreement expired at the end of 2018 and is currently being renewed.

4 Operations Summary

4.1 Mining Operations

The extent of mining activities is shown on **Figure 2** (Bulga Underground Operations) and **Figure 3** (Bulga Open Cut), and is discussed in the following sections.

4.1.1 Mining Personnel

As at the end of the reporting period, Bulga Coal employed approximately 764 full time equivalent personnel made up of 756 at Bulga Open Cut and eight at Bulga Underground Operations.

4.1.2 Exploration

A total of six exploration holes were drilled in 2018 as follows:

- SBR211 and SBR212 were drilled to further define the structural model for the Glen Munro, Woodlands Hill and Mt Arthur Seams;
- SBD220 was drilled to provide additional samples for National Greenhouse and Energy Reporting Scheme (NGERS) gas testing to the Bayswater Seam;
- SBR213 and SBR214 were drilled for additional water monitoring of the proposed SSD-4960 Mod 3 open cut extension area; and
- EBR091 was drilled to define a large normal fault in the East Pit.

The locations of the exploration holes are shown on **Figure 3**.

4.1.3 Land Preparation

Land preparation ahead of open cut mining operations involves the construction of erosion and sediment control measures, clearing vegetation and stripping and stockpiling topsoil. These activities were undertaken in accordance with the *Bulga Coal Biodiversity Management Plan*.

Where applicable, grassland, fragmented woodland communities, previously rehabilitated land and topsoil is cleared ahead of mining. Vegetation and vegetative matter are either mulched and incorporated into topsoil or stockpiled for future use in rehabilitation. During 2018, 90,000 m^3 of topsoil was stripped and 57 habitat trees were salvaged by Bulga Coal.

During 2018, 120.4 ha of disturbance was undertaken to allow mining, overburden dumping and construction activities (roads, drains and dams) to commence.

Clearing and disturbance areas are shown on **Figure 3**.

4.1.4 Mining Operations

Bulga Underground Operations

Bulga Underground Operations comprises the Blakefield South Mine, along with the approved but not yet commenced, Blakefield North Mine. During 2018, underground mining operations included the completion of Blakefield South Longwall 1B using longwall retreat mining techniques.

Mining of Blakefield South Longwall 1B commenced on 9 February 2018 and was completed on 3 May 2018. The mined length of Blakefield South Longwall 1B excluding the installation heading was 772 m. The longwall face width excluding the first workings is 320 m. The longwall was extracted from the south-west towards the northeast.

Following the completion of Blakefield South Longwall 1B, underground mining at Bulga Underground Operations has now ceased and the mine has been sealed. The Blakefield North Mine has been postponed however the associated pre drainage wellfield continues to be operated to supply the gas fired power station. The Blakefield South Pit top facilities have been demolished to allow the progression of open cut mining.

Table 8 shows the production and waste summary for Bulga Underground Operations in 2018.

Table 8 Production and Waste Summary for Bulga Underground Operations

Aspect	Approved Limit DA 376-8-2003	2017 Reporting Period (actual)	2018 Reporting Period (actual)	2018 MOP Predictions	2019 Reporting Period (forecast)
Waste Rock/ Overburden (bcm)	N/A	N/A	N/A	N/A	N/A
ROM Coal (t)	14,000,000	6,145,750	1,281,682	1,200,000	0
Coarse reject (t)	N/A	1,588,000	379,288	300,000[1]	0
Fine Reject (tailings) (t)	N/A	400,000	140,664		
Saleable Product (t)	N/A	4,308,473	939,626	900,000	0

1- Total waste volume. The Bulga Underground Operations MOP does not split the volumes of fine and coarse reject produced per year.

During the reporting period, ROM coal and saleable volumes were generally consistent with forecast MOP production rates with only minor variations from the predicted volumes. Coarse reject and tailings volumes were higher than predicted due to lower yields.

Bulga Open Cut

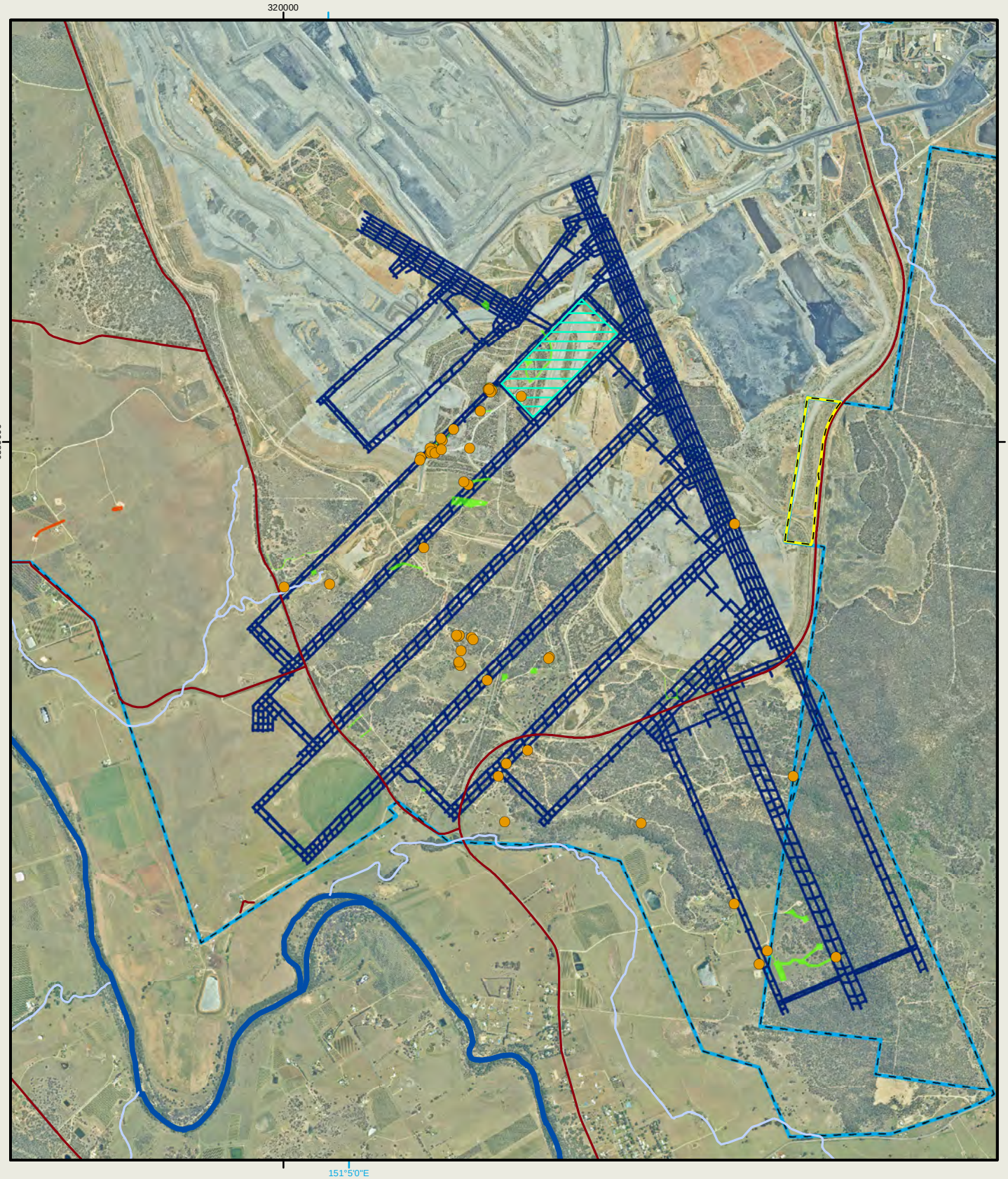
Bulga Open Cut continued mining coal reserves from the Bulga Pit, Southern Extension Pit and East Pit. In the Bulga and Southern Extension Pits, mining progressed in a westerly direction. Overburden was placed mainly in the Noise and Visual Bund and in-pit dumps.

Mining in the East Pit continued progressing to the south. Overburden from the East Pit was mostly placed in the Eastern Emplacement Area dump, with some placed in the Noise and Visual Bund.

Overburden was stripped using a dragline and a truck/shovel fleet. Coal was mined by a fleet of excavators and trucks. ROM coal was transported by dump truck via an overpass on Broke Road to the ROM coal hopper.

The total mining fleet as at 31 December 2018 is listed in **Table 9**.

FIGURE 2 - BULGA UNDERGROUND SUMMARY OF OPERATIONS 2018



- Public Road
- Wollombi Brook
- Minor Watercourse
- Mining Lease
- Sublease
- Mining Lease AMA
- Blakefield South Mine Workings
- 2018 Rehabilitation
- 2018 Disturbance
- Demolished Infrastructure
- Decommissioned Boreholes

0 0.25 0.5 1
Kilometres

Coordinate System
GDA 1994 MGA Zone 56
1:35,000 @ A4

GLENCORE

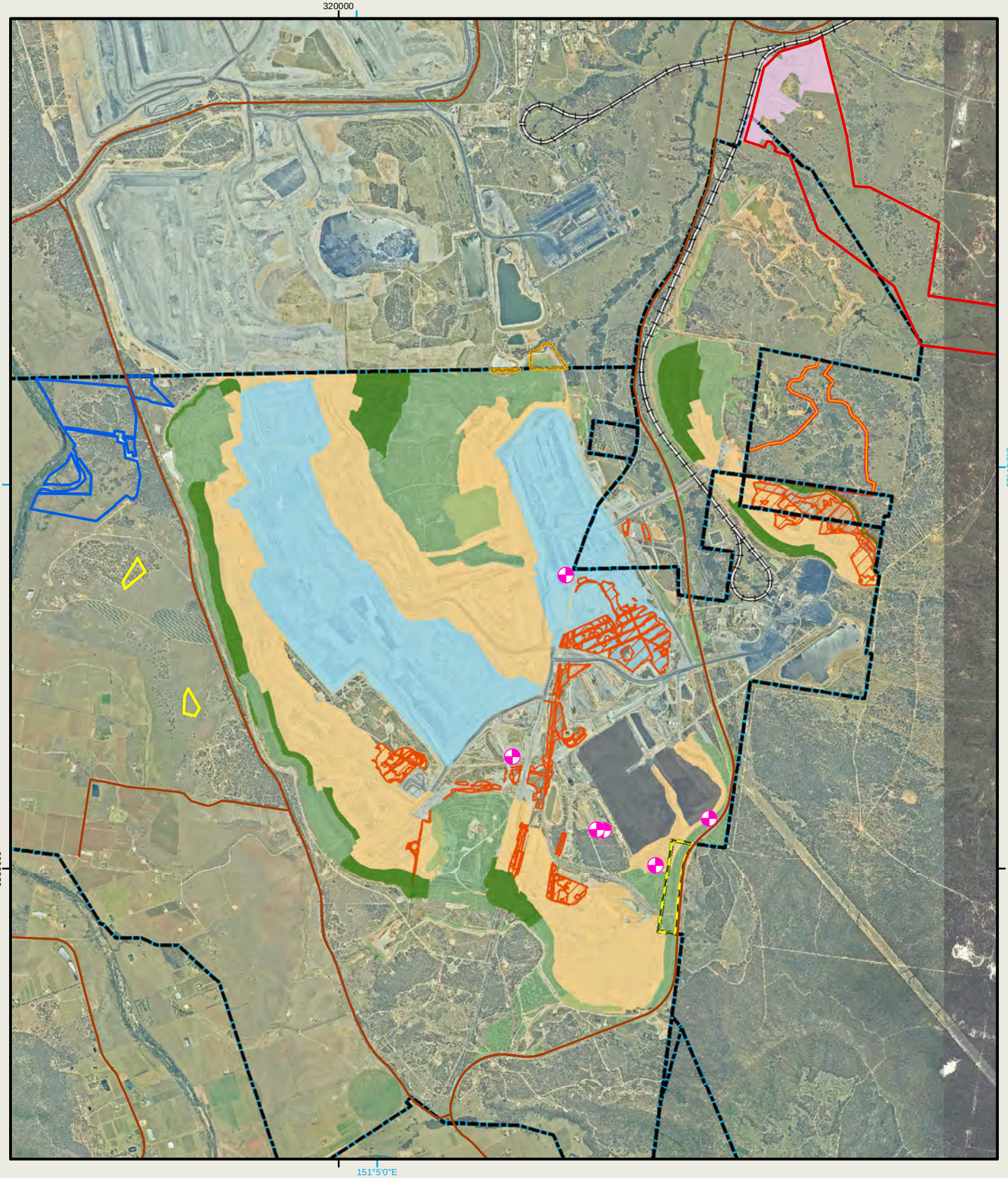
N

DISCLAIMER
Subject To Survey.
Glencore makes every effort to ensure the quality of the information available on this map. Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

DATA SOURCE
© NSW Department of Finance, Services & Innovation 2017
© NSW DTIRIS (Minerals & Petroleum) 2017
© Glencore 2019 © ESRI 2017

Ref: \\AUSYDSRVCS500\BUGSI\Mapping\Reporting\AEMR\2018\2018_AEMR_FIGURE02_BUG_SUMMARY_OF_OPERATIONS.mxd

FIGURE 3 - BULGA OPEN CUT SUMMARY OF OPERATIONS 2018



- Public Road
- Railway
- Mining Lease
- Sublease
- Mining Lease AMA
- Active Mining
- Overburden Emplacements
- Tailings Storage Facility
- Existing Rehabilitation
- 2018 Rehabilitation
- 2018 Disturbance
- Exploration Borehole

Biodiversity Offsets

- Broke Road BOA
- WBCA
- Weeping Myall MA
- 2018 Offset Reveg Areas

0 0.425 0.85 1.7
Kilometres

Coordinate System
GDA 1994 MGA Zone 56
1:55,000 @ A4

GLENCORE

N

DISCLAIMER
Subject To Survey.
Glencore makes every effort to ensure the quality of the information available on this map. Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

DATA SOURCE
© NSW Department of Finance, Services & Innovation 2017
© NSW DTIRIS (Minerals & Petroleum) 2017
© Glencore 2019 © ESRI 2017

Ref: \\AUSTD1SRVCS500\BUGIS\Mapping\Reporting\EMR\2018\20180216_EMR_FIGURE03_BOC_SUMMARY_OF_OPERATIONS.mxd

Table 9 Bulga Open Cut Mining Fleet

Type	Model	Units
Dragline	P&H9020	1
Shovels – Electric	P&H4100	1
Shovels – Hydraulic	Hitachi EX8000	1
	Hitachi EX5600	1
	Hitachi EX5500	2
	Hitachi EX3600	1
	Hitachi EX2500	1
	Liebherr EX9400	1
	Liebherr EX9250	1
	Liebherr EX9100	2 (1 Hire)
Haulage Trucks	Cat 793C XQ	6
	Cat 793D XQ	30
	Cat 789C XQ	9
	Cat 797F XQ	7
	Cat 789C XQ Water Trucks	4
	Cat 777D Water Truck	1 (Hire)
Front End Loaders	LeTourneau L1850	2
	Cat 980H	1
Dozers (tracked)	Cat D11T	5
	Cat D11R	11
	Cat D10T	3
	Cat D10R	1
Dozers (tyred)	Cat 834H	1
	Cat 854H	2 (1 Hire)
Graders	Cat 24H	1
	Cat 24M	2
	Cat 16H	1
	Cat 16M	1
Fuel Trucks	Cat 777E	2
	Cat 775E (Hire)	1
Drills	Sandvik D75K	1
	Terex SKS-W	2
	Terex SKF	2

A summary of coal production and waste material (overburden) production for the Bulga Open Cut is provided in **Table 10**.

Table 10 Production and Waste Summary for the Bulga Open Cut

Aspect	Approved Limit SSD-4960	2017 Reporting Period (Actual)	2018 Reporting Period (Actual)	2018 MOP Predictions	2019 Reporting Period (MOP Forecast)
Waste Rock/ Overburden (bcm)	N/A	45,937,000	51,647,323	52,122,000	52,150,000
ROM Coal (t)	12,200,000	8,807,000	12,092,025	11,748,000	9,788,000[2]
Coarse reject (t)	N/A	2,903,883	3,870,289	3,616,000[1]	3,488,000
Fine Reject (tailings) (t)	N/A	551,368	1,120,733		
Saleable Product (t)	N/A	5,765,427	8,098,781	8,075,000	6,386,000[2]

1- Total waste volume. The Bulga Open Cut MOP does not split the volumes of fine and coarse reject produced per year.
2- ROM coal and saleable product (t) for 2019 may exceed MOP forecast due to potential changes in the mine plan.

During the reporting period, overburden, ROM coal and saleable volumes were generally consistent with forecast MOP production rates with only minor variations from the predicted volumes. Coarse reject and tailings volumes were higher than predicted due to lower yields from coal within the East Pit.

4.2 Other Operations

4.2.1 Coal Handling and Preparation Plant

In 2018, 13.4 million tonnes (Mt) of Run of Mine (ROM) coal was washed producing 9.0 Mt of saleable product coal. The CHPP has approval to wash up to 20 Mt of ROM coal per year. 9.1 Mt of coal was railed to the Port of Newcastle.

4.2.2 Tailings Management

The Bayswater Pit was used as the primary tailings emplacement facility. Minor volumes of tailings were pumped to the Deep Pit emplacement throughout the year. A minor volume was also pumped to the North Pit Tailings Storage Facility (Main Pit) during the commissioning of the pipeline and decant water infrastructure.

4.2.3 Construction

Bulga Coal construction works included:

- East Pit Muster Facility – several Bulga Underground Operations demountable buildings were relocated to the Bulga Optimisation Project site offices. This facility is now called the East Pit Muster Facility and is being used as the main work force deployment point;
- Mining Infrastructure Area Upgrades – a new demountable building was established for the maintenance workshop offices and the external sheeting on the existing workshop office was refurbished; and
- Light Vehicle Workshop Area Relocation – the Light Vehicle Workshop was relocated from Beltana to the Area Station to allow pit progression, installation of offices, lift hoist, store etc.

The CHPP was upgraded to improve coal throughput and recovery, and reduce water usage. The upgrades included:

- Upgrades to the effluent sump control circuit at the Bulga Coal flotation plant – increased fine coal recovery from tailings and reduced tailings output;

- Tailings thickener optimisation – further upgrades to improve underflow density to paste thickener and tailings dams;
- Module 1 tailings drive upgrade;
- LC3 low cut spirals installed to improve efficiency of fine coal recovery;
- Continuation of structural integrity works including sand blasting, painting, beam replacement and flooring replacement; and
- Completion of the CHPP roof replacement.

In addition to the CHPP upgrades, the Cell A dam wall at the Northern Tailings Storage Facility was constructed along with the Modules 1 and 2 pipelines, and decant water infrastructure to allow for its use. The secondary flocculation plant was also relocated from the Bayswater Pit to the Northern Tailings Storage Facility.

4.2.4 Demolition

Following the cessation of underground mining in May 2018, Bulga Underground Operations infrastructure was demolished/dismantled to allow for Bulga Open Cut pit progression:

- The administration buildings were demolished;
- Ventilation Fans #1 and #2 were dismantled and the shafts sealed in accordance with DPE-RR guidelines;
- The Stockpile Gantry (CV701) was dismantled and concrete demolished; and
- Beltana Arch Bridge was demolished.

A redundant residential dwelling at 154 Broke Road and a shed at 14 Broke Road were dismantled and rehabilitated by Bulga Open Cut. Both structures were not on the mining lease area and the work was done in accordance with separate Development Approvals issued by Singleton Council. The sites were rehabilitated with a pasture seed mix.

All demolition works were carried out by a licensed demolition contractor in accordance with *Australian Standard AS 2601-2001.*

As shown in **Figure 2,** 49 bores were decommissioned at Bulga Underground Operations.

4.2.5 Waste Management

Waste management is undertaken in accordance with the *Bulga Coal Complex Waste Management Plan*. Waste is removed by a licenced contractor and, where possible, is recycled. Waste removed from site includes batteries, light vehicle tyres, scrap metal, domestic waste, fuel and oil filters, solvent, radiator coolant, wooden pallets, oily rags and hydrocarbon contaminated material from maintenance workshops.

80% of the waste produced by Bulga Open Cut (3,275 t) and 83% of the waste at Bulga Underground Operations (2,696 t) was recycled. 1,902 t of scrap steel was recycled at Bulga Underground Operations during decommissioning associated with the cessation of mining.

Waste oil and grease removed from equipment is stored in bunded tanks. Wastewater generated from the workshop areas is treated through hydrocyclone oily water separators. Waste oil, grease and oily water from oil water separators are then removed by an authorised waste contractor for recycling.

The treatment and disposal of sewage at Bulga Open Cut is through an extended aeration sewage treatment plant. Effluent from this plant goes to two maturation ponds before it is returned to CHPP circuit water. Sewage from the East Pit Muster is treated by an extended aeration sewage treatment plant. Effluent is also treated with ultra-violet (UV) light. Treated water is transferred to a mine water dam for reuse. Deactivated sludge is transported to the Singleton Council Treatment Works Depot. The Bulga Underground Operations sewage treatment plant located at the pit top facilities ceased operating during 2018.

4.2.6 Hazardous Materials Management

Hazardous and dangerous goods are stored and labelled according to the relevant Australian Standard.

Hazardous materials are stored at Bulga Open Cut in accordance with Notification of Hazardous Chemicals on Premises (Acknowledgement NDG018992) issued by WorkCover NSW. NDG018992 lists the hazardous chemicals which are stored in volumes that warrant notification.

Disposal of hazardous waste requires waste tracking, transport by a licenced waste transporter and disposal at a licenced facility. Transport and disposal of polychlorinated biphenyls will continue to be undertaken by Environment Protection Authority (EPA) licenced waste contractors.

Explosives are stored in licenced explosive magazines according to WorkCover requirements. Licence No. XSTR100095 covers the storage of these materials at Bulga Open Cut.

4.3 Next Reporting Period

4.3.1 Bulga Underground Operations

Activities proposed in 2019 are generally consistent with DA 376-8-2003 and the approved Bulga Underground Operations MOP. Due to the cessation of underground mining, activities will include the decommissioning and demolition of Bulga Underground Operations surface infrastructure, rehabilitation of redundant gas drainage infrastructure, access tracks and pipelines. **Figure 4** illustrates the proposed rehabilitation activities.

4.3.2 Bulga Open Cut

Activities proposed in 2019 are generally consistent with SSD-4960 and the approved Bulga Open Cut MOP. **Figure 5** illustrates the proposed operations.

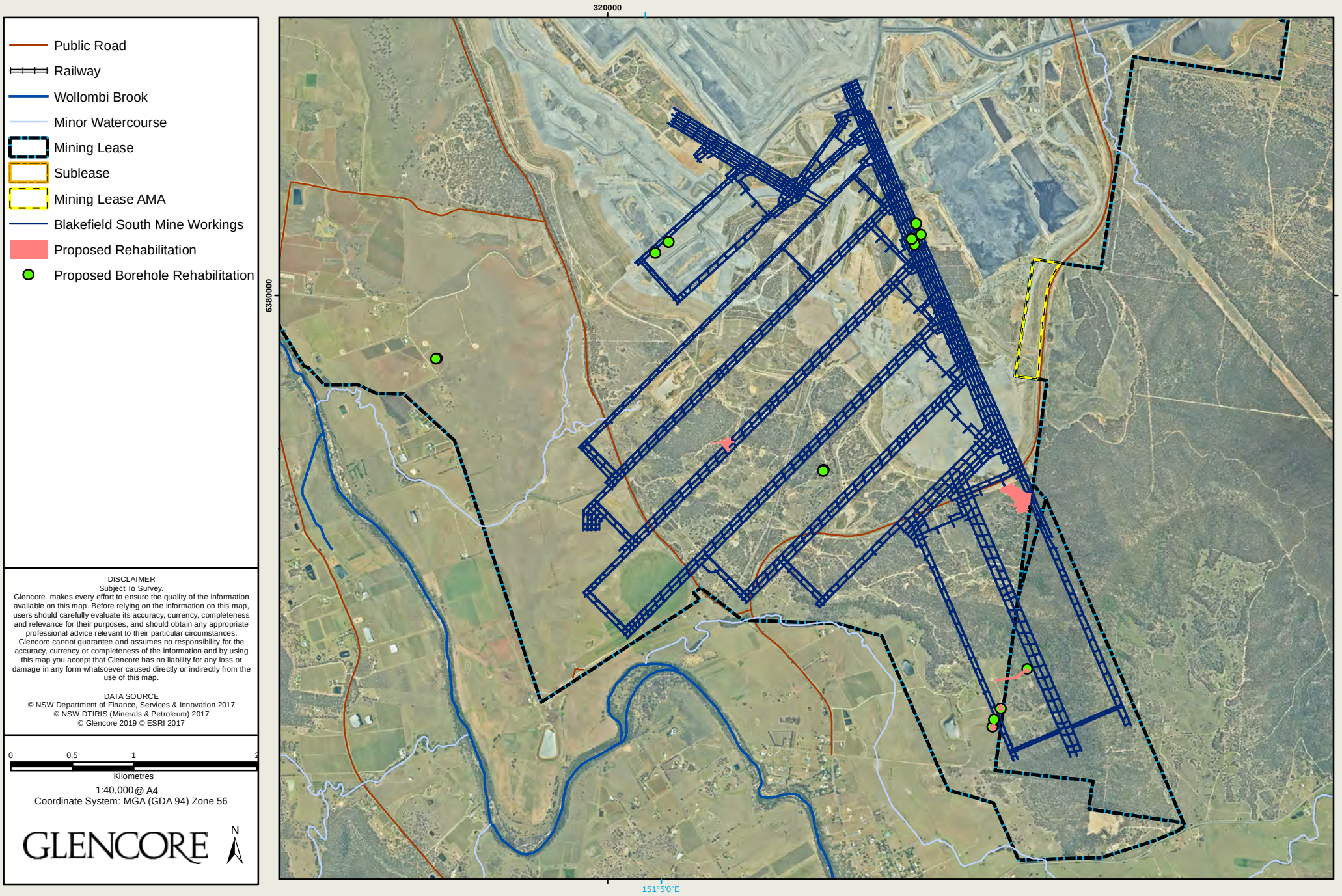
Mining operations will continue in the Bulga Pit, Southern Extension Pit and East Pit. Bulga Open Cut will continue to place overburden on the Noise and Visual Bund and Eastern Emplacement Area.

Construction activities will include water management infrastructure at the Eastern Emplacement Area and an Aboriginal Teaching and Keeping Place at the Wollombi Brook Conservation Area.

Seven boreholes are planned to be drilled. The exploration will aim to:

- further define the large fault structure in the East Pit;
- define the northern limit of the Woodlands Hill Pit within the SSD-4960 (Mod 3) area; and
- provide additional samples for NGERS gas testing.

FIGURE 4 - BULGA UNDERGROUND PROPOSED OPERATIONS 2019



DISCLAIMER
Subject To Survey.
Glencore makes every effort to ensure the quality of the information available on this map. Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

DATA SOURCE
© NSW Department of Finance, Services & Innovation 2017
© NSW DTIRIS (Minerals & Petroleum) 2017
© Glencore 2019 © ESRI 2017

0 0.5 1 2
Kilometres

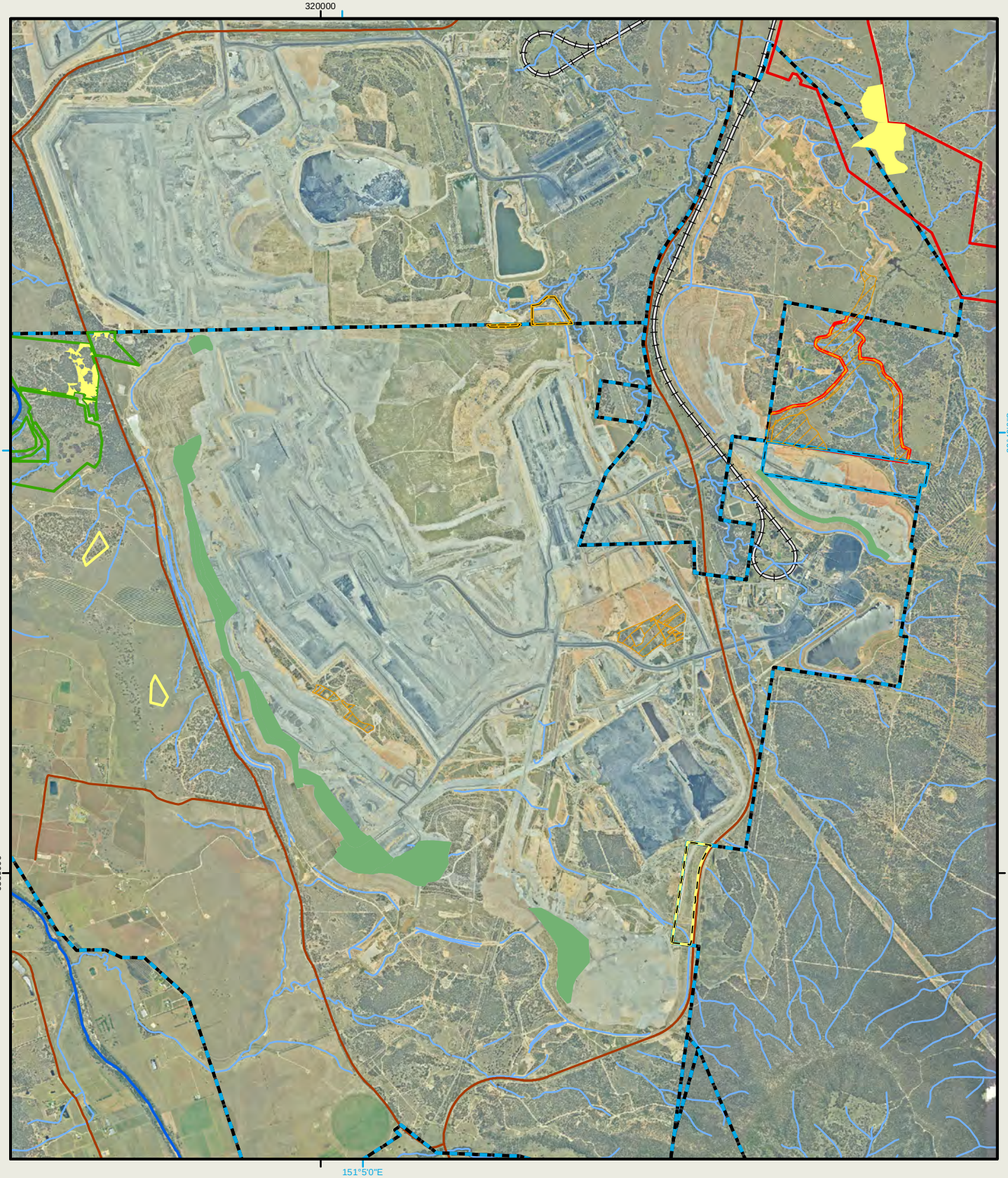
1:40,000 @ A4
Coordinate System: MGA (GDA 94) Zone 56

GLENCORE

N

Ref: \\AUSYDSRVC5980\BulkISM\apping\Reporting\AEMR\2018\2018_AEMR_FIGURE04_BUG_PROPOSED_OPERATIONS.mxd

FIGURE 5 - BULGA OPEN CUT PROPOSED OPERATIONS 2019



- Public Road
- Railway
- Wollombi Brook
- Minor Watercourse
- Mining Lease
- Sublease
- Mining Lease Application
- Mining Lease AMA
- 2019 Rehabilitation
- 2019 Disturbance

Biodiversity Offsets

- Broke Road BOA
- WBCA
- Weeping Myall MA
- 2019 Proposed Revegetation Area

0 0.375 0.75 1.5
Kilometres

Coordinate System
GDA 1994 MGA Zone 56
1:50,000 @ A4

GLENCORE

N

DISCLAIMER
Subject To Survey.
Glencore makes every effort to ensure the quality of the information available on this map. Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

DATA SOURCE
© NSW Department of Finance, Services & Innovation 2017
© NSW DTIRIS (Minerals & Petroleum) 2017
© Glencore 2019 © ESRI 2017

Ref: \\AUSTYDSRVC5500\BUGIS\Mapping\Reporting\AEMR\2018\2018_AEMR_FIGURE05_BOC_PROPOSED_OPERATIONS.mxd

5 Actions Required from Previous Annual Review

The 2017 Annual Review was provided to DPE and DPE-RR on 29 March 2018. DPE and DPE-RR considered the Annual Review to generally meet the requirements of the approval in relation to reporting and the DPE Annual Review Guideline; however, additional information was requested to be included in future annual reviews. **Table 11** presents the requested additions and where the information has been included in this document.

Table 11 Action required from 2017 Annual Review

DPE Comment	Section Addressed
The Department notes that it provided a further approval for an extension for the surrender of DA 41-03-09 to 31 December 2018, in a letter dated 18 December 2017. The status of actions from the 2015 IEA, as presented in Table 45, is inaccurate and should be updated.	The 2017 Annual Review was update to reflect this comment.
Please ensure that future Annual Reviews provide a status update of outstanding actions from RAR[1] as at the end of the reporting period.	Section 10
That the Rehabilitation Reports that monitor the trajectory of the rehabilitation performance is attached to the Annual Report or alternatively provided to Resources Regulator to demonstrate performance.	Section 8. Rehabilitation Reports will be provided to the Resources Regulator with this Annual Review.

1 – Response to Audit Recommendations

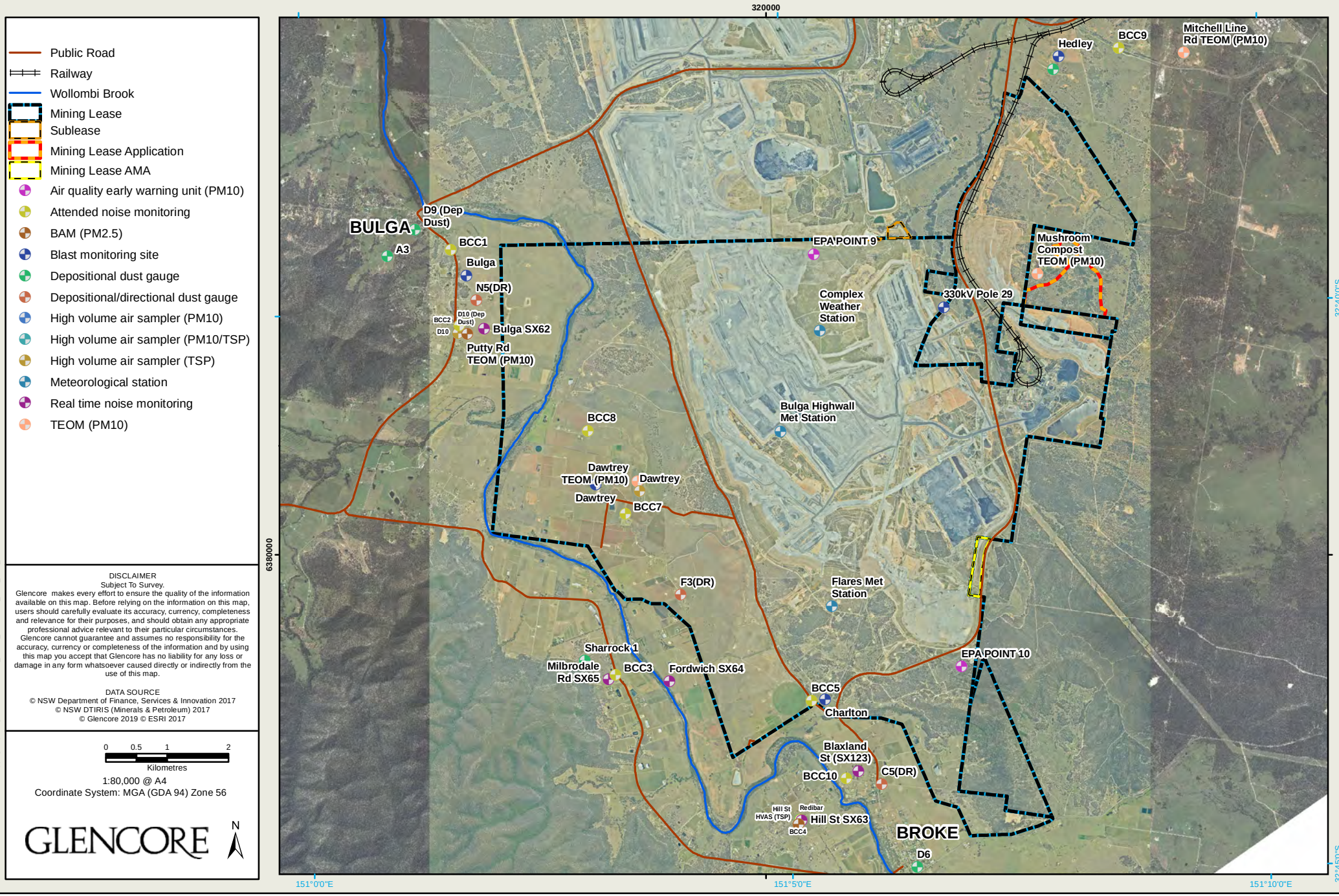
6 Environmental Management Performance

Bulga Coal implements a comprehensive *Environmental Management Strategy* (EMS), which provides a framework for managing all environmental and community aspects and impacts of mining operations. The EMS includes management plans, procedures and standards to minimise the risks of impact to the environment and continually improve the environmental management performance of operations. An extensive environmental monitoring network is in place to monitor the environmental management performance of the site. The environmental monitoring network is shown in **Figure 6**, **Figure 7** and **Figure 11.**

6.1 Meteorology

Bulga Coal has three meteorological monitoring sites as shown in **Figure 6**. Meteorological data from the Bulga Complex Meteorological Station is reported in the quarterly environmental monitoring reports available on the Bulga Coal website (www.bulgacoal.com.au).

FIGURE 6 - BULGA COAL ENVIRONMENTAL MONITORING



DISCLAIMER
Subject To Survey.
Glencore makes every effort to ensure the quality of the information available on this map. Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

DATA SOURCE
© NSW Department of Finance, Services & Innovation 2017
© NSW DTIRIS (Minerals & Petroleum) 2017
© Glencore 2019 © ESRI 2017

0 0.5 1 2
Kilometres

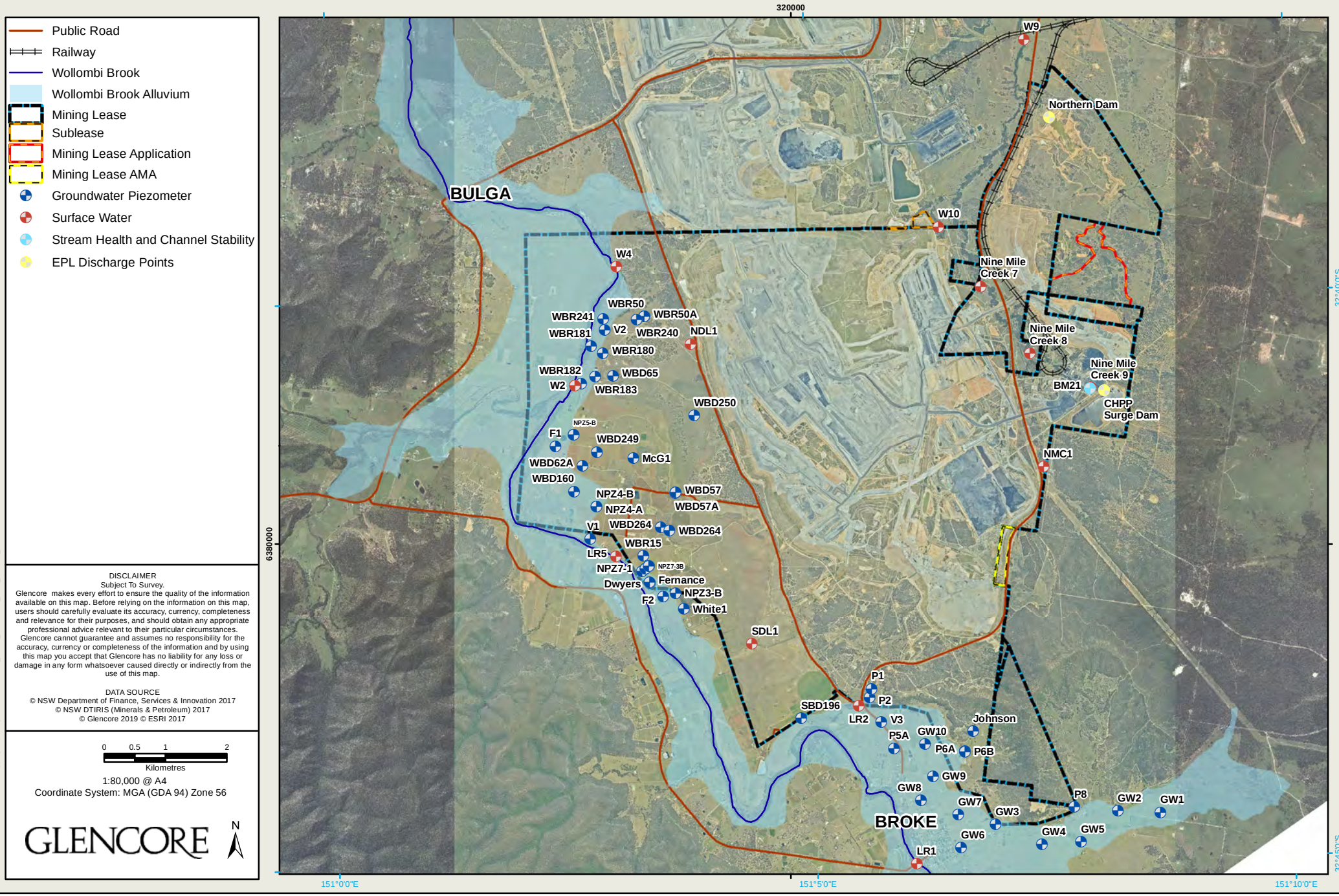
1:80,000 @ A4
Coordinate System: MGA (GDA 94) Zone 56

GLENCORE

N

Ref: \\AUSTOSRVC5960\BulkISM\apping\Reporting\AEMR\2018\2018_AEMR_FIGURE06_BCC_ENV_MONITORING.mxd

FIGURE 7 - BULGA COAL WATER MONITORING



6.2 Noise

6.2.1 Environmental Management

Noise monitoring is undertaken in accordance with the *Bulga Coal Noise Management Plan*.

The location of monitoring sites is shown on **Figure 6**. The monitoring program includes:

- monthly attended night-time monitoring at nine sites;
- real-time monitoring at five locations;
- sound power testing of a representative sample of the open cut fleet; and
- additional monitoring as initiated by alarms or in response to community concerns.

The real-time monitoring network assists with the management of noise impacts from mining operations. Monitors are operated at locations representative of Broke, Fordwich, Milbrodale and Bulga. Data is recorded continuously and reported real-time to the Bulga Open Cut control room via an internal website. Dispatch is notified of noise levels that are approaching or exceeding the Development Consent noise criteria. Dispatch and Open Cut Examiners investigate noise sources and make changes to reduce noise, where required.

Sound power testing is conducted in accordance with the *Bulga Coal Noise Management Plan*. A representative sample of the open cut fleet is tested annually. Every item of mobile equipment is tested at least once every three years. Measured sound power levels are compared to levels included in the Statement of Environmental Effects (SEE) titled *Bulga Surface Operations Eastern Emplacement Area Modification Statement of Environmental Effects*, dated July 2016, including the Response to Submissions titled *Bulga Surface Operations Eastern Emplacement Area Modification Response to Submissions*, dated December 2016. Exceedances are investigated and actioned. A targeted sound power monitoring campaign is undertaken if a number of items of the same equipment type fail to meet the modelled specification.

6.2.2 Environmental Performance

Attended Noise Monitoring

A summary of attended noise monitoring data for each monitoring location (**Figure 6**) is shown in **Table 12**. Results are presented as the maximum noise levels from Bulga Coal at each location during 2018. Exceedances of the noise criteria are highlighted in bold and discussed further below. A detailed discussion of monitoring results is provided in Monthly Noise Monitoring Reports available on the Bulga Coal website.

Table 12 Summary of Attended Noise Monitoring Data – 2018

Location	Bulga Coal Noise Monitoring Results - dBA (Max)		Bulga Coal Project Specific Noise Criteria - dBA	
	LAeq(15minute)	LA1(1minute)	LAeq(15minute)	LA1(1minute)
BCC1	35	42	36	45
BCC2	35	42	36	
BCC3	**38**	44	35	
BCC4	**36**	40	35	
BCC5	**37**	**50**	36	
BCC7	33	**48**	36	

Location	Bulga Coal Noise Monitoring Results - dBA (Max)		Bulga Coal Project Specific Noise Criteria - dBA	
BCC8	36	45	36	
BCC9	<30	32	37	
BCC10	**37**	43	35	

Bulga Coal was compliant with noise criteria, with the following exceptions:

- **BCC3 – 803 Milbrodale Road**

  A 3 dB exceedance of the $L_{Aeq(15minute)}$ noise criterion was recorded on 5 September 2018. This was caused by engine and exhaust noise. A 2 dB low-frequency modifying factor was applied to the noise level resulting in a site only noise level of 38 dBA $L_{Aeq(15minute)}$. Dispatch was notified and a follow up noise measurement was undertaken. Noise levels were compliant during the follow up measurement.

- **BCC4 – 115 Hill Street**

  A 1 dB exceedance of the $L_{Aeq(15minute)}$ noise criterion was recorded on 17 December 2018. This was primarily caused by engine noise and exhaust noise. A 2 dB low-frequency modifying factor was applied to the measured noise level. Dispatch was notified and a follow up noise measurement was undertaken. Noise levels were compliant during the follow up measurement.

- **BCC5 – Broke Cemetery**

  A 1 dB exceedance of the $L_{Aeq(15minute)}$ noise criterion was recorded on 21 June 2018 due to mine noise continuum. Impact noise (trucks loading/dozer tracks/bucket impact noise etc) generated a site only $L_{A1(1minute)}$ of 50 dB resulting in a 5 dB exceedance of the $L_{A1(1minute)}$ noise criterion. Reverse alarms and truck engine noise were also noted. Dispatch was notified and a follow up noise measurement was undertaken. The criteria were not applicable for the second measurement due to inversion and wind conditions. Noise levels were compliant during the follow up measurement.

- **BCC7 – 179 Cobcroft Road**

  A 3 dB exceedance of the $L_{A1(1minute)}$ noise criterion was recorded on 10 August 2018 caused by haul truck transmission whine. Dispatch was notified and a follow up noise measurement was undertaken. Noise levels were compliant during the follow up measurement.

- **BCC10 – Blaxland Street**

  A 2 dB exceedance of the $L_{Aeq(15minute)}$ noise criterion was recorded on 10 August 2018. This was primarily caused by mine noise continuum and haul truck engine surges. A 2 dB low-frequency modifying factor was applied to the measured noise level. Dispatch was notified and a follow up noise measurement was undertaken. Noise levels were compliant during the follow up measurement.

Mobile Plant Sound Power Testing

The purpose of sound power testing is to identify individual mobile plant items that may require additional maintenance, due to malfunction or insufficient attenuation. Items of plant that fail to meet sound power targets by greater than 2 dB are inspected, and maintained where required, and retested. This process is used to maintain equipment noise levels at or near modelled levels, assisting in maintaining compliance with off-site noise levels.

Sound power testing is undertaken over a three-year cycle, with the current period being 2016 to 2018. During 2018 measurements were taken on 44 individual plant items as listed in **Table 13**.

Table 13 2018 Sound Power Testing

Plant Type	Number of Plant Tested	Percentage of Equipment Type Tested
Dozer (tracked)	9	45 %
Dozer (wheeled)	7	66 %
Front end loaders	2	66 %
Graders	3	60 %
Haul trucks	18	32 %
Drills	3	60 %
Shovels/excavators	1	11 %
Draglines	1	100 %

Mobile plant items tested were within 2 dB of the noise targets, except for:

- Three Caterpillar D11 Dozers;
- Two Caterpillar 789 Trucks;
- Six Caterpillar 793 Trucks;
- One Terek SKF Drill; and
- One Hitachi EX5500-6 Excavator

Sound attenuation packages on trucks are inspected every three to four weeks and replaced every four years. Some variation across the feet is expected as individual units will be at different stages of their build cycle.

Individual sound power levels must be considered within the context of the total site sound power to understand the significance of these results off-site.

Table 14 shows fleet averages from 2016 to 2018 annual testing and a comparison to the modelled sound power levels.

Table 14 Overall Sound Power Results 2016 - 2018 and Comparison to Modelled Levels

Plant Type	Items Tested (2016-2018)	Fleet Average[1] L_W / L_{WA}	Modelled L_W/ L_{WA}	Difference L_W/ L_{WA}
CAT D10/D11 Bulldozers	18	122/117	122/115	Nil/+2
CAT Rubber Tyre Bulldozers	2	116/110	116/111	Nil/-1
LeTourneau L1850 Loader	2	125/121	125/122	Nil/-1
CAT 16H/16M Graders	2	113/108	114/108	-1/Nil
CAT 24H/24M Graders	3	116/110	117/110	-1/Nil
CAT 789C Water Carts	4	121/115	121/115	Nil/Nil
CAT 773E Fuel/Service Trucks	2	122/114	121/115	+1/-1
CAT 789C Rear Dump Trucks	9	123/116	121/115	+2/+1
CAT 793C/D Rear Dump Trucks	36	123/116	121/115	+2/+1

Plant Type	Items Tested (2016-2018)	Fleet Average[1] L_W / L_{WA}	Modelled L_W/ L_{WA}	Difference L_W/ L_{WA}
CAT 797F Rear Dump Trucks	7	125/117	124/117	+1/Nil

1 - All averages listed are logarithmic means of testing results and based on most recent test result for each item.

The average sound power level measured across the fleet during 2016 to 2018 varied from modelled sound power levels by 2 dB or less. Therefore the net difference between the measured and predicted total sound power for site would be less than 2 dB.

6.2.3 Comparison against Predictions

The *Noise Impact Assessment for the Bulga Optimisation Project – Eastern Emplacement Area Development Consent Modification* (Global Acoustics, 2016) predicted Bulga Coal only noise levels from reasonable worst case operating conditions throughout the life of the open cut mine. Modelling was done for Year 4 of the Bulga Optimisation Project.

With the exception of the exceedances highlighted in **Section 6.2.2**, attended monitoring results in 2018 were compliant with SSD-4960 noise criteria. This shows that measured noise levels were managed below reasonable worst case night time predictions made for Year 4 of the Bulga Optimisation Project.

6.2.4 Long Term Analysis

An assessment of long-term trends in noise generated by Bulga Coal operations was undertaken by Global Acoustics (2019). The assessment considered noise levels measured from Bulga Coal during monthly attended environmental noise monitoring over a 5-year period from January 2014 to December 2018 with the findings summarised as:

- Four monitoring locations (BCC1, BCC2, BCC3 and BCC6) showed an upward trend in noise levels from Bulga Coal operations;
- Five monitoring locations (BCC4, BCC5, BCC7, BCC8 and BCC9) showed no significant trends in noise from Bulga Coal operations; and
- Noise monitoring only commenced at BCC10 in 2018 therefore long-term trends cannot be assessed.

The long term monitoring report is attached as **Appendix B**.

6.2.5 Implemented / Proposed Improvements

The *Noise Management Plan* was revised and approved by DPE on 21 December 2017. The revised *Noise Management Plan* was implemented during 2018 and included these improvements:

- relocation of the Milbrodale Road real-time noise monitor (SX65) from Watts Creek Vineyard to a private property further north on Milbrodale Road in response to community concerns;
- relocation of an attended monitoring site from Watts Creek Vineyard (BCC3) to a private property further north on Milbrodale Road;
- addition of an attended noise monitoring site at Mitchell Line Road (BCC9) to assess impacts from the Eastern Emplacement Area and East Pit on local residents;
- addition of an attended noise monitoring site (BCC10) in Blaxland Street, Broke to assess impacts on local residents; and

- revision of the Noise Management Trigger Action Response Procedure to include noise alarms from the Hill Street and Blaxland Street real-time noise monitors during the morning (6:00 am to 10:00 am).

6.3 Blasting

6.3.1 Environmental Management

Blasting at Bulga Open Cut is undertaken in accordance with the approved *Blast Management Plan*. Monitoring is carried out to assess air blast overpressure and ground vibration impacts to the nearest privately owned residents.

Private property blast impact assessment criteria are provided in **Table 15**. The criteria apply at the compliance monitoring locations (Dawtrey, Bulga, Charlton and Hedley) shown on **Figure 6**.

Table 15 Private Property Amenity Impact Assessment Criteria

Airblast Overpressure Level (dB(Lin Peak))	Ground Vibration Peak Particle Velocity (ppv)	Allowable Exceedance
115	5 mm/s	5% of the total number of blasts over a period of 12 months
120	10 mm/s	0%

Blasting is managed to minimise ground vibration at public infrastructure. Infrastructure impact assessment criteria are provided in **Table 16**. Vibration monitoring is undertaken when the predictions from the scaled distance model are greater than or equal to 80% of the criteria. During the year, monitoring was undertaken at Pole 29 of the 330 kV powerline as shown on **Figure 6**.

Table 16 Infrastructure Impact Assessment Criteria

Infrastructure	Ground Vibration peak particle velocity (ppv)	Allowable Exceedance
330 kV Suspension Towers, Private Irrigation District (PID) Pipeline and public roads	100 mm/s	0%
All other public infrastructure	50 mm/s *(Unless the Director-General has agreed to an alternative a specific limit determined in accordance with the structural design methodology in AS2187.2-2006, or its latest version)*	0%

Heritage blast vibration impact assessment criteria are listed in **Table 17.** The Bulga, Charlton, Dawtrey and Hedley blast monitors shown in **Figure 6** are used to assess compliance with the criteria, as nominated in the *Blast Management Plan*.

Table 17 Heritage Impact Assessment Criteria

Heritage Site	Ground vibration ppv	Allowable Exceedance
'Mt Leonard Homestead', BH14 – 'Charlton', B13 – Stone Wall alongside Monkey Place Creek, St Andrews Anglican Church, BH6 – Broke Cemetery, Murinbin House Group.	5 mm/s	0%

6.3.2 Environmental Performance

144 blasts from Bulga Open Cut were monitored during 2018. Monitoring data is available on the Bulga Coal website, with a summary provided in **Table 18** and **Table 19.**

Table 18 2018 Private Property Overpressure and Vibration Monitoring Results

Monitoring Location	Airblast Overpressure Level dBL (Lin Peak)				Ground Vibration ppv (mm/s)			
	Average	Max	Results > dBL	Results > dBL	Average	Max	Results >10 mm/s	Results >5 mm/s
Bulga	97.6	113.5	0 (0%)	0 (0%)	0.3	2.1	0 (0%)	0 (0%)
Charlton	91.5	106.6	0 (0%)	0 (0%)	0.2	0.9	0 (0%)	0 (0%)
Dawtrey	95.3	114.2	0 (0%)	0 (0%)	0.4	1.6	0 (0%)	0 (0%)
Hedley	93.0	112.8	0 (0%)	0 (0%)	0.5	4.2	0 (0%)	0 (0%)

Table 19 2018 Infrastructure Vibration Monitoring Results

Monitoring Location	Ground Vibration ppv		
	Average	Max	Results > 100 mm/s
330 kV Pole 29	1.2	7.0	0 (0%)

During 2018 there were no non-compliances with regard to blasting.

During 2018, blasting was undertaken within 500 m of the Mushroom Composting Facility for the purpose of breaking rock to construct a drain. In accordance with Schedule 3, Condition 14 of SSD 4960, Bulga Coal obtained written agreement from the owners of the Mushroom Composting Facility and notified the DPE of the agreement. Monitoring and post-blast inspections were undertaken and no impacts were identified.

6.3.3 Comparison against Predictions

A *Blasting Noise and Vibration Impact Assessment* (Wilkinson Murray, 2012) was undertaken as part of the Bulga Optimisation Project EIS. The assessment noted that blasting would be managed to meet the amenity airblast and vibration criteria identified for inclusion in the Development Consent and EPL. There were no exceedances of the blasting criteria and is consistent with predictions.

6.3.4 Implemented / Proposed Improvements

The Blast Management Plan was revised in 2018 and submitted to DPE for approval. The main changes were an improved pre-blast assessment process that considers dust risk, fume risk and air quality measured by the Mount Thorley and Bulga Upper Hunter air quality monitors, prior to firing.

6.4 Air Quality

6.4.1 Environmental Management

Bulga Coal implements controls to mitigate air quality impacts in accordance with the *Bulga Coal Air Quality Management Plan* and the *Eastern Emplacement Area Air Quality Management Framework* (EEAAQMF), which are available on the Bulga Coal website. Bulga Coal also operates a monitoring system to assess air quality impacts on surrounding communities. The monitoring system (refer **Figure 6**) consists of:

Air quality monitors required by the development consents:

- Ten Dust Deposition Gauges (three of which are directional) used for monitoring of larger dust particles (typically >50µm). Dust Deposition Gauges are sampled monthly (+/- 2 days) and results include the insoluble (mineralogical) matter (IM) and ash residue (organic);
- Three High Volume Air Samplers (HVAS) that monitor Total Suspended Particulates (TSP) over a 24 hour period every sixth day, known as D10, Dawtrey and Hill Street monitors;
- Two HVAS's that monitor particulate matter less than ten microns in diameter (PM_{10}) over a 24 hour period every sixth day, known as D10 and Dawtrey;
- Five Tapered Element Oscillating Microbalance (TEOM) continuous air quality monitors that measure the concentration of particulate matter less than ten microns in diameter (PM_{10}), located at Putty Road (D3), Dawtrey (D5), Hill Street (D1), Mitchell Line Road (D11) and the Mushroom Composting Facility (D4);
- Two Beta Attenuation Monitors (BAM) located at Hill Street (D2) and Putty Road (D10) that measure the concentration of particulate matter less than 2.5 microns in diameter ($PM_{2.5}$); and

Air quality monitors required by EPL 563:

- Two E-SAMPLER early warning dust monitors continuously measuring PM_{10}, namely EPA Point 9 and EPA Point 10 at the north and south-east of the EPL premises respectively.

6.4.2 Environmental Performance

Depositional Dust Monitoring

Depositional dust monitoring results are summarised in **Table 20**. Monitoring results are available on the Bulga Coal website.

Table 20 Summary of Dust Deposition Monitoring Results – 2018 Annual Average

Offsite Gauge		IM Deposited ($g/m^2/mth$)	Ash Residue ($g/m^2/mth$)	Adopted Consent Criteria ($g/m^2/mth$)
Code	General Location			
A3	Inlet Road	2.1	1.3	4.0
C5	Mount Eyre Vineyard	1.2	0.8	
D6	Howe Street	1.3	0.9	
D9	Inlet Road	1.8	1.3	
D10	Putty Road	1.5	1.0	
F3	Fordwich	1.7	1.1	
N5	Putty Road	2.0	1.3	

Offsite Gauge		IM Deposited	Ash Residue	Adopted Consent
Redibar	Redibar	0.9	0.5	
Sharrock 1	Sharrock	1.1	0.7	
Hedley	Mitchell Line Road	1.4	0.9	

There were no exceedances of the depositional dust criteria. There were two elevated results recorded at D6 that were contaminated. The elevated results were excluded from the annual averages.

In November 2018, Bulga Coal received a Show Cause Notice from the EPA with regard to excessive dust emissions. The non-compliance is discussed in detail in **Section 11.2**.

In response, Bulga Coal has modified mining operations to manage dust generation, for example:

- shutting down elevated overburden dumps and operating sheltered dumps;
- stopping the dragline handling overburden; and
- stopping excavators and trucks loading and hauling.

The Show Cause Notice has been communicated with the workforce and emphasised that:

- how Bulga Coal operates every piece of equipment counts;
- if Bulga Coal is generating excessive dust, modifications or ceasing activities must occur to prevent generation of dust; and
- if operators are unsure they must talk to their Supervisors.

High Volume Air Sampling

Table 21 presents a summary of HVAS monitoring results and compares annual averages for PM_{10} and TSP against consent criteria. Results include dust from mine (including neighbouring operations) and non-mine sources and are not attributable to Bulga Coal only.

Table 21 Summary of High Volume Air Sampling Results – 2018 Annual Average

Gauge	Annual Average (µg/m^3)	
	PM_{10} (µg/m^3)	TSP (µg/m^3)
Consent Criteria	**30**	**90**
Dawtrey	18.3	42.9
D10	18.0	48.6
Hill Street	-[1]	32.1

1 – PM_{10} not monitored at Hill Street

Table 21 shows that the average annual PM_{10} and TSP levels were low and that there were no exceedances of the annual average criteria at any of the HVAS monitors.

A summary of the maximum 24 hour PM_{10} averages recorded at the HVAS units is presented in **Table 22**. The number of days that exceeded the consent criterion is also shown.

Table 22 Summary of High Volume Air Sampling Results – 2018 Maximum 24 Hour Average and Number of Exceedance

Gauge	Maximum 24 hour average PM_{10} ($\mu g/m^3$)	
	PM_{10} ($\mu g/m^3$)	Number of days exceeding criterion
Consent Criteria	**50**	-
Dawtrey	54	1
D10	52	1

As presented in **Table 22**, the maximum 24 hour average PM_{10} criteria of 50 $\mu g/m^3$ was exceeded at both HVAS units on 21 November 2018. A state-wide dust storm event in late November 2018 was responsible for the peak 24-hour average PM_{10} levels recorded at the HVAS monitors.

Continuous Monitoring

A summary of continuous PM_{10} and $PM_{2.5}$ monitoring results at the TEOM and BAM Monitors is presented in **Table 23**. Results include particulates from mining (including neighbouring operations) and non-mining sources, and are therefore not attributable to Bulga Coal only.

Table 23 Summary of TEOM and BA Monitoring Results – 2018 Annual Average

Gauge	Type	Annual Average ($\mu g/m^3$)	
		PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
Consent Criteria or Standard		**30**	**8**[1]
Hill Street (D1)	TEOM	15.1	-
Putty Road (D3)		19.6	-
Dawtrey (D5)		18.5	-
Mitchell Line Road (D11)		22.3	-
Hill Street (D2)	BAM	-	5.3
Putty Road (D10)		-	6.4

1 – National Environment Protection (Ambient Air Quality) Measure Standard

Table 23 shows there were no exceedances of the annual average PM_{10} criteria. During 2018, measured annual average $PM_{2.5}$ levels were also below the National Environment Protection (Ambient Air Quality) Measure Standard of 8 $\mu g/m^3$.

A summary of the maximum 24 hour average PM_{10} monitoring results at the TEOMs is presented in **Table 24**. The number of days that exceeded the consent criterion is also shown.

Table 24 Summary of TEOM PM_{10} Results – 2018 Maximum 24 Hour Average and Number of Exceedances

Gauge	Maximum 24 hour average PM_{10} ($\mu g/m^3$)	
	PM_{10} ($\mu g/m^3$)	Number of days exceeding criterion
Consent Criteria	**50**	-
Hill Street (D1)	138.6	5
Putty Road (D3)	166.4	7
Dawtrey (Cobcroft Road) (D5)	160.3	7

Gauge	Maximum 24 hour average PM_{10} ($\mu g/m^3$)	
Mitchell Line Road (D11)	159.6	15

As presented in **Table 24**, all TEOM PM_{10} monitors recorded multiple days with elevated 24-hour average PM_{10} levels above the criterion of 50 $\mu g/m^3$. Several exceptional events including bushfires and dust storms occurred in February, March, April and November 2018 which contributed to the high number of 24-hour average PM_{10} exceedances in 2018. The state-wide dust storm event in late November 2018 was responsible for the peak 24-hour average PM_{10} levels recorded at all the TEOM monitors.

Investigations were undertaken following every measured exceedance of the 24 hour average PM_{10} criterion of 50 $\mu g/m^3$. Bulga would not have made a significant contribution to the levels recorded on any of the days with elevated levels.

Onsite EPL Monitors

In accordance with the requirements of EPL 563, Bulga Coal operates two continuous air quality (PM_{10}) and weather monitoring units (E-SAMPLER) close to the EPL premises boundary. The data are analysed with wind speed and wind direction data to calculate the Bulga Coal PM_{10} contribution at each location. The monitors are not used to assess compliance with the air quality criteria in the Development Consent; they inform the Bulga Open Cut Air Quality TARP. Alarms are generated in the control room when elevated PM_{10} levels occur due to mining activities. Actions to minimise dust are taken in response to alarms, where required.

Figure 8 and **Figure 9** present the pollution roses for the EPA Point 9 and EPA Point 10 PM_{10} E-SAMPLER monitors respectively. The figures show that EPA Point 9 and EPA Point 10 measured low PM_{10} levels most of the time. Both figures show that high levels occur in the north-west quadrant under high wind speeds regardless of the monitor position relative to Bulga Coal and likely arise from regional events or other unknown sources.

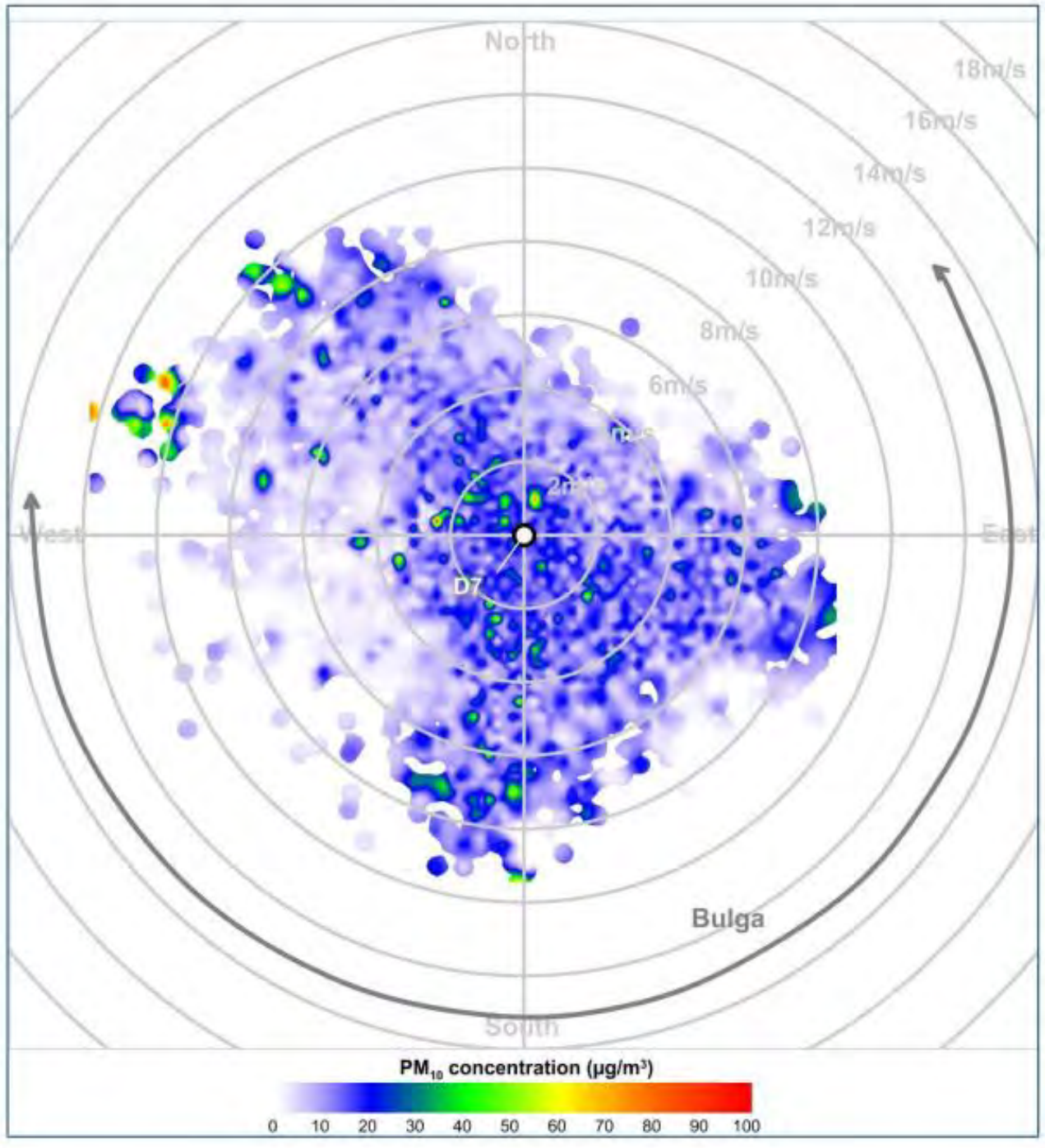


Figure 8 2018 Pollution rose[1] for EPA Point 9 (D7 in Todoroski Air Sciences (2019)) E-SAMPLER PM_{10} data

[1] How to read a pollution rose:

- The colour indicates the pollutant concentration measured at the monitor.
- The position of pollutant concentration markings along the 360° axis indicates the corresponding direction from which pollutants arise from.
- The position of pollutant concentration markings relative to the banded rings indicates the wind speed for the corresponding hourly concentration.
- The arc labelled "Bulga" indicates the relative direction of Bulga Complex from the monitor.

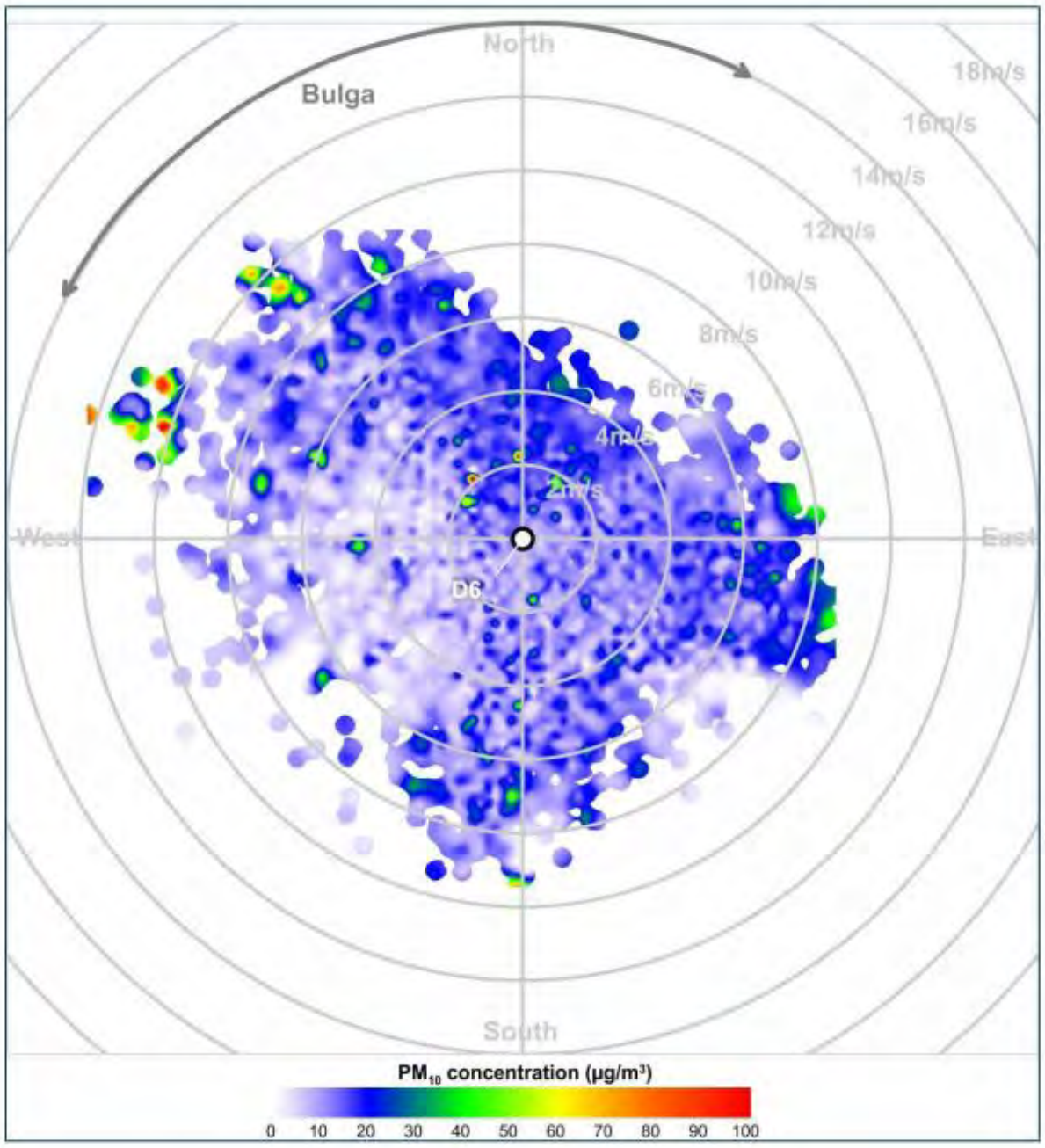


Figure 9 2018 Pollution rose[2] for EPA Point 10 (D6 in Todoroski Air Sciences (2019)) E-SAMPLER PM_{10} data

[2] How to read a pollution rose:

- The colour indicates the pollutant concentration measured at the monitor.
- The position of pollutant concentration markings along the 360° axis indicates the corresponding direction from which pollutants arise from.
- The position of pollutant concentration markings relative to the banded rings indicates the wind speed for the corresponding hourly concentration.
- The arc labelled "Bulga" indicates the relative direction of Bulga Complex from the monitor.

Mushroom Composting Facility

Figure 10 presents the PM_{10} 13 hour average measured at the Mushroom Composting Facility (D4 TEOM monitor) against the 13 hour average Assessment Level of 91 µg/m^3. The Assessment Level only applies during the approved operating hours of the Mushroom Composting Facility. These are between 6:00 am and 7:00 pm Monday to Friday, and any additional operating hours of the Mushroom Composting Facility, provided that:

- such operating hours do not exceed 6:00 am to 12:00 pm on weekends; and
- the Mushroom Composting Facility has given Bulga Coal at least one month advance notice of the intention to operate during those additional operating hours.

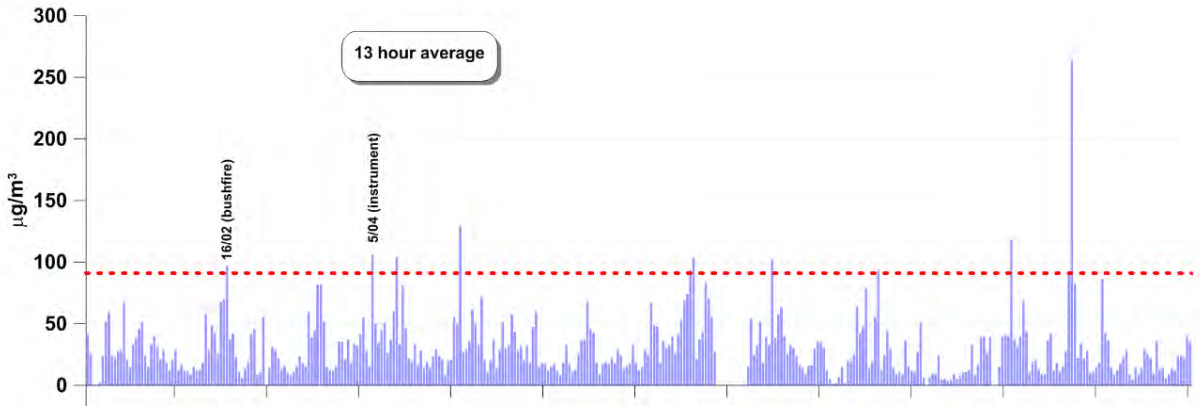


Figure 10 Mushroom Composting Facility (D4) Sampling Results 2018 – 13 hour PM_{10} Averages

As shown in **Figure 10**, there were 9 occasions where levels exceeded the assessment level of 91 µg/m^3 and triggered the EEAAQMF TARP. It is noted that the exceedances were not specifically attributable to Bulga Coal as described in **Section 11**.

6.4.3 Comparison against Predictions

A comparison of 2018 dust monitoring data with the modelled predictions made in the *Bulga Open Cut Eastern Emplacement Area Modification Air Quality Impact Assessment* (Year 3) (Jacobs, 2016) was undertaken by Todoroski Air Sciences (2019). The assessment identified that there was generally a good agreement between modelling predictions and measured results. A copy of the full report is provided as **Appendix C**.

6.4.4 Long Term Analysis

An assessment of long-term trends over the life of Bulga Coal operations was undertaken by Todoroski Air Sciences (2019) with the findings summarised as:

- levels are generally low and below the relevant criteria for all monitoring sites and pollutants with the exception of short term $PM_{2.5}$ and PM_{10} on occasion;
- data from the $PM_{2.5}$ and PM_{10} monitors indicate a general trend where higher levels occur during periods of higher temperatures and lower rainfall;
- data from the D3, D5 and D11 TEOM PM_{10} monitors showed that 2018 had the highest annual average PM_{10} since monitoring began. This can be attributed to the numerous exceptional events which occurred during 2018 including bushfires and the November dust storm;

- no exceedances of the annual average $PM_{2.5,}$ PM_{10} or TSP criteria have been recorded at the HVAS or TEOM monitors since the installation of the first monitors in 2005 and 2012, respectively; and
- depositional dust levels are relatively similar over time. No exceedances of the annual average deposited dust criteria have been recorded since 2007.

6.4.5 Implemented / Proposed Improvements

Air quality management training was provided to the entire workforce in February 2019. The training focused on:

- identifying receivers offsite;
- managing dust in line with visual triggers; and
- managing visible dust appropriately in adverse weather conditions or periods of poor air quality as per the sites Air Quality Management Trigger Action Response Procedure.

6.5 Mine Subsidence

6.5.1 Environmental Management

Mining of Blakefield South Longwall 1B commenced on 9 February 2018 and was completed on 3 May 2018. Mining of Blakefield South Longwall 1B completed the remaining 780 m of Blakefield South Longwall 1, leaving a 615 m long coal block to the previously extracted Blakefield South Longwall 1A. Longwall 1B was the final longwall panel mined for the Blakefield South Mine.

Surface safety monitoring above Blakefield South Longwall 1B was conducted on Bulga Coal land in accordance with the approved *Blakefield South Longwall 1B and Longwall 9 Subsidence Surface Safety Monitoring Program*. These documents are available on the Bulga Coal website.

Figure 2 shows the areas subject to secondary extraction at Bulga Underground Operations in 2018.

Surface subsidence cracking is mapped with a hand-held GPS device and characteristics of the cracking recorded in the Bulga Coal Geographic Information System (GIS). Where damage is significant enough to warrant repairs, information on the repair method is also stored in the GIS.

6.5.2 Environmental Performance

6.5.2.1 Monitoring Results

The observed impacts caused by subsidence from Blakefield South Longwall 1B are summarised in **Table 25**.

Table 25 Observed Subsidence Impacts from Blakefield South Longwall 1B

Feature	Impact Performance Measures	Observed Impacts
Built Feature		
Bulga Coal Dam S7	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts reported due to the extraction of Blakefield South Longwall 1B.

Feature	Impact Performance Measures	Observed Impacts
Bulga Coal owned pipelines	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts reported due to the extraction of Blakefield South Longwall 1B.
Bulga Coal owned access road	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts reported due to the extraction of Blakefield South Longwall 1B.
Telstra fibre optic	Serviceability should be maintained wherever practicable.	No adverse impacts reported due to the extraction of Blakefield South Longwall 1B.
Bulga Coal owned power lines	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts reported due to the extraction of Blakefield South Longwall 1B.
Bulga Coal owned fences	Serviceability And security should be maintained wherever practicable.	No adverse impacts reported due to the extraction of Blakefield South Longwall 1B.

6.5.2.2 Surface Impacts

As shown in **Table 26**, there were no adverse impacts to Bulga Coal services as a result of the extraction of Blakefield South Longwall 1B.

Repairs to surface subsidence cracking identified during monitoring activities for previously mined areas continued to be undertaken during the reporting period. Repairs were undertaken in accordance with the relevant SMPs and the Bulga Underground Operations *Subsidence Mapping and Repair Procedure*.

6.5.3 Comparison against Predictions

6.5.3.1 Blakefield South Longwall 1B

Table 26 compares the maximum results of subsidence against predictions for Blakefield South Longwall 1B. Mine Subsidence Engineering Consultants (MSEC) evaluated the observed subsidence and provided an assessment of the predictions and adequacy of the management strategies in place. As shown in **Table 28**, the maximum measured vertical subsidence, tilt and strains along the LW1B_BUOAR Line following the completion of mining in Blakefield South Longwall 1B were less than predicted.

Table 26 Comparison between the Maximum Observed and Maximum Predicted Total Subsidence Parameters for the Monitoring Lines due to the Extraction of Blakefield South Longwall 1B

Monitoring Line	Type	Maximum Vertical Subsidence (mm)	Maximum Tilt (mm/m)	Maximum Tensile Strain (mm/m)	Maximum Compressive Strain (mm/m)
LW1B_BUOAR Line	Measured	725	18	3	4
	Predicted	880	28	16	12

6.5.4 Proposed / Implemented Improvements

As noted above, Bulga Underground Operations have continued to progressively complete repairs to surface subsidence cracking identified from monitoring activities. Monitoring of previously mined areas will continue in 2019, with any required mitigation works to be completed in accordance with the Bulga Underground Operations *Subsidence Mapping and Repair Procedure*.

6.6 Flora and Fauna (Remnant Vegetation)

Bulga Coal conducts ecological monitoring of the:

- remnant vegetation around the mine site (**Section 6.6**);
- offset areas (**Section 6.7**); and
- mine rehabilitation (**Section 8.6**).

6.6.1 Environmental Management

Flora and fauna monitoring is conducted around the mining operations in accordance with the *Bulga Coal Biodiversity Management Plan*. The location of ecological monitoring sites is shown in **Figure 11**. The ecological monitoring of mine rehabilitation is covered in **Section 8.6**.

6.6.1.1 Annual Ecological Monitoring Program - Flora

The annual ecological monitoring program for flora was undertaken by Emergent Ecological (2018) with a summary of the results presented in **Section 6.6.2**. The full report is available on the Bulga Coal website.

The primary objective of the monitoring program is to assess the health and condition of remnant vegetation at Bulga Coal. The Biodiversity Assessment Methodology (BAM) was adopted during 2018 to be consistent with Office of Environment and Heritage (OEH) requirements and to match the methodology used at rehabilitation sites. BAM involves assessing vegetation condition based on the compositional, structural and functional attributes of a site (OEH 2018). This generates a score referenced against the target Plant Community Types (PCT) for each attribute. An Integrity score is generated which indicates the difference between the attribute scores at a site and those of the target PCT. A score of 100 for Integrity indicates that a site has achieved the benchmark conditions determined for the target PCT. A score of 50 indicates a site provides 50 percent of the benchmark attributes determined for the target PCT.

6.6.1.2 Annual Ecological Monitoring Program - Fauna

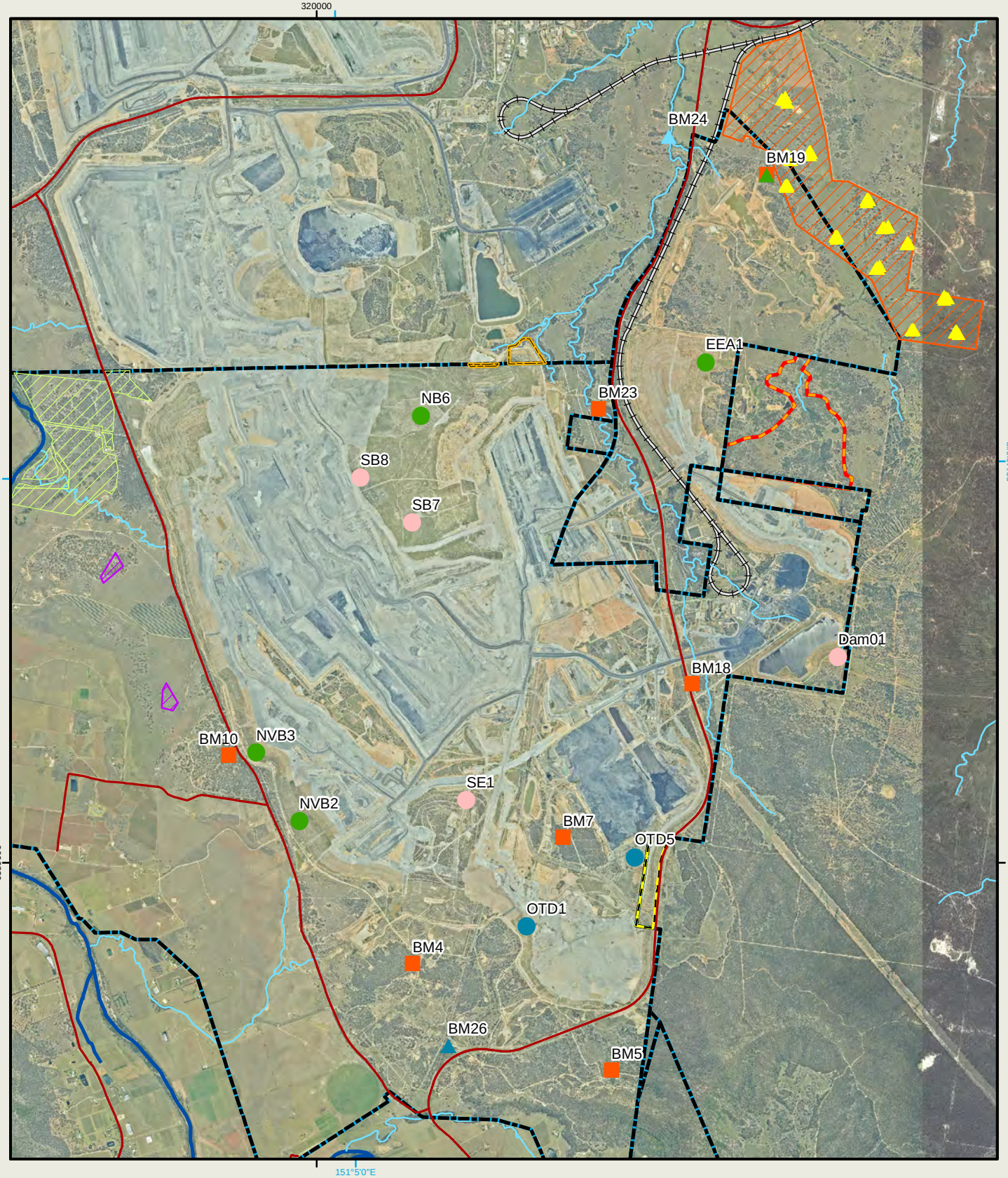
Ecological monitoring for fauna was completed by RPS (2018) and results provided in the *2018 Annual Ecological Monitoring Report*, available on the Bulga Coal website. A summary of results is provided in **Section 6.6.2**. The methodology includes targeted surveys for birds, bats, reptiles and amphibians, owl call-playback, fauna spotlighting and opportunistic fauna surveying.

The program is designed to check if there have been any impacts on the surrounding terrestrial and aquatic habitats (outside of approved disturbance areas) as a result of mining operations and to monitor the strength of rehabilitation areas.

6.6.1.3 Nest Box Installation

During 2018, 120 nest boxes were installed in remnant vegetation within the Broke Road Biodiversity Offset Area (BOA). These were installed upon a recommendation to increase the habitat availability within the BOA. The nest boxes were placed in clusters of 10 to 12, with each group providing habitat for a range of different species. The locations of the next box clusters installed in 2018 are shown on **Figure 11**. The total number of nest boxes installed is now 665.

FIGURE 11 - ECOLOGICAL AND REHABILITATION MONITORING 2018



Public Road
Railway
Wollombi Brook
Minor Watercourse
Mining Lease
Sublease
Mining Lease Application
Mining Lease AMA

CHGBI Reference Site
CHSGGBI Reference Site
Riparian Reference Site
Pasture Reference Site
CHGBI Rehabilitation Site
CHSGGBI Rehabilitation Site
Woodland Rehabilitation Site
Ecological

2018 Nest Box Cluster
Broke Road Conservation Offset Area
Weeping Myall Management Area
Wollombi Brook Conservation Area

0 0.425 0.85 1.7
Kilometres

Coordinate System
GDA 1994 MGA Zone 56
1:55,000 @ A4

GLENCORE

N

DISCLAIMER
Subject To Survey.
Glencore makes every effort to ensure the quality of the information available on this map. Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

DATA SOURCE
© NSW Department of Finance, Services & Innovation 2017
© NSW DTIRIS (Minerals & Petroleum) 2017
© Glencore 2019 © ESRI 2017

Ref: I:\AUST\DSRVC\SSOB\BUGIS\Mapping\Reporting\EMR\2018\2018_EMR_FIGURE11_BCC_ECOLOGICAL_REHABILITATION_MONITORING.mxd

6.6.2 Environmental Performance

6.6.2.1 Flora Monitoring

Monitoring was conducted at six sites in 2018 located within the following vegetation communities:

- Central Hunter Grey Box – Ironbark Woodland Endangered Ecological Community (EEC) (three sites);
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC (one site);
- Paperbark Swamp Forest (one site);
- Bulloak Regeneration (one site); and
- Swamp Oak Forest (one site).

Composition, Structure and Function scores were generated for each site and compared to the relevant benchmark using the OEH Vegetation Information System (VIS). Generally all sites displayed reduced scores when compared to the benchmark. This is to be expected given the land use history of the area and previous clearing for agricultural purposes. Sites BM4 and BM10 (both Central Hunter Grey Box – Ironbark Woodland) scored the highest Integrity scores with 69.1 and 64.3. BM24 (Swamp Oak Forest) recorded the lowest Integrity score of 49.4.

Despite the low scores when compared to OEH benchmarks, monitoring indicated the mining activities at Bulga Coal are not having a detrimental impact on the surrounding vegetation. This is evidenced by the low Integrity score of analogue monitoring sites up to 1,800 metres from the operation (such as BM19) compared to the high Integrity score of monitoring sites closer to the operation (such as BM4 and BM10).

Feral animal presence and exotic weed cover were low at all sites. Weed cover percentage was highest a BM23 with approximately 11 % cover. All other sites recorded a weed cover percentage of 5 % or less. Where pest animal species were recorded, there was no evidence that they were detrimental to the integrity of the sites.

6.6.2.2 Fauna Monitoring

Diurnal bird surveys were performed at selected sites during winter and spring of 2018. The surveys recorded 68 different bird species, an increase of five unique species from the previous year. Despite this increase, numbers are still significantly lower than pre-2017, which is likely due to the severe dry period experienced in the region during the spring and summer.

A total of nine microbat species were detected during the 2018 surveys, two less than in 2017. Two of the species recorded in 2018 were listed as threatened under the *Biodiversity Conservation Act 2016*; the Eastern Bent-winged Bat (*Miniopterus orianae oceanensis)* and the Large-eared Pied Bat *(Chalinolobus dwyeri*). The Large-eared Pied Bat is also listed as vulnerable under the EPBC Act.

There were no new threatened species identified during the 2018 surveys.

6.6.3 Implemented / Proposed Improvements

Current management practices utilised on site were reported as appropriate for the conservation of the identified fauna species. Recommendations made in regards to control of Noisy Miner (*Manorina melanocephala*) included re-establishment of shrub layers within some remnant vegetation areas and continued establishment of wildlife corridors.

Recommendations from monitoring reports have been incorporated, where appropriate, into the Environment and Community operating budgets for 2019. These recommendations focus on land management practices to improve the health of vegetation and quality of habitat in surrounding vegetation. Other recommendations include ongoing weed management (particularly focussing on *Lantana camara* and *Juncus acutus*), pest animal management and re-using salvaged habitat resources in remnant vegetation areas.

6.7 Biodiversity Offsets

Schedule 3, Condition 29 of SSD-4960 requires Bulga Coal to establish and maintain four Biodiversity Offset Areas (BOAs). Condition 9 of EPBC 2012/6637 requires an annual report including implementation of the associated management plans (see **Sections 6.7.1** to **6.7.5**) and detailing compliance with the conditions of the approval (see **Appendix A**). The BOAs are:

- Reedy Valley BOA (1,486 ha);
- Broke Road BOA (241 ha);
- Wollombi Brook Conservation Area (WBCA) including 62 ha of BOA and 51 ha of Aboriginal heritage conservation area; and
- Condran BOA (50 ha).

The Broke Road and Wollombi Brook BOAs are shown in **Figure 11**, and are located in the north-eastern and north-western corners of Bulga Coal, respectively. The Reedy Valley and Condran BOAs are located further from Bulga Coal and are approximately 30 km north-west and 10 km south-east of Muswellbrook, respectively.

During 2018, Bulga Coal continued to work with OEH on the finalisation of Voluntary Conservation Agreements for the BOAs. Final signed copies of the Conservation Agreements were returned to OEH in December 2018. It is anticipated they will be executed by OEH in early 2019.

In addition, Bulga Coal committed to establishing two Weeping Myall Management Areas in the Bulga Optimisation Project EIS. These were established in 2015 and are shown on **Figure 11**.

6.7.1 Broke Road BOA

6.7.1.1 Environmental Management

Environmental management activities undertaken at the Broke Road BOA in 2018 included:

- Weed control works focussing in particular on Lantana (*Lantana camara*), Boxthorn (*Lycium ferocissimum*), African Olive (*Olea africana*), Galenia (*Galenia pubescens*) and Saffron Thistle (*Carthumnus lanatus*) in natural regeneration areas;
- Planting of approximately 45,000 tubestock, including ground preparation and follow-up watering and weed control;
- Installation of 120 nest boxes;
- Wild dog baiting during winter months (15 dogs, eight foxes and three pigs);
- Pig trapping (seven pigs caught during 2018);
- Six monthly inspections; and
- Ongoing ecological monitoring program.

6.7.1.2 Monitoring Results

Flora

Nine monitoring transects were established in 2015 at the Broke Road BOA. Transects were positioned to allow monitoring across the Central Hunter Grey Box – Ironbark Woodland, which was identified as the dominant vegetation type in the BOA (Umwelt 2013a). Much of the Broke Road BOA comprises derived grasslands, with relatively few sizeable woodland remnants. Some mapped woodland remnants comprise stands of young Ironbark regrowth in former grassland areas. Consequently, transects were positioned to sample a range of successional stages of Central Hunter Grey Box – Ironbark Woodland, from regenerating grassland to woodland.

The spring and summer of 2018 were very dry, continuing the drought period experienced in 2017. Consequently, the 2018 monitoring for the Broke Road BOA (Bell & Murray 2019a) showed overall species diversity within Broke Road BOA continued the decreasing trend recorded in 2017. 118 plant species were recorded within the nine transects, comparable to 2017 (116) and a decrease on 2016 (144) and 2015 (142) results. The single plant of *Cymbidium canaliculatum* (an endangered population in the Hunter) remains in the Narrow-leaved Ironbark (*Eucalyptus crebra*) adjacent to transect BRO04.

45 of the identified species are weeds, predominantly herbaceous or grassy species typical of former grazing lands. Potentially problematic woody weed species identified include:

- Lantana (*Lantana camara*);
- Saffron Thistle (*Carthamnus lanatus*); and
- African Boxthorn (*Lycium ferocissimum*).

Targeted spraying of Lantana and African Boxthorn has been ongoing, but continual monitoring is required as both remain in the area. Slashing of Saffron Thistle has been completed over large parts of the offset but also requires ongoing control until newly planted canopy species can shade the species out.

Additionally, three monitoring plots were established in areas with new tubestock planting to monitor the progress of the revegetation works. Survivorship in these plantings varied considerably across each site, from 14 % to 90 %. Inspection of dead individuals suggest that most died of water stress during the recent drought.

Fauna

Bird census surveys were conducted at nine sites over three monitoring periods, two in winter and one in spring. The diurnal bird census recorded 43 bird species in 2018, compared to 26 in 2017, 37 in 2016 and 38 in 2015.

Several new bird species were recorded in 2018 including Barn Owl, White-throated Needletail and Plumed Whistling Duck. The Grey-crowned Babbler was the only threatened bird species recorded in 2018.

Infra-red motion detection (or field game) cameras were installed to monitor for presence of larger mammals. In 2018, larger mammals recorded include the Eastern Grey Kangaroo, Red-necked Wallaby and Fox. Smaller terrestrial mammals recorded by camera include Short-beaked Echidna, Common Brushtail Possum and Brown Hare. European Rabbits were also observed during standard operations.

Thirteen microchiropteran bat species were recorded in 2018 by echolocation call recordings. A total of 1,278 calls of microchiropteran bats were identified from recordings, a significant increase from only 59 calls recorded in 2017. Of the 13 species recorded, five species are threatened, the East-coast Freetail-bat, Eastern Bent-wing Bat, Little Bent-wing Bat, Large-eared Pied Bat and Eastern Cave Bat. All five of these threatened species had previously been recorded within the Broke Road BOA.

Two reptile species were recorded in 2018, the Bearded Dragon and Lace Monitor. No frogs or larger snakes were recorded in 2018.

6.7.1.3 Implemented / Proposed Improvements

Weed Control

Spraying of high threat weed species will continue whenever individual plants or groups of plants are encountered. At present, Lantana does not appear to be expanding significantly, and continued monitoring will be undertaken to determine when targeted control may be required. Similarly, stands of Saffron Thistle will be continue to monitored and controlled through slashing as required.

Pest Management

Surveys and control activities undertaken in 2018 indicate that feral pig numbers have declined. Feral pigs that do occur at the Broke Road BOA are part of the wider surrounding landscape and will require a co-operative approach with input from several stakeholders to manage effectively.

6.7.2 Condran BOA

6.7.2.1 Environmental Management

Activities undertaken at the Condran BOA in 2018 included:

- Minor repairs to boundary fences;
- Weed controls works, focusing on:
    - Coolatai Grass (*Hyparrhenia hirta*); and
    - Spiny Rush (*Juncus acutus ssp. acutus*);
- Planting of approximately 5,500 tubestock, including ground preparation and follow-up watering and weed control;
- Six monthly inspections; and
- Continuation of the ecological monitoring program established in 2013.

6.7.2.2 Monitoring Results

Flora

The 2018 monitoring represented the sixth consecutive monitoring period for the Condran BOA (Bell & Murray 2019b). Six monitoring transects (3 transect-pairs) were established in 2013, within Central Hunter Ironbark – Spotted Gum – Grey Box Forest and River-flat Eucalypt Forest EECs, and associated grasslands.

Overall species diversity within Condran BOA has been low for the last two years due to the dry spring and summer seasons. 120 plant species were recorded within the six transects at the Condran BOA during 2018 surveys. This was an increase from 101 in 2017, but a decrease from all previous years (a maximum of 146 taxa recorded in 2016).

34 of the identified species were weeds, and this suite of taxa has been impacted by the lack of rain. Continuing control of Coolatai Grass (*Hyparrhina hirta*) has prevented excessive spread of this species, but follow up spraying will be required in ongoing years as small outbreaks remain. Two individuals of emerging weeds (*Grevillea robusta* and *Morus alba*) were identified which should be removed to prevent potential further spread.

Two new transects were established within the 2018 revegetation areas to monitor the progress of the revegetation works. Survivorship in these plants was generally good, with 85 % and 88 % survival recorded.

Monitoring of the threatened Pine Donkey Orchid (*Diuris tricolor*) population at Condran BOA in October 2018 showed only six individuals present. Although lower than most previous years (2017 recorded no individuals), this is not unexpected and has also been recorded in other parts of the Hunter Valley. Much of the walked grassland examined during the 2018 orchid survey also failed to yield many of the more common orchid species, and parallels the *Diuris* result. Fruiting was observed within the Condran population of *Diuris* in 2018, confirming the presence of a pollinating population of insects.

Fauna

27 bird species were recorded by diurnal census in 2018 which compares with 34 species in 2017. One threatened bird species was recorded in 2018, the Varied Sitella, which has previously been recorded nesting at Condran BOA. No new bird species were recorded in 2018.

Four large macropod species were recorded by opportunistic observations and camera photographs in 2018; the Eastern Grey Kangaroo, Red-necked Wallaby, Swamp Wallaby and Common Wallaroo. Other mammals recorded include Dingo / wild dog, Short-beaked Echidna and Common Wombat.

No arboreal mammals were detected by spotlight searches in 2018. Previously, the Common Brushtail Possum has been detected, and several additional arboreal mammals have been observed in adjoining offsets.

Echolocation calls were recorded at two fauna monitoring sites (ConFA1 and ConFA2) in 2018. Ten bat species were recorded, with a total of 243 call sequences suitable for identification. The most commonly recorded species were the Little Forest Bat (83 calls), Chocolate Wattled Bat (76 calls) and Gould's Wattled Bat (50 calls). Two threatened microbat species were recorded in 2018, the East-coast Freetail-bat and the Eastern Bentwing-bat.

6.7.2.3 Implemented / Proposed Improvements

Weeds

Bulga Coal will continue targeted control of Coolatai Grass, particularly in the area around transect CON03 and near the farm shed at the top of the property. Ample effort has already been spent on eradicating this species from the BOA, but given its presence in neighbouring lands, it will require follow-up control. Whisky Grass was observed to be dying back in some parts of the BOA as a result of targeted control.

Pest Animals

Based on monitoring of the Condran BOA by field cameras, the presence of introduced pest animals is considered low. Pest species that do occur at the Condran BOA are part of the wider surrounding landscape and will require a co-operative approach with input from several stakeholders to manage effectively. It is not considered that the pest species present are adversely affecting the quality of the existing or regenerating vegetation or fauna population at the Condran BOA at present.

6.7.3 Reedy Valley BOA

6.7.3.1 Environmental Management

The activities undertaken at the Reedy Valley BOA in 2018 included:

- Weed control works in natural regeneration areas, focussing on:
    - Prickly Pear (*Cylindropuntia spp*);
    - Paterson Curse (*Echium plantagineum*);
    - African Boxthorn (*Lycium ferocissimum*);
    - Sweet Briar (*Rose rubiginosa*); and
    - Saffron Thistle (*Carthamnus lanatus*);
- Feral animal control including wild dog baiting, pig trapping and shooting, and deer and goat shooting;
- Ground preparation for tubestock planting, although this was postponed until 2019 due to the severe drought conditions;
- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.3.2 Monitoring Results

Flora

Plant growth and health was once again poor during the 2018 monitoring period due to ongoing drought conditions (Bell & Murray, 2018c). Survey of transects revealed the presence of only 118 species, comprising 74 natives and 44 weeds. This is comparable to 2017 (122) but a reduction from that recorded in 2015 (174 species, 33 % weeds). This is to be expected given the drought conditions and grazing pressure by native mammals.

Weed species showed a generally increasing trend across most transects, however this is also likely to be due to the drought conditions and grazing pressures. Of the weed species recorded Saffron Thistle (*Carthamnus lanatus*) and Nodding Thistle (*Carduus nutans*) are the most problematic and will require ongoing management and monitoring.

Two new transects were proposed in revegetation areas however these were not monitored due to the planting works being postponed until 2019.

Fauna

Bird census surveys were conducted at 12 sites in 2018, with a total of 93 bird species being detected. The Reedy Valley BOA supports the most diverse assemblage of bird species of the Bulga Coal biodiversity offsets due to its size and variety of vegetation communities and fauna habitats.

Comparison of bird species diversity scores across all monitoring sites at Reedy Valley reveal the remnant vegetation sites score the highest average diversity. Whilst several of the derived native grassland sites also score comparable diversity values, some sites will require extensive regeneration to improve habitat value for birds. Four threatened bird species were recorded at Reedy Valley BOA in 2018. These were:

- Speckled Warbler;
- Varied Sittella;
- Grey-crowned Babbler;
- Diamond Firetail.

12 microchiropteran bat species were recorded at Reedy Valley BOA in 2018. A total of 2,757 echolocation calls were identified which is significantly higher for most sites. Despite the dry conditions, night time temperatures were relatively warm in October and December which may have influenced microbat activity. Three threatened microbats were recorded, the Large-eared Pied Bat, Eastern Bentwing-bat and Eastern Cave Bat.

The use of infra-red motion detection (or field) cameras detected a number of native and introduced species. Cattle were recorded throughout the Reedy Valley BOA. The Fox was recorded at several sites, although abundance appears low. Pigs and goats were seldom observed or recorded, and no evidence of deer or other large herbivores recorded in 2018.

One arboreal mammal species was detected during spotlight searches in 2018, the Common Brushtail Possum.

6.7.3.3 Implemented / Proposed Improvements

Pest Management

Management of pest species is a significant issue for the Reedy Valley BOA. Whilst new fencing has been installed along the boundary of the offset areas, there is still evidence of cattle and sheep in parts of the offsets. Ongoing monitoring will determine if cattle persist within the offset. Other pest species, including feral pigs, deer, fox, goat and feral cat occur in the elevated and riparian parts of the offset. Management of some of these pests, particularly in the rocky outcrop parts of the site, will be difficult due to difficulty of terrain and abundance of source populations in adjoining properties.

Weed Management

Despite the presence of a relatively high number of exotic weeds at Reedy Valley, there are few highly invasive species that require ongoing monitoring and management. Thistles (*Cathamnus, Carduus, Cirsium*) are the most important of these, but were uncommon during 2018 due to the dry conditions. Continual management of these species will be required into the future, including regular assessment of their growth during wetter years and slashing as required.

6.7.4 Wollombi Brook Conservation Area

6.7.4.1 Environmental Management

The activities undertaken at the Wollombi Brook Conservation Area in 2018 included:

- Weed control works focussing on:
    - Prickly Pear (*Cylindropuntia spp*);
    - Tiger Pear (*Opuntia aurantiaca*);
    - African Boxthorn (*Lycium ferocissimum*); and
    - Green Cestrum (*Cestrum parquai*);
- Upgrades to existing access tracks to improve access and reduce erosion;
- Monitoring of trial plots to establish the effectiveness of thinning of Bulloak (*Allocasuaina luehmannii*) and tea-tree (*Leptospermum polyanthum*) species;
- Wild dog baiting and pig trapping;
- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.4.2 Monitoring Results

Flora

Six monitoring transects were established in 2015 at the Wollombi Brook Conservation Area. Two monitoring transects have been established in Central Hunter Grey Box – Ironbark Woodland and associated grassland, and four in Warkworth Sands Woodland EEC and associated grassland. Warkworth Sands Woodland transects include different successional stages of this EEC, from open grassland on remnant sand, through mixed shrubland on sand to regenerated forest.

Overall species diversity within Wollombi Brook Conservation Area has been limited due to drought conditions (Bell & Murray, 2018d). In total, 83 plant species were recorded within the six transects, which when compared to 2017 data is a slight increase in native plant species and a mostly stable or slight decrease in weed species. In regards to the monitoring plots that have been established in the trial thinning areas, natural regeneration of the Warkworth Sands Woodland has been slow, although there is some evidence of an increase in native species within these areas.

A few weedy grasses and herbs dominate the grassland and regenerating areas of Warkworth Sands Woodland including:

- Red Natal Grass (*Melinis repens*);
- Mexican Clover (*Richardia brasiliensis, R. stellaris*); and
- Coolah Grass (*Panicum coloratum var. coloratum*).

No problematic woody weeds species were noted within the Wollombi Brook Conservation Area.

Key diagnostic understorey species for Warkworth Sands Woodland continue to flourish within Warkworth Sands Woodland grassland and shrubland monitoring transects in the absence of stock grazing pressures. These include:

- *Lomandra leucocephala subsp. Leucocephala*;
- *Perotis rara*;
- *Podolepis canescens*;
- *Brachyloma daphnoides;* and
- *Pimelea linifolia subsp. linifolia*.

Fauna

A total of 61 bird species were recorded at the Wollombi Brook Conservation Area by census survey in 2018.

In 2018, three threatened bird species were recorded:

- White-bellied Sea Eagle;
- Grey-crowned Babbler;
- Speckled Warbler; and
- Scarlet Robin.

Echolocation calls recorded the presence of 11 bat species in 2018, with a total of 188 calls suitable for identification. The most commonly recorded species was the Gould's Wattled-bat (*Chalinolobus gouldii*). Despite the survey effort and timing, microbat activity (as defined by echolocation call recordings) is very low for this offset.

Frog activity was very low in 2018 due to the extended dry period with below average rainfall.

6.7.4.3 Implemented / Proposed Improvements

Weeds

Four key invasive species (*Eragrostis curvula, Melinis repens, Opuntia humifusa* and *Panicum coloratum var. coloratum*) and several exotic herbs will require ongoing monitoring and management at the Wollombi Brook Conservation Area, as their persistence and spread may adversely affect the biodiversity value of existing and regenerating EECs.

The experimental thinning trial established in Warkworth Sands Woodland to combat the invasion of the native woody shrub *Leptospermum polyanthum* and the native small tree *Allocasuarina luehmannii* has shown only limited results after 28 months. Although encouraging, recolonization by native shrubs, grasses and herbs has been delayed within monitoring plots, and likely exacerbated by the drought. Given that at the time of thinning (mid-2016), not all individuals of these two species were removed it is recommended that follow-up thinning of these two species be undertaken both within each of the four treatment plots (BU_TH01, BU_TH02, TI_TH01, TI_TH02), and in the surrounding 5 m band from their boundaries. This will allow more light to reach the ground and encourage new recruitment of key Warkworth Sands Woodland species from surrounding areas.

Pest Management

Feral pig activity was low during visits to the Wollombi Brook Conservation Area in 2018. Monitoring of revegetation and regeneration areas will continue to identify if Feral Pigs are causing damage to habitat augmentation works within the Wollombi Brook Conservation Area and if additional management is required.

6.7.5 Weeping Myall Management Area

6.7.5.1 Environmental Management

The activities that were undertaken within the Weeping Myall Management Areas (WMMAs) during 2018 included:

- Weed control works focussing on Prickly Pear (*Cylindropuntia spp*) and African Boxthorn (*Lycium ferocissimum*);
- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.5.2 Monitoring Results

Monitoring of Weeping Myall within the two WMMAs during 2018 has revealed few changes to either *Acacia pendula* individuals or the landscapes in which they occur. Extensive coppice growth from root suckers is continuing to occur in both management areas, but there remains no evidence of successful flowering, fruiting or new recruitment. Monitoring of the rare flowering event in the first half of 2018 showed how multiple stressors (invertebrates, mistletoes, drought) appear to be acting on the population of *Acacia pendula* within WMMA#2, such that maintenance of individuals relies solely on the production of ramets.

Overall, floristic diversity and abundance within the two monitoring plots showed an increase of both native and weed species in 2018 when compared to previous years. Changes in diversity and abundance are a normal feature of grassy woodland environments, as variability in the timing and amount of rainfall influences species presence. The prolonged dry conditions experienced in the Hunter Valley over the past two years are clearly reflected in the number of species present within the WMMAs. Rainfall data from Bulga Coal shows the limited amount of rain received throughout most of 2018, with only the month of October receiving above average falls, and with a similar situation occurring during 2017.

With the 2018 monitoring program, a new experiment has been established and baseline data tabulated from 12 plots (six treatment, six control) within WMMA#1. These plots aim to quantify how emerging and expanding thickets of *Acacia pendula* ramets may be impacting upon co-occurring species within grassland and woodland environments, and will be monitored on an annual basis.

6.7.5.3 Implemented / Proposed Improvements

Flowering

It is proposed to continue to informally monitor for flowering on the *Acacia pendula* trees, in the event another flowering event occurs.

Weeds

Bulga Coal will undertake spot eradication of African Olive (*Olea africana*) where it occurs within the Weeping Myall Management Area. More formal monitoring of the mistletoe plants on mature Weeping Myall plants should occur, and selectively remove individuals where limb mortality is likely. This may initially entail annual counts of mistletoe individuals on selected Weeping Myall trees to assess their rate of spread.

Monitoring

Bulga Coal will continue to monitor the small quadrats (approximately 5 m by 5 m) added in 2018 to investigate observed floristic differences occurring beneath dense suckering regrowth of Weeping Myall, which may potentially have negative long term impacts on the Central Hunter Grey Box - Ironbark Woodland EEC.

6.8 Weeds and Pests

6.8.1 Environmental Management

An ongoing weed control program was carried out by licenced contractors. Quarterly buffer land and rehabilitation inspections monitor success of any previous weed control and identify areas which will require additional treatment.

A land management contractor was engaged by Bulga Coal to undertake a vertebrate pest control program in winter 2018. As part of the program, 1080 baiting was conducted targeting wild dog and fox populations within the landholdings. Feral pig trapping was also conducted throughout the year.

6.8.2 Environmental Performance

Quarterly buffer land inspections generally indicate that weed management is successful, but ongoing monitoring and treatment is required to prevent further infestations.

The 1080 baiting program was successful as shown by the number of baits taken. A total of 64 baits (approximately 28%) were taken for both wild dog and fox combined. This was almost identical when compared to 2017, where there was a 29% success rate in the number of baits taken.

Across the Bulga Coal buffer lands and biodiversity offset properties, a total of 27 pigs were caught in a targeted pig trapping program.

6.8.3 Implemented / Proposed Improvements

Weed management will focus on the recommendations from the Annual Weed Action Plan. Monitoring inspections will continue and further vertebrate pest control will be undertaken during 2019.

6.9 Archaeology and Heritage

6.9.1 Environmental Management

Bulga Coal continues to work with the Registered Aboriginal Parties (RAPs) regarding aspects of Aboriginal heritage and the implementation of the *Bulga Coal Aboriginal Cultural Heritage Management Plan* (ACHMP).

Bulga Coal manages European (historical) heritage through the implementation of the *Historic Heritage Management Plan* (HHMP).

Wollombi Brook Conservation Area

Cultural heritage in the Wollombi Brook Conservation Area is managed in accordance with the Wollombi Brook Plan of Management (Appendix K of the ACHMP).

In accordance with the *Wollombi Brook Plan of Management*, Bulga Coal is committed to the construction of an Aboriginal cultural teaching place and artefact storage facility within the Wollombi Brook Conservation Area. Bulga Coal aimed to commence construction of these facilities during 2018; however this did not occur. In 2018, the tender process for the construction was undertaken. It is anticipated that the construction contract will be finalised in Q1 2019 and Bulga Coal aims to complete construction by the end of 2019.

The construction of the Aboriginal cultural teaching place and artefact storage facility was discussed at the annual RAP meeting, attended by 23 RAPs, on 5 December 2018. The proposed building layout includes a secure artefact room, presentation room, toilets, kitchen and outdoor assembly area. There will be access to the waterhole at the Wollombi Brook, barbeque facilities, signage telling the Wonnarua story, solar power and toilets. The draft signage was presented at the meeting with positive feedback received.

6.9.2 Environmental Performance

6.9.2.1 2018 Quarterly Monitoring

A program for quarterly monitoring of Aboriginal heritage sites began in 2013 at Bulga Coal. Bulga Coal continued to monitor Aboriginal heritage sites in conjunction with (up to) four RAPs and an OzArk archaeologist in 2018. Quarterly monitoring reports are available on the Bulga Coal website and the results are summarised as follows:

- Quarter 1 monitoring was undertaken on 27 February 2018. The inspection included review of sites within the Wollombi Brook Conservation Area and the Loders Creek Grinding Grooves relocation area. Photographic monitoring of the grinding grooves area is discussed in **Section 6.9.2.3**;
- Quarter 2 monitoring was undertaken on 22 May 2018, this included a review of sites on the western portion of Bulga Coal;
- Quarter 3 monitoring was undertaken on 28 August 2018. This monitoring was focused on sites in the southern and eastern portions of Bulga Coal; and
- Quarter 4 monitoring occurred on 27 November 2018 and included a number of sites to the north and northeast of Bulga Coal.

The annual RAP meeting included a visit to the relocated Loders Creek Grinding Grooves and the Vere Grinding Grooves (in situ).

As a result of a recommendation from the quarterly monitoring program, erosion and sediment control works were undertaken at B-HED AS 1 (33-6-0032), B-HED IF 2 (33-6-0035) and B-HEDCMT (33-6-0031) on 29 November 2018. An archaeologist and RAP were present and the works included thinning Casuarinas from nearby areas and using the Casuarinas to create vegetation bunds up slope of the sites to redirect water from the sites.

6.9.2.2 2018 Salvages

During 2018, three sites were salvaged under permit at Bulga Coal. The sites were salvaged in accordance with the Aboriginal Cultural Heritage Impact Assessment for the Bulga Open Cut Eastern Emplacement Area Disturbance Boundary Modification. The salvage works as described in Section 8.1.1 of the ACHMP were conducted in accordance with SSD 4960 at sites BOP-SC3 (37-6-2847), BOP-OS2 (37-6-2836) and BOP IF-8 (37-6-3661) on 29 August 2018.

Salvage at the remaining northern portion of BOP-SC3 recovered 25 artefacts. A single artefact was recovered from BOP-OS2 and no artefacts were located at BOP IF-8. As all reasonable attempts were made to collect all visible surface artefacts from the remainder of BOP-SC3, BOP-OS2 and BOP IF-8 Aboriginal Site Impact Recording Forms have now been submitted to the Aboriginal Heritage Information Management System register to record that all sites are now considered 'destroyed'.

6.9.2.3 Loders Creek Grinding Grooves Conservation Area Photographic Monitoring

In February 2018, the four fixed photo points were photographed to monitor the condition of the Loders Creek Grinding Grooves. **Photo 1** and **Photo 2** present the 2017 and 2018 condition from Photo Point 4 for comparison. The site was originally photographed in September 2015 following the relocation. As detailed in the monitoring reports, there has been no discernible change in condition of Groups A to E between 2015 and 2018.

Photographic monitoring occurs annually and the site is monitored at least annually as part of the Quarterly Monitoring Program.

Photo 1 Loders Creek Grinding Groove Photographic Monitoring – 2017 view from Photo Point 4

Photo 2 Loders Creek Grinding Groove Photographic Monitoring – 2018 view from Photo Point 4

6.9.2.4 Historic Heritage – Blasts Assessments

Structural assessments were undertaken at Monkey Place Creek Stone Wall; Broke Cemetery; 'Charlton' Homestead; St Andrews Anglican Church and Mt Leonard Homestead to determine any blasting impacts as per the *Historic Heritage Management Plan*. The assessments are carried out annually by a structural engineer. The reports indicate there are no noticeable changes from blast impacts.

6.9.3 Incidents

Two Aboriginal heritage sites were reported as having been impacted on 6 September 2018. Bulga Coal engaged a consultant to prepare archaeological studies in April 2018 as part of a heritage assessment in support of the proposed SSD-4960 (Mod 3) application. During the survey two new sites were found, being 37-6-3880 and 37-6-3881 (**Photo 3**). The survey area included a portion of vegetation approved to be disturbed and a portion of vegetation where the approval to disturb was relinquished as part of SSD 4960 (Mod 1). The two new sites were found in an area approved for disturbance and where previously known artefacts had been salvaged in 2015.

The locations of these two artefacts were not put into the Bulga Coal GIS mapping system until copies of the site cards were received in July 2018. When Bulga Coal planned to have these sites fenced on the 5 September 2018 it became evident that a Ground Disturbance Permit over that area had been issued in June 2018. The area where the artefacts were located had been graded and covered with gravel for the area to be used as a laydown area.

On 6 September 2018, OEH and the DPE were notified of the incident and this was followed up with a detailed report on 12 September 2018.

Bulga Coal committed to revising the ACHMP to include a form that must be filled out upon the identification of a new archaeological site to prevent a reoccurrence of the incident. Bulga Coal revised the ACHMP and distributed the draft (along with notification of the incident) for RAP consultation on 20 September 2018. Bulga Coal has submitted the revised ACHMP to the DPE and OEH for review.

Photo 3 Location of identified archaeological sites (April 2018)

6.9.4 Implemented / Proposed Improvements

Following the incident described in **Section 6.9.3**, the ACHMP was revised and submitted to DPE and OEH for review on 19 October 2018. No comments have been received for DPE or OEH as yet.

Bulga Coal aims to complete construction of the Aboriginal cultural teaching place and artefact storage facility by the end of 2019.

6.10 Visual and Lighting

6.10.1 Environmental Management

Control strategies are implemented to reduce potential visual and light related impacts associated with mining operations. Management is undertaken in accordance with the *Bulga Lighting Plant Procedure* and the *Visual Impact Management Plan*.

Visual and lighting impacts are assessed through monitoring and inspection regimes. Onsite monitoring includes assessments of lighting impacts, compliance with development consent conditions and the angle at which light is emitted from lamps and luminaries, glare, spill and sky glow.

6.10.2 Environmental Performance

Potential lighting impacts are assessed as part of the overburden dump design process. Dumps are orientated and windrows or bunds are designed and constructed to mitigate lighting impacts.

A sensitive lighting receiver's map is updated and communicated to mining personnel prior to commencing exposed dumps that have the potential to cause lighting impacts offsite.

During 2017, a lighting compliance audit was undertaken to confirm compliance with SSD-4960 and relevant Australian Standards. The audit found that Bulga Coal was compliant with all requirements.

There were no changes to lighting management in 2018.

6.11 Spontaneous Combustion

6.11.1 Environmental Management

Spontaneous combustion is managed in accordance with the *Spontaneous Combustion Management Plan*. Inspections of potentially affected areas are conducted during each shift. Spontaneous combustion incidents at Bulga Coal are predominantly associated with coal stockpiles.

Monitoring at Bulga Underground Operations and CHPP includes continuous gas monitoring. This is undertaken for the purpose of identifying the presence of spontaneous combustion and any potential increase in risk. This includes monitoring of mine airway and goaf atmospheres in line with minimum standards and analysis of sample results and trends.

6.11.2 Environmental Performance

There were four incidences of spontaneous combustion that occurred:

- on the raw coal stockpile in May;
- on a haul road on the Noise and Visual Bund in May; and
- on the clean coal stockpile in August and November.

No complaints were received with regard to these events. Spontaneous combustion was managed in accordance with the *Spontaneous Combustion Management Plan*. An excavator was used to excavate and spread the hot coal out to allow it to cool until it extinguished.

6.12 Bushfire

6.12.1 Environmental Management

Bushfire management strategies and monitoring are undertaken at Bulga Coal in accordance with the *Bulga Coal Bushfire Management Plan.*

The following monitoring activities were undertaken during the reporting period:

- Monitoring of fuel loads in areas that adjoin Charlton Road and the former Broke Road, private property boundaries, tenanted properties and mine owned assets;
- Monitoring of tracks and trails within the Bulga Coal colliery holding to ensure these remain accessible by checking for fallen logs, erosion or other signs of trail degradation;
- Monitoring of weather conditions; and
- Monitoring of the requirement for hazard reduction measures to be completed, particularly for areas associated with boundaries of adjoining land holdings.

6.12.2 Environmental Performance

While several bushfires occurred in the region during 2018, no bushfires were recorded on the site.

6.12.3 Implemented / Proposed Improvements

Bulga Coal continued to maintain existing fire breaks and monitor fuel loads.

6.13 Methane Drainage, Mine Ventilation and Greenhouse Gas Emissions

6.13.1 Environmental Management

Bulga Underground Operations used both pre-mining and post-mining gas drainage to provide a safer, more productive underground mining environment. Pre-mining drainage extracts methane and carbon dioxide from the coal seams and, where practical, is piped to a 9 Megawatt (MW) gas fired power station and Pre-drainage Flaring Facility where it is burned and converted to carbon dioxide. Post-mining drainage methane and carbon dioxide is extracted from the mined out goaf behind the longwall and is sent to the Post-drainage Flaring Facility for combustion of the methane. This conversion of coal seam methane gas to carbon dioxide gas and water substantially reduces greenhouse gas emissions from the Bulga Underground Operations. Coal seam water is also extracted from these gas drainage boreholes as a necessary stage in gas removal. All coal seam water is contained within the Bulga Coal water management system.

Mine ventilation and gas drainage are undertaken solely by Bulga Underground Operations. Methane and carbon dioxide levels are measured in the gas drainage operations and mine ventilation system. The gas drainage operations have monitoring at the gas wells, flaring facilities and the 9 MW power station. The gas composition and flow rate is trended in the site's continuous monitoring system, and long-term data stored offsite in a database.

The air extracted by the mine ventilation is a mix of both atmospheric air and gases released from the underground exposed coal. Both carbon dioxide and methane are measured in the ventilation air.

It is noted that although mining has ceased in the Blakefield South Mine, gas drainage and associated activities will continue as required. Continued monitoring will guide the operation of this system until no longer required.

Bulga Coal records greenhouse gas emissions by utilising industry standard factors for diesel usage, explosives and fugitive emissions from mining coal, and operates in accordance with the approved *Greenhouse Gas Management Plan*.

6.13.2 Environmental Performance

Greenhouse gas emissions are shown in **Table 27**. The emissions have been estimated using the methods specified in the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* and the publication, *National Greenhouse Accounts Factors July 2014*.

Table 27 Bulga Coal Greenhouse Gas Emissions (Scope 1 and 2 Direct Emissions)

Emission Source	Bulga Open Cut ($t CO_2$-e)	Bulga Underground Operations ($t CO_2$-e)
Electricity consumption (grid)	65,969	3,773
Fuel Combustion (transport)	228	11
Fuel Combustion (non-transport)	211,535	342
Fugitive emissions from ROM coal	244,561	21,772
Mine ventilation	N/A	27,027
Sub-total	**522,293**	**52,925**
Gas Drainage		
Vented	N/A	744
Flared	N/A	139,527
Sent Offsite	N/A	0
Power Generation	N/A	19,056
Sub-total	**N/A**	**159,327**
Total	**522,293**	**212,252**

Overall, there was a slight increase in Bulga Open Cut emissions of about 2.3% when compared to the 2017 reporting period.

Emissions from Bulga Underground Operations were significantly (91.4%) lower during 2018 when compared to the previous reporting period. This reduction was due to mining area that generated considerably less gas and the cessation of underground mining and subsequent sealing of the mine following the completion of Blakefield South Longwall 1B in May 2018.

6.13.3 Comparison against Predictions

6.13.3.1 Bulga Underground Operations

The annual average emissions from gas drainage and ventilation sources at the Bulga Underground Operations, based on the 2007 Blakefield South Statement of Environmental Effects (SEE) were predicted to be 1,415,362 CO_2-e.

The considerable difference between the 2007 SEE prediction and the 2018 result can be explained by the completion of underground mining in May 2018.

6.13.3.2 Bulga Open Cut

A Greenhouse Gas and Energy Assessment was prepared by Umwelt (2012) as a component of the Bulga Optimisation Project EIS. A comparison against the predictions of the Greenhouse Gas and Energy Assessment is included in **Table 28**.

Table 28 Comparison of 2018 Scope 1 and 2 Greenhouse Gas Data against Bulga Optimisation Project maximum Annual Predictions

Scope	Source	Predicted Source Totals (t CO_2-e)	Predicted Scope Totals (t CO_2-e)	2018 Data (t CO_2-e)	2018 Totals (t CO_2-e)
Scope 1 (Direct)	Diesel use	240,885	1,011,888	211,763	456,324
	Fugitive emissions	771,003		244,561	
Scope 2 (Indirect)	Electricity	55,042	55,042	65,969	65,969
Total Annual Operation			**1,066,930**		**522,293**

Note that these predictions represent the maximum annual greenhouse gas emissions for Bulga Coal during operations. Diesel use and fugitive emissions were significantly lower than predicted, however electricity consumption was higher. Overall, greenhouse emissions were 51% lower than predicted in the Bulga Optimisation Project EIS. This is due to the predictions in the EIS being based upon Method 1 which specifies the use of designated emission factors in the estimation of emissions. Bulga Coal has since adopted Method 2 which is an industry-specific method using site sampling in order to gain more accurate estimates for emissions. Therefore the emissions are being calculated more accurately, which is resulting in lower than predicted fugitive emissions.

6.14 Hydrocarbon Management

6.14.1 Environmental Management

Controls implemented to manage the risk of hydrocarbon related impacts are conducted under:

- *Bulga Coal Hydrocarbon Management Plan*, incorporating spill response procedure and Bulga Open Cut Hydrocarbon TARP;
- *Bulga Underground Operations Spill Management Response Procedure*; and
- *Bulga Coal Pollution Incident Response Management Plan*.

Hydrocarbon storage facilities have been designed generally in accordance with AS 1940-2004 – '*The Storage and Handling of Flammable and Combustible Liquids'*. The storage system includes computerised controls for the purpose of monitoring and identification of faults.

Bulga Coal monitor for petroleum hydrocarbons at dirty water dams, EPL discharge points and groundwater bores surrounding hydrocarbon storage and natural watercourses, in accordance with the *Bulga Open Cut Remediation Action Plan* and the *Bulga Coal Hydrocarbon Management Plan*. The monitoring program involves:

- regular inspections of hydrocarbon infrastructure to identify losses or leakages;
- monthly oil and grease analysis at the surface water monitoring sites shown on **Figure 6**; and

- hydrocarbon monitoring at the locations listed in **Table 29**. Surface water sites are monitored quarterly, following rain. Groundwater sites are monitored six-monthly.

6.14.2 Environmental Performance

Surface water and groundwater monitoring was conducted at the locations listed in **Table 29** and shown on **Figure 7**. Results were assessed against the Hydrocarbon Trigger Action Response Plan (TARP) triggers in **Table 30** and **Table 31**.

Table 29 Hydrocarbon Monitoring Sites

Type	Monitoring Location
Groundwater	ASMW02
	ASMW06
	BFMW01
	BFMW02
	BFWW03
	C2MW03
	C2MW04
Surface Water	Nine Mile Creek (NMC) 1
	NMC2
	NMC6
	NMC Culvert
Licenced Discharge Point (LDP)	CHPP Surge Dam
	Northern Dam
Onsite Dirty Water Dam	AS Dam 1
	AS Dam 2
	AS Dam 3
	C2 Dam
	C3 Dam

Table 30 Ecological Investigation Levels (ANZECC) Adopted for Natural Waters (Surface and Groundwater) at Bulga Open Cut

Sampling Location	Contaminant	Trigger (pg/L)
Surface Water NMC2, NMC3, NMC4, NMC5, NMC6, Nine Mile Creek Culvert. **Groundwater** ASMW02, ASMW06, BFMW01, BFMW02, BFMW03, C2MW02, C2MW03, C2MW04, C3MW01.	TRH C6-C10	20 (LOR)
	TRH >C10-C16	100 (LOR)
	TRH >C16-C34	100 (LOR)
	TRH >C34-C40	100 (LOR)
	TRH >C10-C40	300 (LOR)
	Naphthalene	16
	Phenanthrene	0.6
	Anthracene	0.01

Sampling Location	Contaminant	Trigger (pg/L)
	Fluoranthene	1
	Benzo(a) pyrene	0.1

Table 31 Trigger Levels for Onsite Dirty Water Dams

Sampling Locations	Contaminant	Trigger * (pg/L)
AS Dam 1	Total Recoverable Hydrocarbons	1,600
AS Dam 2	Total Recoverable Hydrocarbons	1,900
AS Dam 3	Total Recoverable Hydrocarbons	1,300
C2 Dam	Total Recoverable Hydrocarbons	1,300
C3 Dam	Total Recoverable Hydrocarbons	1,000

*Triggers have been developed based on an average from the monitoring results over 2010-2013.

Groundwater and surface water monitoring results in 2018 were below the relevant Ecological Investigation Levels.

Monitoring results for onsite dirty water dams were below the trigger levels with the exception of one elevated reading at C2 Dam. This is a low risk given as it is part of the mine water management system and is reused in the washery.

6.14.2.1 Hydrocarbon Plume Associated with the Area Station and Tank Farm

Surface and groundwater monitoring is undertaken in the vicinity of the Area Station and Tank Farm at these locations:

- surface water - AS Dams 1, 2 and 3; and
- groundwater – ASMW02 and ASMW06.

The data show that were no exceedances of surface water or groundwater hydrocarbon trigger values at these sites.

6.14.2.2 Spills

There were six recorded hydrocarbon spills at Bulga Open Cut during 2018. One was classed as Category 2 (>1000 litres), Four were classed as Category 1 (20 - 1,000 litres) and one as nil Category (<20 litres). Spill incidents were managed in accordance with the *Bulga Open Cut Emergency Procedure – Environmental Spill Response.*

There were four hydrocarbon spills at Bulga Underground Operations during 2018. Three were classed as Category 1 (20 - 1,000 litres) and one as nil Category (<20 litres). Spill incidents were managed in accordance with the *Bulga Open Cut Emergency Procedure – Environmental Spill Response*.

6.14.3 Implemented / Proposed Improvements

6.14.3.1 Petroleum Hydrocarbon Remediation and Validation Assessment

Remediation and validation works were completed to remove petroleum hydrocarbon impacted soils from the Bulga Underground Operations workshop and vehicle refuelling area in October and November 2018. These works were carried out prior to the construction of a haul road over the area.

Remediation works involved the excavation of visually impacted and odorous soils from four areas:

- diesel fuel lines;
- a sump;
- western portion of the workshop; and
- the vehicle servicing pits located within the workshop.

Validation samples were analysed for petroleum hydrocarbons, heavy metals and polyaromatic hydrocarbons.

No exceedances of the criteria for petroleum hydrocarbons, heavy metals or polyaromatic hydrocarbons were recorded from the samples collected from the diesel fuel line and excavations.

Validation samples from the vehicle servicing pits exceeded the Environmental Screening Level. This was assessed as low risk for groundwater contamination. No further remediation was required.

6.14.3.2 Phase 1 Contamination Assessment

A Phase 1 Contamination Assessment was undertaken at Bulga Coal in 2018 by a contaminated land consultant. A report of the findings will be provided in early 2019 with a summary of the findings to be presented in the 2019 Annual Review.

6.15 Public Safety

6.15.1 Environmental Management

Controls implemented to minimise the potential for public safety incidents include:

- implementation of a security system. These systems and procedures have been established in accordance with the relevant requirements under the *Work Health and Safety Act 2011*, *Mining Act 1992* and conditions stipulated in the relevant mining tenements;
- management of public safety associated with underground mining activities is undertaken in accordance with the approved *Blakefield South Surface and Public Safety SMP for BSLW1 to BSLW5;;*
- using sentries to prevent unauthorised entry into the blast exclusion zone;
- maintaining a fence around the perimeter of mining operations; and
- employee and contractor inductions regarding mine safety and environmental management issues prior to commencement of work at the site.

6.15.2 Environmental Performance

There were no public safety incidents recorded at Bulga Coal during the reporting period. Management measures and control strategies implemented at Bulga Coal have been effective in the prevention of incidents regarding public safety during the reporting period.

7 Water Management

7.1 Water Management

7.1.1 Water Balance

Bulga Coal uses a water balance model to assist in the management of water onsite. The model is used to review performance and undertake short term projections (12 months) of water requirements. The model is also used to predict water needs for the life of the mine. Major water transfers are monitored via flow meters. Water storage volumes are measured fortnightly.

The water balance for Bulga Coal is been presented in **Table 32**. The discrepancy between inflows, outflows and change in storage is due to the limitations of the accuracy of the surface and groundwater storage measurements and water balance model predictions.

Table 32 Bulga Coal 2018 Water Balance

Bulga Coal 2018 Water Balance	Volume (ML)
Water Inventory and Capacity	
Total estimated water stored on site 1 January 2018 (3,869 ML predicted to be in the underground goaf)	6,765
Total estimated water stored on site 31 December 2018 (4,000 ML predicted to be in the underground goaf)	6,633
Change in water inventory	-132
Inflows	
Water extracted from Hunter River (monitored)	2,025
Rainfall and runoff intercepted from mine areas	961
Groundwater inflow to Bulga Open Cut (Groundwater model prediction)	1,029
Pumped from dewatering bores	404
Water entrained in CHPP feed material	564
Potable supply	38
Total Inflows	**5,021**
Outflows	
Evaporation	900
Discharge to Hunter River under Hunter River Salinity Trading Scheme	0
Water entrained in product coal, coarse rejects and tailings	2,184
Open Cut Dust suppression	2,294
Bulga Underground Operations Water Consumption	90
Potable water consumption	38
Other losses	157
Total outflows	**5,663**

7.1.2 Water Take

Water taken by Bulga Coal during the previous water year (1 July 2017 to 30 June 2018) is summarised in **Table 33**.

Table 33 Water Take 2017-2018

Water Licence #	Water Sharing Plan, Source and Management Zone	Entitlement (ML)	Passive take/inflows	Active Pumping	Total
Groundwater					
20BL168475	Whybrow void (Beltana MG1)	500	0	0	0
20BL169514	Whybrow void (Beltana MG4)	500	0	98	98
20BL172658	Whybrow void (South Bulga MGE1)	500	0	0	0
20BL172673	Whybrow void (South Bulga MGE4)	500	0	0	0
20BL169347	Underground workings (in-pit dewatering Blakefield Seam)	365	0	0	0
Pending	Blakefield South void (MG01)	710 (application)	0	99	99
Pending	Blakefield South gas wells	100 (application)	0	28	28
Surface Water					
Singleton Council Agreement	Hunter River	1,140	0	871	871

In accordance with the requirements of water licences 20BL169347 and 20BL168475, an Annual Groundwater report - the *Annual Groundwater Report for Blakefield South* (David, 2019) has been prepared and is attached as **Appendix D**. Details of compliance are provided in **Table 34**.

Table 34 20BL169347 and 20BL168475 Compliance Table

Requirement	Comments
Location of the licenced sites	**Figure 1 of Appendix D -** this licences are for operational dewatering of the Bulga Underground
Monitoring Results	**Table 33** and **Appendix D**
Assessment of compliance with licence conditions	Compliant
A summary of new bores or pits constructed during the year	No new bores or pits constructed in 2018
The trend graphs for monitoring data collected for each bore associated with the mine workings	**Section 7.4.4** and **Appendix D**
Contingency events that impacted on groundwater during the reporting period	No events occurred during 2018
Recommendations for improvements	None required during 2018

7.2 Surface Water

7.2.1 Environmental Management

Bulga Coal implements surface water management measures in accordance with the *Water Management Plan*. This Plan outlines procedures for the detection of significant offsite impacts. The *Plan* also outlines trigger levels to identify and manage potentially adverse impacts. Trigger levels are included in the site Environmental Monitoring Database (EMD), which generates an alarm if a trigger level is reached.

The site also operates a Surface Water TARP to assist with managing the site's surface water during storm events. The Plan further outlines the methods for monitoring the quantities of water extracted, imported or discharged under groundwater extraction licences, surface water extraction licences and the EPL.

Monthly surface water quality monitoring is undertaken at dams, streams and creeks in and around Bulga Coal mining operations. Monitoring locations were selected to obtain representative samples. Water quality parameters including temperature and depth are tested onsite, whilst pH, EC, and total suspended solids (TSS) are undertaken by a National Association of Testing Authorities (NATA) accredited laboratory.

Surface water quality monitoring is conducted in accordance with:

- *AS 5667.4 – 1998 Water Quality Sampling – Guidance on Sampling from Lakes, Natural and Man-made*;
- *AS 5667.6 – 1998 Water Quality Sampling-Guidance on Sampling of Rivers and Streams*; and
- the *Bulga Coal Water Management Plan*.

The *Water Management Plan* was updated and resubmitted for approval in 2016. It was approved by DPE on 21 June 2016 and DEE in February 2017.

In accordance with the *Water Management Plan* requirement to establish additional water quality monitoring locations as part of continued Bulga Open Cut operations, four additional sites were established in July 2018. These locations will be sampled as per the existing arrangement with respect to parameters and frequency.

- SDL1 - the Southern Drainage Line West of Charlton Rd;
- NDL1 - Northern Drainage Line also West of Charlton Rd;
- W10 - Loders Creek north of monitoring location Dam S6A; and
- NMC1 - Nine Mile Creek south of the Surge Dam.

7.2.2 Environmental Performance

A summary of surface water monitoring results is shown in **Table 35**. The location of surface water monitoring sites is shown on **Figure 7**. Monitoring data is available on the Bulga Coal website.

Table 35 Summary of Surface Water Monitoring Results – 2018 Annual Averages

Sample Point	pH (range)	EC (µS/cm)	TSS (mg/L)	Temp. (°C)
LR1	6.77 - 7.45	1,162	16	20
LR2[1]	-	-	-	-

Sample Point	pH (range)	EC (µS/cm)	TSS (mg/L)	Temp. (°C)
LR5	7.77 – 8.08	1,456	13	23
W2	7.04 – 7.88	893	11	21
W4	7.58 – 8.13	1,428	11	19
SDL1[1]	-	-	-	-
NDL1[1]	-	-	-	-
W10[1]	-	-	-	-
NMC1[1]	-	-	-	-

1 – No samples taken in 2018 due to no flow.

The results in **Table 35** remained within historical ranges at all monitoring locations (refer **Section 7.2.4**).

Stream flow impacts in Wollombi Brook from Bulga Coal are determined by comparing the Water NSW gauging station records, upstream and downstream of the site. The upstream site is the Wollombi Brook – Brickmans Bridge (Paynes Crossing) gauging station (210135), which is located approximately 20 km upstream of Bulga Coal. The downstream site is the Wollombi Brook – Bulga gauging station (210028), located approximately 5 km downstream of Bulga Coal. **Figure 12** and **Figure 13** show the gauging station records for 2017 to 2018 for the upstream and downstream sites, respectively.

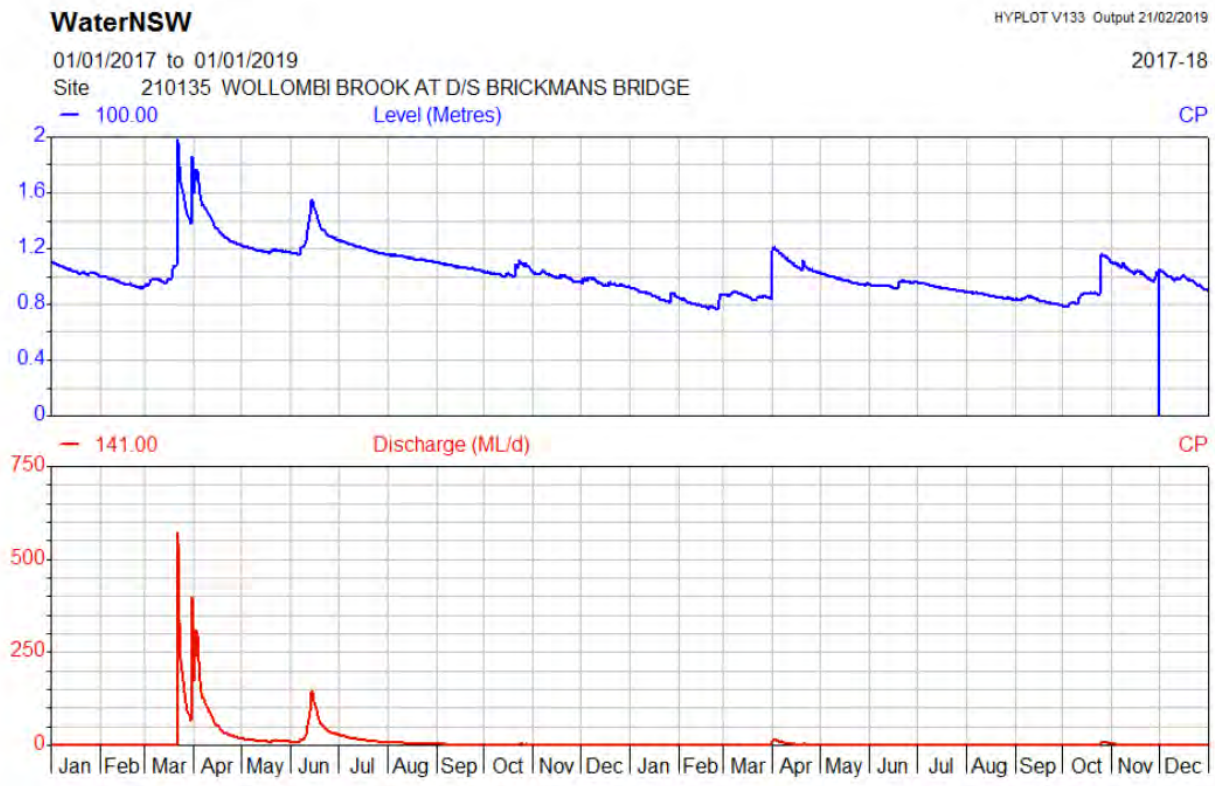


Figure 12 Wollombi Brook Brickmans Bridge Gauging Station 210135 (Upstream)

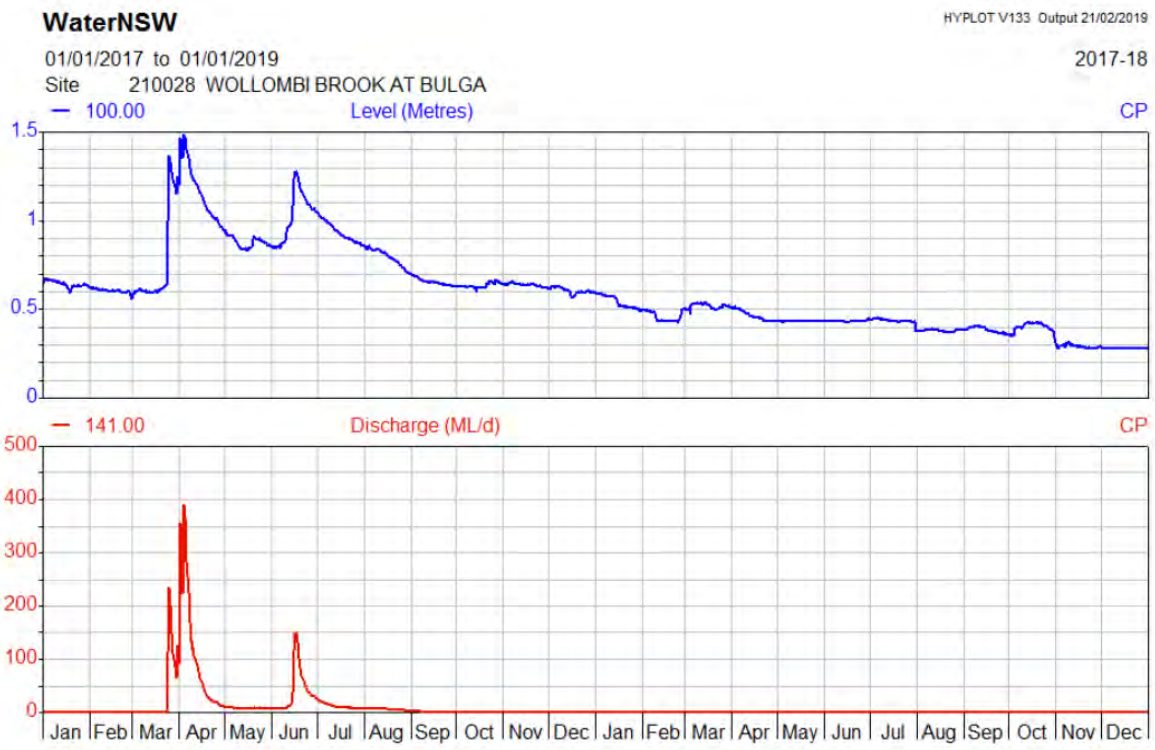


Figure 13 Wollombi Brook – Bulga Gauging Station (210028) (Downstream)

The data presented in **Figure 12** and **Figure 13** indicates that the water level in Wollombi Brook continues to fluctuate in response to rainfall events with an overall decline reflective of the ongoing dry weather. The declining water level is likely to also be influenced by increased irrigation demand on the Wollombi Brook by landholders during the prolonged dry period.

It is interpreted that Bulga Coal are not impacting on water levels in Wollombi Brook.

7.2.2.1 Hunter River Salinity Trading Scheme

The site has two Hunter River Salinity Trading Scheme (HRSTS) LDP's:

- EPL ID 4 – CHPP Surge Dam; and
- EPL ID 11 – Northern Dam.

EPL 563 requires the discharge volume, pH and TSS to be monitored during discharge events.

There were no discharges from licenced discharge points during 2018.

7.2.2.2 Channel Stability Monitoring Results

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) Ephemeral Stream Assessment Methodology was used to assess the channel stability of Nine Mile Creek, Loders Creek and Wollombi Brook. The assessment uses indicators (vegetation presence, shape and profile, type of materials, nature of walls etc.) to produce a rating which ranges from Very Stable to Very Active.

The stability assessments along Nine Mile Creek (BM21 and BM22) recorded Stable and Potentially Stabilising classifications, with good vegetation cover on banks and little evidence of active erosion.

The monitoring sites on Loders Creek displayed several classifications, with BM35 (located immediately downstream of the Nine Mile Creek and Loders Creek confluence) being classed as Active. This was due to lateral erosion at the top of the bank causing rilling down (approximately 50 cm deep) into the base of the channel. BM34, further downstream Loders Creek, was classed as Stable.

Monitoring site BM36 (the only site on Wollombi Brook) was classified as being Potentially Stabilising. With the exception of this area, the creek was noted to be generally more stable than observed in previous years.

Future assessment will be able to compare against these results to assess whether any sections of the Wollombi Brook have changed or are eroding, potentially as a result of discharges from Bulga Open Cut.

7.2.2.3 Stream Health

The Rapid Appraisal of Riparian Condition (RARC) is an assessment method incorporating indicators of geophysical, and biological properties and processes which are likely to provide reliable estimate of ecological condition in riverine ecosystems (Jansen et al, 2005). Each indicator is given a score which combine to provide an overall creek health score. Scores range from Very Poor (<25) to Excellent (40 - 50).

The Nine Mile Creek monitoring locations (BM21 and BM22) classified as Very Poor and Good. These scores were largely impacted by dense Casuarina regrowth which hindered the growth of other species. These sections of the creek were also isolated from other stands of native vegetation due to historical mining and agricultural activities.

Both of the Loders Creek monitoring locations (BM34 and BM35) were classified as Poor. These sites were also impacted by dense Casuarina regrowth, as well as weed infestation in the areas and paddocks adjacent to the creek.

The monitoring site on Wollombi Brook (BM36) recorded an Average classification. Generally only a thin band of vegetation (5 m – 15 m) was present along the creek being mainly Swamp Oak, River Oak and occasional regrowth eucalypt. Upslope of this vegetation is mostly cleared paddocks of exotic pasture grasses with some native woodlands.

7.2.3 Comparison against Predictions

A Surface Water Assessment was undertaken by Umwelt (2013) as part of the Bulga Optimisation Project EIS. The assessment concluded that with the implementation of the water management system and the proposed controls there was only a low risk of impacting on the water quality of the downstream watercourses, and that results would be comparable to background levels. A comparison of the background water quality against the 2018 data has been made in **Table 36**. The results show that while the 2018 data is variable, it is within the historical ranges for each site.

Table 36 Comparison of Surface Water Monitoring Results (2018) against Background (2013 Bulga Optimisation Project EIS)

Sample Point	pH		EC (µS/cm)		TSS (mg/L)	
	2018 Range	EIS Range	2018 Average	EIS Range	2018 Average	EIS Range
LR1	6.77 - 7.45	6.6 - 8.8	1,162	4 - 9,470	16	1 - 72

Sample Point	pH		EC (µS/cm)		TSS (mg/L)	
LR2[1]	-	6.3 - 8.8	-	130 - 6,230	-	3 - 440
LR5	7.77 – 8.08	6.7 - 8.4	1,456	196 - 3,470	13	2 - 144
W2	7.04 – 7.88	6.6 - 8.2	893	195 - 1,470	11	1 - 114
W4	7.58 – 8.13	6.5 - 8.2	1,428	200 - 1,760	11	2 - 42

1 – no flow during 2018.

7.2.4 Long Term Trend Analysis

Figures 14, 15 and **16** show surface water monitoring results recorded by Bulga Coal during the period 2005 to 2018 for EC, pH and TSS, respectively.

Seasonal variations in pH, EC and TSS are evident at the sites along Wollombi Brook (LR1, LR5, W2 and W4) with values remaining within the predicted ranges shown in **Table 36**.

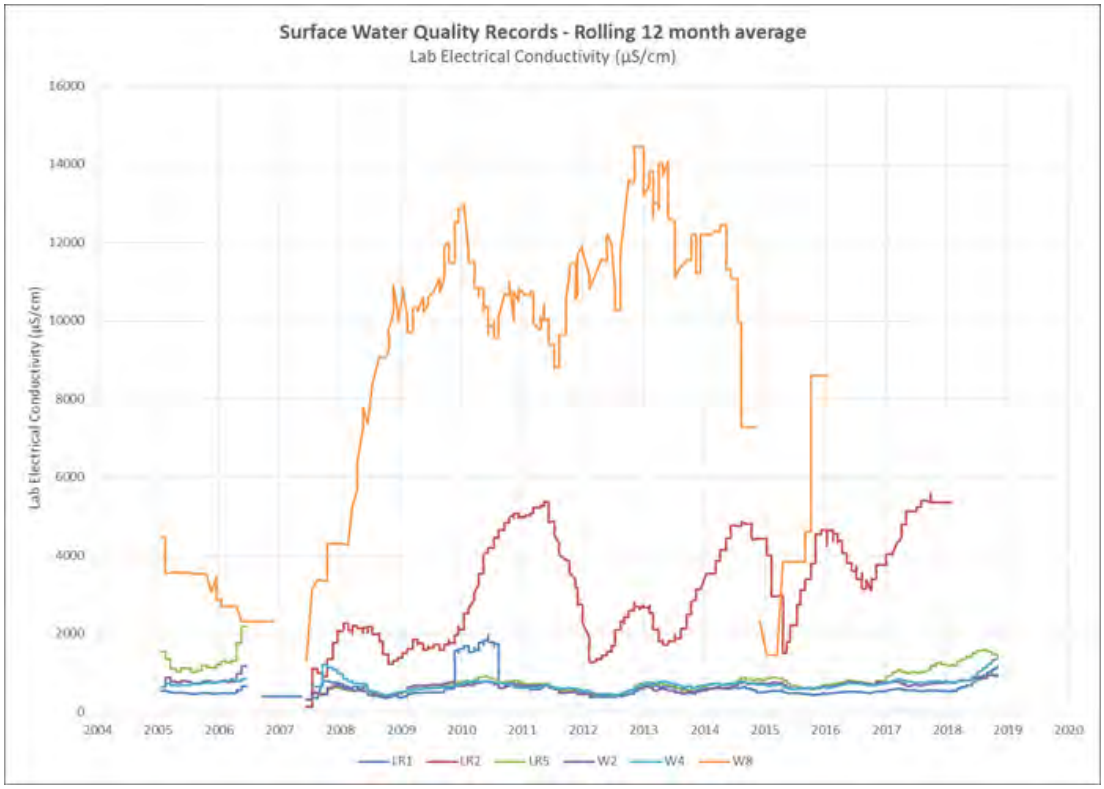


Figure 14 Long Term Surface Water EC Results

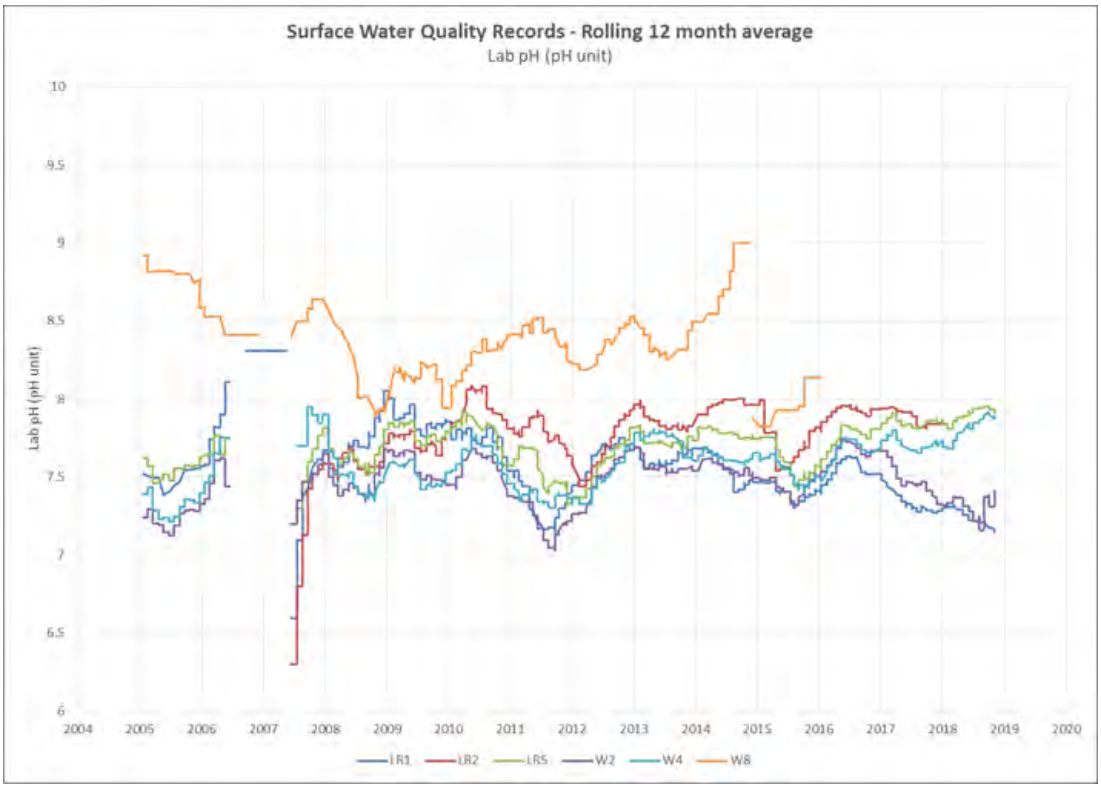


Figure 15 Long Term Surface Water pH Results

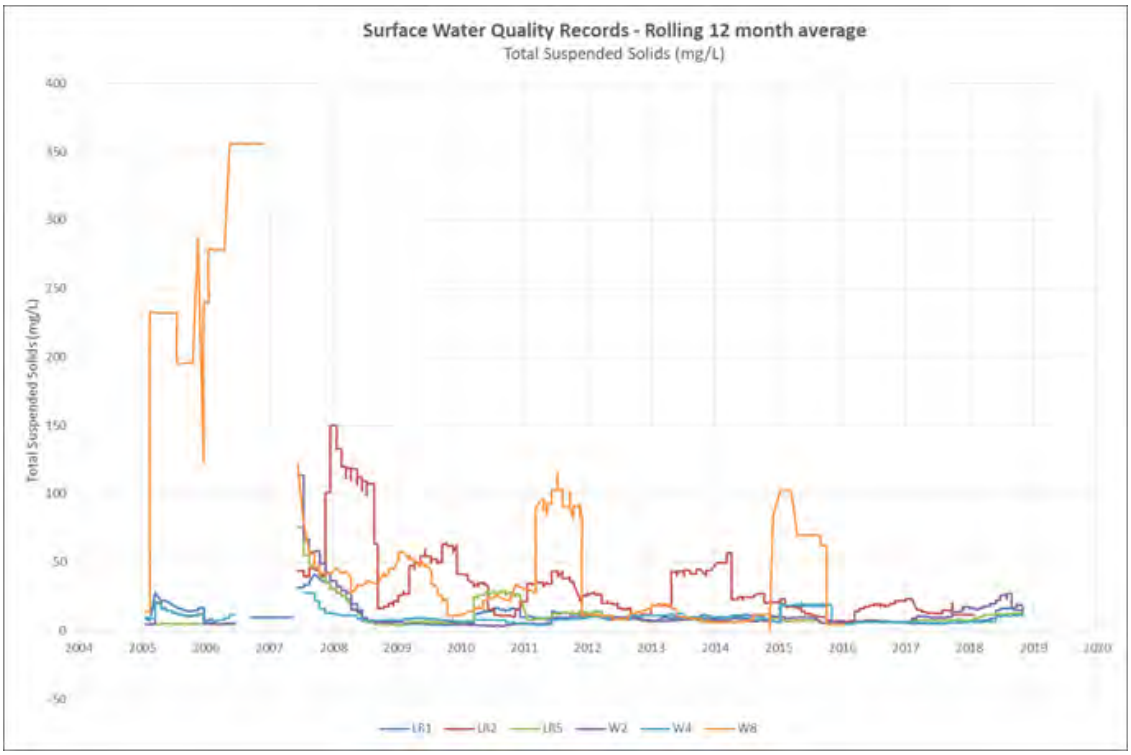


Figure 16 Long Term Surface Water TSS Results

7.3 Erosion and Sedimentation

7.3.1 Environmental Management

A variety of controls are implemented at Bulga Coal to mitigate operational risks associated with erosion and sediment control. During and following ground disturbance, structures such as sediment ponds, sediment fences, spoon drains, sediment catches and site catch sumps are used where appropriate to manage runoff, and minimise erosion and sedimentation. Inspections are undertaken, following more than 20 mm of rain in 24-hours, to evaluate the effectiveness of erosion and sediment control structures. Additional stabilisation works for these areas may include reshaping, amelioration of dispersive soil, revegetation, fencing and weed control.

High risk sediment dams have been incorporated into an automatic management system which continuously monitors dam water levels and commences dewatering when the water level reaches set trigger levels. Other sediment dams are monitored weekly and following rainfall events to determine pumping requirements.

Monitoring and inspections at Bulga Coal are completed in accordance with the approved Bulga Coal *Erosion and Sediment Control Plan*. This monitoring system is designed to comply with EPL 563 and the erosion and sediment control conditions stipulated within the Bulga Underground Operations and Bulga Open Cut Development Consents.

7.3.2 Environmental Performance

The implementation of the monitoring system and associated management measures in accordance with the approved *Bulga Coal Erosion and Sediment Control Plan* have resulted in no erosion and/or sediment control related incidents at Bulga Coal during 2018.

7.4 Groundwater

7.4.1 Environmental Management

Groundwater is managed in accordance with the approved *Water Management Plan*. This was developed and approved by the DPE in 2016 and received Commonwealth approval in February 2017.

Mapping of the deep and shallow depressurisation of the hard rock (coal measures) strata is undertaken. This identifies the potential for any adverse impacts on the shallow alluvial aquifer systems associated with Wollombi Brook and Monkey Place Creek. Depressurisation is predicted within the coal measures on a regional scale; however, it is not expected to produce any measurable impact in the overlying alluvial aquifer.

The monitoring program provides early warning for potential changes in groundwater levels and quality which exceed site trigger levels. These trigger levels are outside of the predicted (modelled) values. Activities can be modified if monitoring shows that the mining operation is likely to cause, or is causing, adverse impacts.

The groundwater monitoring network consists of a total of 49 groundwater monitoring points shown in **Figure 7**. The monitoring network comprises both standpipe piezometers and multilevel vibrating wire piezometers installed in all hydrostratigraphic units.

The groundwater monitoring program currently comprises:

- bi-monthly water level monitoring in all standpipe piezometers including the measurement of EC and pH;

- continuous monitoring of pressure heads in 15 vibrating wire piezometers;
- continuous monitoring of water levels in 22 standpipe piezometers which are equipped with dataloggers; and
- comprehensive geochemical sampling and analysis undertaken on a half yearly basis in all 49 standpipe piezometers (including major ions and metals).

The groundwater monitoring system is designed to effectively monitor the two general types of groundwater located within the vicinity of Bulga Coal. These groundwater resources are the alluvial aquifers of Wollombi Brook and Monkey Place Creek, and the typically more saline and low yielding hard rock aquifers associated with the Whittingham and Wollombi Coal Measures (various coal seams within these).

7.4.2 Environmental Performance

A summary of groundwater monitoring results is shown in **Table 37**, with detailed groundwater monitoring results available on the Bulga Coal website.

Table 37 Summary of Groundwater Monitoring Results – 2018 Annual Averages

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Lab pH	Lab EC (µS/cm)
Broke Area Alluvials				
GW1	4.2	88.0	6.9	2882
GW2	2.6	83.7	6.9	6,037
GW3	2.5	75.5	7.3	5,103
GW4	2.2	78.4	7.4	1,734
GW5	2.2	79.8	6.9	5,693
GW6	3.4	73.6	7.4	7,572
GW7	1.8	73.3	7.6	3,568
GW8	3.7	71.4	6.9	5,300
GW9	2.1	71.7	6.8	4,657
GW10	1.7	71.6	7.4	1852
V3	6.6	68.8	7.5	2,108
Broke Area Wollombi Seam				
P2	6.9	67.7	7.1	12,368
P5A	7.1	69.1	7.6	3,890
P6A	16.8	68.4	7.5	1,777
Northern Area Shallow Alluvials				
F1	6.7	63.4	7.5	1,348
F2	5.7	64.4	7.3	1,694
WBR50A	7.7	57.4	7.5	10,492
V1	7.0	64.0	7.6	1,487
V2	7.5	59.8	7.1	878
SBC/Broke Area Lower Whybrow Seam				

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Lab pH	Lab EC (µS/cm)
P1	-	82.0	-	-
P6B	0.5	84.4	8.3	6,436.7
P7B	*Located on AGL land and no longer accessible*			
P8	12.2	75.9	7.1	376
Northern Area Lower Whybrow Seam				
WBR50	38.8	25.8	7.7	7,345
Northern Alcheringa Seam				
WBD62A	16.0	64.2	7.2	1,307
Beltana Area Miscellaneous Bores and Wells				
Dwyers	8.3	61.8	7.4	1,696
Fernance	8.9	62.7	7.9	1,589
McG1	21.1	91.3	7.8	388
White1	6.1	64.4	7.1	2,297
WBR15	17.9	60.2	7.5	1,009
Beltana Area NPZ				
NPZ3-A	Blocked and flooded during 2017.			
NPZ3-B	12.3	60.4	7.4	834
NPZ4-A	23.0	59.7	6.9	670
NPZ4-B	32.5	49.6	7.7	1,275
NPZ5-A	11.1	63.4	7.0	888
NPZ5-B	25.4	48.5	7.4	2,733
NPZ7-1	12.1	56.9	7.6	1,202
NPZ7-2A	8.0	62.6	7.3	2,277
NPZ7-2B	15.7	54.6	7.5	1,140
NPZ7-3A	11.6	62.4	7.0	2,667
NPZ7-3B	16.3	57.3	7.6	1,268
Wollombi Alluvials and Shallow Coal Measures				
WBD160	9.4	64.5	7.0	1,108
WBR180	34.1	35.8	7.2	19,638
WBR181	8.1	60.4	7.3	3,260
WBR182	7.3	62.4	7.4	1,441
WBR183	14.1	60.6	7.1	3,590
SBD196	5.4	67.6	7.0	4,513
WBR240	6.4	59.0	6.7	25,833
WBR241	8.3	60.0	6.7	334

Groundwater Report for Blakefield South

Following the completion of secondary extraction of Blakefield South Longwall 1B and cessation of mining in the Blakefield South Mine, a detailed groundwater report was prepared to provide an overview and summary of the post-mining groundwater conditions (David, 2019). The report is attached as **Appendix D**.

The report undertook a review of standpipe and vibrating wire piezometer data to understand any change since the completion of underground operations at Blakefield South Mine. It was concluded that the alluvial water table in Wollombi Brook and Monkey Place Creek has declined and fluctuated during 2018 coincidental with the continued low rainfall period.

Salinity measurements show EC levels fluctuation (up to 1500 µS/cm) reflecting the rainfall recharge. Hydrograph analysis of Wollombi Brook and Monkey Place Creek alluvial data indicates that the water table is strongly influenced by rainfall and to a lesser extent by other factors such as irrigation.

7.4.3 Comparison against Predictions

The overall groundwater inflows into the Blakefield South workings have been compared to historical data and predicted groundwater modelling. The actual inflows were less than those predicted by modelling by around 0.6 ML/day. The water imbalance is 117.4 ML with more water produced in the underground and pumped via dewatering bores than input in the underground.

7.4.4 Long Term Trend Analysis

Bulga Coal has an extensive groundwater monitoring network which covers Wollombi Brook and Monkey Place Creek alluvium, overburden, sandstone, and deep coal seam hydrostratigraphic units. A long term monitoring record (over 20 years) now exists and it enables interpretation of groundwater trends.

The groundwater levels in the Wollombi Brook and Monkey Place Creek alluvium continue to fluctuate in response to rainfall events with an overall decline due to ongoing dry weather. Overall there does not appear to be any measurable impact from mining operations on the alluvial aquifers (David 2019). It is of note that the most recent alluvial groundwater levels are still well above those recorded before the 2007 Pasha Bulker storm event. Detailed groundwater monitoring trend graphs are presented in the *Annual Groundwater Report for Blakefield South* (David, 2019) which is attached as **Appendix D**.

8 Rehabilitation

Progressive rehabilitation of disturbed areas is an important aspect of the mining operations at Bulga Coal. The objective of rehabilitation is to restore the land to a condition that is equal or greater than that prior to disturbance. Ongoing rehabilitation of areas disturbed by operations has continued throughout the reporting period. Monthly and annual rehabilitation inspections are undertaken by experienced rehabilitation consultants to monitor the success of rehabilitation works.

As requested, the Rehabilitation Reports that monitor the trajectory of the rehabilitation performance have been provided to the Resources Regulator with this Annual Review. The table outlining the progression towards the completion criteria attached as **Appendix E.**

The table presented in **Appendix E** provides a colour-coded guide to how the rehabilitation is progressing towards the closure criteria. The colour-coding relates to green achieving the benchmark value, blue within 20% of the benchmark value, orange between 21% and 50% of the benchmark value and red below 50% of the benchmark value.

8.1 Post Rehabilitation Land Use

In accordance with SSD-4960 and the *Biodiversity Management Plan*, rehabilitation has continued to focus on the goal of establishing EECs.

It is anticipated that following the expected closure of Bulga Coal and the subsequent rehabilitation activities, that the areas disturbed by mining activities will be predominantly native vegetation (woodlands on spoil dumps and riparian communities along established drainage lines) with a minimum of 260 ha being returned to land suitable for agricultural uses. Land above underground workings to the east of Charlton Road (not disturbed by the Noise and Visual Bund) will become regenerating woodland, and land above underground workings to the west of Charlton Road will be rehabilitated to retain the agricultural productivity of the land.

It is expected that the areas disturbed by mining will be predominantly returned to land and soil capability Classes 6 and 7. Existing areas currently mapped as being land and soil capability Class 3 and Class 4 will remain generally consistent post closure, with a small reduction in Class 5 areas expected. Based upon current approvals mining operations at Bulga Coal will cease in 2035.

8.2 Rehabilitation Performance during the Reporting Period

8.2.1 Rehabilitation Summary

Rehabilitation activities have been completed in accordance with the approved Bulga Open Cut and Bulga Underground Operations MOPs. Rehabilitation activities undertaken in 2018 were:

- shaping of overburden dumps to between 10 and 14 degrees;
- removal of decommissioned infrastructure (where required);
- installation of contours and drains;
- deep ripping;
- rock raking;

- installation of habitat features (e.g. stag trees, woody debris);
- spreading of topsoil or organic matter;
- application of ameliorants;
- re-ripping of prepared surface; and
- revegetation.

Further details on these steps are provided in the Bulga Open Cut and Bulga Underground MOPs which are available on the Bulga Coal website. A summary of rehabilitation at Bulga Coal as at the end of 2018 is presented in **Table 38** and is shown in the plan included as **Appendix F**.

Table 38 Rehabilitation Status at Bulga Coal

Mine Area Type	Previous Reporting Period (Actual) 2017	This Reporting Period (Actual) 2018	Next Reporting Period (Forecast) 2019
Total mine footprint	3,170.3	3,290.7	3,329.3
Total active disturbance	2,431.0	2,471.7	2,590.0
Land being prepared for rehabilitation	101.1	174.1	123.0
Land under active rehabilitation	739.3	829.2	893.3
Completed rehabilitation*	0	0	0

* Denotes land that has been signed off by DPE-RR as completed rehabilitation.

8.2.2 2018 Rehabilitation – Bulga Open Cut

During 2018, Bulga Open Cut predominantly completed rehabilitation in three separate areas, those being:

- The Noise and Visual Bund (79.6 ha);
- Eastern Emplacement Area (50.2 ha); and
- Mount Thorley Warkworth Common Boundary (36.8 ha).

Rehabilitation and disturbance at Bulga Open Cut has been shown on **Figure 17.**

8.2.2.1 Landform Details

The Noise and Visual Bund rehabilitation for 2018 was spread out along the majority of the length of the bund (see **Figure 17**). A detailed drainage design has been completed for the entire outer face of the Noise and Visual Bund. This was completed to enable sections of the rehabilitation to be completed progressively each year, whilst ensuring the broader catchments had been considered. The drainage design was also developed to reduce the potential impacts associated with subsidence that would be caused by the approved Blakefield North underground mine that is currently suspended.

The rehabilitation at Noise and Visual Bund Section 4 (30 ha) consisted of a relatively steeper slope that varied from approximately 12 to 14 degrees up to a level of RL 120. Contour drains were constructed in this area for water management, and two existing drop structures were continued up the slope. Rehabilitation was also completed within Sections 1, 2 and 3 of the Noise and Visual Bund, and were a continuation of previously rehabilitated areas, working up the slope towards the crest of the outer face. All drainage within these areas was constructed in accordance with the detailed drainage design. The rehabilitation at Noise and Visual Bund Section 1 was the only area completed up to full design height in 2018.

The rehabilitation of the Eastern Emplacement Area continued, with 50.2 ha being completed. Rehabilitation in this area was again prioritised to allow for direct emplacement of topsoil from other areas of the Eastern Emplacement Area where clearing and topsoil stripping was occurring. A detailed drainage design was also completed for this area with contour banks, drop structures and surface drains designed and progressively constructed. All slopes at the Eastern Emplacement Area were designed and constructed to approximately 10 degrees.

The 2018 Mount Thorley Warkworth Common Boundary rehabilitation was located adjacent to the common mining lease boundary with Mount Thorley Warkworth Operations. The rehabilitation consisted of a 10 degree slope up from the common boundary, and a large flat area at RL150. This area was treated with pasteurised green waste as an alternative to topsoil.

8.2.2.2 Cover Materials

The majority of 2018 rehabilitation areas were directly emplaced with topsoil stripped from clearing areas. Some areas were covered with topsoil sourced from stockpiles where direct emplacement was not possible. Topsoil stockpiles were scalped to remove any weeds present. As mentioned above, the Mount Thorley Warkworth Common Boundary area was treated with pasteurised green waste as an alternative to topsoil.

Gypsum was applied at a rate between 3 t/ha and 8 t/ha, depending on the results of soil analysis for each rehabilitation area. This was applied immediately after spreading of topsoil and ripped to a depth of at least 450 mm to incorporate the gypsum into the cover material and overburden.

8.2.2.3 Physical and Chemical Characteristics

Bulga Open Cut has identified some coal seams and interburdens which are potentially acid forming and have elevated sulfur. These seams and interburdens have been analysed and are separated and handled/dumped to reduce the long term potential to form acids.

8.2.2.4 Vegetation Species

Revegetation activities in 2018 focussed on the establishment of the vegetation communities required by SSD-4960. Subsequently, two main vegetation communities were seeded in 2018, those being:

- Central Hunter Grey Box – Ironbark Woodland (Noise and Visual Bund, Eastern Emplacement Area and Mount Thorley Warkworth Common Boundary rehabilitation areas); and
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest (southern Noise and Visual Bund rehabilitation areas).

The seed mixes for these areas focussed on establishing the key overstorey, shrub and ground cover species for each community (as outlined in the Bulga Open Cut MOP and *Biodiversity Management Plan*).

8.2.2.5 Habitat Resources and Potential

The *Biodiversity Management Plan* outlines the requirement for incorporating habitat features into rehabilitated landscapes. In 2018, a number of methods were used to increase the habitat potential of the rehabilitated areas:

- woody debris;
- incorporation of drains and water sources;
- rock piles; and
- stag trees.

As rehabilitation matures, other habitat enhancement methods such as nest boxes will be utilised.

8.2.2.6 Temporary Rehabilitation and Visual Mitigation

No temporary rehabilitation was completed in 2018.

8.2.2.7 Rehabilitation Maintenance

Rehabilitated areas at Bulga Open Cut are subject to an ongoing monitoring and maintenance program to ensure that the completion criteria are achieved. Monthly inspections are conducted by an external rehabilitation consultant to ensure all rehabilitation areas across the site are inspected on a regular basis. A summary of these care and maintenance activities undertaken during 2018 are outlined in the following sections and in **Table 39.**

Table 39 Maintenance Activities on Rehabilitated Land for Bulga Open Cut

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
	2018 (actual)	2019 (planned)	
Additional erosion control works (drains re-contouring, rock protection)	<1	<1	Only very minor areas of rilling were identified during 2018 and these were stabilised by adding pasture seed to the active rills. Some small areas of erosion on contour banks were also remediated and re-seeded.
Re-covering (further topsoil, subsoil sealing etc.)	0	0	No re-covering undertaken in 2018 or planned for 2019.
Soil treatment (fertiliser, lime, gypsum etc.)	0	0	No areas required further soil treatment during 2018. A sampling program is being undertaken in 2019 to determine if fertiliser application is required in older rehabilitation areas
Treatment/management (grazing, cropping, slashing etc.)	0	0	No areas in 2018 or 2019.
Re-seeding/replanting (species density, season etc.)	27	20	Supplementary tube stock planting completed in rehabilitation areas in 2018 and planned for 2019 (approximately 1,000 per ha)

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
Adversely affected by weeds (type and treatment)	240	300	Weed control works in 2018 focused mainly on the Noise and Visual Bund, Eastern Emplacement Area, Old Tailings Dam and Mount Thorley Warkworth Common Boundary Area. This will continue in 2019 with new rehabilitation areas being added to the program as required.
Feral animal control (additional fencing, trapping, baiting etc.)	As required	As required	Feral animal control will concentrate on wild dog control using baiting and kangaroo culls within rehabilitation areas.

During 2018, tube stock overplanting was conducted on some of the 2015 and 2016 rehabilitation areas. Overplanting with the key canopy and shrub species was undertaken to assist in meeting the species diversity required for *Central Hunter Grey Box – Ironbark Woodland* and *Central Hunter Spotted Gum – Ironbark – Grey Box Forest* communities. It is proposed to continue this overplanting program each year, focussing on the areas that were seeded two to three years earlier.

Weed control works were continued based on the findings of monthly inspections. Only one area (2012 Primary Rehabilitation) is considered to be adversely affected by weeds (Rhodes grass), however this area is proposed to be dumped over as part of the ongoing mine development. All other areas required only minor weed control works as part of the regular maintenance program.

8.2.3 2018 Rehabilitation – Bulga Underground Operations

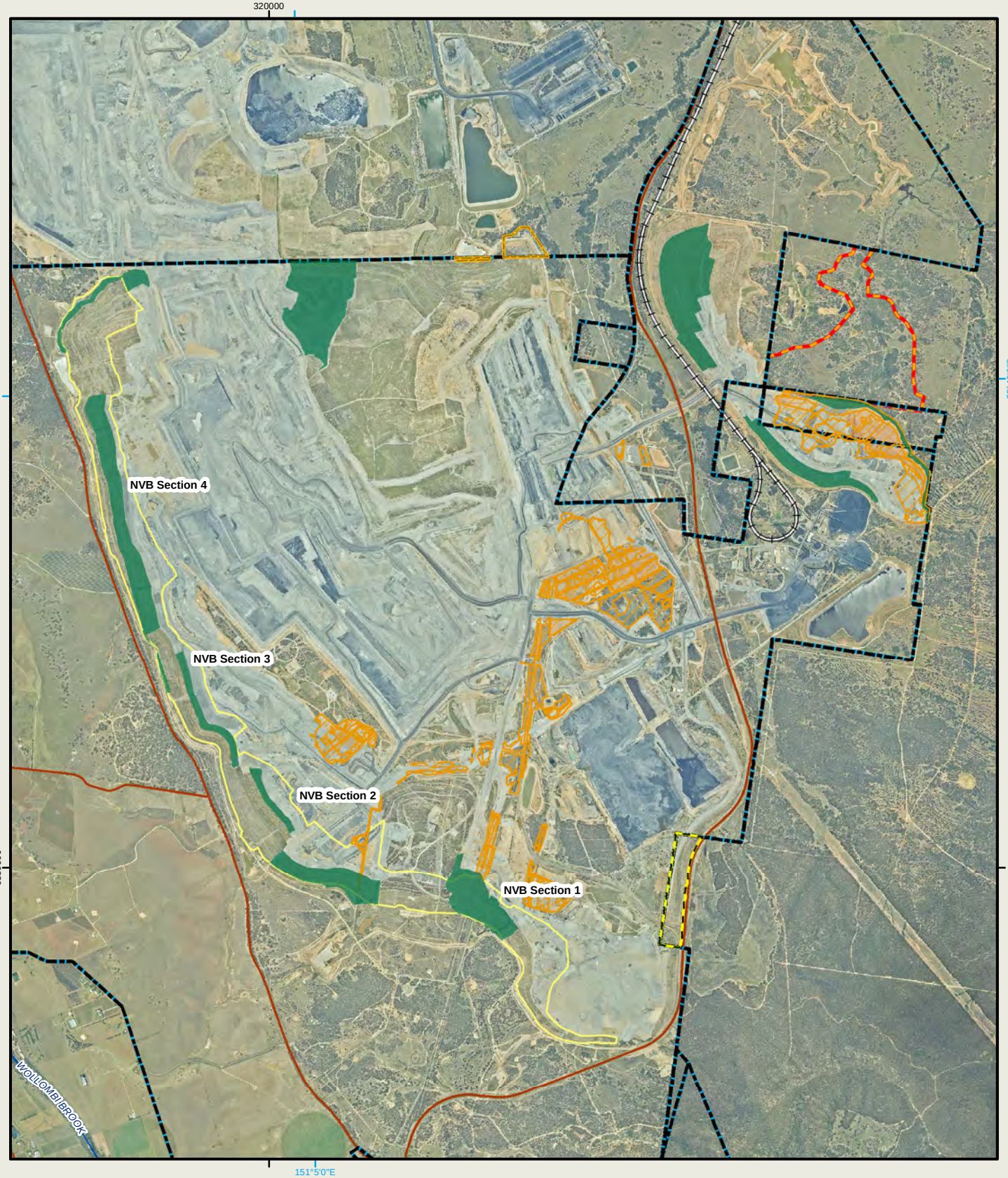
Rehabilitation during the reporting period focussed on remediation of land affected by mine subsidence and the rehabilitation of decommissioned gas drainage infrastructure. Bulga Underground Operations disturbance and rehabilitation has been shown in **Figure 18**. Additional detail regarding the rehabilitation of these areas during the reporting period has been provided in the following sections.

8.2.3.1 Landform Details

In general, disturbance and subsequent rehabilitation activities at Bulga Underground Operations require minimal modification of the existing land form. Rehabilitation of decommissioned gas drainage infrastructure is undertaken to match the previous and surrounding landform, reinstating cut fill, levelling windrows and respreading stockpiles.

Rehabilitation of disturbance associated with gas drainage infrastructure is undertaken considering existing landform, drainage, stability and mitigation of visual impacts.

FIGURE 17 - BOC REHABILITATION AND DISTURBANCE 2018



Public Road
Railway
Wollombi Brook
Mining Lease
Sublease
Mining Lease Application
Mining Lease AMA
2018 Rehabilitation
2018 Disturbance
NVB Outer Face Boundary

0 0.25 0.5 1
Kilometres

Coordinate System
GDA 1994 MGA Zone 56
1:45,000 @ A4

N

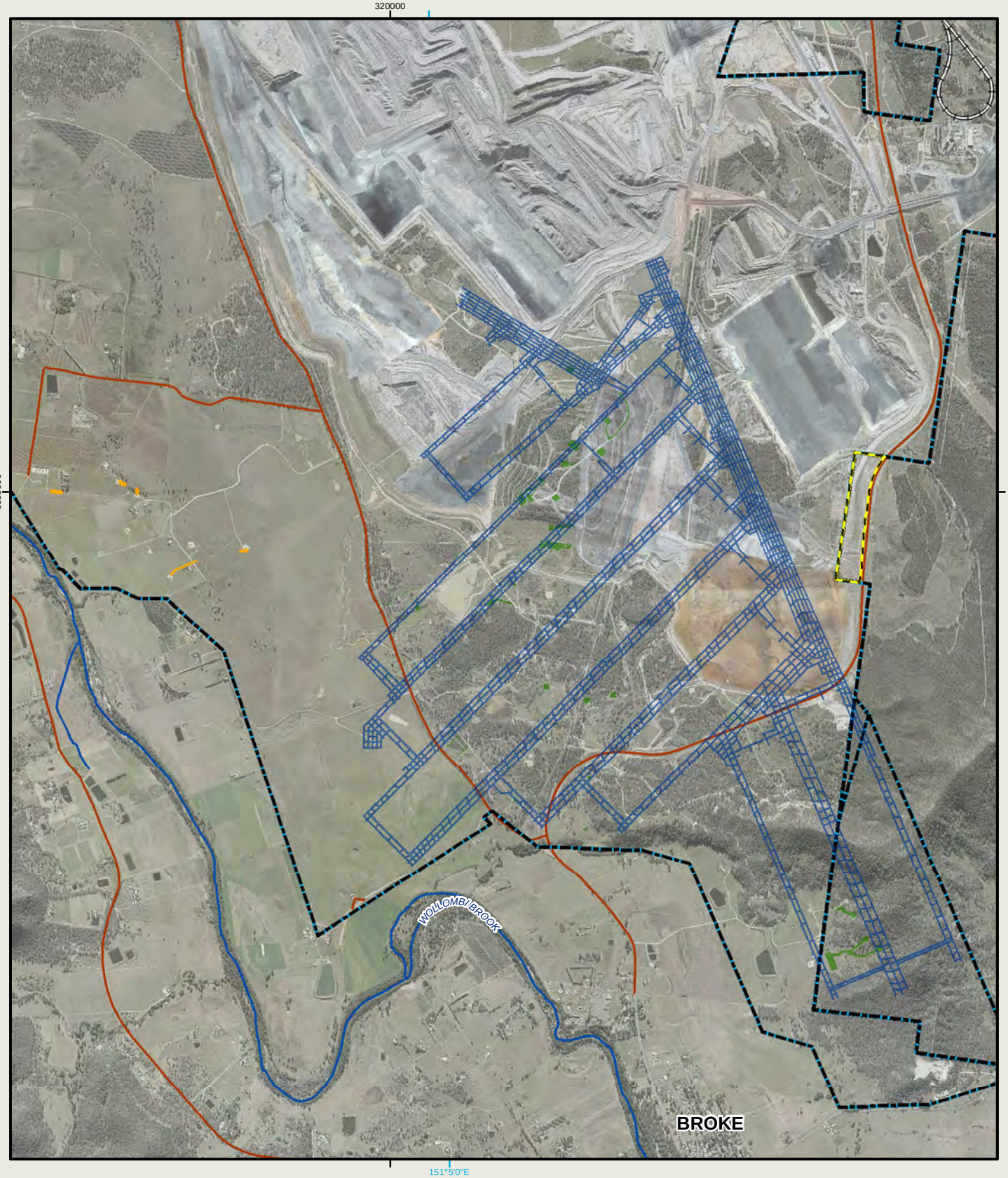
GLENCORE

DISCLAIMER
Subject To Survey.
Glencore makes every effort to ensure the quality of the information available on this map. Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

DATA SOURCE
© NSW Department of Finance, Services & Innovation 2017
© NSW DTIRIS (Minerals & Petroleum) 2017
© Glencore 2019 © ESRI 2017

Ref: \\AUSYD\DFS\VCS\SOB\BUG\SU\Mapping\Reporting\AEMR\2018\2018_AEMR_FIGURE16_BOC_REHAB_&_DIST.mxd

FIGURE 18 - BUO REHABILITATION AND DISTURBANCE 2018



Public Road
Railway
Wollombi Brook
Mining Lease
Sublease
Mining Lease AMA
Blakefield South Workings
2018 Rehabilitation
2018 Disturbance

0 0.25 0.5 1
Kilometres

Coordinate System
GDA 1994 MGA Zone 56
1:39,484 @ A4

GLENCORE

N

DISCLAIMER
Subject To Survey.
Glencore makes every effort to ensure the quality of the information available on this map. Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

DATA SOURCE
© NSW Department of Finance, Services & Innovation 2017
© NSW DTIRIS (Minerals & Petroleum) 2017
© Glencore 2019 © ESRI 2017

Ref: \\AUSYD\DFS\VCS\SOB\BUG\SU\Mapping\Reporting\AEMR\2018\2018_AEMR_FIGURE18_BUO_REHAB_&_DIST.mxd

8.2.3.2 Cover Materials

Topsoil is spread over the prepared final landform for drill pads and pipeline corridors; generally to a depth of 100 mm. Seeding of the area is undertaken as soon as practicable following the surface preparation using a site and season specific grass or tree mix, however this will be subject to weather conditions (seeding will be delayed during windy conditions). The seed mix is applied to ensure consistent ground cover.

All 2018 rehabilitation areas were covered with topsoil sourced from onsite. Topsoil was generally sourced from stockpiles directly associated with the rehabilitation activity. 100 kg/ha of slow release fertiliser is also added to the topsoil as part of the seed mix.

8.2.3.3 Physical and Chemical Characteristics

Topsoil is generally stockpiled for less than two years and at a scale not warranting material characterisation prior to use in rehabilitation.

8.2.3.4 Vegetation Species

Specific tree seed mix (based on local vegetation communities) and pasture seed mix have been developed for the rehabilitation of disturbed land at Bulga Underground Operations. The mix is consistent with the native environmental setting of Bulga Underground Operations and includes seed that has been harvested from within the mining lease boundaries and properties managed by Bulga Underground Operations.

Additionally, an agricultural seed mix is applied to subsidence repairs and disturbance associated with gas drainage infrastructure on grazing land.

8.2.3.5 Rehabilitation Maintenance

Rehabilitated areas at Bulga Underground Operations are subject to an ongoing monitoring and maintenance program to ensure that the completion criteria are achieved. A summary of rehabilitation maintenance activities undertaken during 2018 are outlined in the following sections and in **Table 40**.

Table 40 Maintenance Activities on Rehabilitated Land for Bulga Underground Operations

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
	2018 (actual)	2019 (planned)	
Additional erosion control works (drains re-contouring, rock protection)	1	0	Maintaining temporary controls around disturbance and active rehabilitation areas as identified in routine and scheduled inspections.
Re-covering (further topsoil, subsoil sealing etc.)	0	0	-
Soil treatment (fertiliser, lime, gypsum etc.)	10	2.4	Fertiliser used in seed mix for rehabilitation.
Treatment/management (grazing, cropping, slashing etc.)	0	0	-
Re-seeding/replanting (species density, season etc.)	2.2	0	Supplementary seeding of disturbance with less than adequate strike identified in quarterly rehabilitation inspections.

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
Adversely affected by weeds (type and treatment)	As required	As required	Weed management activities were ongoing for 2018. Target areas identified during Ground Disturbance Permit inspections, monthly inspections, quarterly rehabilitation inspections and quarterly buffer land inspections.
Feral animal control (additional fencing, trapping, baiting etc.)	As required	As required	Feral animal control concentrating on wild dog and pig control.

8.3 Buildings

As outlined in **Section 4.2.4**, in 2018 Bulga Underground Operations demolished/dismantled infrastructure including:

- The administration buildings;
- Ventilation Fans #1 and #2;
- The Stockpile Gantry (CV701); and
- Beltana Arch Bridge.

A redundant residential dwelling at 154 Broke Road and associated shed at 14 Broke Road were also dismantled and rehabilitated in 2018.

8.4 DPE-RR Sign-Off on Rehabilitation

In 2018 no areas of rehabilitation received formal sign-off from DPE-RR that land use objectives and completion criteria had been met.

8.5 Variations from Proposed MOP Activities

Table 41 summarises the rehabilitation progress at Bulga Coal (including Bulga Open Cut and Bulga Underground Operations) during 2018 against the MOP predictions.

Table 41 Bulga Coal MOP Rehabilitation Predictions against 2018 Data

Mine Area Type	2018 Actual Data (Bulga Coal)	MOP Prediction 2018
Rehabilitation (ha)	174.1	133.9
Disturbance (ha)	112.6	134.0
Rehabilitation Disturbance (ha)	21.7	56.4

During 2018, the rehabilitation target was exceeded by 40.2 ha. The rehabilitation was largely completed in the same areas as outlined in the MOP, with an additional 37 ha being completed in the Mount Thorley Warkworth Common Boundary area.

Disturbance was 21.4 ha less than that proposed in the MOPs for 2018. The completed disturbance areas were in the same locations as proposed in the MOPs, with the total for each area being slightly smaller than expected. Rehabilitation disturbance was also 34.7 ha less than proposed, mainly due to the inside dumps of Noise and Visual Bund Section 2 progressing slightly slower than planned.

During 2019, it is proposed to commence construction of the water management system for the Eastern Emplacement Area southern extension (as approved by SSD-4960 Mod 1). This was not included in the current MOP, so will require a variation to the Bulga Open Cut MOP in 2019.

8.6 Rehabilitation Monitoring, Trials and Research

Bulga Coal has an extensive rehabilitation monitoring program to track the establishment and progress of rehabilitated areas towards the completion criteria. The objectives of the rehabilitation monitoring program are to:

- Assess the long term stability and functioning of re-established ecosystems on mine affected land;
- Assess rehabilitation performance against the completion criteria; and
- Facilitate continuous improvement in rehabilitation practices.

The monitoring program will continue within rehabilitated and non-mined areas (reference sites) until it can be demonstrated that rehabilitation has satisfied the closure criteria. The rehabilitation monitoring criteria for each domain have been developed to demonstrate that selected indicators (or criteria) have reached their established completion criteria or that a satisfactory successional trajectory has been established that will result in a self-sustainable ecosystem.

Based on the outcomes of the rehabilitation monitoring program, a care and maintenance program is implemented. The scope of the care and maintenance program may include weed and feral animal control, fertilising, re-seeding or planting (where required) and erosion and sediment control works.

8.6.1 Annual Rehabilitation Monitoring Program

During 2018, the existing annual rehabilitation monitoring was continued and expanded to include recently rehabilitated sites. The monitoring methodology was also modified slightly to be based on the Biodiversity Assessment Methodology (BAM) which is OEH's preferred methodology. The proposed new closure criteria which form part of DPE-RR's new Rehabilitation Reform Project are also based on the BAM method.

The rehabilitation monitoring summarises how rehabilitated areas are progressing in relation to the rehabilitation phases defined in the Bulga Coal MOPs. A set of criteria has been established to determine when each rehabilitation area has met the intent of each phase.

The annual rehabilitation monitoring was completed in May 2018 (Emergent Ecology, 2018). As requested, a copy of the rehabilitation monitoring report has been provided to the DPE-RR with the Annual Review. A copy of the report is also available on the Bulga Coal website.

A summary of the results has been provided in the following section with the table outlining the progression towards the completion criteria attached as **Appendix E.**

8.6.1.1 Woodland Rehabilitation Site Monitoring

Overall, the 2018 rehabilitation monitoring identified that sites are generally trending towards the target community in many aspects, however still required active management and further monitoring to ensure the sites remain on target.

Vegetation Integrity scores varied across the rehabilitation monitoring sites. Whilst no sites met the criteria for their relevant community, some sites (EEA1, NVB2, NVB3, OTD5 and SE1) were within 12.4 points (12 % of benchmark). Most rehabilitation monitoring sites scored well in regards to native plant species richness, with two sites (NVB3 and EEA1) meeting the required benchmark. The majority of sites lack adequate canopy and shrub layer cover, however this is a direct reflection of the age of the rehabilitation sites and will increase over time.

All sites (other than SE1) met the native ground cover (grasses) benchmark, which indicates a good diversity of native grasses has germinated in rehabilitation areas from the topsoil and/or seed mix. However, no sites (including reference sites) met the benchmark for native ground cover (other) which is an indication of native herbs and forbs. Exotic plant cover scores met or were close to meeting the benchmark at all of the rehabilitation monitoring sites.

Landscape Function Analyses (LFA) monitoring was continued in 2018 to assess landscape organisation and soil surface condition. Landscape organisation scores were generally lower than previous years, likely a result of the dry conditions prior to the survey effort and the successional stage of the vegetation. Rehabilitation site scores ranged from a moderately low value of 31 at NB6 to a high value of 92 at SB7. Although NB6 recorded the lowest value, this site occurs on a flat gradient and therefore does not relate to a high erosion potential. Minor erosion (<200 mm) was recorded at some rehabilitation sites; however sediment and erosion control work are not currently required.

Soil surface results from 2018 indicated an ongoing improvement in soil conditions at rehabilitation sites. Soil stability scores increased from 2017 to 2018, with scores generally ranging from 60 to 80. Sites SB7 and SE1 met the reference site benchmark for soil stability, with all others being close to meeting the benchmark or trending towards meeting it. Soil infiltration scores also increased with scores ranging from 31 to 66 (reference sites scored between 51 and 53). Soil nutrient values were also higher at all monitoring sites compared with previous records, with rehabilitation sites recording values between 38 and 81 (54 to 69 for reference sites). Overall, the sum of LFA scores for rehabilitation sites were within 20% of references sites scores, indicating that rehabilitation sites are trending towards the reference sites.

Overall, rehabilitation monitoring data indicates that rehabilitation is progressing well towards the closure criteria with nine of the 18 completion indicators achieving the closure criteria benchmark for all sites and only three completion indicators having the lowest score for all sites (refer to **Appendix E**). Recommendations have been made to improve rehabilitation practices/management to assist in meeting the criteria and they broadly include:

- Increasing the abundance of fallen timber to increase habitat and meet the closure criteria indicator;
- Continue existing annual pest management programs;
- Continue existing weed management programs targeting high risk invasive plant species;
- Conducting selective thinning at monitoring site SE1; and
- Review rehabilitation seed mix to assist in meeting native plant species richness benchmarks.

8.6.2 Rehabilitation Trials and Research

No rehabilitation trials are currently being conducted at Bulga Coal.

8.7 Key Issues that may Affect Rehabilitation

A risk assessment was conducted during preparation of the Bulga Coal MOPs which identified the key risks to rehabilitation. The key risks to rehabilitation at Bulga Coal are:

- Drought (or extended dry conditions);
- Exposure to fire prior to rehabilitation reaching an age at which it will demonstrate tolerance;
- Erosion and sedimentation;
- Exotic weeds; and
- Unapproved access and/or disturbance.

Key risks to rehabilitation area included in a rehabilitation TARP within the Bulga Open Cut and Underground MOPs to identify required management actions in the event of impacts to rehabilitation, or where rehabilitation outcomes are not achieved in an acceptable timeframe. No rehabilitation TARPs were triggered during 2018.

Ongoing works will be undertaken throughout the life of the operation to ensure rehabilitation areas meet the requirements of the completion criteria. These works will mostly include weed control, erosion repairs and planting/seeding to meet the requirements of target vegetation communities. Identification of these works will be through the long term rehabilitation monitoring program and annual walkover inspections.

8.7.1 Bulga Open Cut

8.7.1.1 Weeds and Pest Species

Weed management in rehabilitation areas is an ongoing challenge for all mining operations. Considerable planning is undertaken at Bulga Open Cut to prevent weeds entering rehabilitation areas in the first instance, primarily through topsoil management. Despite this, several weed species are present throughout most historical rehabilitation areas and significant resources are dedicated to their removal. The methods employed at Bulga Open Cut include:

- Appropriate topsoil management, including scraping of topsoil stockpiles prior to spreading;
- Seeding with quick establishing cover crops and acacia species to out-compete weed species;
- Ongoing weed spraying and removal; and
- Seeding with a eucalypt and acacia heavy forest seed mix to shade-out introduced weed species such as Rhodes grass (*Chloris gayana*) and Galenia (*Galenia pubescens*).

The key weed species targeted in 2018 were Galenia (*Galenia pubescens*), Golden Wreathe Wattle (*Acacia saligna*) and Saffron thistle (*Carthamus lanatus*).

As part of the dog baiting program, 1080 baits were placed in rehabilitation areas where wild dogs had previously been identified. One kangaroo cull was also undertaken in November 2018 with 200 tags being used exclusively on rehabilitation areas. It is proposed to undertake follow-up culls in 2018 to reduce the grazing pressure on ground covers, seedling shrubs and trees in the rehabilitation areas.

8.7.1.2 Erosion and Water Quality

Drainage structures such as contour banks and drop structures at Bulga Open Cut are largely functioning as designed and require little to no maintenance. During 2018 some minor rilling was found on the Noise and Visual Bund and Old Tailings Dam areas and these were seeded with pasture seed. To date this has largely stabilised the erosion so no further work is currently planned. During regular monthly inspections, one contour bank was found to have silted up and tunnelled through. This was repaired and re-seeded, with follow up inspections indicating no further work is required.

Ongoing monthly rehabilitation inspections will identify any maintenance required throughout 2019.

8.7.1.3 Safety Risks

Currently there are no rehabilitation areas that present safety risks to the public or employees. At the time of mine closure (in year 2035 based upon current approvals), the proposed final void and highwall will be rehabilitated in accordance with the approved Bulga Open Cut MOP and appropriate safety controls will be implemented.

8.7.2 Bulga Underground Operations

8.7.2.1 Weed and Pest Species

Due to the small and isolated nature of rehabilitation and the maintenance of buffer land at Bulga Underground Operations, weed and pest management activities are not isolated to rehabilitation areas. Weed and pest management, inclusive of rehabilitation was undertaken throughout 2018 as outlined in **Section 6.8.**

8.7.2.2 Erosion and Water Quality

Maintenance of erosion controls identified during scheduled and routine inspections was undertaken during 2018. Drains such as contour banks and diversions required little to no maintenance. During 2018 minor maintenance works were undertaken on numerous temporary control structures such as sediment fences, sandbag checks and culverts.

8.7.2.3 Safety Risks

Currently there are no rehabilitation areas that present safety risks to the public or employees.

8.8 Actions for the Next Reporting Period

8.8.1 Rehabilitation Outcomes

The rehabilitation outcomes have been agreed with stakeholders and documented in the approved MOPs, which are available on the Bulga Coal website.

8.8.2 Proposed Rehabilitation Trials, Projects and Initiatives

No rehabilitation trials are currently proposed at Bulga Coal.

8.8.3 Rehabilitation Activities Proposed for 2019

As per the 2019 Annual Rehabilitation Plan, Bulga Coal plans to undertake the following rehabilitation and disturbance works during 2019:

- 64 ha of disturbance;
- 123 ha of rehabilitation (levelled/re-contoured, topsoiled and seeded);
- Maintenance tasks as required on existing rehabilitation areas;
- Progressive decommissioning and rehabilitation of gas drainage infrastructure and boreholes (gas, services, geology etc.); and
- Subsidence repairs as required.

The proposed 2019 operations for Bulga Underground Operations and Bulga Open Cut have been presented in **Figure 4** and **Figure 5**, respectively.

9 Community

9.1 Community Engagement

Bulga Coal updated the community about mining activities and mine plans through community barbeque sessions, newsletters and one on one meetings. Bulga consulted with the community about the delay in completing the outer face of the Noise and Visual Bund and the revised timeframe for completion. Updates were provided to the community regarding SSD-4960 Mod 3.

9.1.1 Community Barbeque Program

The community barbeque program aims to strengthen relationships with community members and provide the opportunity for further consultation. In 2018 the barbeques were attended by:

- 57 community members in Bulga and 44 in Broke during April 2018; and
- 70 community members in Bulga and 69 in Broke during October/November 2018.

During the October/November barbeques, Bulga Coal undertook a survey of the attendees. The survey results are summarised in **Section 9.4** and will be incorporated into the Social Impact Assessment for the proposed SSD-4960 Mod 3.

Photo 4 Community Barbeques in Bulga and Broke

9.1.2 Community Consultative Committee

A combined Community Consultative Committee (CCC) operates for Bulga Underground Operations and Bulga Open Cut. Bulga Coal hosted CCC meetings in May and October 2018. Minutes from the CCC meetings are available on the Bulga Coal website.

9.1.3 Voluntary Planning Agreement

A Voluntary Planning Agreement Committee was formed in 2015 with members of the Broke and Bulga communities, Singleton Shire Council and Bulga Coal to administer funds associated with the Village Master Plan. One meeting was held during 2018, at which the final funds were allocated to projects and the committee was disbanded. Singleton Council worked with relevant community groups to undertake the project works. A disabled toilet and ladies toilet upgrade was completed at the Bulga Hall in early 2018. Completion of projects at McTaggart Park in Broke and the Bulga Recreation Ground will continue in 2019.

Other payments made as part of the Voluntary Planning Agreement included $770,000 towards Riverside Park in Singleton which opened in December 2018.

9.1.4 Newsletters and Notices

A newsletter was distributed to letterboxes in Broke, Milbrodale and Bulga in April 2018 to coincide with the community barbeques. In January and April, letters were distributed to the community about the application to modify SSD-4960 to extend the completion of the outer face of the noise and visual bund (SSD-4960 Mod 2). Another letter was sent to the community in July confirming the modification application had been submitted.

9.1.5 Annual Stakeholder Meeting

As discussed in **Section 6.9**, the annual stakeholder meeting was held in December 2018 with 23 RAP representatives. The majority of the discussion focused on the construction of the Aboriginal cultural teaching place and artefact storage facility at the Wollombi Brook Conservation Area and ongoing management of the facility. The meeting concluded with a voluntary site visit to the Vere and Loders Creek Grinding Grooves.

Photo 5 Annual Stakeholder Meeting

9.2 Community Sponsorship and Donations

Bulga Coal contributed approximately $80,000 in sponsorships and donations in 2018 to the projects and organisations listed below. A further $824,000 worth of contributions were made as part of the Voluntary Planning Agreement in the local area (see **Section 9.1.3**).

9.2.1 Broke School

The school purchased furniture and resources to support project based learning with a contribution from Bulga Coal's Voluntary Planning Agreement. The furniture provides learning environments that encourage collaboration, cooperation, creativity, critical thinking, innovation and communication.

The school and the Parents and Citizens Group were able to lower the cost of swimming lessons for families by securing a grant from Glencore to cover transportation costs.

Photo 6 Broke School students and teachers using the furniture purchased with funding by Bulga Coal

9.2.2 Broke Village Fair

Bulga Coal is the major sponsor of the annual Broke Village Fair and works in partnership with the Fair Committee, participating in the committee as well as marketing the event. It was another successful year with an estimated 5,600 visitors. Native trees were handed out in the Bulga Coal marquee. Bulga Coal staff were available to answer questions from the community.

Photo 7 Broke Village Fair

9.2.3 Broke Bulga Landcare – McNamara Park

Bulga Coal is working with Broke Bulga Landcare and Singleton Council to remove weeds at McNamara Park. This is part of a long term plan to manage the weeds and restore the River Red Gum Ecological Community at the Wollombi Brook.

In August 2018, Broke Bulga Landcare engaged Koori Country Firesticks, funded by Bulga Coal and supported by Council, to undertake a cultural cool burn of approximately 2 ha. A cool burn was also conducted in 2017 and another burn is planned for autumn 2019.

Photo 8 Cool Burn, McNamara Park

9.2.4 Community Yoga Classes

Bulga Coal organised free community yoga classes in Broke in late 2018, with more free sessions planned for 2019 in both Broke and Bulga. The aim is to promote well-being, fun and a sense of community.

Photo 9 Community Yoga Classes

9.2.5 Sponsorships

Organisations and events that were sponsored by Bulga Coal during the reporting period include:

- Singleton Library – Summer Reading Program;
- Broke Public School – project based learning furniture;
- Broke Fordwich Wine and Tourism Association – A Little Bit of Italy Festival;
- Hunter Valley Off Road Racing Association – Milbrodale Mountain Classic;
- Broke Village Fair;
- Broke Bulga Landcare;
- Smoke in Broke; and
- Singleton Tidy Towns Adopt a Spot Broke Road Clean-up.

9.2.6 Donations

Donations were made to these recipients in 2018:

- Cessnock Hospital: nitrous oxide analgesia sedation system;
- Singleton Neighbourhood Centre;
- Jodie's Place: solar panels;
- Carrie's Place;
- Broke Hall: tree removal;
- Bulga Craft Group;
- CWA Hunter River Group: Friendship Day at Baiame Cave;
- Singleton Scouts;
- Maitland Pony Club;
- St John the Baptist School;
- MND Research Institute of Australia: Sydney Running Festival;
- Beyondblue and Calvary Mater Hospital;
- Beards of Hope;
- Abermain Hawks;
- Cystic Fibrosis;
- Movember;
- Leukaemia Foundation: Wold's Greatest Shave; and
- Special Children's Christmas Party.

9.3 Community Complaints

During the reporting period a total of 22 community complaints were recorded from 9 stakeholders. 14 of the 22 complaints related to noise, received from 7 stakeholders. The other complaints related to lighting (3), dust (3) and visual impact (2).

Table 42 shows a comparison of the environmental complaints received by Bulga Coal during the reporting period against the previous three years.

Table 42 Summary of Complaints by Issue 2015 – 2018

Complaint Type	2015	2016	2017	2018
Blast vibration/ overpressure	0	3	0	0
Lighting	11	5	3	3
Dust	4	0	3*	3#
Noise	13	10	9*	14
Subsidence	0	0	0	0
Traffic	0	0	1	0
Visual Amenity	0	0	0	2#
Odour	0	0	0	0
Fume	0	0	0	0
Other	0	0	1	0
Total	**28**	**18**	**17**	**22**

* One complainant recorded two issues (noise and dust). These have been treated as two complaints.

\# One complainant recorded two issues (dust and visual amenity) in 2018. These have been treated as two complaints.

Each of these complaints followed the *Bulga Coal Community Complaint Procedure* and the response is available in the complaints register on the Bulga Coal website.

The key issue with regard to community complaints is noise and each complaint was investigated. Where the noise levels were found to be above our consent criteria at the nearest real-time monitor or by the hand held monitor, operational changes were made to reduce the noise. Where the noise was below the criteria, the complainant was notified of this and the levels were monitored.

9.4 Community Feedback

Bulga Coal receives formal and informal feedback about the consultation program and the mine's environmental performance.

At the community barbeques in November, attendees were surveyed to identify concerns about the existing operation and perceived concerns with the proposed SSD-4960 (Mod 3). 89 surveys were completed. Air quality and noise were raised as the two main issues. Over a quarter of the participants also provided positive feedback about Bulga Coal. 13% stated they had no concerns with the existing operation. **Figure 19** shows the results of the survey.

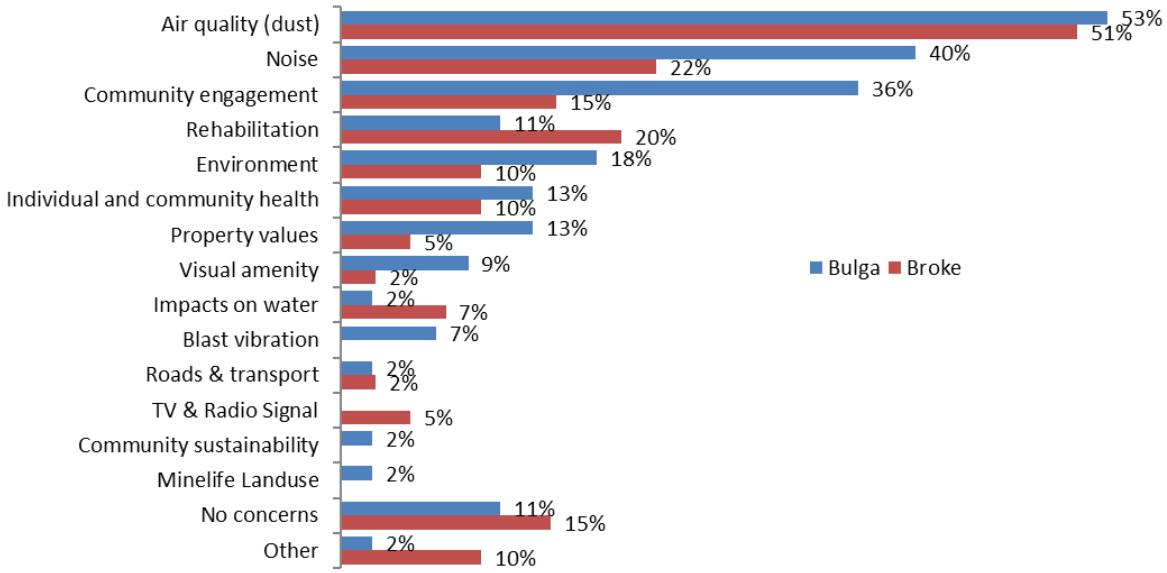


Figure 19 Community Survey Results (Issues of concern from existing operations)

With regard to concerns about the proposed SSD-4960 (Mod 3), preliminary results show that nearly half of those surveyed did not respond and 26% of respondents reported no issues. The key issues identified were air quality (9%), followed by environmental concerns (6%). Final results will be included in the Social Impact Assessment for the proposed SSD-4960 (Mod 3).

The Glencore Perception Survey was held in 2018 with 37 residents in Broke / Bulga area and 10 opinion leaders (community groups) completing interviews. The main issues of concern included air quality followed by noise, broad environmental and health and well-being.

In response to concerns from the community and the CCC regarding air quality, Bulga Coal is conducting an analysis of the dust from approximately six houses in Broke and Bulga. The aim is to understand the composition of the dust and report back to the participants in the first half of 2019.

10 Independent Audit

10.1 2018 Independent Environmental Audit

In accordance with the requirements Schedule 5 Conditions 9 and 10 of SSD-4960, Condition 8.4 of DA 41-03-99 and Schedule 6 Conditions 6 and 7 of DA 376-8-2003, an Independent Environmental Audit was undertaken for Bulga Coal in 2018. The audit was conducted in November 2018 and was submitted to DPE on 15 February 2019. The results of the audit including details of non-compliances and proposed corrective actions will be reported in the 2019 Annual Review following approval by DPE.

10.2 2015 Independent Environmental Audit

The previous independent environmental audit was undertaken in November 2015. This audit reviewed 37 approvals and environmental management documents in detail and other documents in a more general manner, where relevant. A total of 1,689 conditions and commitments were assessed as part of this audit, which identified 27 issues and resulted in 40 non-compliances. 11 of the issues were administrative. Some of the non-compliances noted in the audit related to the same issue which, due to the duplication of commitments between consent documents and management plans, raised the same non-compliance several times.

A basic risk assessment was conducted for all non-compliances with Low/Medium/High risk levels as results. For the non-compliances that were not administrative, there were 12 Low, and 17 Medium ranked risks. No High risks were identified in the audit. It is noted that these non-compliances relate to the entire three year audit period.

The audit found that Bulga Coal achieved 98% compliance with approval and licence conditions during the three year audit period. The status of the proposed actions is presented in **Table 43**. Actions that are ongoing, required no action or were completed prior to this Annual Review have been excluded.

Table 43 Non-Compliance Finding and Proposed Actions

Non Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Progress to Date
DA 41-03-99, Schedule 2, Condition 4.1	The Surface and Groundwater Response Plan did not adequately describe the "measures or procedures that would be implemented" in response to triggering the plan.	Relinquish DA 41-03-99	30 June 2019	Site is continuing consultation with local landholders regarding relinquishment of DA-41-03-99. Extension has been given by DPE until 30 June 2019 for this to be completed.

Non Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Progress to Date
DA 41-03-99, Schedule 2, Condition 8.2	Sampling strategies and protocols did not include a quality assurance / quality control plan.	Relinquish DA 41-03-99	30 June 2019	Site is continuing consultation with local landholders regarding relinquishment of DA-41-03-99. Extension has been given by DPE until 30 June 2019 for this to be completed.
Bulga Open Cut MOP 2.2.9	Rehabilitation area slope lengths were not kept to 50-70m, at the time of the audit some extended to 100 m.	Where slope lengths exceeded 70m, site specific drainage design were produced by surface water consultants and implemented. Clarify in next MOP update.	Complete	The following wording has been included in the recently submitted Bulga Open Cut MOP: "Slope lengths are generally limited to between 50 m and 70 m. If slope lengths are to exceed 70 m, site specific drainage design will be developed by surface water consultants and implemented." The revised MOP was approved on 13 June 2018.
Bulga Open Cut MOP 3.3.6	Routine sampling of overburden/interburden materials did not occur in the audit period.	Remove from revised MOP.	Complete	These actions have been removed from the revised Open Cut MOP as they are deemed not required. The revised MOP was approved on 13 June 2018.
Bulga Open Cut MOP 3.3.6	A programme of routine sampling and testing of seepage and runoff from pit walls and floors, overburden emplacements, ROM stockpiles and washery waste disposal areas was not undertaken in the audit period.	Remove from revised MOP.	Complete	
Bulga Underground Operations MOP 2.3.2.3	Laydown areas do not have sign posted parking or drop off areas.	Remove from revised MOP.	Complete	This has been removed from the revised Underground MOP as it is deemed not required. The revised MOP was approved on 13 June 2018.

11 Incidents and Non-Compliances during the Reporting Period

Incidents and non-compliances which are considered as low risk of environmental harm are detailed in this section.

11.1 Air Quality

11.1.1 PM_{10} – TEOM Monitors

The maximum 24 hour average PM_{10} exceeded the consent criterion of 50 µg/m^3 on multiple days at each of the TEOM PM_{10} monitors during 2018. Investigations were undertaken following each measured exceedance and on the occasions that the TEOM PM_{10} monitors were downwind of Bulga Coal, the potential maximum contribution for Bulga Coal was calculated. On those occasions, the maximum Bulga Coal contribution was calculated to be 28.1 µg/m^3 and would have been below the consent criterion of 50 µg/m^3.

Several exceptional events including bushfires and dust storms occurred in February, March, April and November 2018 which contributed to the high number of 24-hour average PM_{10} exceedances. A state-wide dust storm event in late November 2018 was responsible for the peak 24-hour average PM_{10} levels recorded at all the TEOM monitors.

It was concluded that Bulga Coal would not have made a significant contribution to the levels recorded on any of the days with elevated levels. Since it was determined that the exceedances were not be attributable to Bulga Coal, no corrective actions were required.

11.1.2 PM_{10} – HVAS Monitors

The maximum 24 hour average PM_{10} exceeded the consent criterion on one occasion each at the Dawtrey and D10 HVAS monitors. The exceedances were due to the regional dust storm which occurred between 21 and 23 November 2013 and were not attributable to Bulga Coal.

Since it was determined that the exceedances were not attributable to Bulga Coal, no corrective actions were required.

11.1.3 PM_{10} – Eastern Emplacement Area

As discussed in **Section 6.4,** there were 9 occasions when the EEAAQMF PM_{10} criterion of 91 µg/m was exceeded. As stated in the EEAAQMP, it is noted that the PM_{10} criterion of 91 µg/m is highly conservative. If the Work Health and Safety Standards (applicable to the mine workforce) of 10 mg/m^3 (inhalable dust) was adopted for the purpose of calculating the equivalent 13-hour average PM_{10} concentration, the resulting criterion would be 973 µg/m^3.

It is noted that the exceedances were not attributable to Bulga Coal. Notwithstanding, all exceedances were reported to the DPE. The exceedances and the corrective actions implemented are detailed in **Table 44**.

Table 44 Eastern Emplacement Area PM_{10} Non-Compliances

Date	Details of the Non-Compliance	Corrective Actions
16 February 2018	Bulga Coal measured a 6µg/m³ exceedance of the PM_{10} Assessment Level of 91µg/m³ at the Mushroom Composting Facility. The Assessment Level of 91µg/m³ is the 13-hour average PM_{10} over the Mushroom Composting Facility approved hours of work (6am to 7pm). There were elevated PM_{10} levels in the region caused by bushfire smoke from a bushfire in Wollemi National Park on this day.	No actions were taken as mining activities were occurring downwind of the Mushroom Composting Facility. The Mushroom Composters were notified of the EEAAQMF TARP triggers. Both parties agreed that the primary cause of the elevated PM_{10} was bushfire smoke.
13 April 2018	Bulga Coal measured a 13µg/m³ exceedance of the PM_{10} Assessment Level of 91µg/m³ at the Mushroom Composting Facility. Strong north-westerly winds occurred during the day. An elevated PM_{10} level was also recorded at the OEH Mt Thorley monitor. This monitor is upwind of Bulga Coal operations, indicating high ambient PM_{10} levels in the region.	Overburden handling upwind of the Mushroom Composting Facility was stopped at the Eastern Emplacement Area early into the 13-hour assessment period (approx. 9am) in response to EEAAQMF TARP triggers.
4 May 2018	Bulga Coal measured a 41µg/m³ exceedance of the EEAAQMF PM_{10} Assessment Level at the Mushroom Composting Facility. Strong north-westerly winds occurred during the day. An elevated PM_{10} level was also recorded at the OEH Mt Thorley monitor.	Overburden handling upwind of the Mushroom Composting Facility was stopped at the Eastern Emplacement Area early into the 13-hour assessment period (approx. 11am) in response to EEAAQMF TARP triggers. The Mushroom Composters were notified of the actions implemented to control dust.
19 July 2018	Bulga Coal measured a 3µg/m³ exceedance of the EEAAQMF PM_{10} Assessment Level at the Mushroom Composting Facility. It was a regional dust event on this day with strong north-westerly winds. The DPE advised this was considered an '*Extraordinary Event*' as defined by Schedule 3, Condition 16 of SSD-4960. An elevated PM_{10} level was also recorded at the OEH Mt Thorley and Singleton monitors.	All mining and rehabilitation activities were stopped upwind of the Mushroom Composting Facility early into the 13-hour assessment period (approx. 11am) in response to TARP triggers. The Mushroom Composters were notified of the actions implemented to control dust.
20 July 2018	Bulga Coal measured a 13µg/m³ exceedance of the EEAAQMF PM_{10} Assessment Level at the Mushroom Composting Facility. It was a regional dust event on this day with strong north-westerly winds.	All mining and rehabilitation activities were stopped upwind of the Mushroom Composting Facility early into the 13-hour assessment period (approx. 11am) in response to TARP triggers. The Mushroom Composters were notified of the actions implemented to control dust.
15 August 2018	Bulga Coal measured an 11µg/m³ exceedance of the EEAAQMF PM10 Assessment Level at the Mushroom Composting Facility. Strong west-north-westerly winds occurred during the day. An elevated PM_{10} level was also recorded at the OEH Mount Thorley monitor.	No mining, clearing and rehabilitation activities upwind of the Mushroom Composting Facility. The Mushroom Composters were notified of the action taken to control dust.

Date	Details of the Non-Compliance	Corrective Actions
19 September 2018	Bulga Coal measured a 2µg/m³ exceedance of the EEAAQMF PM_{10} Assessment Level at the Mushroom Composting Facility. Strong north-westerly winds occurred. An elevated PM_{10} level was also recorded at the OEH Mt Thorley monitor.	Bulga Coal ceased overburden handling and rehabilitation upwind of the Mushroom Composting Facility early into the 13-hour assessment period (approx. 9:30am) in response to TARP triggers. The Mushroom Composters were notified of the action taken to control dust. The Mushroom Composting Facility advised that they also watered the Mushroom Composting Facility access road in response.
2 November 2018	Bulga Coal measured a 31µg/m³ exceedance of the EEAAQMF PM_{10} Assessment Level at the Mushroom Composting Facility. Strong north-westerly winds occurred during the day.	Bulga Coal ceased hauling, dozing and dumping overburden at the Eastern Emplacement Area downwind of the Mushroom Composting Facility (no upwind activities occurred). The Mushroom Composters were notified of the action taken to control dust.
22 November 2018	Bulga Coal measured a 173µg/m³ exceedance of EEAAQMF PM10 Assessment Level at the Mushroom Composting Facility. There was a regional dust storm that occurred during 21 -23 November 2018, with strong north-westerly winds occurring on this day. An elevated PM_{10} level was also recorded at the OEH Mt Thorley and Singleton monitors.	No rehabilitation or clearing activities occurred upwind of the Mushroom Composting Facility. The downwind overburden dump was shut down at 9:00 am in accordance with the EEAAQMF dust TARP.

11.2 EPL 563 Condition O1.1 – Failure to Carry out Operations in a Competent Manner

11.2.1 Details of the Incident/Non-compliance

As outlined in **Section 6.4**, Bulga Coal received a Show Cause Notice from the EPA with regard to excessive dust emissions in November 2018. Following Bulga Coal's response the EPA issued an Official Caution Notice on 14 December 2018. The EPA stated that "*the EPA is of the opinion that the operations observed on 3 November 2018 between 10:50am to 11:50am constitute Bulga failing to carry out licensed activities in a competent manner as required by condition O1.1 of the Licence, which is a breach of section 64 of the Act*".

11.2.2 Corrective Actions

Bulga provide additional training to the entire workforce with regard to the management of dust emissions (refer **Section 6.4**), including the requirement to stop operating in exposed locations during adverse weather conditions to minimise visible dust.

11.3 Aboriginal Cultural Heritage

11.3.1 Details of the Incident / Non-compliance

As detailed in **Section 6.9.3**, two Aboriginal heritage sites were impacted during 2018. OEH and the DPE were notified of the incident on 6 September 2018 and provided with a detailed report on 12 September 2018.

11.3.2 Corrective Actions

Bulga Coal committed to revising the ACHMP to include a form that must be filled out upon the identification of a new archaeological site to prevent an accident like this from occurring again. Bulga Coal revised the ACHMP and distributed the draft (along with notification of the incident) for RAP consultation on 20 September 2018. Bulga Coal has submitted the revised ACHMP to the DPE and OEH for review.

11.4 Administrative Non-Compliances

There were four administrative non-compliances during 2018. The non-compliances and the corrective actions implemented are detailed in **Table 45**.

Table 45 Administrative Non-Compliances

Approval / Condition	Details of the Non-Compliance	Corrective Actions
EPBC 2012/6637 Condition 2	On 6 September 2018 the DEE advised Bulga Coal of a Potential Breach of EPBC 2012/6637 Condition 2 which requires Bulga Coal to provide for the protection of offset lands through a conservation covenant which was due to be finalised by 3 December 2017. A response was provided on 28 September 2018 and on 4 October 2018 DEE advised that they advised that Bulga Coal was non-compliant with Condition 2 of EPBC 2012/6637. Bulga Coal was unable to meet the timeline largely due to Glencore (on behalf of Bulga Coal and other Glencore sites) being unable to agree on a conservation mechanism with OEH. Bulga Coal has finalised the conservation agreements and is currently organising to return them for execution by the Minister.	Bulga Coal will continue to keep DEE informed of the progress of the conservation covenants.
EPBC 2012/6637 Condition 9	On 6 September 2018 the DEE advised Bulga Coal of a Potential Breach of EPBC 2012/6637 Condition 9 which required for Bulga Coal to publish the Annual Review on the public website by 31 March 2018. The Bulga Coal Annual Review was provided to the DEE on 29 March 2018 via file transfer however it was not place on the website until 4 April 2018 (first working day after Easter).	Bulga Coal accepted that the report publication was not provided as part of the notification process and updated site procedures to include it in subsequent years.
AUTH 450 Condition 7	Bulga Coal was required to submit an Annual Community Consultation Report for AUTH 450 on 27 January 2018 in accordance with Condition 7 of AUTH 450. Bulga became aware of this during an internal compliance audit.	Bulga Coal accepted that the report was not provided and updated site procedures to include it in subsequent years.
EPL 563 M8.4	The two continuous air quality monitors at the EPL premises boundary did not record valid data on a number of occasions during 2018 due to technical issues.	On each occasion appropriate repairs or replacements were made.

12 Activities to Be Completed In the Next Reporting Period

Bulga Underground Operations

The works listed in **Table 46** have been/will be completed in 2019 at Bulga Underground Operations.

Table 46 Bulga Underground Operations Proposed Activities in 2019

Topic	Proposed Activity	By When
Approvals	Submit post-mining independent environmental compliance audit report for the Commonwealth Subsidence Management Plan.	Q1 2019
Decommissioning	Decommission and demolish remaining Bulga Underground Operations surface infrastructure.	Q2 2019
	Decommission and seal 16 boreholes.	Q4 2019
Rehabilitation	Rehabilitation of gas drainage infrastructure on Commonwealth land as approved under access agreement.	Q3 2019
	Progressive rehabilitation of redundant gas drainage infrastructure, access tracks, pipelines and boreholes on Bulga Coal land.	Q4 2019

Bulga Open Cut

The works listed in **Table 47** have been/will be completed in 2019 at Bulga Open Cut.

Table 47 Bulga Open Cut Proposed Activities in 2019

Topic	Proposed Activity	By When
Construction	Construction of new Aboriginal Teaching and Keeping Place at the Wollombi Brook Conservation Area.	Q4 2019
	Construct the water management infrastructure at the Eastern Emplacement area in accordance with the Eastern Emplacement Area Modification SEE.	Q4 2019
Approvals	Submit a MOP variation to include the land disturbance works associated with construction of the water management infrastructure at the Eastern Emplacement Area.	Q2 2019
	Modification to SSD-4960 for the relocation of tailings to allow mining of underlying resource.	2019
	Submit application for Eastern Area Sublease to Bulga Coal within the Mount Thorley Operations CL 219.	Q2 2019
Rehabilitation	Complete development and rehabilitation of Noise and Visual Bund.	August 2019
	Completion of statutory capping of the Old Tailings Dam.	Q4 2019
Tailings	Commence use (Cell A) of the Northern Tailings Storage Facility for tailings emplacement.	Q1 2019
	Construction of Cell B in the new Northern Tailings Storage Facility.	Q4 2019

13 References

Bell, S.A.J. (2018) *Monitoring of* Acacia pendula *in the Weeping Myall Management Areas, Bulga Coal, Singleton LGA*. Unpublished Report to Bulga Surface Operations (Glencore). October 2018. Eastcoast Flora Survey.

Bell, S.A.J. & Murray, M. (2019a) *Flora and Fauna Monitoring at Broke Road BOA, Singleton LGA: 2018 Results*. Unpublished Report to Bulga Surface Operations (Glencore). January 2019. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.

Bell, S.A.J. & Murray, M. (2019b) *Flora and Fauna Monitoring at Condran BOA, Singleton LGA: 2018 Results*. Unpublished Report to Bulga Surface Operations (Glencore). January 2019. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.

Bell, S.A.J., Murray, M. & Sims R. (2019c) *Flora and Fauna Monitoring at Reedy Valley BOA, Singleton LGA: 2018 Results*. Unpublished Report to Bulga Surface Operations (Glencore). January 2019. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.

Bell, S.A.J., Murray, M. & Sims R. (2019d) *Flora and Fauna Monitoring at WBCA BOA, Singleton LGA: 2018 Results*. Unpublished Report to Bulga Surface Operations (Glencore). March 2018. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.

Bulga Underground, 2015, *Bulga Underground Operations Mining Operations Plan 2015 to 2021*.

David, K. 2019, *Annual Groundwater Assessment Report for Blakefield South.*

Department of Environment, Water, Heritage and the Arts (DEWHA) 2008, *National Greenhouse and Energy Reporting (Measurement) Determination.*

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education 2013, *National Greenhouse Accounts Factors.*

DRE 2013, *ESG3: Mining Operations Plan (MOP) Guidelines*

Emergent Ecology 2018, *2018 Rehabilitation Monitoring Report for Bulga Coal Complex.*

Emergent Ecology 2019, *2018 Ecological Monitoring Report for Bulga Coal Complex.*

Environment Protection Agency (EPA) 2000, *NSW Industrial Noise Policy.*

Global Acoustics 2013, *Bulga Optimisation Project – Revised Project Environmental Noise Assessment.*

Global Acoustics 2019, *Bulga Surface Operations Mobile Plant Sound Power Survey 2016 – 2018 December 2018 Progress Report.*

Global Acoustics 2018, *Environmental Noise Monitoring Quarters 1 to 4 2018.*

Global Acoustics 2019, *Long-term noise trends for Bulga Coal.*

GSS Environmental 2013, *Common Boundary Rehabilitation Plan*.

Horn, P. 2015, *2015 Independent Environmental Audit, Bulga Coal Complex.*

Jacobs 2016, *Bulga Open Cut Eastern Emplacement Area Modification Air Quality Impact Assessment.*

Jansen, A., Robertson, A., Thompson, L. & Wilson, A., 2005, '*Rapid appraisal of riparian condition, version 2*', River Management Technical Guideline No. 4A, Land & Water Australia, Canberra.

Mackie Environmental Research 2013, *Assessment of Groundwater Related Impacts Arising From The Proposed Bulga Optimisation Project.*

MSEC 2018, *End of Panel Subsidence Monitoring Review Report for Blakefield South Longwall 1B MSEC941.*

PlantNet 2010*, ROTAP Coding System* http: http://anpsa.org.au/coding.html

RPS 2018, *2018 Annual Fauna Monitoring Report, Bulga Coal.*

SLR Consulting 2014, *Bulga Open Cut Mining Operations Plan December 2014 to December 2021.*

SLR Consulting 2018a, *Bulga Open Cut Mining Operations Plan: 29 May 2018 – 31 December 2023.*

SLR Consulting 2018b, *Bulga Underground Operations – Mining Operations Plan: 29 May 2018 – 31 December 2023.*

Standards Australia 1993, *AS 1940 – 2004 Storage and Handling of Flammable and Combustible Liquids.*

Standards Australia 1998, *AS 5667.11 – 1998 Water Quality Sampling – Guidance on Sampling of Ground Waters.*

Standards Australia 1998, *AS 5667.4 – 1998 Water Quality Sampling – Guidance on Sampling from Lakes, Natural and Man-made.*

Standards Australia 1998, *AS 5667.6 – 1998 Water Quality Sampling – Guidance on Sampling of Rivers and Streams.*

Standards Australia 2003, *AS 3580.10.1 – 2003 Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method.*

Standards Australia 2009, *AS/NZS ISO 31000:2009 Risk Management – Principles and Guideline.*

Standards Australia 2015, *AS/NZS 3580.9.3:2015 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method.*

Todoroski Air Sciences 2019, *Air Quality Monitoring Data Review and Analysis at Bulga Complex 2018.*

Umwelt 2012, *Greenhouse Gas and Energy Assessment Bulga Optimisation Project.*

Umwelt 2013a, *Environmental Impact Statement Bulga Optimisation Project.*

Umwelt 2013b, *Surface Water Assessment Bulga Optimisation Project.*

Webb Australia Group 2010. *Bulga Coal Complex Obtrusive Lighting Compliance Report.*

Wilkinson Murray 2012*, Blasting Noise and Vibration Impact Assessment.*

APPENDIX A

EPBC Approval 2012/6637 Compliance Table

Condition	Actions During the Reporting Period	Status
1. The approval holder must not clear more than 611 ha of native woodland vegetation.	422.75 ha of native woodland vegetation has been cleared to date as part of the Project.	Compliant
2. To compensate for the loss of approximately 557 ha of Regent Honeyeater, Swift Parrot and Grey Headed Flying Fox habitat, 611 ha of Large-eared Pied Bat habitat and approximately 65 Slatey Red Gum trees, the approval holder must provide for the protection of offset lands identified in the maps at Schedule 1 of this notice as: • Reedy Valley Offset Site; • Wollombi Brook Conservation Area; • Broke Road Offset Site. These offset lands must meet the requirements of the EPBC Offsets Policy and provide for the protection of threatened species habitat on these sites for the duration of the action's impact through a legally binding conservation covenant which must be in force within 3 years of the commencement of the action. Written evidence of compliance against this condition must be provided to the Department prior to the commencement of the action including evidence that action is being taken to put in place a suitable legally binding conservation covenant.	On 6 September 2018 the DEE advised Bulga of a Potential Breach of EPBC 2012/6637 Condition 2 which requires Bulga to provide for the protection of offset lands through a conservation covenant which was due to be finalised by 3 December 2017. A response was provided on 28 September 2018 and on 4 October 2018 DoE advised that they advised that Bulga was non-compliant with Condition 2 of EPBC 2012/6637. Bulga was unable to meet the timeline largely due to Glencore (on behalf of Bulga Coal and other Glencore sites) being unable to agree on a conservation mechanism with OEH. Bulga Coal has finalised the conservation agreements and is currently organising to return them for execution by the Minister. An update was provided to DoE on 19 December 2018. Bulga Coal will continue to keep DoE informed of the progress of the conservation covenants.	Non-compliant
3. The approval holder must submit for the Minister's approval a Biodiversity Management Plan (BMP) which provides for the offsetting of residual impacts to matters of national environmental significance including but not limited to: • Regent Honeyeater; • Swift Parrot; • Large-eared Pied Bat; • Slatey Red Gum. The BMP must include: a). management actions designed to improve the ecological quality of habitat for the above species on offset lands identified in Condition 2 and protect these sites from ecological degradation for the duration of the action's impact on matters of national environmental significance;	The Biodiversity Management Plan was submitted to the former Department of Environment (now DEE) on 23 February 2015. The DEE provided comments on the draft plan in April 2016, December 2016 and April 2017 and subsequently approved the document in April 2017.	Compliant
b). an ecological monitoring program to monitor the success of the management actions in the BMP and define measurable targets of management actions, performance indicators, and an adaptive management framework for the duration of the action's impact on habitat for matters of national environmental significance. Management actions prescribed by the BMP must be clear, measurable, auditable and time bound;	The Biodiversity Management Plan contains an ecological monitoring program. Program commenced in 2015. Results are summarised in this Annual Review.	Compliant
c). clear objectives and performance indicators as well as corrective actions for circumstances where a management action fails to meet its prescribed objective or performance indicator. The BMP must be approved in writing by the Minister within 3 months of approval of the action. The approved BMP must be implemented and must be published on the approval holder's website within one month of approval of the BMP and remain published on this website for the duration of the action.	The Biodiversity Management Plan meets the requirements of this condition. The Biodiversity Management Plan was approved by the DEE in April 2017. The draft version of the plan as submitted to DEE is available on the Bulga Coal website.	Compliant
4. The approval holder must submit for the Minister's approval a Water Management Plan (WMP) which provides for the avoidance, mitigation and offsetting of residual impacts to water resources. The WMP must include:	The Water Management Plan was approved by the DEE in February 2017.	Compliant

Condition	Actions During the Reporting Period	Status
a). management actions, mitigation measures and practices designed to limit impacts of the proposal on surface and groundwater resources;		
b). surface and groundwater monitoring programs to monitor the success of the management actions in the WMP and define measurable targets of management actions, performance indicators, and an adaptive management framework for the duration of the action's impact on water resources. Management actions, mitigation measures and practices prescribed by the plan must be clear, measurable, auditable and time bound;	The Water Management Plan meets the requirements of this condition.	Compliant
c). clear objectives and performance indicators, as well as corrective actions for circumstances where a management action, mitigation measure or practice fails to meet its prescribed objective or performance indicator. The WMP must be approved in writing by the Minister within 3 months of commencement of the action. The approved WMP or plan revised under condition 12 must be implemented.	The Water Management Plan meets the requirements of this Condition. The Water Management Plan was approved by the DEE in February 2017.	Compliant
5. The approval holder must provide written evidence and detailed documentation relating to the conservation covenant specified in Condition 2 to the Department within one month of the conservation covenant coming into force. This must include offset attributes, shapefiles and textual descriptions and maps to clearly define the location and boundaries of the offset sites.	This condition has not been triggered to date as the conservation covenant has not come into force.	Not applicable
6. Unless otherwise agreed to in writing by the Minister, the approval holder must provide the approved plans referred to in these conditions of approval to members of the public upon request. Copies must be provided within 14 days of the request.	There have been no requests from members of the public to provide approved plans referred to in the conditions of approval. Notwithstanding, the approved plans are available to the public on the Bulga Coal website.	Compliant
7. Within 30 days after the commencement of the action, the approval holder must advise the Department in writing of the actual date of commencement of the action.	Action under this approval commenced 3 December 2014. Notification of the commencement of the action was provided by Bulga Coal to the DEE on 2 December 2014.	Compliant
8. The approval holder must maintain accurate records substantiating all activities associated with or relevant to these conditions of approval, including measures taken to implement the management plans, and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be published on the Department's website. The results of audits may also be publicised through the general media.	Accurate records substantiating all activities associated with conditions of approval are maintained in accordance with the Bulga Coal Environmental Management System. Results are also summarised in the Bulga Coal Annual Review. There have been no audits to date.	Compliant
9. By 31 March each year, the approval holder must publish a report on their website addressing compliance with each of the conditions of this approval including implementation of the management plans for the previous calendar year (i.e. 01 January to 31 December). Documentary evidence providing proof of the date of publication must be provided to the Department at the same time as the compliance report is published.	The Bulga Coal Annual Review was provided to the DoE on 29 March 2018 via file transfer however it was not put up onto the website until 4 April 2018 (first working day after Easter).	Non-Compliant
9A. Potential or actual contraventions of conditions of approval must be reported to the Department in writing within 2 business days of the approval holder becoming aware of the actual or potential contravention. All contraventions must also be included in the annual compliance report outlined in condition 9.	Bulga Coal reported the non-compliance with condition 2 to the Department on 21 December 2017, which was within two days of Bulga becoming aware of the potential non-compliance. In regards to condition 9, Bulga only became aware of the issue on receipt of the letter from the DoE.	Compliant
10. Upon the direction of the Minister, the approval holder must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be	No directions for an independent audit of compliance with	Compliant

Condition	Actions During the Reporting Period	Status
approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.	EPBC Ref: 2012/6637 have been received by Bulga Coal.	
11. If, at any time after five (5) years from the date of this approval, the approval holder has not commenced the action, then the approval holder must not commence the action without the written agreement of the Minister.	Action under EPBC Ref: 2012/6637 was commenced 3 December 2014.	Compliant
12. The approval holder may choose to revise a plan approved by the Minister under condition 4 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the revised plan would not be likely to have a new or increased impact. If the approval holder makes this choice they must: i. notify the Department in writing that the approved plan has been revised and provide the Department with an electronic copy of the revised plan. ii. implement the revised plan from the date that the plan is submitted to the Department; and iii. for the life of this approval, maintain a record of the reasons the approval holder considers that taking the action in accordance with the revised plan would not be likely to have a new or increased impact.	This Condition was not triggered during the reporting period.	Compliant
12A. The approval holder may revoke their choice under condition 12 at any time by notice to the Department. If the approval holder revokes the choice to implement a revised plan, without approval under section 143A of the Act, the plan approved by the Minister must be implemented.	This Condition was not triggered during the reporting period.	Compliant
12B. Condition 12 does not apply if the revisions to the approved plan include changes to environmental offsets provided under the plan in relation to a matter protected by the controlling provision for the action, unless otherwise agreed by the Minister. This does not otherwise limit the circumstances in which the taking of the action in accordance with a revised plan would, or would not, be likely to have new or increased impacts.	This Condition was not triggered during the reporting period.	Compliant
12c. If the Minister gives a notice to the approval holder that the Minister is satisfied that the taking of the action in accordance with the revised plan would be likely to have a new or increased impact, then: i. Condition 12 does not apply, or ceases to apply, in relation to the revised plan; and ii. The approval holder must implement the plan approved by the Minister. To avoid any doubt, this condition does not affect any operation of conditions 12, 12A and 12B in the period before the day the notice is given. At the time of giving the notice the Minister may also notify that for a specified period of time that condition 12 does not apply for one or more of the specified plans required under the approval.	This Condition was not triggered during the reporting period.	Compliant
12D. Conditions 12, 12A, 12B and 12C are not intended to limit the operation of section 143A of the EPBC Act which allows the approval holder to submit a revised plan, to the Minister for approval.	This Condition was not triggered during the reporting period.	Compliant
13. Condition 13 has been revoked.		
14. Unless otherwise agreed to in writing by the Minister, the Approval holder must publish all management plans referred to in these conditions of approval on their website. Each Management plan must be published on the website within 1 month of being approved by the minister or being submitted under condition 12i, and remain published for the duration of the action.	The Biodiversity Management Plan and Water Management Plan were approved by the DEE in April 2017 and February 2017 respectively. The approved plans are available on the Bulga Coal website.	Compliant

APPENDIX B

Long-term noise trends for Bulga Coal (Global Acoustics, 2019)

Global Acoustics
Noise and Vibration Analysis and Solutions

7 March 2019

Bulga Open Cut
Broke Road
Singleton NSW 2330
Attention: Scott Wolfenden

Dear Scott,

Regarding: Long-term noise trends for Bulga Coal

1 INTRODUCTION

This letter provides information regarding long-term trends in noise generated by Bulga Coal Complex (BCC). Site-only L_{Aeq} noise levels measured during monthly attended environmental noise monitoring over a 5-year period from January 2014 to December 2018 have been collated and graphed to summarise BCC long-term noise performance.

Definitions of terminology that may be used in this document are provided in Table 1.1.

Table 1.1: TERMINOLOGY

Descriptor	Definition
dB	Decibels. For sound pressure level this is 10 times the logarithm to the base 10 of the ratio of the mean-square sound pressure to the square of the reference sound pressure (20 μPa);
dB(A)	Noise level measurement units are decibels (dB). The A-weighting scale is used to approximate human perception of noise
SPL	Sound pressure level
L_{Aeq}	The average A-weighted noise energy (in dB) for a measurement period
L_{A90}	The noise level (in dB) exceeded for 90 percent of a measurement period, also known as the background level

2 BCC NOISE PERFORMANCE

Monthly attended noise monitoring data collected at ten locations (BCC1 to BCC10) from January 2014 to December 2018 inclusive was evaluated. In some cases, less than five years of data was available due to monitoring either ceasing or commencing at three locations during the 5-year period evaluated.

The BCC-only L_{Aeq} for each monitoring event has been categorised into one of four categories:

1. inaudible(IA)/not measurable(NM);
2. less than or equal to 30 dB;
3. less than or equal to the relevant impact assessment criterion; or
4. greater than the impact assessment criterion for that location.

For each calendar year, the percentage of occurrence for each of these categories is shown.

Figure 1 to Figure 10 provide percentage occurrence information for BCC noise levels at BCC1 through BCC10. A brief summary of long-term noise trends measured at each location is provided after each corresponding figure.

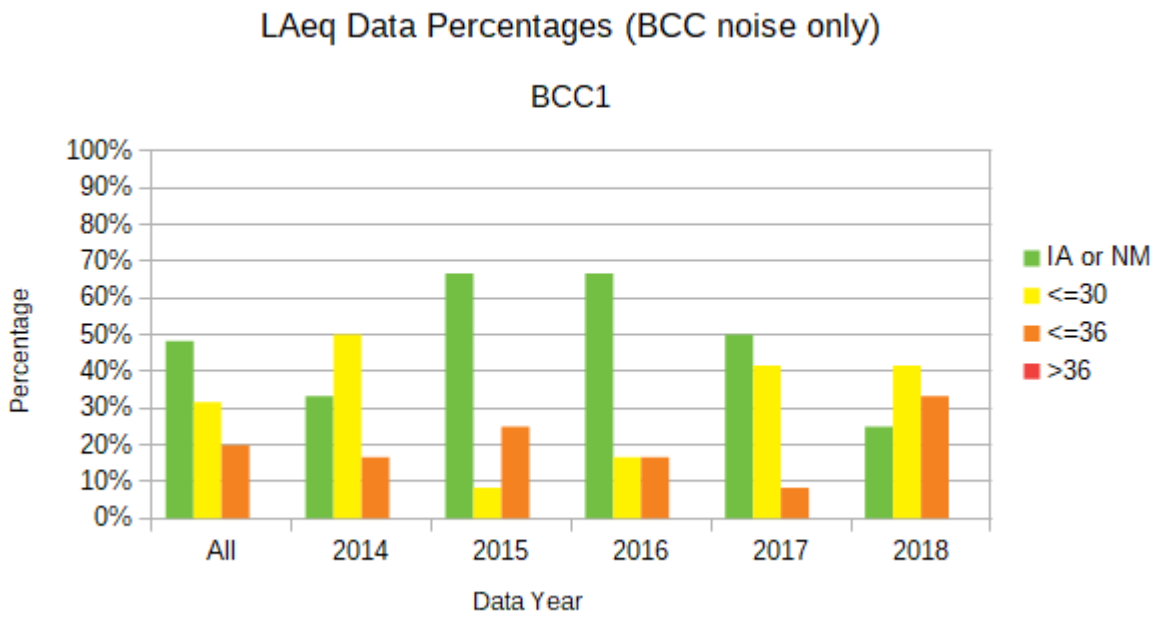


Figure 1: Attended noise monitoring data, BCC1

The percentage of measurements where BCC was IA or NM decreased from 2015 to 2018, whereas the percentage of measurements where BCC was less than or equal to the criterion of 36 dB increased. Therefore, site-only noise measured at BCC1 showed an upward trend during the period from 2015 to 2018.

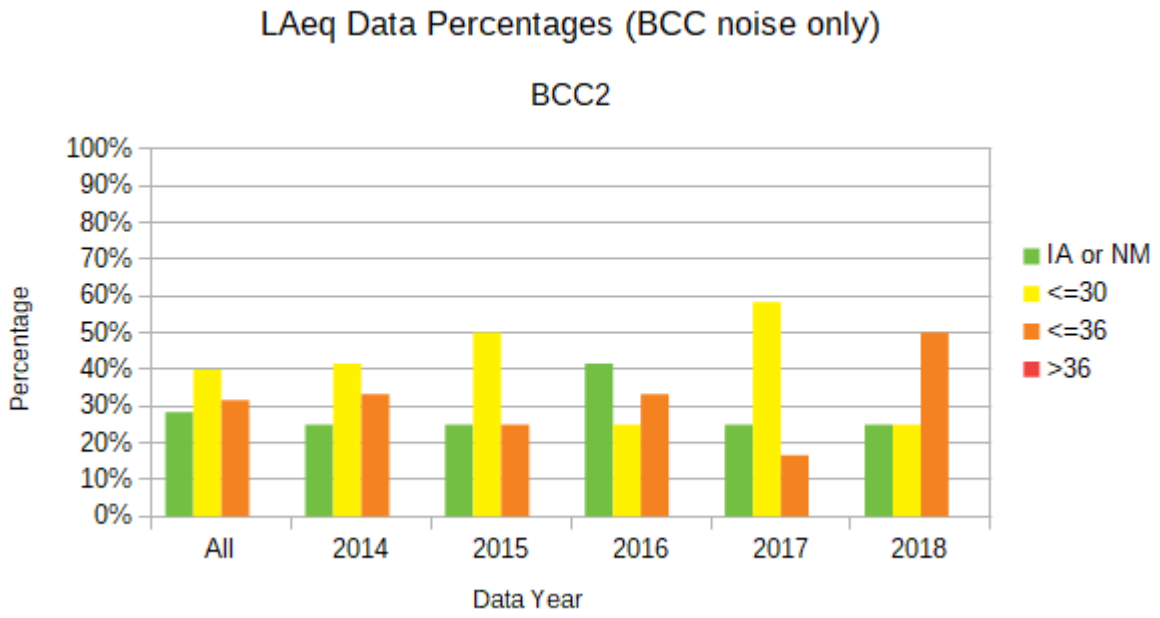


Figure 2: Attended noise monitoring data, BCC2

The percentage of measurements where BCC was between 30 and 36 dB increased in 2018 compared to previous years at BCC2.

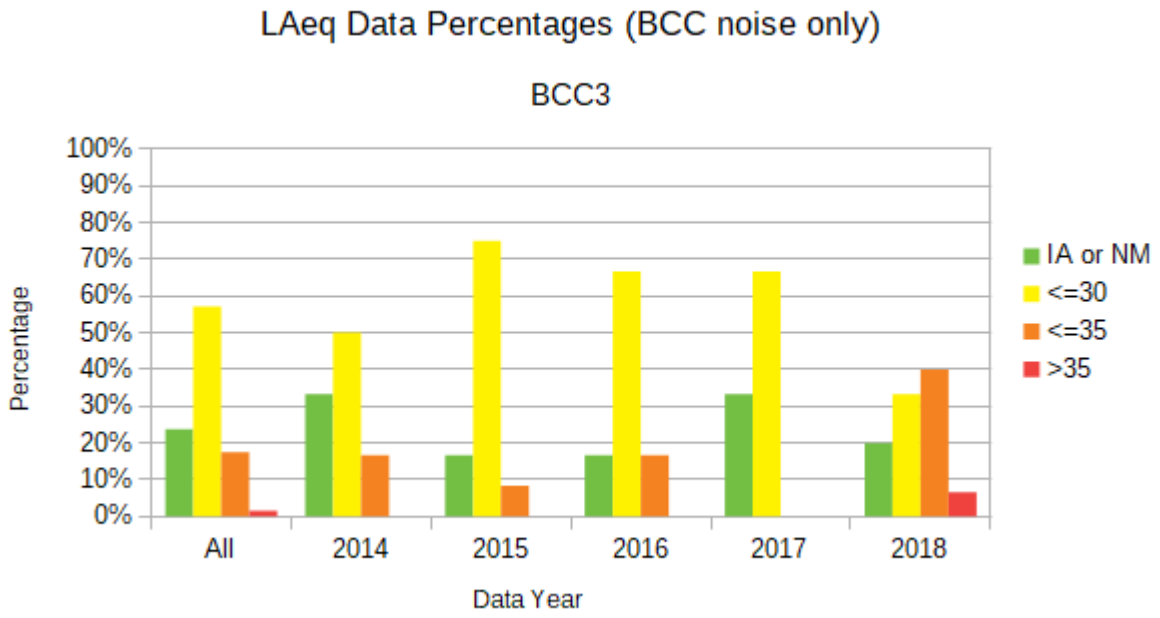


Figure 3: Attended noise monitoring data, BCC3

The percentage of measurements where BCC was near the criterion of 35 dB increased in 2018 compared to previous years at BCC3.

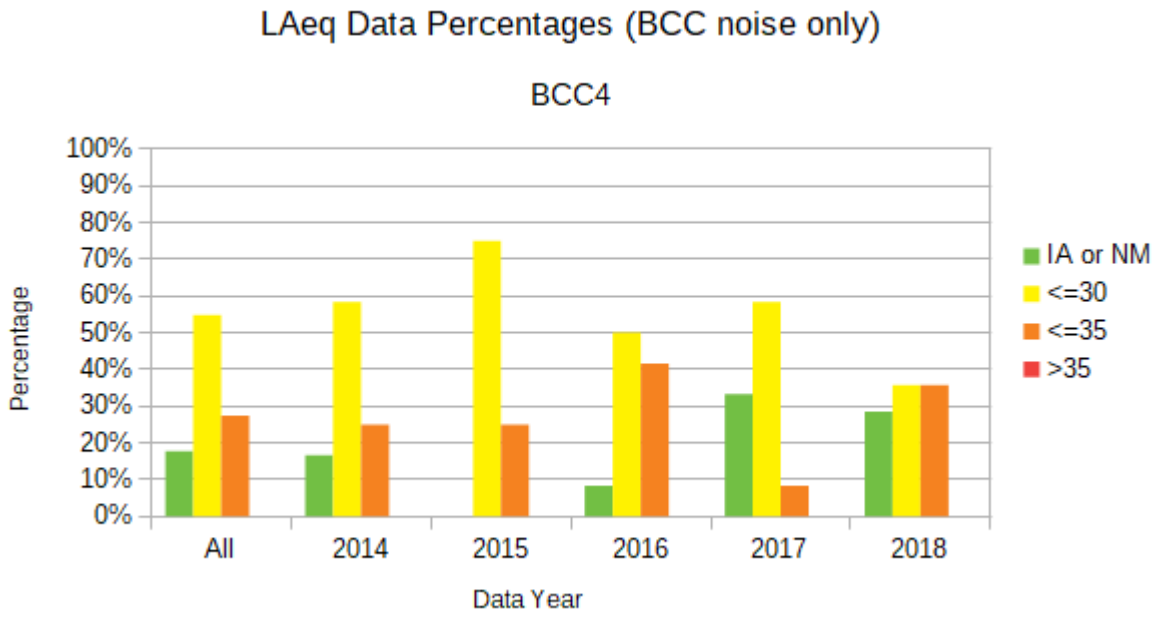


Figure 4: Attended noise monitoring data, BCC4

There were no significant trends in site-only noise measured at BCC4.

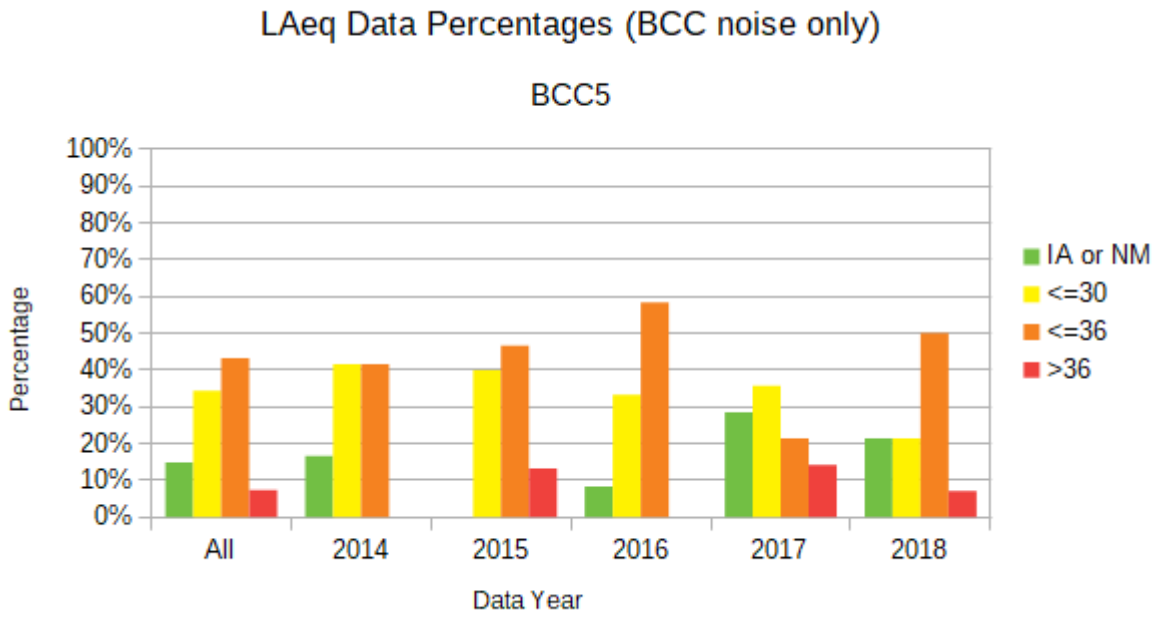


Figure 5: Attended noise monitoring data, BCC5

There were no significant trends in site-only noise measured at BCC5.

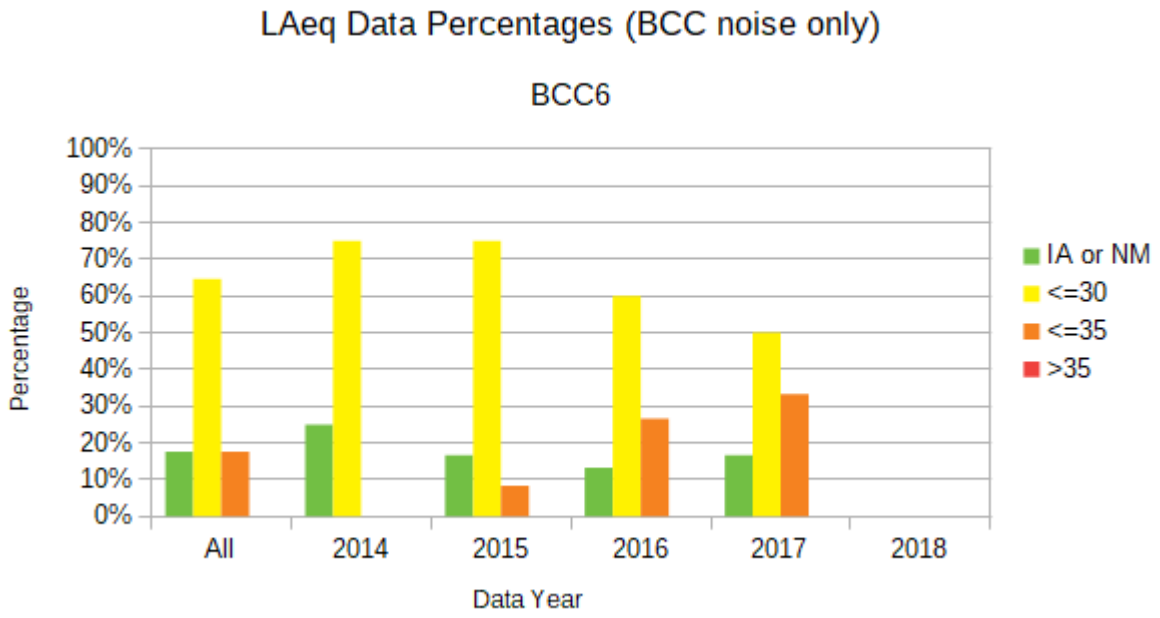


Figure 6: Attended noise monitoring data, BCC6

Noise monitoring at at BCC6 ceased in 2017. The percentage of measurements where BCC was between 30 and 35 dB increased from 2014 to 2017.

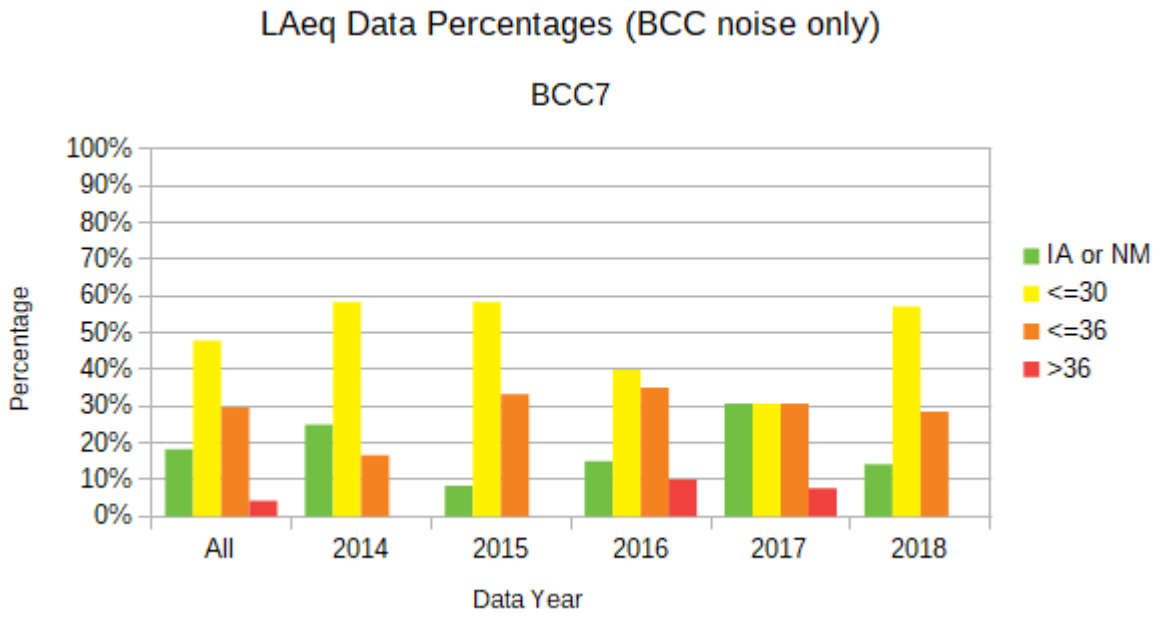


Figure 7: Attended noise monitoring data, BCC7

There were no significant trends in site-only noise measured at BCC7.

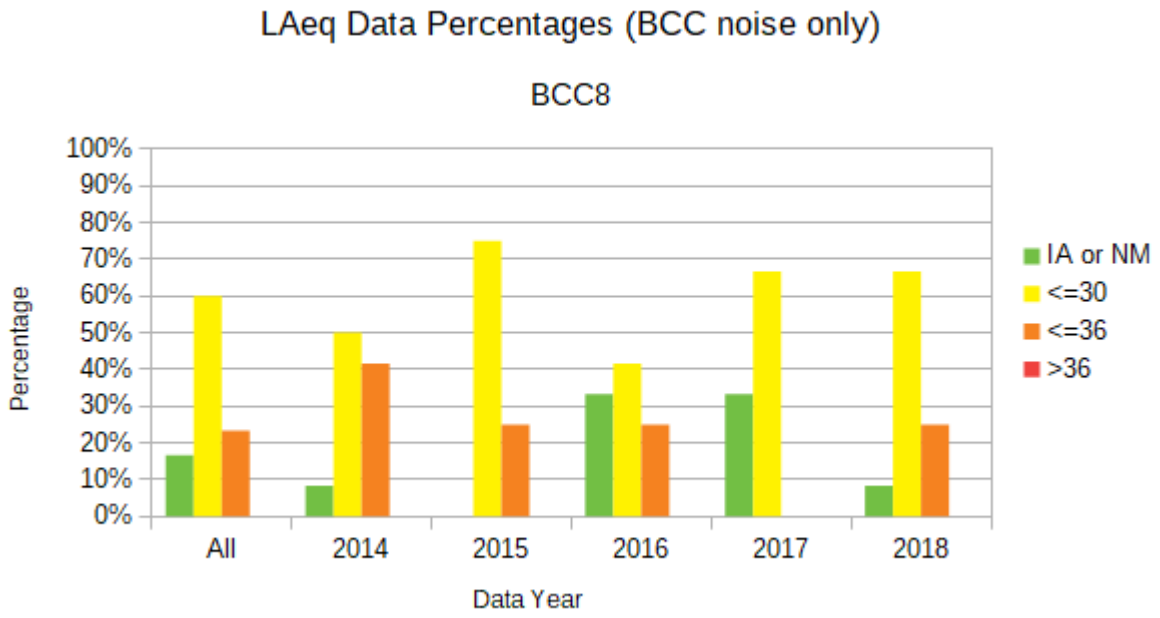


Figure 8: Attended noise monitoring data, BCC8

There were no significant trends in site-only noise measured at BCC8.

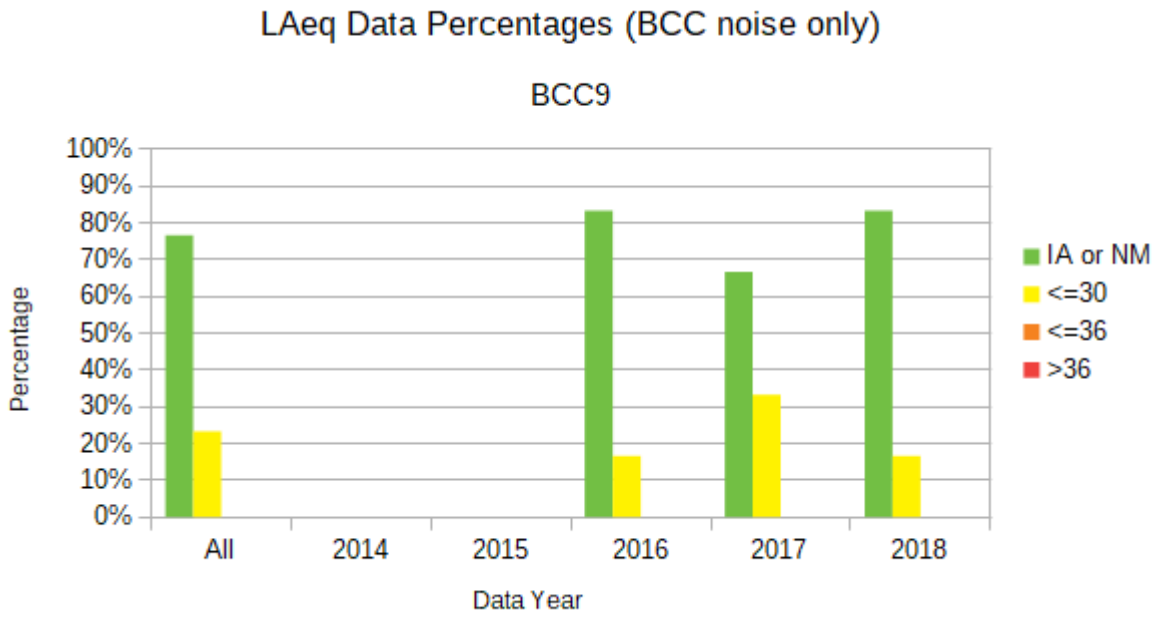


Figure 9: Attended noise monitoring data, BCC9

Noise monitoring at this location commenced in 2016. There were no significant trends in site-only noise measured at BCC9.

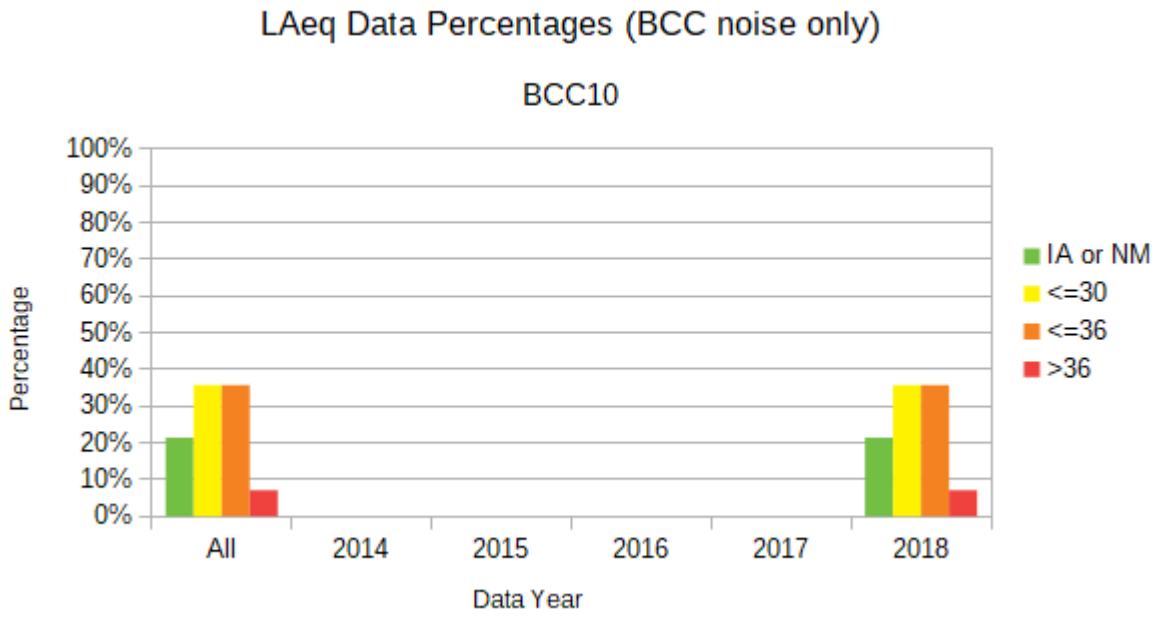


Figure 10: Attended noise monitoring data, BCC10

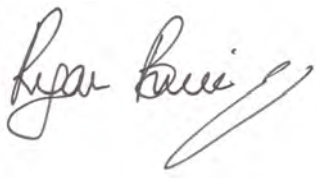
Noise monitoring at this location commenced in 2018. Not enough data was available to assess long-term trends in site-only noise at BCC10.

3 SUMMARY

BCC-only L_{Aeq} noise levels measured during monthly noise monitoring over a 5-year period have been collated and graphed to summarise long-term noise trends.

- At 4 monitoring locations, noise from BCC showed an upward trend during the assessment period;
- At 5 monitoring locations, there were no significant trends, neither increasing nor decreasing, observed in noise from BCC; and
- At 1 monitoring location, not enough data was available to comment on long-term trends.

I trust this information meets your requirements. If you have any questions or need further details please contact me.



Prepared: Jesse Tribby
Consultant

QA review: Ryan Bruniges
Consultant

APPENDIX C

Air Quality Monitoring Data Review and Analysis at Bulga Complex 2018
(Todoroski, 2019)

AIR QUALITY MONITORING DATA REVIEW AND ANALYSIS AT BULGA COMPLEX 2018

Bulga Coal

23 January 2019

Job Number 14070348K

Prepared by
Todoroski Air Sciences Pty Ltd
Suite 2B, 14 Glen Street
Eastwood, NSW 2122
Phone: (02) 9874 2123
Fax: (02) 9874 2125
Email: info@airsciences.com.au

Air Quality Monitoring Data Review and Analysis at Bulga Complex 2018

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	22/01/2019	K Trahair	D Kjellberg
FINAL - 001	23/01/2019	K Trahair	P Henschke

This report has been prepared in accordance with the scope of works between Todoroski Air Sciences Pty Ltd (TAS) and the client. TAS relies on and presumes accurate the information (or lack thereof) made available to it to conduct the work. If this is not the case, the findings of the report may change. TAS has applied the usual care and diligence of the profession prevailing at the time of preparing this report and commensurate with the information available. No other warranty or guarantee is implied in regard to the content and findings of the report. The report has been prepared exclusively for the use of the client, for the stated purpose and must be read in full. No responsibility is accepted for the use of the report or part thereof in any other context or by any third party.

TABLE OF CONTENTS

1 INTRODUCTION 1
2 PROJECT SETTING AND METEOROLOGY 2
3 COMPARISON OF MEASURED 2018 DATA AND MODEL PREDICTIONS 5
3.1 Annual average PM_{10} 5
3.2 Annual average TSP 6
3.3 Annual average deposited dust 8
4 AIR QUALITY CRITERIA 10
4.1 Particulate Matter 10
4.1.1 EPA impact assessment criteria 10
4.1.2 DP&E air quality criteria 10
4.1.3 NEPM measure 11
4.1.4 Summary of applicable criteria for this assessment 12
5 LONG TERM REVIEW 13
5.1 $PM_{2.5}$ monitoring data 13
5.2 PM_{10} monitoring data 17
5.3 TSP monitoring data 25
5.4 Deposited dust data 28
6 POLLUTION ROSES 30
6.1 $PM_{2.5}$ data 30
6.2 PM_{10} data 32
7 CONCLUSIONS 39
8 REFERENCES 40

APPENDIX

Appendix A: How to read a windrose and pollution rose

LIST OF TABLES

Table 4-1: EPA air quality impact assessment criteria 10
Table 4-2: Long term criteria for particulate matter 10
Table 4-3: Short term criteria for particulate matter 11
Table 4-4: Long term criteria for deposited dust 11
Table 4-5: NEPM standards for ambient PM_{10} and $PM_{2.5}$ concentrations 11
Table 4-6: Air quality impact assessment criteria used in this assessment 12
Table 5-1: Summary of recorded BAM $PM_{2.5}$ levels 13
Table 5-2: Summary of the recorded TEOM PM_{10} levels 17
Table 5-3: Summary of the recorded HVAS PM_{10} levels 18
Table 5-4: Summary of the recorded HVAS TSP levels 25
Table 5-5: Summary of the annual average deposited dust levels (g/m^2/month) at compliance dust gauges 28

LIST OF FIGURES

Figure 2-1: Site Location 2
Figure 2-2: Annual windroses (2018) 3
Figure 2-3: Windroses for each season of 2018 for the Bulga Complex, Bulga High Wall and Flares weather stations 4
Figure 3-1: TEOM, BAM, HVAS and E-Sampler monitor locations 5
Figure 3-2: 2018 PM_{10} annual average monitoring data superimposed over the predicted PM_{10} annual average modelling contour (Year 3 Bulga plus background) 6
Figure 3-3: 2018 TSP annual average monitoring data superimposed over the predicted TSP annual average modelling contour (Year 3 Bulga plus background) 7
Figure 3-4: Deposited dust gauge locations 8
Figure 3-5: 2018 deposited dust annual average monitoring data superimposed over the predicted deposited dust annual average modelling contour (Year 3 Bulga plus background) 9
Figure 5-1: 24-hour average $PM_{2.5}$ concentrations 14
Figure 5-2: Annual average $PM_{2.5}$ concentrations 15
Figure 5-3: 31-day running average of the 24-hour average $PM_{2.5}$ concentrations with the 31-day running average of daily rainfall and mean daily temperature 16
Figure 5-4: 24-hour average PM_{10} concentrations at TEOM monitors 20
Figure 5-5: 24-hour average PM_{10} concentrations at HVAS monitors 21
Figure 5-6: Annual average PM_{10} concentrations at TEOM and HVAS monitors 22
Figure 5-7: 31-day running average of the 24-hour average PM_{10} concentrations at the TEOM monitors with the 31-day running average of daily rainfall and mean daily temperature 23
Figure 5-8: 30-day running average of the 24-hour average PM_{10} concentrations at the HVAS monitors with the 31-day running average of daily rainfall and mean daily temperature 24
Figure 5-9: 24-hour and annual average TSP concentrations 26
Figure 5-10: 30-day running average of the 24-hour average TSP concentrations with the 31-day running average of daily rainfall and mean daily temperature 27
Figure 5-11: Annual and monthly averages deposited dust at the statutory compliance dust gauges 29
Figure 6-1: Pollution rose for D2 BAM $PM_{2.5}$ data (2018) 30
Figure 6-2: Pollution rose for D10 BAM $PM_{2.5}$ data (2018) 31
Figure 6-3: Pollution rose for D1 TEOM PM_{10} data (2018) 33
Figure 6-4: Pollution rose for D3 TEOM PM_{10} data (2018) 34
Figure 6-5: Pollution rose for D5 TEOM PM_{10} data (2018) 35
Figure 6-6: Pollution rose for D11 TEOM PM_{10} data (2018) 36
Figure 6-7: Pollution rose for D6 E-Sampler PM_{10} data (2018) 37
Figure 6-8: Pollution rose for D7 E-Sampler PM_{10} data (2018) 38

1 INTRODUCTION

This report has been prepared by Todoroski Air Sciences on behalf of Bulga Coal (hereafter referred to as the Proponent). The report presents a review and analysis of the dust monitoring data recorded at the Bulga Complex and includes a comparison between the dust levels measured in 2018 with the modelled predictions for the approximate year (Year 3) per the *Bulga Open Cut Eastern Emplacement Area Modification Air Quality Impact Assessment* (**Jacobs, 2016**) and a long-term trend analysis of air quality data from the beginning of monitoring to the end of 2018.

The review involved analysis of the monitoring data retrieved from:

- the Bulga Complex monitors including High Volume Air Samplers (HVAS), Tapered Element Oscillating Microbalances (TEOMs), Beta Attenuation Monitors (BAMs), E-Samplers and Dust Deposition Gauges; and,
- concurrent meteorological data from the Bulga High Wall, Bulga Complex and Flares weather stations collected over the same period.

2 PROJECT SETTING AND METEOROLOGY

Figure 2-1 presents the location of the Bulga Complex in the context of the Hunter Valley and the Upper Hunter Air Quality Monitoring Network (UHAQMN) monitoring locations.

Figure 2-2 shows the locations of the weather stations at the Bulga Complex, together with the 2018 annual wind distributions at the weather stations. The weather stations experienced similar wind patterns with relatively strong winds from the northwest quadrant, east and east-southeast directions dominating the annual distribution. All stations recorded a relatively large proportion of winds from the south, and very few winds from the northeast. The Flares weather station experienced lower wind speeds compared to the other two stations.

Figure 2-3 shows the seasonal windroses at the weather stations for 2018. The Bulga Met and Bulga Highwall weather stations generally experienced similar seasonal wind patterns. The Flares Met Station recorded a higher percentage of light and calm winds compared to the other weather stations most likely due to sheltering from vegetation.

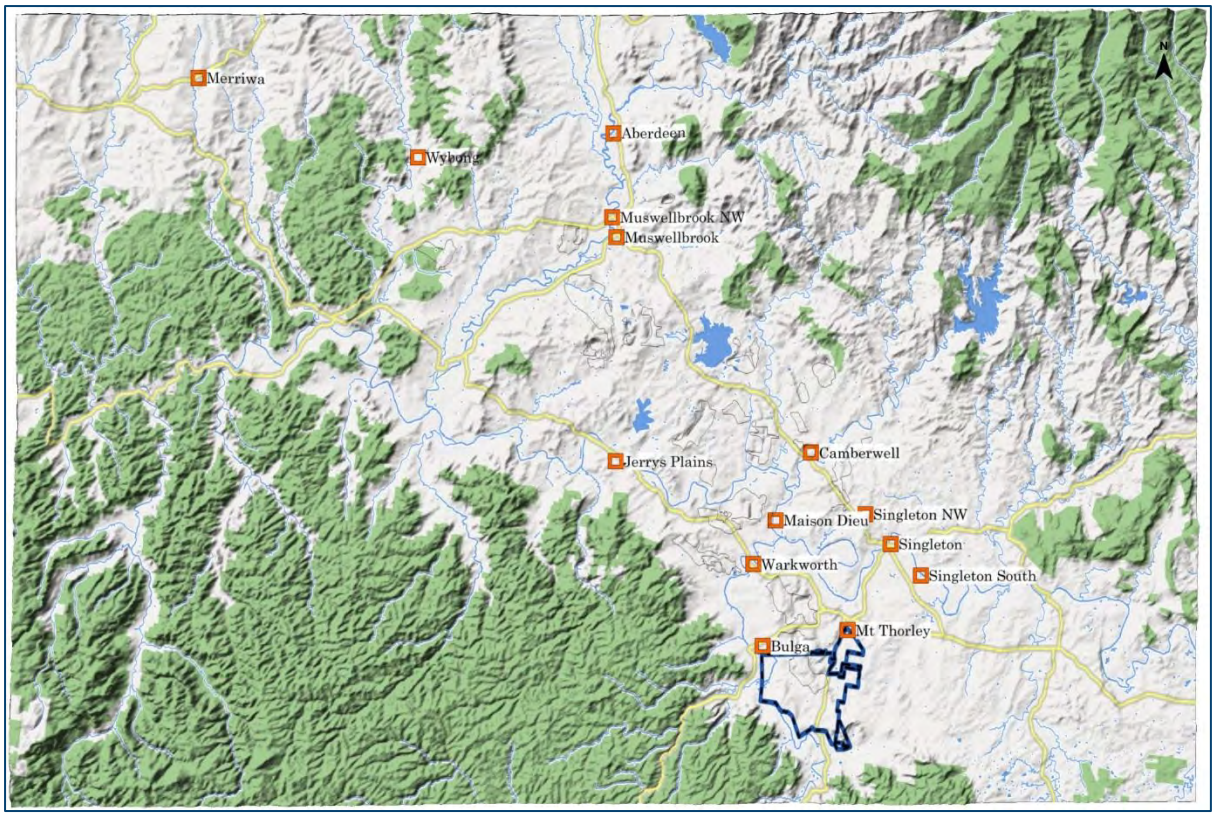


Figure 2-1: Site Location

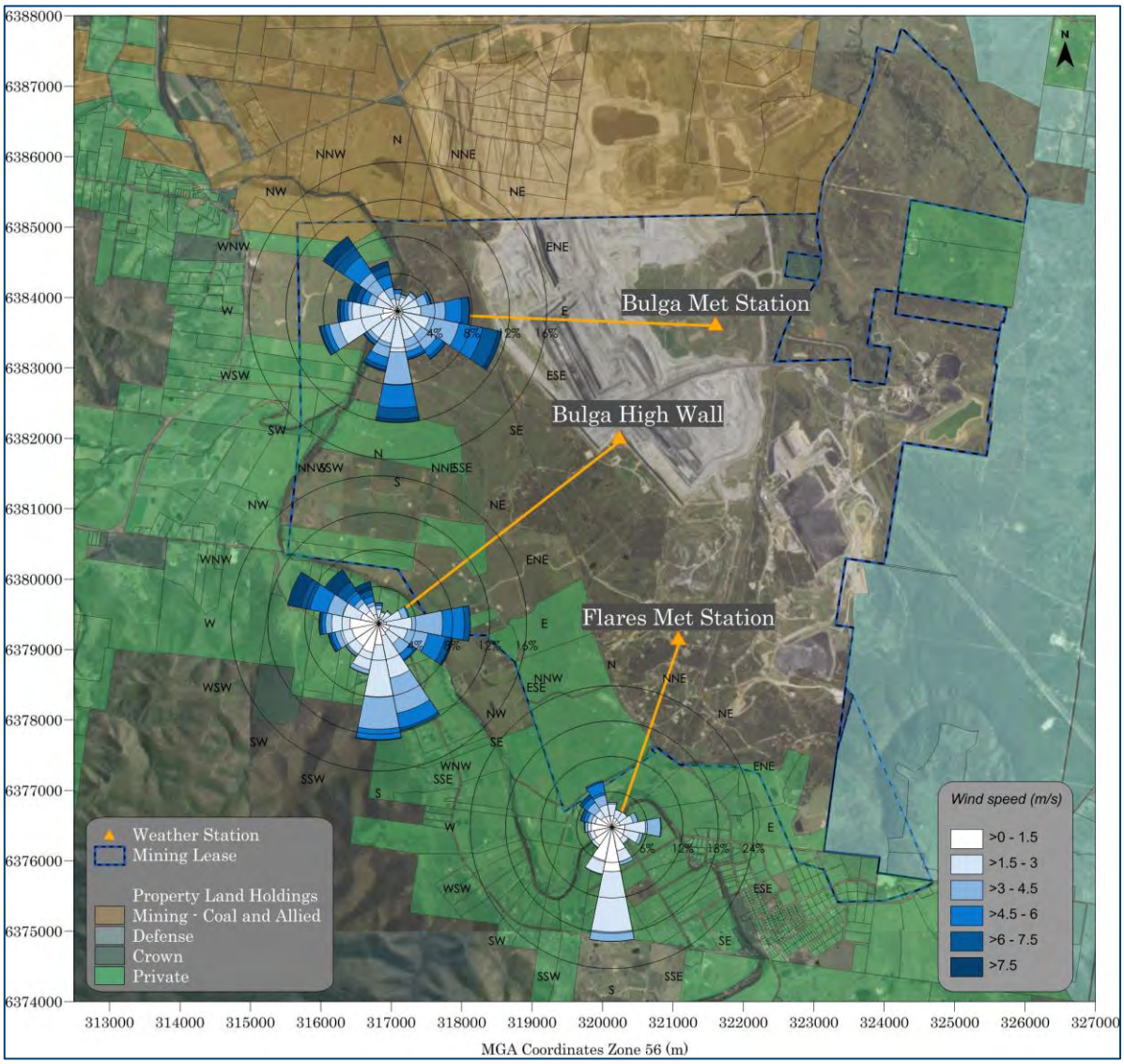


Figure 2-2: Annual windroses (2018)

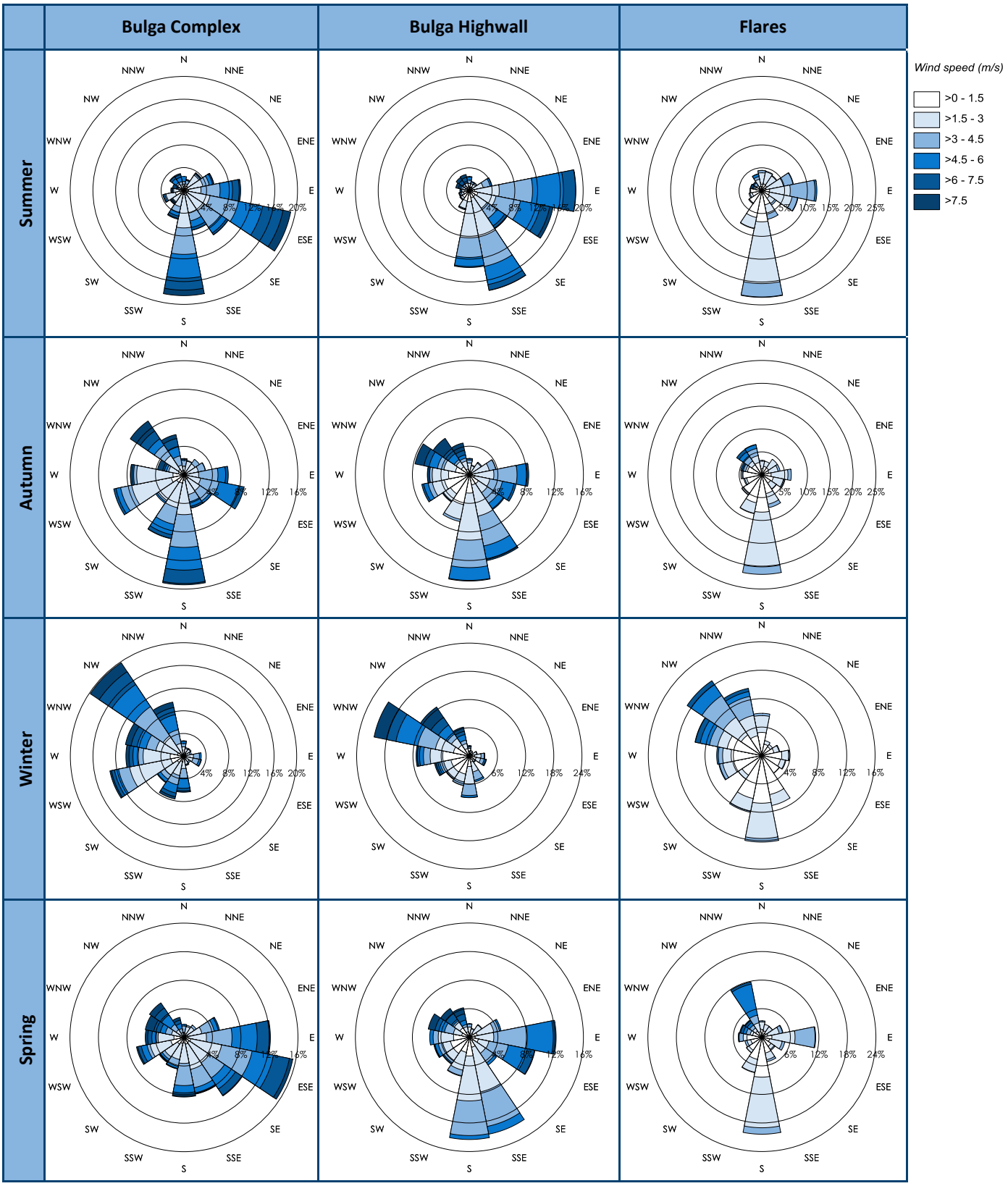


Figure 2-3: Windroses for each season of 2018 for the Bulga Complex, Bulga High Wall and Flares weather stations

3 COMPARISON OF MEASURED 2018 DATA AND MODEL PREDICTIONS

The locations of the HVAS, TEOM, BAM and E-Sampler monitors surrounding the Bulga Complex are shown in **Figure 3-1**.

Monitoring data collected at these locations during 2018 were compared with modelling predictions for the approximate year (Year 3) per the *Bulga Open Cut Eastern Emplacement Area Modification Air Quality Impact Assessment* (**Jacobs, 2016**).

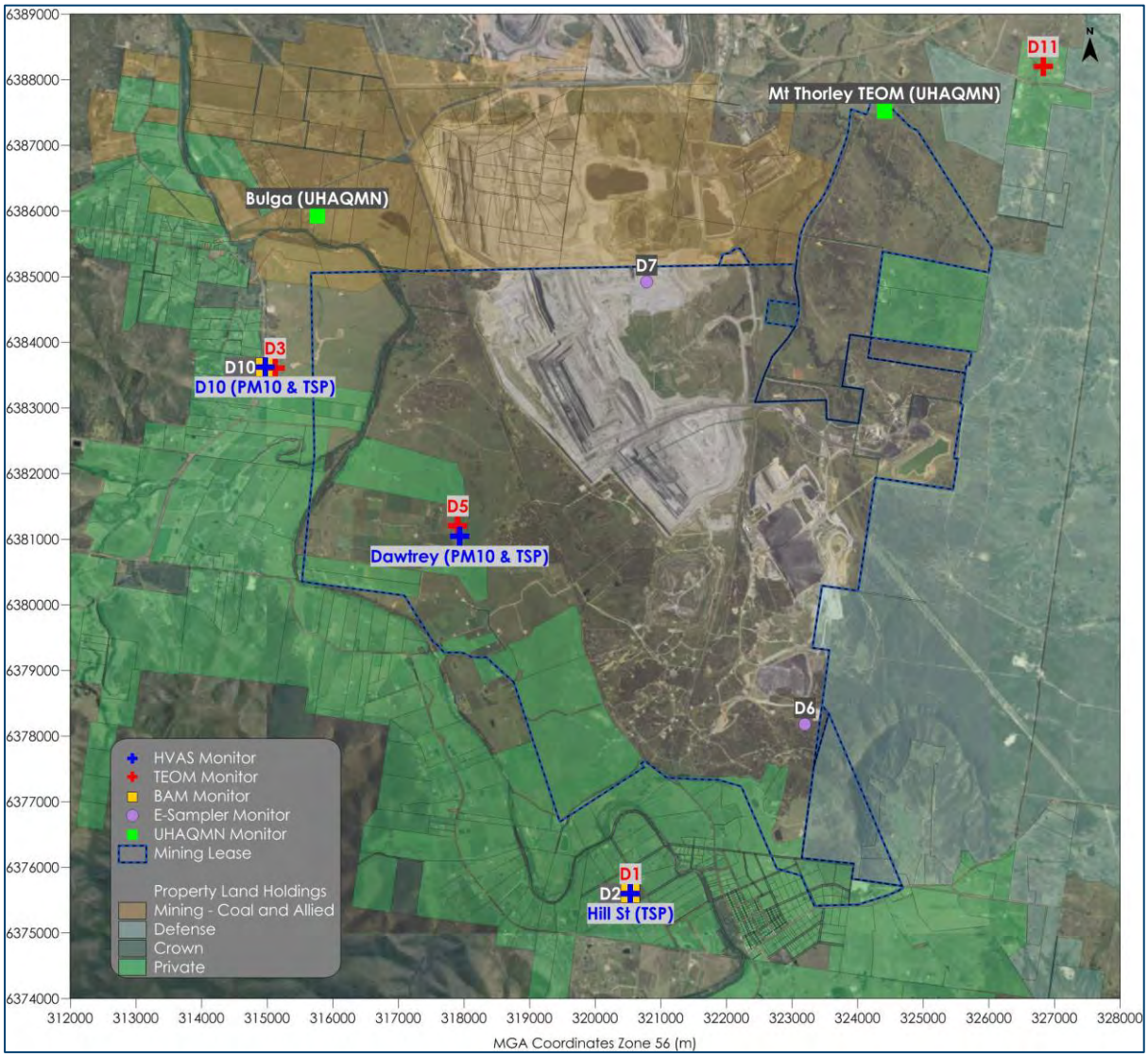
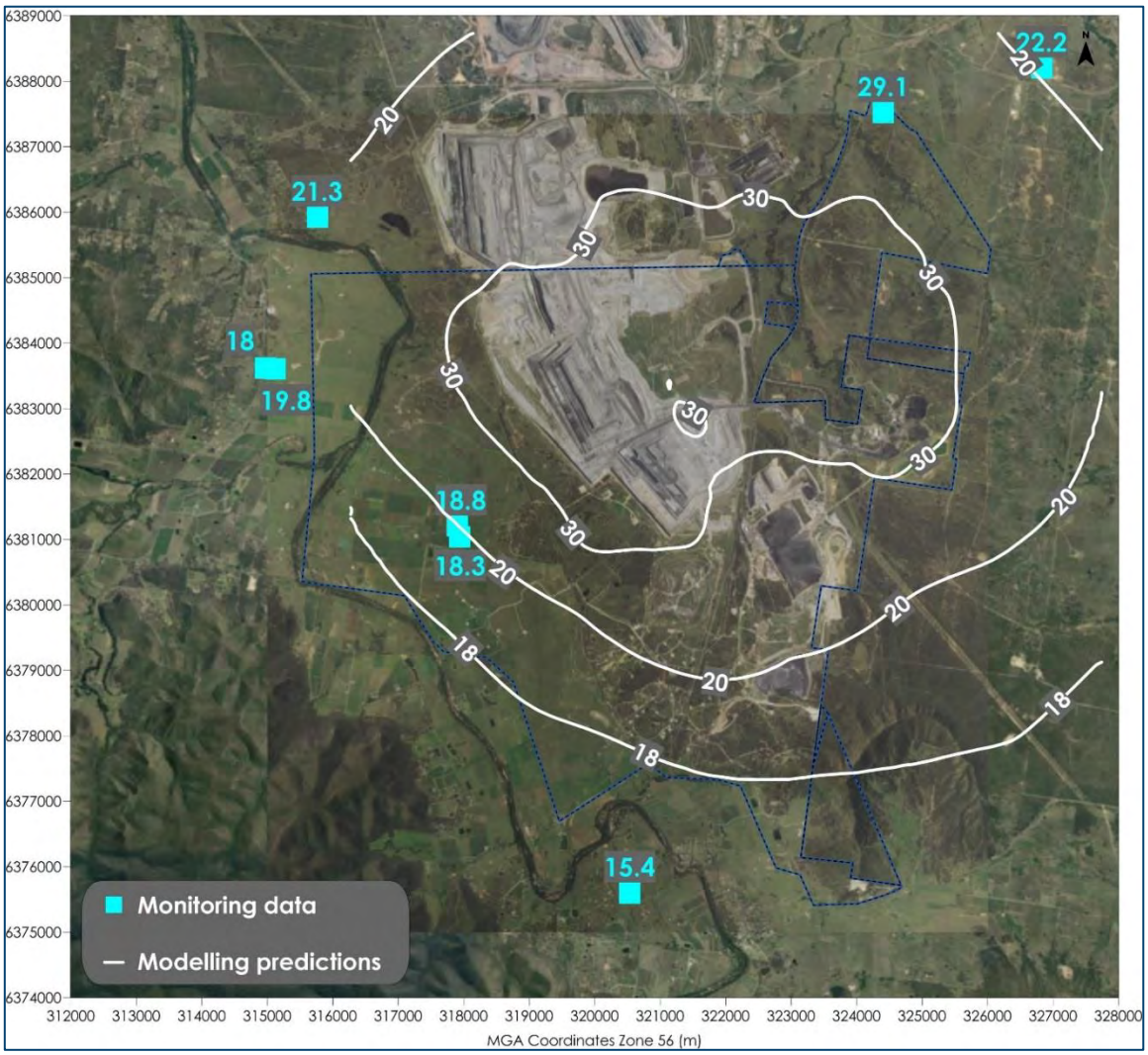


Figure 3-1: TEOM, BAM, HVAS and E-Sampler monitor locations

3.1 Annual average PM_{10}

Figure 3-2 presents the measured 2018 annual average PM_{10} data superimposed over the dispersion modelling contours reproduced from the *Bulga Open Cut Eastern Emplacement Area Modification Air Quality Impact Assessment* (Year 3) (**Jacobs, 2016**). The measured and predicted data in the figure include dust levels from Bulga and other sources.

Figure 3-2 shows that there is generally a good correlation between the modelling results and the recorded levels at the Bulga Complex monitoring stations.



Source: **Jacobs, 2016**

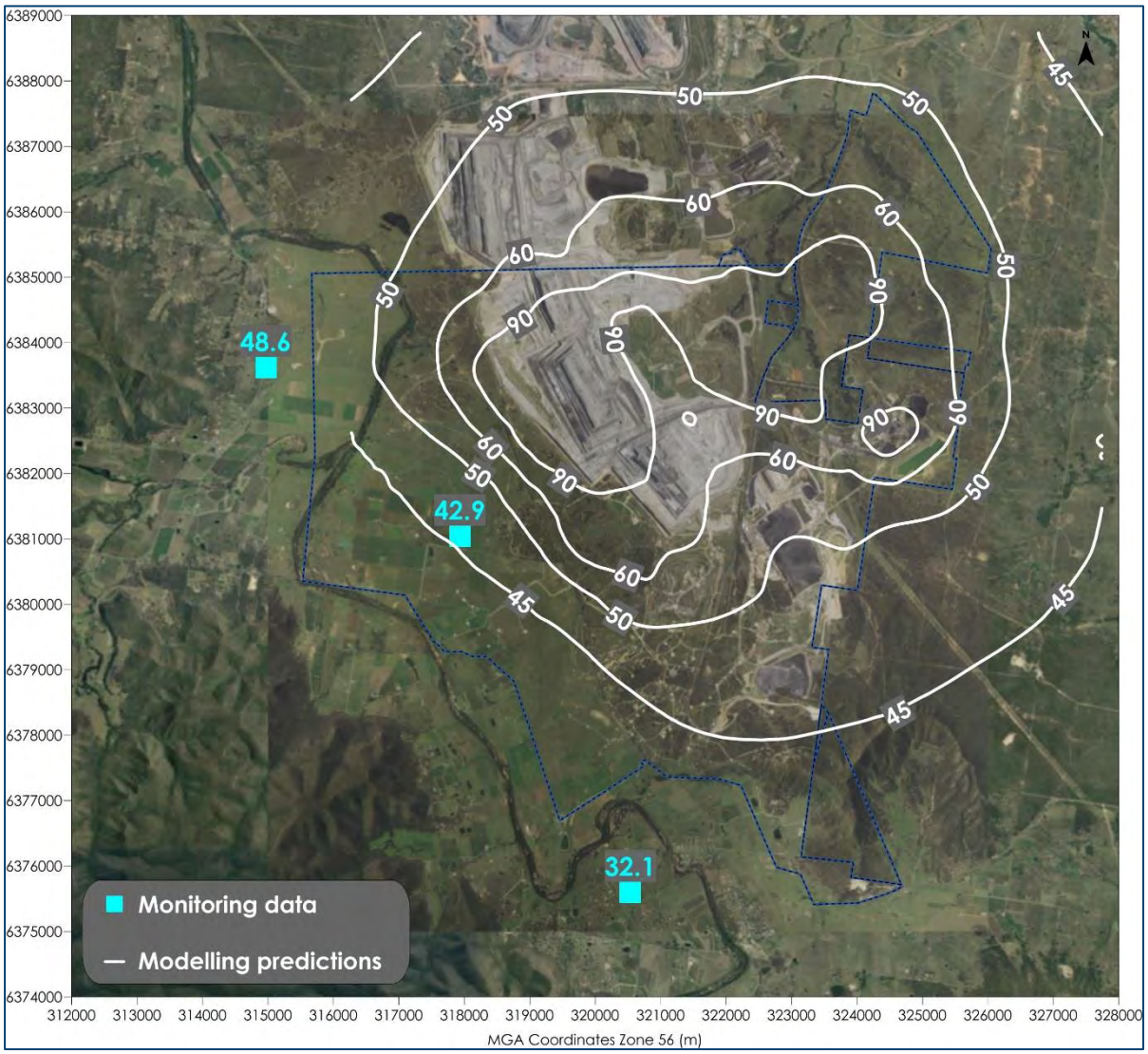
Figure 3-2: 2018 PM_{10} annual average monitoring data superimposed over the predicted PM_{10} annual average modelling contour (Year 3 Bulga plus background)

3.2 Annual average TSP

Figure 3-1 presents the locations of the TSP HVAS monitors where the measured TSP data were derived to calculate the 2018 annual average TSP concentrations.

Figure 3-3 presents an overlay of the measured 2018 annual average TSP data over the dispersion modelling predictions. The measured and predicted data in the figure include dust levels from Bulga and other sources.

The measured levels appear generally in agreement with the model predictions.



Source: **Jacobs, 2016**

Figure 3-3: 2018 TSP annual average monitoring data superimposed over the predicted TSP annual average modelling contour (Year 3 Bulga plus background)

3.3 Annual average deposited dust

Figure 3-4 presents the locations of the deposited dust gauges surrounding the Bulga Complex.

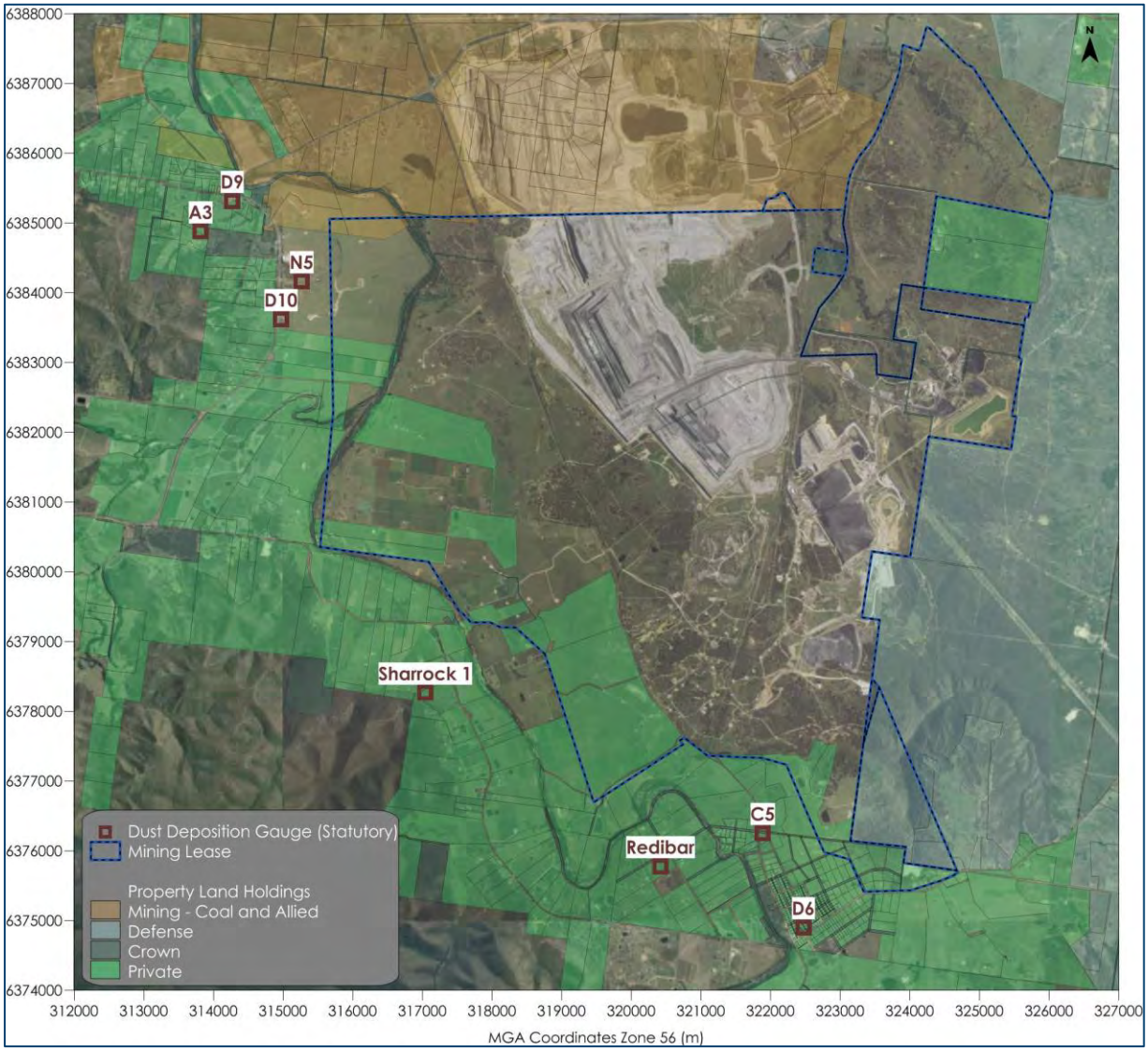
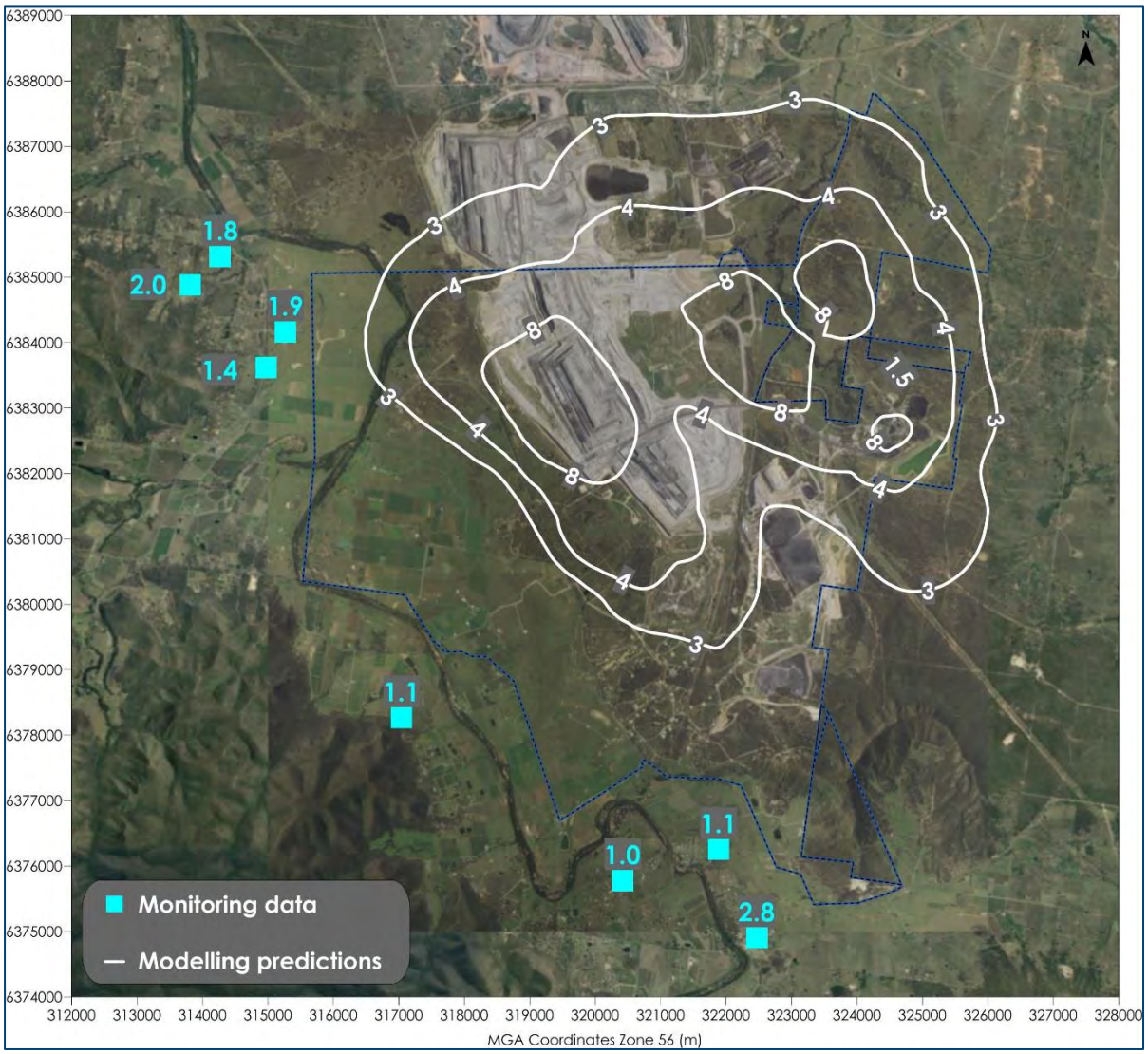


Figure 3-4: Deposited dust gauge locations

Figure 3-5 presents an overlay of the measured 2018 annual average deposited dust levels over the dispersion modelling contours reproduced from the *Bulga Open Cut Eastern Emplacement Area Modification Air Quality Impact Assessment* (Year 3) (**Jacobs, 2016**).

The measured levels appear generally in agreement with the model predictions.



Source: **Jacobs, 2016**

Figure 3-5: 2018 deposited dust annual average monitoring data superimposed over the predicted deposited dust annual average modelling contour (Year 3 Bulga plus background)

4 AIR QUALITY CRITERIA

The sections below identify the key pollutants currently being monitored at the Bulga Coal air quality monitoring sites and the applicable air quality criteria.

4.1 Particulate Matter

Particulate matter consists of particles of varying size and composition. The total mass of all particles suspended in air is defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

The TSP is defined further into two sub-components. They are PM_{10} particles, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

4.1.1 EPA impact assessment criteria

Table 4-1 summarises the air quality goals that are relevant to particulate pollutants as outlined in the NSW Environment Protection Agency (EPA) document "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" (**NSW EPA, 2017**).

Table 4-1: EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact[1]	Criterion
Total suspended particulates (TSP)	Annual	Total	90µg/m^3
Particulate Matter < 10µm (PM_{10})	Annual	Total	25µg/m^3
	24-hour	Total	50µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	Annual	Total	8µg/m^3
	24-hour	Total	25µg/m^3
Deposited Dust[2]	Annual	Incremental	2g/m^2/month
		Total	4g/m^2/month

[1] At nearest existing or likely future off-site sensitive receptor

[2] Dust is assessed as insoluble solids as defined by AS 3580.10.1 – 1991 (AM-19)

Source: **NSW EPA, 2017**

4.1.2 DP&E air quality criteria

Table 4-2 to **Table 4-4** summarise the air quality goals that are relevant to particulate pollutants as outlined in the Bulga Coal Development Consent (SSD-4960).

The development consent outlines that the applicant shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the particulate emissions generated by the Bulga mine complex do not exceed the criteria listed in **Table 4-2** to **Table 4-4** at any residence on privately-owned land.

Table 4-2: Long term criteria for particulate matter

Pollutant	Averaging Period	[d]Criterion
Total suspended particulates (TSP)	Annual	[a]90µg/m^3
Particulate Matter < 10µm (PM_{10})	Annual	[a]30µg/m^3

Table 4-3: Short term criteria for particulate matter

Pollutant	Averaging Period	[d]Criterion
Particulate Matter < 10µm (PM_{10})	24-hour	[a]50µg/m^3

Table 4-4: Long term criteria for deposited dust

Pollutant	Averaging Period	Maximum increase in deposited dust level	Maximum total deposited dust level
[c]Deposited dust	Annual	[b]2g/m^2/month	[a]4g/m^2/month

Notes for **Table 4-2** to **Table 4-4**:

- [a]Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to other sources);
- [b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own);
- [c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003 Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method; and
- [d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed to by the Secretary.

4.1.3 NEPM measure

The National Environment Protection Council (NEPC) varied the Ambient Air Quality National Environment Protection Measure (NEPM) on 4 February 2016 (**NEPC, 2016**). The key amendments with regard to particulate matter include:

- Incorporation of an annual average standard for PM_{10} concentrations of 25µg/m^3;
- Incorporation of 24-hour and annual average standards for $PM_{2.5}$ concentrations of 25µg/m^3 and 8µg/m^3, respectively; and,
- Requiring that all measured 24-hour average PM_{10} and $PM_{2.5}$ data, including monitoring data that are directly associated with an exceptional event (e.g. bushfires and dust storms), are reported however can be excluded for the purpose of reporting compliance.

The NEPM standards for ambient PM_{10} and $PM_{2.5}$ concentrations are presented in **Table 4-5**.

Table 4-5: NEPM standards for ambient PM_{10} and $PM_{2.5}$ concentrations

Pollutant	Averaging Period	NEPM Standard
Particulate Matter < 10µm (PM_{10})	24-hour	50µg/m^3
	Annual	25µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	25µg/m^3
	Annual	8µg/m^3

Source: **NEPC, 2016**

The NEPM standards apply to the average, or general exposure of a population, rather than to "hot spot" locations such as industry monitoring sites.

4.1.4 Summary of applicable criteria for this assessment

Table 4-6 summarises the applicable air quality criteria for this assessment. As the E-Sampler monitors are located within the mine site, the EPA, DP&E and NEPM criteria are not directly applicable to these monitors.

Table 4-6: Air quality impact assessment criteria used in this assessment

Pollutant	Averaging Period	Source	Concentration
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	EPA / NEPM / DP&E	25µg/m^3
	Annual Average	EPA / NEPM / DP&E	8µg/m^3
Particulate Matter < 10µm (PM_{10})	24-hour	EPA / NEPM / DP&E	50µg/m^3
	Annual Average	DP&E	30µg/m^3
		EPA / NEPM	25µg/m^3
Total Suspended Particulates (TSP)	Annual Average	EPA / NEPM / DP&E	90µg/m^3
Deposited Dust	Annual Average	EPA / NEPM / DP&E	4g/m^2/month

5 LONG TERM REVIEW

Figure 5-1 to **Figure 5-11** show the long-term trends for $PM_{2.5}$, PM_{10}, TSP and deposited dust from the start of commissioning of the monitors up until the end of the 2018 calendar year. These plots are discussed in more detail in the following sections.

5.1 $PM_{2.5}$ monitoring data

Table 5-1 presents a summary of the recorded $PM_{2.5}$ levels at the BAM monitors. Annual average $PM_{2.5}$ concentrations were below the relevant criterion of 8µg/m^3 and the maximum 24-hour average $PM_{2.5}$ concentrations were on occasion above the relevant criterion of 25µg/m^3.

Table 5-1: Summary of recorded BAM $PM_{2.5}$ levels

Year	Annual average $PM_{2.5}$ (µg/m^3)		
	D2	D10	Criterion
2012	5.9 *(4%)	-	8
2013	6.1 *(72%)	-	8
2014	5.5	5.4 *(46%)	8
2015	5.0	5.1	8
2016	6.1 *(52%)	5.7	8
2017	5.2	5.0	8
2018	5.5	5.5	8
Year	**Maximum 24-hour average $PM_{2.5}$ (µg/m^3) (No. of days > criterion)**		
	D2	**D10**	**Criterion**
2012	10.2 (0)	-	25
2013	**60.8 (6)**	-	25
2014	**25.3 (1)**	21.3 (0)	25
2015	**32.9 (2)**	**31.2 (1)**	25
2016	22.5 (0)	19.4 (0)	25
2017	24.7 (0)	**30.2 (1)**	25
2018	**46.5 (1)**	23.9 (0)	25

*The recorded data are less than 75% complete for the year, (data availability %)

The numbers in **red** are concentrations that are above the relevant criterion.

Figure 5-1 presents the 24-hour average $PM_{2.5}$ concentrations at the D2 and D10 BAM monitors. It can be seen that the D2 monitor recorded levels above the 24-hour average $PM_{2.5}$ criterion of 25µg/m^3 on ten days between 2013 and 2018. Most of these events occurred towards the end of 2013 and the levels recorded were most likely to have been significantly affected by the extensive hazard reduction burning and bushfires occurring in New South Wales during October 2013. The D10 monitor also recorded levels above the 24-hour average $PM_{2.5}$ criterion of 25µg/m^3 on one day in 2015 and one day in 2017 which were likely due to bushfire activity.

Figure 5-2 presents the annual average $PM_{2.5}$ concentrations recorded at the BAM monitors. The D2 and D10 monitors show generally similar annual average $PM_{2.5}$ levels throughout the monitoring period.

Figure 5-3 presents the 31-day running averages for the 24-hour average $PM_{2.5}$ concentrations, daily rainfall and mean daily temperature (recorded by the Bulga Complex weather station). The data from the two $PM_{2.5}$ BAM monitors are in relatively good agreement with each other. The data indicate a general trend where higher dust levels tend to occur during conditions with higher temperatures and lower rainfall levels.

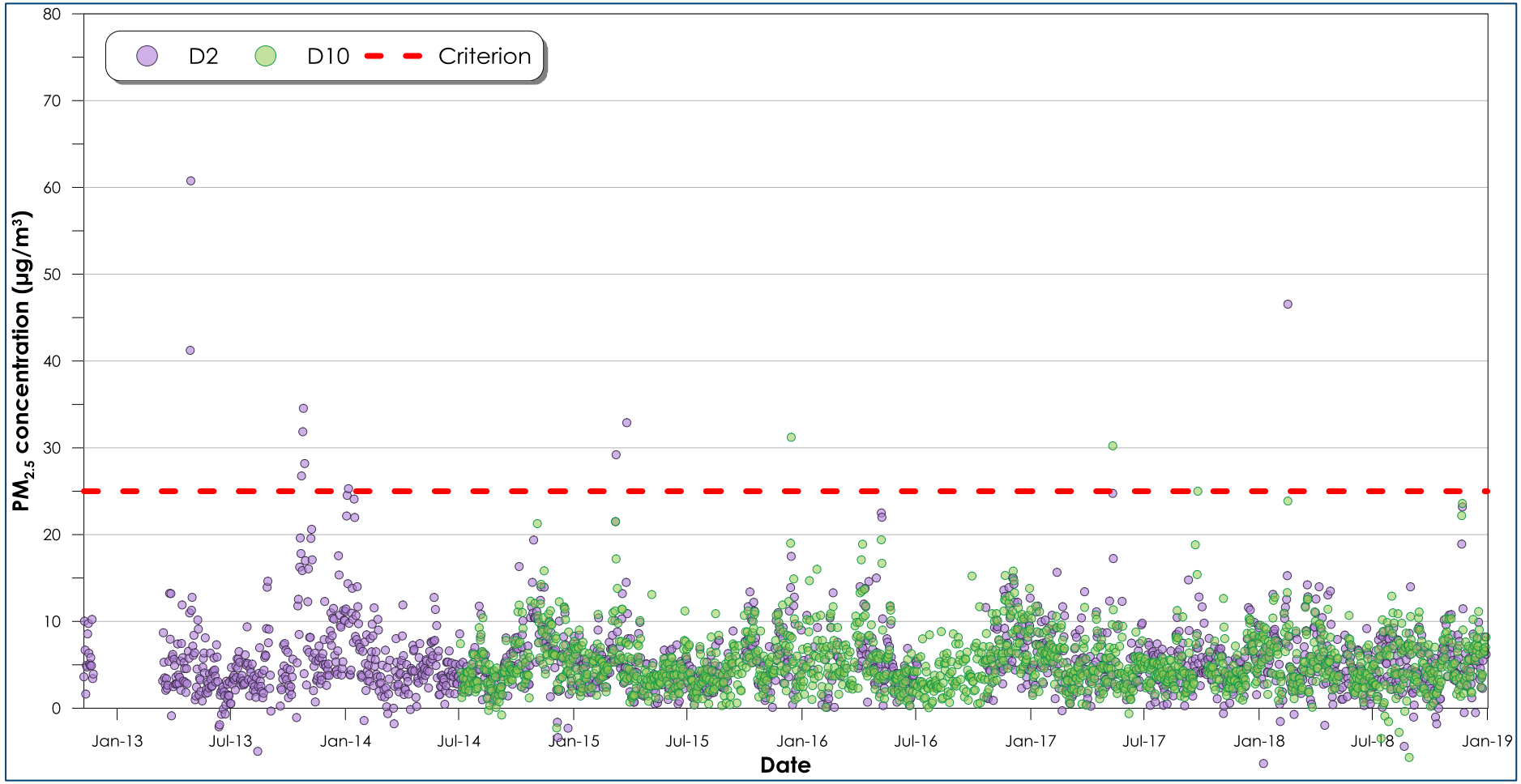


Figure 5-1: 24-hour average $PM_{2.5}$ concentrations

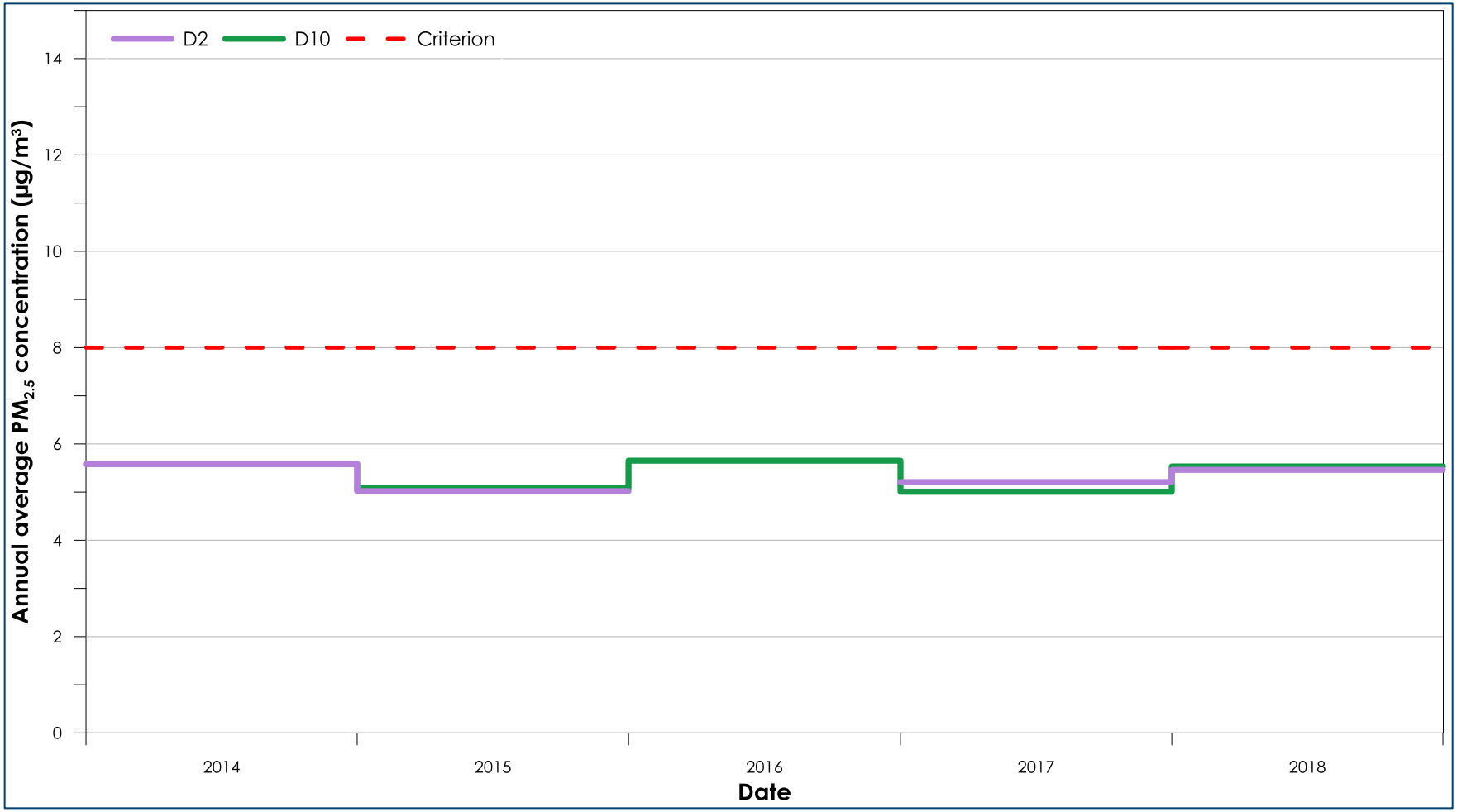


Figure 5-2: Annual average $PM_{2.5}$ concentrations

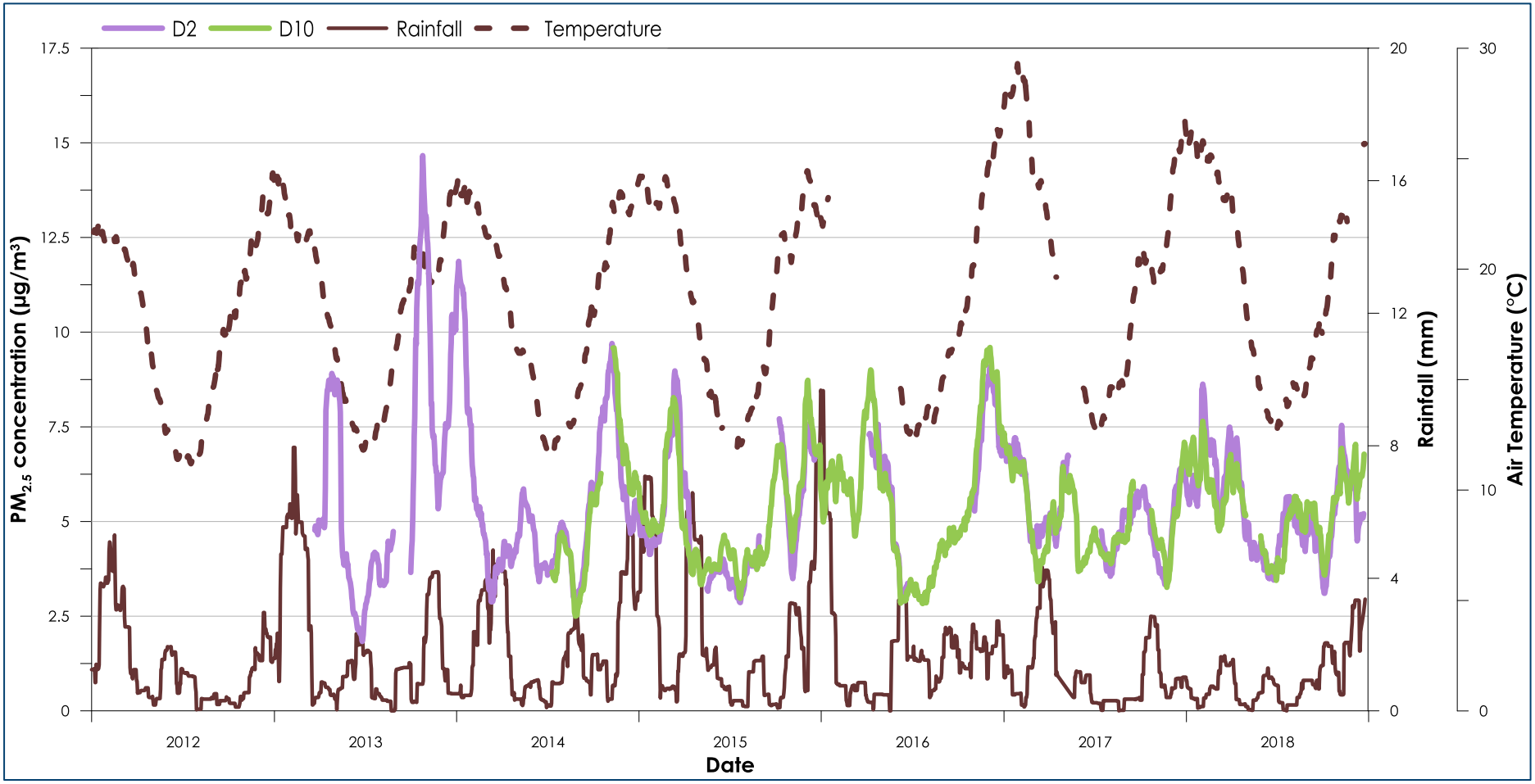


Figure 5-3: 31-day running average of the 24-hour average $PM_{2.5}$ concentrations with the 31-day running average of daily rainfall and mean daily temperature

5.2 PM_{10} monitoring data

Table 5-2 presents a summary of the recorded PM_{10} levels at the TEOM monitors. Annual average PM_{10} concentrations were below both the relevant criteria of 25µg/m^3 and 30µg/m^3, and the maximum 24-hour average PM_{10} concentrations were on occasion above the relevant criterion of 50µg/m^3.

Table 5-2: Summary of the recorded TEOM PM_{10} levels

Year	Annual average PM_{10} (µg/m^3)				
	D1	D3	D5	D11	Criteria
2011	-	12.1 *(7%)	-	-	25 / 30
2012	21.8 *(9%)	14.8	14.3 *(73%)	-	25 / 30
2013	16.1	15.8	15.7	-	25 / 30
2014	15.9	15.3	13.1	-	25 / 30
2015	10.7	11.2	10.7	-	25 / 30
2016	11.5	10.8	11.7	18.8 *(44%)	25 / 30
2017	12.7	12.2	11.5	20.0	25 / 30
2018	15.4	19.8	18.8	22.2	25 / 30
Year	**Maximum 24-hour average PM_{10} (µg/m^3) (No. of days > criterion)**				
	D1	**D3**	**D5**	**D11**	**Criterion**
2011	-	17.7 (0)	-	-	50
2012	48.2 (0)	46.1 (0)	45.3 (0)	-	50
2013	**70.0 (5)**	**75.3 (3)**	**65.0 (2)**	-	50
2014	43.8 (0)	41.8 (0)	46.2 (0)	-	50
2015	**61.2 (1)**	**59.3 (1)**	**61.6 (1)**	-	50
2016	33.0 (0)	33.2 (0)	**53.5 (2)**	**60.7 (1)**	50
2017	36.4 (0)	37.1 (0)	37.7 (0)	**67.5 (6)**	50
2018	**138.6 (5)**	**166.4 (7)**	**160.3 (7)**	**159.6 (15)**	50

*The recorded data are less than 75% complete for the year, (data availability %)

The numbers in **red** are concentrations that are above the relevant criterion.

Table 5-3 presents a summary of the recorded PM_{10} levels at the HVAS monitors. Annual average PM_{10} concentrations were below both the relevant criteria of 25µg/m^3 and 30µg/m^3, and the maximum 24-hour average PM_{10} concentrations were on occasion above the relevant criterion of 50µg/m^3.

Table 5-3: Summary of the recorded HVAS PM_{10} levels

Year	Annual average PM_{10} (µg/m³)		
	Dawtrey	D10	Criteria
2005	13.8	14.5	25 / 30
2006	16.1	14.4	25 / 30
2007	18.4	17.1	25 / 30
2008	16.5	17.1	25 / 30
2009	17.3	16.2	25 / 30
2010	12.8	12.8	25 / 30
2011	12.2	12.7	25 / 30
2012	13.2	13.1	25 / 30
2013	12.6	12.3	25 / 30
2014	14.5	13.9	25 / 30
2015	11.9	11.1	25 / 30
2016	12.8	13.4	25 / 30
2017	13.6	14.0	25 / 30
2018	18.3	18.0	25 / 30
Year	**Maximum 24-hour average PM_{10} (µg/m³) (No. of days > criterion)**		
	Dawtrey	**D10**	**Criterion**
2005	41 (0)	41 (0)	50
2006	40 (0)	39 (0)	50
2007	**61 (3)**	**63 (3)**	50
2008	**61 (3)**	**58 (3)**	50
2009	49 (0)	50 (0)	50
2010	**55 (1)**	**51 (1)**	50
2011	40 (0)	47 (0)	50
2012	38 (0)	50 (0)	50
2013	41 (0)	45 (0)	50
2014	41 (0)	47 (0)	50
2015	35 (0)	30 (0)	50
2016	**56 (1)**	**68 (1)**	50
2017	**67 (1)**	**58 (1)**	50
2018	**54 (1)**	**52 (1)**	50

The numbers in **red** are concentrations that are above the relevant criterion.

Figure 5-4 and **Figure 5-5** show the 24-hour average PM_{10} concentrations at the TEOM and HVAS monitors, respectively. **Figure 5-6** presents the annual average PM_{10} concentrations at both the TEOM and HVAS monitors.

Figure 5-4 shows that generally PM_{10} levels appear to be more elevated during warmer months. The PM_{10} levels at the end of April 2013 and during October 2013 were elevated, as is also apparent for the $PM_{2.5}$ levels shown in **Figure 5-1**. These elevated levels were likely due to smoke from hazard reduction burns and bushfires.

Several exceptional events such as bushfires and dust storms occurred in February, March, April and November 2018 which contributed to the high number of 24-hour average PM_{10} exceedances in the 2018 year period at all TEOM monitors. For the review period, a state-wide dust storm event in late November 2018 was responsible for the peak 24-hour average PM_{10} levels recorded at all TEOM monitors.

All of the TEOM monitors recorded similar trends in PM_{10} levels with the exception of the D11 monitor which generally recorded higher levels than the rest of the monitors. The D11 monitor recorded fifteen days with elevated levels above the 24-hour average criterion of 50µg/m^3 in 2018. Some of the elevated levels recorded at D11 were likely due to its location toward the northeast of the Bulga Complex, which is along the prevailing axis of northwesterly to southeasterly winds in the Hunter Valley, and would likely be influenced by particulates from other mining operations, agricultural and industrial activities.

The HVAS PM_{10} levels in **Figure 5-5** show generally similar trends to TEOM PM_{10} levels in **Figure 5-4**.

In 2018, the Dawtrey and D10 monitors both recorded one day above the 24-hour average PM_{10} criteria, during the November dust storm event.

Figure 5-6 shows that all monitors recorded slightly higher annual average PM_{10} levels in 2018 than the previous years.

Figure 5-7 and **Figure 5-8** show the 31-day running averages of the 24-hour average PM_{10} concentrations at the TEOM monitors and HVAS monitors respectively, together with the 31-day running averages of daily rainfall and mean daily temperature as recorded by the Bulga Complex weather station. The figures indicate a trend in dust levels being lower during significant rainfall and/or colder temperatures, or dust levels being higher in dry and hot conditions.

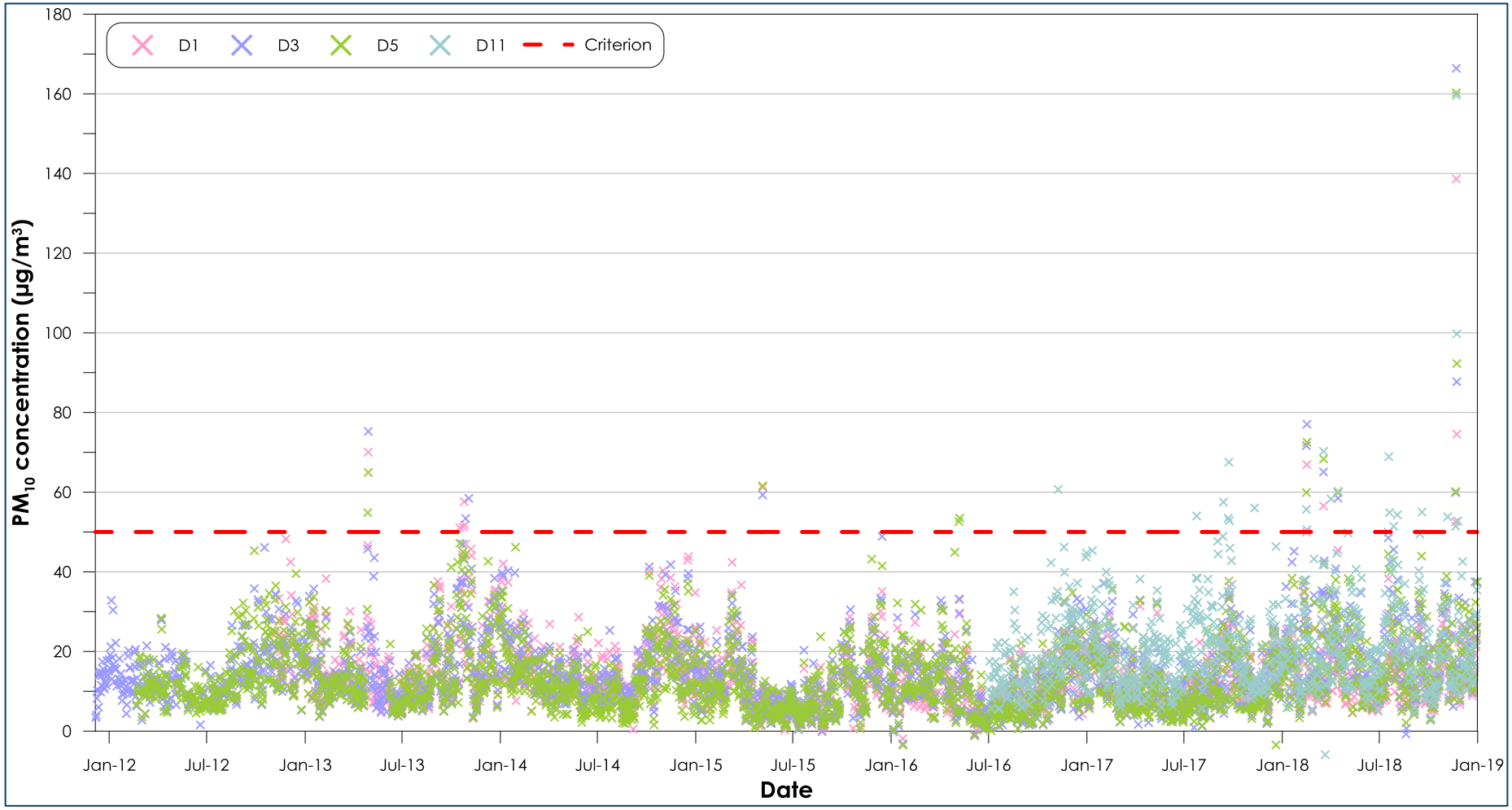


Figure 5-4: 24-hour average PM_{10} concentrations at TEOM monitors

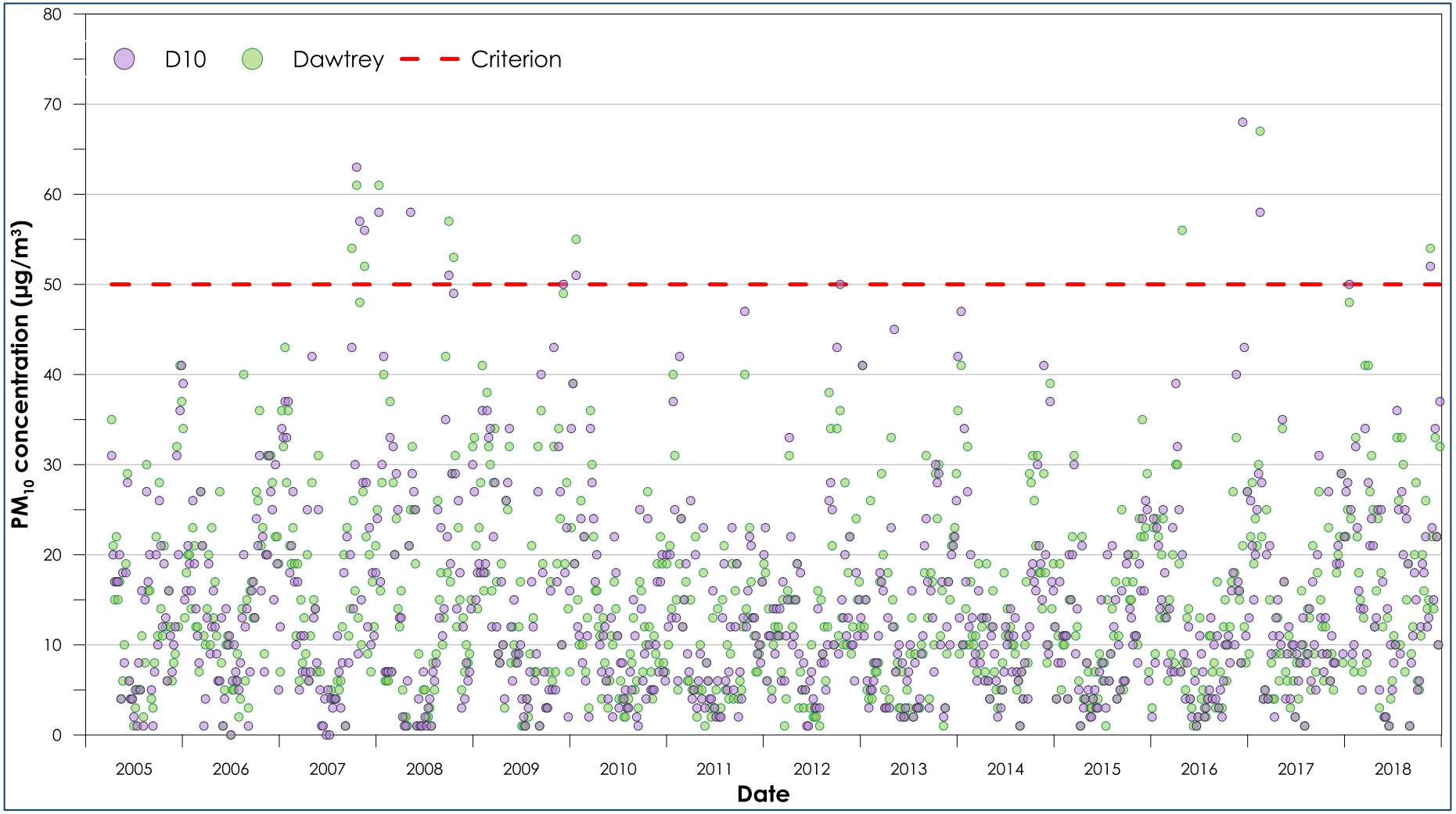


Figure 5-5: 24-hour average PM_{10} concentrations at HVAS monitors

Figure 5-6: Annual average PM_{10} concentrations at TEOM and HVAS monitors

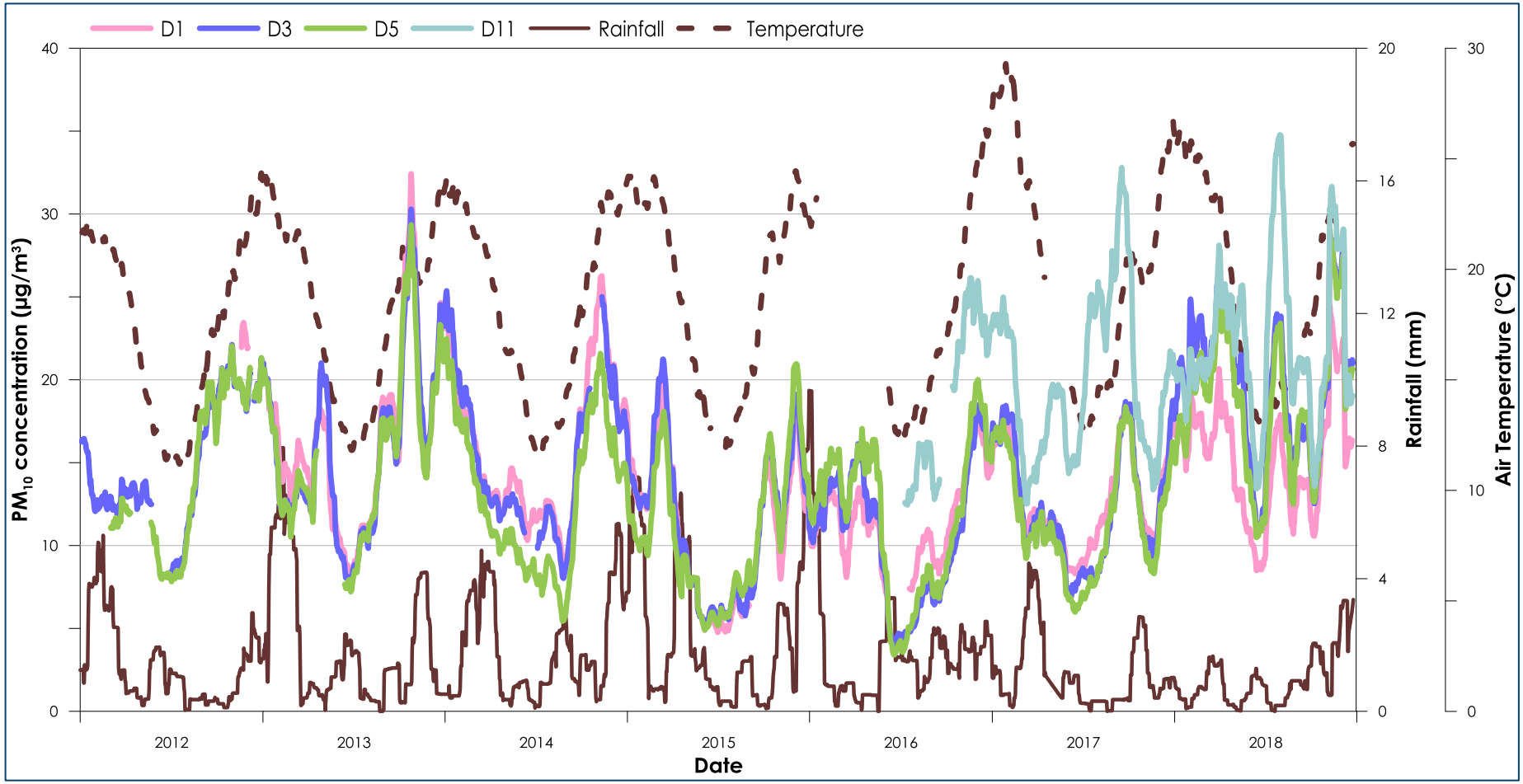


Figure 5-7: 31-day running average of the 24-hour average PM_{10} concentrations at the TEOM monitors with the 31-day running average of daily rainfall and mean daily temperature

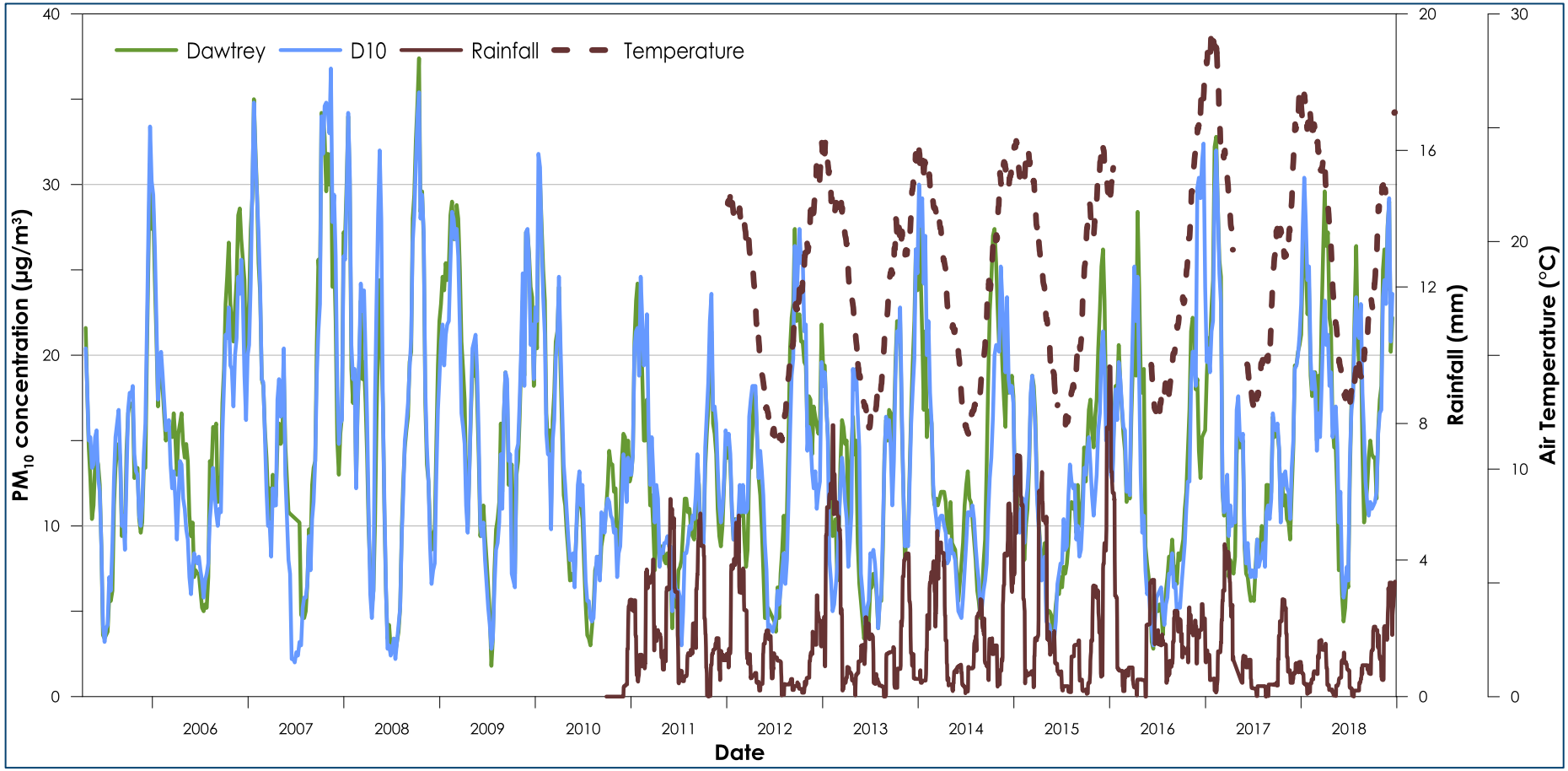


Figure 5-8: 30-day running average of the 24-hour average PM_{10} concentrations at the HVAS monitors with the 31-day running average of daily rainfall and mean daily temperature

5.3 TSP monitoring data

Table 5-4 presents a summary of the recorded TSP levels at the HVAS monitors. Annual average TSP concentrations were below the relevant criterion of 90µg/m^3.

Table 5-4: Summary of the recorded HVAS TSP levels

Year	Annual average TSP (µg/m^3)			
	Dawtrey	D10	Hill St	Criterion
2005	28.2 *(74%)	32.3 *(67%)	-	90
2006	35.0	36.2	-	90
2007	33.2	36.7	-	90
2008	33.3	34.8	-	90
2009	39.3	41.4	-	90
2010	26.9	29.2	-	90
2011	27.1	33.8	-	90
2012	26.2	34.5	-	90
2013	30.4	32.5	-	90
2014	34.5	40.0	-	90
2015	27.9	30.6	-	90
2016	31.7	36.9	23.3 *(67%)	90
2017	29.8	36.5	26.0	90
2018	42.9	48.6	32.1	90

*The recorded data are less than 75% complete for the year, (data availability %)

Figure 5-9 shows the 24-hour and annual average TSP concentrations at the HVAS monitors. The data from the Dawtrey and D10 monitors follow a similar seasonal trend, and as with the PM_{10} levels, show elevated readings during the warmer months.

The annual average data from the Dawtrey and D10 monitors show generally similar levels throughout the monitoring period, and remained below the criterion of 90µg/m^3.

Figure 5-10 shows the 31-day running average of the TSP concentrations, rainfall readings and mean daily temperatures. The levels show a general trend of lower TSP concentrations during periods of higher rainfall and lower temperatures.

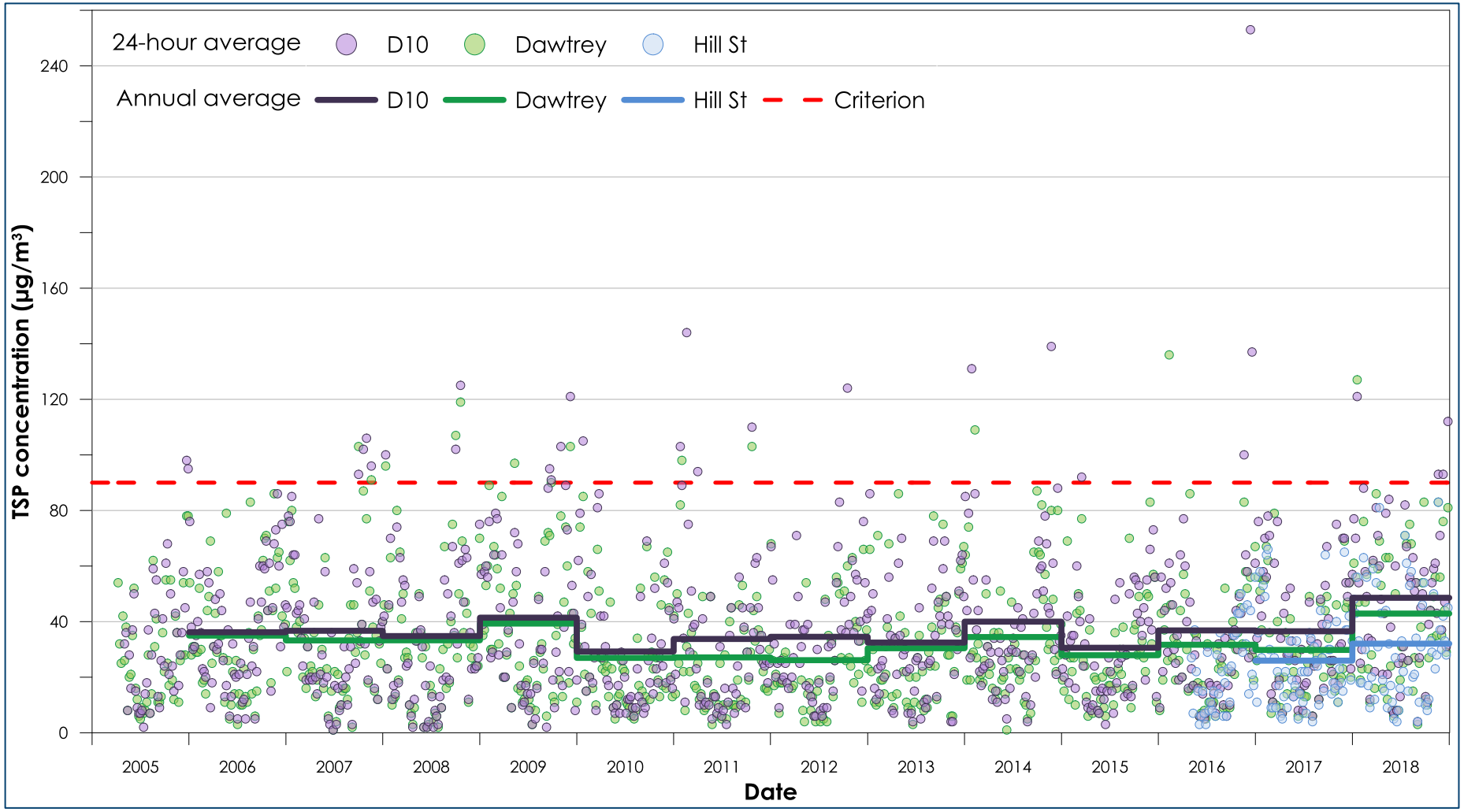


Figure 5-9: 24-hour and annual average TSP concentrations

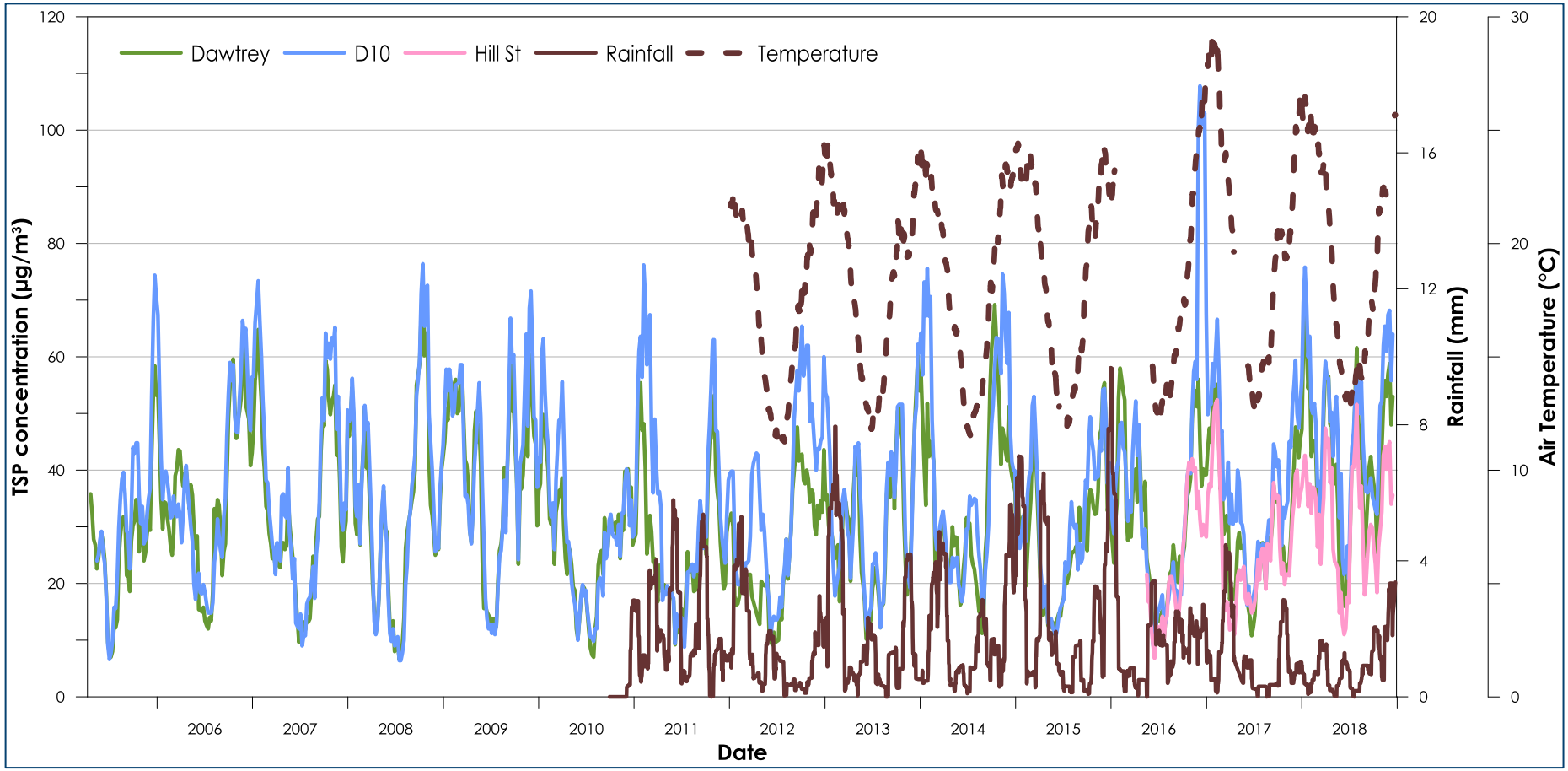


Figure 5-10: 30-day running average of the 24-hour average TSP concentrations with the 31-day running average of daily rainfall and mean daily temperature

5.4 Deposited dust data

Table 5-5 presents a summary of the annual average deposited dust levels at the statutory compliance dust gauges. The results show that in all years at all times the deposited dust levels were below the limit at the compliance monitoring locations, with the exception of the A3 gauge in 2007. Sharrock 1 also recorded an annual average level above 4g/m^2/month in 2007 however there were less than 75% data available during this period.

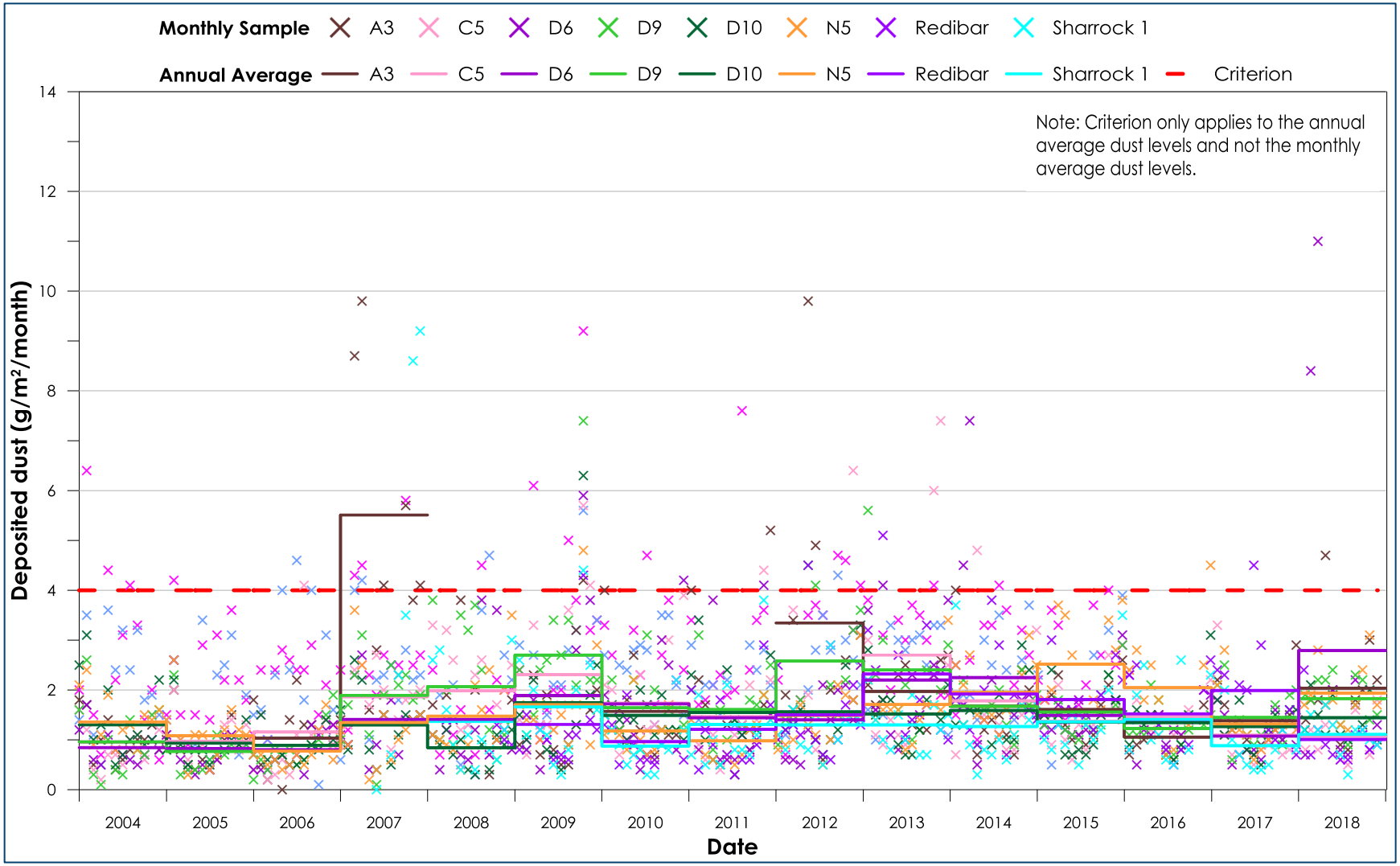
Table 5-5: Summary of the annual average deposited dust levels (g/m^2/month) at compliance dust gauges

Year	A3	C5	D6	D9	D10	N5	Redibar	Sharrock 1	Criterion
2004	1.0	0.9	0.8	1.0	1.3	1.4	-	-	4
2005	1.0	1.0	0.8	0.8	0.9	1.1	-	-	4
2006	1.0	1.2	0.8	0.9	0.9	0.8	-	-	4
2007	**5.5**	1.9	1.4	1.9	1.3	1.3	-	4.1 *(50%)	4
2008	1.7 *(67%)	2.0	1.4	2.1	0.8	1.5	1.1 *(25%)	1.4	4
2009	1.9	2.3	1.9	2.7	1.7	1.7	1.3	1.7	4
2010	1.6	1.7	1.7	1.6	1.5	1.2	1.0	0.9	4
2011	1.8 *(67%)	1.5	1.4	1.6	1.6	1.0	1.2	1.3	4
2012	3.3	2.3 *(58%)	1.4	2.6	1.6	1.5	1.5	1.3	4
2013	2.0	2.7	2.2	2.4	1.5	1.7	2.3	1.3	4
2014	1.7	1.8	2.3	1.7	1.6	2.0	1.9	1.3	4
2015	1.6	1.4	1.5	1.6	1.4	2.5	1.8	1.4	4
2016	1.1	1.5	1.4	1.2	1.3	2.0	1.5	1.4	4
2017	1.4	1.1	1.1	1.5	1.3	1.3	2.0	0.9	4
2018	2.0	1.1	2.8	1.8	1.4	1.9	1.0	1.1	4

Contaminated samples were not included in the computation of the average.

*The recorded data are less than 75% complete for the year, (data availability %)

Figure 5-11 shows the monthly and annual average deposited dust levels at the statutory compliance dust gauges of the Bulga Complex. The deposited dust levels at the A3 monitor exceeded the cumulative annual average deposited dust criteria of 4g/m^2/month in 2007. No other exceedance was recorded from the onset of monitoring until the end of the 2018 calendar year. The levels at the monitors show relatively similar trends over time.



Note: Data are clipped at a maximum of 14g/m^2/month. Only the A3 dust gauge measured a level above 14g/m^2/month (at 16.8g/m^2/month).

Figure 5-11: Annual and monthly averages deposited dust at the statutory compliance dust gauges

6 POLLUTION ROSES

The following section presents an analysis of a hybrid of a pollution rose and back trajectory data for all of the $PM_{2.5}$ and PM_{10} data measured at the BAM, TEOM and E-Sampler monitors for 2018. The meteorological data used in generating the figures are from the Bulga Complex weather station.

6.1 $PM_{2.5}$ data

Figure 6-1 and **Figure 6-2** present the pollution roses for the D2 and D10 $PM_{2.5}$ monitors respectively for 2018. The figures show higher $PM_{2.5}$ levels from the northwest quadrant for periods of high wind speeds regardless of monitor position relative to Bulga.

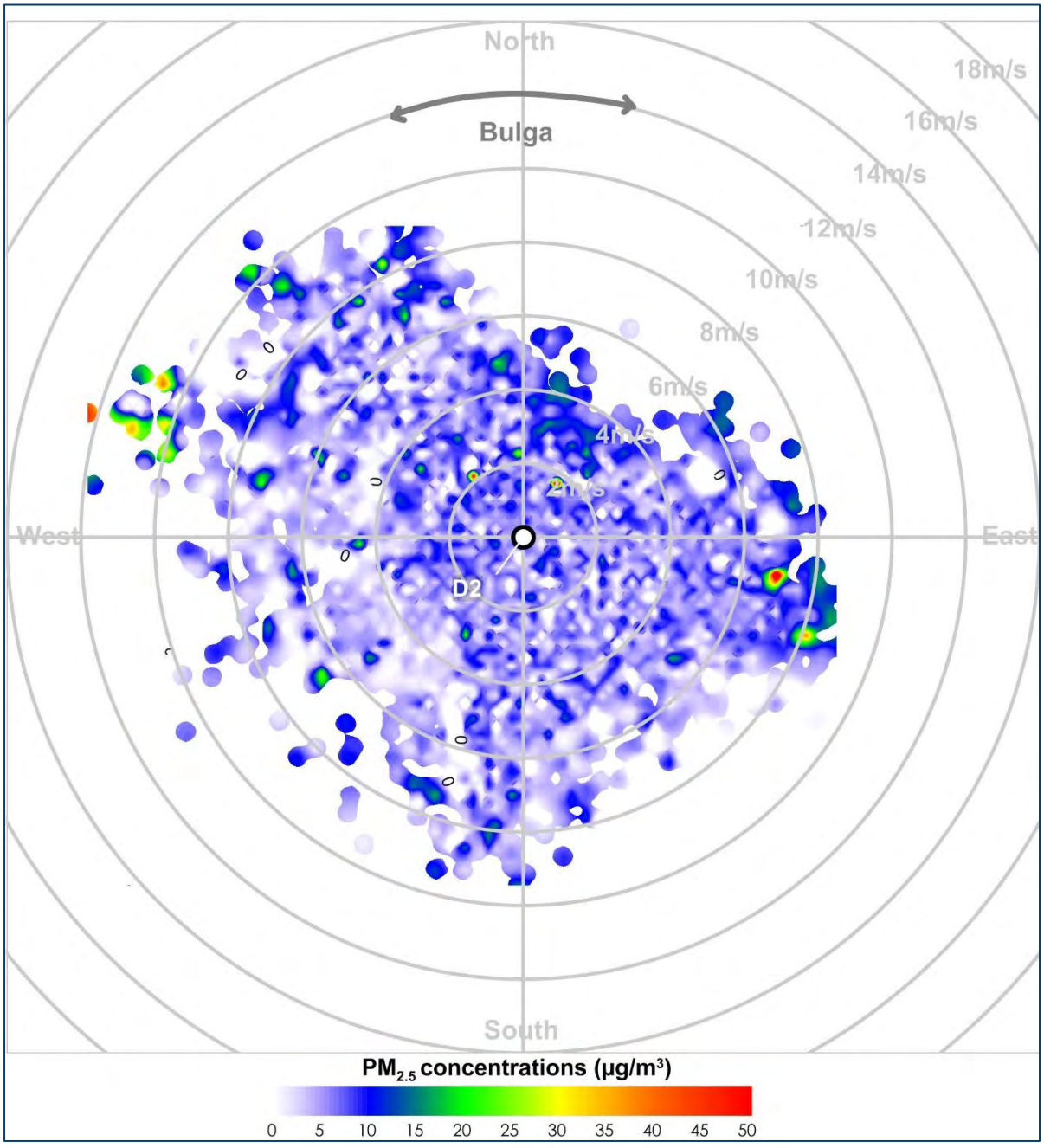


Figure 6-1: Pollution rose for D2 BAM $PM_{2.5}$ data (2018)

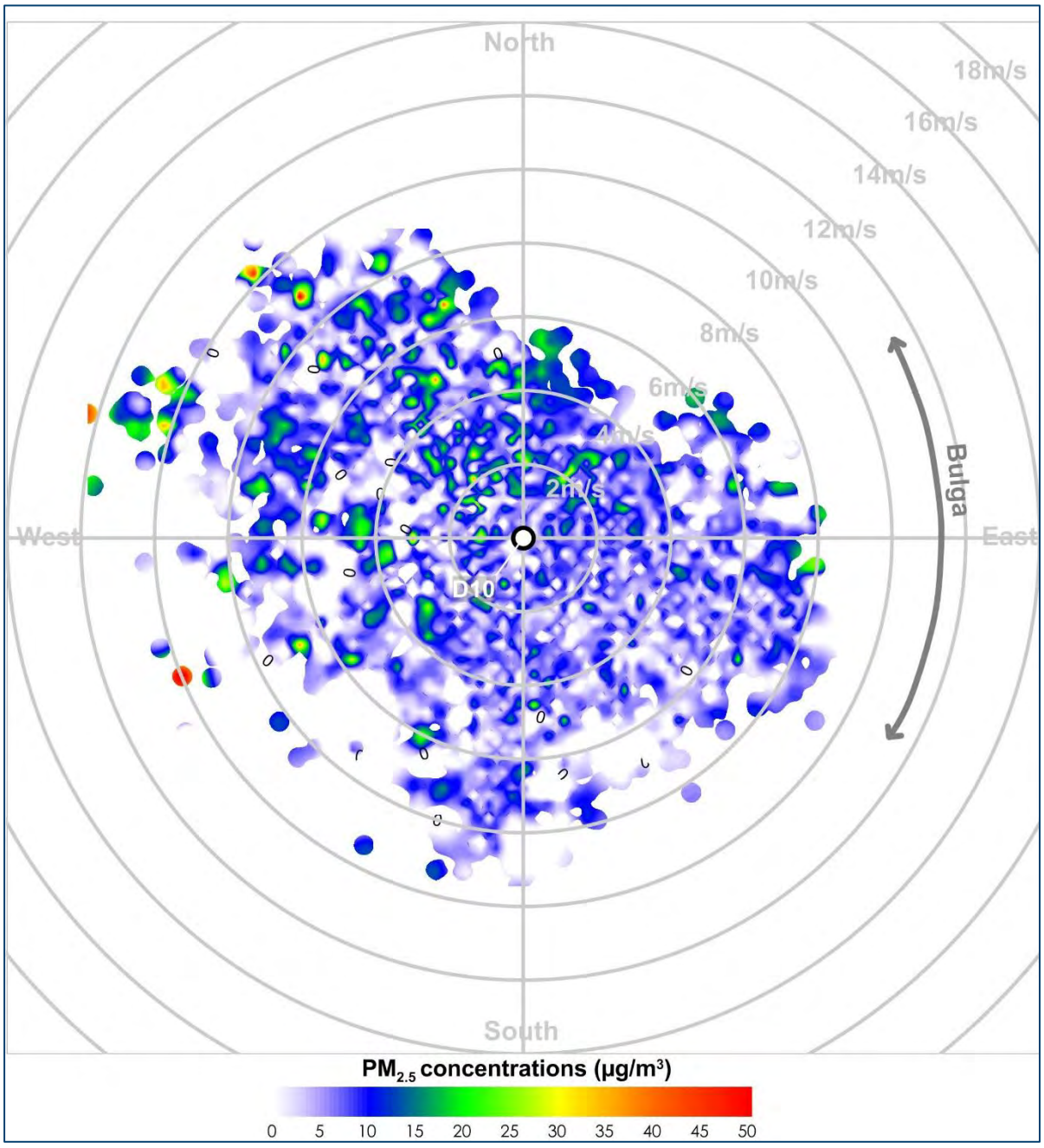


Figure 6-2: Pollution rose for D10 BAM $PM_{2.5}$ data (2018)

6.2 PM_{10} data

Figure 6-3 to **Figure 6-6** present the pollution roses for the D1, D3, D5 and D11 PM_{10} TEOM monitors respectively for 2018. The figures generally show that there is a moderate effect on dust levels from the direction of the Bulga mine.

High levels occur in the northwest quadrant under high wind speed conditions regardless of monitor position relative to Bulga and likely arise from regional events or other unknown sources.

Figure 6-7 and **Figure 6-8** present the pollution roses for the D6 and D7 PM_{10} E-Sampler monitors respectively for 2018. Similar to the TEOMs, the E-samplers recorded higher levels from the northwest quadrant during periods of high wind speed.

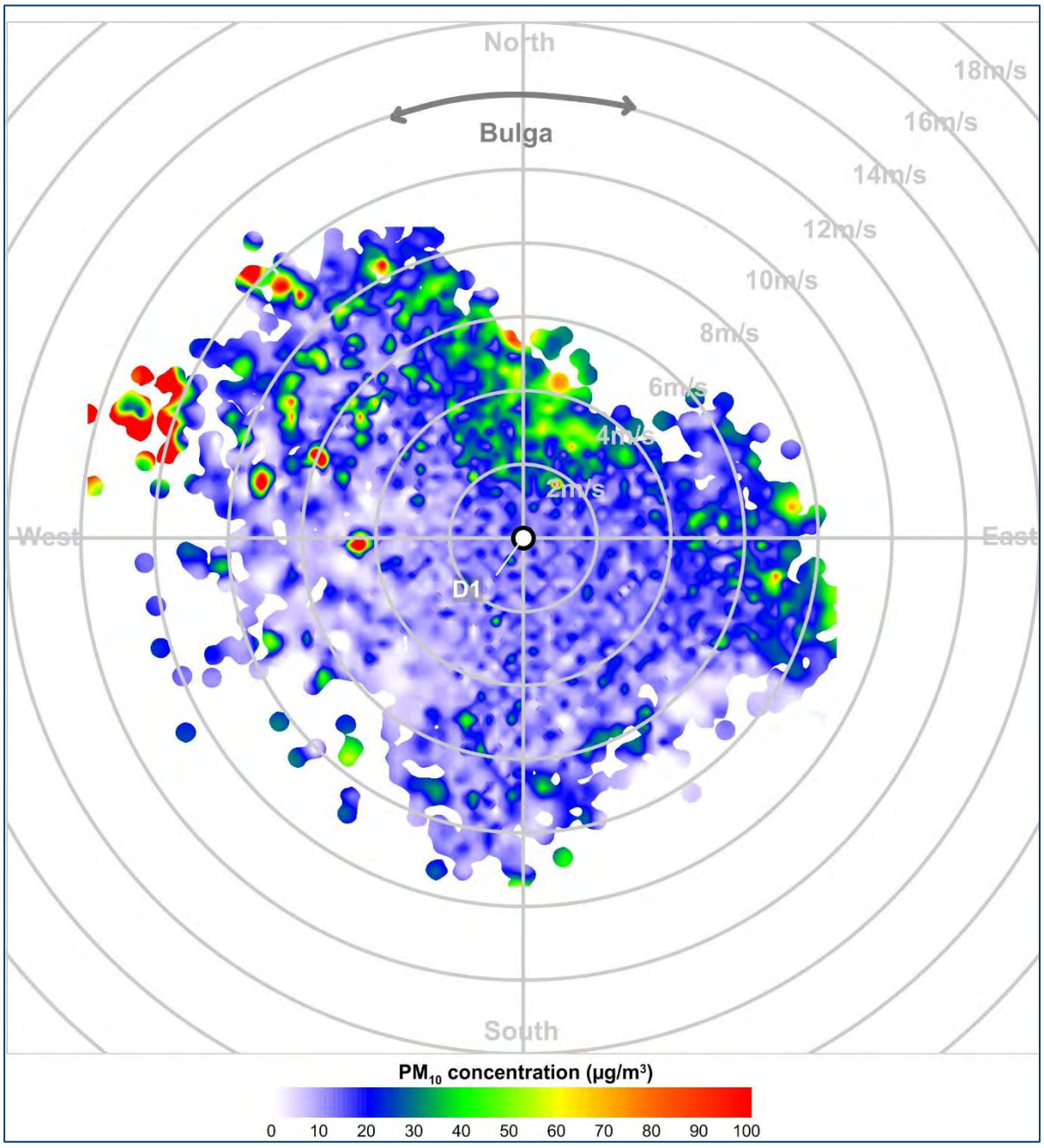


Figure 6-3: Pollution rose for D1 TEOM PM_{10} data (2018)

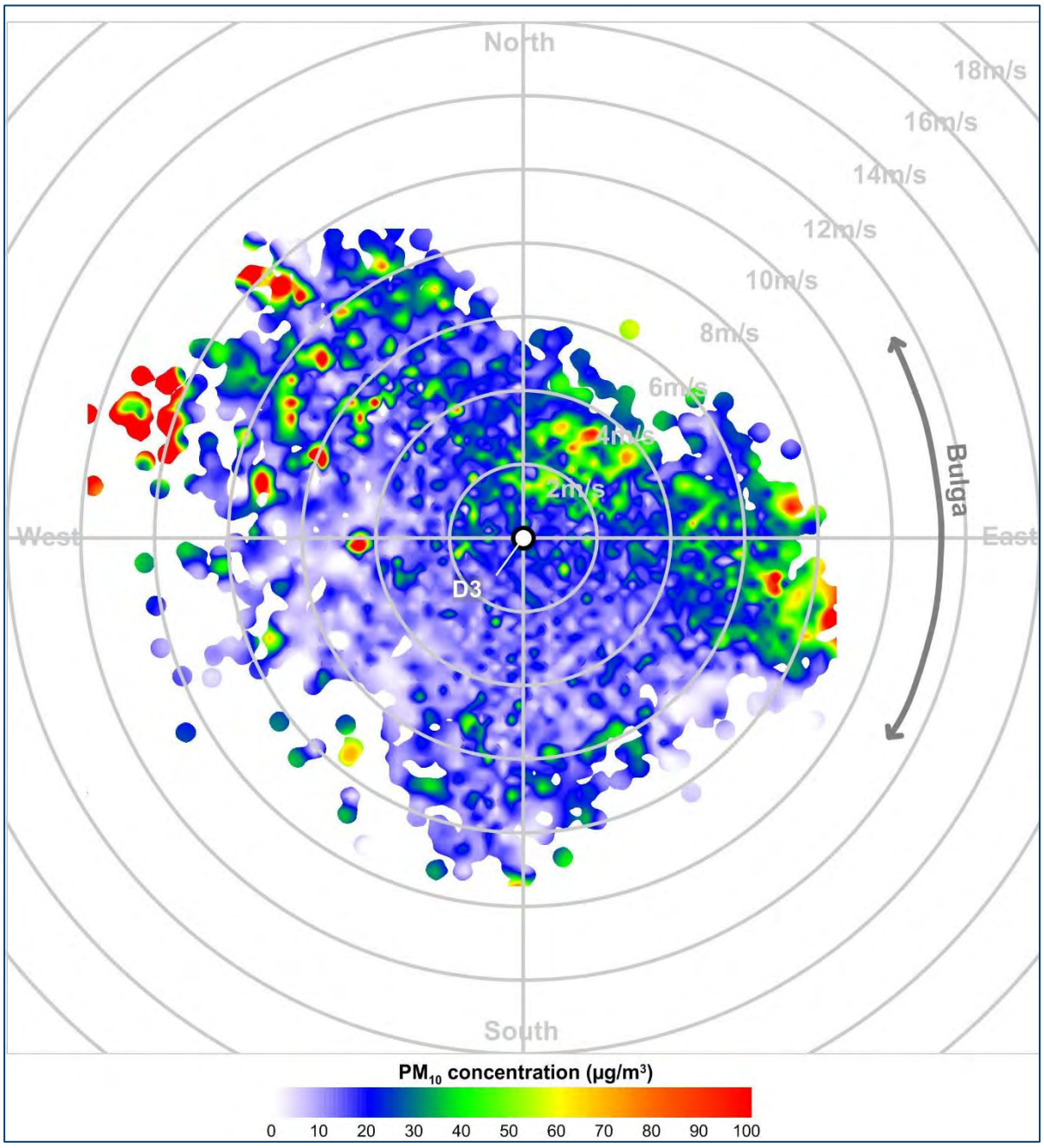


Figure 6-4: Pollution rose for D3 TEOM PM_{10} data (2018)

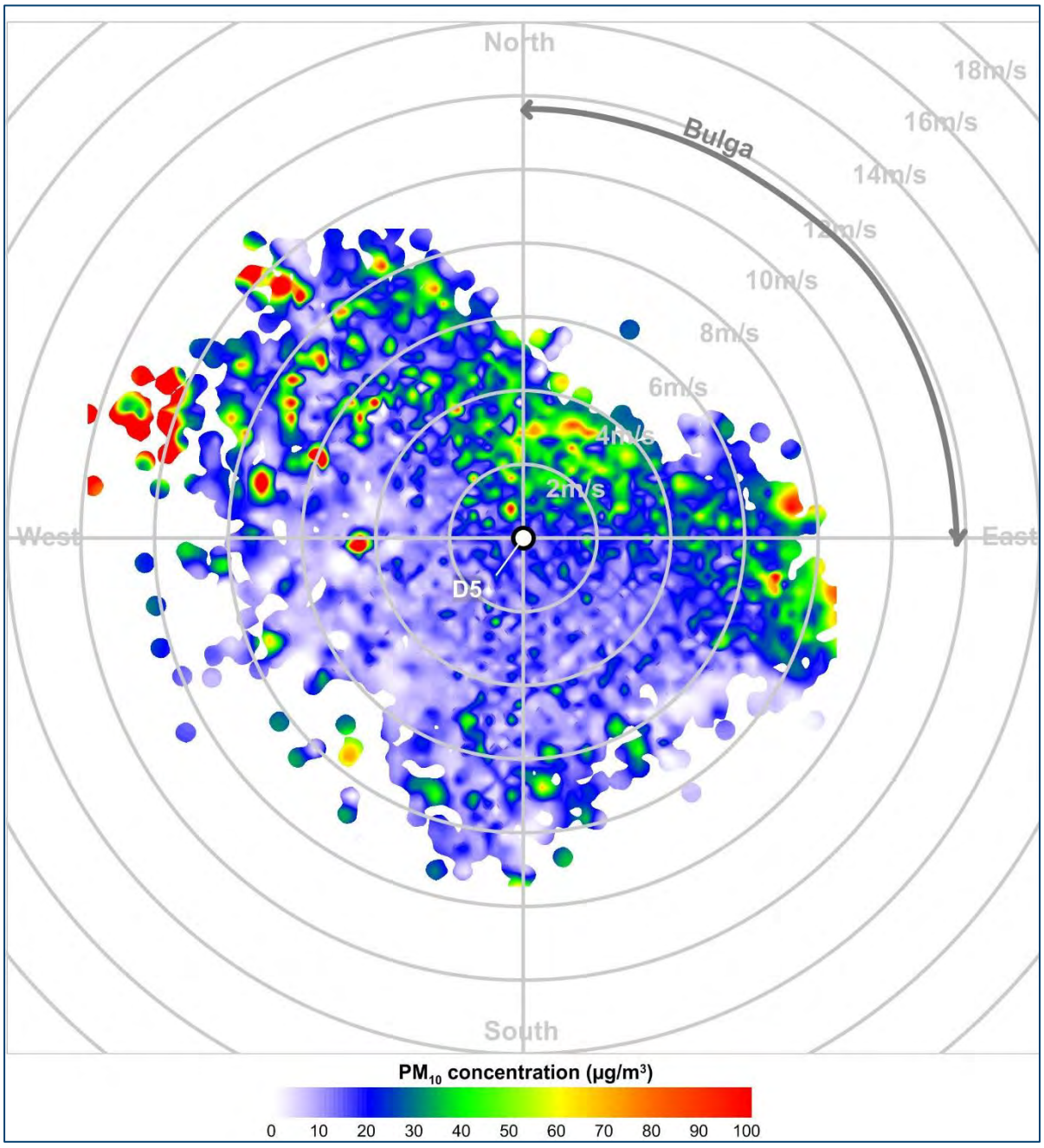


Figure 6-5: Pollution rose for D5 TEOM PM_{10} data (2018)

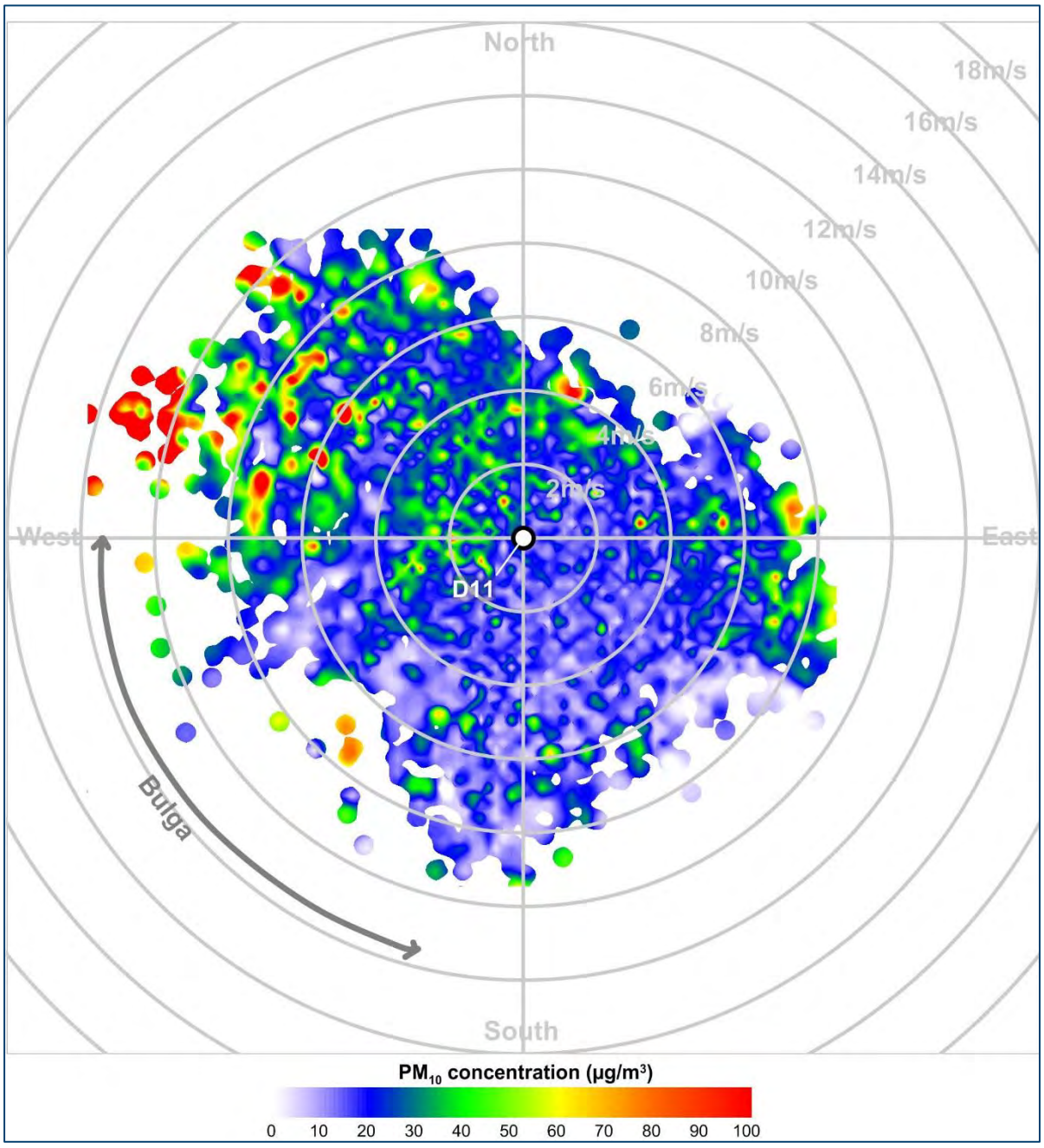


Figure 6-6: Pollution rose for D11 TEOM PM_{10} data (2018)

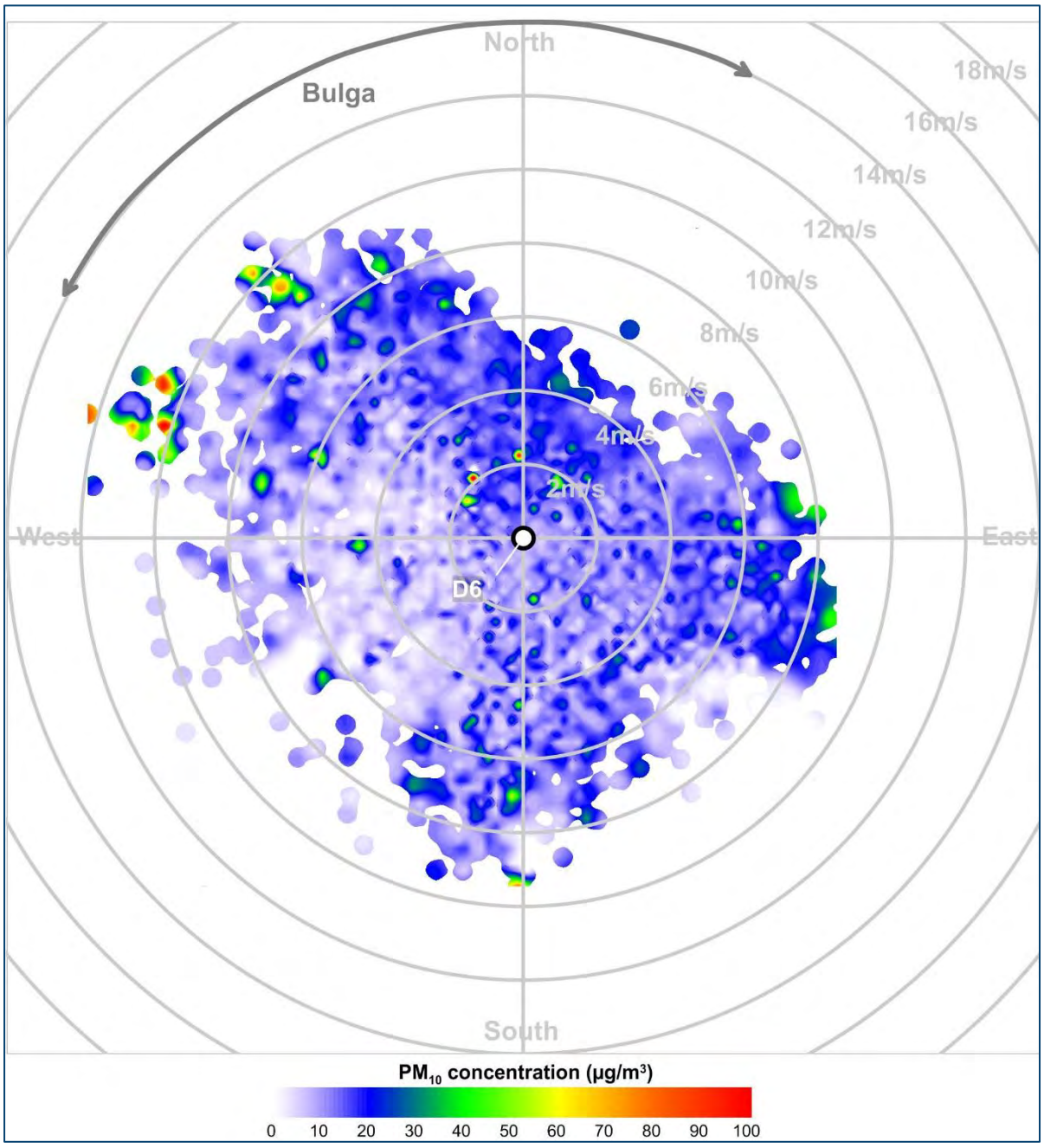


Figure 6-7: Pollution rose for D6 E-Sampler PM_{10} data (2018)

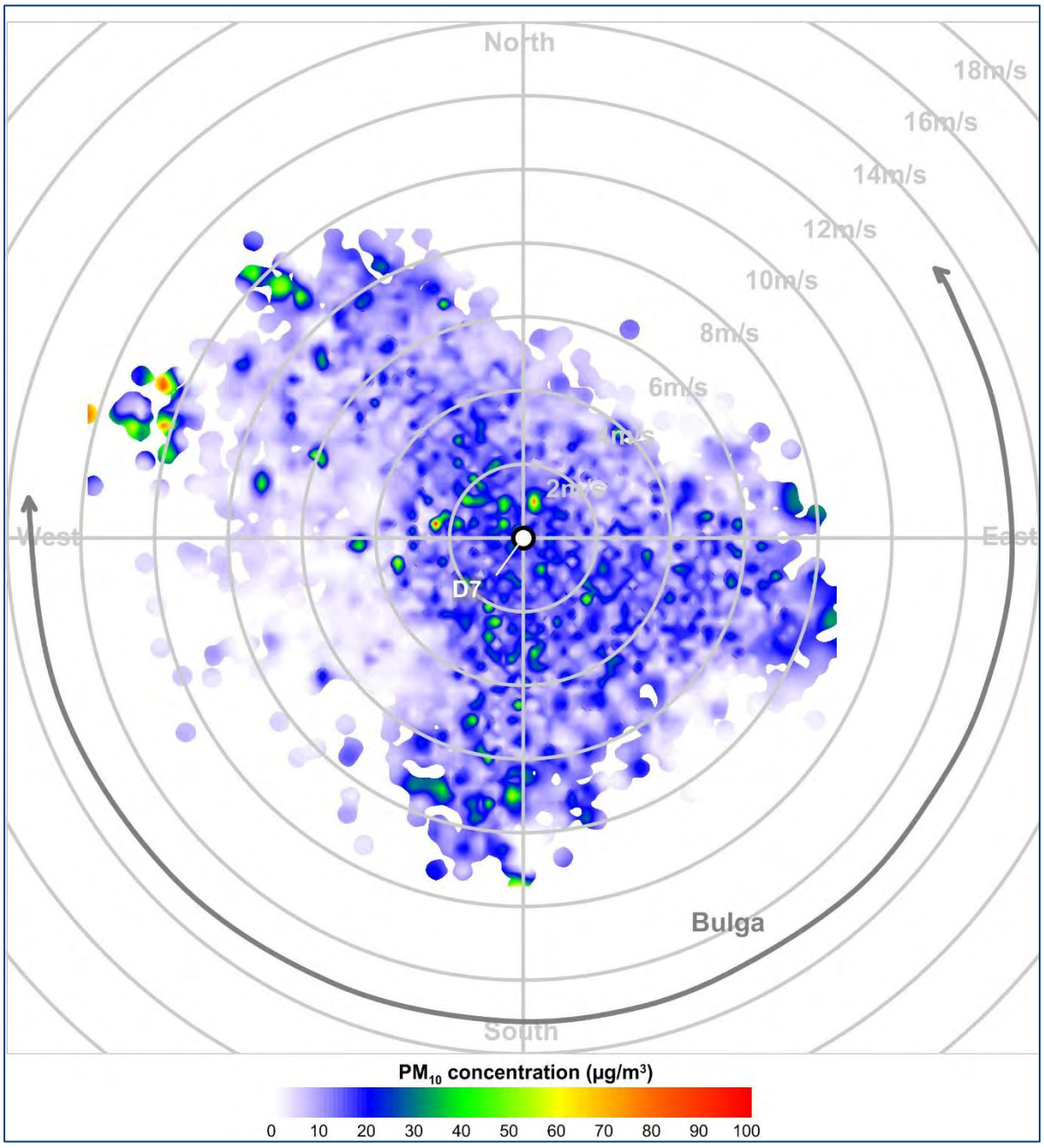


Figure 6-8: Pollution rose for D7 E-Sampler PM_{10} data (2018)

7 CONCLUSIONS

This report has analysed the dust monitoring data recorded at the Bulga Complex and provides a comparison between the dust levels measured in 2018 with the modelled predictions for that approximate year (Year 3) per the Bulga Open Cut Eastern Emplacement Area Modification Air Quality Impact Assessment (**Jacobs, 2016**).

The analysis shows that there was generally good agreement between the modelling predictions and the measured results.

This report has also presented a review and long-term trend analysis of air quality data from the beginning of monitoring to the end of 2018. The analysis shows that levels were generally low and below the relevant criteria for all monitoring sites and pollutants, with the exception of short term $PM_{2.5}$ and PM_{10} levels on occasion.

An analysis of the pollution roses for 2018 shows that there is a moderate effect on PM_{10} dust levels from the direction of the Bulga Complex and also high levels arising from regional events or other sources not related to the mine.

8 REFERENCES

Jacobs (2016)

"Air Quality Impact Assessment – Bulga Surface Operations Eastern Emplacement Area Modification", prepared by Jacobs Group (Australia) Pty Ltd for Bulga Coal Management Pty Ltd, 22 June 2016.

NEPC (2016)

"National Environment Protection (Ambient Air Quality) Measure", National Environment Protection Council, February 2016.

NSW EPA (2017)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", NSW Environment Protection Authority, January 2017.

Appendix A: How to read a windrose and pollution rose

Windrose

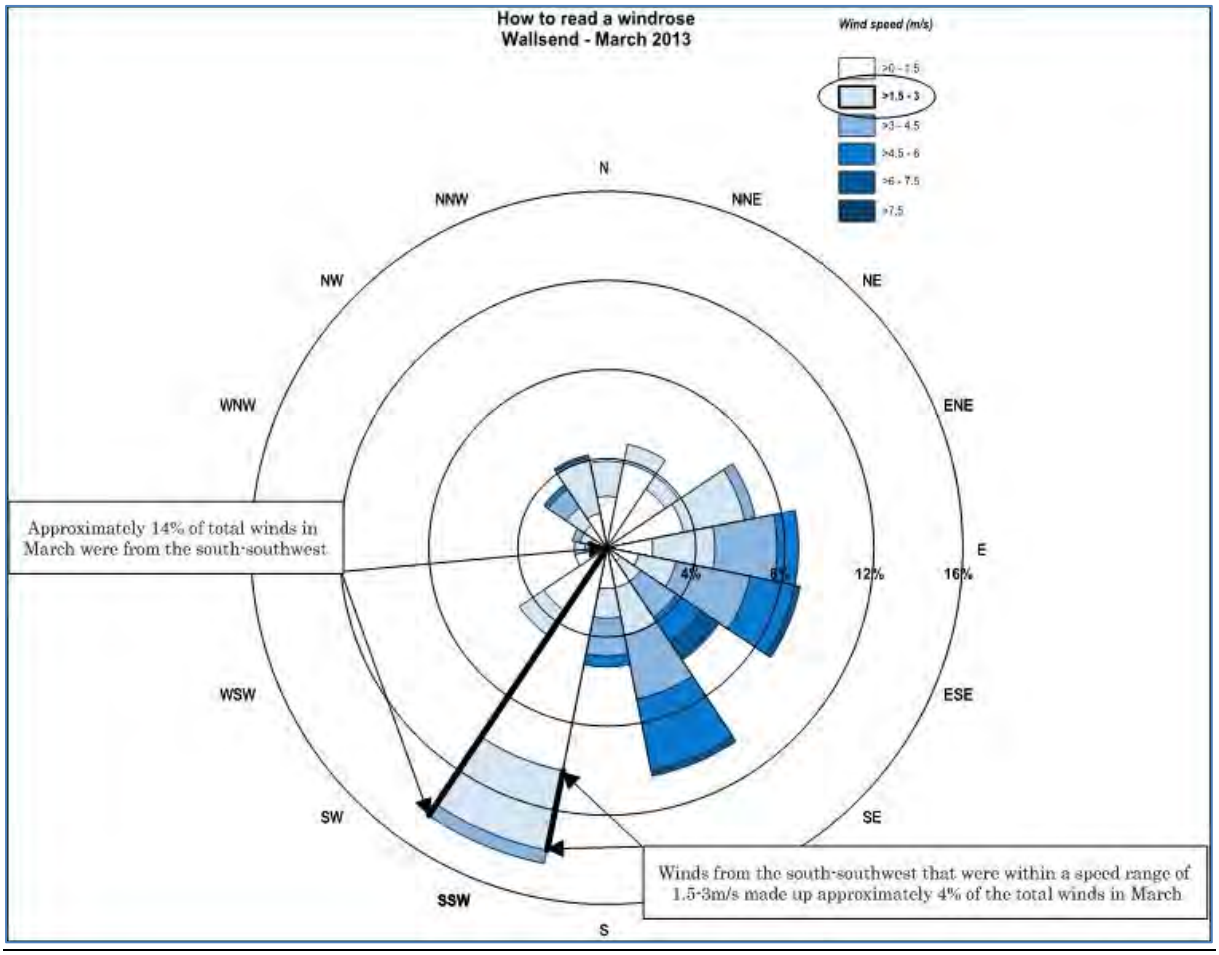


Figure A-1: How to read a windrose

Pollution rose

How to read a pollution rose:

- The colour indicates the pollutant concentration measured at the monitor.
- The position of pollutant concentration markings along the 360° axis indicate the corresponding direction from which pollutants arise from.
- The position of pollutant concentration markings relative to the banded rings indicate the wind speed for the corresponding hourly concentration.
- The arc labelled "Bulga" indicates the relative direction of Bulga Complex from the monitor.

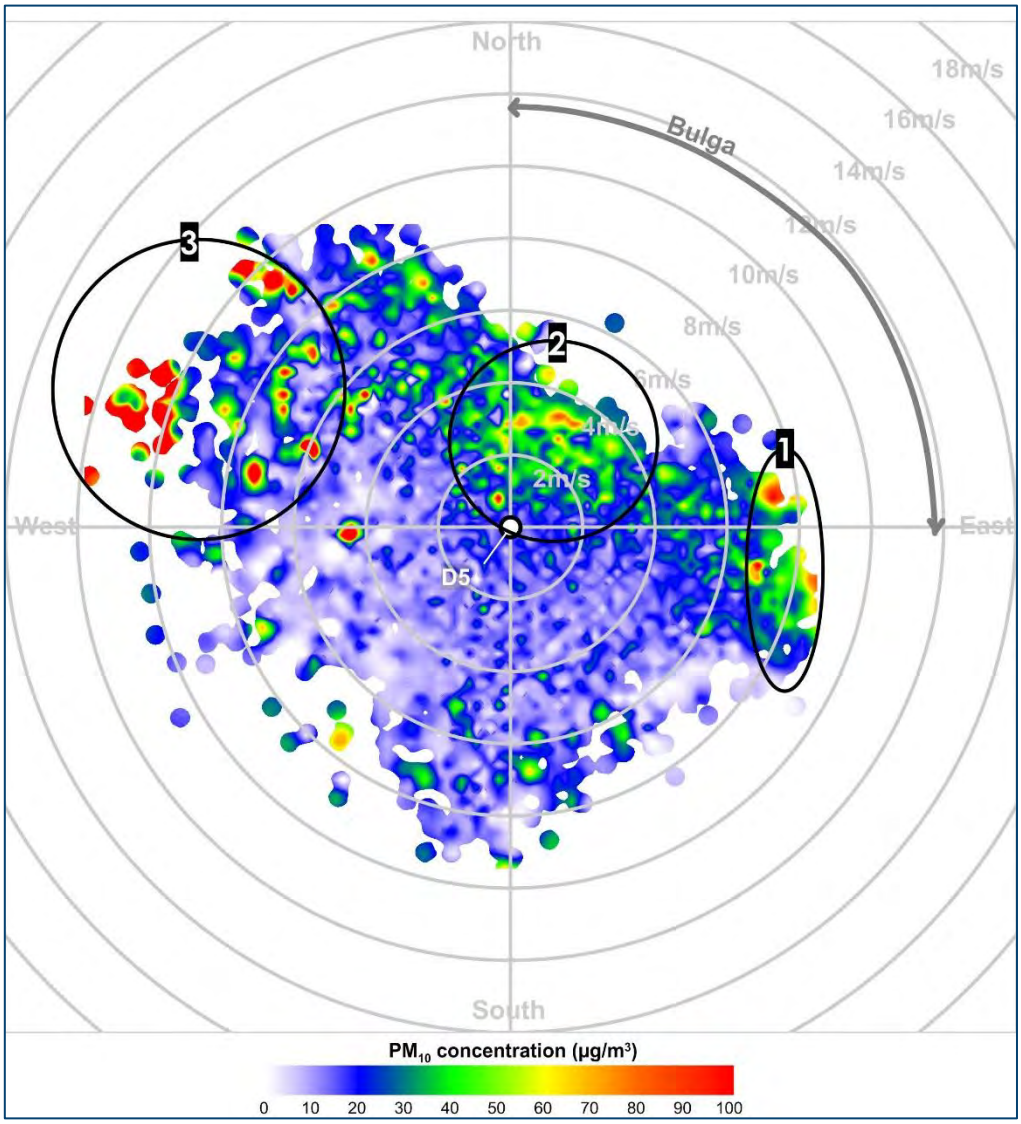


Figure A-2: Example Pollution Rose

1 - Moderate PM_{10} levels tended to originate from the east under wind speeds around 8m/s.

2 - Moderate PM_{10} levels were also recorded from the north and north-northeast direction under wind speeds generally between 2 m/s and 4 m/s.

3 - Some high levels were also recorded from the northwest under moderate wind speeds.

APPENDIX D

Annual Groundwater Monitoring Report (David, 2019)

ANNUAL GROUNDWATER REPORT FOR BLAKEFIELD SOUTH

For BULGA UNDERGROUND OPERATION Pty LTD

Report KD2018/11
March 2019

Katarina David
RPGeo (Hydrogeology) No 10060

DOCUMENT REGISTER

Revision	Status	Date	Comments
A	Draft	09/01/2019	R.Northey, S. Moore
B	Final	22/03/2019	

Table of Contents

1. Introduction 6
1.1 Background 6
1.2 Study Area 6
1.3 Geology 6
1.4 Hydrogeology 7
2. Groundwater Monitoring Network 9
3. Groundwater System Performance 11
3.1 Shallow Groundwater System 11
3.1.1 Wollombi Brook Alluvium 12
3.1.2 Monkey Place Creek (MPC) Alluvium 13
3.1.3 Regolith 15
3.1.4 Interburden Sandstone and Shallow Permian 15
3.2 Shallow Coal Measures 15
3.2.1 Undifferentiated Coal Seams 15
3.2.2 Alcheringa Seam 15
3.3 Deep Coal Measures 16
3.4 Nested Standpipe Piezometers 16
3.4.1 Alcheringa and Interburden Sandstone Connectivity 16
3.4.2 Shallow and Deep Coal Measures Connectivity 16
3.5 Vibrating Wire Piezometers 17
3.4 Water Flow in Alluvium 17
3.5 Groundwater Chemistry 20
4. Comparison with Groundwater Modelling Predictions 21
4.1 Groundwater Levels 21
4.2 Groundwater Inflow 22
4.3 Mine Water Balance 22
5. Conclusions 23
6. References 24

TABLE OF FIGURES

Figure 1 Blakefield South location map and groundwater monitoring network 9
Figure 2 Interpreted alluvial groundwater contours December 2018 19
Figure 3 Piper diagram showing abundance of ions and different water facies 21

LIST OF TABLES

Table 1 General stratigraphy of the Hunter Coalfields 7
Table 2 Coal seams nomenclature of Jerrys Plains Subgroup (Beckett, 1988) 7
Table 3 Summary of standpipe monitoring bores 10
Table 4 Summary of vibrating wire piezometers monitored during 2018 11
Table 5 Evaluation of cumulative rainfall deviation and impact of rainfall on groundwater (Wollombi Brook and MPC) 14
Table 7 Predicted and observed groundwater inflow comparison post mining 22

LIST OF APPENDICES

Appendix A Groundwater hydrographs and piezometric head profiles

Appendix B Alluvial hydrograph analysis using HARTT method

EXECUTIVE SUMMARY

This is the first groundwater report prepared after the completion of mining in Blakefield South (BFS) The report is an appendix to the Annual Environmental Report at Bulga Underground Operations (BUO). It provides an overview and a summary of the groundwater conditions after the completion of all BFS longwall panels and compares the groundwater response to model predicted values. The report also covers the dewatering licence requirement (20BL169347) for Bulga Coal underground workings.

The extraction of BFS commenced with BFSLW1 in 2010 and was completed in May 2018 with coal extraction from the Blakefield Seam. BFSLW1A was partially extracted in 2011 and the BFSLW1B (its eastern part) was completed in 2018. The longwalls varied in length from 960 m to 3170 m long, 400 m wide and had an extraction height of approximately 3 m. All panels were oriented southwest to northeast except for BFSLW7 and BFSLW8 which were oriented north to south. The panels were located east of the Wollombi Brook, and north of Monkey Place Creek and south of the open cut. The closest panels to water courses were: BFSLW3 (at its western end around 250 m distance to Wollombi Brook).

A full review of standpipe and vibrating wire piezometer data was undertaken to understand any change since the completion of underground operations at BUO. For this purpose, piezometeric heads and groundwater chemistry were assessed for temporal change. Spatial analysis was undertaken by plotting the shallow alluvial groundwater levels to understand any change in groundwater levels and flow direction compared to historical data and modelling predictions.

Alluvial water table in Wollombi Brook and Monkey Place Creek has declined and fluctuated during 2018 in response to continued low rainfall period. It is of note that the purpose drilled GW series of Monkey Place Creek alluvial piezometers show the recent water levels still to be well above the 2007 water levels recorded before the Pasha Bulker flood event. Salinity measurements show EC levels fluctuation (up to 1500 µS/cm) reflecting lack of the rainfall recharge. Hydrograph analysis of Wollombi Brook and Monkey Place Creek (MPC) alluvial data indicates that the water table is strongly influenced by rainfall and to a lesser extent by other factors such as irrigation and surface water-groundwater interaction.

During 2018 the vertical connectivity between the upper sandstone/shallow coal and the underlying sedimentary strata remains generally unchanged. The most significant change was related to declining head in sandstone (NPZ7-2 and NPZ7-3) compared to stable piezometeric heads in the overlying Alcheringa Seam. At SBD194 (the western end of BFSLW3) the piezometric heads are re-pressurising in Blakefield Seam (with over 20 m recovery at the western side of the extracted workings) and Whybrow Seam (with a lesser magnitude - 1 m increase in piezometric head). Both re-pressurisation and depressurisation are occurring in the overburden strata below 100 m depth; however, this process is not uniform. Regolith and sandstone bores (to a depth of around 50 m) installed to the northwest of BFS close to the eastern edge of Wollombi alluvium mostly respond to rainfall recharge and have not shown any further changes in piezometric head following cessation of mining.

The overall groundwater inflows into the Blakefield South workings were compared to historical data and predicted groundwater modelling. The actual inflows were less than those predicted by modelling by around 0.5 ML/day. The water imbalance was 22.6 ML with more water produced in the underground and pumped via dewatering bores than input in the underground for operational purposes.

1. Introduction

1.1 Background

The Bulga Coal Complex (BCC) is located in the NSW Hunter Coalfield, approximately 12 km southwest of Singleton and 1km north of Broke (**Figure 1**). The complex is managed by Bulga Coal Management Pty Ltd and comprises both open cut (Bulga Surface Operations) and an underground mine (Bulga Underground Operations (BUO)).

BUO included two operations, Blakefield South (BFS) which ceased operation in 2018 and historical Beltana No.1. Beltana No.1 underground mine extracted coal from the Whybrow Seam and ceased operation in 2011. In 2010, BUO started the BFS operation and extraction of the Blakefield Seam which underlays previously extracted Whybrow Seam. Mining operations at BUO were undertaken using the longwall retreat mining method. The BFSLW1A to BFSLW5 longwalls were extracted in the southwest to northeast direction, while longwalls BFSLW7 and BFSLW8 were extracted in the southeast-northwest direction.

The extraction of the original BFSLW1A started in 2010 but was suspended in January 2011 due to fire and related working conditions. Most recently extracted panel BFSLW1B was a continuation of BFSLW1A and was completed in April 2018. The intact coal was left in place between BFSLW1A and BFSLW1B.

This report was prepared to support the Annual Environmental Report for BUO and to satisfy the Part 5 licence (20BL169347) for Bulga Coal underground workings. It documents groundwater conditions after the underground operations have ceased and provides comparison of observed with predicted range of groundwater inflows.

1.2 Study Area

BFS is situated east-northeast of the Broke township in the Hunter Coalfields, within the north-eastern part of the Sydney Basin, NSW. The area is bounded by Monkey Place Creek to the south and southwest and Wollombi Brook to the west (**Figure 1**).

1.3 Geology

BUO is geologically located within the Hunter Coalfield in the northern part of the Sydney Basin. Major structural feature to the east of the BFS is the Mt Thorley monocline. The BUO area is underlain by Late Permian age strata- the Whittingham Coal Measures, which are directly overlain by the Wollombi Coal Measures Group. The late Permian sequence is characterised by a series of sandstone, siltstone, conglomerate and coal formations.

The strata dip at a shallow 2°-5° angle to south-west. The Late Permian strata outcrops across the site but is overlain by more recent Quaternary alluvial deposits along watercourses - Wollombi Brook and Monkey Place Creek. Table 1 shows the detailed geology of this part of the Sydney Basin.

Table 1 General stratigraphy of the Hunter Coalfields

Period	Stratigraphy		
Quaternary			
Tertiary			
Jurassic			
Triassic	Hawkesbury Sandstone		
	Narrabeen Group	Terrigal Formation	
		Clifton Subroup	Patonga Claystone
			Tuggerah Formation
			Widden Brook
Permian	Singleton Supergroup	Wollombi Coal Measures	Glen Gallic Subgroup
			Doyles Creek Subgroup
			Horseshow Creek Subgroup
			Apple Tree Flat Subgroup
			Watts Sandstone
		Wittingham Coal Measures	Denman Formation
			Jerrys Plains Subgroup
			Archerfield Sandstone
			Vane Subgroup
			Saltwater Creek Formation

Table 2 Coal seams nomenclature of Jerrys Plains Subgroup (Beckett, 1988)

Subgroup	Coal Seams
Jerrys Plains	Whybrow
	Redbank Creek
	Wambo
	Whynot
	Blakefield
	Glen Munro
	Woodlands Hill
	Mount Arthur
	Piercefield
	Vaux
	Bayswater

1.4 Hydrogeology

Three hydrostratigraphic units (HSU) are identified within the Project area:

- Alluvial aquifer associated with Wollombi Brook and Monkey Place Creek;
- Weathered and fractured shallow sandstone and coal strata, regolith and colluvium; and
- Fractured rock aquifer associated with Whittingham and Wollombi Coal measures.

The alluvium typically has the highest permeability and therefore highest yield of all hydrostratigraphic units identified in the Project area. Around 20 private bores are installed in this aquifer within 3 km radius from the BFS and are used for stock and domestic, water supply and irrigation purpose.

Weathered rock unit exhibits relatively low permeability and provides the transition zone. Fractured rock aquifer comprises sandstone, siltstone and coal sequence with varying degree of fracturing. This

unit is characterised by generally poor-quality water and low permeability. There are no private bores installed in weathered or fractured rock unit within the vicinity of the Project area.

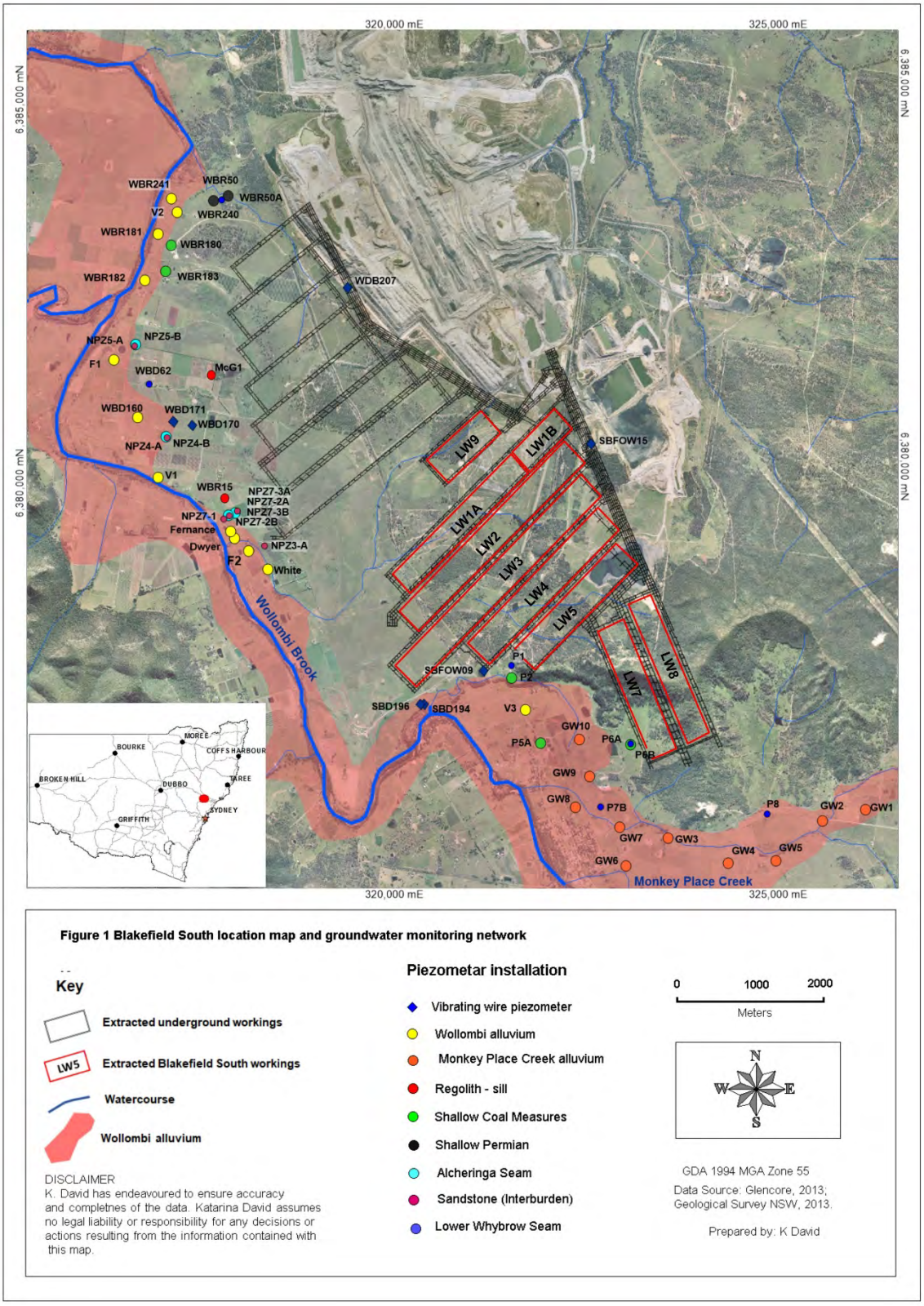


Figure 1 Blakefield South location map and groundwater monitoring network

Key

- Extracted underground workings
- LW5 — Extracted Blakefield South workings
- Watercourse
- Wollombi alluvium

Piezometar installation

- Vibrating wire piezometer
- Wollombi alluvium
- Monkey Place Creek alluvium
- Regolith - sill
- Shallow Coal Measures
- Shallow Permian
- Alcheringa Seam
- Sandstone (Interburden)
- Lower Whybrow Seam

0 1000 2000
Meters

N W E S

GDA 1994 MGA Zone 55
Data Source: Glencore, 2013; Geological Survey NSW, 2013.

Prepared by: K David

DISCLAIMER
K. David has endeavoured to ensure accuracy and completnes of the data. Katarina David assumes no legal liability or responsibility for any decisions or actions resulting from the information contained with this map.

Figure 1 Blakefield South location map and groundwater monitoring network

Recharge to the shallow aquifer system is provided mainly by rainfall recharge directly at the outcrop, with topography driving the groundwater flow near surface. Deeper hydrostratigraphic units are confined and are recharged at some distance away from the BUO. The bedding of sedimentary strata promotes horizontal groundwater flow within the deep sedimentary strata.

Discharge from the shallow system occurs via groundwater abstraction, evapotranspiration, leakage to deeper strata and baseflow contribution. Discharge from deeper units occurs via dewatering, upward flow where the strata is confined and regional lateral outflow at some distance away from the mining operation.

2. Groundwater Monitoring Network

A number of standpipe piezometers, nested piezometers and multilevel vibrating wire piezometers (VWP) (**Figure 1**) form the groundwater monitoring network within the BUO. The monitoring bores are installed in various HSU: alluvium, overburden coal and sandstone, shallow and deep coal seams. Groundwater monitoring is undertaken in accordance with the BUO Water Management Plan using manual gauging and continuously using dataloggers. Over the past 15 years a number of monitoring points were discontinued, and new ones were installed as the underground development progressed. A summary of currently operational piezometers is provided in Table 3 for standpipe and Table 4 for vibrating wire piezometers, respectively. The locations of all currently monitored piezometers are shown on Figure 1.

The following monitoring locations are part of the monitoring network and are separated here based on the screened/monitored unit:

- Wollombi Alluvium – twelve standpipe piezometers are located to the south and west of BFS. Three of the twelve piezometers are also equipped with dataloggers for continuous monitoring of groundwater levels;
- Monkey Place Creek (MPC) Alluvium - ten piezometers are installed to a maximum depth of 16 m to the south BFS. Nine of those are equipped with continuous datalogging equipment;
- Regolith - two standpipe piezometers are installed in regolith of which one was equipped with datalogger during 2018;
- Interburden sandstone - six standpipe piezometers are installed in shallow interburden sandstone to a depth of up to 52 m to the west and northwest of BFS;
- Shallow Permian and Coal Measures (undifferentiated) - eight standpipe piezometers are currently being monitored in this unit; they are located to the northwest and the southwest of BFS. Two piezometers were equipped with dataloggers in 2018.
- Alcheringa Seam – six standpipe piezometers are currently monitored to the northwest of BFS to a depth ranging from 10-42 m. All piezometers are equipped with continuous datalogging equipment;

- Lower Whybrow Seam - three actively monitored standpipe piezometers with one standpipe piezometer equipped with a datalogger;
- Four multilevel vibrating wire piezometer sites were used in this assessment. They are installed west, northwest and east of the BFS to a maximum depth of 170 m below the mined Blakefield Seam.

Table 3 Summary of standpipe monitoring bores

Piezometer	Easting (m)	Northing (m)	Depth of installation (mbgl)	Aquifer	Elevation (mAHD)	Continuous Datalogger Monitoring
Dwyers	317704.5	6379357.9	<30	Wollombi Alluvium		
F1	316154	6381596.6	17.4	Wollombi Alluvium		Yes
F2	317916.5	6379140.5	14	Wollombi Alluvium		Yes
Fernance	317697.3	6379366.7	Unknown	Wollombi Alluvium		
V1	316720.3	6380086.2	<30	Wollombi Alluvium		
V2	316959.4	6383505.3	<30	Wollombi Alluvium		
V3	321479.5	6377087.4	<30	Wollombi Alluvium		
WBD160	316460	6380857	18	Wollombi Alluvium		
WBR181	316735.2	6383229.6	9	Wollombi Alluvium		
WBR182	316570.5	6382623	11.5	Wollombi Alluvium		
White1	318248.9	6378943	Unknown	Wollombi Alluvium		
WBR241	316931.6	6383672	13.5	Wollombi Alluvium		Yes
GW1	326035.5	6375616.6	Unknown	Monkey Place Creek		Yes
GW2	325328.7	6375636.4	Unknown	Monkey Place Creek		Yes
GW3	323342.3	6375423.8	13.2	Monkey Place Creek		Yes
GW4	324107.4	6375104.1	Unknown	Monkey Place Creek		Yes
GW5	324731.9	6375152.5	Unknown	Monkey Place Creek		Yes
GW6	322800.9	6375050.5	13.3	Monkey Place Creek		
GW7	322467.9	6375809.5	10	Monkey Place Creek		Yes
GW8	322120.9	6375817.9	16	Monkey Place Creek		Yes
GW9	322319.1	6376212.9	13	Monkey Place Creek		Yes
GW10	322177.7	6376728.3	16	Monkey Place Creek		Yes
WBR15	317585.7	6379804.4	24	Regolith-sill-alluvium		Yes
McG1	317425.8	6381405.4	Unknown	Regolith-sill-alluvium		
WBD62A	316593.5	6381282.7	27	Alcheringa Seam		Yes
NPZ4-A	316824.2	6380615.3	42.4	Alcheringa Seam		Yes
NPZ5-A	316448.3	6381790.4	15.7	Alcheringa Seam		Yes
NPZ3-A	318117.7	6379200.5	17	Alcheringa Seam		Yes
NPZ7-2A	317623.9	6379598.2	10.0	Alcheringa Seam		Yes
NPZ7-3A	317680.7	6379639.5	17.7	Alcheringa Seam		Yes
NPZ3-B	318116.8	6379199.7	51.4	Sandstone		
NPZ4-B	316820.6	6380615.8	63.3	Sandstone		
NPZ5-B	316448.3	6381790.4	51.3	Sandstone		
NPZ7-1	317566.2	6379556.3	50	Sandstone		
NPZ7-2B	317623.9	6379598.2	57.5	Sandstone		
NPZ7-3B	317680.7	6379639.5	54	Sandstone		
WBR240	317493.6	6383681	9	Shallow Permian		Yes
WBR50A	317607.4	6383715.5	18	Shallow Permian		Yes
WBR180	316926.1	6383123.8	46	Shallow Coal		
WBR183	316802.5	6382733.6	30.6	Shallow Coal		
P2	321283.3	6377492.6	21	Shallow Coal		
P5A	321682.0	6376660.7	<100	Shallow Coal		
P6A	322839.7	6376615.3	<100	Shallow Coal		
SBD196	320164	6377155		Shallow Coal		
P6B	322839.8	6376615.3	390.0	Lower Whybrow		
P8	324628.2	6375708.2	392.4	Lower Whybrow		
WBR50	317559.5	6383707.4	125	Lower Whybrow	65.27	Yes

Table 4 Summary of vibrating wire piezometers monitored during 2018

Piezometer	MGA Coordinates		Ground Level (m AHD)	Depth Drilled (m)	Depth of Vibrating Wire Completions (m below GL)	Hydrostratigraphic Unit
	Easting	Northing				
WBD170	317164.3	6380768.3	93.9	220	60	Undifferentiated
					110	Undifferentiated Permian
					160	Undifferentiated Permian
					220	Whybrow Seam
WBD171	316939.8	6380797.6	85.3	223	60	Undifferentiated Permian
					110	Undifferentiated Permian
					160	Undifferentiated Permian
					223	Whybrow Seam
SBD194	320162.1	6377154.6	73	367.6	35.34	Shallow coal
					90.76	Watt's Sandstone
					171.42	Whybrow Seam
					197.315	Redbank Creek Seam
					227.015	Wambo Seam
					265.88	300/301 (Blakefield) Seam)
					278.835	Glen Munro Seam
					321.325	Woodlands Hill Seam
					367.655	Piercefield A and B Seam
SBFOW15	322380.2	6380379.1	89.1	383	96	Redbank Creek Seam
					122	Wambo Seam
					158	Blakefield Seam
					184	Glen Munro Seam
					224	Woodlands Hill Seam
					334	Piercefield C Seam

3. Groundwater System Performance

Groundwater quality and piezometeric head data collected during 2018 for different HSUs have been analysed to determine groundwater response to natural events and provide comparison with historical data. Appendix A shows the hydrographs for the period during 2018 and includes historical data for comparison with long term trends.

3.1 Shallow Groundwater System

Two methods were used for the analysis of the groundwater trends:

- Comparison of the hydrographs and rainfall trends; and
- Hydrograph analysis using Rainfall and Time Trend method (HARTT).

Groundwater levels for alluvial piezometers are plotted (Figures 1-8, Appendix A) along with rainfall residual mass (RM). RM is calculated as the cumulative difference between total and long term mean monthly rainfall. Positive, rising trends represent above average rainfall periods and negative trends represent below average rainfall periods. The RM curve helps interpretation of the water level fluctuations and allows differentiation between climate and other impacts on groundwater.

Rainfall data used for this time period is sourced from Bureau of Meteorology Broke station (061100), and data from the Bulga Complex Weather Station. The rainfall data records for these stations are available since 1887 and 2009 respectively. The records for the last 128 years of rainfall data from SN-61100 have been used to obtain the long-term average rainfall. The average monthly rainfall data for the period from 2013-2018 have been sourced from Bulga Complex Weather Station, with missing periods complemented by BOM 061100 station data.

HARTT analysis was used to analyse all Monkey Place Creek piezometers. HARTT is a methodology developed by R. Ferdowsian of the Department of Agriculture, Western Australia, to statistically analyse and estimate trends in groundwater levels. The approach separates the effect of typical rainfall events from the underlying time trend and the lag between rainfall and groundwater response. The impact of rainfall on groundwater is explicitly represented. For HARTT method it is recommended that long-term rainfall data (10 years and over) are used to understand the delay period and long-term trend analysis. The method produces a fitted curve through the groundwater level readings using two variables: rainfall Variable Accumulative Monthly Residual Rainfall (AMRR) or Accumulative Annual Residual Rainfall (AARR) and time trend. These variables can differentiate between the effect of rainfall fluctuations and the underlying trend of groundwater level over time. Rainfall is represented as an accumulation of deviations from average rainfall, and the lag between rainfall and its impact on groundwater is explicitly represented (Ferdowsian et al. 2001).

The degree of fit between the calculated curve compared to the recorded water levels is represented by R^2 value where 1 is a perfect fit. The p-value indicates the level of significance of each variable. If the p-value is less than 0.05 then the variable is significant, and the groundwater response is related to rainfall recharge.

For the purpose of this report the method has been applied to selected piezometers in the Wollombi Brook and Monkey Place Creek alluvium based on the period of data available for analysis.

3.1.1 Wollombi Brook Alluvium

The Wollombi Brook alluvium piezometers during 2018 have generally shown a downward groundwater trend. This is in response to the reduced rainfall recharge (Figures 1 to 4, Appendix A). The declining rainfall trend continues through 2018 with a rise in October 2018 following the above average rainfall.

Most piezometers show a decrease in groundwater level of around 1 to 1.5 m following the cessation of mining. The exceptions are V1, V2 and V3 and White 1 (Figure 1 and 2, Appendix A) which show groundwater level fluctuation in the maximum range of up to 0.5 m. An increase in RM during October 2018 is observed in White1, Dwyers, Fernance and F1 (Figure 2 and 4, Appendix A) but has not been recorded in other piezometers.

The HARTT analysis was undertaken for three piezometers (Fernance, White and WBD160) located to the west of the BFS. The R^2 of the regression varied from 0.54 to 0.61 (Table 5) and improved on the most recent analysis undertaken for BFSLW1B. The results indicate that at White there is weaker agreement between rainfall and groundwater level response (R^2 0.54) compared to two other bores. However, the R^2 has increased based on previous results (Appendix B). The fact that the correlation with rainfall is weak, indicates there must be other influence on the water table in the vicinity of White. Similar low R^2 is estimated at WBD160 bore (0.58) which maybe a result of increased stock and domestic pumping due to prolonged dry period. Based on these results rainfall is not the only parameter that influences water table fluctuation. Other influences may include surface water-groundwater

interaction and irrigation. The low p-values (Table 5) indicate that the rainfall variable is significant and has strong influence on groundwater table fluctuation.

Typically, the groundwater level in alluvium mirrors the rainfall trends, with the overall decline during the year. The datalogger records closely follow the manual reading trends indicating good data quality. Based on this response and continuing historical trend, it is observed that there was no change in Wollombi Brook alluvium during 2018 (Figures 1-4, Appendix A).

3.1.2 Monkey Place Creek (MPC) Alluvium

A comprehensive groundwater network of ten piezometers monitors the Monkey Place Creek Alluvium. These piezometers are located mainly to the south and south-west of the BFS.

Continuous datalogger monitoring at 8-hour intervals enables identification of any minor changes in groundwater trends. During 2018, three dataloggers have not functioned (GW2, GW4 and GW5) and one (GW8) was not accessible during the second half of 2018. However, manual groundwater readings provide the information to allow assessment of trends. Groundwater hydrographs for the bores GW1 to GW10 are shown on Figures 5 to 7 in Appendix A. For GW1 the datalogger records were discontinued after October 2018, however manual readings continued through to the end of 2018.

Groundwater level fluctuations in MPC piezometers are generally within 0.5 m following cessation of mining. A decline in groundwater levels in most MPC piezometers occurred during 2018. This decline agrees with below average rainfall over this period. An unusual groundwater level rise was recorded in GW5 in the first half of the year, probably related to irrigation in the area. However, although the declining groundwater trend was noted in most piezometers, only some piezometers recorded a rise following above average rainfall in October 2018. This included GW2, GW3, GW6, GW10 and GW9, while GW1 and GW8 continued declining.

The HARTT analysis was undertaken for two piezometers in MPC alluvium: GW9 to GW10. The R^2 of the regression was low and varied from 0.57 to 0.51 (Table 5 and Appendix B). The agreement was weaker than in the previous period which indicates the importance of parameters other than rainfall and their influence on water table fluctuation. This is observed in groundwater levels stabilisation and rise occurring in some piezometers (GW4, GW5, GW9). High p-values (Table 5) indicate that the rainfall variable may not have been significant during 2018 in relation to the groundwater table fluctuation. Other influence on groundwater levels may include the groundwater-surface water interaction (Monkey Place creek) and irrigation.

Based on both hydrograph analyses, the groundwater trend in shallow piezometers continues to follow the historical trend. It is of note that the purpose drilled GW series of Monkey Place Creek alluvial piezometers show the recent water levels still to be well above the 2007 water levels recorded before the Pasha Bulker flood event.

Table 5 Evaluation of cumulative rainfall deviation and impact of rainfall on groundwater (Wollombi Brook and MPC)

Bore	Depth Initial	Final	Best Fit Delay AMRR (months)	R^2	C	Acc. Residual Rainfall (mm)		Time (m/month) values		Monitoring period (years)	No. readings
						value	p	value	p		
Fernance	-9.61	-9.21	0	0.61	-9.19	0.00	0.00	0.00	0.05	11	69
White	-7.19	-6.25	1	0.54	-5.81	0.00	0.00	0.00	0.01	11	70
WBD160	-8.97	-9.54	2	0.58	-9.80	0.00	0.00	0.01	0.00	10	64
GW10	-3.96	-1.56	0	0.51	-2.33	0.00	0.00	0.00	0.01	11	70
GW9	-2.73	-2.04	0	0.57	-2.23	0.00	0.00	0.00	0.89	11	70

3.1.3 Regolith

McG1 and WBR15 piezometers are installed in regolith and are located west of the BFS, at the eastern edge of Wollombi alluvium. In the past year, the groundwater in piezometer McG1 followed the rainfall trend, with a decrease of around 2 m (Appendix A, Figure 9). This behaviour is consistent with long term trend.

3.1.4 Interburden Sandstone and Shallow Permian

Generally, the interburden sandstone piezometers are installed in Permian sedimentary formation at shallow depths (<20 m) and in sandstone the at a range of depths between 50 to 70 m. The depth of piezometers is given in Table 3.

Piezometers installed in sandstone all indicated a declining trend during 2018 (Appendix A, Figures 10 to 12). The only exception was NPZ-5B which is still recovering after historical longwall extraction (since 2011). The fluctuations in sandstone vary from <0.5 m at NPZ4-B (Figure 10, Appendix A) to around 2 m at NPZ7-2B (Figure 11, Appendix A). The groundwater fluctuations in shallow Permian are less, at around 0.5 m.

The declining trend in both sandstone and regolith is related to lower rate of rainfall recharge during 2018. The same trend was observed during the longwall extraction.

3.2 Shallow Coal Measures

3.2.1 Undifferentiated Coal Seams

Some shallow coal piezometers are located to the south of the BFS (P2, P5A, P6 and SBD196) and two piezometers (WBR180 and WBR183) are located at to the northwest at a distance of over 2 km.

Most piezometers show decline or stabilising groundwater conditions during 2018. P2, P5 and SBD196 have all recorded a decline in groundwater level of <0.5 m which is directly related to rainfall deficit. However, P5A has recorded a decline of over 2 m and appears to be historically impacted by factors other than rainfall. P6 and WBR180 installed in shallow coal (Figure 13b, Appendix A) remained mostly stable through 2018 which continues the long-term trend in these piezometers.

3.2.2 Alcheringa Seam

Piezometers monitoring Alcheringa Seam are installed to the west of the BFS and at the eastern edge of Wollombi Brook alluvium. During 2018 the groundwater levels in both NPZ7-3A and NPZ7-2A (Figure 15, Appendix A) show a decline in piezometric head of up to 1 m since the cessation of mining, similar to previously observed decline. At these locations the fluctuations in Alcheringa Seam piezometric heads are the response to rainfall recharge and agree with historical trends (Figure 15, Appendix A).

While most piezometers have shown a declining trend during 2018 (Figure 14b, Appendix A) groundwater levels in NPZ3-A have continued the recovery since 2011. Piezometer NPZ4-A (Figure 14b, Appendix A) has recorded the most decline in head (>1.5 m) during 2018 and this trend is coincidental to rainfall. Overall, groundwater level response in piezometers installed in Alcheringa Seam continues to decline with low rainfall in 2018 with the exception of long term recovery in NPZ3-A.

3.3 Deep Coal Measures

As a result of either Beltana and/or South Bulga operations in the Whybrow Seam, coal measures have been depressurised to some extent in the past. This is observed in three piezometers (P6B, P8 and WBR50) (Figures 16a, 16b and 17a, Appendix A).

In 2018 groundwater in P6B and P8 declined by 28 m and 8 m, respectively. Similar to historical records in other deep coal measures (WBR50), depressurisation of around 8 m occurred in P6B during the year, followed by another significant decline in December (almost 20 m). Such response is likely to be related to previous mining activity, and pore pressure redistribution after mining was completed. Piezometric head in P8 during the second half of 2018 also recorded a significant decline but to a lower magnitude compared to that at P6B. At WBR50 the heads remained stable (Figure 17a, Appendix A). Overall depressurisation and re-pressurisation response in the deep coal measures is in agreement with model predicted impacts.

3.4 Nested Standpipe Piezometers

The change in vertical gradients and connectivity between different HSUs is monitored by seven nested standpipe piezometers. Connectivity between two groundwater units is a function of both the permeability of individual hydrogeological unit and hydraulic gradient which creates a driving force for water flow.

Currently monitored nested piezometers are:

- One pair (P6) installed in the Lower Whybrow Seam and shallow coal measures southwest of BFS (Figure 17b, Appendix A,)
- Four pairs (NPZ-4, NPZ-5, NPZ7-2 and NPZ7-3) installed in Alcheringa Seam and interburden sandstone to the west of the BFS (Figures 18b, 19a, 19b, 20a, Appendix A).
- One pair (WBR50) installed in Lower Whybrow and shallow Permian strata to the northwest of BFS (Figure 20b, Appendix A)

3.4.1 Alcheringa and Interburden Sandstone Connectivity

During 2018, the vertical groundwater gradient at piezometer pair NPZ4 remained stable but decreased slightly (2 m) at NPZ5. The reduction at NPZ5 is mainly due to lower water table at surface and continued recovery in sandstone aquifer (Figure 18b and 19a, Appendix A).

However, the vertical gradient between the sandstone and Alcheringa Seam at NPZ7-2 and NPZ7-3 has increased as a result of decreasing head in deeper sandstone unit and stable trends at overlying Alcheringa Seam. Shallow and deep groundwater at these locations show limited connection with higher fluctuations recorded in the deeper sandstone units. In shallow Alcheringa Seam the response to rainfall is observed. The groundwater gradients are generally downward and vertical head difference between the units exceeds 10 m.

3.4.2 Shallow and Deep Coal Measures Connectivity

The erratic behaviour of groundwater in Lower Whybrow resulted in changing vertical gradient between deep and shallow strata throughout 2018. During 2018 at WBR50 (Lower Whybrow) there was minor change in piezometric heads in both shallow coal and Lower Whybrow Seam (Figure 20b, Appendix A). These piezometers show less than 0.5 m difference in head since the start of 2018 with vertical head gradient between these HSUs remaining at just over 30 m.

Groundwater at nested piezometer P6 shows an increase in vertical gradient between the shallow and deep coal measures. Piezometric head in shallow coal (P6A) shows a decline while head in P6B shows

both depressurisation and re-pressurisation during the same period (Figure 17b, Appendix A). Based on the data collected, piezometric head at P6A (shallow coal) is not influenced by depressurisation in deeper lower Whybrow seam.

3.5 Vibrating Wire Piezometers

Vibrating wire piezometers (VWP) installed to the west, east, northwest and north of the BFS measure piezometric heads along a vertical depth profile. At BUO the VWPs have anywhere between 4 to 9 sensors installed at different depths in one borehole to measure the differences in head over time, to understand the trends in the vertical gradients and connectivity between HSUs. Four multilevel VWP sites, monitored as part of groundwater monitoring network, were used in this groundwater assessment. SBF015 site was originally used for gas drainage purpose (Table 4). The summary of the VWPs is as follows:

- WBR170 and WBR171 are installed to the west of the BFS on the eastern edge of the Wollombi Alluvium;
- SBD194 is to the west of the BFS (western end of BFSLW3); and
- SBFOW15 is the closest VWP installed immediately east of the BFS.

Whybrow Seam and the Permian overburden are monitored by WBR170 and 171 (Figure 21, Appendix A) with four instruments at each site. Data record exists since June 2009.

The Whybrow Seam and Permian strata (160 m) above have started re-pressurising since 2008. Following the last longwall extraction there was a decline in head at shallow Permian (60 m) of around 0.7 m, similar to a change in other shallow piezometers. At the same time re-pressurisation was occurring at 160 m depth above Whybrow Seam with a rise of 0.8 m. Other strata had negligible change in head during this period (Figure 21, Appendix A).

At WBR170 piezometric head de-pressurised at depth (110 m) by around 3 m. During the same period upper strata (60 m) also recorded a decrease in head by around 1.2 m which is similar to observations at other piezometers. However, there has been no change in deeper hydrostratigraphic units.

VWP SBD194 has nine vibrating wire piezometers installed in major seams including Blakefield Seam, lower Whybrow Seam and the interburden sandstone. Readings exist for the lower six sensors. Following the completion of mining, there was minor change in piezometeric head at upper HSUs with a decline at 90 m depth of around 1.1 m and a rise at Whybrow Seam level of around 1 m. However, changes occurred in Wambo Seam where strata depressurised by 7 m. At Blakefield Seam re-pressurisation occurred with groundwater head rise of around 23 m since the completion of mining (Figure 23, Appendix A). These changes are related to previous mining at BFS.

A very different response was observed at SBFOW15. This point (east of BFS) was installed for gas monitoring purpose, however given the good quality long term dataset of pore pressure measurement, (since 2006) (Figure 22, Appendix A) it was used in this assessment. There was no change at Wambo or Blakefield Seam but an increase in pressure is observed in strata underlying the Blakefield Seam.

3.4 Water Flow in Alluvium

This groundwater map was prepared using groundwater level data measured in Wollombi Alluvium and Monkey Place Creek piezometers in December 2018. The interpreted groundwater contours are shown on Figure 2.

The groundwater flow direction in alluvium is influenced by the flow in the Monkey Place Creek and Wollombi Brook. The groundwater flow is towards and along the Wollombi Brook to the north. The gentle overall gradient remains at 1 in 350 m, somewhat steeper in the southern upgradient section and just west of extracted LW5 and gentler in the northern downgradient section. Groundwater levels are lower compared to the beginning of 2018. A groundwater depression is interpreted in the vicinity of Dwyers piezometer, which is most likely due to pumping for stock and domestic or irrigation purpose following a long period of below average rainfall and is similar to the last reporting period. The presence of localised depression agrees with the results of hydrograph analysis undertaken by HARTT method which indicates influence other than rainfall on hydrographs. Decline in groundwater table in alluvium

during 2018 was mainly due to reduced rainfall recharge (below average for most of the year).

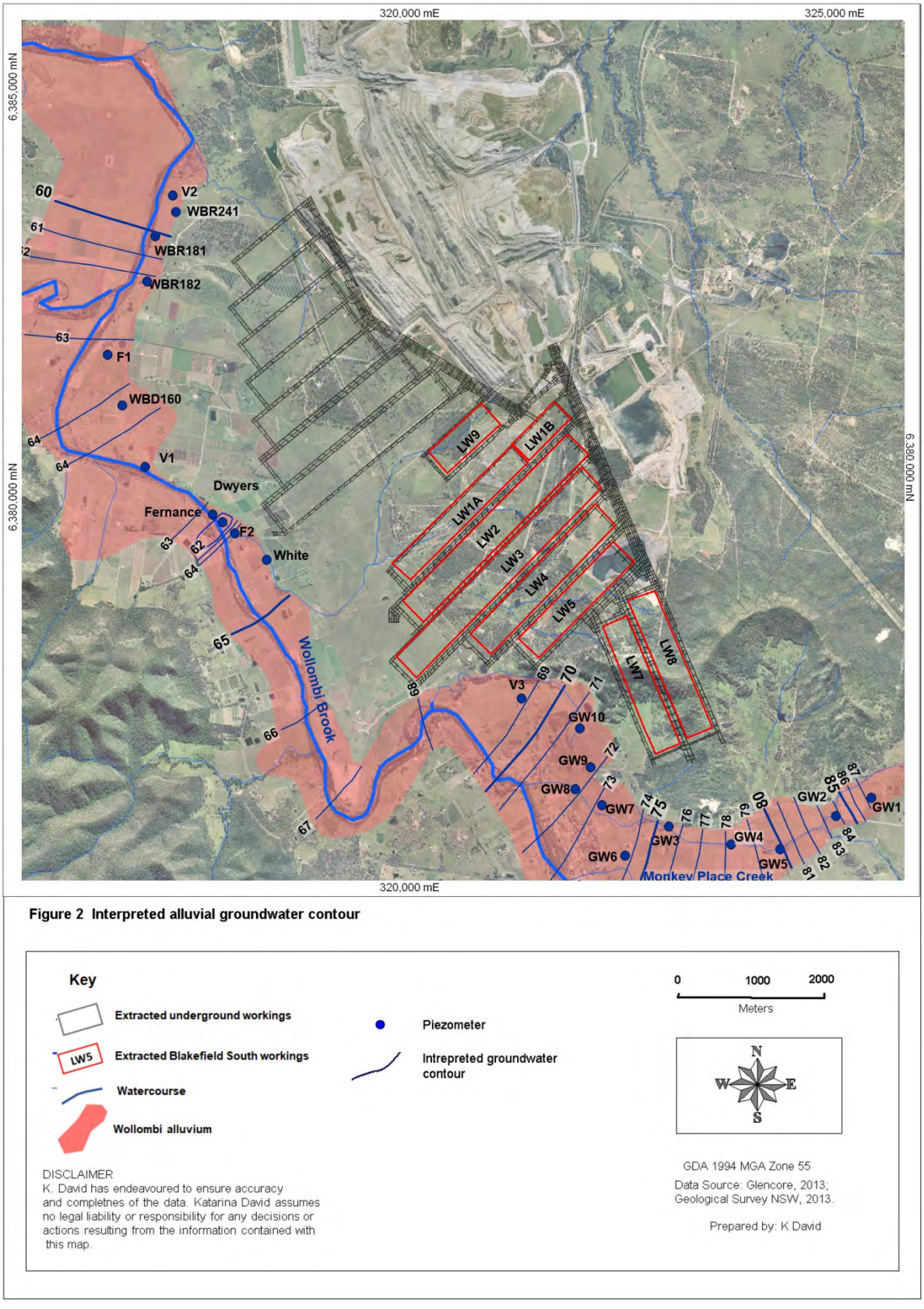


Figure 2 Interpreted alluvial groundwater contour

Figure 2 Interpreted alluvial groundwater contours December 2018

3.5 Groundwater Chemistry

A full comprehensive geochemical sampling is undertaken on a half yearly basis, while field parameters (electrical conductivity (EC) and pH) are sampled every 2 months in all standpipe piezometers. EC readings are used in this groundwater assessment as an early indicator of water chemistry change in selected Wollombi Creek and Monkey Place Creek alluvial bores and to assist interpretation of the groundwater system changes. Comprehensive water quality data set was collected in December 2018 and the results are presented on the Piper diagram (Figure 3).

Historically, the EC levels in the shallow strata were the reflection of climate conditions, with lower EC in higher rainfall periods and higher EC in lower rainfall periods. During 2018 the same trend is observed in all alluvial piezometers indicating their close relationship and response to rainfall recharge.

Figure 3 shows different groundwater facies for samples collected in December 2018 and is based on the major ion composition represented using Piper diagram. Piper diagram is a tool for visualising the relative abundance of common ions in water samples. The plot groups the samples by groundwater facies, and it has three components. Diagram to the left represents cations, the one to the right represents anions and a diamond plot in the middle is a transformation of the two triangular plots. Each sample is normalised to 100 so the relative concentrations are represented as percentages. Samples have been separated in alluvial, sandstone/regolith and coal measures.

The results on Figure 3 show that sandstone/regolith samples are Na-HCO_3 type and are different to other alluvial and coal seam samples. The alluvial and coal seam samples appear to have some similarities; all samples plot on a path of increasing Na concentration. However, there is significant difference between shallow and deep coal seam samples, and these should be presented as separate groups. Overall, their characteristic is high Cl concentration along the flowpath, compared to alluvial samples which occur in the wide range of Cl concentration. This is in agreement with the understanding that alluvium receives the rainfall recharge and mixes with fresh surface water.

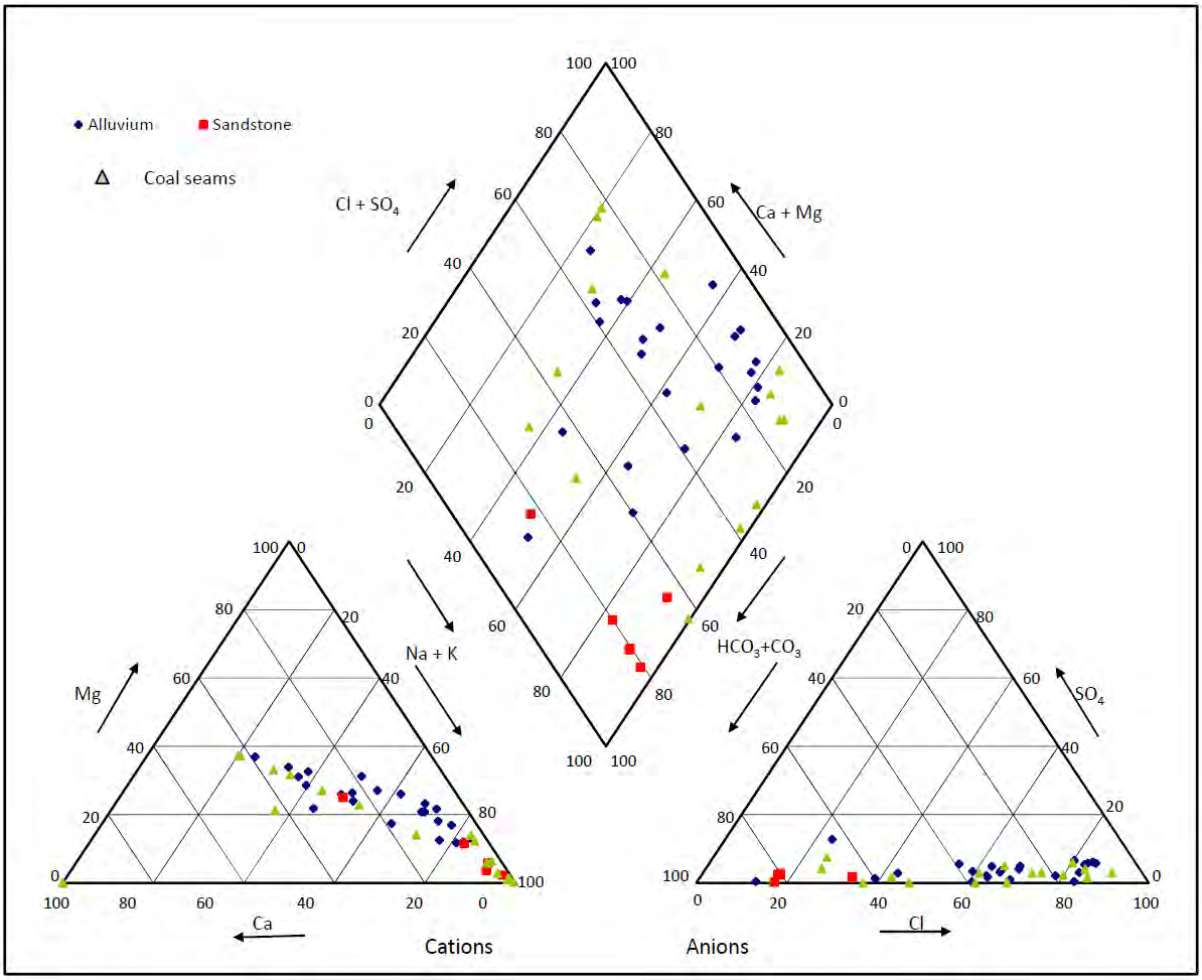


Figure 3 Piper diagram showing abundance of ions and different water facies

4. Comparison with Groundwater Modelling Predictions

4.1 Groundwater Levels

The results of the groundwater model (MER, 2013 and MER, 2010) have been used to compare the predicted modelling results to the observed data post BFS development. Some changes occurred during the extraction of the panels compared to mine plan, such that BFSLW1B was the last panel instead of BFSLW2 predicted to be competed at the start of 2018. However, it was considered that modelling predictions for the period after the extraction of BFS panels can be used for this comparison.

The model predicted that as a result of mining the following would occur:

- Impact of depressurisation in Blakefield Seam is expected to extend more than 8 km beyond the mined panels (5 m drawdown);
- Likelihood of zero impact on water levels in alluvium; and
- Negligible losses to Wollombi Brook baseflow and consistent with previous estimates.

The observation data indicates the following:

- Stable conditions were observed in overburden strata above Blakefield Seam. At SBFOW15, located immediately east of the BFS and last panel there was no change in piezometric head in the overlying Permian strata (Figure 22, Appendix A) but at SBD194 at the western end of BFS at Blakefield Seam re-pressurisation occurred with groundwater head rise of around 23 m since the completion of mining;
- Within 3-4 km from the BFS footprint re-pressurisation is ongoing at Whybrow Seam but de-pressurisation is occurring in the underlying strata in particular in the Wambo Seam (SBD194);
- The extraction of BFS panels had no impact on the water levels and groundwater quality in the Wollombi Brook and Monkey Place Creek alluvium as confirmed by hydrograph analysis, EC values and groundwater quality data. The rainfall is not the only contributor to groundwater recharge, other factors such as irrigation and surface water-groundwater interaction are also possible. Groundwater levels in alluvium have decreased during 2018 with low rainfall recharge during the same period. Some piezometers have recorded a rise following above average rainfall in October 2018.

4.2 Groundwater Inflow

Following the completion of mining the total observed mine inflow into the workings (from Blakefield South) was 112.6 ML (including the gas well contribution of 16.6 ML in total) around 0.3 ML/day. The inflow was recorded until July 2018 after which no inflow was registered. The modelling prediction for post-mining groundwater inflow was obtained as described in Section 4.1 by comparing the observed inflow to the predicted inflow from the latest groundwater model (Mackie, 2013) which scheduled this after 2018. The outcome is reported in Table 7, and predicted groundwater inflow exceeded the observed inflow. The discrepancy is due to a different predicted mine schedule compared to actual extraction schedule.

Table 6 Predicted and observed groundwater inflow comparison post mining

	Predicted groundwater inflow (ML/day)	Observed groundwater inflow (ML/day)
Post-mining Year 1	~`0.8 ML/day	0.3 ML/day

4.3 Mine Water Balance

BFS maintains mine water balance which contains detailed daily records of inflows and outflows from the system. It includes both Beltana No.1 and BFS areas. For the purpose of this report, the water balance has been considered for BFS areas and the Blakefield Seam only.

The input and output components of the water balance are listed below:

- Underground input:
    - Water supply to underground for operational purposes (excluding moisture in the air).
- Underground output:
    - Inflow into the BFS workings (collected in longwall sumps)
    - Pumping from dewatering bores from Blakefield Seam;
    - Gas pre-drainage wells.

Total water input into BFS from surface during the extraction of BFSLW1B and post-mining was 90 ML.

The total volume extracted from dewatering bores from Blakefield Seam was 96 ML during this reporting period. The mine water inflow into the BFS (including some gas related water 16.6 ML) amounted to 112.6 ML in total. The underground inflow and dewatering made majority of the total underground output, while the groundwater volumes from gas drainage made around 7% of the balance. BUO has groundwater extraction licence (mine dewatering 20BL168475) which covers this volume. Total imbalance (based on input minus output) is – 22.6 ML for the extraction period.

5. Conclusions

This groundwater report documents groundwater conditions within the BFS following the extraction of last Blakefield South longwall LW1B (completed in April 2018) and during post-mining period. The potential impact on the groundwater levels and quality is assessed in addition to addressing the requirements of the dewatering licence 20BL169347. The study found the following:

- Groundwater monitoring network spatially covers the area along the Wollombi Brook and Monkey Place Creek to the west and south and extends 5 km to the north and northwest of the BFS footprint. The current network of standpipe piezometers is comprehensive and covers different strata at depth with high frequency data collected by dataloggers at 26 monitoring locations. This includes: the alluvium, overburden strata (sandstone and coal seams), Whybrow Seam and Blakefield Seam and underlying and overlying strata. VWPs monitor the change in vertical gradients and depressurisation above and below the Blakefield Seam;

- Overburden pressures in the top 50 to 100 m from surface remain stable following the extraction of the last panel with a decline in head observed only at some monitoring points and likely to be related to lower rainfall during 2018. Both re-pressurisation and depressurisation are occurring in the overburden strata below 100 m depth; however, this process is not uniform. For example, at WBR170 and WBR171 both depressurisation and re-pressurisation are occurring above the Whybrow Seam, while at SBD194 depressurisation in the strata above the Blakefield Seam (Wambo Seam) is ongoing with a 7 m decline in head. Re-pressurisation of around 23 m is observed in the Blakefield Seam at SBD194 located to the west of the extracted panels. These changes agree with historical response to mining and groundwater model predictions while the decline in head and fluctuations in shallow sandstone/coal and alluvium are related to the response to climate events;

- Regolith and sandstone bores (to a depth of around 50 m) installed to the west of BFS close to the eastern edge of Wollombi alluvium mostly respond to rainfall recharge and have not shown any further changes in piezometric head related to mining. This is consistent with model predictions in the overburden strata;

- Shallow groundwater systems as monitored in Wollombi and MPC alluvial bores, do not show any changes from historical groundwater level trends. Hydrograph analysis of alluvial bores indicates that in addition to rainfall recharge, there are other influences on alluvial groundwater fluctuations such as irrigation and/or surface water-groundwater interaction as observed at GW10 and White 1 bore. However, rainfall events continue to have the major influence on groundwater level fluctuation, with an overall decrease in water table as a result of ongoing dry weather conditions;

- Salinity fluctuations in shallow alluvial system (EC was 200 to 1500 µS/cm) are closely related to fluctuations observed in groundwater levels, with an increase in salinity with the absence of rainfall and decrease with increased rainfall recharge. Alluvial groundwater quality is manly influenced by climate events but also by anthropogenic influences;

- Water quality dataset, collected from all groundwater bores in December 2018, indicates that there is a similarity between alluvial and coal seam groundwater in terms of groundwater facies, however the coal seam water has higher chloride concentration compared to alluvial water. Groundwater in sandstone HSU has different geochemical signature from alluvium and coal seam and is Na-HCO_3 dominated.

- The observed mine inflows into the workings during and post extraction of the last panel (0.3 ML/day) were lower than the groundwater model predicted dewatering rates of 0.8 ML/day. The discrepancy is due to different model scheduling compared to the actual extraction;

- The overall Blakefield South water balance has an imbalance with a loss of -22.6 ML over the year resulting from more produced water compared to water introduced to the underground for operational purposes. Production bore dewatering from Blakefield Seam was 96 ML with additional 16.6 ML sourced from gas wells.

6. References

Beckett, J. 1988. The Hunter Coalfield, Notes to accompany 1: 100,000 geological map; New South Wales Department of Mineral Resources, Geological Survey Report GS 1988/051 unpublished

Ferdowsian, R., Pannell, D.J., McCarron, C., Ryder, A.T., Crossing, L. 2001: Explaining Groundwater Hydrographs: Separating Atypical Rainfall Events from Time Trends. AJSR vol. 39, 4.

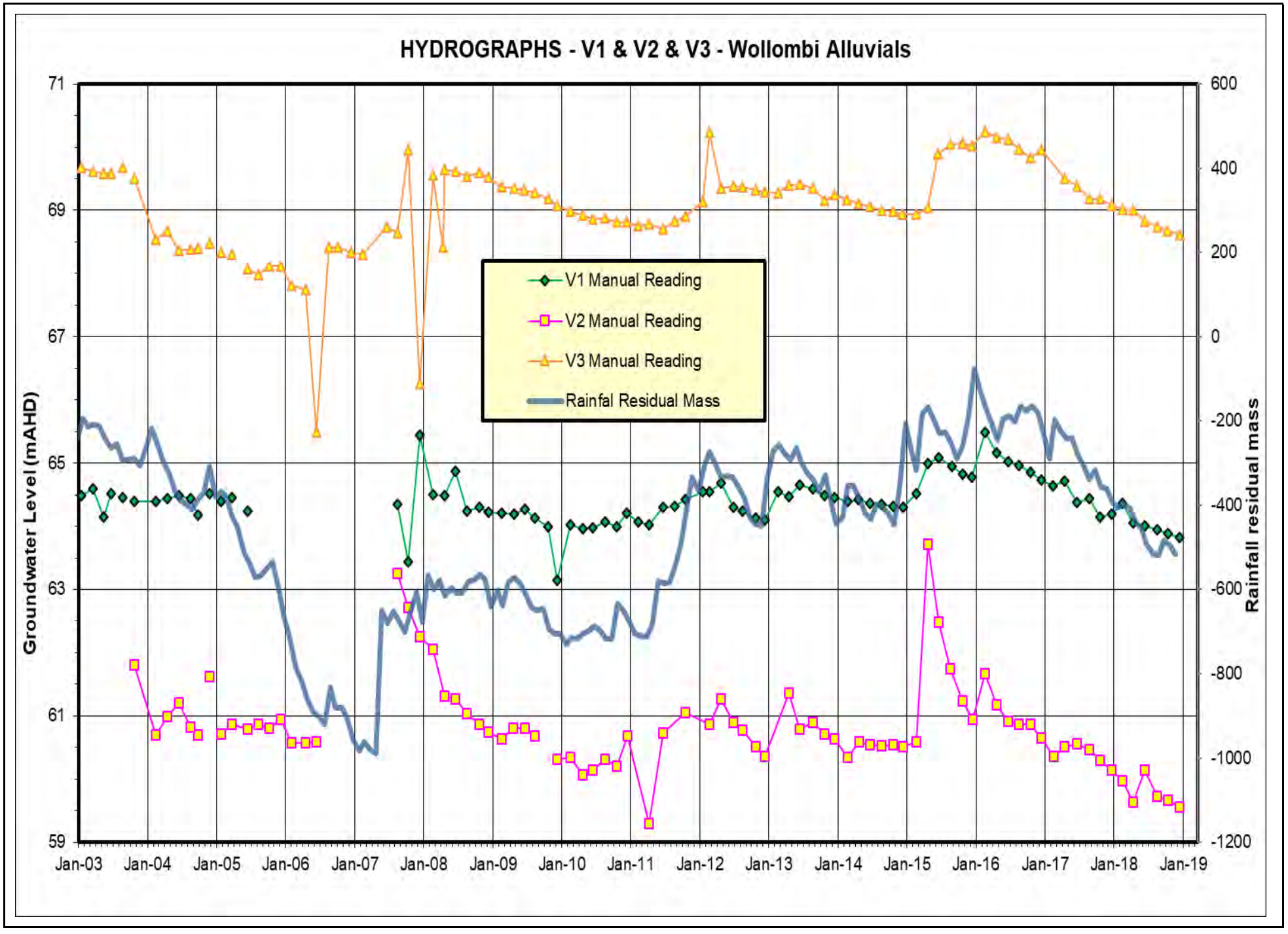
Mackie Environmental Research, 2003. Bulga Coal continued underground operations – Hydrogeological studies. Report prepared for Bulga Coal Management, May 2003.

Mackie Environmental Research, 2010. Beltana Highwall mining, South Blakefield Groundwater Model Update.

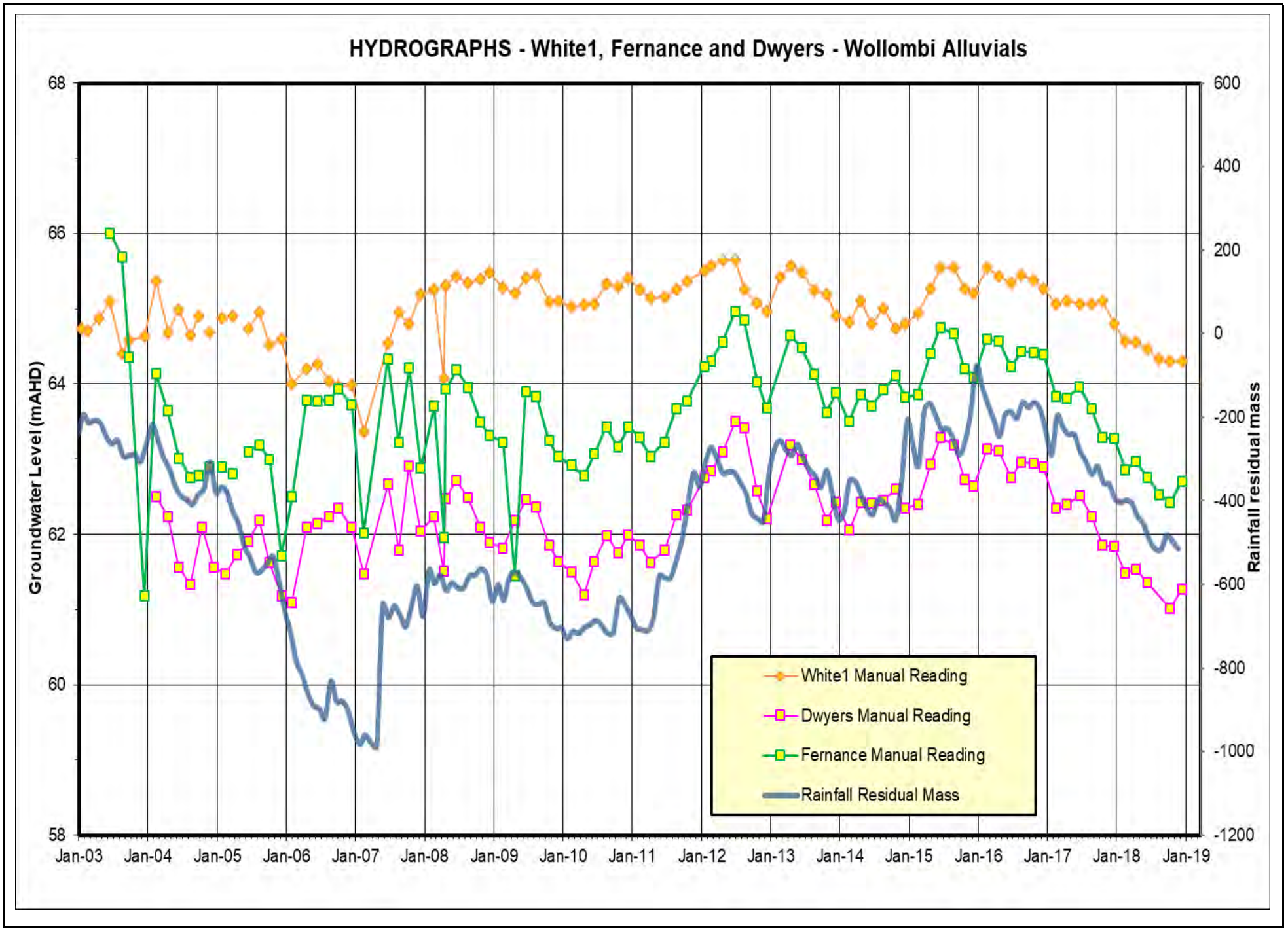
Mackie Environmental Research 2013. Assessment of groundwater related impacts arising from the proposed Bulga optimisation project, Appendix 11 of the EIS, report prepared for Bulga Coal Management.

APPENDIX A

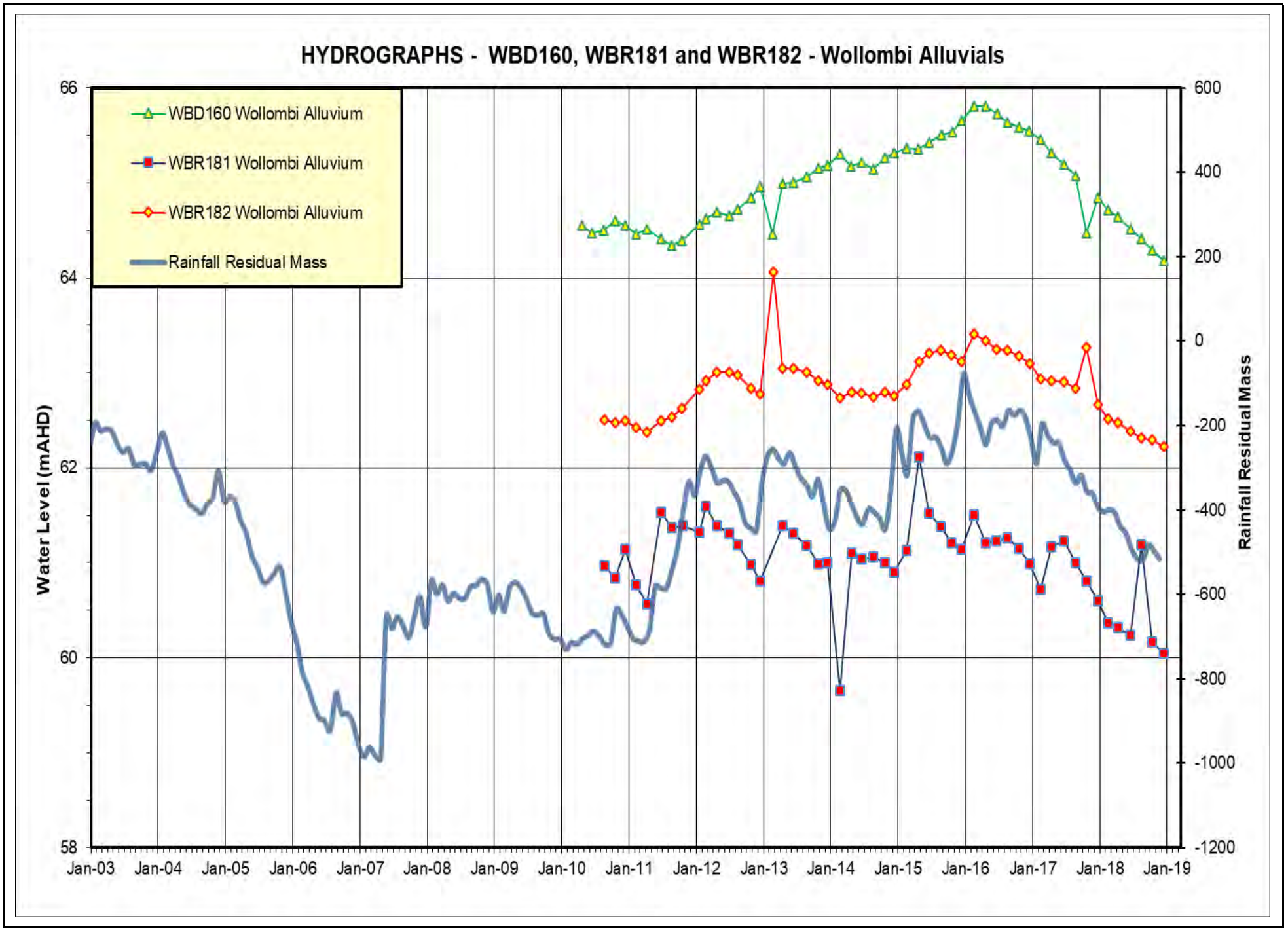
Groundwater hydrographs and piezometric head profiles



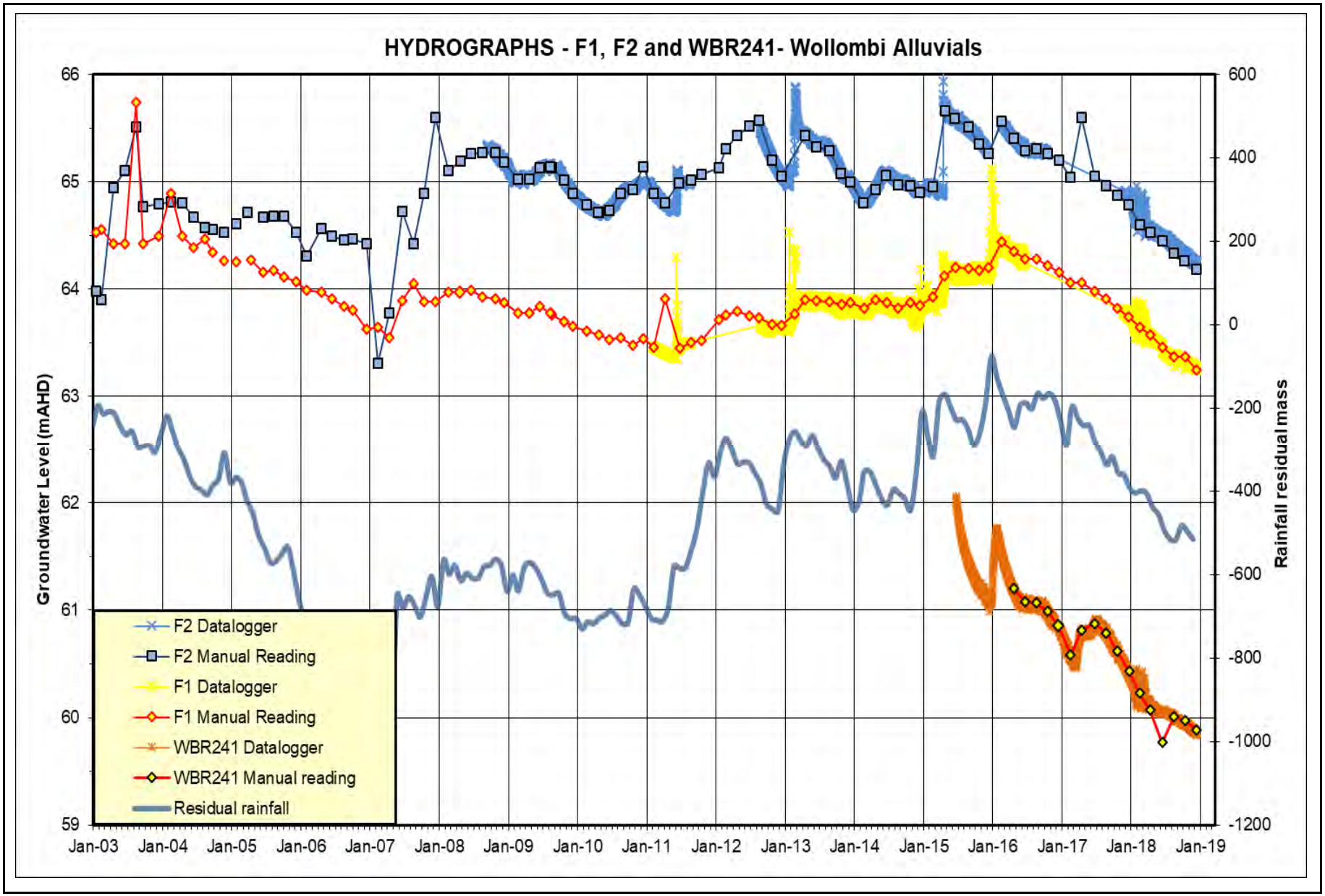
HYDROGRAPH FOR PIEZOMETERS V1,V2 and V3 FIGURE 1



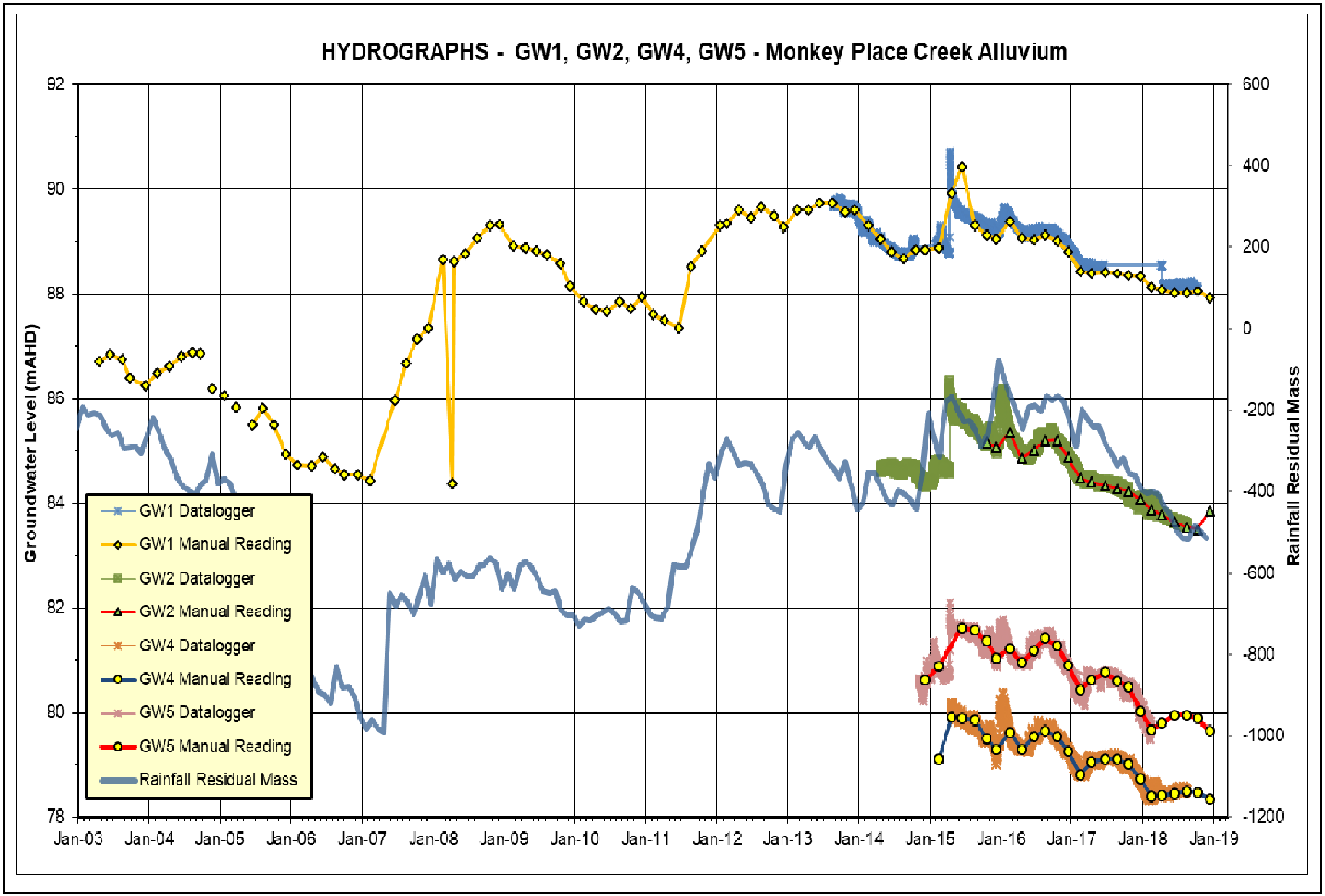
HYDROGRAPH FOR PIEZOMETERS White, Fernance and Dwyers FIGURE 2



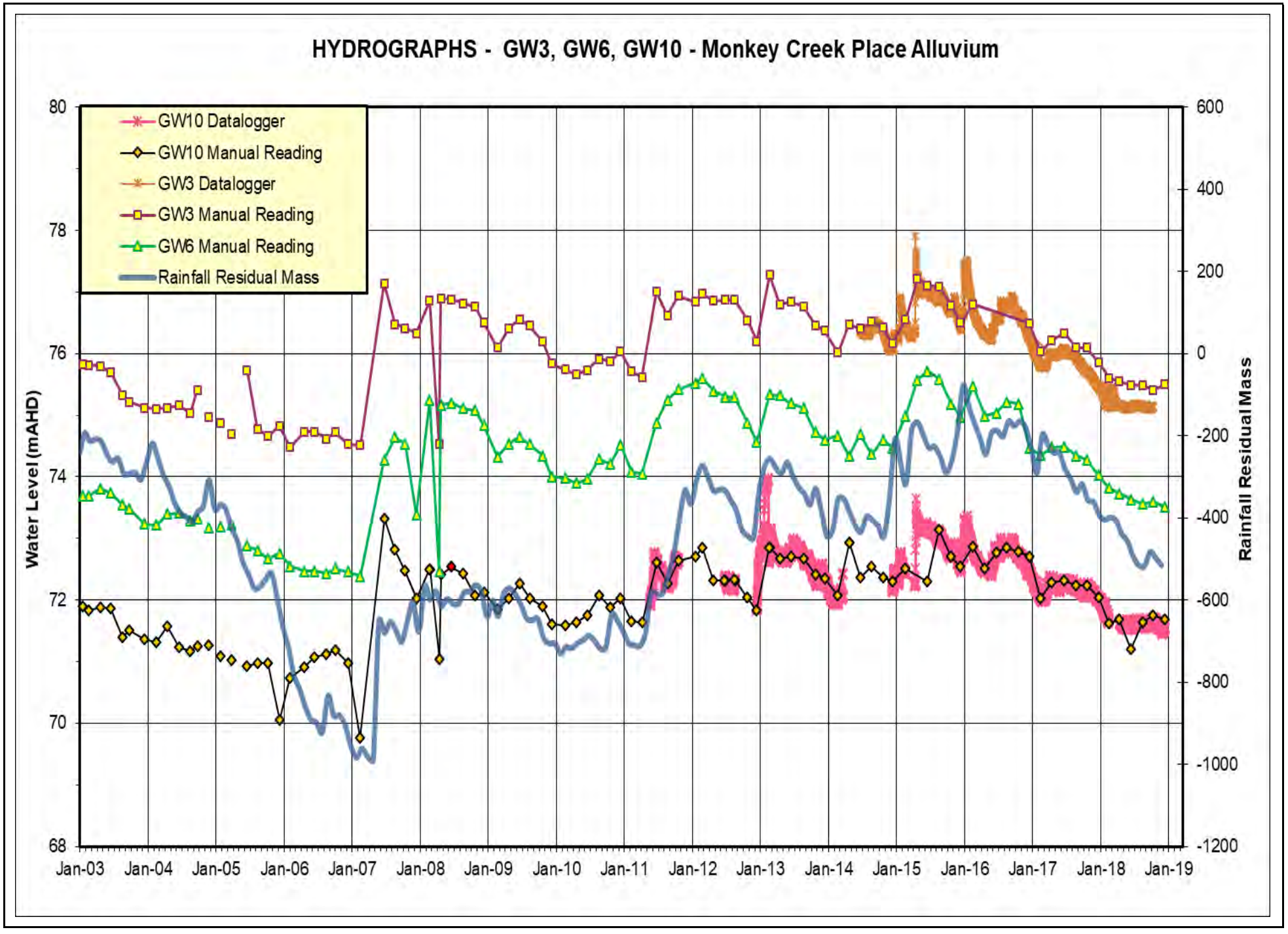
HYDROGRAPH FOR PIEZOMETERS WBD160, WBR180 and WBR 182 FIGURE 3



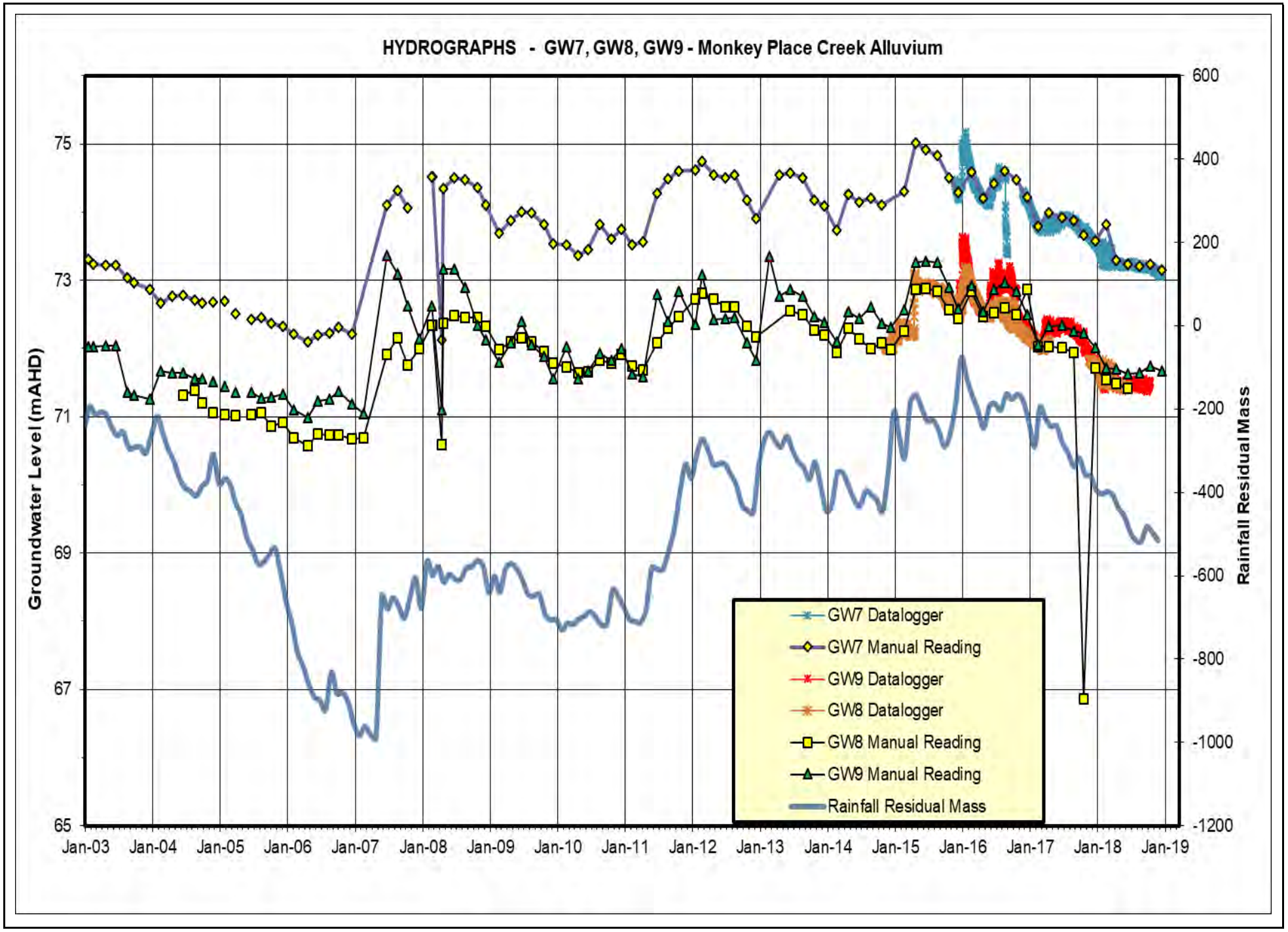
HYDROGRAPH FOR PIEZOMETERS F1, F2 and WBR241 FIGURE 4



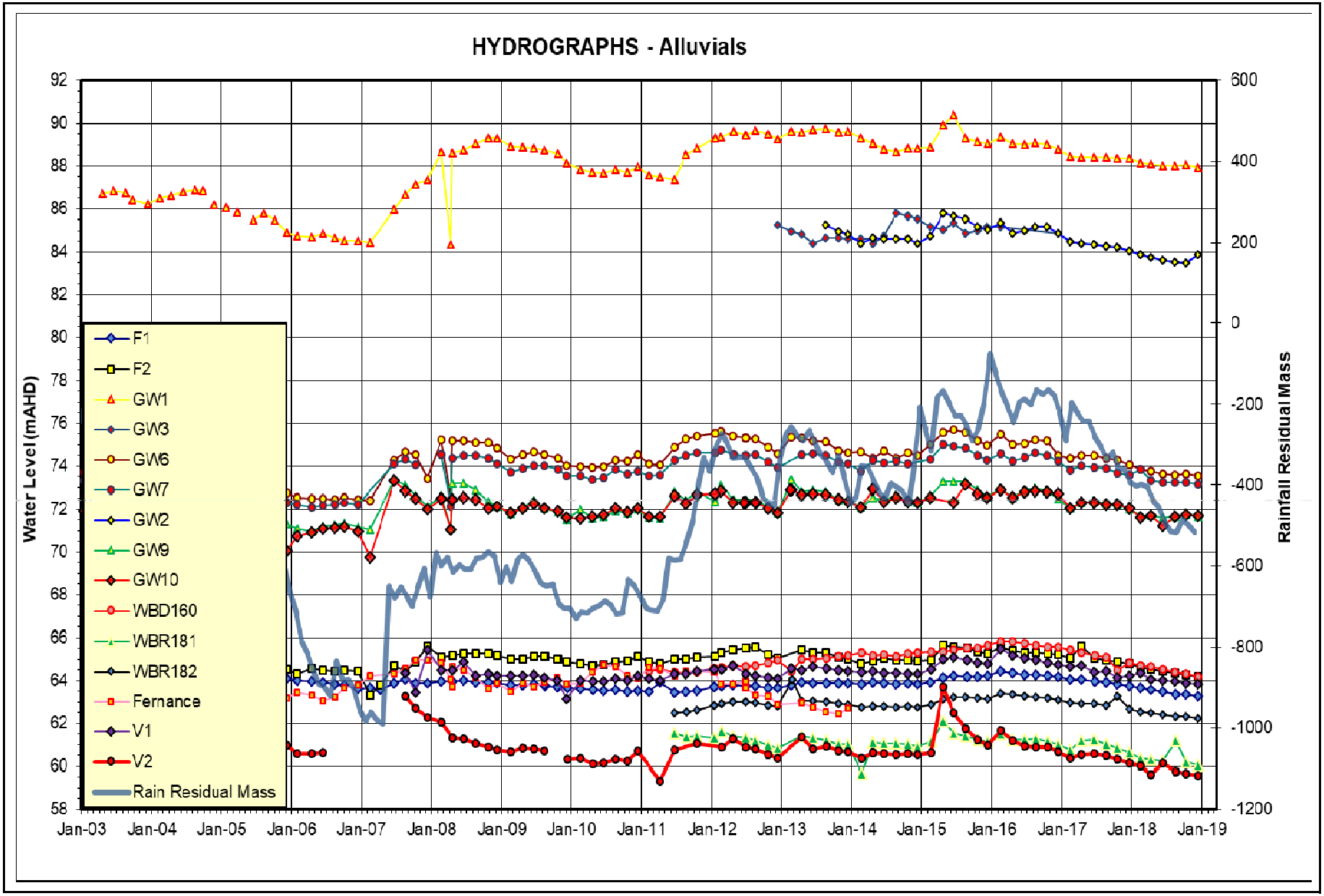
HYDROGRAPH FOR PIEZOMETERS GW1, GW2, GW4 and GW5 FIGURE 5



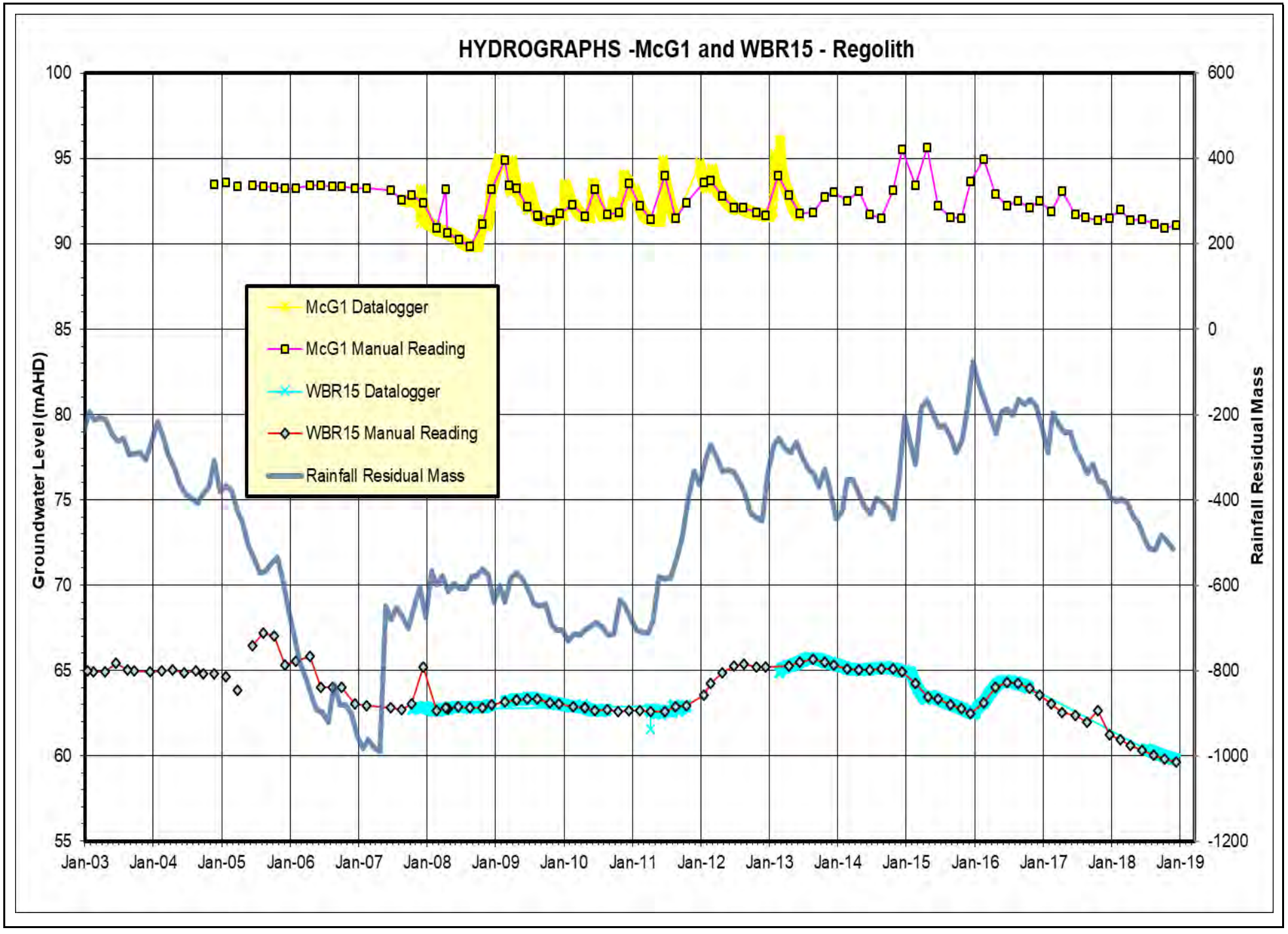
HYDROGRAPH FOR PIEZOMETERS GW3, GW6, GW10 FIGURE 6



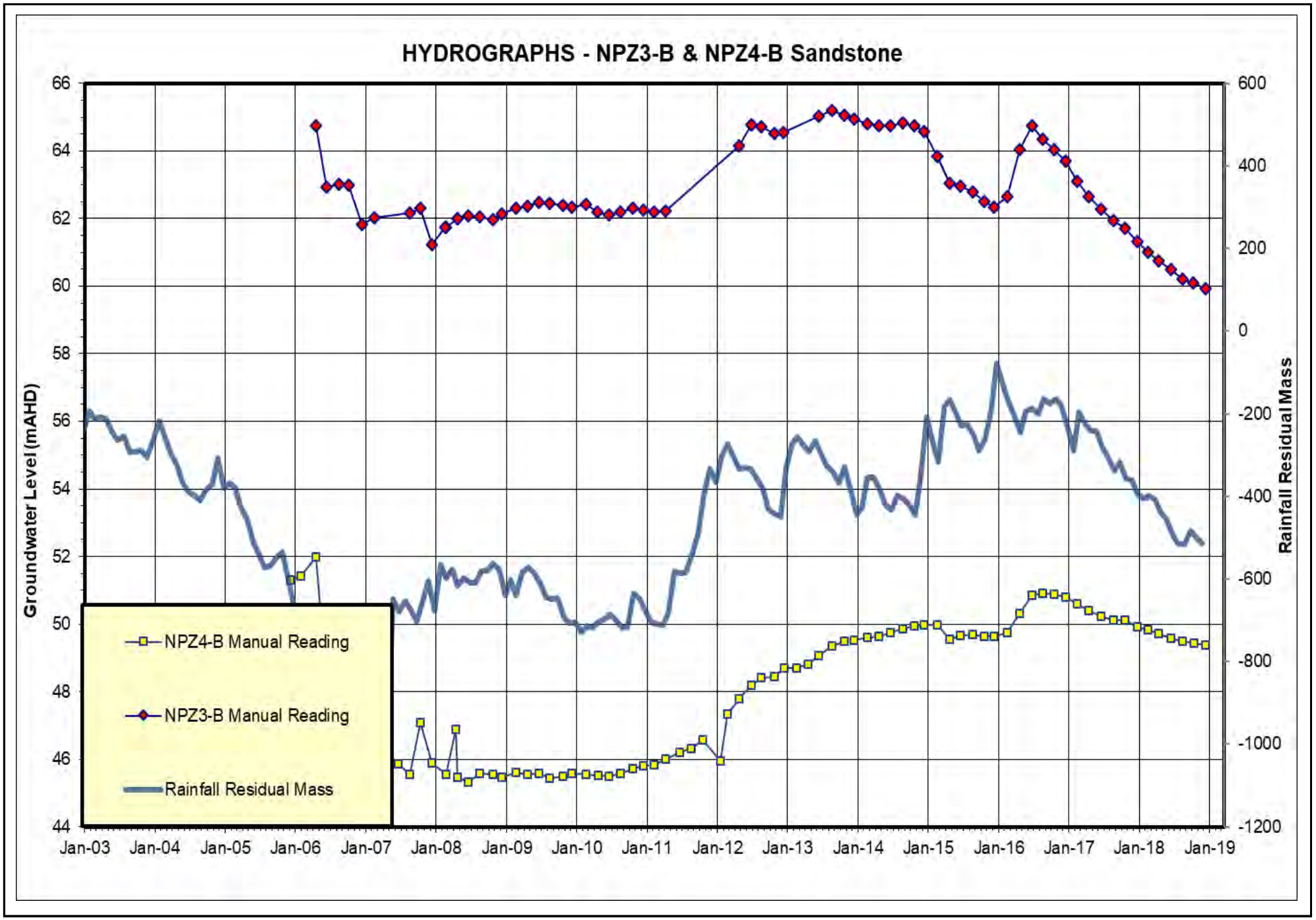
HYDROGRAPH FOR PIEZOMETERS GW7, GW8 and GW9 FIGURE 7



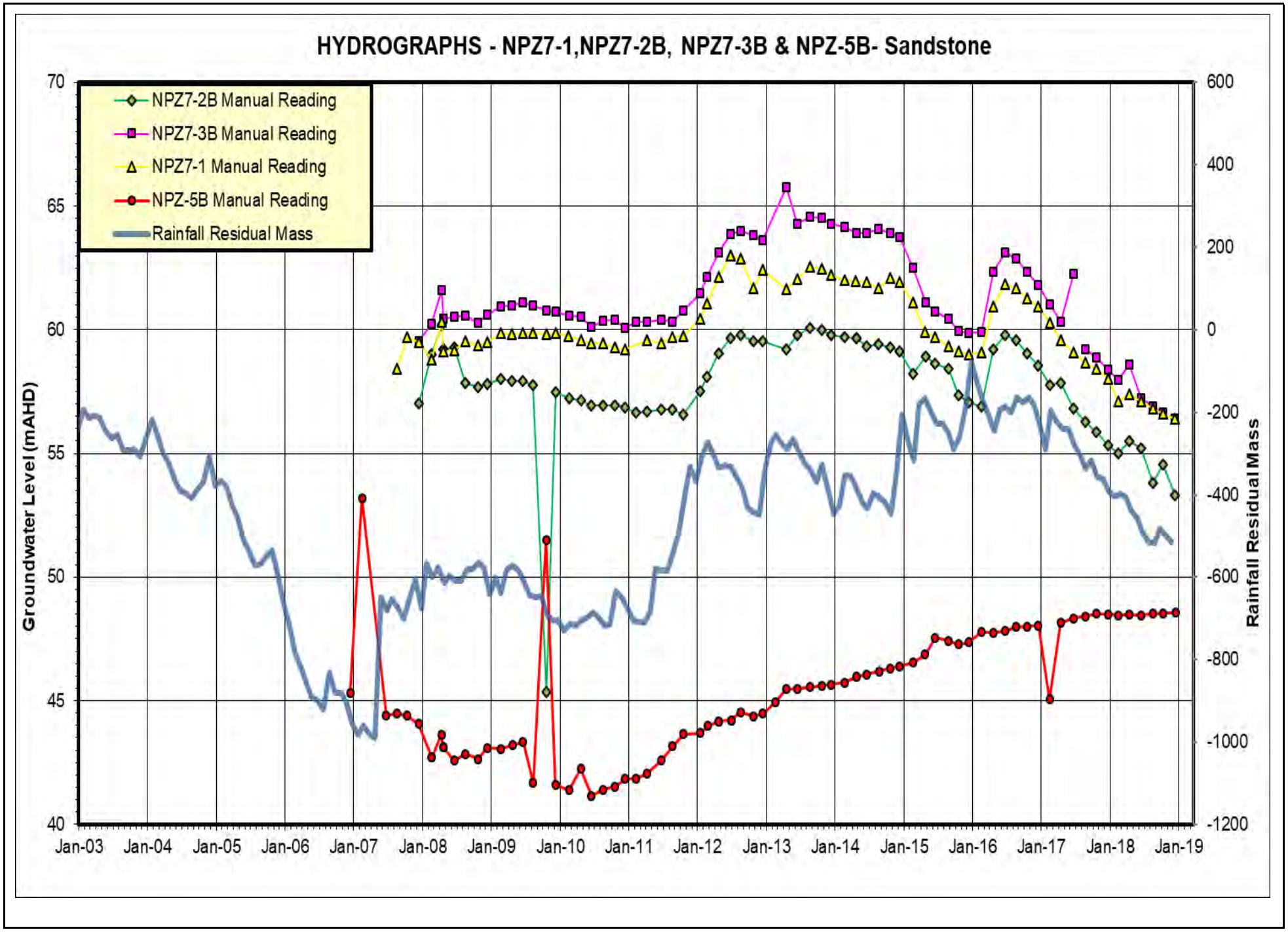
HYDROGRAPH FOR ALLUVIAL PIEZOMETERS FIGURE 8



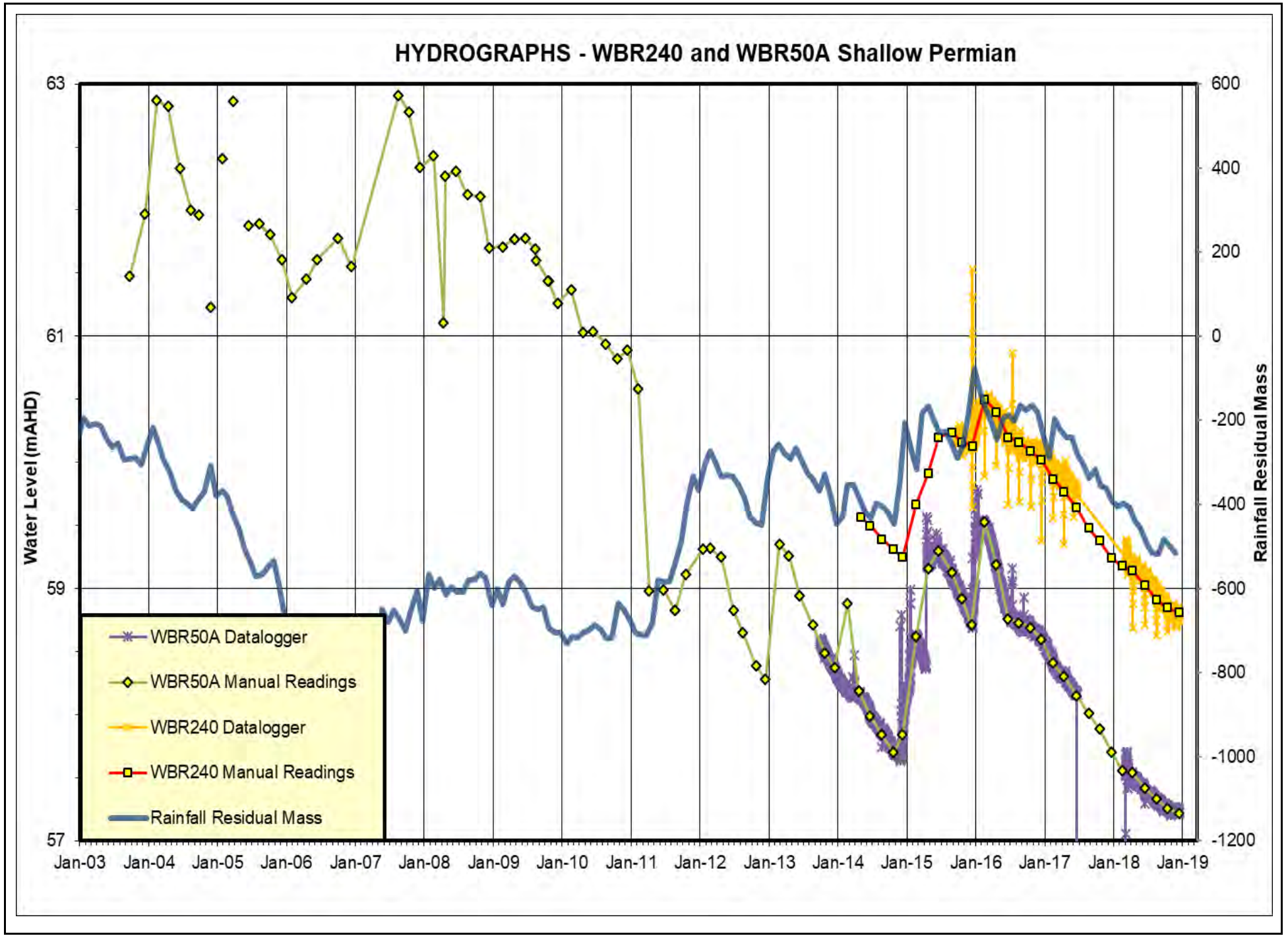
HYDROGRAPH FOR McG1 and WBR15 PIEZOMETERS FIGURE 9



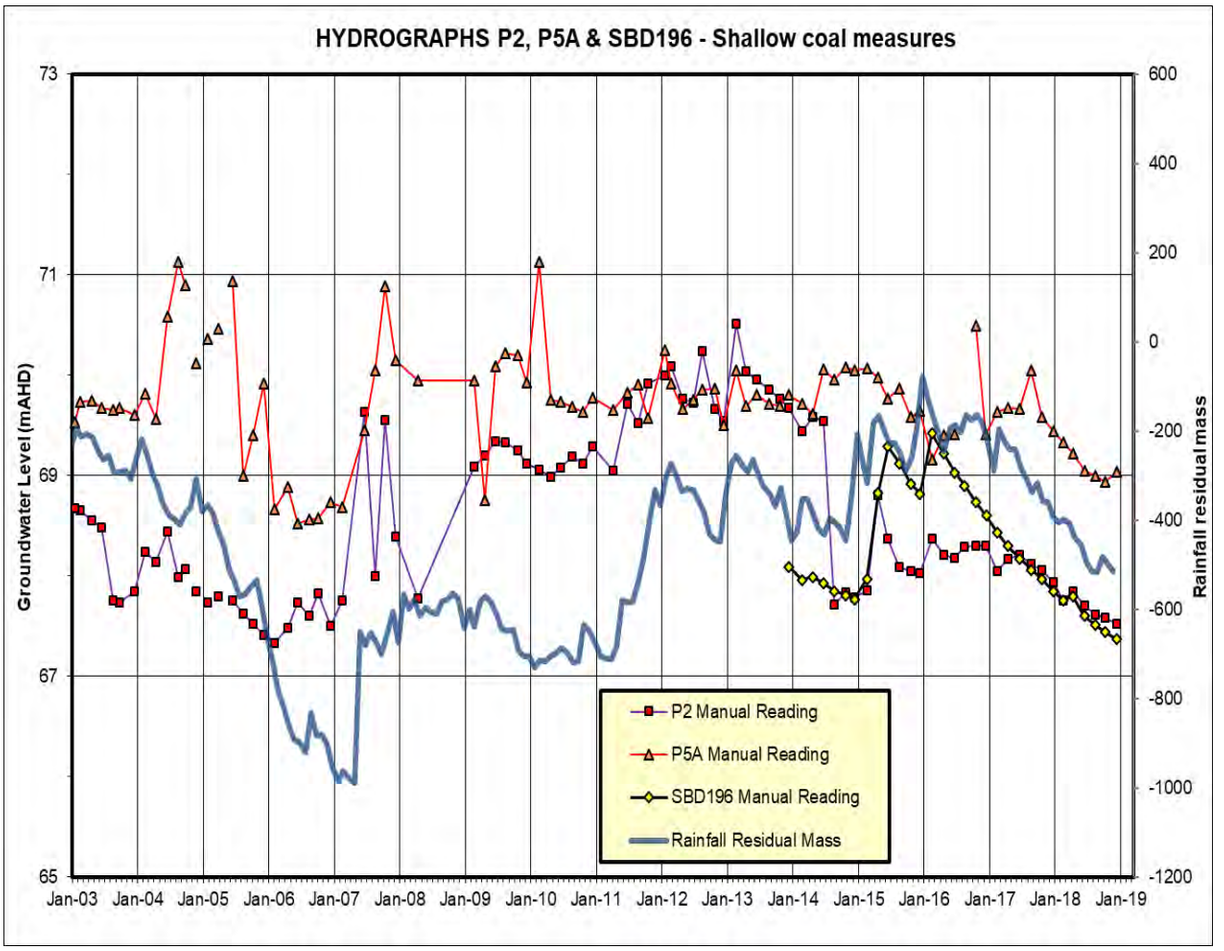
HYDROGRAPH FOR PIEZOMETERS NPZ-3B and NPZ-4B FIGURE 10

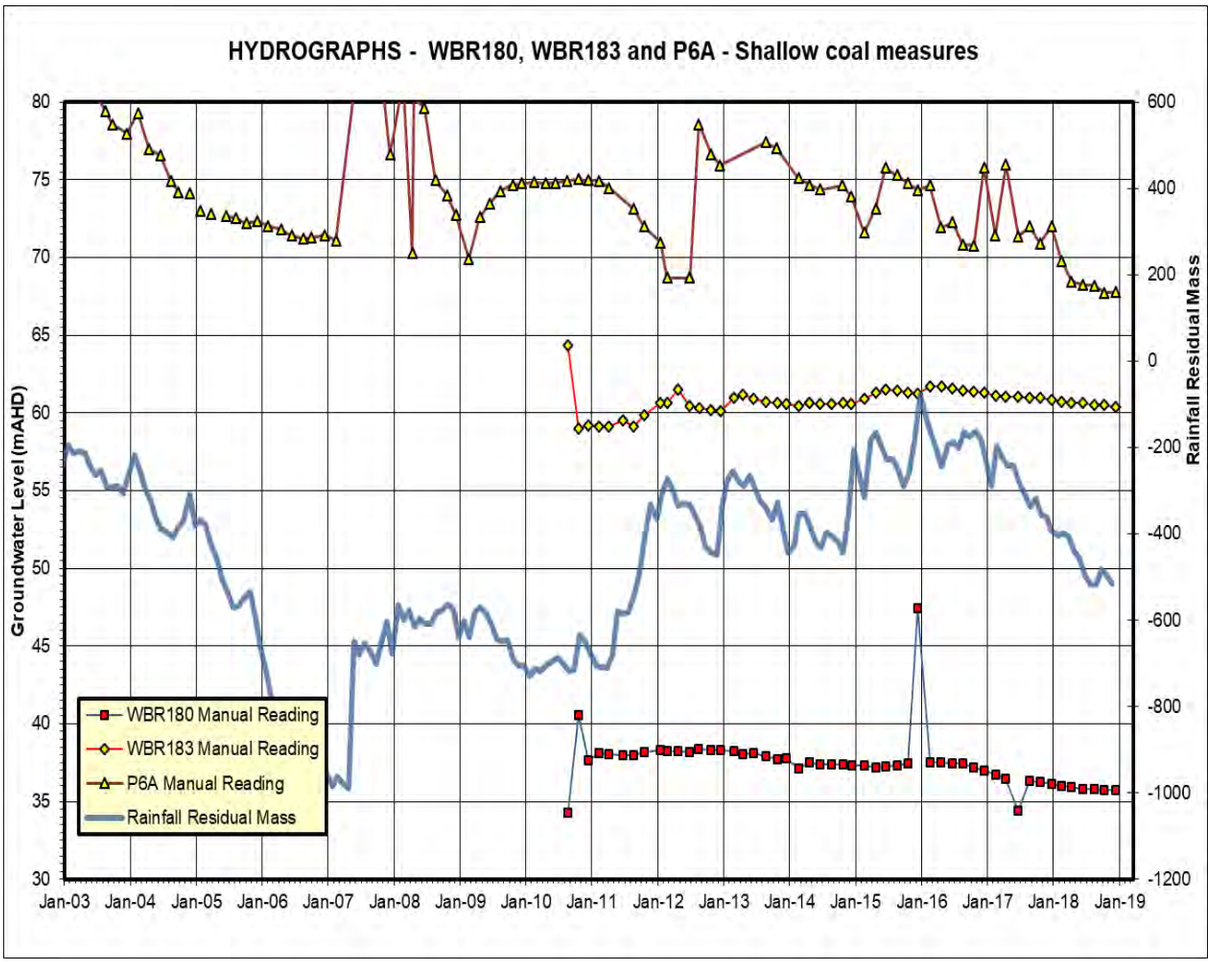


HYDROGRAPH FOR PIEZOMETERS NPZ7-1,NPZ7-2B,NPZ7-3 and NPZ-5B FIGURE 11

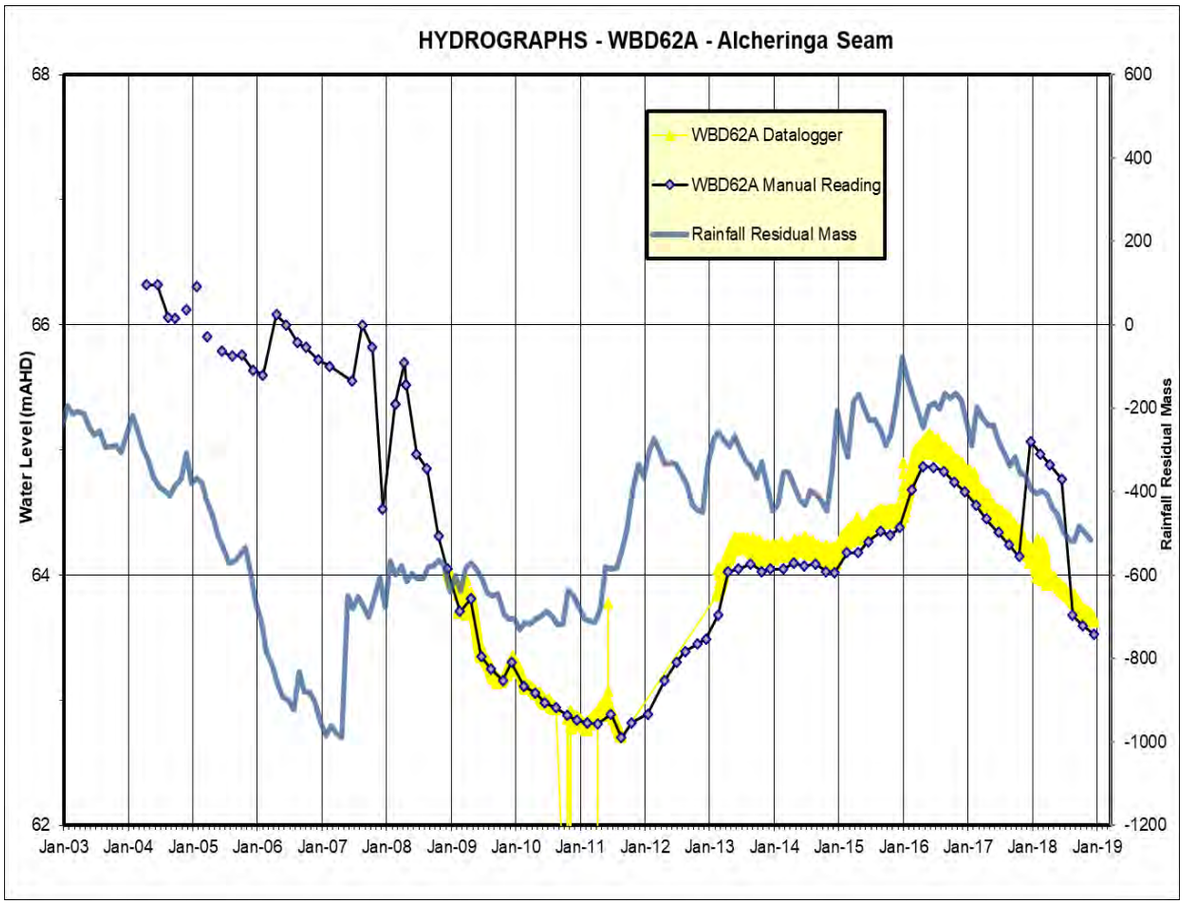


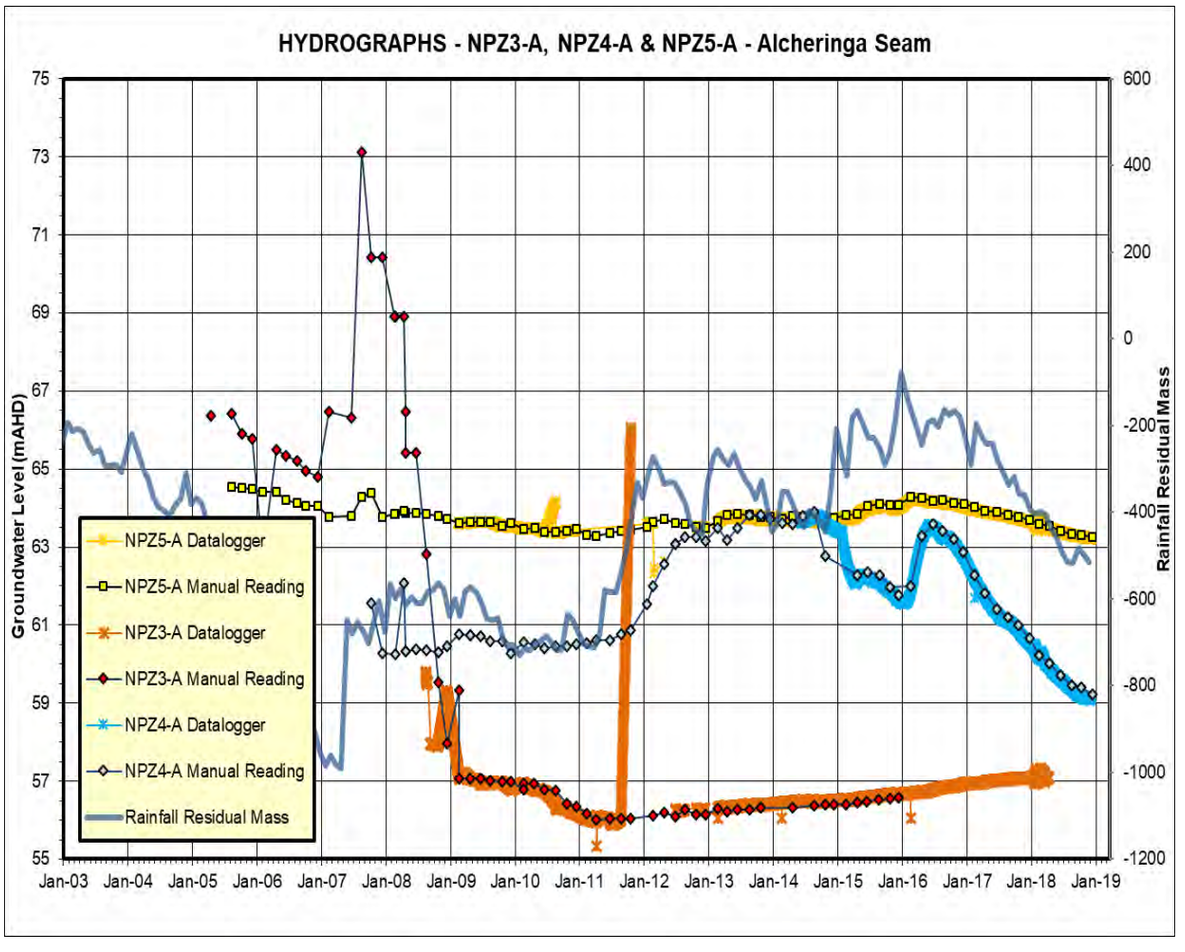
GROUNDWATER LEVELS IN SHALLOW PERMIAN FIGURE 12



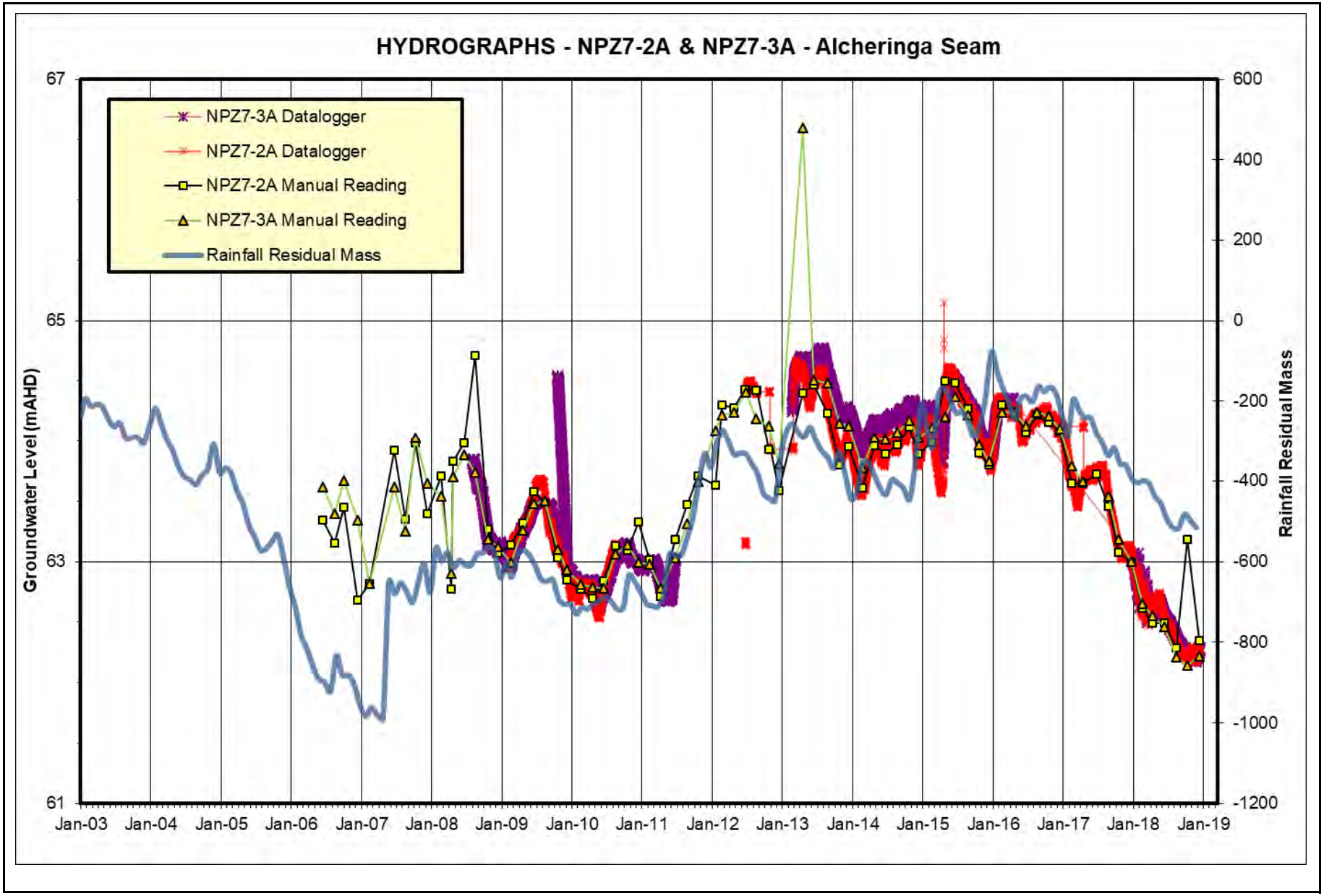


GROUNDWATER LEVELS IN SHALLOW COAL MEASURES FIGURE 13a and 13b

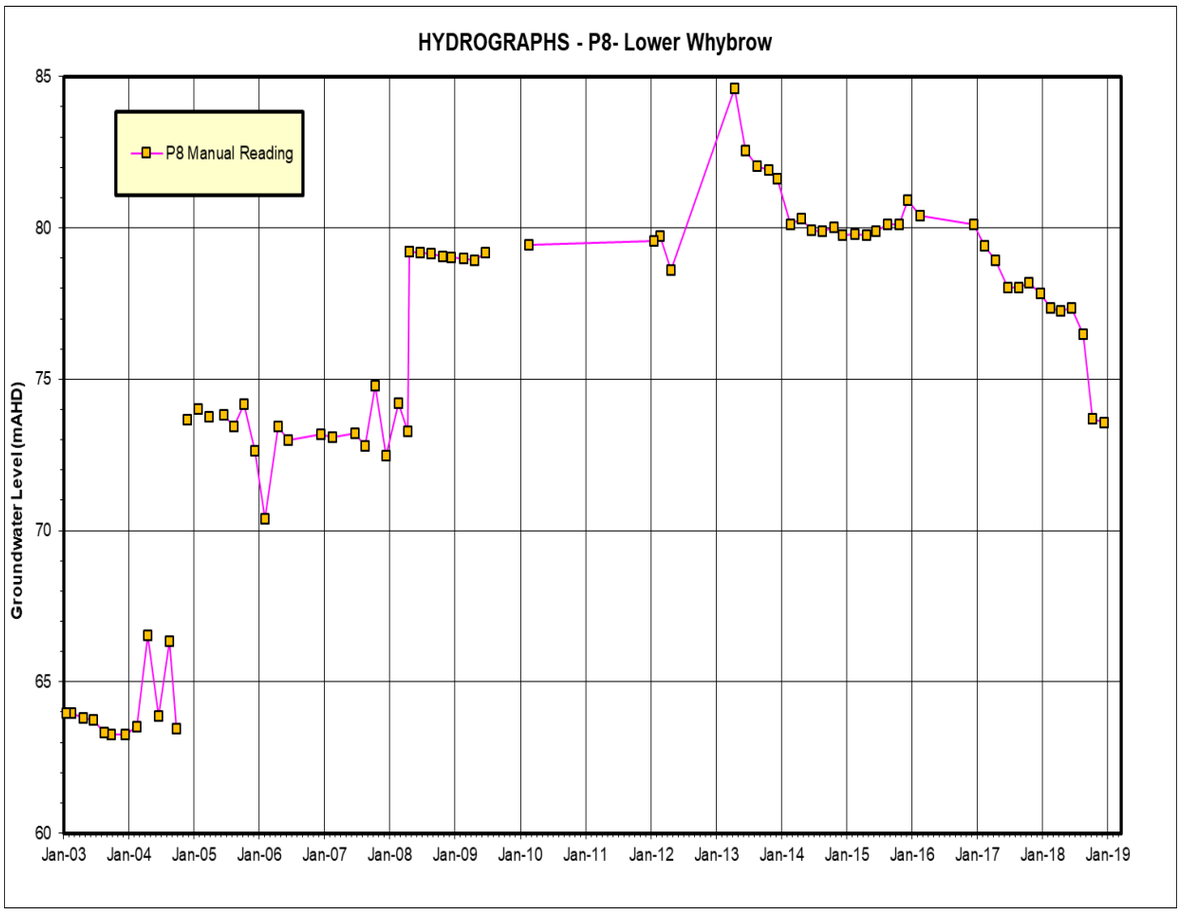




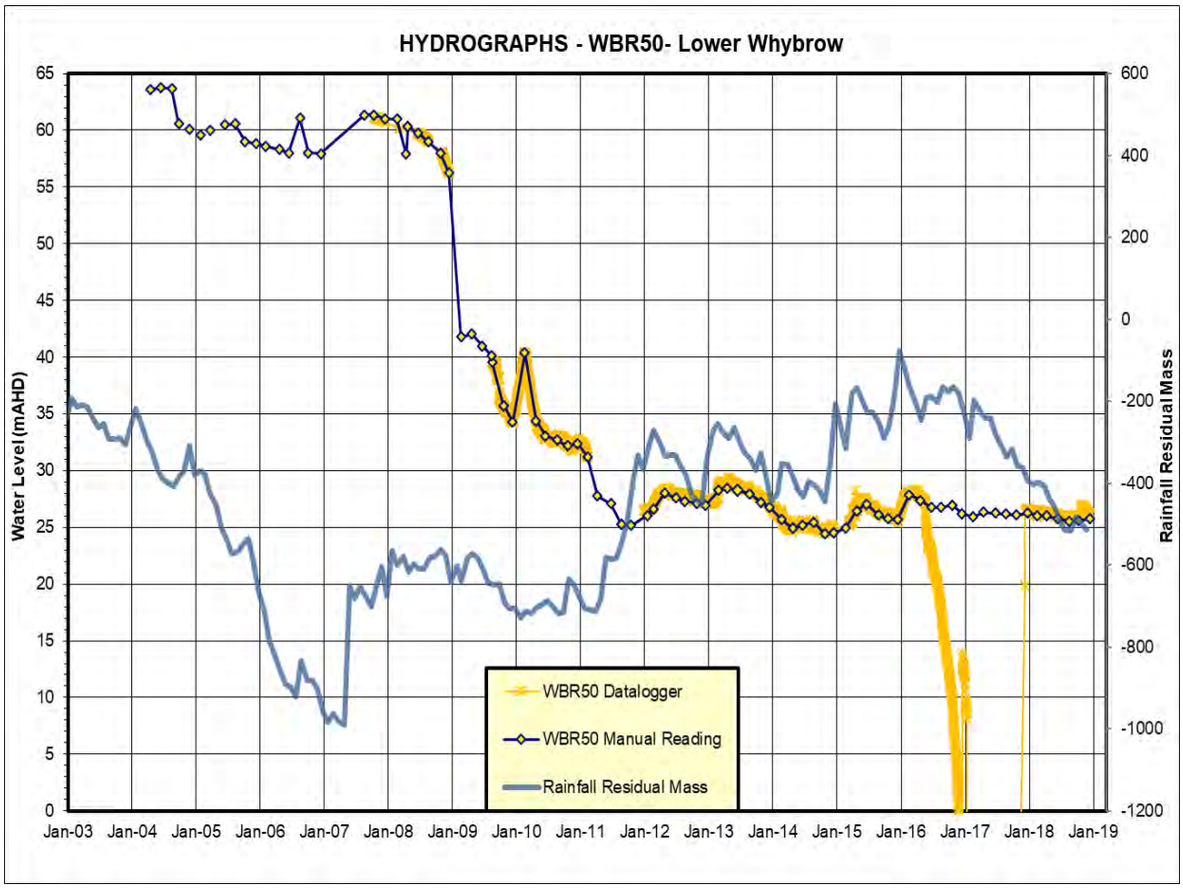
GROUNDWATER LEVELS IN ALCHERINGA SEAM FIGURE 14a and 14b

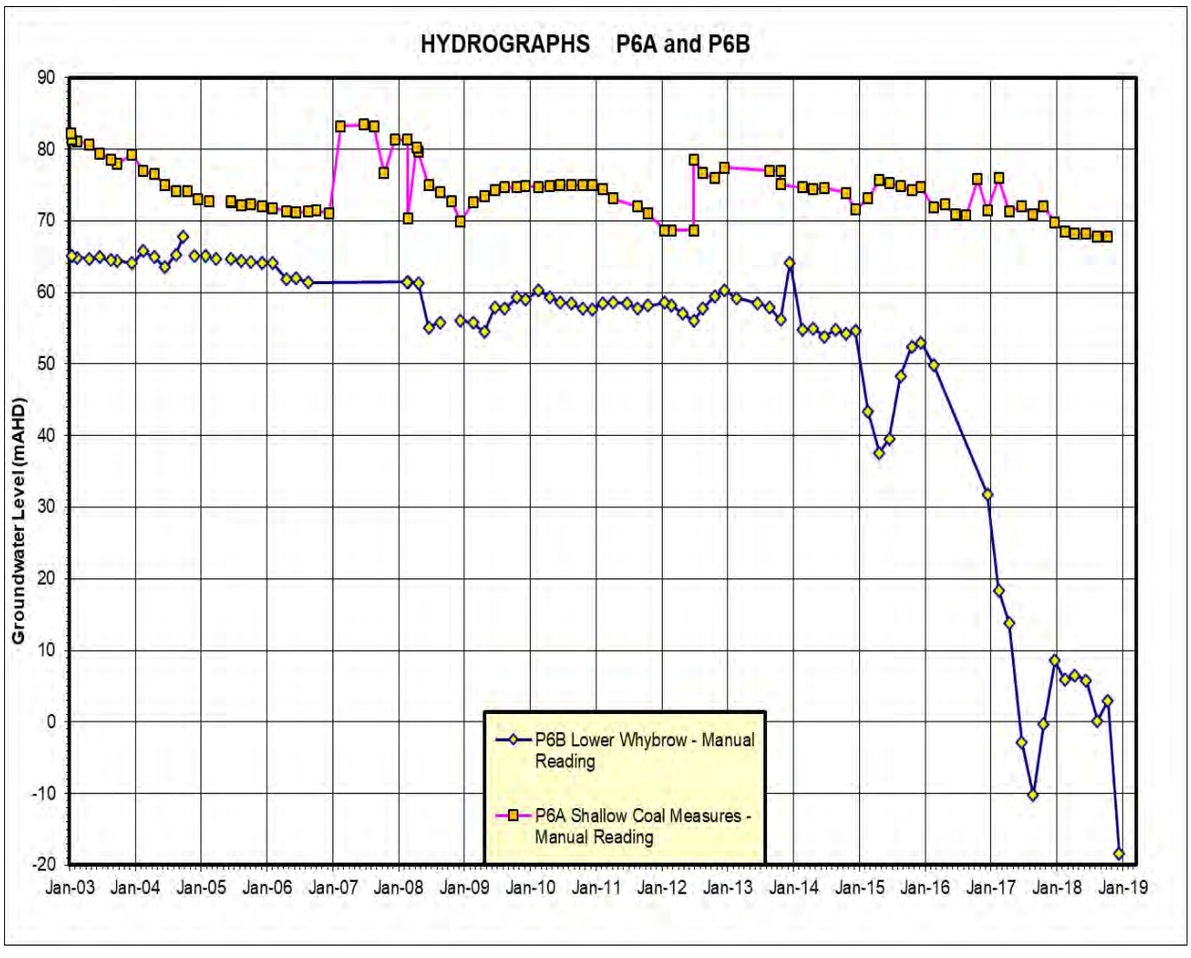


HYDROGRAPH FOR PIEZOMETERS IN ALCHERINGA SEAM FIGURE 15

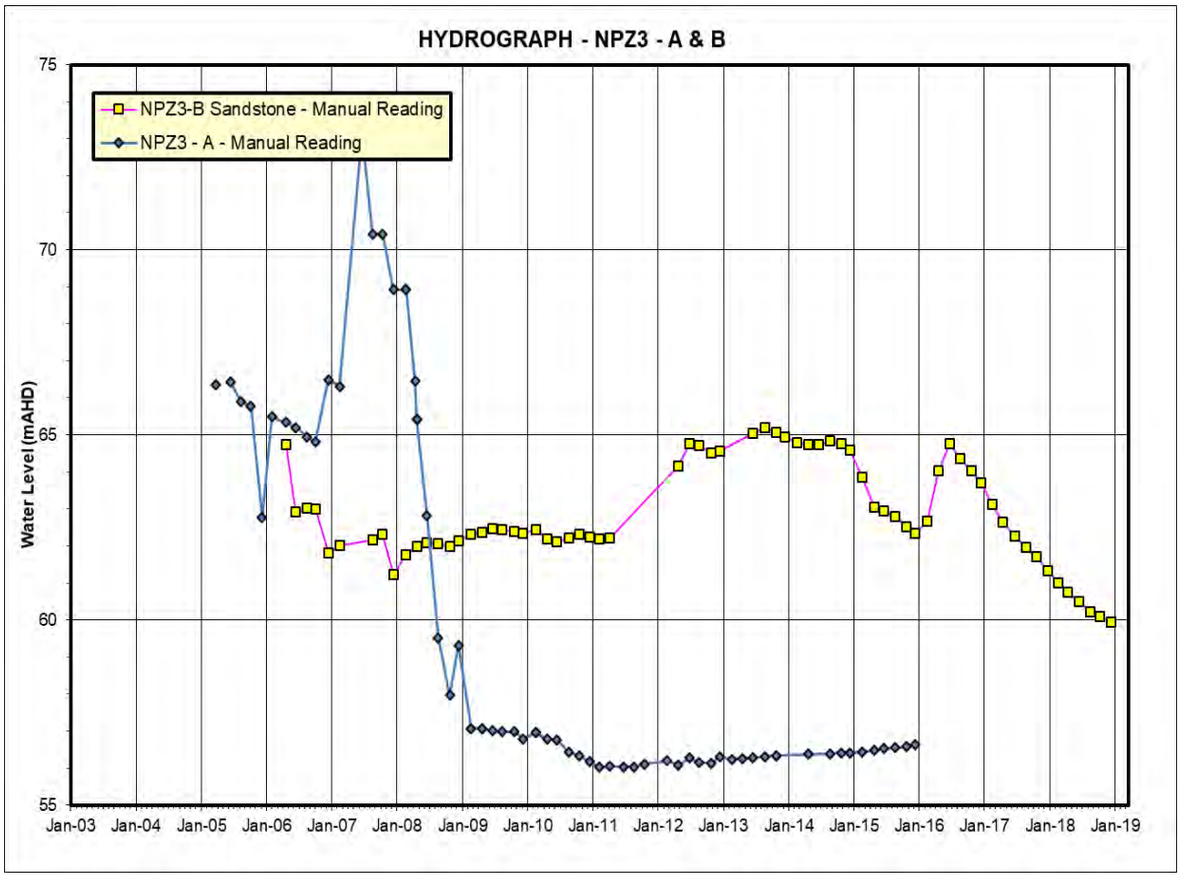


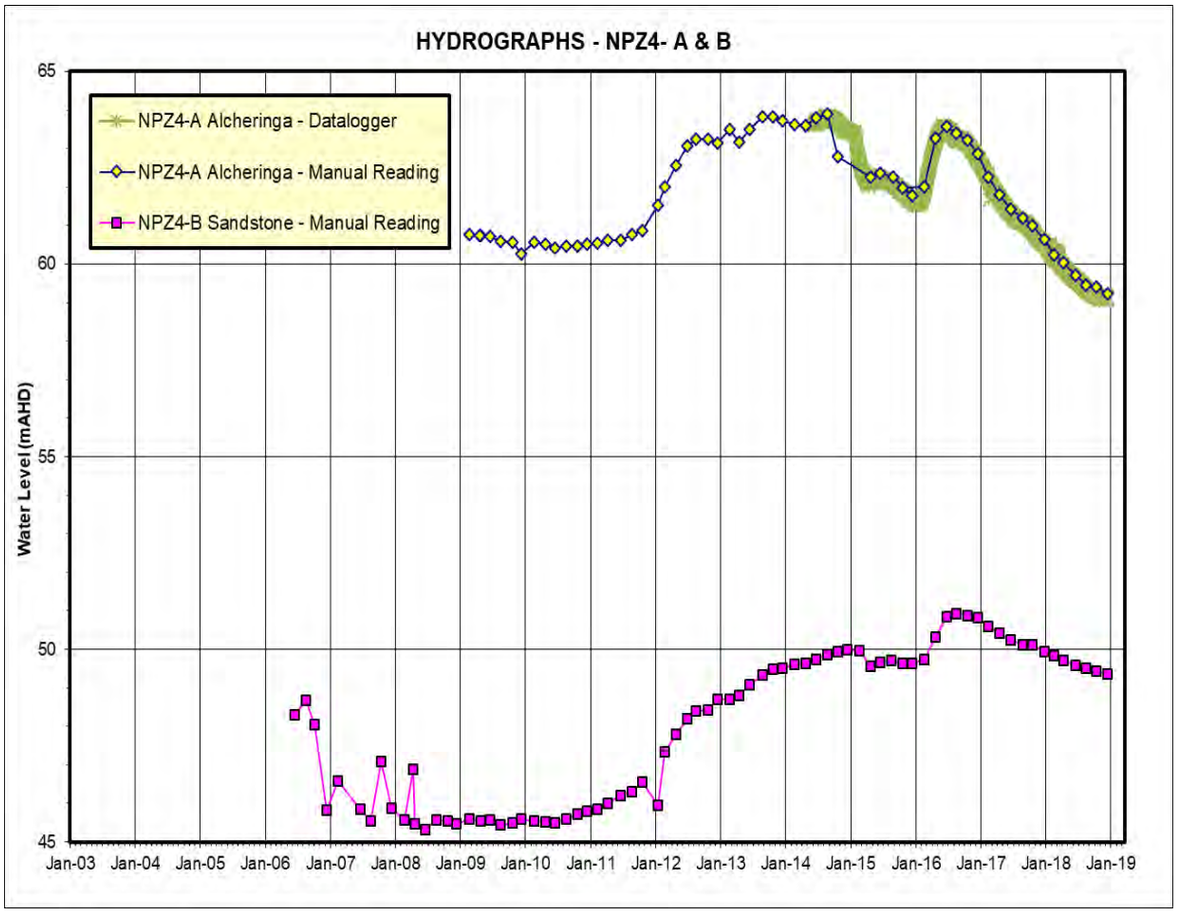
GROUNDWATER LEVELS IN LOWER WYBROW SEAM FIGURES 16a and 16b



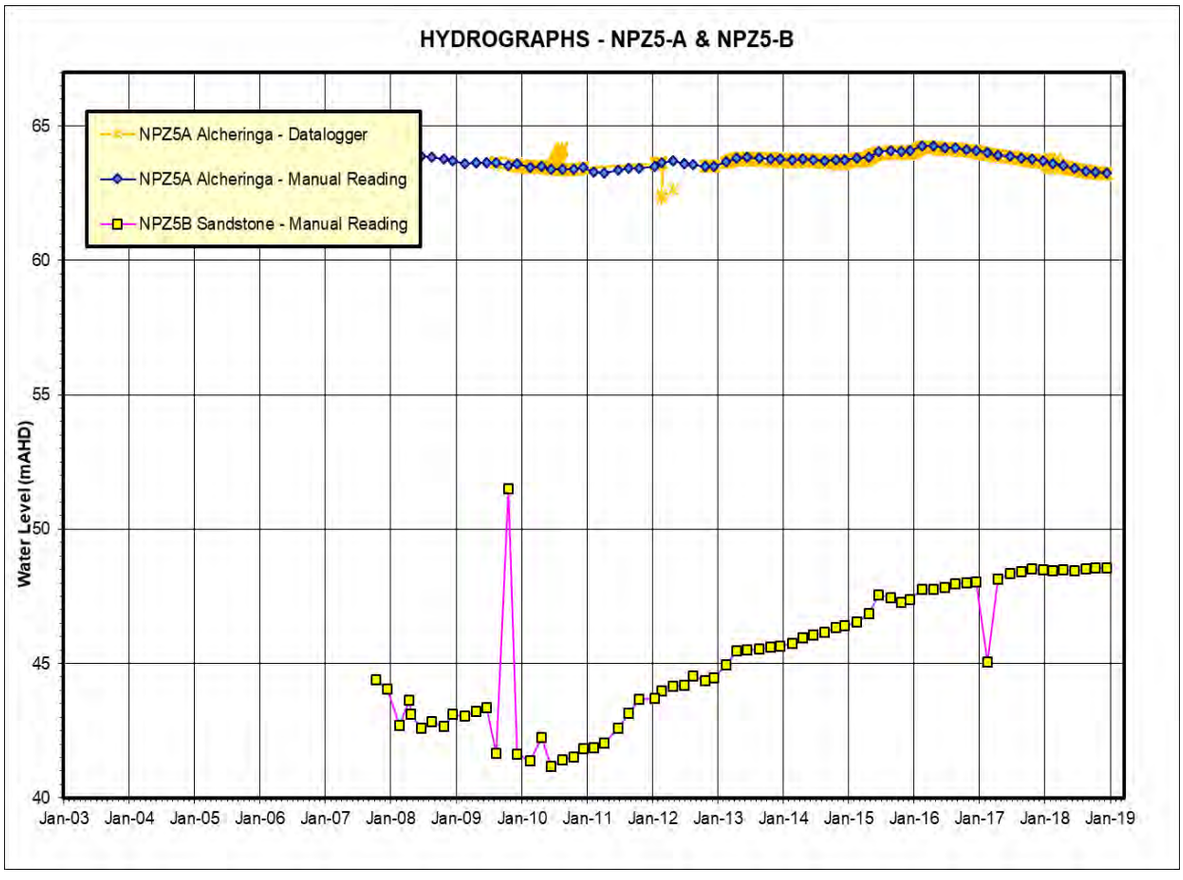


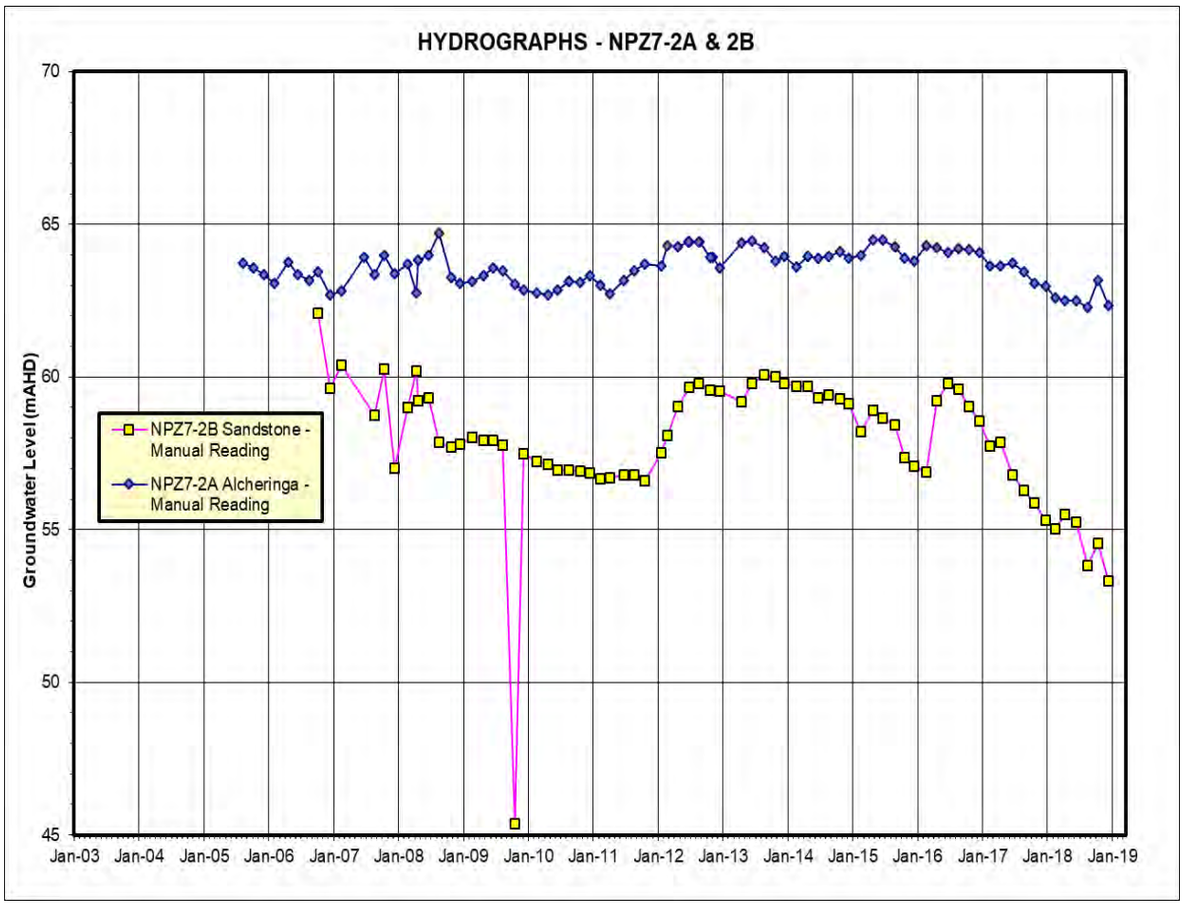
GROUNDWATER LEVELS IN LOWER WYBROW SEAM FIGURE 17a and 17b



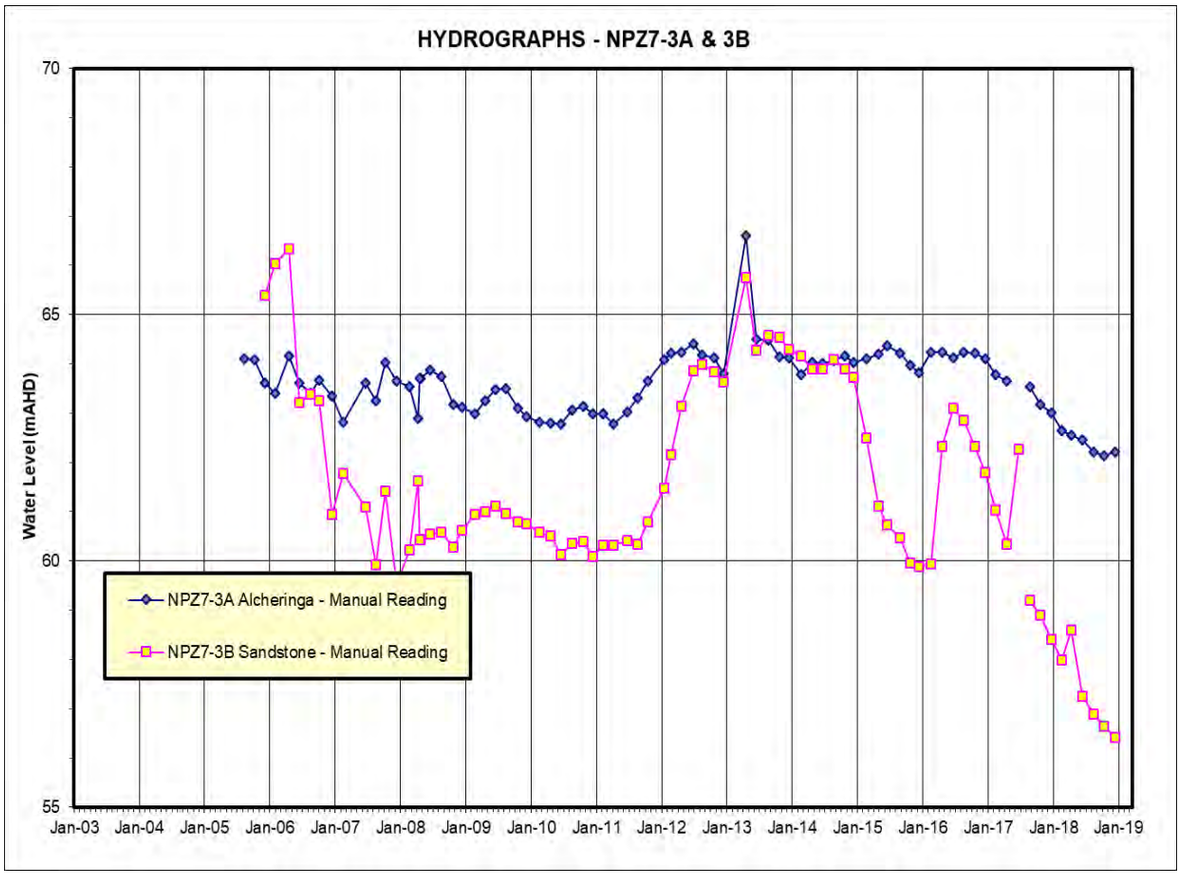


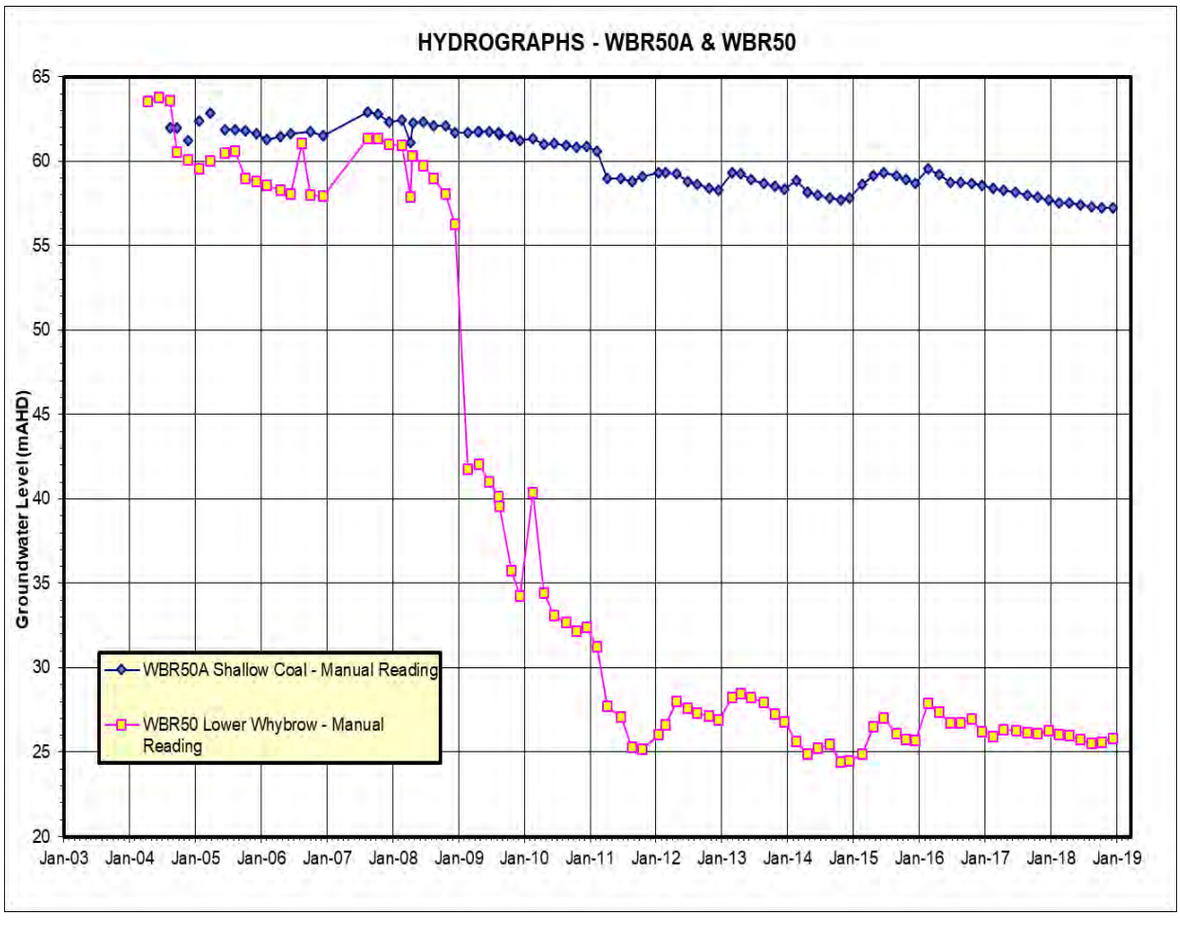
GROUNDWATER LEVELS IN NPZ-3A& NPZ-4A NESTED PIEZOMETERS FIGURE 18a and 18b



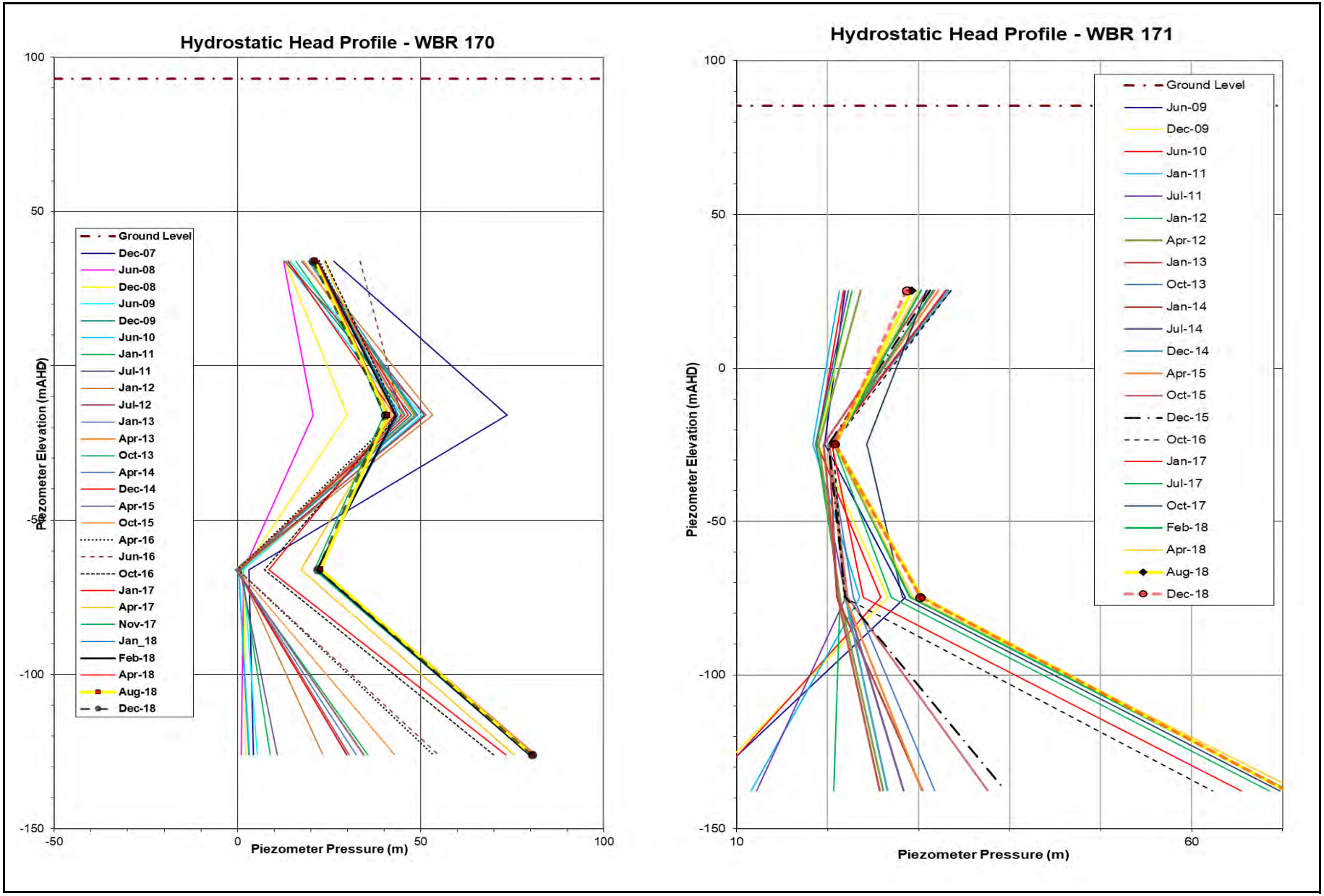


GROUNDWATER LEVELS IN NPZ-5 & NPZ7-2 NESTED PIEZOMETERS FIGURE 19a and 19b

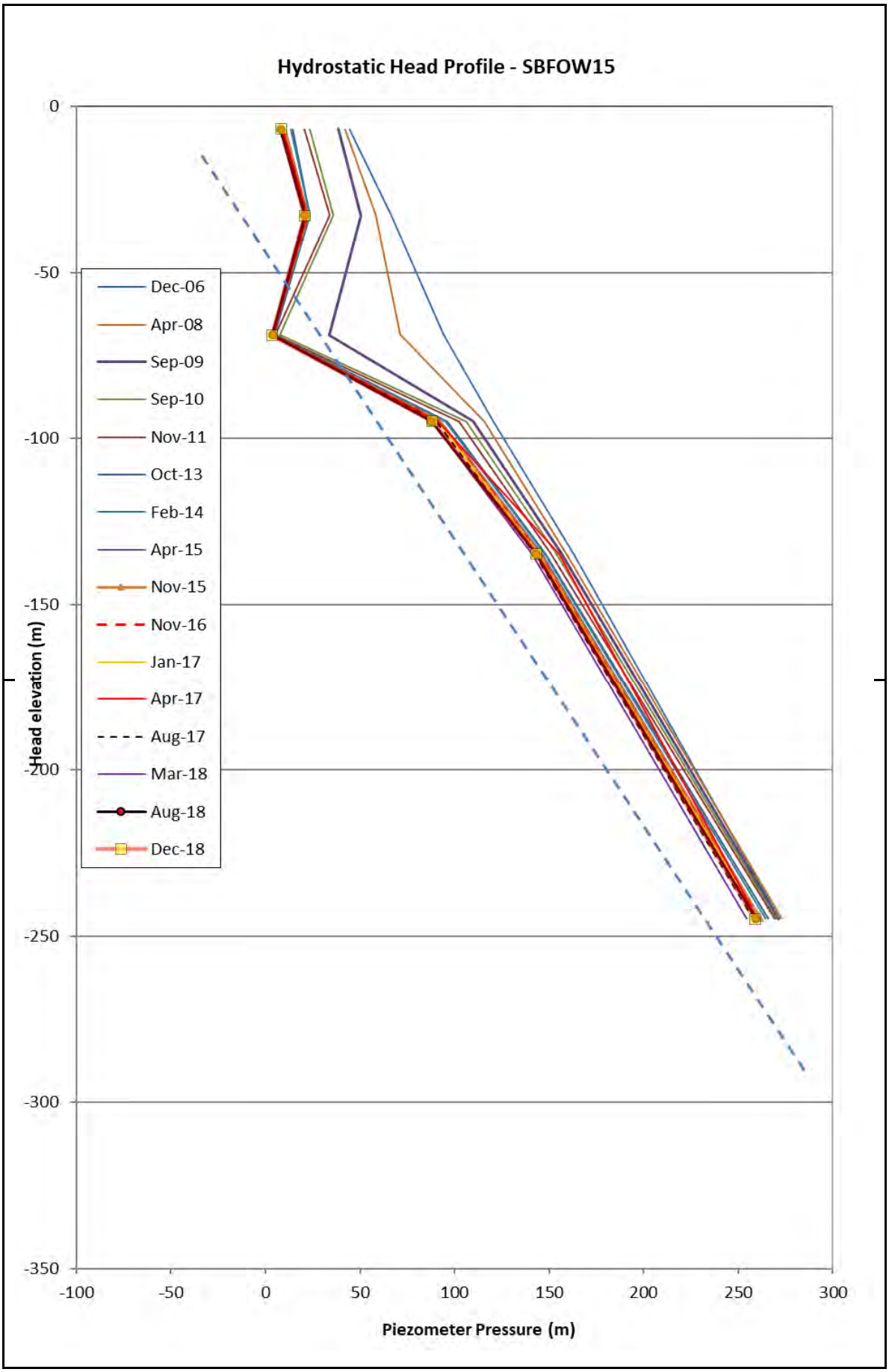




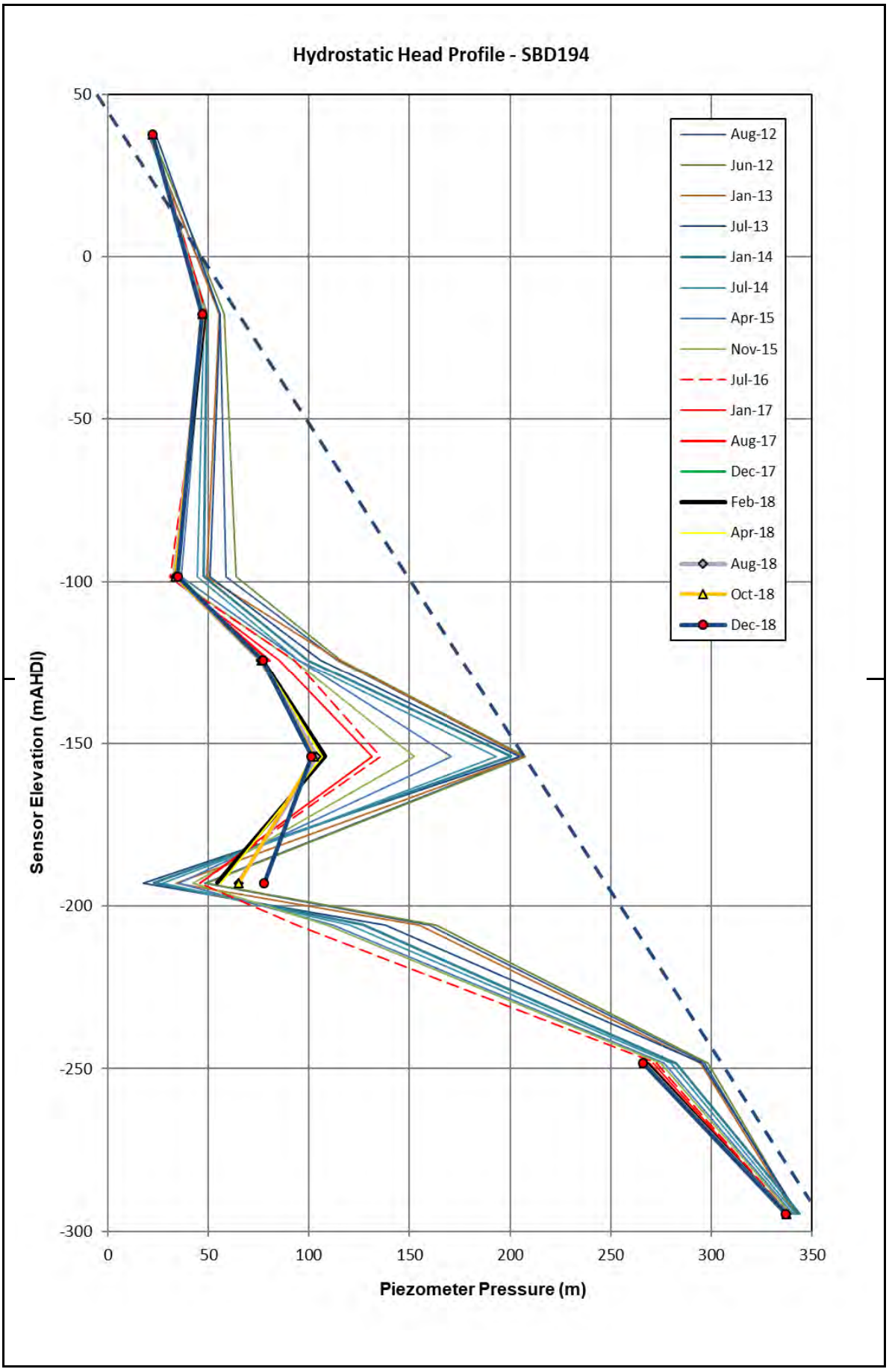
GROUNDWATER LEVELS IN NPZ7-3 and WBR50 NESTED PIEZOMETERS FIGURE 20a and 20b



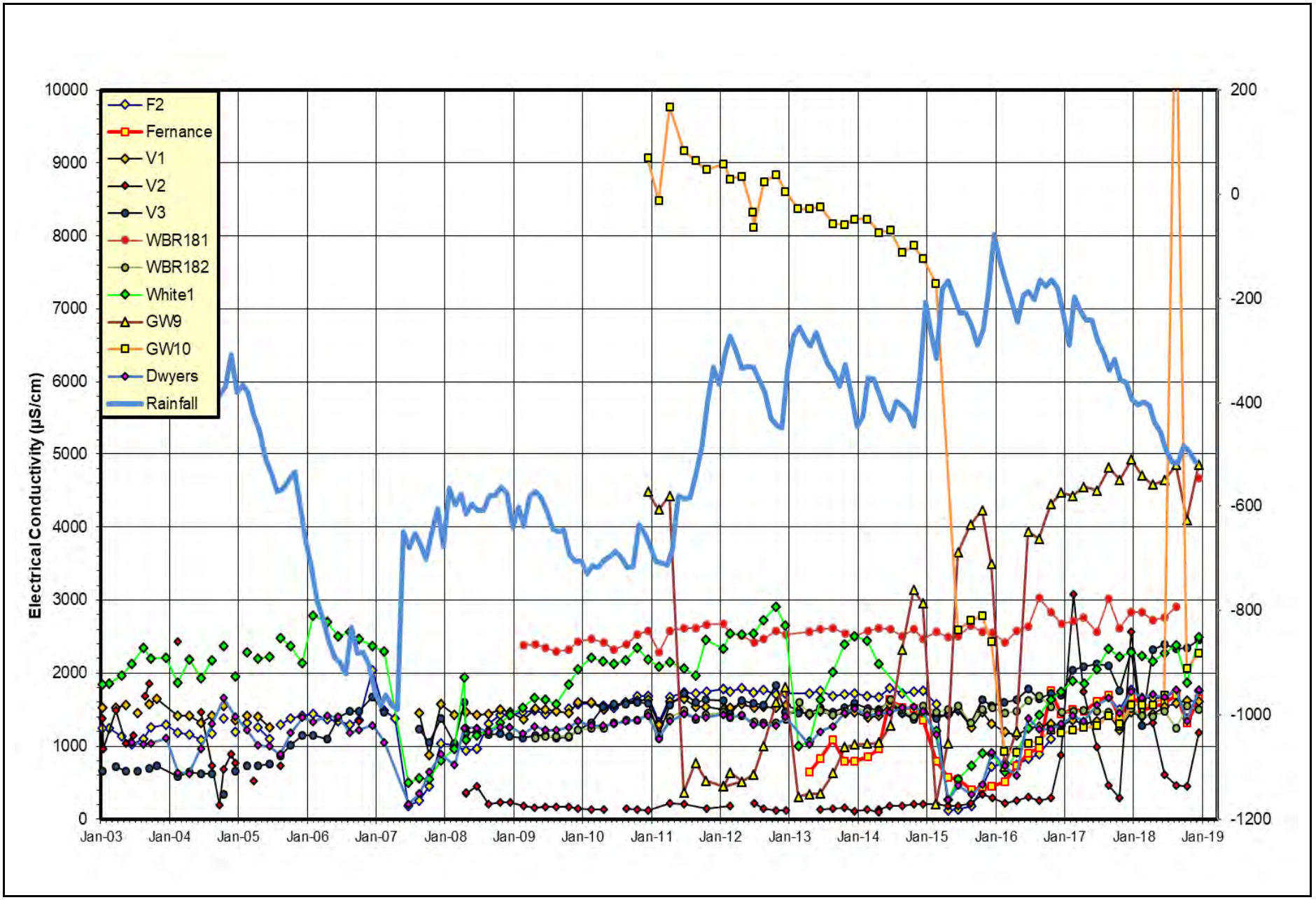
HYDROSTATIC HEAD PROFILE FOR WBR170 and WBR171 FIGURE 21



HYDROSTATIC HEAD PROFILE FOR SBFOW15 FIGURE 22



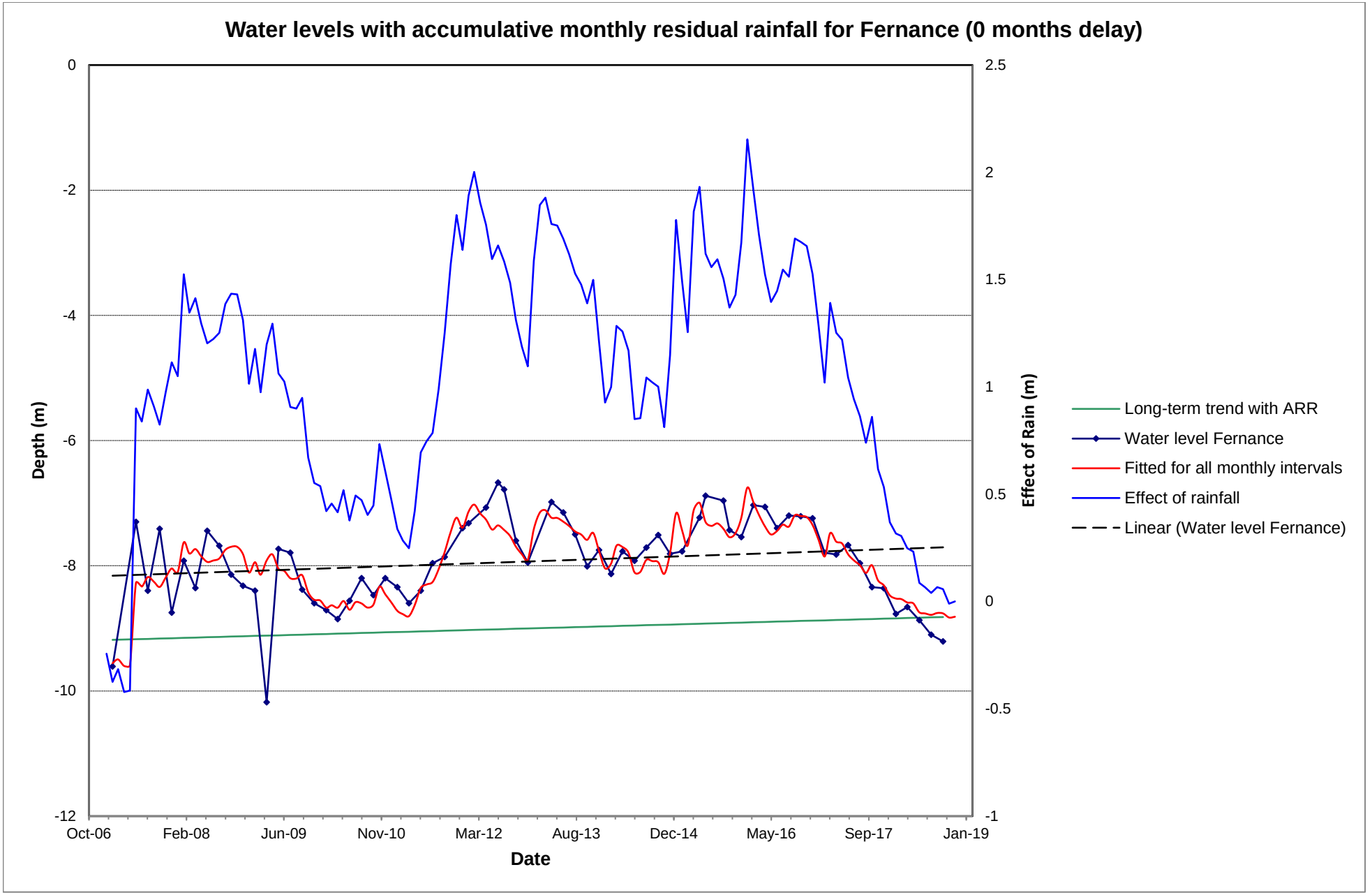
HYDROSTATIC HEAD PROFILE SBD194 FIGURE 23

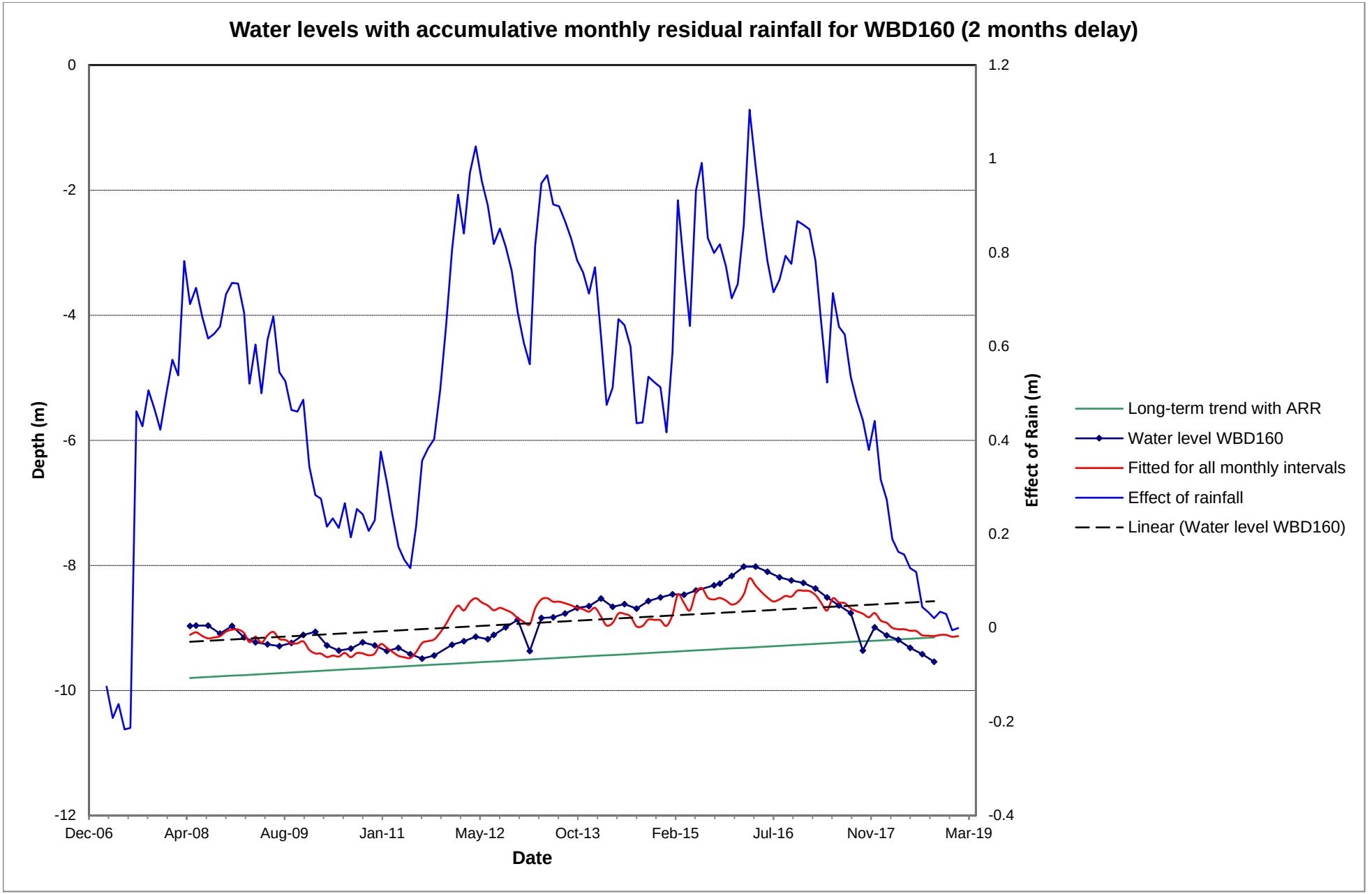


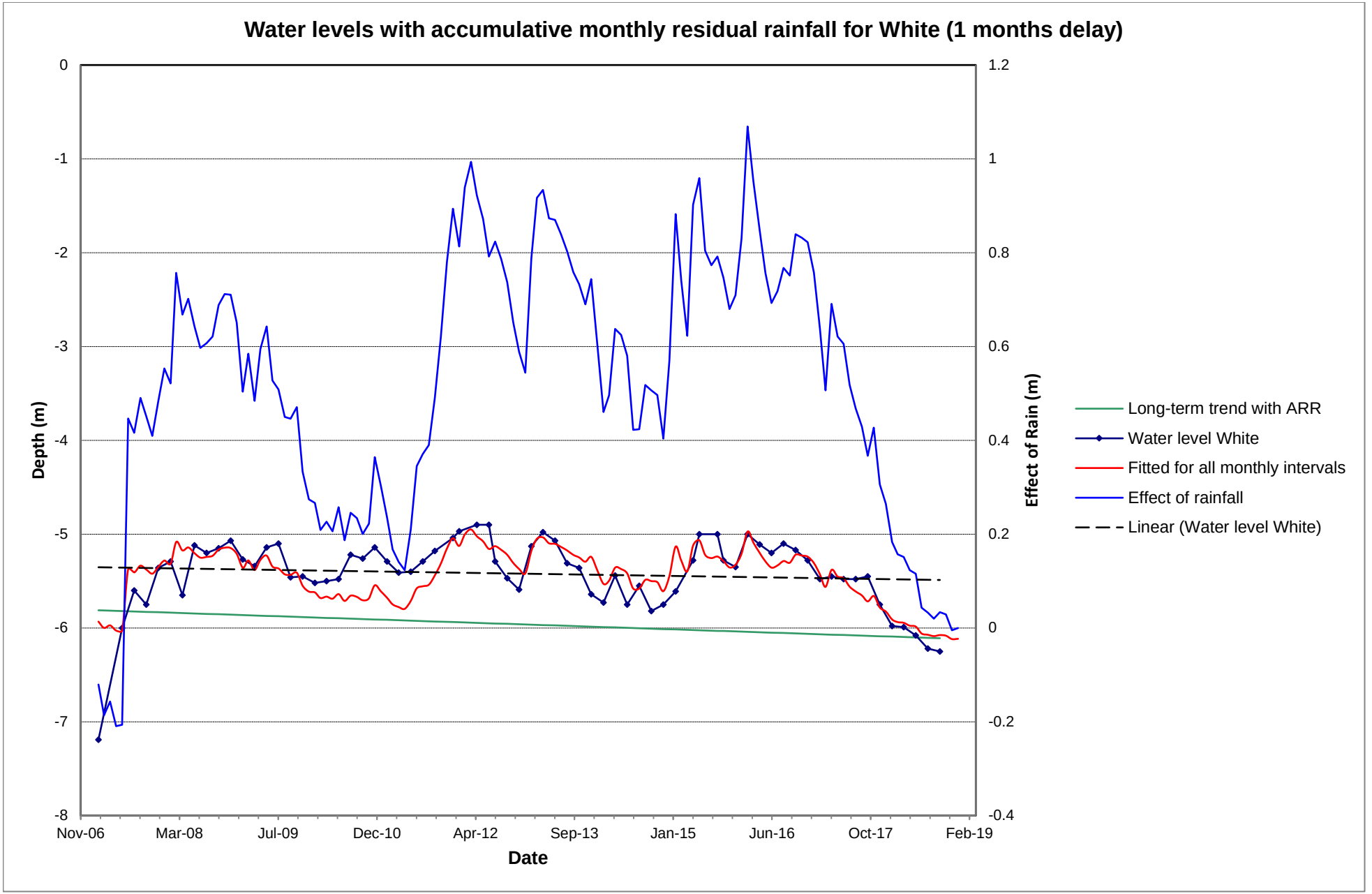
SHALLOW ALLUVIUM GROUNDWATER ELECTRICAL CONDUCTIVITY FIGURE 24

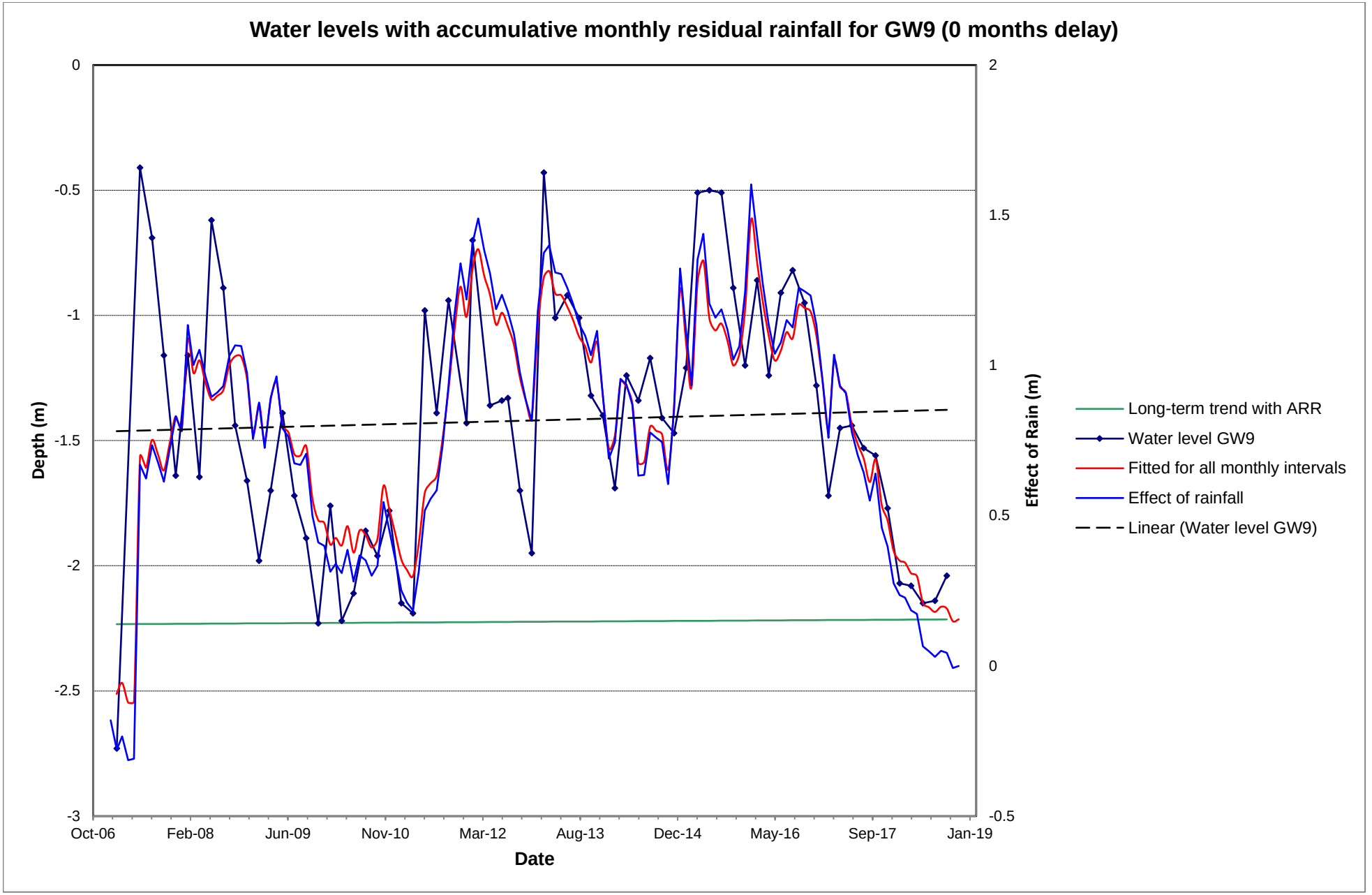
APPENDIX B

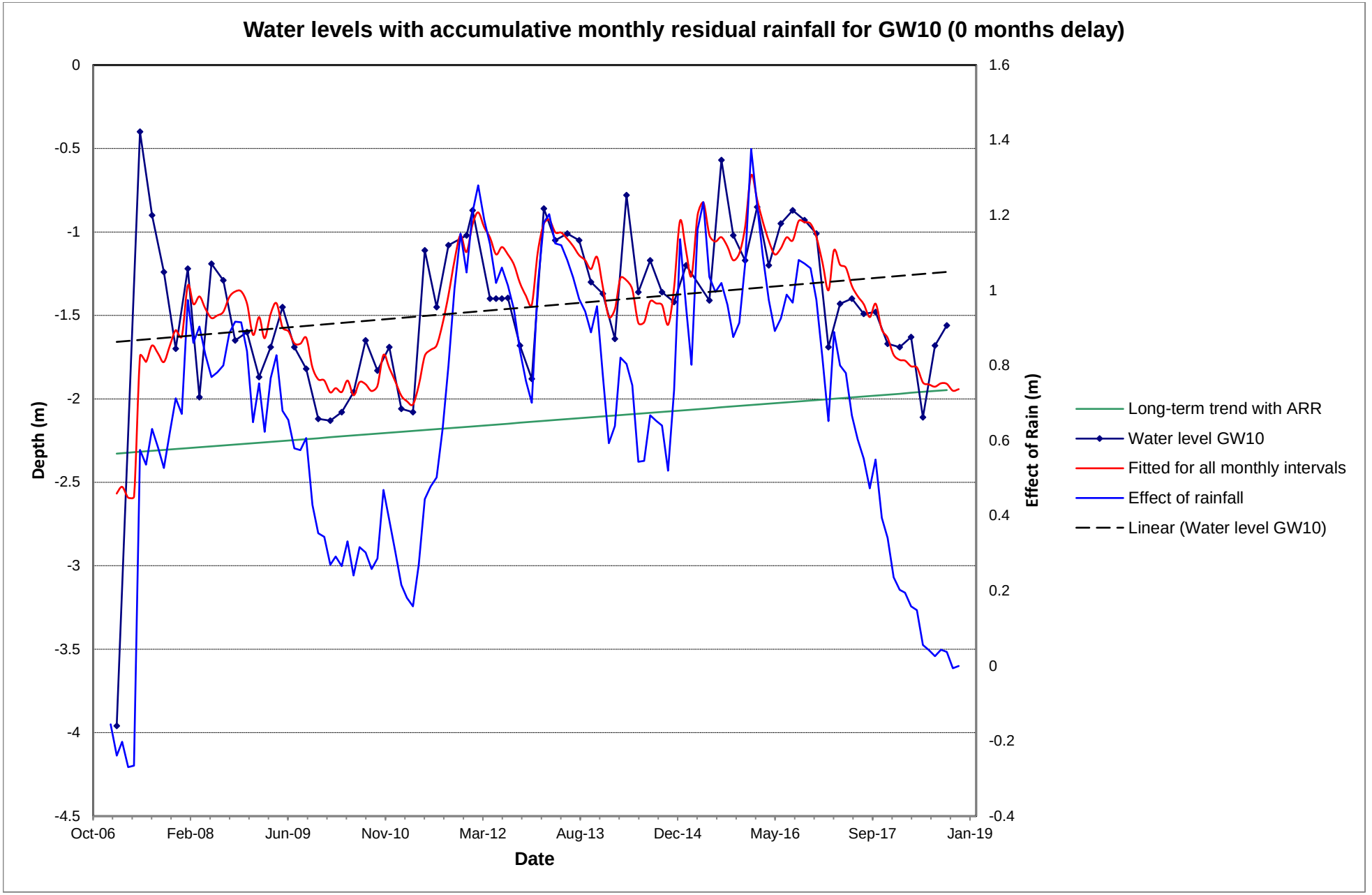
Alluvial hydrograph analysis using HARTT method


Water levels with accumulative monthly residual rainfall for Fernance (0 months delay)
Depth (m)
0
-2
-4
-6
-8
-10
-12
Effect of Rain (m)
2.5
2
1.5
1
0.5
0
-0.5
-1
Oct-06
Feb-08
Jun-09
Nov-10
Mar-12
Aug-13
Dec-14
May-16
Sep-17
Jan-19
Date
Long-term trend with ARR
Water level Fernance
Fitted for all monthly intervals
Effect of rainfall
Linear (Water level Fernance)


Water levels with accumulative monthly residual rainfall for WBD160 (2 months delay)
Depth (m)
0
-2
-4
-6
-8
-10
-12
Effect of Rain (m)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
Dec-06
Apr-08
Aug-09
Jan-11
May-12
Oct-13
Feb-15
Jul-16
Nov-17
Mar-19
Date
Long-term trend with ARR
Water level WBD160
Fitted for all monthly intervals
Effect of rainfall
Linear (Water level WBD160)


Water levels with accumulative monthly residual rainfall for White (1 months delay)
Depth (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
Effect of Rain (m)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
Nov-06
Mar-08
Jul-09
Dec-10
Apr-12
Sep-13
Jan-15
Jun-16
Oct-17
Feb-19
Date
Long-term trend with ARR
Water level White
Fitted for all monthly intervals
Effect of rainfall
Linear (Water level White)


Water levels with accumulative monthly residual rainfall for GW9 (0 months delay)
Depth (m)
0
-0.5
-1
-1.5
-2
-2.5
-3
Effect of Rain (m)
2
1.5
1
0.5
0
-0.5
Oct-06
Feb-08
Jun-09
Nov-10
Mar-12
Aug-13
Dec-14
May-16
Sep-17
Jan-19
Date
Long-term trend with ARR
Water level GW9
Fitted for all monthly intervals
Effect of rainfall
Linear (Water level GW9)


Water levels with accumulative monthly residual rainfall for GW10 (0 months delay)
Depth (m)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
Effect of Rain (m)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
Oct-06
Feb-08
Jun-09
Nov-10
Mar-12
Aug-13
Dec-14
May-16
Sep-17
Jan-19
Date
Long-term trend with ARR
Water level GW10
Fitted for all monthly intervals
Effect of rainfall
Linear (Water level GW10)

APPENDIX E

Completion Criteria Checklist

The following table provides a colour-coded guide to how the rehabilitation is progressing towards the closure criteria. The colour-coding relates to green achieving the benchmark value, blue within 20% of the benchmark value, orange between 21% and 50% of the benchmark value and red below 50% of the benchmark value.

Table 4.1. Rehabilitation Progress Towards the Closure Criteria.

Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site									
							Dam01	EEA1	NB6	NVB2	NVB3	OTD1	OTD5	SB7	SB8	SE1
Landform Establishment	Provide a sustainable final landform and use that can co-exist with surrounding land uses	All	The constructed final landform is stable and complies with the approved final landform	Landform slope, gradient	Drainage structures have been constructed in accordance with the final landform plan	LFA										
				Active erosion	The number of gullies or rills (>1.0m width or depth) occurring in a 50m transect	LFA										
		Native Woodland	The final landform includes features which provide habitat for native fauna species	Habitat Features	Salvaged hollows, nest boxes, stag trees or rock piles are included in the rehabilitated areas	BAM										
Growth Medium Development	Soil properties are suitable for the establishment and maintenance of selected vegetation species	All	Soil chemistry does not affect the ongoing health of desired vegetation species	Soil chemical, physical properties and amelioration	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements, and ameliorants applied as required	LFA										
		Native Woodland	Soil properties do not affect the ongoing health of desired vegetation species	Landform Function	LFA stability index is comparable to or trending towards that of the local remnant vegetation	LFA										
					LFA infiltration index is comparable to or	LFA										

Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site									
							Dam01	EEA1	NB6	NVB2	NVB3	OTD1	OTD5	SB7	SB8	SE1
					trending towards that of the local remnant vegetation											
					LFA nutrient recycling index is comparable to or trending towards that of the local remnant vegetation	LFA										
		Pasture	Soil properties do not affect the ongoing health of desired vegetation species	Landform Function	LFA stability index is comparable to or trending towards that of the reference pasture sites	LFA	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					LFA infiltration index is comparable to or trending towards that of the reference pasture sites	LFA	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					LFA nutrient recycling index is comparable to or trending towards that of the reference pasture sites	LFA	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

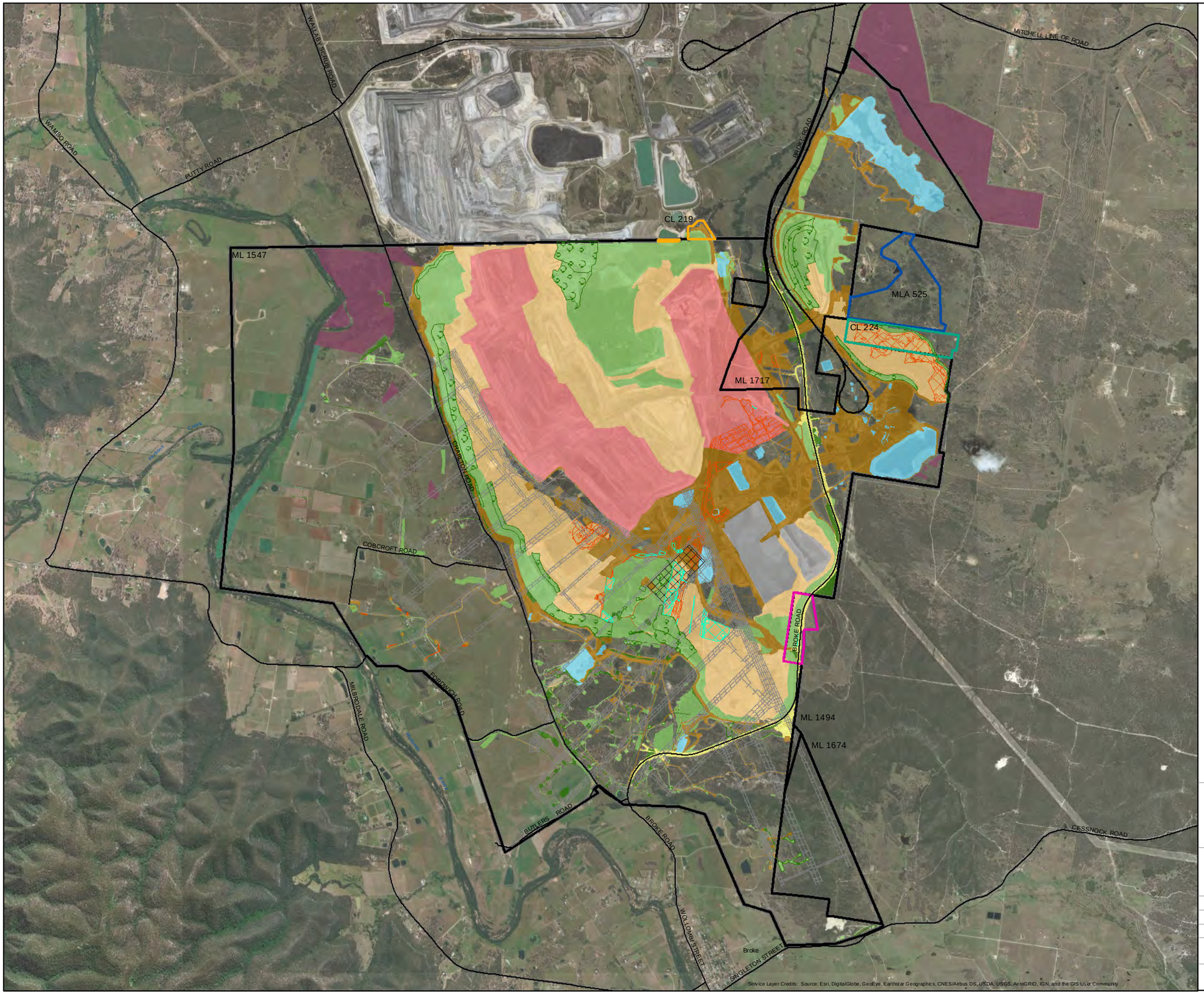
Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site									
							Dam01	EEA1	NB6	NVB2	NVB3	OTD1	OTD5	SB7	SB8	SE1
Ecosystem and Land Use Establishment	Establish similar native woodland communities to those that will be impacted by the operations	Native Woodland	Native species diversity is consistent with benchmark values published by NSW Government and/or collected at reference sites	Vegetation Diversity	Indigenous plant species richness achieves a biometric score of 2 for the relevant PCT	BAM										
				Vegetation Diversity	The density of shrubs or juvenile trees is comparable to that of the local reference sites (no./400m2)	BAM										
	Establish areas suitable for agriculture (grazing) purposes	Pasture	Pasture composition comprises palatable grasses and legumes appropriate to the district and suitable for cattle grazing.	Vegetation Diversity	Pasture grass and legumes diversity is consistent with ranges provided by the agricultural industry or the local reference sites	Pasture Assessment	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
				Weed Species	Weed presence is within ranges found at reference sites and does not present a risk to rehabilitation areas	BAM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
			Ground cover is greater than 70%	Protective Ground Cover	Ground cover provided by perennial vegetation species is greater than 70%	BAM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site									
							Dam01	EEA1	NB6	NVB2	NVB3	OTD1	OTD5	SB7	SB8	SE1
Ecosystem and Land Use Sustainability	Establish self-sustaining native woodland communities consistent with the final land use, and that require no on-going care and maintenance	All	Pest animals do not pose a risk to the ongoing health of rehabilitation areas	Pest Animals	Monitoring reports do not indicate that pest animals are impacting upon health of rehabilitation areas	Pest Animals										
		Native Woodland	The rehabilitated vegetation community is consistent with the desired EEC required by the Project Approval (according to NSW Government benchmarks)	Ecosystem Structure	Native over-storey cover achieves a biometric score of 2 for the relevant PCT	BAM										
					Native mid-storey cover achieves a biometric score of 2 for the relevant PCT	BAM										
				Ground Cover	Native ground cover (grasses) achieves a biometric score of 2 for the relevant PCT	BAM										
					Native ground cover (shrubs) achieves a biometric score of 2 for the relevant PCT	BAM										
					Native ground cover (other) achieves a biometric score of 2 for the relevant PCT	BAM										

Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site									
							Dam01	EEA1	NB6	NVB2	NVB3	OTD1	OTD5	SB7	SB8	SE1
			The rehabilitated vegetation community is self-sustaining	Ecosystem Health	The proportion of over-storey species occurring as regeneration achieves a biometric score of 2 for the relevant PCT	BAM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
				Weed Species	The exotic species richness achieves a biometric score of 2 for the relevant PCT (if available) or is comparable to the local reference sites (no./400m2)	BAM										
			The rehabilitated vegetation community provides suitable habitat for native fauna	Fauna Habitat	The number of trees with hollows achieves a biometric score of 2 for the relevant PCT (no./1000m2)	BAM										
	Establish self-sustaining agricultural areas that are capable of achieving required production	Pasture	Grazing areas are assessed to have a Rural Land Capability Class of VI or better	Land Capability	Combination of slope, erosion and vegetation conditions indicate land capability is Class VI or better	Reporting	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
			Grazing areas have comparable productivity to district averages	Carrying Capacity	Pasture biomass is consistent with agricultural industry guidelines and/or local reference sites	Pasture Assessment	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

APPENDIX F

Annual Review Plan



Legend

- Colliery Holding
- Mining Lease
- Mining Lease Application
- Sub Lease
- Coal Lease
- Commonwealth Licence Agreement
- Road
- Railway
- Blakefield Seam Workings

2018 Rehabilitation and Disturbance Activities

- 2018 Rehabilitation Woodland
- 2018 Rehabilitation Pasture
- 2018 Dehab
- 2018 Disturbance
- 2018 Secondary Extraction

Rehabilitation Domains (31 December 2018)

- Domain 1 - Infrastructure
- Domain 2 - Emplacement Areas
- Domain 3 - Active Mining
- Domain 4 - Tailings Emplacement
- Domain 5 - Rehabilitation Woodland
- Domain 6 - Rehabilitation Pasture
- Domain 7 - Surface Water / Dams
- Domain 8 - Conservation Area & Offsite Offsets
- Domain 9 - Vegetation Re-establishment Area
- Public Infrastructure

Bulga Coal
Annual Review
2018
Domain Plan

GLENCORE

N

Date: 21-Feb-2019	Sheet size: A3
Drawn by: LH	Approved: AW
Scale: 1:50,000	

0 0.25 0.5 1 1.5
Kilometers

Prepared by SLR Consulting Australia Pty Ltd

H:\Projects-SLR\630-SrvNTL\630-NTL\630.12687 Bulga Coal 2018 Annual Review\06 SLR Data\01 CADGIS\ArcGIS\SLR63012687_Bulga_AEMR_2018_01.mxd

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
5 Foelsche Street
Darwin NT 0800
Australia
T: +61 8 8998 0100
F: +61 2 9427 8200

GOLD COAST
Ground Floor, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

ROCKHAMPTON
rockhampton@slrconsulting.com
M: +61 407 810 417

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TAMWORTH
PO Box 11034
Tamworth NSW 2340
Australia
M: +61 408 474 248
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
5 Duncan Street
Port Nelson 7010
New Zealand
T: +64 274 898 628

NEW PLYMOUTH
Level 2, 10 Devon Street East
New Plymouth 4310
New Zealand
T: +64 0800 757 695