2019
Annual Review

BULGA
COAL

GLENCORE

PREPARED BY

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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
630.12954-R01-v1.0	26 March 2020	Sam McDonald / Nathan Archer (SLR)	Nathan Archer (SLR) / Bulga Coal E&C Team	Nathan Archer (SLR)

Cover photograph: The Bulga Coal workforce (770 people) viewing the pit from the Cobcroft Road lookout, Broke, to understand the local community setting and environmental aspects during training in February 2019.

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, ML1788, 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 #	WAL36221, WAL41543, WAL41544, WAL41545, WAL41546, WAL41687.
Name of holder of water licence	Bulga Coal Management, Saxonvale Coal Pty Ltd, Beltana Highwall Mining Pty Ltd
MOP/RMP start date	29 May 2019 (Bulga Open Cut) 29 May 2019 (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 2019
Annual Review end date	31 December 2019

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 2019 to 31 December 2019 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	
Date	27-3-20

DOCUMENT REFERENCES

TABLES

FIGURES

PHOTOS

APPENDICES

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
ML 1788	Yes
EPL 563	No
EL 5277	Yes
EL 5461	Yes
EL 8315	Yes
AUTH 447	Yes
AUTH 450	Yes

Table 2 Summary of Non-Compliances

Approval/ Licence	Condition / Legislative Reference	Condition Summary	Compliance Status	Date	Details of the Non-compliance	Corrective Action/s	Section of this Annual Review
N/A	Section 120 of the POEO Act 1997	Prohibition of pollution of waters	Non-Compliant	18/9/19 19/9/19	Discharge of sediment laden water from an active mining area, through a culvert, into Nine Mile Creek. The discharge was caused by the failure of two drainage pipes that had previously been sealed to prevent discharge.	Placing sandbag weirs in the dry creek bed. Installing pumps and pipes and pumping water back into the water management system. Sealing pipes and other similar pipes onsite.	Section 7.2.2 and 11
SSD-4960	Schedule 5, Condition 6	DPIE CCC Guidelines	Non-Compliant	8/5/19	Not operating the Bulga Community Consultative Committee in accordance with the Department of Planning, Industry and Environment's CCC guidelines.	Department appointed independent chairperson. CCC operated in accordance with the DPIE CCC guidelines.	Section 9 and 11
N/A	Section 4.2 of Environmental Planning and Assessment Act 1979	Carrying out the development not in accordance with the conditions of development consent SSD-4960	Non-Compliant	20/06/18	Failure to provide interim protection of aboriginal heritage items (such as fencing and signage), as required by the Aboriginal Cultural Heritage Management Plan (ACHMP), until permanent protection and signage could be installed, and the sites added to Bulga's GIS database.	The Aboriginal Cultural Heritage Management Plan was reviewed and updated to include a process for identifying and providing interim protection of new isolated aboriginal heritage finds.	Section 6.9 and 11

Approval/ Licence	Condition / Legislative Reference	Condition Summary	Compliance Status	Date	Details of the Non-compliance	Corrective Action/s	Section of this Annual Review
EPL 563	O1.1 O3.1	Dust	Non-Compliant	8/8/19	Failure to minimise dust emissions from the deep pit tailings emplacement area. Dust from tailings dam observed blowing across Broke Rd.	Tailings and water placed on tailings emplacement area. Air Quality Management Trigger Action Response Procedure modified to include an action to consider placing tailings or water on the dam in response to forecast adverse weather conditions.	Section 6.4 and 11
EPL 563	M2.2	Air Quality Monitoring	Non-Compliant	Various	Failure to monitor PM_{10} continuously at EPA Point 9 and EPA Point 10 air quality monitors.	Monitors fixed.	Section 6.4 and 11
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality Monitoring	Non-Compliant	5/2/19	Exceedance in PM10 concentration (24-hour average) at Putty Rd (D3) TEOM. Exceedance caused by local cattle.	N/A	Section 6.4 and 11
SSD-4960	Schedule 3, Condition 16						
DA 376-8-2003	Schedule 4, Condition 22						
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality Monitoring	Non-Compliant	10/2/19	Exceedance in PM10 concentration (24-hour average) at Mitchell Line Rd (D11) and Putty Rd (D3) TEOM's. Exceedances caused by wind erosion of dust from other sources upwind of Bulga Open Cut.	N/A	Section 6.4 and 11
SSD-4960	Schedule 3, Condition 16						
DA 376-8-2003	Schedule 4, Condition 22						
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality Monitoring	Non-Compliant	8/04/19	Exceedance in PM_{10} concentration (24-hour average) at Mitchell Line Rd (D11) TEOM.	N/A	Section 6.4 and 11

Approval/ Licence	Condition / Legislative Reference	Condition Summary	Compliance Status	Date	Details of the Non-compliance	Corrective Action/s	Section of this Annual Review
SSD-4960	Schedule 3, Condition 16				Cause of the exceedance is unknown; however, investigations show it is unlikely that Bulga had a significant contribution to the elevated PM10 levels.		
DA 376-8-2003	Schedule 4, Condition 22						
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality Monitoring	Non-Compliant	9/04/19	Exceedance in PM_{10} concentration (24-hour average) at Mitchell Line Rd (D11) TEOM. Cause of the exceedance is unknown; however, investigations show it is unlikely that Bulga had a significant contribution to the elevated PM10 levels.	N/A	Section 6.4 and 11
SSD-4960	Schedule 3, Condition 16						
DA 376-8-2003	Schedule 4, Condition 22						
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality Monitoring	Non-Compliant	29/04/19	Exceedance in PM_{10} concentration (24-hour average) at Mitchell Line Rd (D11) TEOM. Exceedance caused by a local source.	N/A	Section 6.4 and 11
SSD-4960	Schedule 3, Condition 16						
DA 376-8-2003	Schedule 4, Condition 22						
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality Monitoring	Non-Compliant	22/07/19	Exceedance in PM_{10} concentration (24-hour average) at Putty Rd (D3) TEOM.	Area rehabilitated.	Section 6.4 and 11
SSD-4960	Schedule 3, Condition 16						

Approval/ Licence	Condition / Legislative Reference	Condition Summary	Compliance Status	Date	Details of the Non-compliance	Corrective Action/s	Section of this Annual Review
DA 376-8-2003	Schedule 4, Condition 22				Exceedance caused by rehabilitation adjacent to the monitor.		
DA 41-03-99	Schedule 6, Condition 1.2 (c)	Air Quality Monitoring	Non-Compliant	29/10/19	Exceedance in $PM_{2.5}$ concentration (24-hour average) at Hill Street (D2), and Putty Road (D10)and PM_{10} concentration (24-hour average) at Putty Rd (D10) HVAS. Exceedances caused by bushfire smoke.	N/A	Section 6.4 and 11
SSD-4960	Schedule 3, Condition 16						
DA 376-8-2003	Schedule 4, Condition 22						
Eastern Emplacement Area Air Quality Management Framework (EEAAQMF)	Section 4.2 of the EEAAQMF	Air Quality Monitoring	Non-Compliant	25/07/19	Exceedance in PM_{10} concentration (13-hour average) at the Mushroom Composting Facility TEOM (D4). Exceedance caused by a regional dust storm.	N/A	Section 6.4 and 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 **Section11**.

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. 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 2019 to 31 December 2019. It has been prepared in accordance with the *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.

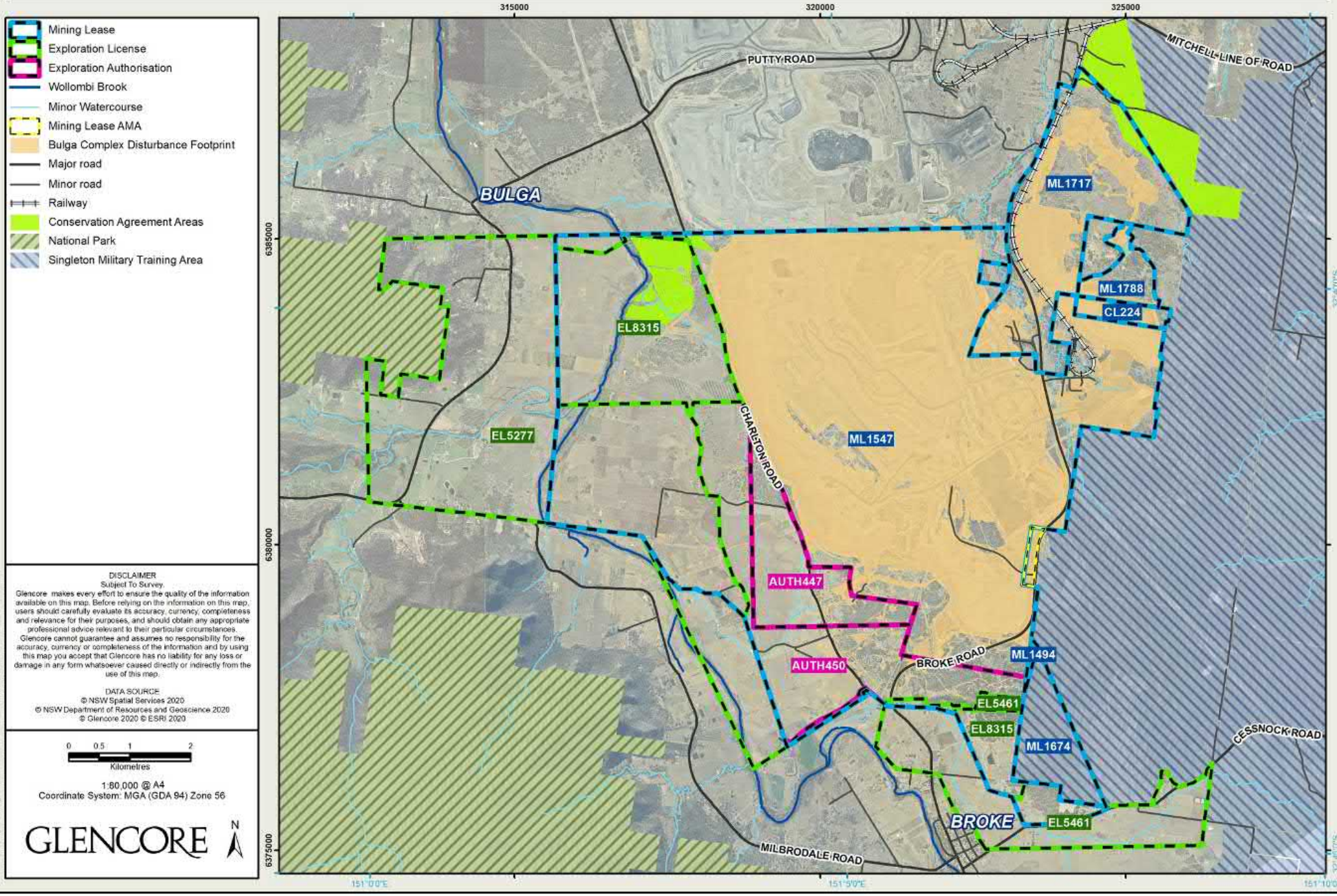
2.2 Mine Contacts

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
Dave Foster	Bulga Coal Operations Manager	T: 02 6570 2400
		E: David.Foster@glencore.com.au

FIGURE 1 - BULGA COAL LOCALITY & LICENCES 2019



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. SSD-4960 superseded DA 41-03-99 at the granting of the Bulga Optimisation Project approval. DA 41-03-99 is in the process of being relinquished.

In 2019, Bulga Coal applied to modify the Bulga Open Cut SSD-4960 (Mod 3) and Bulga Underground DA 376-8-2003 (Mod 7). Key aspects of the modifications include:

- SSD-4960 (Mod 3)
    - Continuation of mining behind the noise and visual bund and within the existing approved project area;
    - Relocation of tailings within the Deep Pit to an in-pit tailings facility in the north of the mine to enable mining of the underlying coal. Relocation of the tailings will be via a system of pumps and pipelines;
    - Mining of an approximately 63 million additional tonnes of coal over the life of the mine;
    - Disturbance of an additional 20.2 hectares (ha) of vegetation, which will be offset; and
    - Extension of the mine life of the open cut operation by four years to 2039;
    - Re-disturbance and rehabilitation of approximately 200 ha of existing immature rehabilitation.
- DA 376-8-2003 (Mod 7)
    - Demolition and relocation of the Bulga Underground Operations MIA;
    - Allowance for the relocation of underground mine ventilation, as required;
    - Relocation of the 9 megawatt (MW) power station and associated flares;
    - Relocation of the Bulga Underground Operations electrical substation; and
    - Upgrading, relocation, construction and decommissioning of mine owned power transmission lines and associated access tracks.

At the time of writing of this Annual Review, these modifications were awaiting approval.

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
	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)	
	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 – Extend the period for construction of the outer face of the noise and visual 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

3.2 Mining Tenements

Mining operations at Bulga Coal are undertaken within Mining Lease (ML) 1494, ML 1547, ML 1674, ML 1717, ML 1788, Coal Lease (CL) 224. Bulga Coal has approval to undertake exploration activities in accordance with Exploration Lease (EL) 5277, EL 5461, EL 8315, Authorisation (AUTH) 447 and AUTH 450.

On 19 June 2019, Mining Lease Application (MLA) 525 was granted and the instrument of grant for ML 1788 was received. ML 1788 is in the north-eastern portion of the site and allows Bulga Coal to undertake mining activities associated with the Eastern Emplacement Area as approved under SSD-4960 Mod 1.

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
ML 1788	Bulga Coal Management Pty Ltd	19 June 2040
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]
EL 8315	Saxonvale Coal Pty Ltd	13 October 2019[1]
AUTH 447	Saxonvale Coal Pty Ltd	2 September 2022
AUTH 450	Saxonvale Coal Pty Ltd	30 December 2018[1]

3.2.1 Mining Operations Plan Status

Bulga Coal operated in accordance with the following approved Mining Operations Plans (MOPs):

- Bulga Open Cut MOP which covers the period from 29 May 2018 to December 2023; and
- Bulga Underground Operations MOP which covers the period from 29 May 2018 to December 2023.

On 7 August 2019, a minor amendment to the Bulga Open Cut MOP (Amendment A) was approved by the Department of Planning, Industry, and Environment - Resources Regulator (DPIE-RR). MOP Amendment A was prepared to reflect the construction of the eastern portion of the Eastern Emplacement Area overburden dump. It included updates to MOP Plans and rehabilitation and disturbance rates only.

An additional amendment to the Bulga Open Cut MOP (Amendment B) was submitted to DPIE-RR for approval on 13 December 2019 to incorporate changes to the Eastern Emplacement Area overburden emplacement within the approved ML 1788. This was approved on 7 February 2020.

On 5 November 2019, an amendment was sought for the Bulga Underground MOP to allow for the drilling of an additional three boreholes.

3.2.2 Subsidence Management Plan Status

No coal extraction by Bulga Underground Operations was undertaken during 2019. There were no changes to any Subsidence Management Plans (SMPs).

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 the Singleton Council.

Environment Protection Licence (EPL) 563 was varied in April, July and December 2019.

The EPL was varied by the EPA in April 2019 to include reference to 'Hunter River Salinity Trading Scheme (HRSTS) Discharge Point Telemetry Specification'.

The July variation included:

- Changing the premises boundary to include ML 1788;
- Replacement of e-sampler type PM_{10} air quality monitors at EPA Points 9 and 10 with E-BAM type air quality monitors; and
- Removal of the Bulga Underground sewage treatment plant.

The December variation included:

- Adding meteorological monitoring, ambient water quality monitoring, and continuous monitoring of turbidity as Nephelometric Turbidity Units (NTU) (at the HRSTS discharge points) to the licence;
- Adding a condition requiring all contraventions of condition L1 (pollution of waters) to be notified;
- Adding waste to be bought onto the premises under Resource Recovery Exemptions (Plasterboard, Green Waste and Compost) for the purpose of rehabilitation;
- Adding a revised dust condition to require that all activities on operations are carried out in a competent manner to minimise dust from the premises;
- Added mine water discharge to Mount Thorley Mine; and
- Small administrative changes.

Table 7 Bulga Coal Licences

Licence	Details
Environmental Protection Licence (EPL)	
EPL 563	For scheduled activities: Coal works > 5000000T annual handling capacity; Crushing, grinding or separating >100000-500000T annual processing capacity; and Mining for coal >5000 000T annual production capacity. Anniversary Date: 20 July.
Water Licences	
WAL41687	Mining: Volume licence limit 500ML. Sydney Basin-North Coast Groundwater Source
WAL41546	Mining: Volume licence limit 365ML. Sydney Basin-North Coast Groundwater Source
WAL41543	Mining: Beltana MG4. Volume licence limit 500ML. Sydney Basin-North Coast Groundwater Source

Licence	Details
WAL41544	Mining: South Bulga MGE1. Volume licence limit 500ML. Sydney Basin-North Coast Groundwater Source
WAL41545	Mining: South Bulga MGE4. Volume licence limit 500ML. Sydney Basin-North Coast Groundwater Source
WAL36221	Mining: Wollombi Brook Aquifer leakage to Permian coal measures 300 ML
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.
20BL169204	Monitoring: Bore – ACARP Project.
20BL169246	Monitoring: Bore – ACARP Project.
20BL169510	Monitoring: WBR50 WBR50A, WBD55, WBD55A, WBD 57, WBD57A, WBD62, WBD62A, WBR15.
20BL172659	Monitoring: WBR180 and WBR181.
20BL172660	Monitoring: WBR182 and WBR183.
20BL173014	Monitoring: SBD194, SBD196
20BL173617	Monitoring: Lot 61/755264
20BL173618	Monitoring: Lot 34/755264
20BL173619	Monitoring: Lot 33/755264
20BL173620	Monitoring: Lot 23/755264
20BL173621	Monitoring: Lot 24/755264
Radiation/Dangerous Goods Licences	
Radiation Management Licence 5061333	Serial No: 6230GK – Fixed Radiation Gauge ID No 8929 Serial No: 4421GK – Fixed Radiation Gauge ID No 8934 Serial No: 4412GK – Fixed Radiation Gauge ID No 8935 Serial No: 4376GK – Fixed Radiation Gauge ID No 8938 Serial No: 6218GK – Fixed Radiation Gauge ID No 8939 Serial No: OC519 – Fixed Radiation Gauge ID No 9581 Serial No: 0532/06 – Fixed Radiation Gauge ID No 9582 Serial No: 0528/07 – Fixed Radiation Gauge ID No 9583 Serial No: 0538/07 – Fixed Radiation Gauge ID No 9584 Serial No: 0539/07 – Fixed Radiation Gauge ID No 9585
NDG018992	Hazardous Chemicals Notification for the storage and handling of hazardous chemicals.
XSTR100095	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. The access agreement was extended in 2019 to allow the completion of any remaining subsidence repairs and an opportunity to monitor them after substantial rain events.

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 800 full time equivalent personnel.

4.1.2 Exploration

A total of five exploration holes were drilled in 2019:

- EBR091, EBR092 and EBR093 were drilled to define a large normal fault in the East Pit;
- EBR094 was drilled for the installation of a piezometer to monitor depressurisation of the footwall; and;
- EBR095 was drilled to define the change of grade at depth along the Life of Mine (LOM) pit shell.

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

4.1.3 Land Preparation

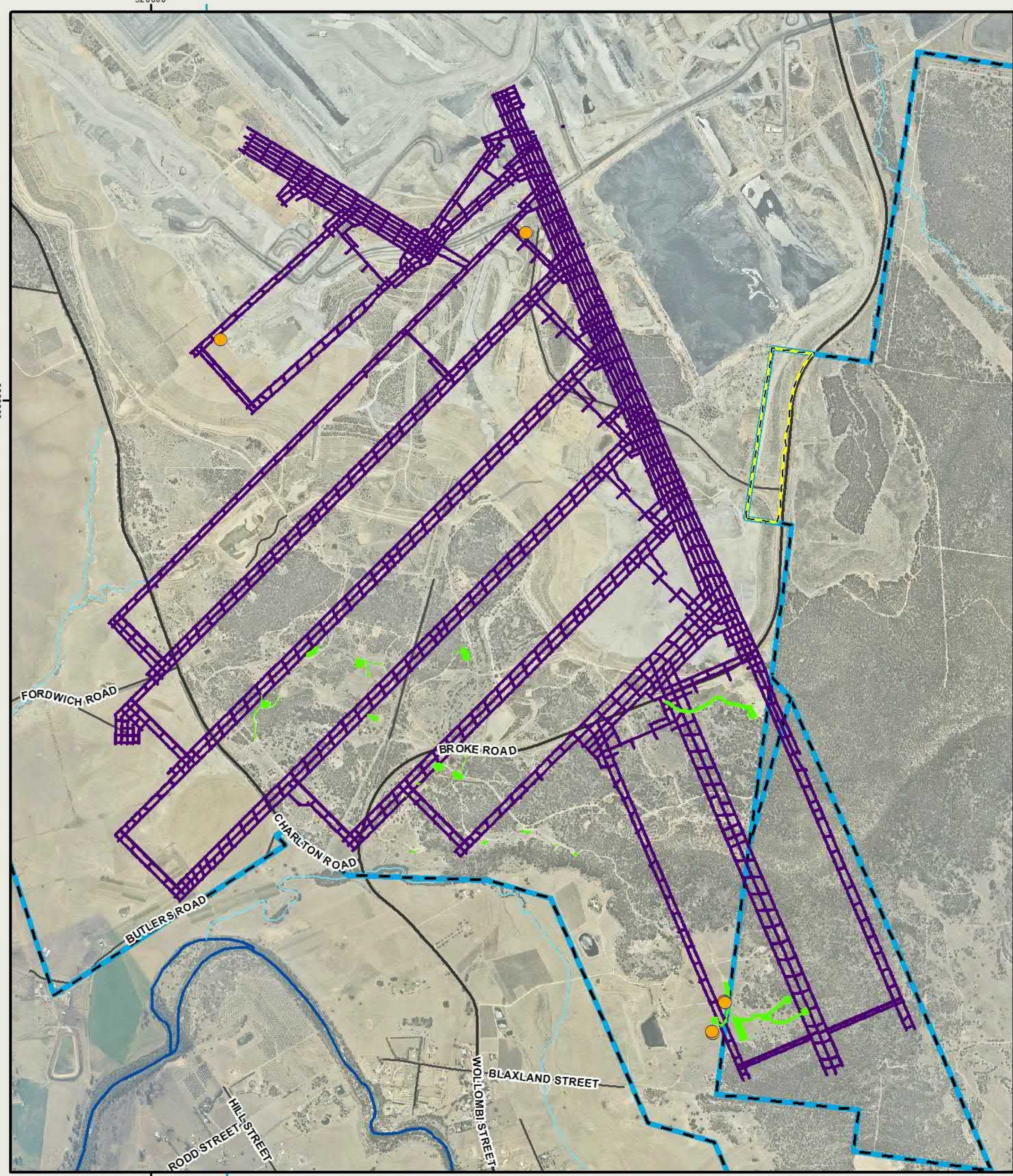
Land preparation ahead of open cut mining operations involves the construction of erosion and sediment control measures, clearing vegetation and stripping and stockpiling topsoil. These activities were undertaken in accordance with the Bulga Coal Biodiversity Management Plan.

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 2019, approximately 60,000 m^3 of topsoil was stripped and 59 habitat trees were salvaged by Bulga Coal.

During 2019, 64.0 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**.

FIGURE 2 - BULGA UNDERGROUND SUMMARY OF OPERATIONS 2019



- Blakefield South Mine Workings
- Decomissioned Boreholes
- 2019 Rehabilitation & Maintenance
- Mining Lease
- Mining Lease AMA
- Major road
- Minor road
- Wollombi Brook
- Minor Watercourse

0 0.225 0.45 0.9
Kilometres

Coordinate System
GDA 1994 MGA Zone 56
1:30,000 @ A4

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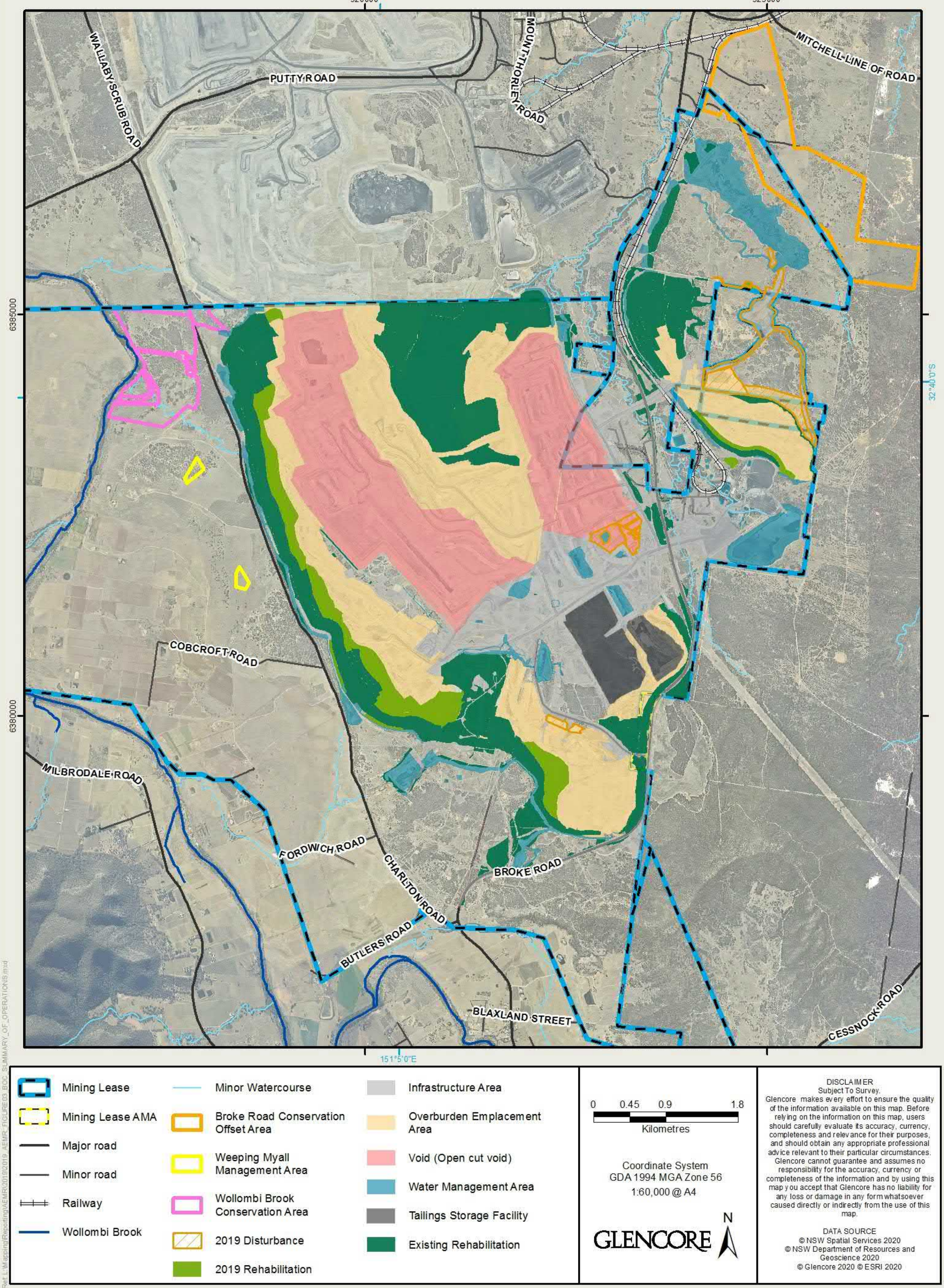
FIGURE 3 - BULGA OPEN CUT SUMMARY OF OPERATIONS 2019



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Ref: L:\Mapping\Reporting\AEMR\2019\2019_AEMR_FIGURE03_BOC_SUMMARY_OF_OPERATIONS.mxd

4.1.4 Mining Operations

Bulga Underground Operations

Bulga Underground Operations comprises the Blakefield South Mine, along with the approved, but not commenced, Blakefield North Mine.

Mining of Blakefield South Longwall 1B was completed on 3 May 2018, following which underground mining at Bulga Underground Operations ceased and the mine was 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.

Bulga Underground finished producing coal in May 2018. Therefore, no ROM coal, saleable coal or reject material was produced by Bulga Underground during the reporting period.

Bulga Open Cut

Bulga Open Cut continued mining coal reserves from the Main Pit and East Pit. Mining commenced in the Woodlands Hill Pit.

In the Main Pit mining progressed in a westerly direction. Overburden was placed mainly in the Noise and Visual Bund and the Eastern Emplacement Area.

Mining in the East Pit and Woodlands Hill Pit progressed to the south. Overburden from the East and Woodlands Hill Pits was stripped using a dragline and a truck/shovel fleet and mostly placed in the Eastern Emplacement Area dump, with some overburden placed in the Noise and Visual Bund.

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 or stockpile at the CHPP.

The total mining fleet as at 31 December 2019 is listed in **Table 8**.

Table 8 Equipment 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
	Liebherr EX9400	1
	Liebherr EX9250	1
	Liebherr EX9100	2
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 777F Hire Water Cart	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 854K	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 and reject) production for the Bulga Open Cut is provided in **Table 9**.

Table 9 Production and Waste Summary for the Bulga Open Cut

Aspect	Approved Limit SSD - 4960	2018 Reporting Period (Actual)	2019 Reporting Period (Actual)	2019 MOP Predictions	2020 Reporting Period (Forecast)
Waste Rock/ Overburden (bcm)	N/A	51,647,323	64,357,000	52,150,000	59,400,000
ROM Coal (t)	12,200,000	12,092,025	12,200,000	9,788,000	10,439,000
Coarse reject (t)	N/A	3,491,001	3,391,551	3,488,0001	3,670,000
Fine Reject (tailings) (t)	N/A	1,294,685	1,065,844		
Saleable Product (t)	N/A	8,098,781	8,461,000	6,386,000	6,745,000

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

Limited wet weather impact throughout the year enabled Bulga Coal to produce more than was forecast.

4.2 Other Operations

4.2.1 Coal Handling and Preparation Plant

12.2 million tonnes (Mt) of Run of Mine (ROM) coal was washed, producing 8.5 Mt of saleable product coal. The CHPP has approval to wash up to 20 Mt of ROM coal per year. 8.4 Mt of coal was railed to the Port of Newcastle.

4.2.2 Tailings Management

Deposition of tailings to the North Pit Tailings Storage Facility (NPTSF) commenced on 21 January 2019. Most tailings were pumped to the NPTSF with small quantities deposited in the Deep Pit.

4.2.3 Construction

Bulga Coal construction works included:

- Dirty water drains and dams and clean water diversion drains around the south of the Eastern Emplacement Area;
- New stores shed;
- Refurbishment of stores offices;
- Upgrade of area station fire system to achieve compliance with Building Code of Australia (BCA);
- Installation of fire system at the East Pit muster to achieve compliance with BCA;
- Upgrade of the main workshop fire system to achieve compliance with BCA;
- A concrete bund around the transformer at the area station; and

- Work commenced on a dewatering bore and pipeline to make more effective use of the water stored in the Bulga Underground Operations workings.

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

- Construction of a new CHPP bath house for employee use;
- Construction of a new Raw Coal Sampler in September / October 2019;
- Construction of a Cross Belt Sampler on CV2106 with cone crusher into rotating canister collection drums;
- Relocation and rehabilitation of CHPP spares area to a newly constructed storage yard adjacent to the clean coal stockpile. This project also included the relocation of Lighting Tower 20 to be within the new storage yard;
- Construction of dirty water dam at the rear of the Train Load-out Facility;

4.2.4 Demolition

Following the cessation of underground mining in May 2018, Bulga Underground Operations infrastructure has continued to be demolished/decommissioned including:

- Clean-up of the equipment laydown areas adjacent to the workshop and flares;
- Removal of redundant gas drainage pipelines;
- Commencement of removal of subsidence survey pegs; and
- Decommissioning of 5 gas wells and 1 inclinometer

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

4.2.5 Waste Management

Waste management is undertaken in accordance with the *Bulga 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.

78.5% of the waste produced by Bulga Open Cut (3,215 t) and 87% of the waste at Bulga Underground Operations (732 t) was recycled. 577 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.

4.2.6 Hazardous Materials Management

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

Hazardous materials stored at Bulga Open Cut have been notified to WorkCover NSW. Notification of Hazardous Chemicals on Premises (Acknowledgement NDG018992) has been issued by WorkCover NSW.

Disposal of hazardous waste requires waste tracking, transport by a licenced waste transporter and disposal at a licenced facility.

Explosives are stored in a licenced explosive magazine according to WorkCover NSW requirements. Bulga Coal hold Licence No. XSTR100095 for the storage of explosives at Bulga Open Cut.

4.3 Next Reporting Period

4.3.1 Bulga Underground Operations

Activities proposed in 2020 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 2020 are generally consistent with SSD-4960 and the approved Bulga Open Cut MOP Amendment B. **Figure 5** illustrates the proposed operations.

Mining operations will continue in the Main Pit, East Pit and Woodlands Hill Pit. Bulga Open Cut will continue to place overburden on the inside of the Noise and Visual Bund, Eastern Emplacement Area and in-pit dumping in the Main Pit and East Pit.

Construction activities will include:

- Construction of a new water cart fill point at the East Pit;
- Resurfacing and widening of the CHPP access road;
- Construction of new sheds at the main workshop to provide additional useable crane space;
- Construction of a new fuel farm near the area station; and
- Construction of an Aboriginal Teaching and Keeping Place at the Wollombi Brook Conservation Area.

Five boreholes are planned to be drilled in 2020. The exploration drilling will aim to:

- Further define the change of grade at depth along the Life of Mine (LOM) pit shell;
- Continue to drill and install piezometers to monitor the depressurisation of the footwall; and
- Provide additional samples for National Greenhouse and Energy Reporting Scheme (NGERS) gas testing.

FIGURE 4 - BULGA UNDERGROUND PROPOSED OPERATIONS 2020

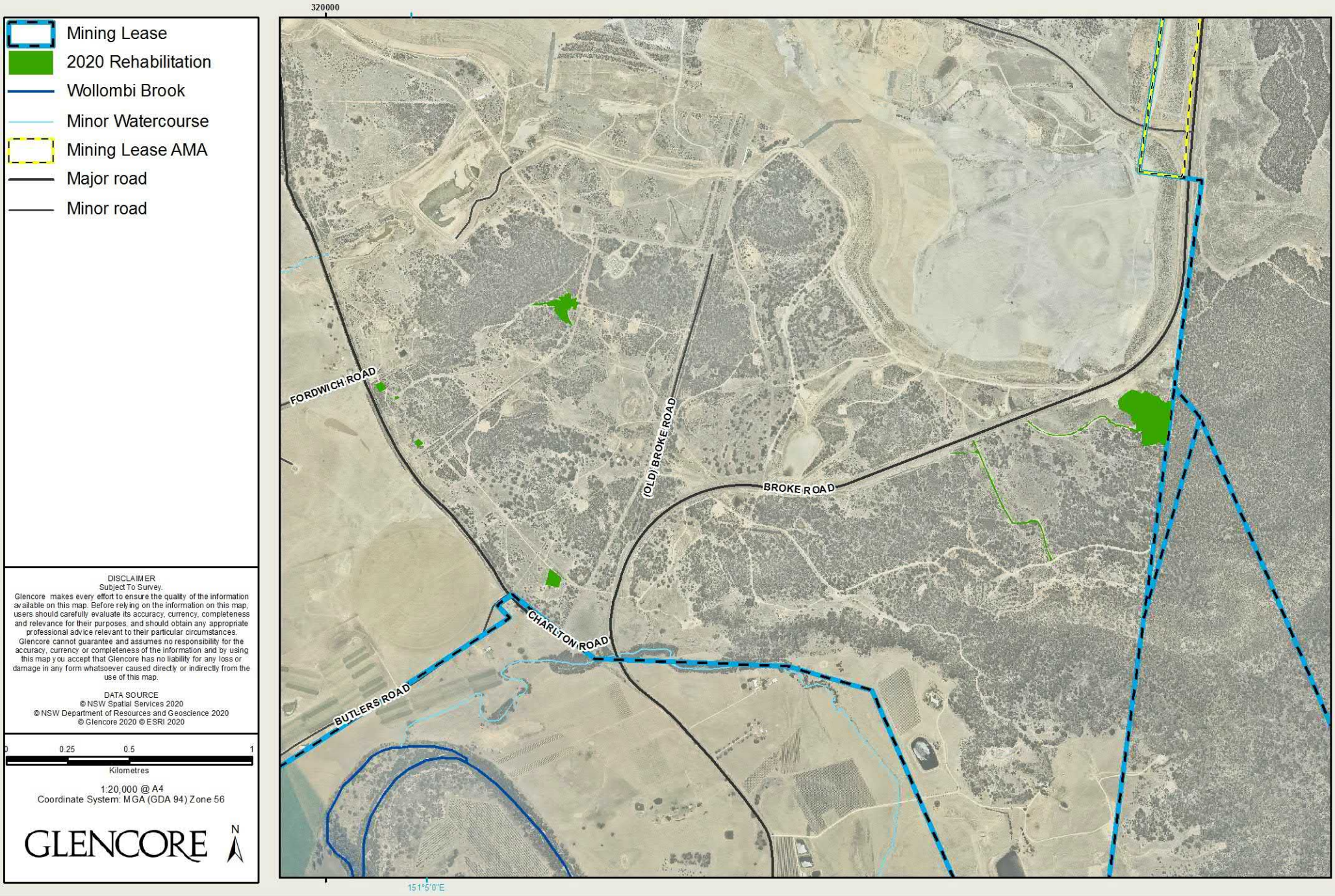
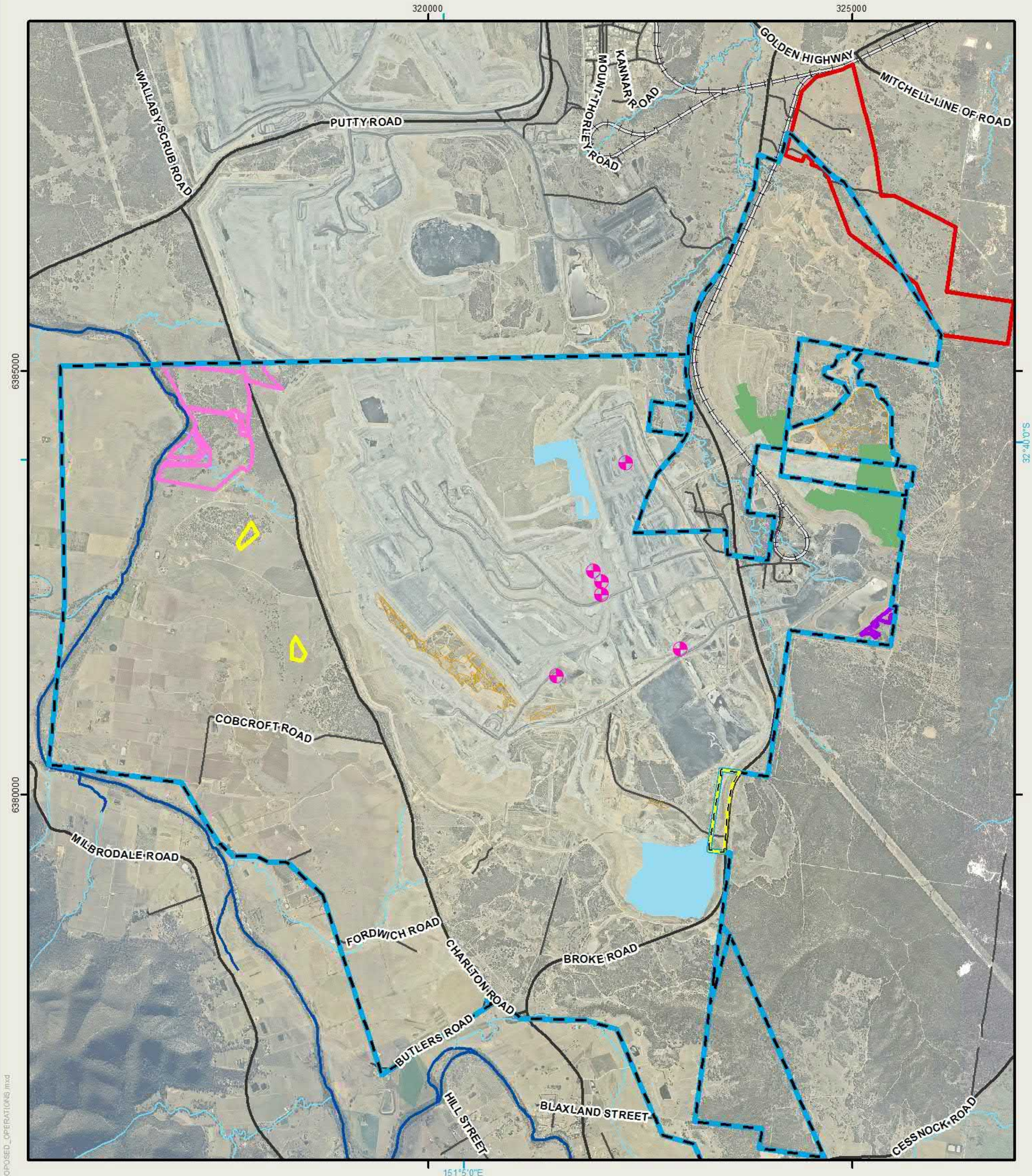


FIGURE 5 - BULGA OPEN CUT PROPOSED OPERATIONS 2020



Mining Lease	Minor Watercourse	2020 Rehabilitation
Mining Lease AMA	Broke Road Conservation Offset Area	2020 Temporary Rehabilitation
Major road	Forest Red Gum Offset Area	2020 Disturbance
Minor road	Weeping Myall Management Area	Exploration Boreholes
Railway	Wollombi Brook Conservation Area	
Wollombi Brook		

0 0.5 1 2
Kilometres

Coordinate System
GDA 1994 MGA Zone 56
1:62,500 @ A4

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5 Actions Required from Previous Annual Review

The 2018 Annual Review was provided to DPIE and DPIE-RR on 29 March 2019. DPIE and DPIE-RR considered the Annual Review to generally meet the requirements of the approval in relation to reporting and the DPIE Annual Review Guideline. No additional actions were required from the 2018 Annual Review, however the DPIE noted that:

> *The Department specifically notes the reported non-compliance in relation to the two aboriginal heritage sites destroyed during ground disturbance works on 6 September 2018. We have consulted with OEH and may provide further correspondence on this matter in due time.*

DPIE carried out an investigation and determined that Bulga Coal had committed an offence against section 4.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) in carrying out development not in accordance with the conditions of SSD-4960. A warning letter was issued for the breach.

6 Environmental Management Performance

Bulga Coal implements a comprehensive *Environmental Management Strategy* (EMS) that provides a framework for managing environmental and community aspects and impacts of mining operations. It 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 13.**

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 AIR, NOISE AND BLAST MONITORING

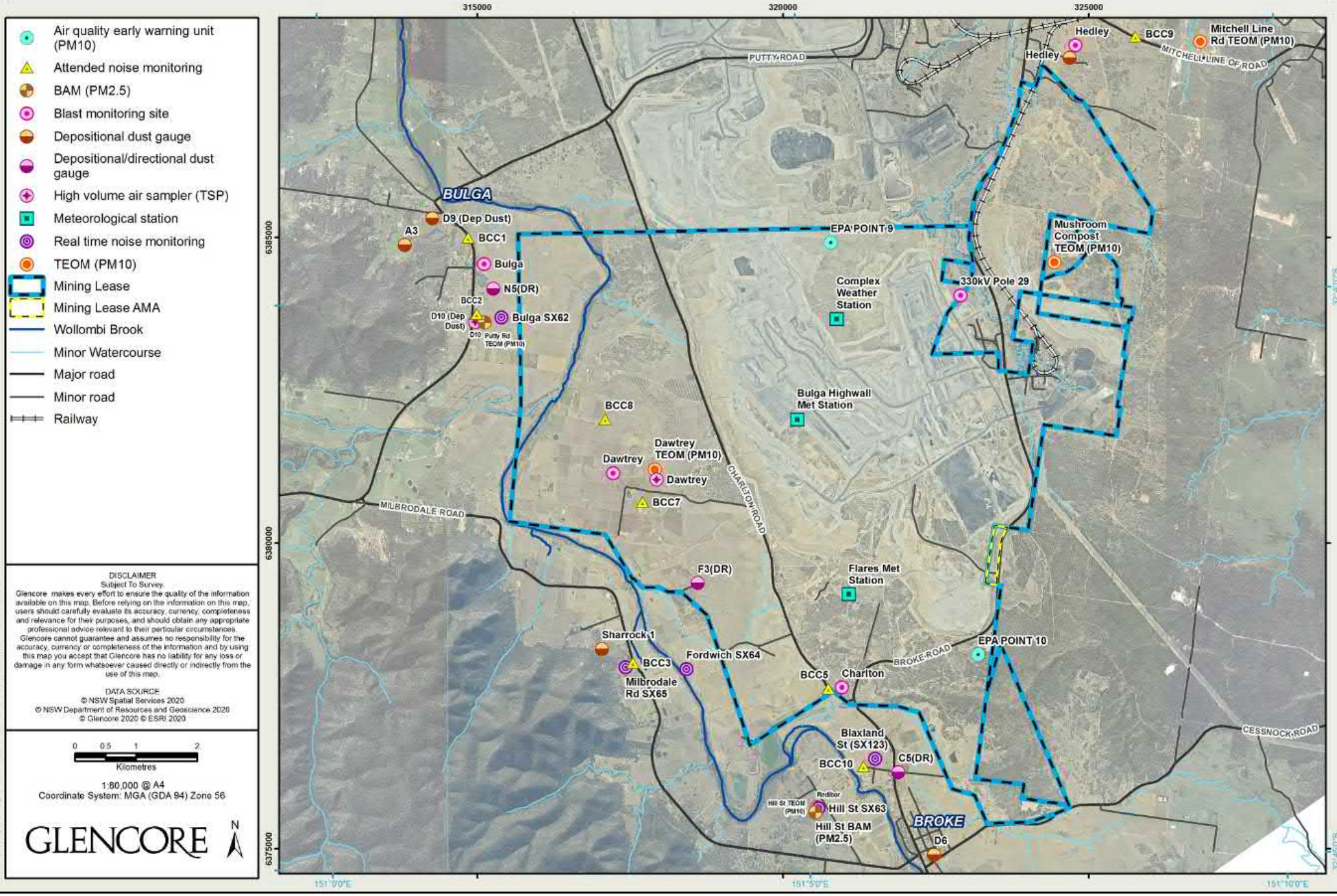
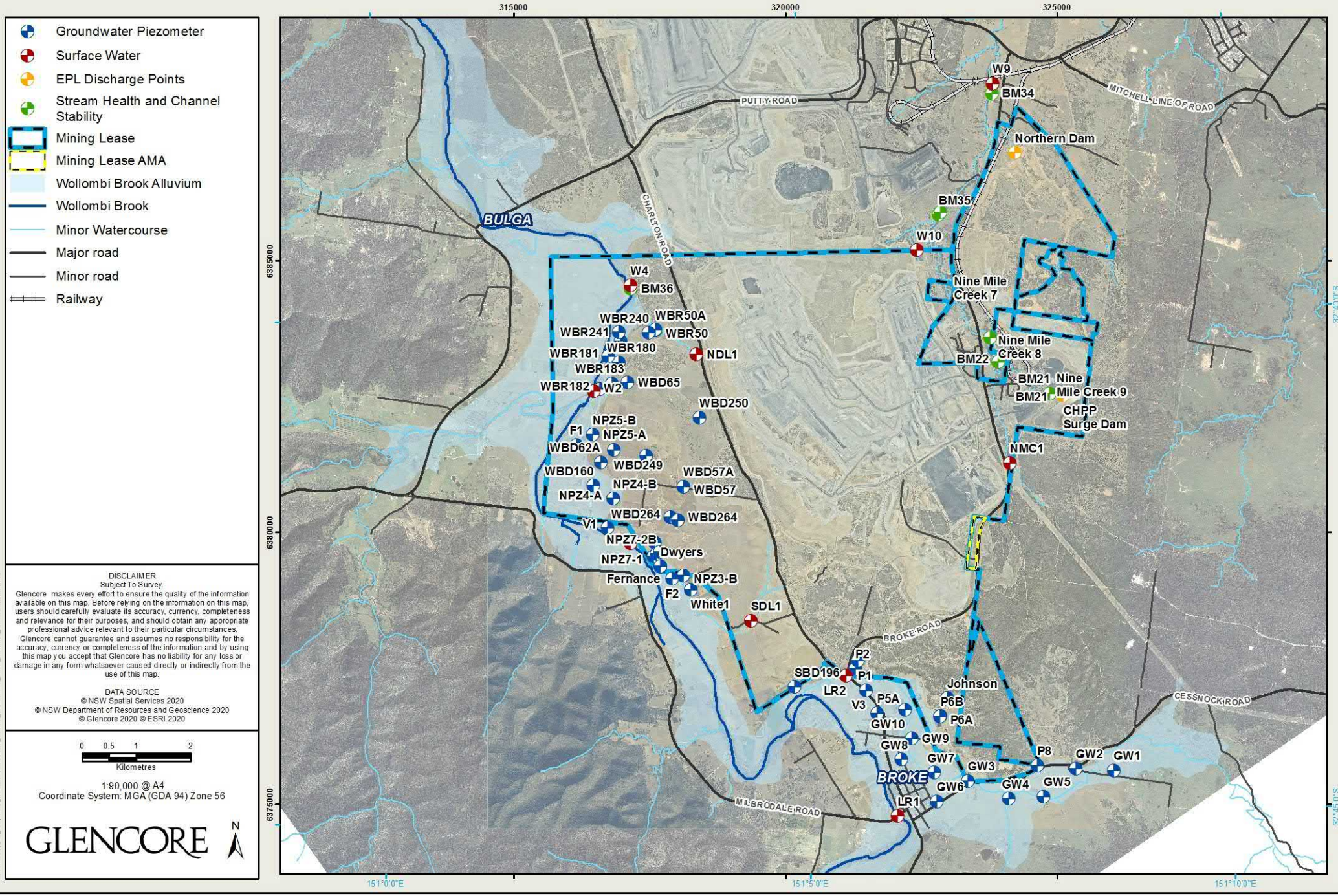


FIGURE 7 - BULGA COAL WATER MONITORING



6.2 Noise

6.2.1 Environmental Management

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

The location of noise 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 involves testing a representative sample of the open cut fleet 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 *Bulga Surface Operations Eastern Emplacement Area Modification Statement of Environmental Effects* (SEE) dated July 2016, including the *Bulga Surface Operations Eastern Emplacement Area Modification Response to Submissions* (RTS) dated December 2016. Individual items that exceed specified levels by 3 dB or more are investigated to assess the cause of the exceedance. Defects are rectified as soon as practicable.

Fleet-wide (logarithmic) averages for each make/model of mobile plant are calculated on a rolling basis at the end of each annual testing campaign using the most recent result available for each item. Fleet averages should remain within 2 dB of the most recent specification for each type of mobile plant.

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 10**. Results are presented as the maximum noise levels from Bulga Coal at each location during 2019. A detailed discussion of monitoring results is provided in Monthly Noise Monitoring Reports available on the Bulga Coal website.

As presented in **Table 10**, Bulga Coal was compliant with noise criteria.

Table 10 Summary of Attended Noise Monitoring Data – 2019

Location	Bulga Coal Noise Monitoring Results - dBA (Max)		Bulga Coal Project Specific Noise Criteria - dBA	
	LAeq(15minute)	LA1(1minute)	LAeq(15minute)	LA1(1minute)
BCC1	<34	44	36	45
BCC2	34	42	36	
BCC3	33	41	35	
BCC4	31	35	35	
BCC5	34	45	36	
BCC7	34	40	36	
BCC8	33	45	36	
BCC9	32	45	37	
BCC10	35	45	35	

Mobile Plant Sound Power Testing

In 2019, sound power testing was undertaken by Global Acoustics (Global Acoustics, 2020). Measurements were taken on 42 individual plant items, or 40% of the entire mobile plant fleet, as listed in **Table 11**.

Table 11 2019 Sound Power Testing

Plant Type	Number of Plant Tested
Dozer (tracked)*	0
Dozer (wheeled)	3
Front end loaders	1
Water carts	1
Fuel / service carts	2
Graders	3
Haul trucks	25
Shovels/excavators	7
Total items	42

* Testing of dozers occurred in 2019, but due to missing data required for composite calculations dozer results have not been included. Additional dozer testing is planned in 2020 to ensure a representative sample is monitored.

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

- One Caterpillar 854K Wheeled Dozer;
- Two Caterpillar 793 Trucks; and
- Three Excavators (Hitachi EX5500, Hitachi EX5600-6 and Hitachi EX8000).

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.

Table 12 shows fleet averages of the most recent annual testing results compared to modelled noise levels. These rolling averages include the most recent testing of mobile plant items, even if testing occurred prior to 2019.

Table 12 Comparison of Measured and Modelled Sound Power Levels

Plant Type	Items Tested	Fleet Average[1] L_W / L_{WA}	Modelled L_W/ L_{WA}	Difference L_W/ L_{WA}
Hitachi EX2500 excavator	3	120/113	124/118	-4/-5
Hitachi EX3600 excavator	2	124/116	124/118	Nil/-2
Hitachi EX5500 excavator	2	130/120	127/120	+3/Nil
Hitachi EX5600 excavator	1	133/120	128/122	+5/-2
Hitachi EX8000 excavator	1	130/116	127/118	+3/-2
Hitachi EX8000 excavator replacement	0	NA	124/118	NA
P&H 4100XPC shovel	1	119/107	123/116	-4/-9
P&H 9020 dragline	1	126/118	125/118	+1/Nil
LeTourneau 1850 front end loader	2	125/120	125/122	Nil/-2
Komatsu WA900 front end loader	0	NA	124/118	NA
CAT 834H rubber tyre dozer4	3	117/111	116/111	+1/Nil
Caterpillar D11 dozer	16	122/117	120/115	+2/+2
Caterpillar D10 dozer	2	122/112	121/114	+1/+2
Caterpillar 789C XQ rear dump truck	9	123/116	121/115	+2/+1
Caterpillar 793D XQ rear dump truck	36	123/116	121/115	+2/+1
Caterpillar 797F XQ rear dump truck	7	124/116	124/117	Nil/-1
Caterpillar 789C XQ water truck	4	121/115	121/115	Nil/Nil
Caterpillar 16H/16M grader	2	113/108	114/108	-1/Nil
Caterpillar 24H/24M grader	3	116/110	117/110	-1/Nil
Terex SKSw75 drill5	5	125/116	125/118	Nil/-2

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

Table 12 shows average sound power levels measured across the fleet were no greater than 2 dB above modelled sound power levels for each make/model of mobile plant on site, with the exception of the Hitachi EX5500, EX5600, and EX8000 excavators. These excavators will be inspected in 2020 and defects fixed, where required.

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.

As noted in **Section 6.2.2**, attended monitoring results in 2019 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

Table 13 shows the number of noise criteria exceedances recorded by Bulga Coal during the period 2011 to 2019.

Table 13 Summary of Exceedances by Noise Monitoring Location 2011 – 2018

Location	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
BCC1	0	1	0	0	0	0	0	0	0	1
BCC2	0	0	0	0	0	0	0	0	0	0
BCC3	0	0	0	0	0	0	0	1	0	1
BCC4	0	0	0	0	0	0	0	1	0	1
BCC5	0	0	0	0	1	0	1	2	0	4
BCC6	0	0	0	0	0	1	0	-[1]	-[1]	1
BCC7	0	1	0	0	0	4	0	1	0	6
BCC8	0	0	0	0	0	0	0	0	0	0
BCC9	-1	-1	-1	-1	-1	-1	0	0	0	0
BCC10	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	1	0	1
Total	**0**	**2**	**0**	**0**	**1**	**5**	**1**	**6**	**0**	**15**

1 – Noise levels not monitored at this location.

As indicated in **Table 13**, occasional exceedances of the Bulga Coal noise criteria have been recorded during the period from 2011 to 2018. With the exception of four exceedances at BCC7 during 2016 no more than two exceedances have been measured annually at any location. These exceedances were likely to have occurred during the construction of the Noise and Visual Bund when equipment was operating in exposed locations on the outer face in closest proximity to BCC7.

No exceedances were recorded during 2019, indicating that noise levels have decreased, coinciding with the completion of the Noise and Visual Bund.

6.2.5 Implemented / Proposed Improvements

The *Noise Management Plan* was revised and approved by DPIE on 24 June 2019. The revised *Noise Management Plan* was implemented during 2019 and included these improvements:

- Removal of references to Bulga Underground which is no longer operational;
- Inclusion of the process used to measure low frequency noise; and
- Revision of the Noise Management Trigger Action Response Procedure to cease noise alarms (from the Hill Street and Blaxland Street) from the real time monitors at 7:00 am and recommence at 7:00 pm. This change was made based on the difficulty in quantifying the mine only contribution over this period considering the frequent occurrence of other noise sources (traffic, wildlife, farm machinery, wind etc).

6.3 Blasting

6.3.1 Environmental Management

Blasting is undertaken in accordance with the *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 14**. The criteria apply at the compliance monitoring locations (Dawtrey, Bulga, Charlton and Hedley) shown on **Figure 6**.

Table 14 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 15**. 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 15 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 16.** The Bulga, Charlton and Dawtrey blast monitors shown in **Figure 6** are used to assess compliance.

Table 16 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

165 blasts from Bulga Open Cut were monitored during 2019. Monitoring data is available on the Bulga Coal website, with a summary provided in **Table 17** and **Table 18.** No exceedances were recorded.

Table 17 2019 Private Property Overpressure and Vibration Monitoring Results

Monitoring Location	Airblast Overpressure Level dBL (Lin Peak)				Ground Vibration ppv (mm/s)			
	Average	Max	Results >115 dBL	Results >120 dBL	Average	Max	Results >10 mm/s	Results >5 mm/s
Bulga	94.1	114.5	0 (0%)	0 (0%)	0.2	2.5	0 (0%)	0 (0%)
Charlton	90.0	108.3	0 (0%)	0 (0%)	0.3	1.6	0 (0%)	0 (0%)
Dawtrey	92.8	114.5	0 (0%)	0 (0%)	0.3	2.1	0 (0%)	0 (0%)
Hedley	92.8	112.9	0 (0%)	0 (0%)	0.1	2.0	0 (0%)	0 (0%)

Table 18 2019 Infrastructure Vibration Monitoring Results

Monitoring Location	Ground Vibration ppv (mm/s)		
	Average	Max	Results > 100 mm/s
330 kV Pole 29	1.3	47.8	0 (0%)

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. The results are consistent with predictions.

6.3.4 Implemented / Proposed Improvements

The *Blast Management Plan* was revised in 2018 and approved by DPIE on 19 March 2019. The revision includes an improved pre-blast assessment process that considers dust and fume risk, and air quality measured by the Mount Thorley and Bulga Upper Hunter air quality monitors, prior to firing.

During 2019, the reintroduction of ANFO explosives with plastic liners in dry blast holes was trialled. The justification for the trial was to reduce the likelihood of generating fume when blasting in weathered zones.

6.4 Air Quality

6.4.1 Environmental Management

Bulga Coal implements controls to mitigate air quality impacts in accordance with the *Air Quality Management Plan* and the *Eastern Emplacement Area Air Quality Management Framework* (EEAAQMF). Bulga Coal 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 (DDGs) (three of which are directional) used for monitoring of larger dust particles (typically >50 micrometres [µm]). DDGs 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 10µm 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 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 2.5µm in diameter ($PM_{2.5}$); and

- Air quality monitors required by EPL 563:
  - Two E-BAM monitors (which replaced the former E-SAMPLER in July 2019) continuously measuring PM_{10}, at EPA Point 9 and EPA Point 10 at the north and south-east of the EPL premises, respectively.

6.4.2 Environmental Performance

The environmental performance presented below includes the data from the Bulga Complex monitors including HVAS, TEOMs, E-BAMs, E-SAMPLER and DDGs.

Schedule 3 Condition 16 of SSD-4960 notes that the long term and short-term criteria for particulate matter exclude extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed to by the Secretary.

In 2019, there were 66 days declared as "extraordinary air quality events" by DPIE. The predominant cause of these extraordinary events was smoke associated with the 2019/2020 bushfires. In addition, drought conditions contributed to the high dust levels in the vicinity of Bulga Open Cut.

Table 19 presents a list of the extraordinary event days in 2019. The summary presented in this Annual Review considers the annual averages excluding these extraordinary event days declared by DPIE.

Table 19 Declared Extraordinary Event Days in 2019

Month	Extraordinary Days
January	16, 17
February	13, 19
March	6, 31
April	26
May	-
June	-
July	-
August	8, 9
September	6
October	7, 8, 18, 19, 24, 25, 26, 27, 28, 29, 30
November	1, 2, 7, 8, 12, 16, 17, 19, 20, 21, 22, 23, 26, 27, 28, 29, 30
December	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 27, 28, 29, 30, 31

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 – 2019 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	1.6	4.0
C5	Mount Eyre Vineyard	1.5	1.1	
D6	Howe Street	2.0	1.4	
D9	Inlet Road	2.3	1.6	
D10	Putty Road	2.0	1.4	
F3	Fordwich	2.3	1.6	
N5	Putty Road	2.4	1.8	
Redibar	Redibar	1.7	1.1	
Sharrock 1	Sharrock	1.3	0.8	
Hedley	Mitchell Line Road	1.9	1.4	

There were no exceedances of the depositional dust criteria during 2019. Todoroski (2020) noted that there was an increase in the monthly deposited dust levels at the end of 2019, likely due to the impact of bushfires; however, this did not appear to have a significant impact on the overall 2019 annual average deposited dust levels.

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.

Annual average PM_{10} and TSP concentrations were below the relevant criteria at all locations in 2019.

Table 21 Summary of High Volume Air Sampling Results – 2019 Annual Average

Gauge	Annual Average ($\mu g/m^3$) (excluding extraordinary events)	
	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)
Consent Criteria	**30**	**90**
Dawtrey	15.5	37.5
D10	17.0	46.3
Hill Street	-[1]	30.7

1 – PM_{10} not monitored at Hill Street

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.

As presented in **Table 22**, there was only one exceedance of the maximum 24 hour average PM_{10} criteria of 50 µg/m^{3}at D10 which occurred on a day not considered to be an extraordinary event. Investigations were undertaken following every measured exceedance of the 24-hour average PM_{10} criterion (refer **Table 25**). This exceedance was determined to be a result of bushfire smoke.

Table 22 Summary of High Volume Air Sampling Results – 2019 Maximum 24 Hour Average and Number of Exceedance

Gauge	Maximum 24 hour average PM_{10} (µg/m^3) (excluding extraordinary events)	
	PM_{10} (µg/m^3)	Number of days exceeding criterion
Consent Criteria	**50**	-
Dawtrey	49	0
D10	**53**	1

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 shows when extraordinary events are excluded there were no exceedances of the annual average PM_{10} or $PM_{2.5}$ criteria.

Table 23 Summary of TEOM and BAM Monitoring Results – 2019 Annual Average

Gauge	Type	Annual Average (µg/m^3) (excluding extraordinary events)	
		PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
Consent Criteria or Standard		**30**	**8**[1]
Hill Street (D1)	TEOM	14.7	-
Putty Road (D3)		19.0	-
Dawtrey (D5)		17.1	-
Mitchell Line Road (D11)		22.2	-
Hill Street (D2)	BAM	-	5.1
Putty Road (D10)		-	6.7

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

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

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 µg/m^3.

Investigations were undertaken following every measured exceedance of the 24-hour average PM_{10} criterion (refer **Table 25**).

Table 24 Summary of TEOM PM_{10} Results – 2019 Maximum 24 Hour Average and Number of Exceedances

Monitor	Maximum 24 hour average PM_{10} (µg/m³) (excluding extraordinary events)	
	PM_{10} (µg/m³)	Number of days exceeding criterion
Consent Criteria	**50**	-
Hill Street (D1)	37.9	0
Putty Road (D3)	**60.4**	3
Dawtrey (Cobcroft Road) (D5)	47.2	0
Mitchell Line Road (D11)	**53.8**	4

Investigation of Elevated 24-hour Average Particulate Days

The elevated days in 2019 (excluding extraordinary events) were investigated to determine the likely cause of the elevated level. The likely primary cause of each elevated day was determined in individual investigation reports and are summarised in **Table 25**.

Table 25 Summary of elevated particulate days (excluding extraordinary events)

Date	Monitors above 24-hour Criteria	Primary Cause of Elevated Levels
5/02/2019	D3	Local cattle
10/02/2019	D3, D11	Regional dust event
8/04/2019	D11	Cause unknown
9/04/2019	D11	Cause unknown
29/04/2019	D11	Local source
22/07/2019	D3	Local rehabilitation activities
29/10/2019	D2, D10, D10 HVAS	Bushfire smoke

Onsite EPL Monitors

In accordance with the requirements of EPL 563, Bulga Coal operated two continuous air quality (PM_{10}) and weather monitoring units close to the EPL premises boundary. On 26 July 2019, EPL 563 was varied to change the monitor type from E-SAMPLERs to E-BAMs. It is noted that both the E-SAMPLERs and E-BAMs were operated for the whole of 2019.

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. **Figure 10** and **Figure 11** present the pollution roses for EPA Point 9 and EPA Point 10 E-BAM monitors, respectively. The figures show that EPA Point 9 and EPA Point 10 measured low PM_{10} levels most of the time. High levels occur in all directions at all monitors. While many of these likely arise from regional dust events and bushfires, the figures do also generally show that there is a moderate effect on dust levels from the direction of Bulga Open Cut. It is noted that the data presented in the pollution roses include background dust and contributions from other sources.

Figure 8 2019 Pollution rose[1] for EPA Point 9 (D7 in Todoroski Air Sciences (2020)) E-SAMPLER PM_{10} data

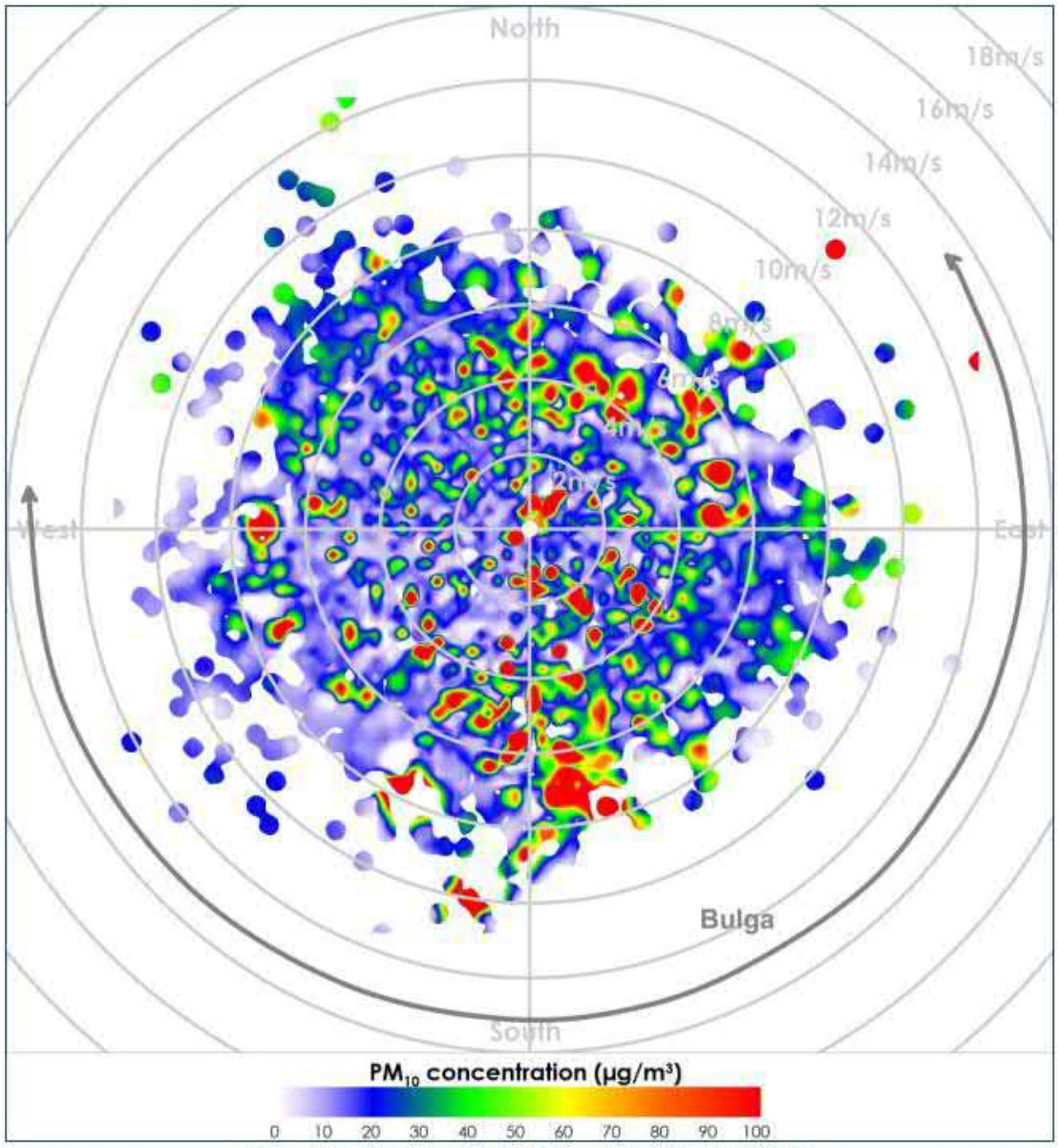


Figure 6-8: Pollution rose for D7 e-sampler PM_{10} data (2019)

[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 2019 Pollution rose[2] for EPA Point 10 (D6 in Todoroski Air Sciences (2020)) E-SAMPLER PM_{10} data

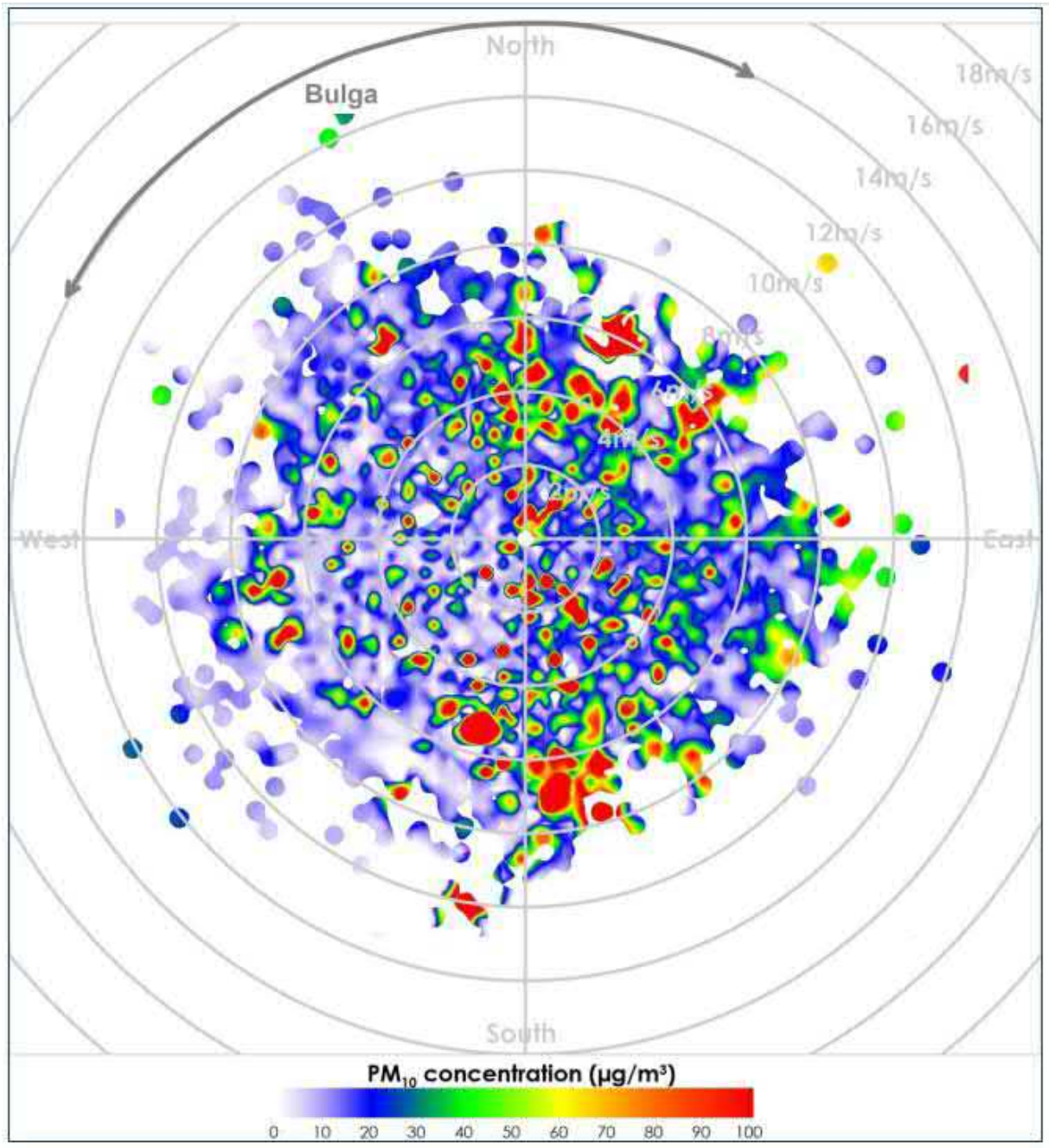


Figure 6-7: Pollution rose for D6 e-sampler PM_{10} data (2019)

[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.

Figure 10 2019 Pollution Rose[3] for E-Bam 8 PM_{10} Data (Todoroski Air Sciences (2020))

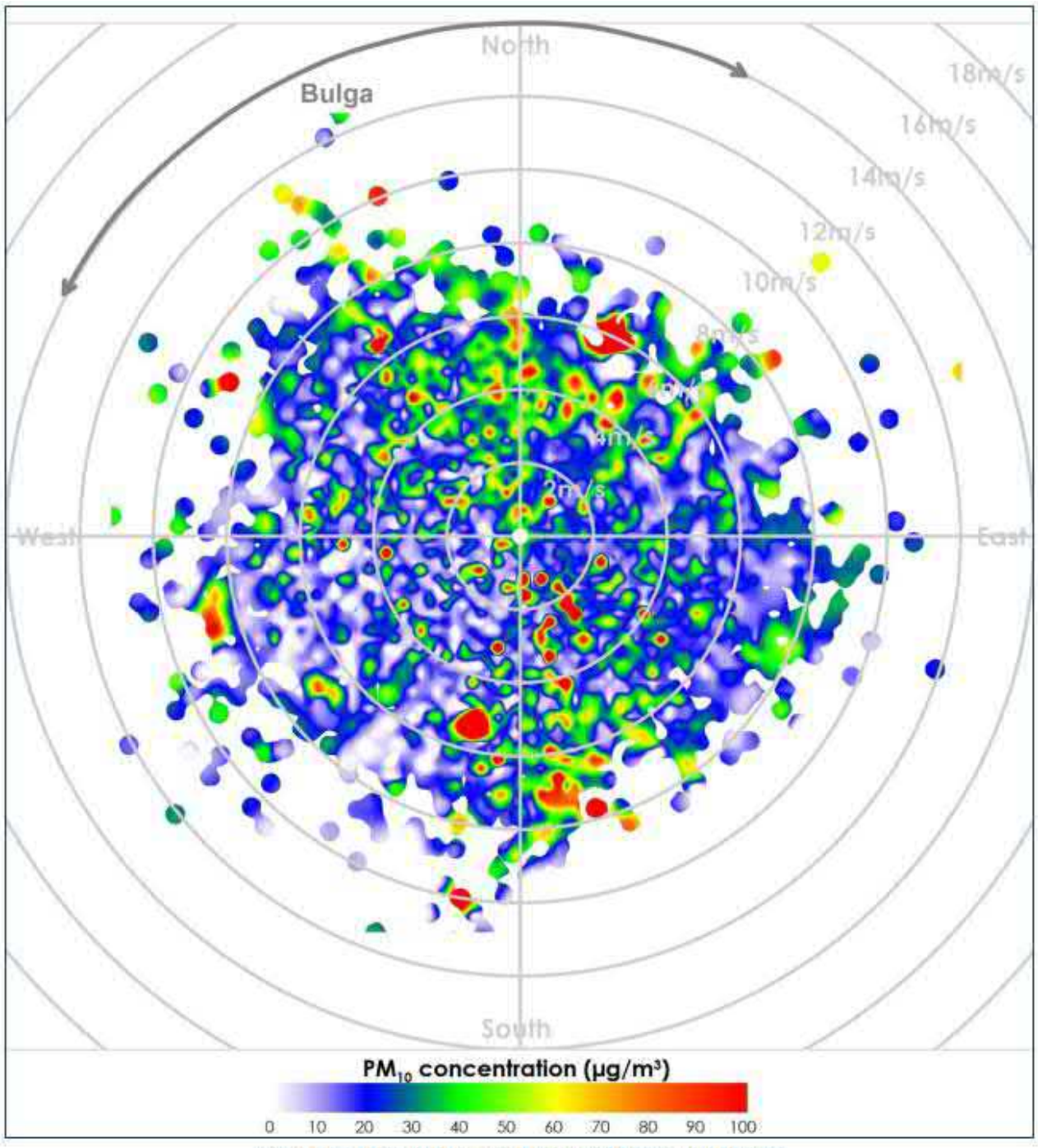


Figure 6-9: Pollution rose for D8 E-BAM PM_{10} data (2019)

[3] 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 11 2019 Pollution Rose[4] for E-Bam 9 PM10 Data (Todoroski Air Sciences (2020))

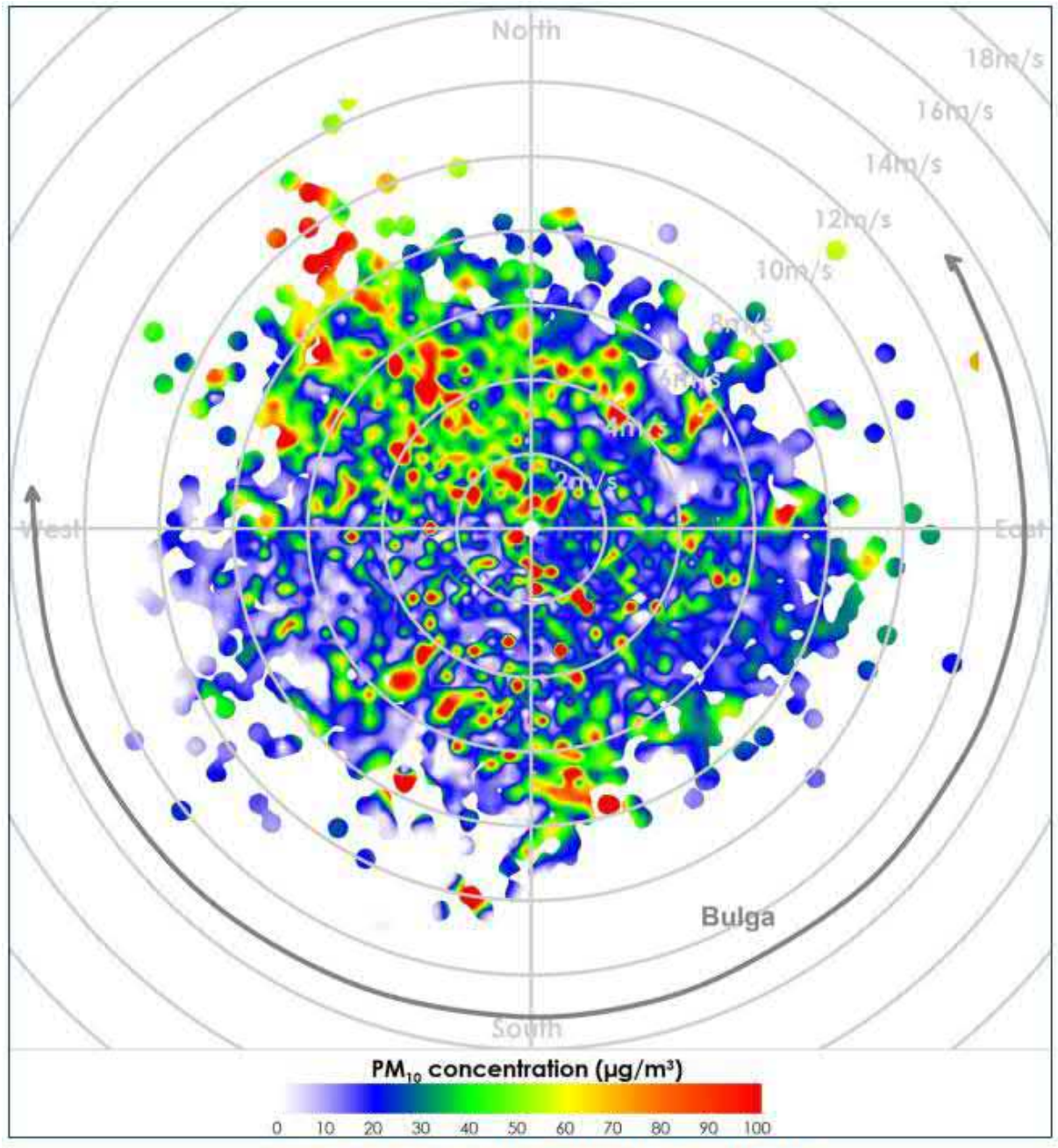


Figure 6-10: Pollution rose for D9 E-BAM PM_{10} data (2019)

[4] 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 12 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.

As shown in **Figure 12**, there were 32 occasions where levels exceeded the assessment level of 91 µg/m3 and triggered the EEAAQMF TARP. These were investigated. **Table 26** presents a summary of the identified exceedance days and the identified causes of each exceedance. Only the exceedance on 27 May 2019 occurred on a day which was not declared as an extraordinary event day by DPIE (refer **Table 19**).

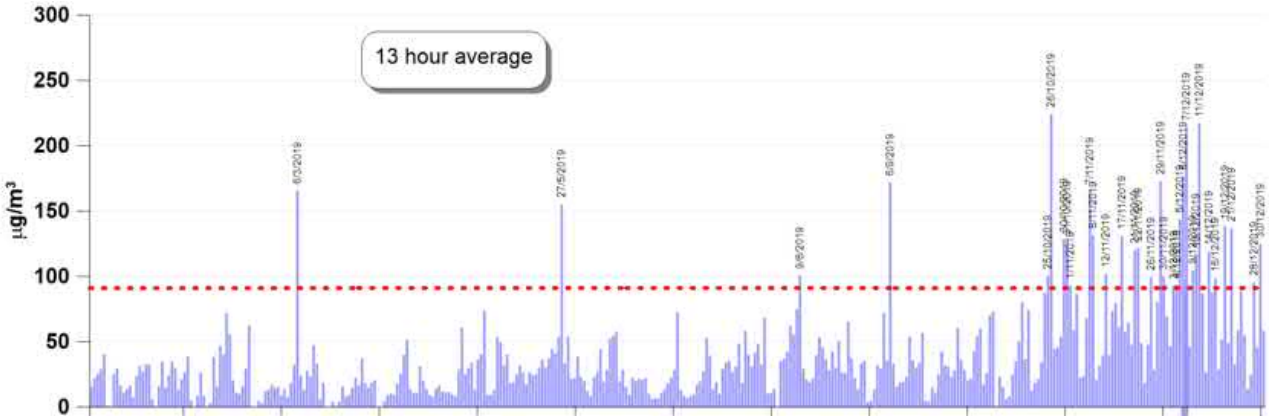


Figure 12 Mushroom Composting Facility (D4) Sampling Results 2019 – 13-hour PM_{10} Averages

Table 26 Eastern Emplacement Area Exceedance Summary

Exceedance date	Cause/s
6/03/2019	Extraordinary event*
27/05/2019	Regional dust event
9/08/2019	Extraordinary event*
6/09/2019	Extraordinary event*
25/10/2019	Extraordinary event*
26/10/2019	Extraordinary event*
30/10/2019	Extraordinary event*
31/10/2019	Extraordinary event*
1/11/2019	Extraordinary event*
7/11/2019	Extraordinary event*
8/11/2019	Extraordinary event*
12/11/2019	Extraordinary event*

Exceedance date	Cause/s
17/11/2019	Extraordinary event*
21/11/2019	Extraordinary event*
22/11/2019	Extraordinary event*
26/11/2019	Extraordinary event*
29/11/2019	Extraordinary event*
30/11/2019	Extraordinary event*
3/12/2019	Extraordinary event*
4/12/2019	Extraordinary event*
5/12/2019	Extraordinary event*
6/12/2019	Extraordinary event*
7/12/2019	Extraordinary event*
9/12/2019	Extraordinary event*
10/12/2019	Extraordinary event*
11/12/2019	Extraordinary event*
14/12/2019	Extraordinary event*
16/12/2019	Extraordinary event*
19/12/2019	Extraordinary event*
21/12/2019	Extraordinary event*
28/12/2019	Extraordinary event*
30/12/2019	Extraordinary event*

* Extraordinary air quality event determined by the Department of Planning, Industry and Environment. As per Schedule 3 Condition 16. of SSD4960 extraordinary events include bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed to by the Secretary.

6.4.3 Comparison against Predictions

A comparison of 2019 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 (2020) (attached as **Appendix B**). The assessment identified that there was generally a good agreement between modelling predictions and measured results.

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 (2020) (**Appendix B**). The assessment concluded that:

> *The analysis shows that the annual levels were generally high compared with previous years and that there was an increase in the number of exceedances of the short term PM_{10} and $PM_{2.5}$ criteria in 2019, due to the large number of extraordinary events. The annual average levels excluding extraordinary events were similar to the previous years and below the relevant annual criteria.*

6.4.5 Implemented / Proposed Improvements

Changes to the air quality management during 2019 included:

- The Air Quality Management Trigger Action Response Procedure was updated to minimise dust emissions from the deep pit tailings emplacement area from leaving the site and travelling across Broke Road. A trigger was added to identify forecast dust generating weather conditions from this area and an action to inspect the tailings dam for tailings/water coverage and consider applying tailings/water.
- The Eastern *Emplacement Area Air Quality Management Framework* was amended in consultation with the Technical Review Committee and approved by DPIE. The changes were the inclusion of a decision tree to determine if exceedances are caused by Bulga Coal and to only report exceedances of the assessment level that were caused by Bulga Coal to the DPIE.
- Face to face air quality management training was provided to the entire workforce;
- Air quality management training was provided to mining supervisors; and
- The two E-SAMPLER air quality monitors at the perimeter of the site were swapped for E-BAM type continuous PM_{10} air quality monitors.

6.5 Mine Subsidence

6.5.1 Environmental Management

Since the cessation of mining in May 2018, surface safety monitoring has continued to be undertaken in accordance with approved methods. Surface subsidence cracking is mapped with a hand-held GPS 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

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*. The observed impacts caused by subsidence are summarised in **Table 27**.

Table 27 Observed Subsidence Impacts

Feature	Impact Performance Measures	Observed Impacts
Surface Cracking	Always safe. Stable, non-polluting post mining Landform.	No adverse impacts reported. Continue to monitor and repair as required
Telecommunications & powerlines	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure
Pipelines and tanks	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure.
Roads and gates	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure.

Feature	Impact Performance Measures	Observed Impacts
Fences	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure.
Buildings	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure.
Archaeology sites and vegetation	Stable, non-polluting post mining Landform.	No adverse impacts reported.

6.5.3 Comparison against Predictions

A comparison against predictions was not applicable considering underground mining did not occur during 2019.

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. Monitoring of previously mined areas will continue in 2020. Any required mitigation works will 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

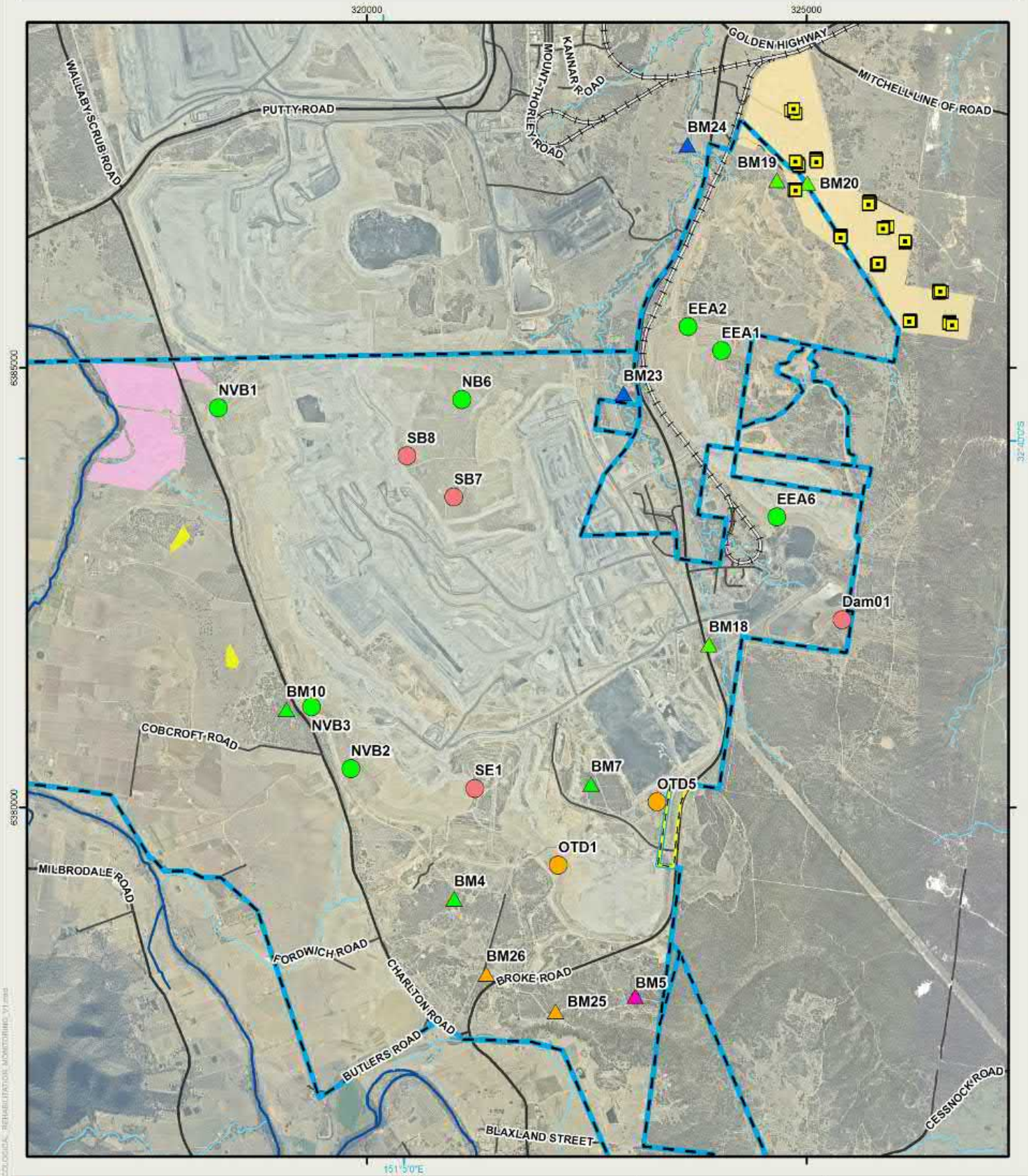
Flora and fauna monitoring are conducted around the mining operations in accordance with the *Bulga Coal Biodiversity Management Plan*. The locations of ecological monitoring sites are shown in **Figure 13**. The ecological monitoring of mine rehabilitation is covered in **Section 8.6**.

6.6.1.1 Annual Ecological Monitoring Program - Flora

The annual ecological monitoring program for flora was undertaken by Emergent Ecological (2019) 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.

FIGURE 13 - ECOLOGICAL AND REHABILITATION MONITORING 2019



0 0.5 1 2
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Coordinate System
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6.6.1.2 Annual Ecological Monitoring Program – Fauna

Ecological monitoring for fauna was completed by RPS (2019) and results provided in the 2019 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.

6.6.2 Environmental Performance

6.6.2.1 Flora Monitoring

Monitoring was conducted at seven sites in 2019 located within the following vegetation communities:

- Central Hunter Grey Box – Ironbark Woodland Endangered Ecological Community (EEC) (four sites);
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC (one site);
- Paperbark Swamp Forest (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. All sites also recorded a decline in composition and structure scores as a result of the extended drought conditions. Sites BM4 and BM10 (both Central Hunter Grey Box – Ironbark Woodland) scored the highest Integrity scores with 62.4 and 51.8. BM18 (Bull Oak grassy woodland) recorded the lowest Integrity score of 24.7.

Feral animal presence and exotic weed cover were low at all sites. Weed cover percentage was highest a BM23 with approximately 12.4 % cover. All other sites recorded a weed cover percentage of 5 % or less.

Evidence of pest animals was recorded at all sites aside from BM4. This included direct sightings or secondary traces such as characteristic scats or disturbance impacts (diggings, burrows and grazed plants). Heavy grazing of ground covers and shrubs by rabbits and/or macropods was observed at most sites, in particular at BM5, BM7, BM10 and BM18. This can be attributed to the dry conditions reducing the availability and condition of resources for these species.

6.6.2.2 Fauna Monitoring

Diurnal bird surveys were performed at selected sites during winter and spring of 2019. The surveys recorded 50 different bird species, a decrease of 18 unique species from the previous year. This is the second year in a row that species numbers have declined and is likely due to the ongoing severe dry period experienced in the region. Four threatened species were recorded, being the Speckled Warbler (*Chthonicola sagittata*), Varied Sittella (*Daphoenositta chrysoptera*), Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) and Little Lorikeet (*Glossopsitta pusilla*). All four threatened species had previously been recorded at Bulga.

A total of nine microbat species were detected during the 2019 surveys, which is the same number of species recorded in 2018. Two of the species recorded in 2019 were listed as threatened under the *Biodiversity Conservation Act 2016*; the Little Bent-winged Bat (*Miniopterus australis)* and the Large-eared Pied Bat *(Chalinolobus dwyeri*). The Large-eared Pied Bat (*Chalinolobus dwyeri*) is also listed as vulnerable under the EPBC Act. Both of these species have previously been recorded at Bulga.

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 regard 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 2020. 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 13** 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.

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 13**.

During 2019, Bulga Coal and OEH finalised the Voluntary Conservation Agreements for the BOAs. The VCA's have now been registered on the title of blocks of land associated with the offsets. As Bulga has been operating in accordance with the requirements of the VCA's for a number of years, there are no management changes as a result of this.

6.7.1 Broke Road BOA

6.7.1.1 Environmental Management

Environmental management activities undertaken at the Broke Road BOA in 2019 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;
- Approximately 12.5 ha of tube stock planting and approximately 6.5 ha of seeding in active revegetation areas, including ground preparation and follow-up watering and weed control;
- Wild dog and feral animal baiting during autumn and spring months (18 dogs, 25 Foxes (*Vulpes vulpes*) and one pig);
- Kangaroo and pig open range shooting;
- Removal of additional redundant internal fences;
- Six monthly inspections; and
- Ongoing ecological monitoring program.

6.7.1.2 Monitoring Results

Flora

Monitoring in 2019 at the Broke Road BOA continued with the nine permanent monitoring transects established in 2015 and the three additional temporary revegetation plots established in 2018.

The spring and summer of 2019 were very dry, continuing the drought period experienced since 2017. Consequently, the 2019 monitoring (Bell & Murray 2019a) showed overall species diversity within Broke Road BOA was very similar to that recorded in 2018. 117 plant species were recorded within the nine transects, comparable to 2018 and 2017 (118 and 116) and a decrease on 2016 (144) and 2015 (142) results. There was a decrease in the number of weed species recorded in 2019, with 32 detected compared to 45 in 2018. Survival rates of the tubestock plantings within the revegetation plots also continued to decrease due to the drought conditions.

Of all the Biometric data collected, only Native Ground Cover (other) met the PCT benchmark, largely due to the ongoing drought and associated poor vegetation condition.

The single plant of Tiger Orchid (*Cymbidium canaliculatum*) (an endangered population in the Hunter) remains in the Narrow-leaved Ironbark (*Eucalyptus crebra*) adjacent to transect BRO04.

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 42 bird species in 2019, compared to 43 in 2018, 26 in 2017, 37 in 2016 and 38 in 2015. As such, results were comparable to previous years' results, with the only noticeable difference being the absence of waterbirds (ducks, cormorants etc.) in 2019 as a result of all dams on the property being dry.

Infra-red motion detection (or field game) cameras were installed to monitor for presence of larger mammals. In 2019, larger mammals recorded include the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*) and Fox (*Vulpes vulpes*). Smaller terrestrial mammals recorded by camera include Common Brushtail Possum (*Trichosurus vulpecula*) and Brown Hare (*Lepus europaeus*). European Rabbits were observed during standard operations. A Squirrel Glider (*Petaurus norfolcensis*) was observed during surveys emerging from a tree hollow.

Nine microchiropteran bat species were recorded in 2019 by echolocation call recordings. A total of 250 calls of microchiropteran bats were identified from recordings, a significant decrease from 1,278 calls recorded in 2018. The low number of recordings in 2019 may be attributed to absence of water across the entire site. Of the nine species recorded, two species are threatened, the Eastern Freetail-Bat (*Micronomomus norfolkensis*) and the Eastern Bent-wing Bat (*Miniopterus fuliginosus*), both of which had previously been recorded within the Broke Road BOA.

Three reptile species were recorded in 2019, the Bearded Dragon (*Pogona barbata*), Lace Monitor (*Varanus varius*) and Wood Gecko (*Varanus varius*).

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 (*Lantana camara*) 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 (*Carthamus lanatus*) will continue to be monitored and controlled through slashing as required. Patches of Galenia (*Galenia pubescens*) are being targeted within revegetation areas where the ground had been disturbed for planting.

Pest Management

Surveys and control activities undertaken in 2019 indicate that feral pig numbers are continuing to decline. 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.

Wild dog (*Canis lupus familiaris*) and Fox (*Vulpes vulpes*) take decreased during the 2019 baiting programs. This is likely a combination of increased effort (two programs per year) and the co-operative approach being undertaken by Local Land Services.

6.7.2 Condran BOA

6.7.2.1 Environmental Management

Activities undertaken at the Condran BOA in 2019 included:

- Minor repairs to boundary fences;
- Weed controls works, focusing on:
    - Coolatai Grass (*Hyparrhenia hirta*);
    - Whisky grass (*Andropogon virginicus*);
    - Spiny Rush (*Juncus acutus ssp. acutus*); and

- Prickly pear (*Opuntia stricta*)

- Six monthly inspections; and
- Continuation of the ecological monitoring program established in 2013.

6.7.2.2 Monitoring Results

Flora

Monitoring in 2019 at the Condran BOA continued with the six permanent monitoring transects established in 2013 and the two additional temporary revegetation plots established in 2018.

110 plant species (72 natives, 28 weeds) were recorded within the eight transects at the Condran BOA during 2019 surveys. Relative to 2018, there was a decrease in diversity of species. Plot CON01G was an exception to this trend, with a decrease in weeds and an increase in native diversity. Overall species diversity within Condran BOA was low as a direct correlation with below average rainfall for the seven months preceding inspection, and the two successive years of dry conditions.

While there was a decrease in weed species compared to 2018 (34 species) – this suite of taxa has been impacted by the lack of rain – the greatest impact came from reoccurring weeds. 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.

The revegetation transects survivorship dropped at CON04R (51%) and had an increase at CON05R (109%) – the apparent increase was due to the adjustment of the transect position.

Monitoring of the threatened Pine Donkey Orchid (*Diuris tricolor*) population at Condran BOA in October 2019 showed only three 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 as a result of the prolonged dry conditions. Fruiting was observed within the Condran population of *Diuris* in 2019, confirming the presence of a pollinating population of insects.

Fauna

49 bird species were recorded by diurnal census in 2019 which compares with 27 species in 2018. Two threatened bird species was recorded in 2019, the Speckled Warbler (*Chthonicola sagittata*) and Grey-crowned Babbler (*Pomatostomus temporalis*), both of which have previously been recorded nesting at Condran BOA. Several new bird species were recorded in 2019, it was noted that these species were widespread but had not been recorded in previous monitoring years.

Three of the four previously sighted macropod species were recorded by opportunistic observations and camera photographs in 2019; the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*) and Common Wallaroo (*Macropus robustus*). Other mammals recorded include Dingo (*Canis lupis dingo*) / wild dog (*Canis lupus familiaris*), Long-nosed Bandicoot (*Perameles nasuta*) and Brown Hare (*Lepus europaeus*).

Arboreal species detected by spotlight searches and/or remote camera monitoring in Condran VCA in 2019 included the Common Brushtail Possum (*Trichosurus vulpecula*). This species has been previously identified.

Echolocation calls of microchiropteran bat species were recorded at two fauna monitoring sites (ConFA1 and ConFA2) in 2019. Eight microbat species were recorded, with a total of 69 call sequences suitable for identification – a drop from 2018 (243 calls). The most commonly recorded species were the Inland Broad-nosed Bat (*Scotorepens balstoni*) (25 calls), and Gould's Wattled Bat (*Chalinolobus gouldii*) (20 calls). Two threatened microbat species were recorded in 2019, the Eastern Freetail-Bat (*Micronomomus norfolkensis*) (two calls) and the Eastern Bentwing-bat (*Miniopterus fuliginosus*) (one call).

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 and dry conditions. Spiny Rush remains an issue along sections of the creek line. Recorded die back was noted during inspections due to dry conditions and ongoing site management. Targeted treatment will continue to minimise the spread of these species.

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 native fauna populations at the Condran BOA.

6.7.3 Reedy Valley BOA

6.7.3.1 Environmental Management

The activities undertaken at the Reedy Valley BOA in 2019 included:

- Weed control works in natural regeneration areas, focussing on:
    - Prickly Pear (*Cylindropuntia spp*);
    - Galenia (*Galenia pubescens*);
    - African Boxthorn (*Lycium ferocissimum*);
    - Cotton Bush (*Gomphocarpus fruticosus*);
    - Saffron Thistle (*Carthamnus lanatus*);
    - Spear Thistle (*Carthamnus lanatus*); and
    - Tiger pear (*Opuntia aurantiaca*)
- Feral animal control continued including wild dog baiting, pig trapping and shooting, and deer goat, rabbit and Fox (*Vulpes vulpes*) shooting;
- Approximately 10.1 ha of tube stock planting and 6.1 ha of seeding of active revegetation areas, including ground preparation and follow-up watering and weed control;
- Minor repairs to boundary and internal fences;

- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.3.2 Monitoring Results

Flora

Monitoring in 2019 at the Reedy Valley BOA continued with the 12 permanent monitoring transects which were established in 2015.

Plant growth and health was again poor during the 2019 monitoring period due to ongoing drought conditions (Bell & Murray, 2019c). Survey of transects revealed the presence of 106 species, comprising 75 natives and 31 weeds. This is a decrease from 2018 (118), and an overall reduction from that recorded in previous years. This is to be expected given the drought conditions and grazing pressure by native and exotic mammals.

Weed species showed a general decreasing 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 require ongoing management and monitoring.

Fauna

Diurnal bird census surveys were conducted at 12 sites in 2019, with a total of 74 bird species detected (72 native and two exotic), and another 21 through opportunistic observations. 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, but there was not a significant difference. Two thirds of the monitored sites decreased in diversity compared to the mean records of 2015 to 2018. Six threatened bird species were recorded at Reedy Valley BOA in 2019. These were:

- Speckled Warbler (*Chthonicola sagittatus*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Grey-crowned Babbler(*Pomatostomus temporalis*);
- Little Lorikeet (*Parvipsitta pusilla*);
- Dusky Woodswallow (*Artamus cyanopterus*); and
- Diamond Firetail (*Stagonopleura guttata*).

Though monitoring of Reedy Valley, four macropods were observed, including the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*), Common Wallaroo (*Macropus robustus*). and Swamp Wallaby (*Wallabia bicolor*). Other mammals detected include the Common Wombat (*Vombatus ursinus*) and Echidna (*Tachyglossidae*).

13 microchiropteran bat species were recorded at Reedy Valley BOA in 2019. A total of 1,909 echolocation calls were identified which was a considerable decrease from 2018 (2,757). Despite the dry conditions, night time temperatures were relatively warm in October and December which may have influenced microbat activity. Four threatened microbats were recorded, the Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Bentwing-bat (*Miniopterus fuliginosus*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) and Eastern Cave Bat (*Vespadelus troughtoni*).

Five feral species (pig, fox, goat, rabbit, brown hare) and two domestic species (cattle and sheep) were recorded throughout the Reedy Valley BOA. Sightings of pigs and goats were made along the creek line, while sheep were sighted at higher country. While introduced herbivores are still present, there is a significant reduction from 2018. Mid-story vegetation is being affected/consumed due to the decrease in groundcover in the current dry conditions.

Two arboreal mammal species were detected during spotlight searches in 2019, the Common Brushtail Possum (*Trichosurus vulpecula*) and Common Ringtail Possum (*Pseudocheirus peregrinus*).

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 offset. Ongoing monitoring will determine if cattle persist. Other pest species, including feral pigs, deer, fox and goat 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 the 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 2019 due to the dry conditions. Continued 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 2019 included:

- Weed control works focussing on:
    - Prickly Pear (*Cylindropuntia spp*);
    - Tiger Pear (*Opuntia aurantiaca*);
    - African Boxthorn (*Lycium ferocissimum*);
    - Balloon vine (*Cardiospermum grandiflorum*); and
    - Green cestrum (Cestrum *parqui*).

- Approximately 7.1 ha of tubestock planting in active revegetation areas, including ground preparation, follow-up watering and weed control;
- Monitoring of trial plots to establish the effectiveness of thinning of bulloak (*Allocasuaina luehmannii*) and tea-tree (*Leptospermum polyanthum*) species;
- Wild dog and fox baiting, pig trapping and kangaroo culling;
- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.4.2 Monitoring Results

Flora

Monitoring in 2019 at the Wollombi Brook Conservation Area continued with the existing six permanent monitoring transects established in 2015 and two new temporary revegetation plots established in 2019.

Overall species diversity within Wollombi Brook Conservation Area has been limited due to drought conditions (Bell & Murray, 2018d). In total, 86 plant species (63 native and 23 weeds) were recorded within the six transects. When compared to 2018 data, diversity has a variable response, although weeds generally reduced in 2019. Across monitoring plots of the trial thinning areas, natural regeneration of the Warkworth Sands Woodland has been slow with variable results relative to target and unthinned controls. While there isn't a significant difference in floristic composition, the trend is on track and in line with targets. In November 2019, all the remaining tea-tree were removed to allow more light to penetrate to the ground.

Noticeable weeds dominating the grassland and regenerating areas of Warkworth Sands Woodland in 2019 including:

- Red Natal Grass (*Melinis repens*);
- Mexican Clover (*Richardia brasiliensis, R. stellaris*);
- Coolah Grass (*Panicum coloratum var. coloratum*);
- African Love Grass (*Eragrostis curvula*);
- Pear (*Opuntia spp*); and
- Blue heliotrope (*Heliotrope amplexicaule*).

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

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

- *Lomandra leucocephala subsp. Leucocephala*;
- Comet Grass (*Perotis rara*);
- Large copper-wire daisy (*Podolepis canescens*);
- Mountain grevillea (*Grevillea montana*);
- Daphne Heath (*Brachyloma daphnoides*); and
- Queen of the Bush (*Pimelea linifolia subsp. linifolia*).

Survivorship of revegetation areas continues to be impacted by the dry conditions. WOL04R recorded 64%, with eight out of ten planted species still present. WOL01R recorded 50%, with seven out of ten species still present.

Fauna

A total of 42 bird species were recorded at the Wollombi Brook Conservation Area by census survey in 2019 and a further 17 species were identified during other field tasks. This is a decrease compared to previous years.

In 2019, two threatened bird species were recorded:

- White-bellied Sea Eagle (*Haliaeetus leucogaster*); and
- Grey-crowned Babbler (*Pomatostomus temporalis*).

Wollombi Brook Conservation Area recorded three macropod species, the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*), Swamp Wallaby. The Common Wombat and Common Brushtail Possum (*Trichosurus vulpecula*) were also identified. One threatened arboreal mammal species was recorded in 2019, being the Squirrel Glider (*Petaurus norfolcensis*).

Echolocation calls of microchiropteran bat species recorded the presence of nine bat species in 2019, with a total of 113 calls suitable for identification. This was a decrease compared to previous years excluding 2016 (40 calls). The most commonly recorded species was the threatened Eastern Bentwing-bat (*Miniopterus fuliginosus)* at 73 calls. All other bats recorded less than ten calls.

No frog or reptile activity was recorded in 2019 due to the extended dry period with below average rainfall.

6.7.4.3 Implemented / Proposed Improvements

Weeds

Four key invasive species Weeping Lovegrass (*Eragrostis curvula*), Natal Grass (*Melinis repens*), *Eastern prickly pear* (*Opuntia humifusa*) and Coolah Grass (*Panicum coloratum var. coloratum*) and several exotic herbs will require ongoing monitoring and management in the Wollombi Brook Conservation Area, as their persistence and spread may adversely affect the biodiversity value of existing and regenerating Endangered Ecological Communities (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 bulloak (*Allocasuarina luehmannii*) has shown only limited and variable results after 40 months. Although encouraging, recolonization by native shrubs, grasses and herbs has been delayed within monitoring plots, and likely exacerbated by the drought. All the targeted tea-tree plants have been removed and it is recommended that the same be done for the Bulloak (*Allocasuarina luehmannii*), with cut stems lain over the ground to limit erosion and assist with water retention.

Pest Management

Feral animal presence was low in 2019. Through field work, nocturnal spotlight searches and remote camera monitoring, the only evidence of activity was pig and fox, each being sighted on just 3 of 137 nights. These records indicate an overall low abundance of feral animals within the Wollombi Brook Conservation Area.

The presence of pests that may occur in the Wollombi Brook Conservation Area will be wide-ranging and present in the surrounding landscape. Therefore, permanent prevention will be difficult but intensive targeted management can be undertaken to minimise pests to the area. This would be especially beneficial to reduce the damage to replanting and regeneration.

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 2019 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 (*Acacia pendula*) within the two WMMAs during 2019 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. Mistletoe still appears to be abundant in the population of *Acacia pendula* within WMMA#2, however it does not appear to be having additional impact on the species.

Overall, floristic diversity and abundance within the two monitoring plots showed a decrease of both native and weed species in 2019 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 three years are clearly reflected in the number of species present within the WMMAs. Numerical analysis of these two plots over five seasons showed significant differences in the diversity and abundance of species relative to rainfall received in the preceding six months, with observable differences in the dry years of 2017 and 2019 (six months of below-average rainfall) compared to the wetter years of 2015, 2016 and 2018 (one to three months of above average rainfall).

Twelve months since implementing the monitoring program within WMMA#1, there has been an increase in overall stem count. The greatest increase was observed at the Grassy Woodland plot (12-25%), while the lowest was at the newly colonised Grassland. While there was a decrease in species diversity, the dry conditions prevent any significant conclusions being made with regard to the impact Weeping Myall has upon co-occurring species within grassland and woodland environments.

6.7.5.3 Implemented / Proposed Improvements

Flowering

It is proposed to continue to informally monitor for flowering on the Weeping Myall 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 Areas. Further monitoring of the mistletoe plants on mature Weeping Myall plants should continue.

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. Annual buffer land 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 vertebrate pest control programs in both Autumn and Spring 2019 in conjunction with the coordinated program being organised by Local Land Services (LLS). As part of the program, 1080 baiting was conducted, targeting wild dog and Fox (*Vulpes vulpes*) populations within the landholdings. Feral pig trapping was also conducted throughout the year.

6.8.2 Environmental Performance

Annual 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. The Autumn program had a total of 92 baits taken, which represented 48% of the available baits and a significant increase on historical results. The Spring program had 63 baits taken which represented 26% of the available baits. This was consistent with previous year's results which generally range from 20 to 30%.

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 2020.

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).

6.9.2 Environmental Performance

6.9.2.1 2019 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 2019. 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 2019. The inspection included review of sites primarily within the Wollombi Brook Conservation Area (refer **Section 6.9.2.3**) and at site BOP SC-6 at Nine Mile Creek;
- Quarter 2 monitoring was undertaken on 30 April 2019, this included a review of sites on the western portion of Bulga Coal and the Loders Creek Grinding Grooves relocation area. Photographic monitoring of the grinding grooves area is discussed in **Section 6.9.2.4**;
- Quarter 3 monitoring was undertaken on 14 August 2018. This monitoring was focused on sites primarily associated with Nine Mile Creek; and
- Quarter 4 monitoring occurred on 6 November 2019 and included sites to the west of Charlton Road and sites to the south of Bulga towards Monkey Place Creek.

6.9.2.2 Salvages During 2019

No salvages occurred during 2019.

6.9.2.3 Wollombi Brook Conservation Area

The Wollombi Brook Conservation Area is both a biodiversity offset area and an Aboriginal and Cultural Heritage Offset Area. Heritage is managed in accordance with the Wollombi Brook Plan of Management (Appendix J of the ACHMP). Land management is undertaken in accordance with the Biodiversity Offset Management Plan (as discussed in **Section 6.7.4**).

The progress of constructing the Aboriginal cultural teaching place and artefact storage facility was discussed at quarterly RAP meetings held on 28 March, 25 June, 26 September and on 28 November 2019 at the annual RAP meeting. 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 septic toilets. The interpretive signage was finalised in 2019 with a positive response received from the RAPs.

Bulga finalised the building design in 2019 and aims to complete construction by the end of 2020.

6.9.2.4 Loders Creek Grinding Grooves Conservation Area

Photographic monitoring of the Loders Creek Grinding Grooves Conservation Area occurs annually, and the site is monitored at least once a year as part of the Quarterly Monitoring Program. In April 2019, the four fixed photo points were photographed to monitor the condition of the Loders Creek Grinding Grooves. The site was originally photographed in September 2015 following the relocation, and again in 2017 and 2018. **Photo 1**, **Photo 2** and **Photo 3** present the 2017, 2018 and 2019 condition from Photo Point 4 for comparison. As detailed in the monitoring reports there has been no discernible change in condition of Groups A to E between 2015 and 2019 (4 and a half years).

During 2019, the *Loders Creek Grinding Grooves Conservation Area Management Plan* (LCGGCA MP) was developed in consultation with RAPs (Appendix I of the ACHMP). In accordance with the LCGGCA MP a wooden barrier was installed in November 2019 along the eastern boundary of the Loders Creek Grinding Grooves Conservation Area to block vehicle access to the grinding grooves. At the annual RAP meeting, held at the Loders Creek Grinding Grooves Conservation Area, the attending RAPs provided positive feedback with regard to the new barrier.

Photo 1 LCGG Photographic Monitoring – 2017 view from Photo Point 4

Photo 2 LCGG Photographic Monitoring – 2018 view from Photo Point 4

Photo 3 LCGG Photographic Monitoring – 2019 view from Photo Point 4

6.9.2.5 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 in accordance with the HHMP. The assessments are carried out annually by a structural engineer. The reports indicate there have been no noticeable changes from blast impacts.

6.9.2.6 Incidents

No heritage related incidents occurred during 2019. However, DPIE carried out an investigation into the 2018 disturbance of two Aboriginal Heritage sites. It was determined that Bulga Coal committed an offence against section 4.2 of the EP&A Act carrying out development not in accordance with the conditions of development consent SSD-4960. The DPIE issued Bulga Coal with a warning letter for the breach.

6.9.3 Implemented / Proposed Improvements

Following the incident in September 2018 when two Aboriginal heritage sites were impacted, the ACHMP was revised and submitted to DPIE on October 2018. The draft ACHMP was then revised again in June 2019 and was approved by DPIE on 3 July 2019. The revised ACHMP includes the following improvements:

- Addition of the *New Aboriginal Heritage Site Recording Form*;
- Addition of the *Loders Creek Grinding Grooves Conservation Area Management Plan* which superseded the previous *Loders Creek Grinding Grooves Plan Stage 1* and *Loders Creek Grinding Grooves Plan Stage 2*;
- Updates to reflect that the Eastern Emplacement Area was salvaged in 2018;
- Updates to reflect the cessation of Bulga Underground mining; and
- General updates.

The HHMP was also revised and submitted to DPIE on 19 December 2019 for approval. The revised HHMP includes these improvements:

- Updates to reflect that the photographic records before, during, and after mining required for Monkey Place Creek Stone Wall (BH13) have now been completed;
- Revision of the schedule for structural assessments;
- Updates to reflect the cessation of Bulga Underground mining; and
- General updates.

Bulga aims to complete construction of the cultural teaching place and artefact storage facility by the end of 2020.

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, where practicable, and windrows or bunds are designed and constructed to mitigate lighting impacts.

A sensitive lighting receiver 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.

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.

Portable gas monitoring units are used by units working in areas of spontaneous combustion or where toxic gases are suspected of being present. This is for the purpose of identifying the presence of spontaneous combustion and any potential increase in risk.

6.11.2 Environmental Performance

Four incidences of spontaneous combustion occurred in 2019; twice on the raw coal stockpile and once on the ROM coal stockpile in March and once in the main pit in May.

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 *Bushfire Management Plan.*

These 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

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 Coal use both pre-mining and post-mining gas drainage to provide a safer, more productive mining environment. Pre-mining drainage wells extract methane and carbon dioxide from the coal seams which is piped to the 9 Megawatt (MW) gas fired power station and Pre-drainage Flaring Facility where it is burned and converted to carbon dioxide. A small amount of coal seam water is also extracted from the pre-drainage wells as a by-product of gas production. All coal seam water is contained within the Bulga Coal water management system.

Post-mining drainage methane and carbon dioxide is extracted from the mined out goaf 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.

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

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

6.13.2 Environmental Performance

Greenhouse gas emissions are shown in **Table 28**. 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 28 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)	56,777	333
Fuel Combustion (transport)	125	-
Fuel Combustion (non-transport)	217,199	-
Fugitive emissions from ROM coal	413,817	-
Vented	-	27,027

Emission Source	Bulga Open Cut ($t CO_2$-e)	Bulga Underground Operations ($t CO_2$-e)
Flared	-	124,496
Power Generation	-	13,888
Total	**687,919**	**165,744**

Overall, there was an increase in Bulga Open Cut emissions of about 31.7% when compared to the 2018 reporting period. The majority of the increase is attributable to fugitive emissions from ROM coal.

Emissions from Bulga Underground Operations were 32 % lower during 2019 when compared to the previous reporting period. This is primarily due to the cessation of underground mining in 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 2019 result is due to the cessation 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 29**.

Table 29 Comparison of 2019 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)	2019 Data ($t CO_2$-e)	2019 Totals ($t CO_2$-e)
Scope 1 (Direct)	Diesel use	240,885	1,011,888	217,325	631,141
	Fugitive emissions	771,003		413,817	
Scope 2 (Indirect)	Electricity	55,042	55,042	56,777	56,777
Total Annual Operation			**1,066,930**		**687,918**

Predictions represent the maximum annual greenhouse gas emissions for Bulga Coal during operations. Diesel use and fugitive emissions were lower than predicted, however electricity consumption was slightly higher. Overall, greenhouse emissions were 35.5% 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:

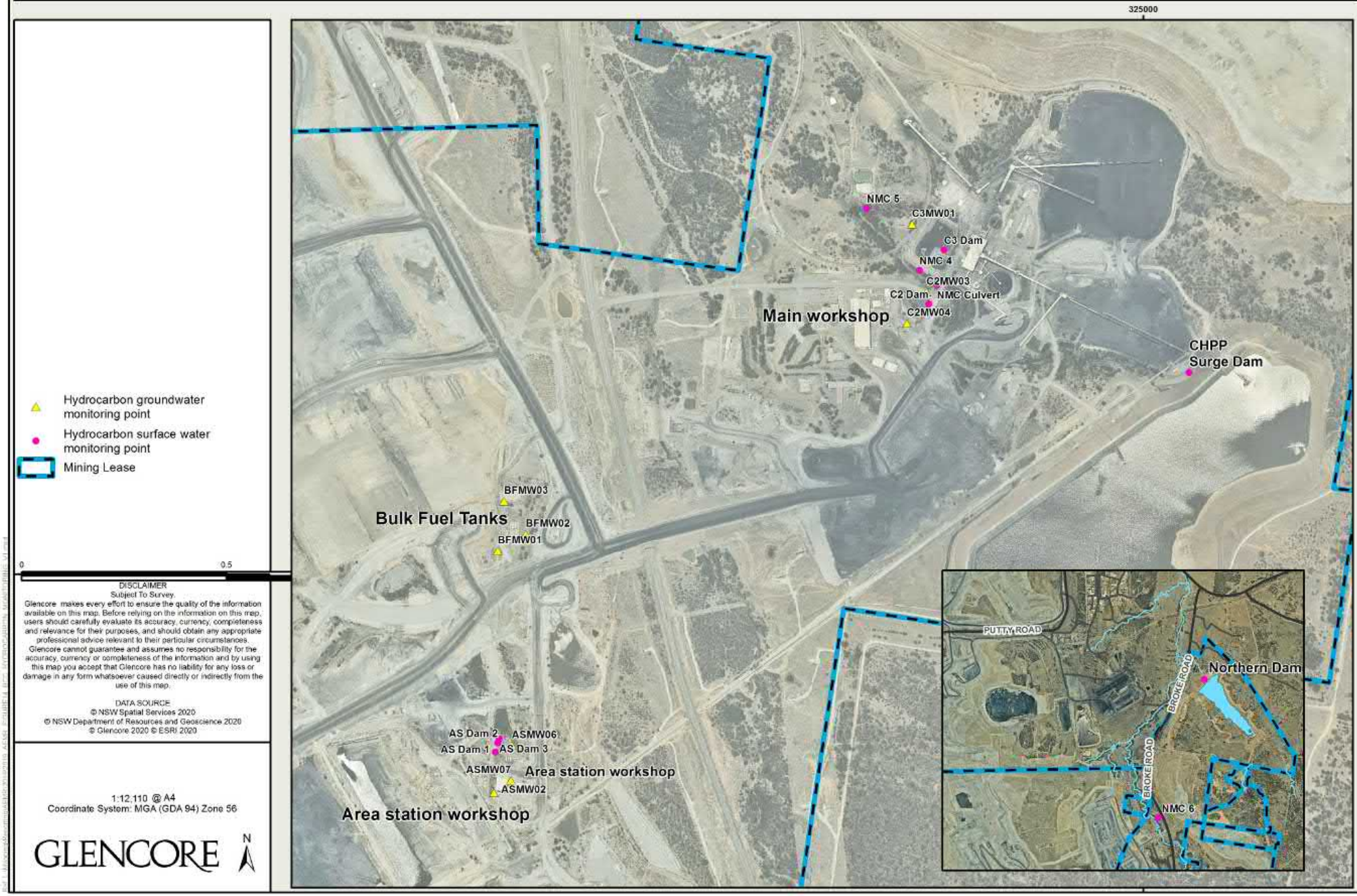
- *Bulga Coal Hydrocarbon Management Plan*, incorporating spill response procedure and Bulga Open Cut Hydrocarbon TARP; and
- *Bulga Coal Pollution Incident Response Management Plan*.

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 14**; and
- hydrocarbon monitoring at the locations listed in **Table 30**. Surface water sites are monitored quarterly, following rain. Groundwater sites are monitored six-monthly.

FIGURE 14 - BULGA COAL HYDROCARBON SURFACE AND GROUNDWATER MONITORING



6.14.2 Environmental Performance

Surface water and groundwater monitoring was conducted at the locations listed in **Table 30** and shown on **Figure 14**. Results were assessed against the Hydrocarbon Trigger Action Response Plan (TARP) triggers in **Table 31** and **Table 32**.

Table 30 Hydrocarbon Monitoring Sites

Type	Monitoring Location
Groundwater	ASMW02
	ASMW06
	ASMW07
	BFMW01
	BFMW02
	BFMW03
	C2MW03
	C2MW04
	C3MW01
Surface Water	NMC4
	NMC5
	NMC6
	NMC Culvert
Licenced Discharge Point (LDP)	CHPP Surge Dam
	Northern Dam (ND1)
Onsite Dirty Water Dam	AS Dam 1
	AS Dam 2
	AS Dam 3
	C2 Dam
	C3 Dam

Table 31 Ecological Investigation Levels (ANZECC) Adopted for Natural Waters (Surface and Groundwater) at Bulga Open Cut

Sampling Location	Contaminant	Trigger (pg/L)
Surface Water NMC4, NMC5, NMC6, Nine Mile Creek Culvert, ND1. **Groundwater** ASMW02, ASMW06, BFMW01, BFMW02, BFMW03, 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 32 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 monitoring results in 2019 were below the relevant Ecological Investigation Levels in the Bulga Open Cut Hydrocarbon Management Trigger Action Response Procedure. These were developed in accordance with the *National Environment Protection (Assessment of Site Contamination) Measure 2013*

There was one exceedance of the hydrocarbon trigger value at the NMC6 sampling site. The exceedance was investigated in accordance with the TARP. The sampling site was inspected, and a silica gel clean-up of the sample was undertaken with the subsequent analysis being below the relevant trigger level.

6.14.2.1 Hydrocarbon Plume Associated with the Area Station and Tank Farm

Surface and groundwater monitoring are 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 nine recorded hydrocarbon spills at Bulga Open Cut during 2019. Seven were classed as Category 1 (20 - 1,000 litres) and two as nil Category (<20 litres). Spill incidents were managed in accordance with the *Bulga Open Cut Emergency Procedure – Environmental Spill Response.*

There were no spills at Bulga Underground Operations in 2019.

6.14.3 Implemented / Proposed Improvements

A Phase 1 contamination assessment was completed in late 2018. The focus of the assessment was to identify potentially contaminating activities since the last Phase 1 assessment in 2013. The investigation found that these areas were no longer a potential concern:

- Former Bulk Fuel Tank Runoff Dam;

- Old Bioremediation Area, which is no longer in use;
- Coal Handling and Preparation Plant.
- Former Saxonvale Mine Waste Disposal Area;
- Beltana Light Vehicle Workshop, which was remediated in 2018;
- Areas where fire-fighting foams containing PFAS may have been used, which have been assessed; and
- No new areas of potential contamination were identified.

During 2019, a Bioremediation Area Management Plan was developed for managing hydrocarbon contaminated soil onsite.

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;
- Using sentries to prevent unauthorised entry into the blast exclusion zone; and
- Maintaining a fence around the perimeter of mining operations.

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.

Changes to public safety management in 2019 included securing fences and gates around the perimeter of the site.

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 33**. 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 33 Bulga Coal 2019 Water Balance

Bulga Coal 2019 Water Balance	Volume (ML)
Water Inventory and Capacity	
Total estimated water stored on site 1 January 2019 (4,000 ML predicted to be in the underground goaf)	6,270
Total estimated water stored on site 31 December 2019 (3,930 ML predicted to be in the underground goaf)	5,809
Change in water inventory	-461
Inflows	
Water extracted from Hunter River (monitored)	1,933
Rainfall and runoff intercepted from mine areas	1,232
Groundwater inflow (Groundwater model prediction)	245
Pumped from dewatering bores	396
Water entrained in CHPP feed material	729
Potable supply	9
Total Inflows	**4,544**
Outflows	
Evaporation	920
Discharge to Hunter River under Hunter River Salinity Trading Scheme	0
Water entrained in product coal, coarse rejects and tailings	2,374
Open Cut Dust suppression	2,614
Bulga Underground Operations Water Consumption	0
Potable water consumption	9
Other losses	5
Total outflows	**5,922**

7.1.2 Water Take

Water taken by Bulga Coal during the previous water year (1 July 2018 to 30 June 2019) is summarised in **Table 34**.

Table 34 Water Take 2018-2019

Water Licence #	Water Sharing Plan, Source and Management Zone	Entitlement (ML)	Passive take/inflows	Active Pumping	Total
Groundwater					
WAL41687	Mining: Sydney Basin-North Coast Groundwater Source	500	0	0	0
WAL41546	Mining: Sydney Basin-North Coast Groundwater Source	365	0	0	0
WAL41543	Mining: Sydney Basin-North Coast Groundwater Source	500	0	376	376
WAL41544	Mining: Sydney Basin-North Coast Groundwater Source	500	0	0	0
WAL41545	Mining: Sydney Basin-North Coast Groundwater Source	500	0	0	0
WAL36221	Mining: Wollombi Brook Aquifer leakage to Permian coal measures	300	0	0	0
Surface Water					
Singleton Council Agreement	Hunter River	2,427*	0	1,933	1,933

* Includes annual Singleton Council agreement allocation along with additional temporary transfers in 2019

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, electrical conductivity (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 is currently being revised and will be re-submitted for approval in 2020.

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 – 2019 Annual Averages

Sample Point	pH (range)	EC (µS/cm)	TSS (mg/L)	Temperature (°C)
LR1	6.6 – 7.5	2,234	22	17
LR2[1]	-	-	-	-
LR5	7.1 – 8.0	1,892	17	19
W2	6.9 – 7.5	740	13	21
W4	7.4 – 8.4	2,003	12	21
SDL1	6.3 – 7.2	216	61	16
NDL1	7.1 – 7.2	263	72	20
W9	7.8 – 8.0	1,890	238	19
W10	6.9 – 7.2	618	120	22
NMC1[1]	-	-	-	-

1 – No samples taken in 2019 due to no flow.

The results 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 15** and **Figure 16** show the gauging station records for 2018 to 2019 for the upstream and downstream sites, respectively.

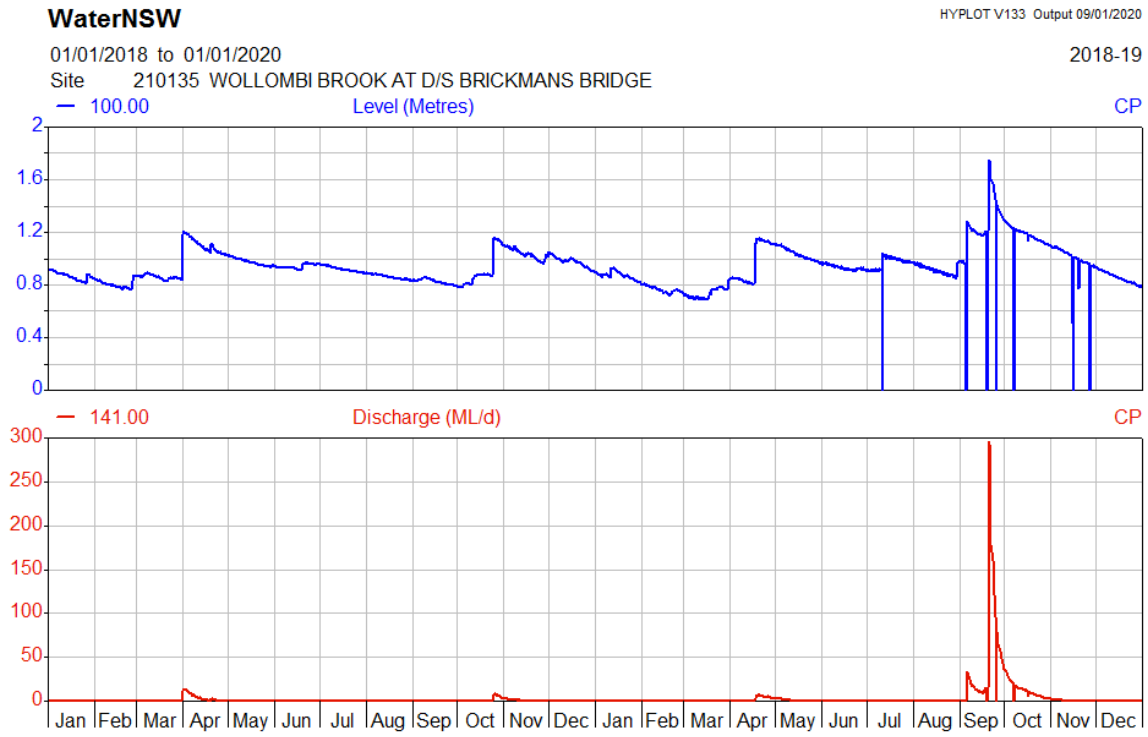


Figure 15 Wollombi Brook Brickmans Bridge Gauging Station 210135 (Upstream)

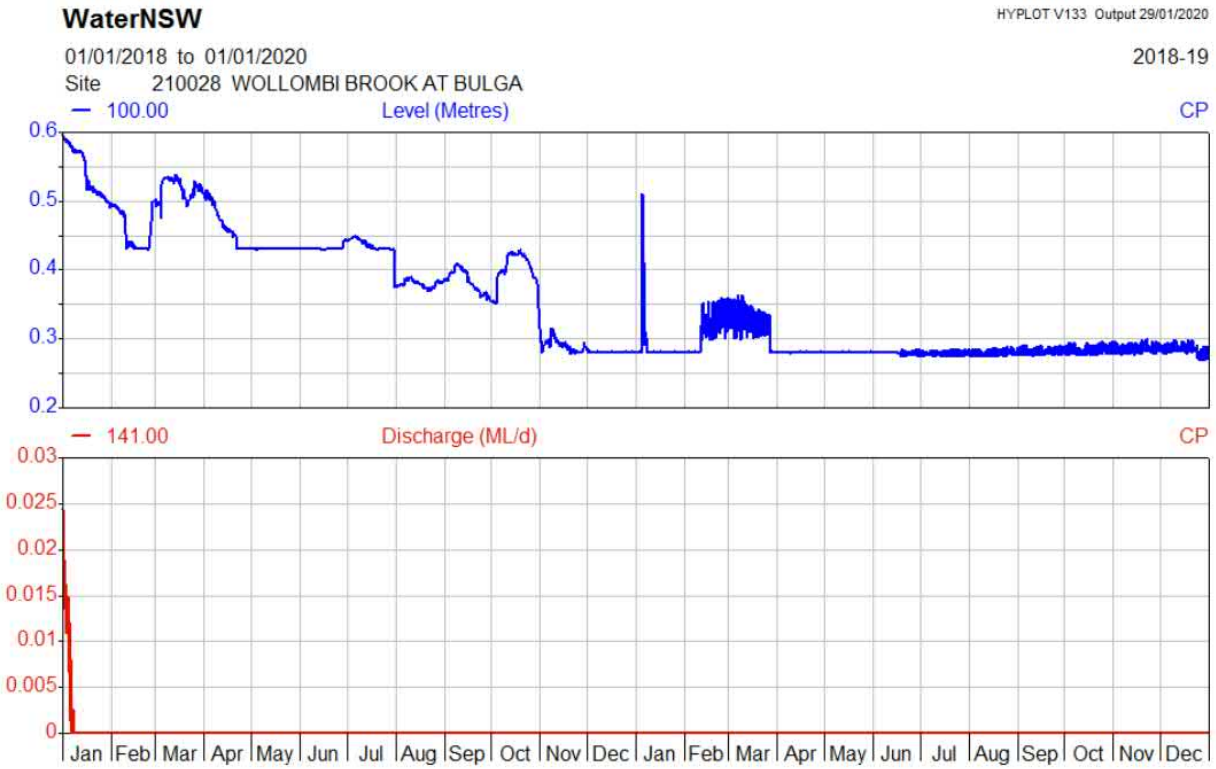


Figure 16 Wollombi Brook – Bulga Gauging Station (210028) (Downstream)

The data presented in **Figure 15** and **Figure 16** 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 drought and increased irrigation demand on the Wollombi Brook by landholders during the prolonged dry period.

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 2019.

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) both recorded Stable 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 and BM35, further downstream Loders Creek, were both classed as Stable.

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, were classified as Very Poor and Good, respectively. 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 agricultural and mining activities.

The two monitoring locations on Loders Creek, BM34 and BM35, were classified as Poor and Average respectively. 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 a Poor 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 2019 data has been made in **Table 36.**

Table 36 Comparison of Surface Water Monitoring Results (2019) against Background (2013 Bulga Optimisation Project EIS)

Sample Point	pH		EC (µS/cm)		TSS (mg/L)	
	2019 Range	EIS Range	2019 Average	EIS Range	2019 Average	EIS Range
LR1	6.6 – 7.5	6.6 - 8.8	2,234	4 - 9,470	22	1 - 72
LR2[1]	-	6.3 - 8.8	-	130 - 6,230	-	3 - 440
LR5	7.1 – 8.0	6.7 - 8.4	1,892	196 - 3,470	17	2 - 144
W2	6.9 – 7.5	6.6 - 8.2	740	195 - 1,470	13	1 - 114
W4	7.4 – 8.4	6.5 - 8.2	2,003	200 - 1,760	12	2 - 42

1 – no flow during 2019.

The results presented in **Table 36**, show that while the 2019 data is variable, it is generally within the historical ranges for each site. The only deviances from the historical ranges was at W4 where the pH was 0.2 above the historical range and EC was 243 µS/cm above the range. These variances are minor in nature and considered to be natural fluctuations in the water quality, particularly considering the drought conditions current being experienced.

7.2.4 Long Term Trend Analysis

Figures 17, 18 and **19** show surface water monitoring results recorded by Bulga Coal during the period 2005 to 2019 for EC, pH and TSS, respectively.

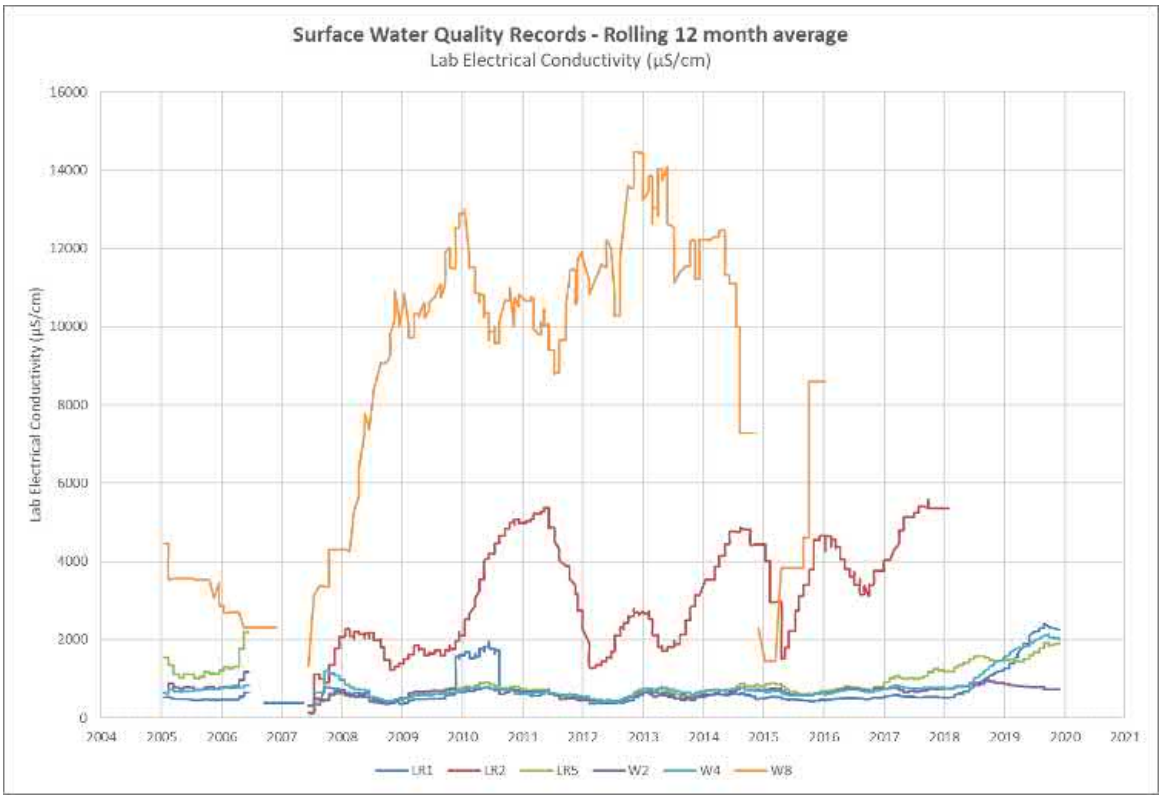


Figure 17 Long Term Surface Water EC Results

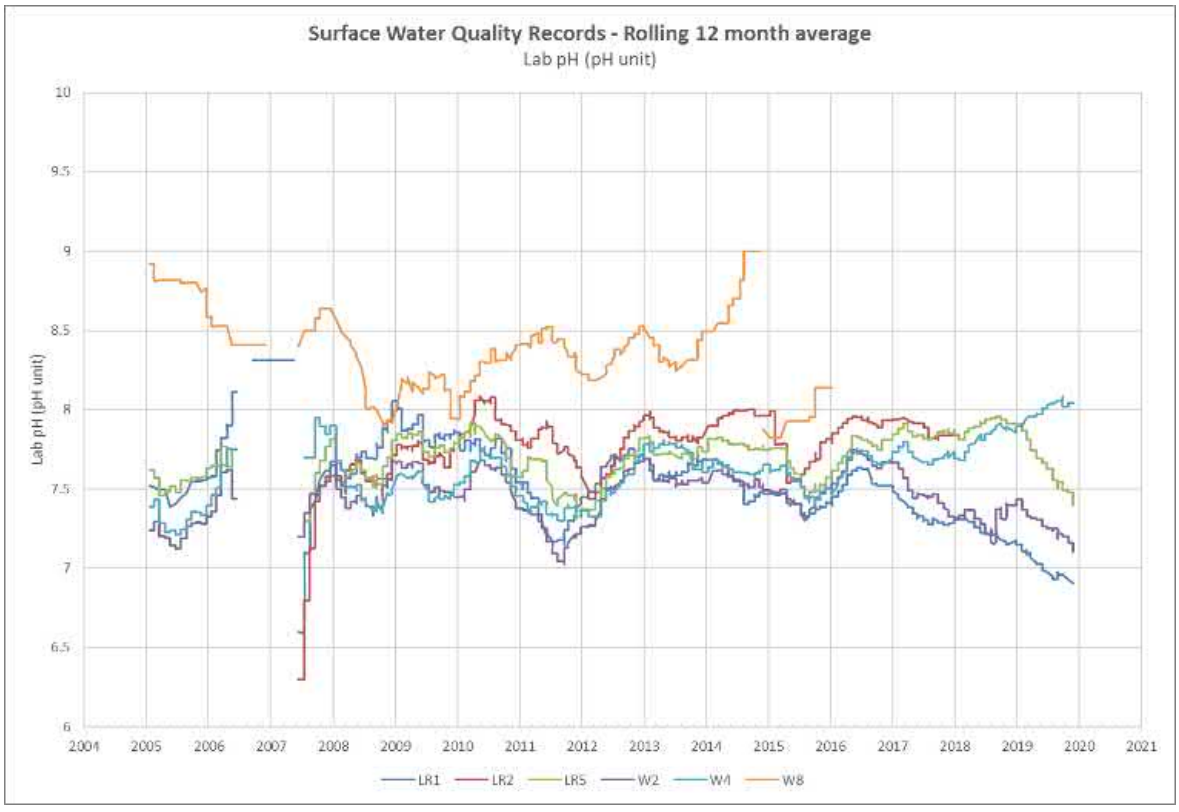


Figure 18 Long Term Surface Water pH Results

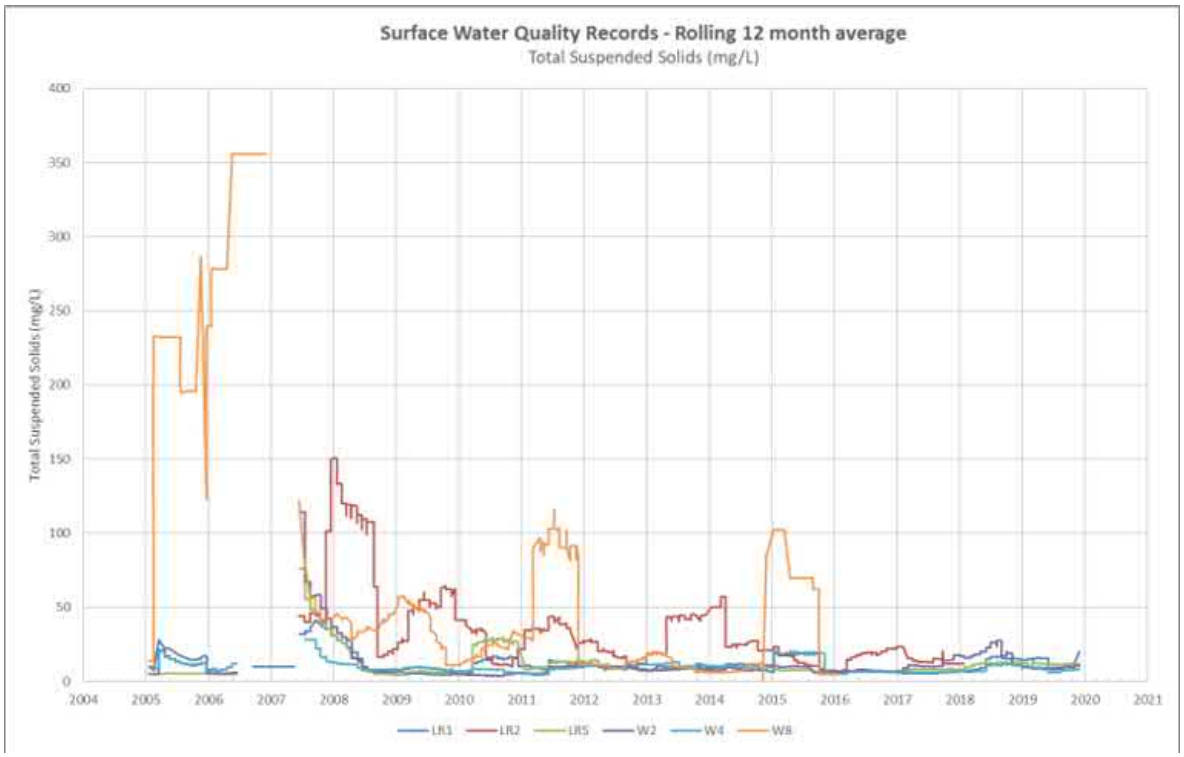


Figure 19 Long Term Surface Water TSS Results

Seasonal variations in pH, EC and TSS are evident at the sites along Wollombi Brook (LR1, LR5, W2 and W4) with values generally remaining within the predicted ranges shown in **Table 36**. Variations in pH and EC since 2018 are interpreted to be a function of the ongoing drought conditions and absence of stream flows.

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 sedimentation. 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

During 2019, Bulga Coal had one water related incident where two decommissioned pipelines underneath a dirty water drain failed, causing approximately 1.4 ML of sediment laden water to be discharged into Nine Mile Creek.

The two pipes from which the discharge occurred were installed in 2015 at ground level during the construction of an elevated dirty water drain to convey clean water through the construction zone. The eastern ends of the pipes were sealed in July 2017 and the pipes decommissioned immediately prior to the catchment reporting to them being cleared to enable overburden emplacement.

Substantial rainfall events occurred between July 2017 and September 2019 without any discharge being detected from the pipelines. Bulga Coal believes that the integrity of the pipes was likely compromised as a result of either placement of overburden or installation of overlaying tailings and decant pipelines.

Bulga Coal received at $15,000 Penalty Notice from the EPA in December 2019 as a result of the incident.

7.4 Groundwater

7.4.1 Environmental Management

Groundwater is managed in accordance with the approved *Water Management Plan*.

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.

The groundwater monitoring network consists of a total of 49 groundwater monitoring points shown in **Figure 7**. The monitoring network comprises both standpipe piezometers (45) and multilevel vibrating wire piezometers (4).

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 4 multi-level 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 45 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 – 2019 Annual Averages

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Lab pH	Lab EC (µS/cm)
Broke Area Alluvials				
GW1	4.5	87.8	6.9	3,416
GW2	3.3	83.0	7.0	5,753
GW3	2.6	75.3	6.9	5,845
GW4	2.6	78.0	7.4	1,720
GW5	2.7	79.3	6.9	5,685
GW6	3.7	73.3	7.4	7,600
GW7	2.2	73.0	7.2	4,372
GW8	4.0	71.2	6.8	5,367
GW9	2.4	71.4	6.8	4,655
GW10	1.9	71.4	7.5	2,883
V3	7.1	68.4	7.4	2,333
Broke Area Wollombi Seam				
P2	7.3	67.3	7.1	12,105
P5A	7.7	68.4	7.6	3,872
P6A	19.1	66.0	7.5	1,828
Northern Area Shallow Alluvials				
F1	7.1	63.0	8.0	1,366
F2	6.0	64.0	7.3	1,714
WBR50A	8.0	57.1	7.3	11,790
V1	7.4	63.6	7.7	1,570
V2	8.0	59.3	6.8	396
SBC/Broke Area Lower Whybrow Seam				
P6B	104.5	-19.4	8.1	6,683
P8	14.8	73.4	6.8	5,461
Northern Area Lower Whybrow Seam				
WBR50	38.3	26.3	7.6	8,040
Northern Alcheringa Seam				
WBD62A	16.9	63.3	7.2	1,369
Beltana Area Miscellaneous Bores and Wells				
Dwyers	9.0	61.1	7.4	1,683
Fernance	6.0	62.6	7.9	1,337
McG1	20.9	91.6	7.9	633

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Lab pH	Lab EC (µS/cm)
White1	6.4	64.2	7.1	2,462
WBR15	18.6	59.5	7.4	1,132
Beltana Area NPZ				
NPZ3-A	Blocked and flooded during 2017.			
NPZ3-B	12.5	60.2	7.4	858
NPZ4-A	23.6	59.0	6.9	672
NPZ4-B	32.3	49.7	7.7	1,310
NPZ5-A	11.8	62.7	7.0	912
NPZ5-B	25.3	48.6	7.5	2,778
NPZ7-1	12.4	56.6	7.6	1,228
NPZ7-2A	8.4	62.2	7.6	2,063
NPZ7-2B	17.2	53.0	7.7	1,479
NPZ7-3A	-[1]	-	-	-
NPZ7-3B	17.3	56.3	7.5	1,526
Wollombi Alluvials and Shallow Coal Measures				
WBD160	9.8	64.0	7.0	1,172
WBR180	34.4	35.5	7.2	18,433
WBR181	8.7	59.9	7.3	3,965
WBR182	7.7	61.9	7.3	1,437
WBR183	14.4	60.2	7.1	3,723
SBD196	5.8	67.2	7.0	4,723
WBR240	6.8	58.6	7.1	23,162
WBR241	8.5	59.8	6.6	400

1 – no results available for 2019.

2019 Bulga Coal Complex Annual Groundwater Monitoring Report

Jacobs have produced the *2019 Bulga Coal Complex Annual Groundwater Monitoring Report* (Jacob, 2020) which is attached as **Appendix C**.

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 2019 predominantly in response to the continued low rainfall/surface flows and the draw for agricultural irrigation.

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

With the cessation of underground mining the combined Blakefield and Whybrow seam working are now filling with groundwater. 396 ML was drawn from the Beltana goad (Whybow seam) in 2019 with a net decrease in storage of approximately 70 ML is consistent with the groundwater model inflow predictions of 245 ML.

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 (Jacob 2020). It is of note that in most of the alluvial aquifer piezometers the recent groundwater levels are still above those recorded before the 2007 Pasha Bulker storm event. Detailed groundwater monitoring trend graphs are presented in the *Annual Groundwater Report* (Jacobs, 2020) which is attached as **Appendix C**.

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 DPIE-RR with this Annual Review. The table outlining the progression towards the completion criteria attached as **Appendix D.**

The table presented in **Appendix D** 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 2019 were:

- Shaping of overburden dumps to between 10 and 14 degrees;
- Removal of decommissioned infrastructure (where required);
- Installation of contour drains and drop structures;
- 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 2019 is presented in **Table 38** and is shown in the plan included as **Appendix E**.

Table 38 Rehabilitation Status at Bulga Coal

Mine Area Type	Previous Reporting Period (Actual) 2018	This Reporting Period (Actual) 2019	Next Reporting Period (Forecast) 2020
Total mine footprint	3,290.7	3,361.3	3,455.3
Total active disturbance	2,471.7	2,422.2	2,434.2
Land being prepared for rehabilitation	174.1	131.2	88
Land under active rehabilitation	829.2	960.4	1,048.4
Completed rehabilitation*	0	0	0

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

8.2.2 2019 Rehabilitation – Bulga Open Cut

During 2019, Bulga Open Cut predominantly completed rehabilitation in two separate areas, those being:

- The Noise and Visual Bund (121.2 ha); and
- Eastern Emplacement Area (8.2 ha).

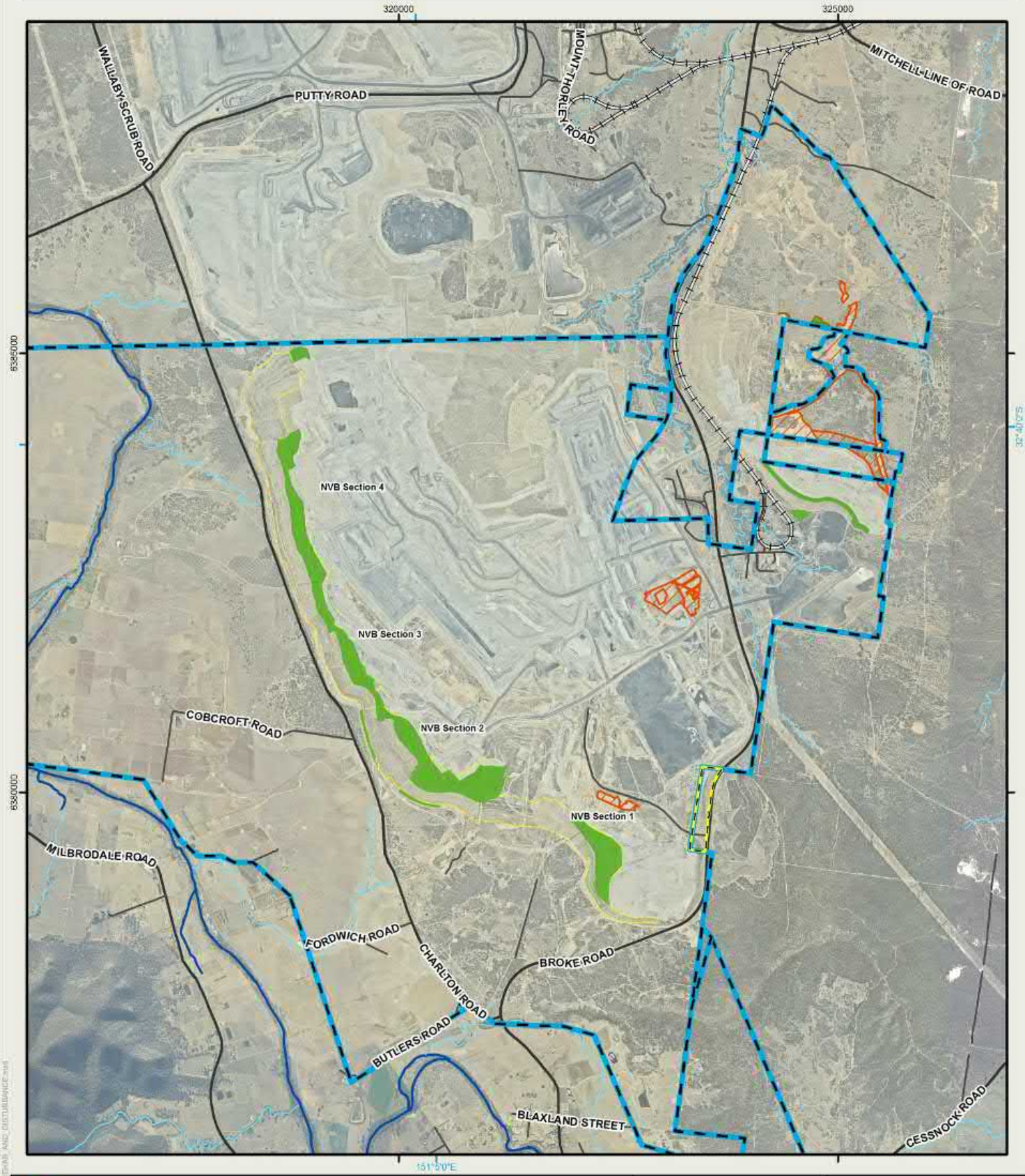
A small area (1.7 ha) of rehabilitation was also completed at the CHPP where a former laydown area was relocated and decommissioned.

Rehabilitation and disturbance at Bulga Open Cut is shown on **Figure 20.**

8.2.2.1 Landform Details

The Noise and Visual Bund rehabilitation for 2019 was spread out along most of the length of the bund (see **Figure 19**). A detailed drainage design was completed in 2015 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 incorporated contour banks and drop structures to help reduce the potential impacts associated with subsidence that would be caused by the approved (but currently suspended) Blakefield North underground mine and subsequent seams.

FIGURE 20 - BOC REHABILITATION AND DISTURBANCE 2019



Mining Lease
Mining Lease AMA
Major road
Minor road
Railway
Wollombi Brook
Minor Watercourse
NVB Outer Face Boundary
2019 Rehabilitation
2019 Disturbance

0 0.45 0.9 1.8
Kilometres

Coordinate System
GDA 1994 MGA Zone 56
1:60,000 @ A4

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The rehabilitation on the Noise and Visual Bund section generally consisted of a gentle slope of around 10 degrees, although one section was slightly steeper at between 12 to 14 degrees. This steeper section was above sediment dam S10 and is consistent with the approved final landform in this area. All drainage along the Noise and Visual Bund consisted of contour banks and drop structures in accordance with the detailed drainage design.

The rehabilitation of the Eastern Emplacement Area continued, with 8.2 ha being completed on the southern lobe. Rehabilitation in this area was 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.

During 2019, a Geofluv landform design was developed for the remainder of the Eastern Emplacement Area southern dump. This will be implemented on the eastern and western faces of the dump from 2020 onwards.

8.2.2.2 Cover Materials

Due to the reduced disturbance in 2019, the majority of the topsoil for rehabilitation was sourced from stockpiles along the Noise and Visual Bund, with the 8.2 ha completed at the Eastern Emplacement Area being direct emplaced. All topsoil stockpiles were scalped to remove any weeds.

Gypsum was applied at a rate between 5 t/ha and 10 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 it 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. Further detail on this material and its management is provided in the Bulga Open Cut MOP.

8.2.2.4 Vegetation Species

Revegetation activities in 2019 focussed on the establishment of the *Central Hunter Grey Box – Ironbark Woodland* on both the Noise and Visual Bund and the Eastern Emplacement Area.

The seed mix 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 2019, 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 2019.

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 2019 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
	2019 (actual)	2020 (planned)	
Additional erosion control works (drains re-contouring, rock protection)	<1	1	Some contour bank breaches and other rilling was repaired during 2019, along with two drop structures that had partially failed. Further contour and rilling repairs are planned for 2020.
Re-covering (further topsoil, subsoil sealing etc.)	0	0	No re-covering undertaken in 2019 or planned for 2020.
Soil treatment (fertiliser, lime, gypsum etc.)	0	75	No areas required further soil treatment during 2019. Fertiliser application is planned for approximately 75 ha of the Noise and Visual Bund in 2020.
Treatment/management (grazing, cropping, slashing etc.)	0	0	No areas in 2019 or 2020.
Re-seeding/replanting (species density, season etc.)	20	0	Supplementary tube stock planting was completed in rehabilitation areas in 2019. No planting is planned for 2020 due to the ongoing drought conditions.
Adversely affected by weeds (type and treatment)	240	300	Weed control works in 2019 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 2020 with new rehabilitation areas being added to the program as required. The main weeds being controlled are Galenia, Acacia Saligna and Lantana.
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 2019, tube stock overplanting was conducted on some of the 2016 and 2017 rehabilitation areas on the Noise and Visual Bund. Planting with 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, such as Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Box (*Eucalyptus moluccana*), wattle species (*Acacia* spp.) and Sticky Hop Bush (*Dodonaea viscosa*).

Tube stock planting was also completed on the Southern Extension dump, where mulching had taken place to thin out excessively dense canopy species. This planting consisted of a range of mid storey shrubs and native groundcovers to increase the structural and species diversity in this rehabilitation area, such as wattle species (*Acacia* spp.), Gorse Bitter Pea (*Daviesia ulicifolia*), Blackthorn (*Bursaria spinulosa*) and Many-flowered Mat-rush (*Lomandra multiflora*).

No planting has been planned for 2020 due to the ongoing drought conditions. Planting for future years will continue once conditions improve.

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 Modification 3 currently with DPIE for consideration. All other areas required only minor weed control works as part of the regular maintenance program.

8.2.3 2019 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 2**. 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 landform. 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.

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 is subject to weather conditions (seeding will be delayed during windy conditions). The seed mix is applied to ensure consistent ground cover.

All 2019 rehabilitation areas were covered with topsoil sourced from onsite. Topsoil was generally sourced from stockpiles directly associated with the rehabilitation activity.

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 2019 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
	2019 (actual)	2020 (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.)	5	3.5	Fertiliser used in seed mix for rehabilitation.
Treatment/management (grazing, cropping, slashing etc.)	0	0	-
Re-seeding/replanting (species density, season etc.)	5	0	Supplementary seeding of rehabilitation maintenance and repairs identified in quarterly rehabilitation inspections.
Adversely affected by weeds (type and treatment)	As required	As required	Weed management activities were ongoing for 2019. 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 2019 Bulga Underground Operations continued to demolish and/or dismantle redundant infrastructure including:

- Equipment laydown areas;
- Gas drainage pipelines and tracks;
- Subsidence survey pegs; and
- Boreholes.

8.4 DPE-RR Sign-Off on Rehabilitation

In 2019, 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 2019 against the MOP predictions.

Table 41 Bulga Coal MOP Rehabilitation Predictions against 2018 Data

Mine Area Type	2019 Actual Data (Bulga Coal)	MOP Prediction 2019 (MOP Amendment B)
Rehabilitation (ha)	131.2	111.9
Disturbance (ha)	64.8	63.5

During 2019, the rehabilitation target was exceeded by approximately 20 ha, and was largely completed in the same areas as outlined in the MOP.

Disturbance was 1.3 ha less than that proposed in the MOP. 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. The current total cumulative rehabilitation area is 9.5 ha less that proposed, mainly due to the inside dumps of Noise and Visual Bund Section 2 progressing slightly slower than planned.

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 2019, the existing annual rehabilitation monitoring was continued and expanded to include recently rehabilitated sites. 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 April 2019 (Emergent Ecology, 2019). As requested, a copy of the rehabilitation monitoring report has been provided to the DPIE-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 D.**

8.6.1.1 Woodland Rehabilitation Site Monitoring

Overall, the 2019 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. Rehabilitation site EEA2 slightly exceeded the target score of 50, whilst site OTD5 was just short of the target at 49.2. All other rehabilitation sites (EEA1, EEA6, NVB1, NVB3, OTD1 and SE1) ranged from 34.6 to 41.5. These scores are similar to the 2018 results and indicate that the rehabilitation is progressing well despite the ongoing drought conditions, particularly EEA2 which was only seeded in March 2018.

Most rehabilitation monitoring sites scored well with regard to tree, shrub and grass richness, with all but two sites meeting the targets for these attributes. Canopy, shrub and grass cover have all improved from 2018 despite conditions and are meeting or trending towards meeting the target. Forb, fern and other richness and cover are generally not meeting targets; however this is a direct reflection of the age of the rehabilitation sites and will increase over time. Exotic plant cover scores met the benchmark at all rehabilitation monitoring sites.

Overall, rehabilitation monitoring data indicates that rehabilitation is progressing well towards the closure criteria with 10 of the 15 completion indicators achieving the closure criteria benchmark for at least half of the sites and only three completion indicators having the lowest score for at least half of the sites (refer to **Appendix D**). Recommendations have been made to improve rehabilitation practices/management to assist in meeting the criteria and they broadly include:

- Continue existing annual pest management programs;
- Continue existing weed management programs targeting high risk invasive plant species; and
- Repair minor erosion in the vicinity of EEA2 monitoring site.

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. One red TARP trigger was identified during the 2019 monitoring, which was for a high weed cover at monitoring site NVB3. NVB3 has a high cover of non-invasive weed species and low cover of High Threat Exotic species. These species are likely to reduce as the shrub and canopy layers develop and no action is required other than the continuation of the existing weed control program.

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 2019 were Galenia (*Galenia pubescens*), Golden Wreathe Wattle (*Acacia saligna*) and Lantana (*Lantana camara*).

As part of the dog baiting program, 1080 baits were placed in rehabilitation areas where wild dogs had previously been identified.

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 2019 some minor rilling was found on the Noise and Visual Bund and Eastern Emplacement Area and these areas were repaired and seeded with pasture seed. Two contour banks which had minor failures were also repaired in 2019.

Ongoing monthly rehabilitation inspections will identify any maintenance required throughout 2020.

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 2019 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 2019. Drains such as contour banks and diversions required little to no maintenance. During 2019 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 2020

Bulga Coal plans to undertake the following rehabilitation and disturbance works during 2020:

- 124 ha of disturbance;

- 88 ha of rehabilitation (levelled/re-contoured, topsoiled and seeded);
- 101 ha of temporary rehabilitation (seeding for stabilisation and reduced air quality impacts);
- 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 2020 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.

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 2019 the barbeques were attended by:

- 80 community members in Bulga and 67 in Broke during March 2019; and
- 54 community members in Bulga and 86 in Broke during November 2019.

At all four barbeques residents were provided with mining updates and updates on the proposed modifications to development consents SSD-4960 (Mod 3) and DA 376-8-2003 (Mod 7).

9.1.2 SSD-4960 (Mod 3) and DA 376-8-2003 (Mod 7) Community Consultation

The results of the environmental assessments for SSD-4960 (Mod 3) and DA 376-8-2003 (Mod 7) were communicated to local residents in the first half of 2019. One on one meetings with local landholders, a community drop in session and a newsletter summarising the results were provided to the community.

In October, Bulga Coal notified residents in Bulga, Milbrodale and Broke that SSD-4960 (Mod 3) and DA 376-8-2003 (Mod 7) were on public exhibition via a letter in letterboxes. A community newsletter in December also provided an update noting Bulga Coal was preparing a response to the community and government agency submissions to DPIE.

9.1.3 Community Consultative Committee

Bulga Coal enjoys an open and honest dialogue with community representatives and Singleton Council through a combined Community Consultative Committee (CCC) for Bulga Underground and Bulga Open Cut. Bulga Coal hosted CCC meetings in May and October 2019. Minutes from the CCC meetings are available on the Bulga Coal website.

In June 2019, Independent Chair John Turner was appointed to the Bulga Coal CCC. Community representative Mike Wilson was appointed to the Bulga Coal CCC in July 2019.

In September 2019, Bulga Coal received a Show Cause Notice from DPIE for allegedly failing to operate the CCC in accordance with the CCC Guidelines. After providing a response, Bulga Coal received a warning letter from DPIE for failing to comply with Schedule 5, Condition 6 of SSD-4960. This non-compliance is discussed further in **Section 11**.

9.1.4 Voluntary Planning Agreement

A Voluntary Planning Agreement Committee was formed in 2015 with members of the Broke and Bulga communities, Singleton Council and Bulga Coal to administer funds associated with the Village Master Plan. All funds have been allocated to projects with the following activities occurring in 2019:

- Three picnic tables and shade structures were replaced in the Bulga Recreation Ground;
- The Clubhouse at the Bulga Recreation Ground was upgraded;
- The playground shade structure, surrounds and soft fall were ordered for the Bulga Recreation Ground and construction is expected to start in early 2020; and
- Council facilitated consultation with Broke School and local residents about designs for the Skate Park, seating and barbeque facilities at McTaggart Park, Broke. Construction started in March 2020.

9.1.5 Newsletters

A booklet summarising the environmental assessments for the proposed SSD-4960 (Mod 3) and DA 376-8-2003 (Mod 7) was distributed to letterboxes in Broke, Milbrodale and Bulga in April 2019. A community newsletter was distributed to letterboxes in Broke, Milbrodale and Bulga in December 2019. The newsletters are available on the Bulga Coal website.

9.1.6 Quarterly and Annual Stakeholder Meeting

Bulga Coal held quarterly meetings with Aboriginal stakeholders in 2019 to discuss the progress of the Aboriginal Cultural Teaching and Keeping Place and other relevant issues. The meetings were held March, June, September with the annual meeting held in November. The minutes of the meetings are available on the Bulga Coal website. Aboriginal heritage is discussed in **Section 6.9**.

9.1.7 Tours

Bulga Coal participated in the Upper Mining Dialogue Schools Program with 40 year 5 students visiting the mine in September 2019.

Bulga Coal also hosted a community rehabilitation tour with 11 local residents to view and discuss rehabilitation objectives and outcomes (**Photo 4**).

Photo 4 Rehabilitation Tour for Community Members

9.2 Community Sponsorship and Donations

Bulga Coal contributed approximately $70,000 in sponsorships and donations in 2019 to the projects and organisations listed below. A further $365,182 worth of contributions were paid to Singleton Council for local projects in the Voluntary Planning Agreement Part A: Implementation of Master Plan (see **Section 9.1.4**).

9.2.1 Broke School

The school purchased 33 iPads and cases from the annual contribution in Bulga Coal's Voluntary Planning Agreement (**Photo 5**).

The Bulga school and the Parents and Citizens Group received two grants from the Glencore grants rounds; lowering the cost of swimming lessons and money for a bush tucker garden program that will start in 2020.

The Broke Parents and Citizens Group were also successful in securing a $50,000 grant from Glencore grant round for new playground equipment. The playground equipment will be installed in Term 1, 2020.

Photo 5 Students at Broke School with iPads donated 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 5,000 visitors. Native trees were handed out in the Bulga Coal marquee and around 300 people participated in bus tours to Bulga Open Cut mine.

9.2.3 Broke Bulga Landcare

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 May 2019, Broke Bulga Landcare engaged Koori Country Firesticks, funded by Bulga Coal and supported by Singleton Council, to undertake a cultural cool burn of approximately 2 ha. This is the third year this weed management activity has been undertaken in the park.

Bulga Coal is a partner of the Wollombi Brook Riparian Rehabilitation Project with Hunter Local Land Services, Broke Bulga Landcare and Singleton Council. The project aims to reduce weed infestations and rehabilitate areas owned by private landholders along the Wollombi Brook. In 2019 Bulga Coal participated in two planting days on two private properties (**Photo 6**). Further planting days are scheduled for 2020.


Photo 6 Tree Plantings organised by Bulga Coal

9.2.4 Community Yoga Classes

Bulga Coal organised free community yoga classes in Bulga and Broke in Summer and Spring in 2019. The aim was to promote well-being, fun and a sense of community.

9.2.5 Sponsorships

Organisations and events that were sponsored by Bulga Coal during 2019 include:

- Singleton Library – Summer Reading Program;
- Broke Public School – iPads, and cases;
- Broke Fordwich Wine and Tourism Association – A Little Bit of Italy Festival and Broke Wine Trail;
- 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 2019:

- Mark Hughes Foundation (Beanies for Brain Cancer);
- Bulga Crafters Group;
- Singleton Public School Support Unit Swimming Lessons;
- Singleton Heights Public School Parents and Citizens School Fete;
- Camp Quality 1000Ks 4 Kids;
- Cancer Council Dancing with the Stars Hunter Valley;
- Firefighter Stair Climb;
- Variety Bash;
- Paxton Bowling Club; and
- Special Children's Christmas Party.

9.3 Community Complaints

During the reporting period, 24 community complaints were recorded from 13 stakeholders. 11 of the 24 complaints related to noise, received from 7 stakeholders. The other complaints related to lighting (5), dust (4), visual impact (2), blast vibration (1) and blast dust (1).

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

Table 42 Summary of Complaints by Issue 2015 – 2019

Complaint Type	2015	2016	2017	2018	2019
Blast vibration/ overpressure	0	3	0	0	1
Lighting	11	5	3	3	5
Dust	4	0	3	3	4
Noise	13	10	9	14	11
Traffic	0	0	1	0	0
Visual Amenity	0	0	0	2	2
Odour	0	0	0	0	0
Fume	0	0	0	0	0
Other	0	0	1	0	1
Total	**28**	**18**	**17**	**22**	**24**

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.

Noise

Each noise complaint was investigated. Where the noise levels were found to be above the relevant criteria at the nearest real-time monitor or by the handheld 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.

Dust training

In 2019, the entire workforce (770 people) were taken to an elevated location in the community to help them understand the proximity and diversity of the community near our mine (**Photo 7**). The training reinforced all environmental aspects with an emphasis on dust management.

Photo 7 Dust Awareness Training undertaken by the Bulga Coal Workforce

9.4 Community Feedback

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

Bulga Coal consulted with the community about the results of the environmental studies of the proposed SSD-4960 (Mod 3) and DA 376-8-2003 (Mod 7). SSD-4960 (Mod 3) and DA 376-8-2003 (Mod 7) received a total of three community submissions.

10 Independent Audit

In November 2018, an independent environmental audit (IEA) was undertaken for Bulga Coal. The Audit was submitted to the DPIE on 15 February 2019. The audit assessed Bulga Coal's compliance with approvals DA-41-03-99, DA 376-8-2003, SSD-4960, EPL 563, relevant mining leases, exploration licences, water licences and subsidence management plan approvals. The audit also included additional provisions from DPIE and OEH.

A total of 942 conditions and commitments were assessed as part of this audit, which identified 22 issues and resulted in 41 non-compliances. 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.

The audit found that approximately 4% of all conditions and commitments were non-compliant, with 55% compliant and 41% not triggered. A summary of non-compliances and 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 Findings and Action Status from 2019 IEA

Non-Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Action Status
DA-41-03-99 Schedule 2, Condition 6.3.5 & Condition 6.3.6	Cumulative noise impact assessment criteria are not provided in the noise management plan. Cumulative mine noise is not measured during regular noise compliance monitoring. It is not possible, based on the information provide, to determine if the cumulative noise impact assessment criteria are being achieved.	Relinquish DA 41-03-99	June 2020.	Outstanding. Bulga Coal has an extension to relinquish DA 41-03-99 until 30 June 2020.
DA-41-03-99 Schedule 2, Condition 8.2	The Air Quality Management Plan does not include a quality assurance section as per this condition. The Water Management Plan has no references to quality assurance.	Relinquish DA 41-03-99	June 2020.	Outstanding. Bulga Coal has an extension to relinquish DA 41-03-99 until 30 June 2020.
Groundwater Monitoring Program (within Site Water Management Plan) Commitment 10.5	There is no evidence of any model update on a three year cycle or since 2013.	The groundwater model has recently been updated and the results will be included in a revision of the Water Management Plan.	Q3 2020.	Outstanding. Review of the Water Management Plan to include the updated groundwater model results has commenced.

Non-Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Action Status
Groundwater Monitoring Program (within Site Water Management Plan) Commitment 11.2	The TARP addresses the broad management actions but does not adequately describe the actual "measures and/or procedures that would be implemented". Clearly document investigations and outcomes for all aspects of the TARP when it is enacted. The TARP in the WMP should be expanded to clearly state the triggers and identify the specific actions and measures for each of the potential impacts identified in Cond 4.1 (a) to (d) of DA41-03-99 No. 4.1(6). The TARP should clearly assign responsibility and timing for the proposed responses.	Update the TARP in the Water Management Plan.	Q3 2020.	Outstanding. Review of the Water Management Plan to include the revised TARP has commenced.

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} 24-hour average

The 24-hour average PM_{10} exceeded the consent criterion of 50 µg/m³ on multiple days at the monitors surrounding the mine. The majority were caused by wind erosion of dust from other sources upwind of Bulga Open Cut or dust storms moving through the region as well as the NSW bushfires occurring in late 2019. Prolonged drought in NSW increased the amount of exposed area susceptible to wind erosion. Most of the exceedances occurred in summer and spring.

Additional dust controls were typically implemented during strong winds and poor air quality. These included changing to less wind exposed dumps, stopping equipment and hot seating water carts through crib breaks.

Exceedances were investigated and reported to the DPIE. The investigations reviewed the mining activities occurring and air quality management controls implemented to prevent or minimise dust and estimated the maximum contribution from the mine.

The maximum contribution from the mine was estimated to be the total level recorded by the monitor during the period in which it was downwind of Bulga Open Cut, minus the underlying background level recorded at upwind monitors. Weather data from the onsite weather station and PM_{10} data from the Bulga Coal air quality monitoring network and Upper Hunter Air Quality Monitoring Network was used. Further information on exceedances is provided in the Annual Air Quality Report in **Appendix B**.

11.1.2 PM_{10} – Eastern Emplacement Area

As discussed in **Section 6.4,** there were 32 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.

Investigations showed that the exceedances were not attributable to Bulga Coal. Notwithstanding, exceedances were reported to the DPIE. The EEAAQMF was revised to assess whether exceedances were attributable to Bulga Coal or not and only report exceedances that were caused by Bulga Coal to DPIE. The exceedances and identified causes have been summarised in **Section 6.4**. Only one elevated level was measured on a day which was not declared as an extraordinary event day by DPIE.

11.2 Pollution of Waters

11.2.1 Details of the Incident/Non-compliance

On 18 and 19 September 2019, sediment laden water was discharged from an active mining area, through a culvert, into a dry creek bed in Nine Mile Creek. The discharge was caused by the failure of two drainage pipes that were sealed and decommissioned in 2017.

Bulga Coal received a Penalty Infringement Notice of $15,000 from the EPA for breaching Section 120 of the *Protection of the Environment Operations Act 1997 (POEO Act) – Prohibition of pollution of waters*.

11.2.2 Corrective Actions

Sandbag weirs were installed in the dry creek bed to contain the water. Pumps and pipes were installed, and water was pumped back into the Bulga Coal water management system. The drainage pipes and other similar pipes onsite were sealed.

11.3 Failure to Minimise Dust from the Deep Pit Tailings Emplacement Area

11.3.1 Details of the Incident/Non-compliance

On 8 August 2019, an EPA Officer observed significant dust being blown from a tailings emplacement area across Broke Road.

Bulga Coal received an advisory letter from the EPA for allegedly failing to comply with the following conditions of EPL 563:

- O1.1. Licensed activities must be carried out in a competent manner. This includes b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity; and
- O3.1 The premises must be maintained in a condition which minimises or prevents the emission of dust from the premises.

11.3.2 Corrective Actions

To minimise dust, tailings and water were placed on the tailings emplacement area.

The Bulga Coal Air Quality Management Trigger Action Response Procedure was modified to include a trigger to review weather forecasts and consider placing water or tailings on the area prior to dust generating weather.

11.4 Aboriginal Cultural Heritage

11.4.1 Details of the Incident / Non-compliance

As reported in the 2018 Annual Review, two Aboriginal heritage sites were impacted during 2018. OEH and the DPIE were notified of the incident on 6 September 2018 and provided with a detailed report on 12 September 2018.

DPIE carried out an investigation into this disturbance and determined that Bulga Coal committed an offence against section 4.2 of the EP&A Act in not carrying out development in accordance with the conditions of development consent SSD-4960. The DPIE issued Bulga Coal with a warning letter for the breach in 2019.

11.4.2 Corrective Actions

Following the incident in September 2018 when two Aboriginal heritage sites were impacted, the ACHMP was revised and submitted to DPIE on October 2018. The draft ACHMP was then revised again in June 2019 and was approved by DPE on 3 July 2019.

Bulga Coal revised 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. The ACHMP was approved by DPIE on 3 July 2019.

11.5 Administrative Non-compliances

11.5.1 Failure to Monitor PM_{10} Continuously at EPA Point 9 and Point 10

11.5.1.1 Details of Incident/Non-compliance

PM_{10} was not monitored continuously at EPA Point 9 and Point 10 due to the equipment failure. 24-hour average data capture rates of 91%, for EPA Point 9, and 98%, for EPA Point 10, were recorded during the EPL Annual Return reporting period.

11.5.1.2 Corrective actions

The cause of the break downs was investigated promptly, and the monitors were fixed. Details were reported to the EPA in the 2018-2019 Annual Return.

11.5.2 Failure to operate Community Consultative Committee in accordance with DPIE Guidelines

11.5.2.1 Details of the Incident/Non-compliance

During 2019, Bulga Coal received a warning letter from the DPIE with regard to not operating the CCC in accordance with the DPIE CCC Guidelines. The former independent chairperson of the Bulga CCC resigned prior to the meeting held on 9 May 2019. From this time, an employee of Bulga Coal was acting as the chairperson, as agreed by the committee. The employee chaired three meetings on 9 May 2018, 17 October 2018 and 8 May 2019. DPIE appointed an independent chairperson on 20 June 2019.

11.5.2.2 Corrective Actions

DPIE appointed an independent chairperson on 20 June 2019 and the CCC is now operates in accordance with the guidelines.

12 Activities to Be Completed in the Next Reporting Period

12.1 Bulga Underground Operations

The works listed in **Table 44** have been/will be completed in 2020 at Bulga Underground Operations.

Table 44 Bulga Underground Operations Proposed Activities in 2020

Topic	Proposed Activity	By When
Decommissioning	Decommission and demolish redundant Bulga Underground Operations surface infrastructure.	Ongoing
Rehabilitation	Progressive rehabilitation of redundant gas drainage infrastructure, access tracks, pipelines and boreholes on Bulga Coal land.	Ongoing

12.2 Bulga Open Cut

The works listed in **Table 45** have been/will be completed in 2020 at Bulga Open Cut.

Table 45 Bulga Open Cut Proposed Activities in 2020

Topic	Proposed Activity	By When
Construction	Commence construction of new Aboriginal Teaching and Keeping Place at the Wollombi Brook Conservation Area.	Q4 2020
	Construction of a new water cart fill point at the east pit to service the east pit.	Q2 2020
	Construction of a new fuel farm near the area station.	Q2 2020
Approvals	Relinquish DA 41-03-99.	30 June 2020
Rehabilitation	Continue weed control works on the Noise and Visual Bund, Eastern Emplacement Area, Old Tailings Dam and Mount Thorley Warkworth Common Boundary Area based on the findings of monthly inspections for Bulga Open Cut.	Ongoing
	Continue weed control, erosion repairs and planting/seeding to meet the requirements of target vegetation communities at Bulga Underground.	Ongoing

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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.	461 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.	Bulga was unable to meet the 3 year timeline largely due to Glencore (on behalf of Bulga Coal and other Glencore sites) being unable to agree on a conservation mechanism with OEH. However, Bulga Coal has now formerly established these offset sites as Conservation Agreements under the National Parks and Wildlife Act 1974. The Conservation Agreements were signed by the NSW Minister for the Environment on the 7th of May 2019.	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. An updated version of the Biodiversity Management Plan has been submitted to NSW Department of Planning in January 2020 and will be submitted to DEE once initial comments are received.	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: a). management actions, mitigation measures and practices designed to limit impacts of the proposal on surface and groundwater resources;	The Water Management Plan was approved by the DEE in February 2017.	Compliant
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

Condition	Actions During the Reporting Period	Status
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 2019 via file transfer. The document was put up onto the website on the 28th of March 2019.	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 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.	No directions for an independent audit of compliance with EPBC Ref: 2012/6637 have been received by Bulga Coal.	Compliant
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

Condition	Actions During the Reporting Period	Status
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

Air Quality Monitoring Data Review and Analysis at Bulga Complex 2019
(Todoroski, 2020)

AIR QUALITY MONITORING DATA REVIEW AND ANALYSIS AT BULGA COMPLEX 2019

Bulga Coal

7 February 2020

Job Number 14070348M

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Air Quality Monitoring Data Review and Analysis at Bulga Complex 2019

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	06/02/2020	K Trahair	D Kjellberg
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1 INTRODUCTION

This report has been prepared by Todoroski Air Sciences on behalf of Bulga Coal. 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 2019 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 2019.

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.

It is noted that in 2019 there were 54 days declared as "extraordinary events" for Bulga. The predominant cause of these extraordinary events was smoke associated with the 2019/2020 bushfires. In addition, drought conditions in 2019 would have contributed to the dust levels in the vicinity of Bulga with higher background levels and an increased frequency of dust storms. This assessment considers both the annual averages calculated for all days and excluding these extraordinary event days. **Appendix A** provides a list of the extraordinary event days in 2019.

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 2019 annual wind distributions at the weather stations. The weather stations experienced similar wind patterns with relatively strong winds from the northwest quadrant, east, east-southeast and south directions dominating the annual distribution. All stations recorded very few winds from the northeast. The Flares weather station experienced lower wind speeds compared to the other two stations and had a greater percentage of winds from the south.

Figure 2-3 shows the seasonal windroses at the weather stations for 2019. 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.

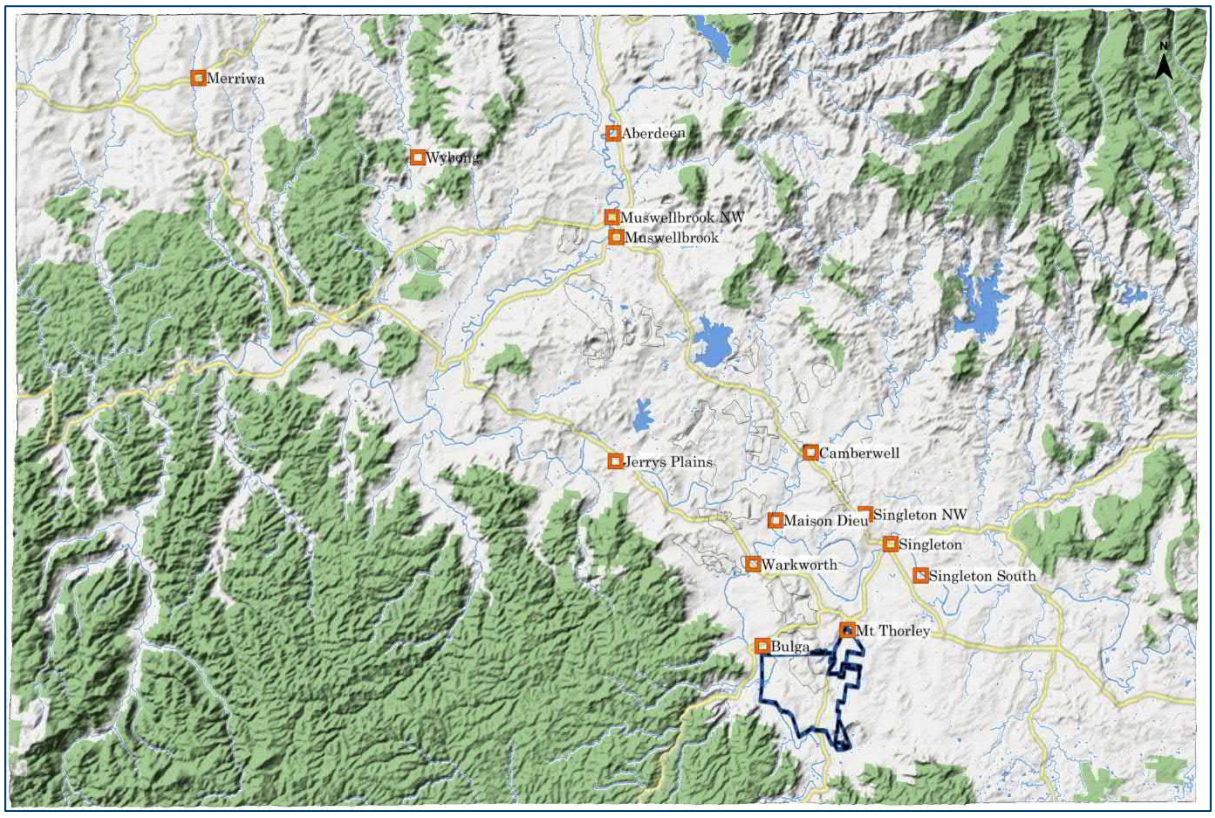


Figure 2-1: Site Location

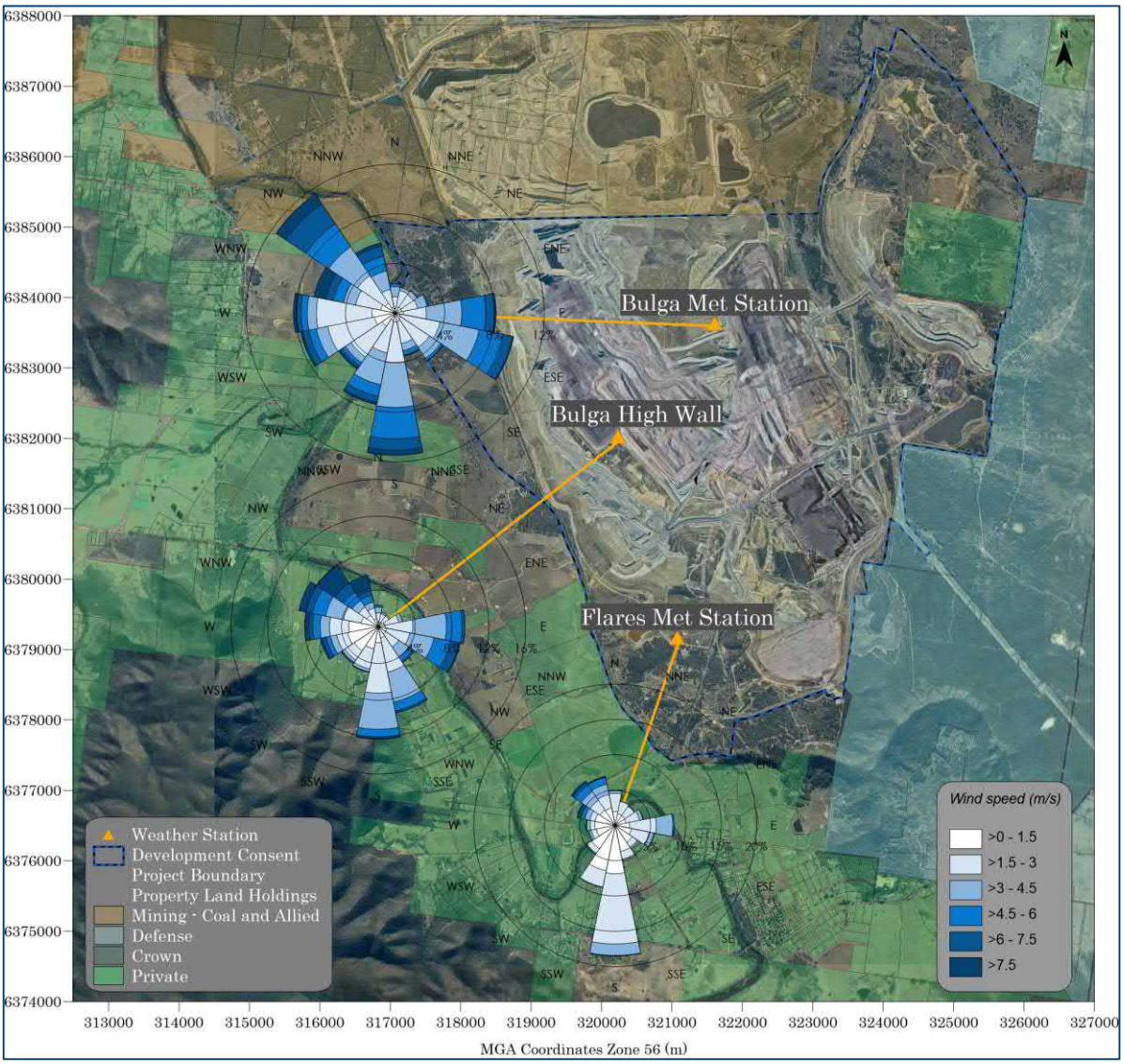


Figure 2-2: Annual windroses (2019)

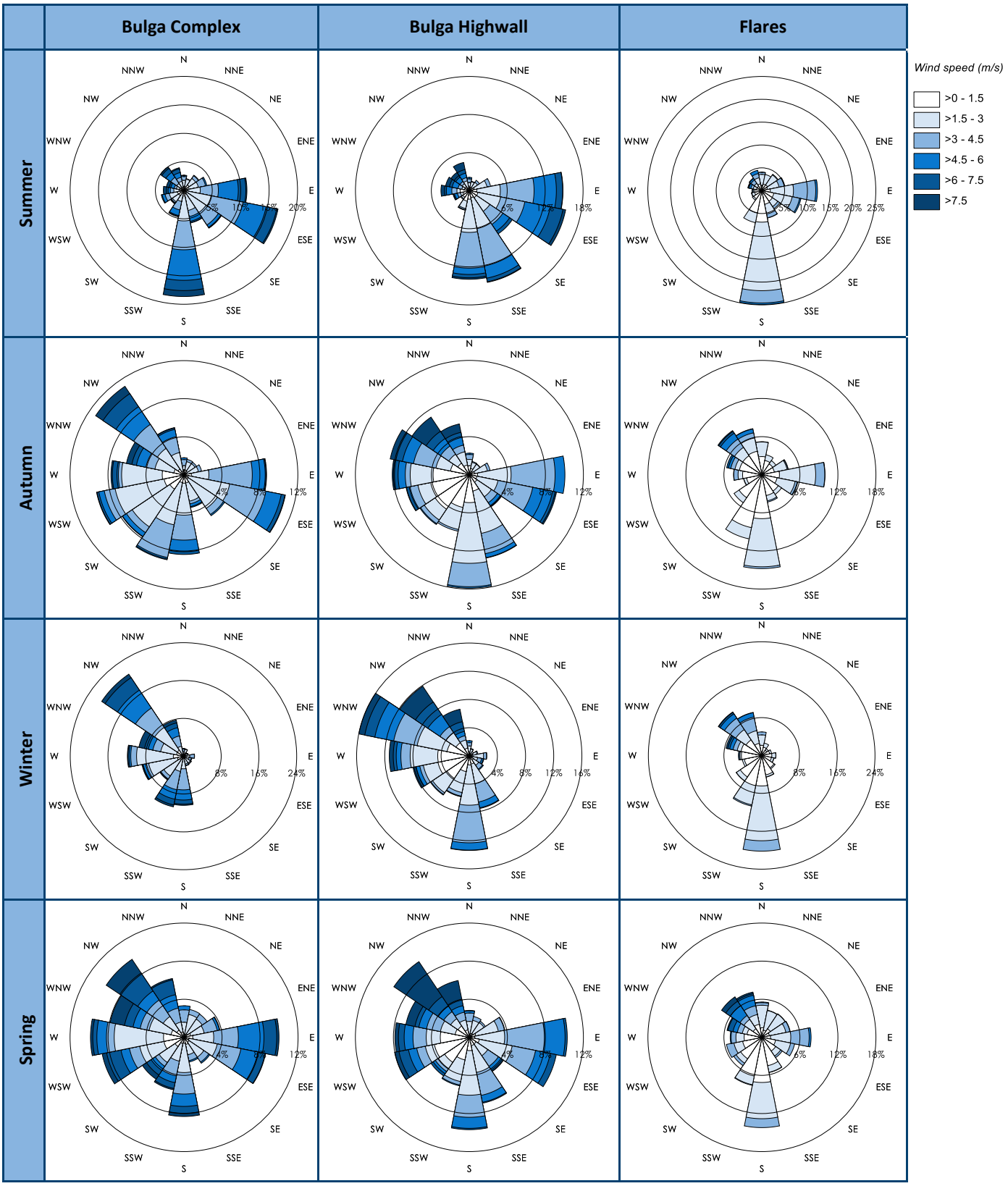


Figure 2-3: Windroses for each season of 2019 for the Bulga Complex, Bulga High Wall and Flares weather stations

3 COMPARISON OF MEASURED 2019 DATA AND MODEL PREDICTIONS

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

Monitoring data collected at these locations during 2019 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**).

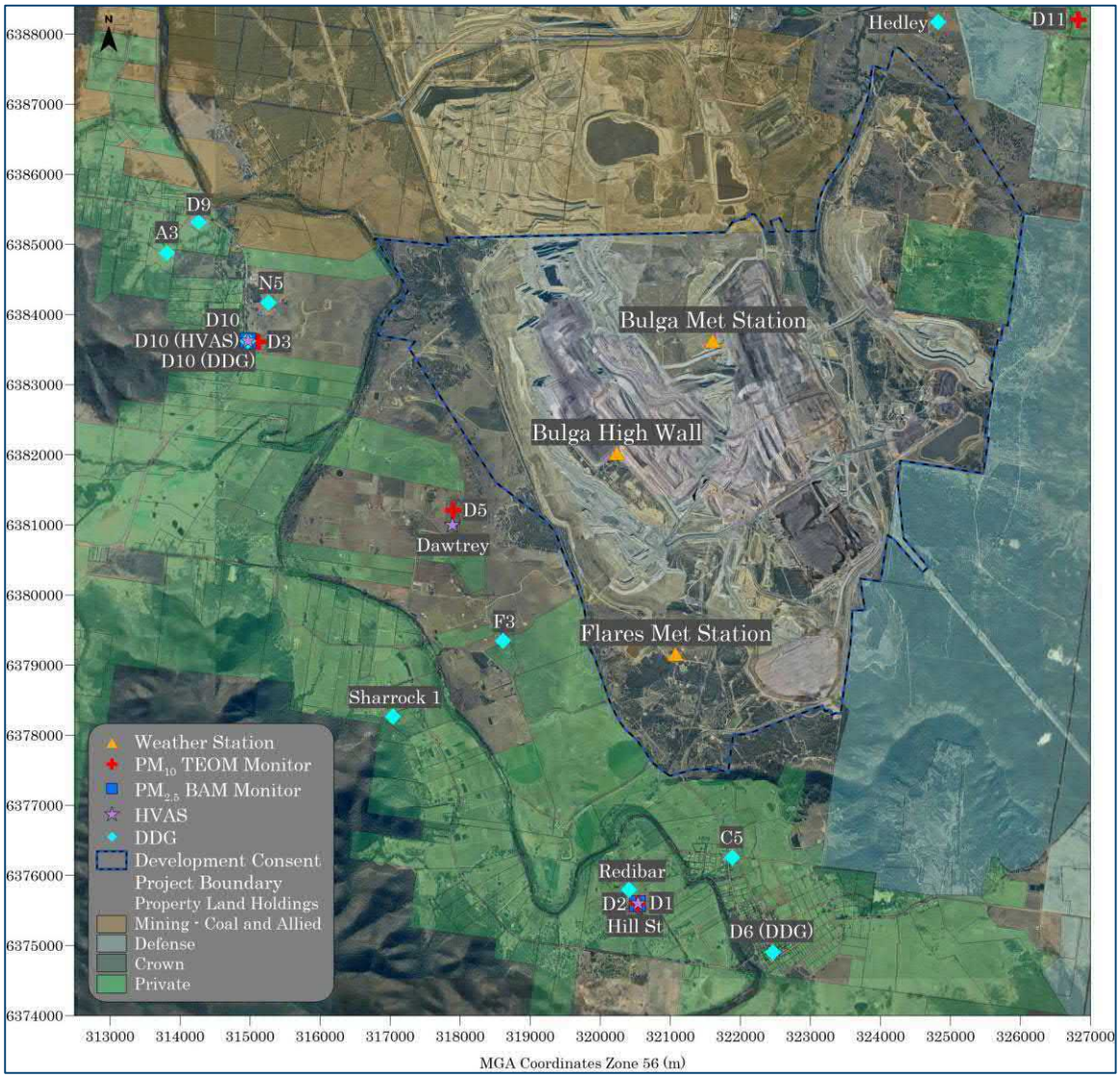


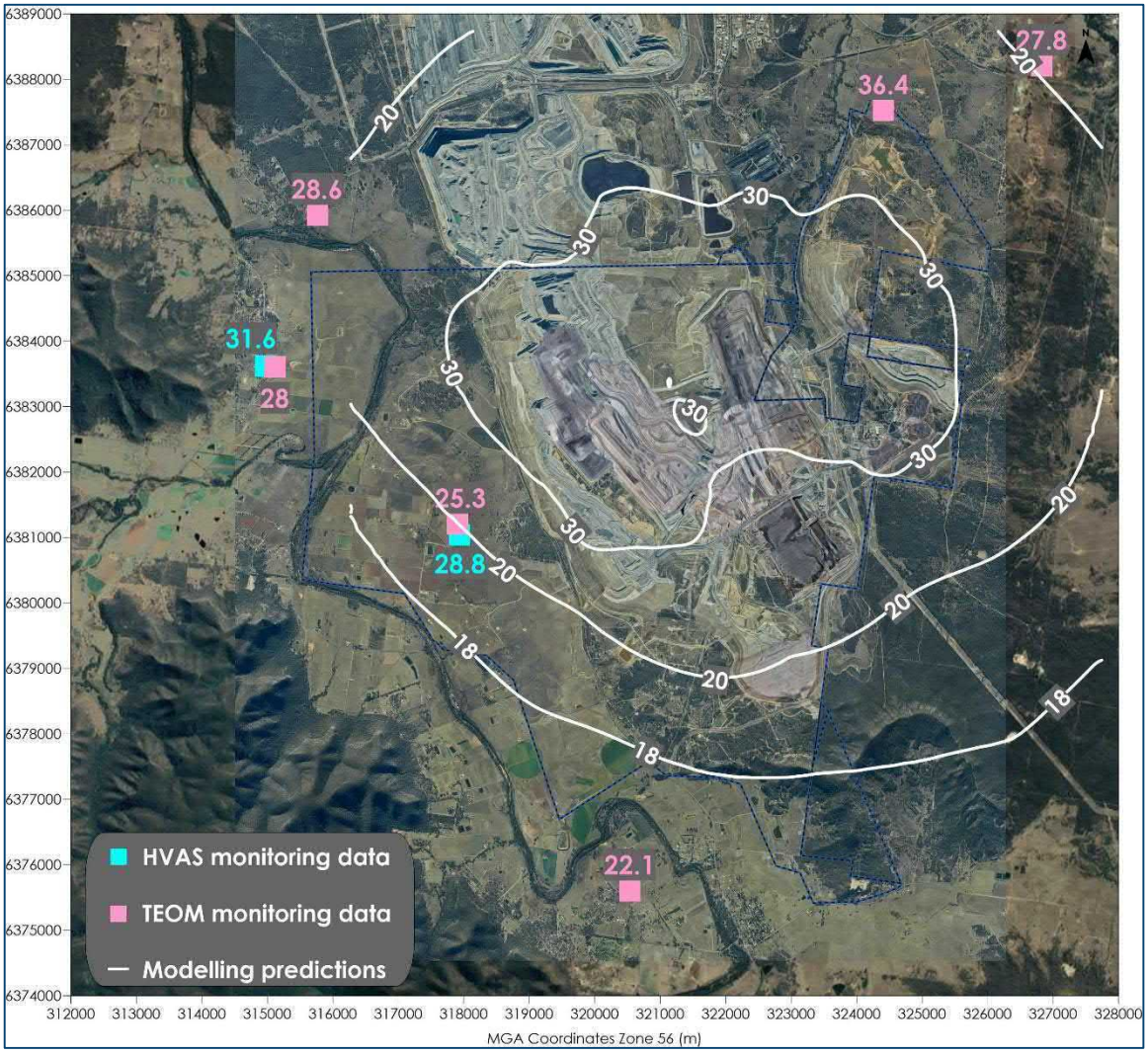
Figure 3-1: TEOM, BAM, HVAS and deposited dust gauge monitor locations

3.1 Annual average PM_{10}

Figure 3-2 and **Figure 3-3** present the measured 2019 annual average PM_{10} data, for all days and excluding extraordinary events respectively, 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 figures include dust levels from Bulga and other sources.

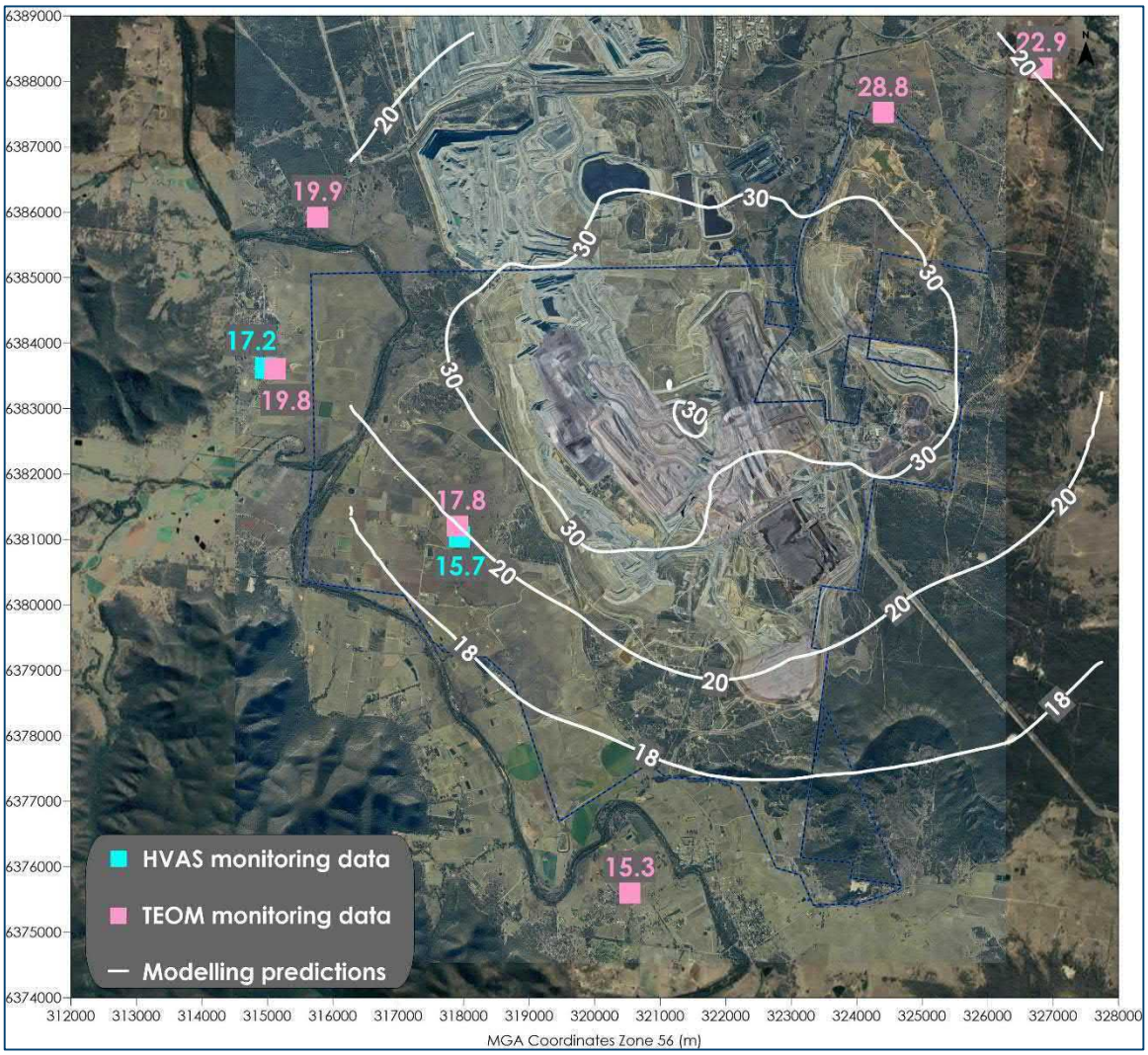
Figure 3-2 shows that the measured PM_{10} levels are higher than the Year 3 modelled levels at the Bulga Complex monitoring stations. The elevated annual average PM_{10} levels measured in 2019 are primarily attributed to smoke associated with the south-east Australian bushfires of 2019/2020.

The measured PM_{10} levels excluding extraordinary events in **Figure 3-3** appear generally in agreement with the model predictions.



Source: **Jacobs, 2016**

Figure 3-2: 2019 PM_{10} annual average monitoring data (all days) superimposed over the predicted PM_{10} annual average modelling contour (Year 3 Bulga plus background)



Source: **Jacobs, 2016**

Figure 3-3: 2019 PM_{10} annual average monitoring data (excluding extraordinary events) superimposed over the predicted PM_{10} annual average modelling contour (Year 3 Bulga plus background)

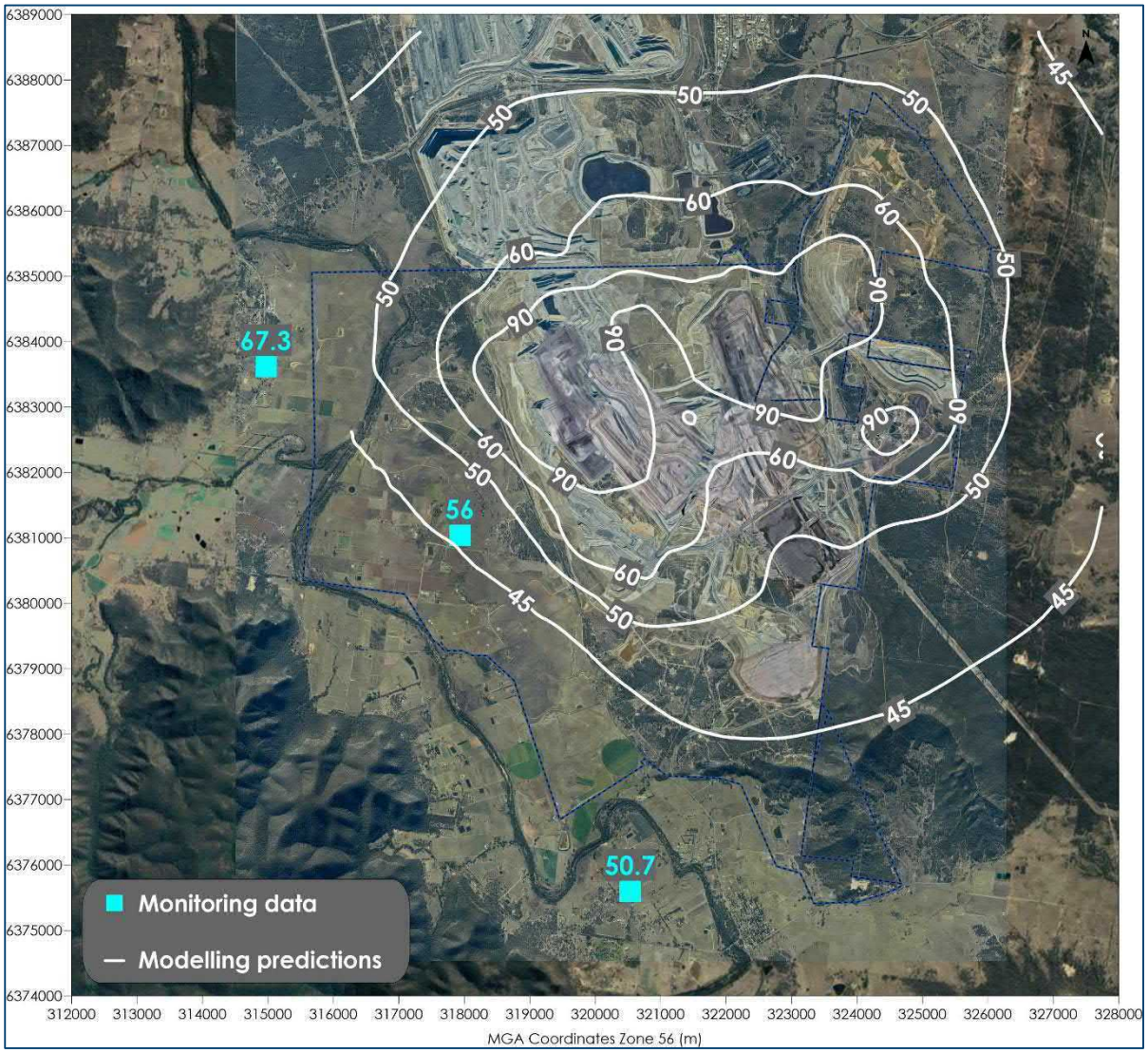
3.2 Annual average TSP

Figure 3-4 and **Figure 3-5** present the locations of the TSP HVAS monitors where the measured TSP data, for all days and excluding extraordinary events respectively, were used to calculate the 2019 annual average TSP concentrations.

The figures present an overlay of the 2019 TSP annual averages over the dispersion modelling predictions. The measured and predicted data in the figures include dust levels from Bulga and other sources.

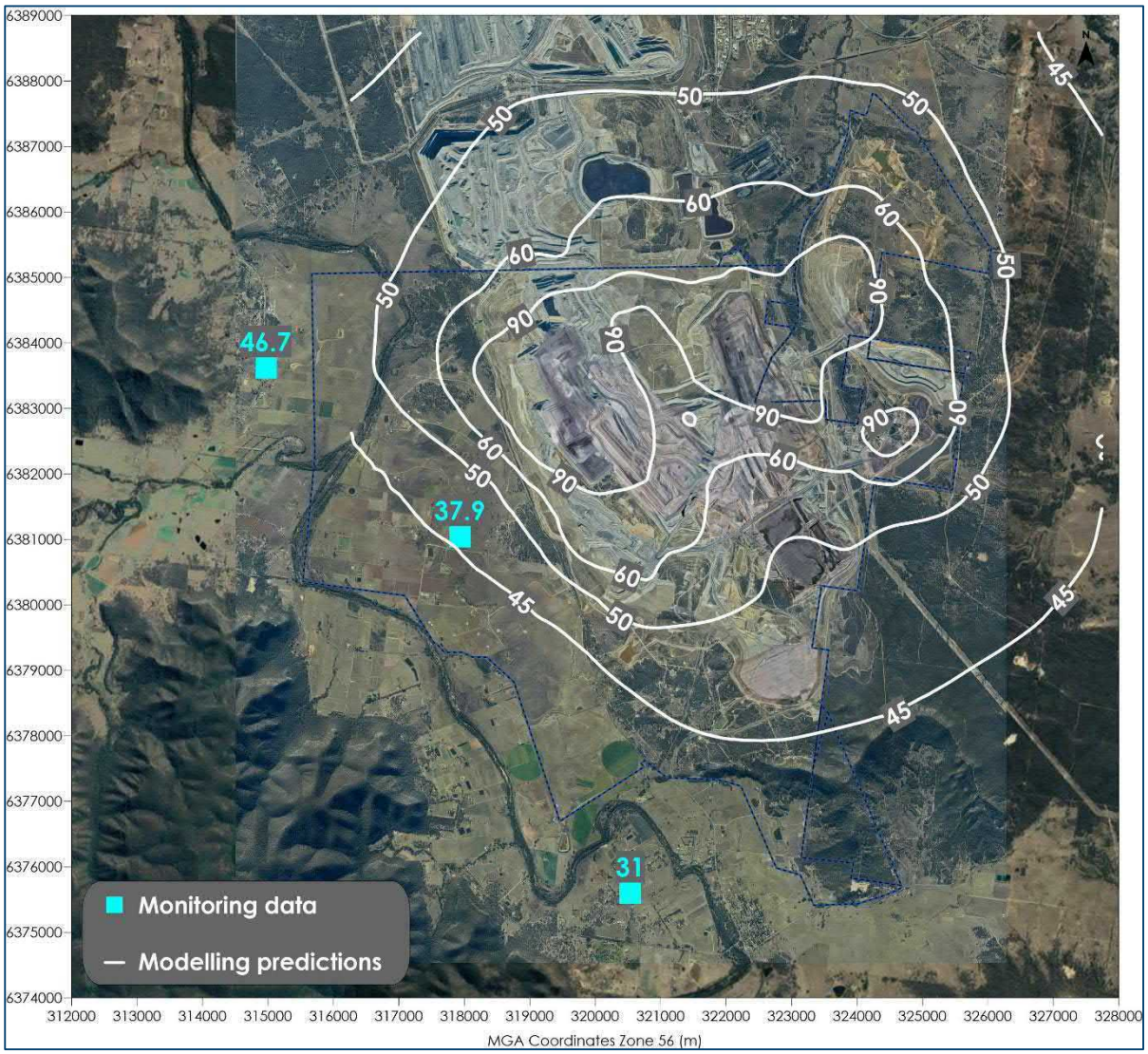
The measured 2019 annual average TSP levels are higher than the Year 3 modelled predictions. Similarly to PM_{10}, the elevated levels are primarily attributed to smoke associated with the south-east Australian bushfires of 2019/2020.

Figure 3-4 shows that the measured TSP levels are higher than the Year 3 modelled levels at the Bulga Complex monitoring stations. The elevated annual average TSP levels measured in 2019 are primarily attributed to smoke associated with the south-east Australian bushfires of 2019/2020.



Source: **Jacobs, 2016**

Figure 3-4: 2019 TSP annual average monitoring data (all days) superimposed over the predicted TSP annual average modelling contour (Year 3 Bulga plus background)



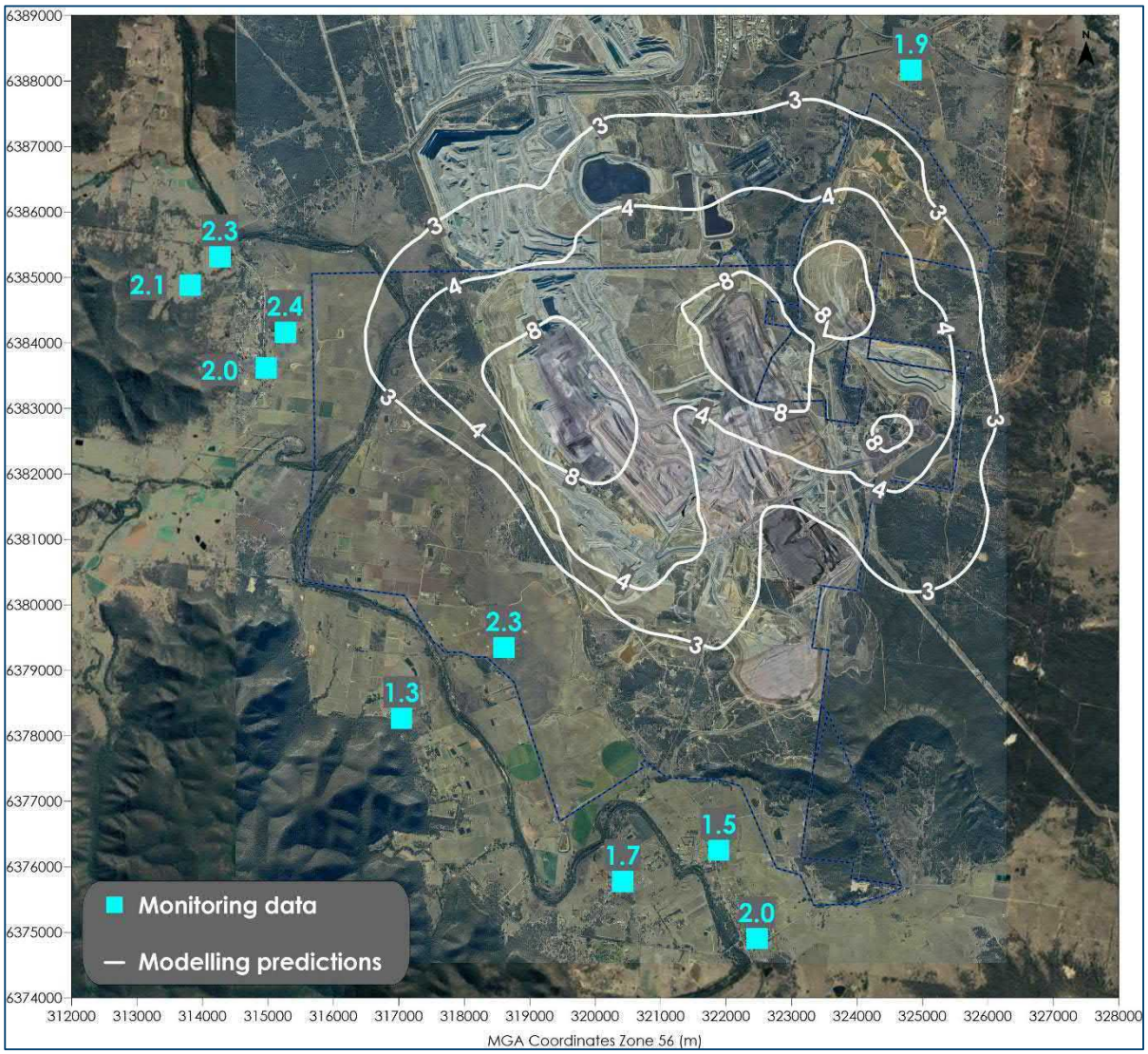
Source: **Jacobs, 2016**

Figure 3-5: 2019 TSP annual average monitoring data (excluding extraordinary events) superimposed over the predicted TSP annual average modelling contour (Year 3 Bulga plus background)

3.3 Annual average deposited dust

Figure 3-6 presents an overlay of the measured 2019 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 deposited dust levels are generally in agreement with the modelled predictions.



Source: **Jacobs, 2016**

Figure 3-6: 2019 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 New South Wales (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/m³

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/m²/month	[a]4g/m²/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/m³;
- Incorporation of 24-hour and annual average standards for $PM_{2.5}$ concentrations of 25µg/m³ and 8µg/m³, 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/m³
	Annual	25µg/m³
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	25µg/m³
	Annual	8µg/m³

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 2019 calendar year. The data in the figures include extraordinary event days. 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. The 2019 annual average $PM_{2.5}$ concentrations for all days were above the relevant criterion of 8µg/m³ and were below the criterion excluding extraordinary events.

The maximum 24-hour average $PM_{2.5}$ concentrations were above the relevant criterion of 25µg/m³ for a significant number of days in 2019. There was only one exceedance at each of D2 and D10 monitors in 2019 which occurred on a day not considered an extraordinary event. **Appendix B** presents a summary of the likely primary causes of elevated days in 2019 which were not declared as extraordinary events.

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

Year	Annual average $PM_{2.5}$ (µg/m³)				
	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
2019	**11.2**	*5.4	**15.4 (73%)**	*7.0	8
Year	**Maximum 24-hour average $PM_{2.5}$ (µg/m³) (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
2019	**188.7 (32)**	***25.3 (1)**	**212.2 (33)**	***25.9 (1)**	25

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

*Excluding extraordinary events

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 $PM_{2.5}$ levels at the end of 2019 are significantly elevated compared with the rest of the data. The levels were affected by bushfire smoke across NSW during the 2019/2020 bushfire season.

Figure 5-2 presents the annual average $PM_{2.5}$ concentrations recorded at the BAM monitors including extraordinary events. The D2 and D10 monitors show generally similar annual average $PM_{2.5}$ levels throughout the monitoring period, until 2019 when the annual average at the D2 monitor is

approximately double that of previous years. Note that there is insufficient data (less than 75%) for an annual average for the D10 monitor in 2019 however it would also have been elevated.

Figure 5-3 presents the 31-day running averages for the 24-hour average $PM_{2.5}$ concentrations (including extraordinary events), daily rainfall and mean daily temperature recorded by the Bulga Complex weather station (where Bulga Complex temperature and rainfall data are unavailable, data from the Bulga DPIE monitor has been used in 2019). 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. There has generally been low rainfall since 2016. In 2019 there was little rainfall during Q2, Q3 and Q4. These drought conditions would have contributed to the increase in dust levels in 2019.

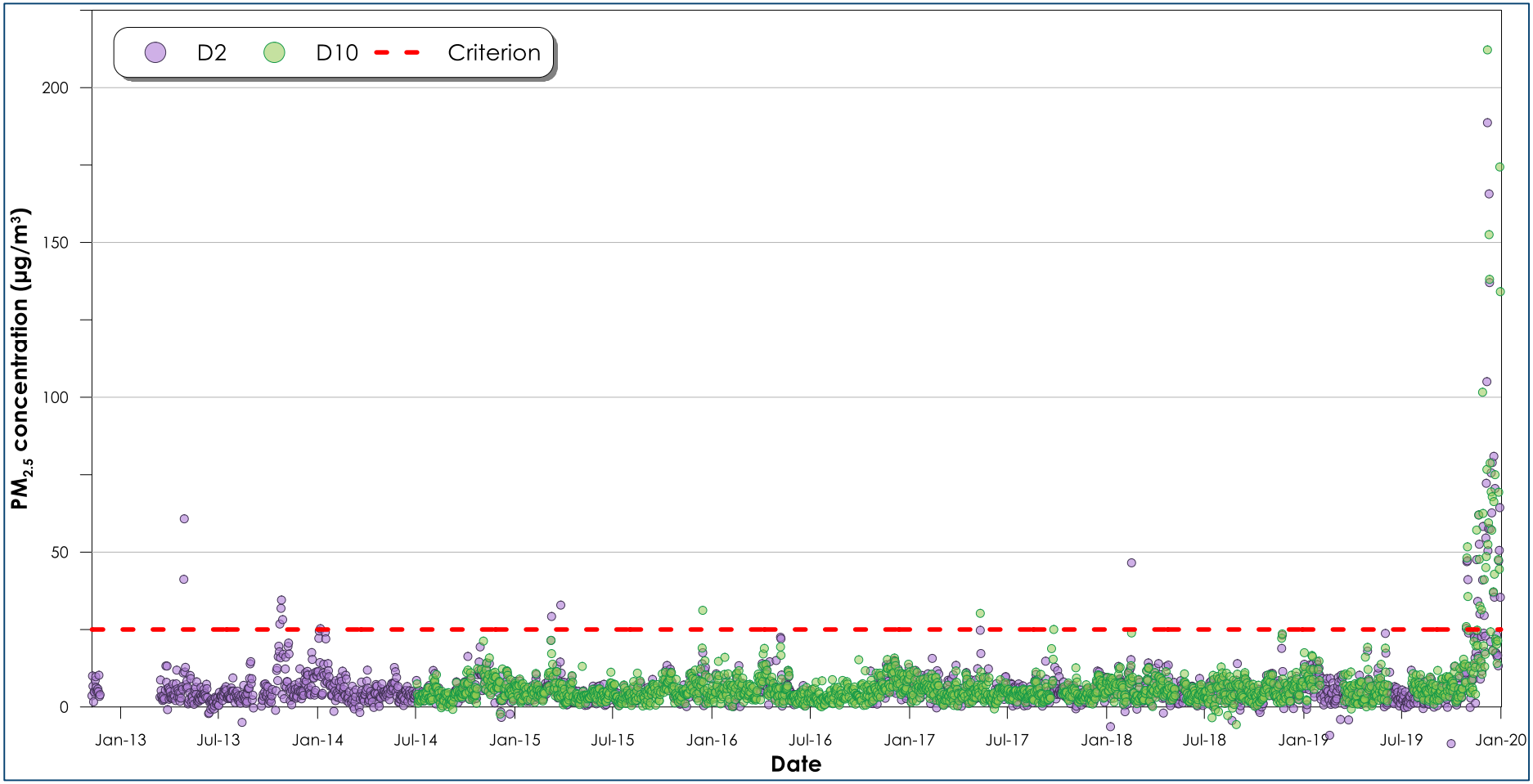


Figure 5-1: 24-hour average $PM_{2.5}$ concentrations

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

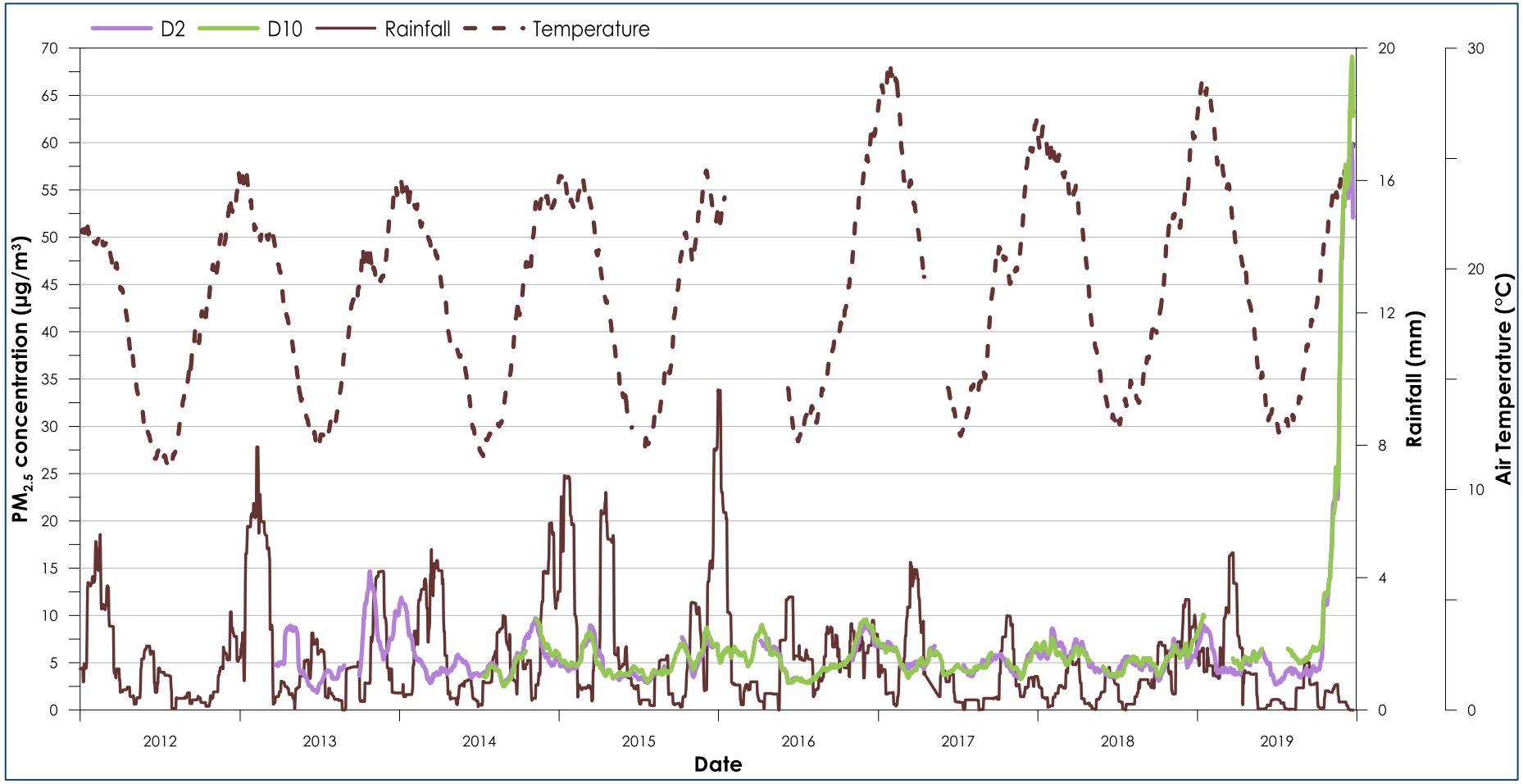


Figure 5-3: 31-day running average of the 24-hour average $PM_{2.5}$ concentrations with the 31-day running average of daily rainfall and mean daily temperature

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 (all days) in 2019 were above the relevant criteria of 25µg/m³ at D3, D5 and D11 but below 30µg/m³.

The maximum 24-hour average PM_{10} concentrations were above the relevant criterion of 50µg/m³ for a significant number of days in 2019. The majority of these days were considered to be extraordinary events due (e.g. bushfires, dust storms, etc). **Appendix B** presents a summary of the likely primary causes of elevated days in 2019 which were not declared as extraordinary events.

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

Year	Annual average PM_{10} (µg/m³)								
	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		19.9		18.9		22.3		25 / 30
2019	22.1	*15.3	**28.0**	*19.8	**25.3**	*17.8	**27.8**	*22.9	25 / 30
Year	**Maximum 24-hour average PM_{10} (µg/m³) (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
2019	**172.1 (31)**	*43.5 (0)	**170.5 (44)**	***90.5 (5)**	**177.4 (36)**	***50.8 (1)**	**180.7 (33)**	***54.6 (7)**	50

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

*Excluding extraordinary events

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.

The 2019 annual average PM_{10} concentrations were above the relevant criterion of 25µg/m³ at Dawtrey and 30µg/m³ at D10 for the annual averages calculated for all days. Annual average PM_{10} concentrations excluding extraordinary events were below both the relevant criteria of 25µg/m³ and 30µg/m³ in 2019.

The maximum 24-hour average PM_{10} concentrations were on occasion above the relevant criterion of 50µg/m³. There was only one exceedance of the 24-hour average PM_{10} criterion at D10 in 2019 which occurred on a day not considered an extraordinary event. **Appendix B** presents a summary of the likely primary causes of elevated days in 2019 which were not declared as extraordinary events.

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

Year	Annual average PM_{10} (µg/m^3)				
	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
2019	**28.8**	*15.7	**31.6**	*17.2	25 / 30
Year	**Maximum 24-hour average PM_{10} (µg/m^3) (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
2019	**270 (7)**	*49 (0)	**266 (7)**	***53 (1)**	50

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

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 including extraordinary events.

Figure 5-4 shows that generally there were a significant number of elevated PM_{10} levels at the end of 2019. The levels were affected by bushfire smoke across NSW during the 2019/2020 bushfire season.

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

Figure 5-6 shows that all monitors recorded higher annual average PM_{10} levels in 2019 than in 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 including extraordinary events, together with the 31-day running averages of daily rainfall and mean daily temperature recorded by the Bulga Complex weather station (where Bulga Complex temperature and rainfall data are unavailable, data from the Bulga DPIE monitor has been used in 2019). 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. There has generally been low rainfall since 2016. In 2019 there was little rainfall during Q2, Q3 and Q4. These drought conditions would have contributed to the increase in dust levels in 2019.

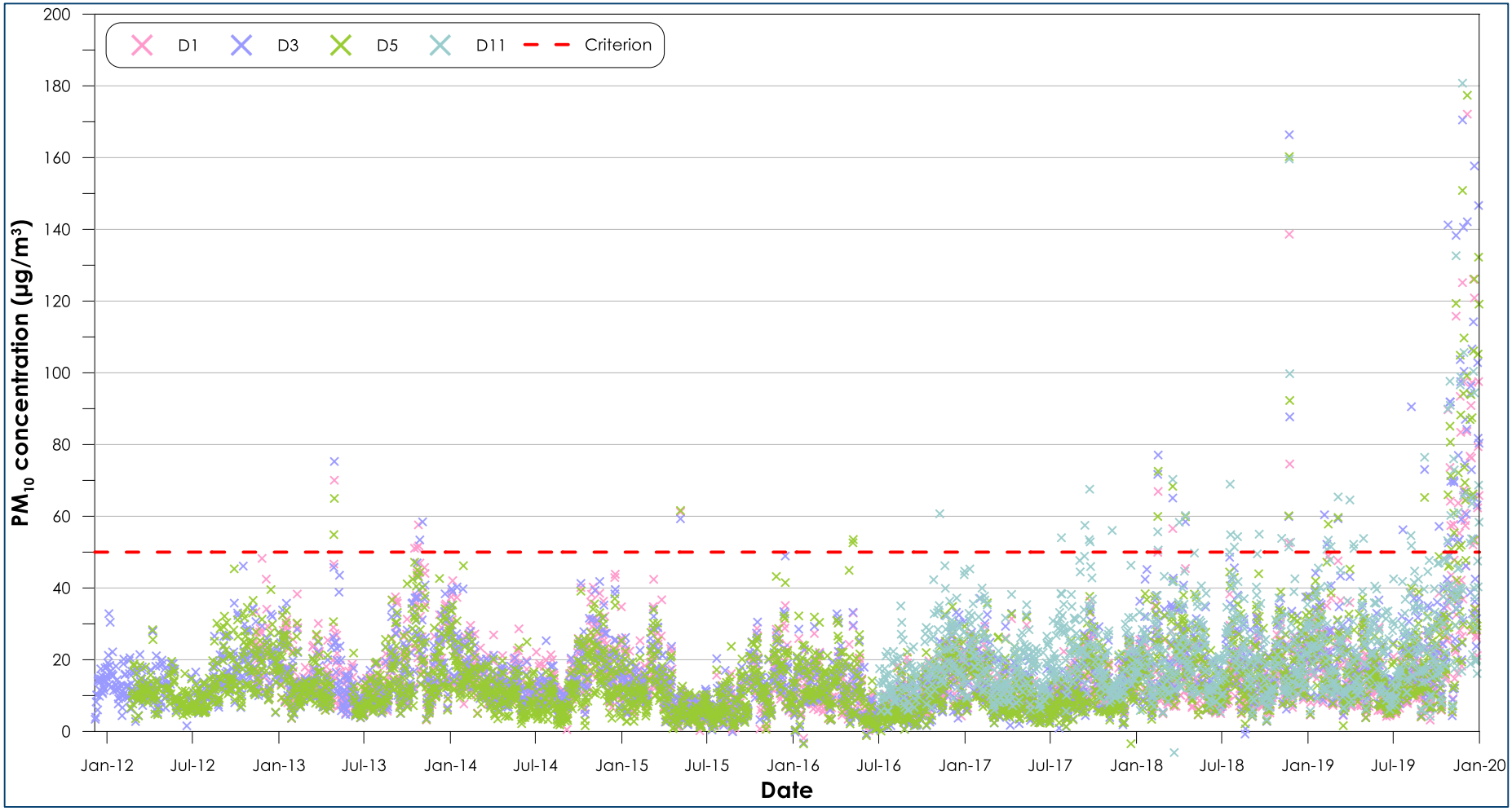


Figure 5-4: 24-hour average PM_{10} concentrations at TEOM monitors

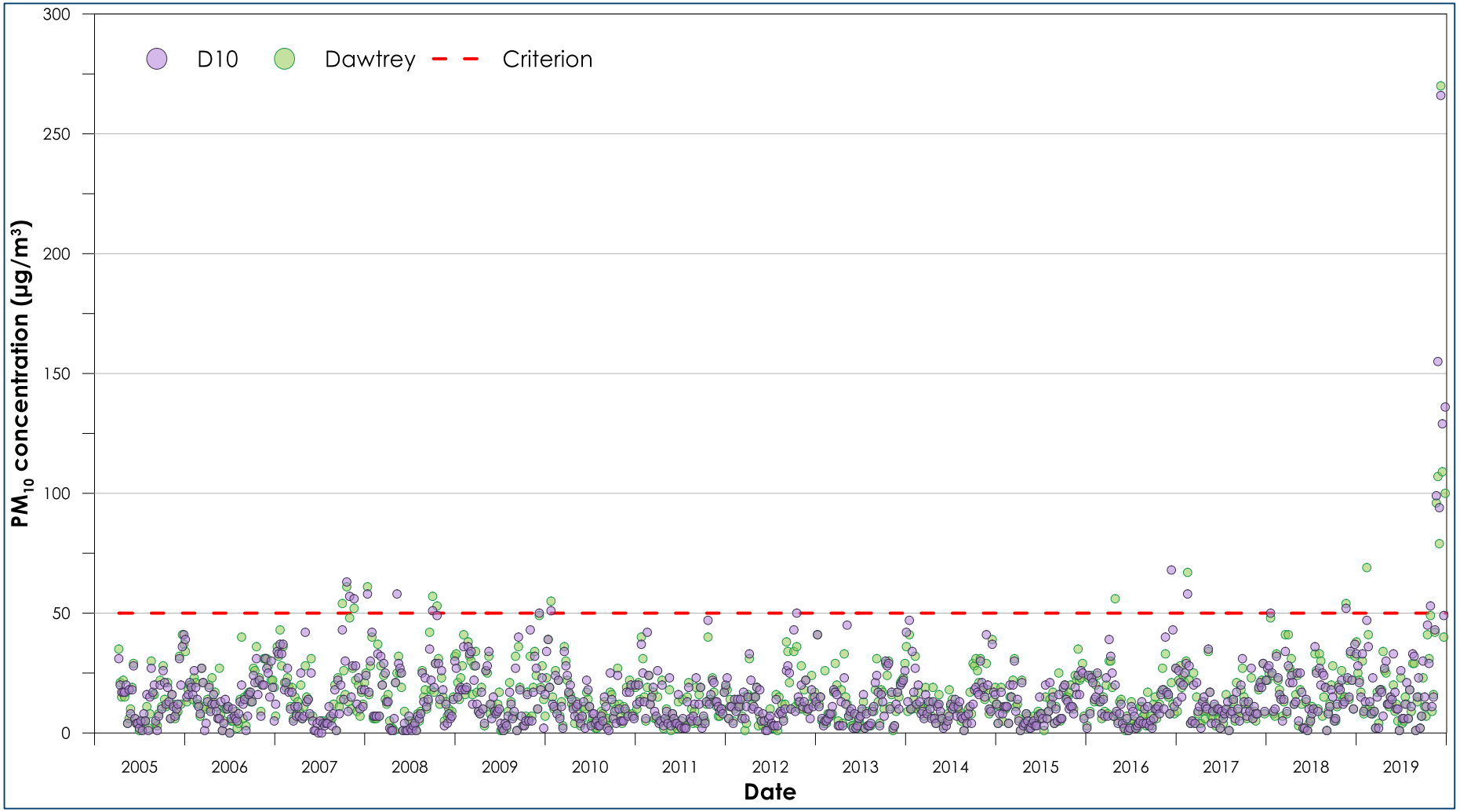


Figure 5-5: 24-hour average PM_{10} concentrations at HVAS monitors

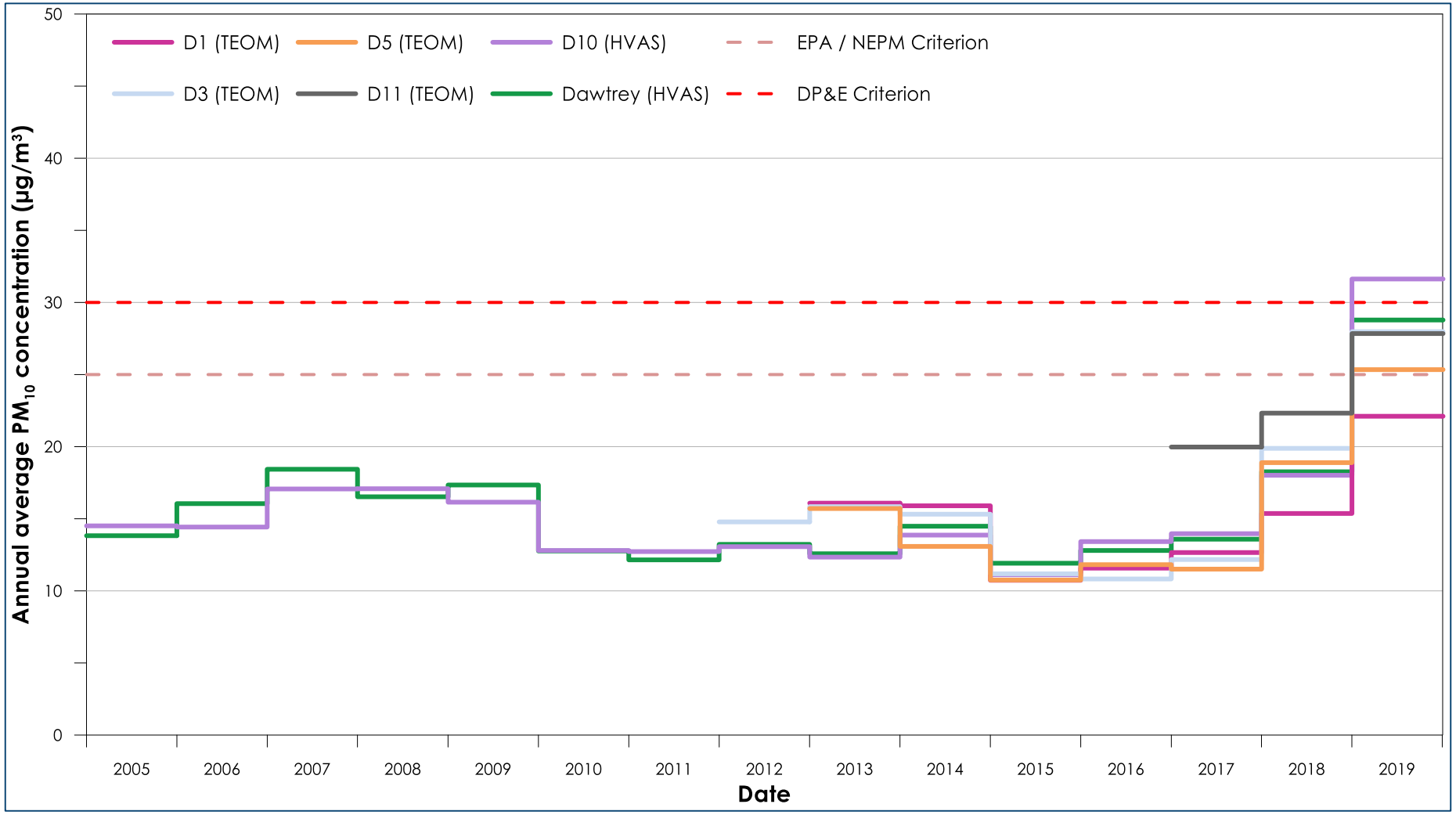


Figure 5-6: Annual average PM_{10} concentrations at TEOM and HVAS monitors

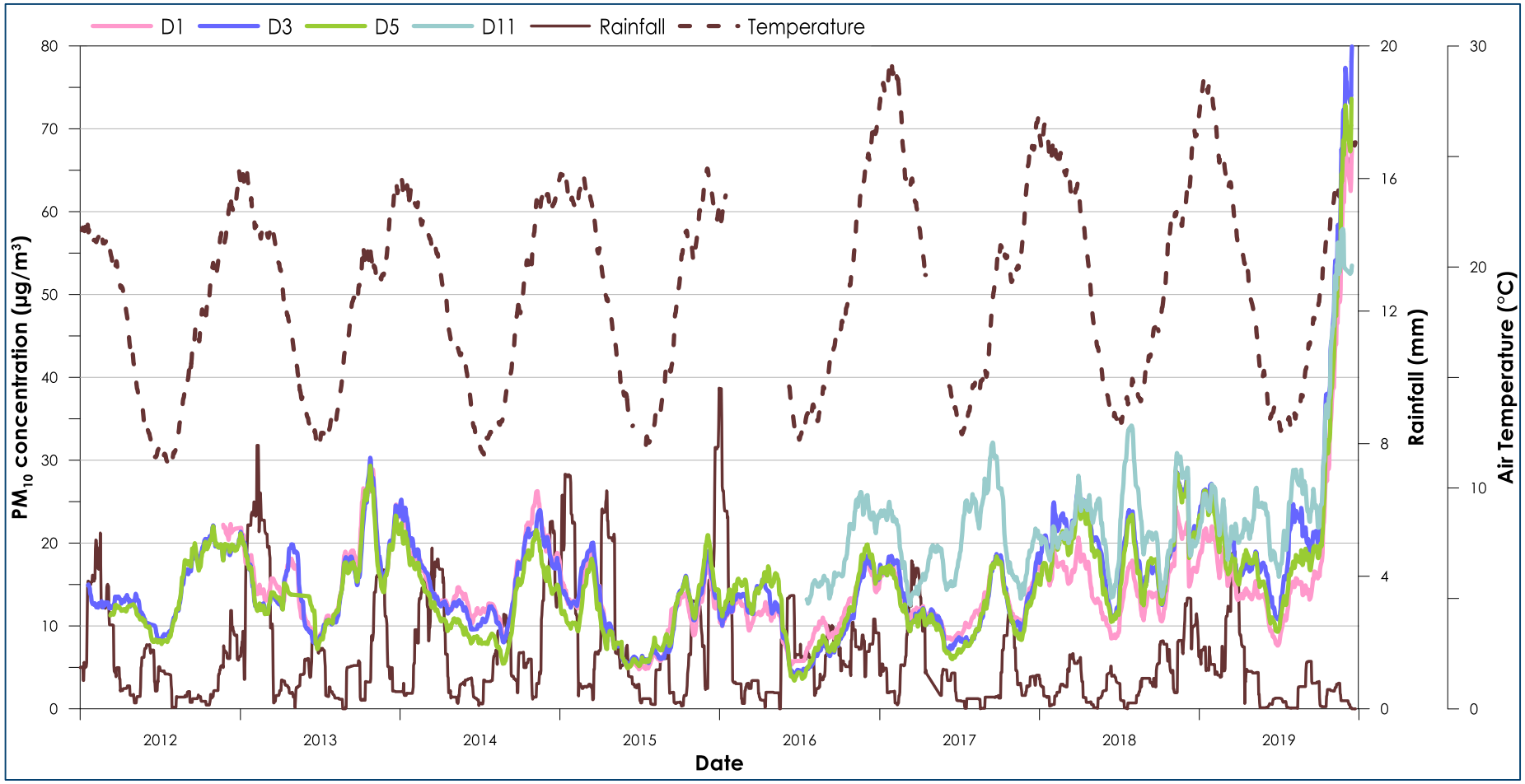


Figure 5-7: 31-day running average of the 24-hour average PM_{10} concentrations at the TEOM monitors with the 31-day running average of daily rainfall and mean daily temperature

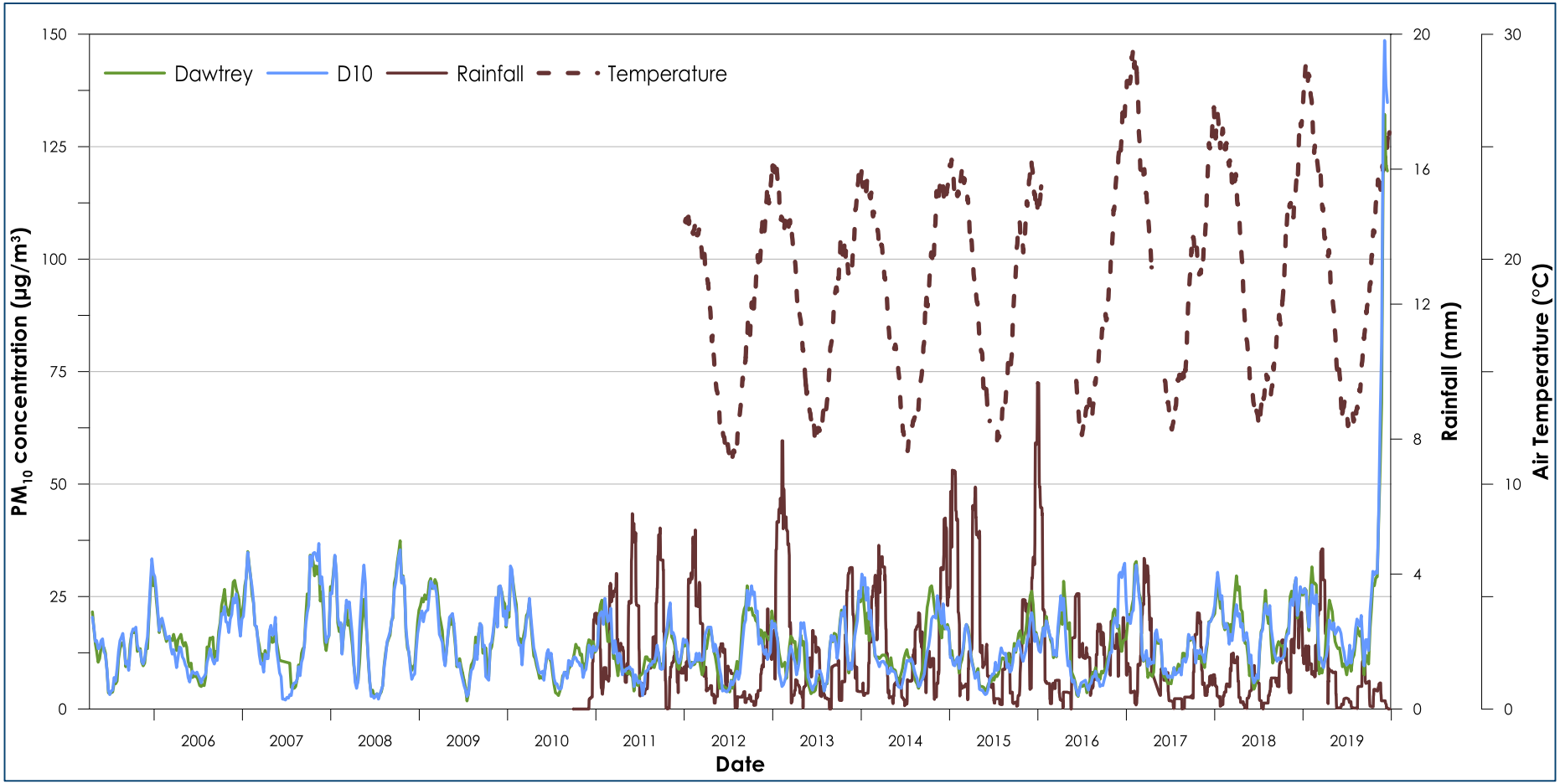


Figure 5-8: 30-day running average of the 24-hour average PM_{10} concentrations at the HVAS monitors with the 31-day running average of daily rainfall and mean daily temperature

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 for all days and excluding extraordinary events in 2019.

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
2019	56.0	*37.9	67.3	*46.7	50.7	*31.0	90

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

*Annual average excluding extraordinary events

Figure 5-9 shows the 24-hour and annual average TSP concentrations including extraordinary events at the HVAS monitors. The annual average data from the TSP HVAS monitors show that the levels remained below the criterion of 90µg/m^3 throughout the period, however all monitors recorded higher annual average TSP levels in 2019 than the previous years.

The data show an increase in the 24-hour TSP levels at the end of 2019. The levels were affected by bushfire smoke across NSW during the 2019/2020 bushfire season.

Figure 5-10 shows the 31-day running average of the TSP concentrations including extraordinary events, rainfall readings and mean daily temperatures. The levels show a general trend of lower TSP concentrations during periods of higher rainfall and lower temperatures. There has generally been low rainfall since 2016. In 2019 there was little rainfall during Q2, Q3 and Q4. These drought conditions would have contributed to the increase in dust levels in 2019.

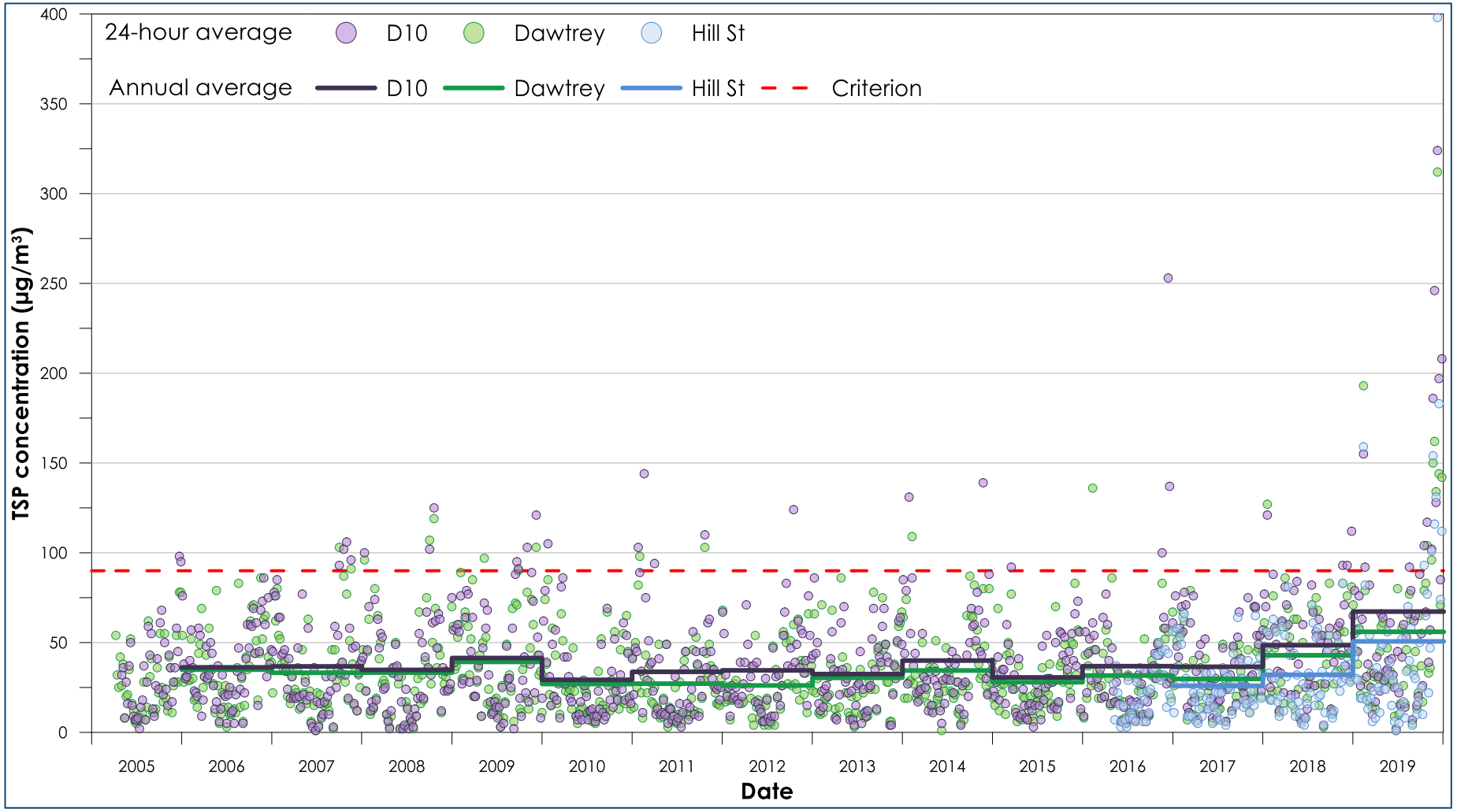


Figure 5-9: 24-hour and annual average TSP concentrations

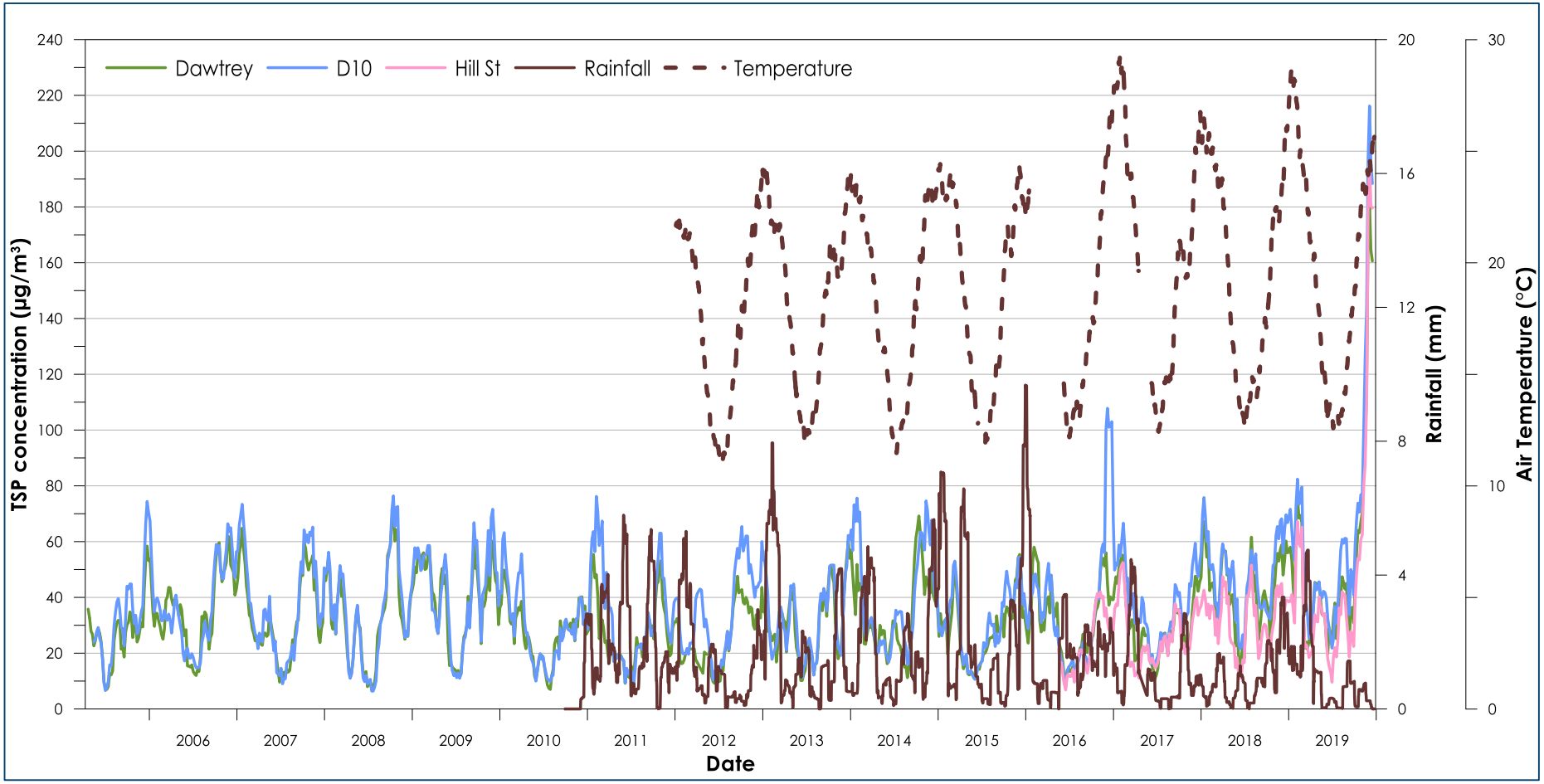


Figure 5-10: 30-day running average of the 24-hour average TSP concentrations with the 31-day running average of daily rainfall and mean daily temperature

5.4 Deposited dust data

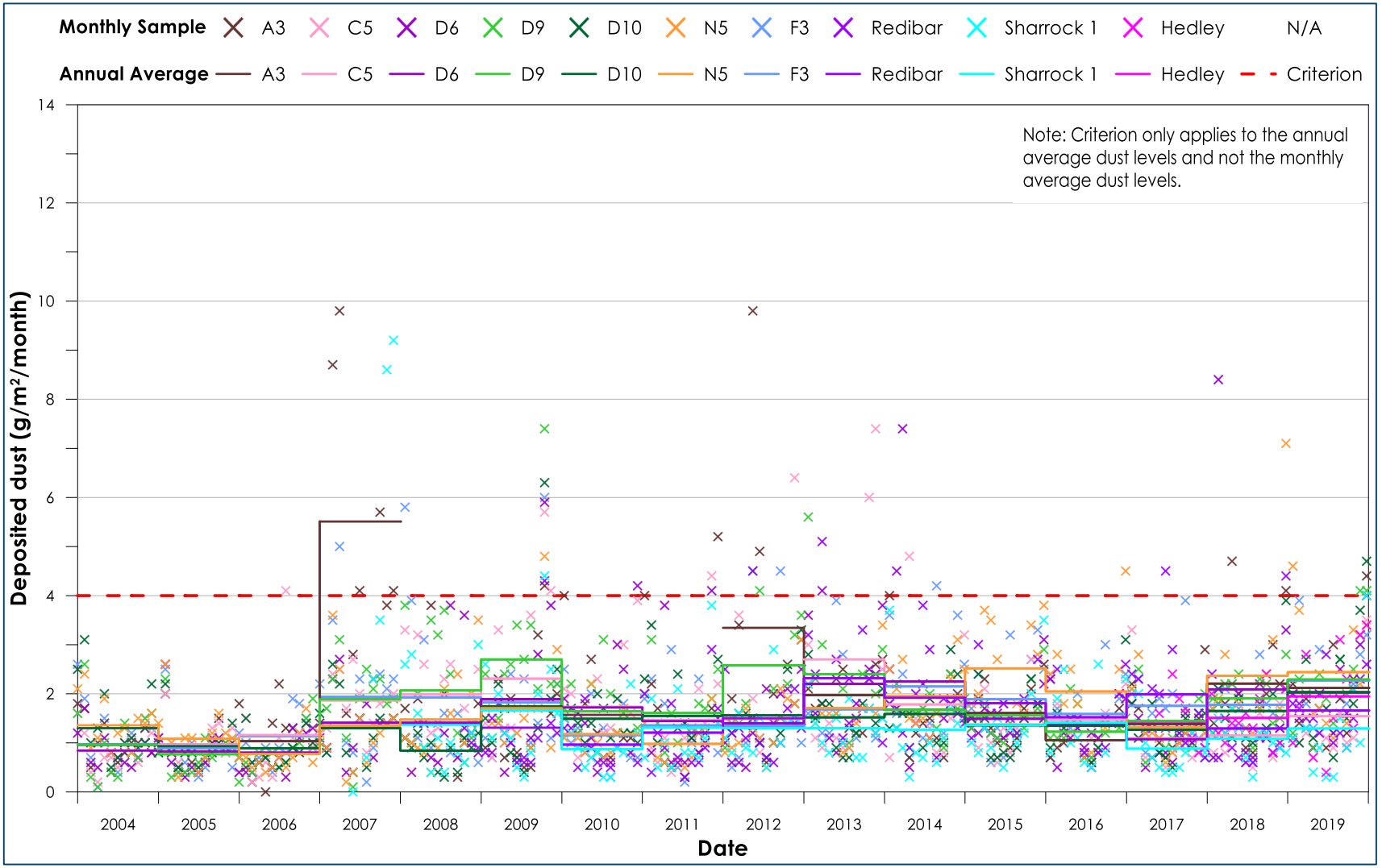
Table 5-5 presents a summary of the annual average deposited dust levels at the statutory compliance dust gauges. The results show that in 2019 the deposited dust levels were below the annual average limit of 4g/m^2/month at the compliance monitoring locations.

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	F3	Redibar	Sharrock 1	Hedley	Criterion
2004	1.0	0.9	0.8	1.0	1.3	1.4	1.0	-	-	-	4
2005	1.0	1.0	0.8	0.8	0.9	1.1	0.9	-	-	-	4
2006	1.0	1.2	0.8	0.9	0.9	0.8	1.1	-	-	-	4
2007	**5.5**	1.9	1.4	1.9	1.3	1.3	1.9	-	4.1 (50%)	-	4
2008	1.7 (67%)	2.0	1.4	2.1	0.8	1.5	1.9	1.1 (25%)	1.4	-	4
2009	1.9	2.3	1.9	2.7	1.7	1.7	1.8	1.3	1.7	-	4
2010	1.6	1.7	1.7	1.6	1.5	1.2	1.2	1.0	0.9	-	4
2011	1.8 (67%)	1.5	1.4	1.6	1.6	1.0	1.4	1.2	1.3	-	4
2012	3.3	2.3 (58%)	1.4	2.6	1.6	1.5	1.3	1.5	1.3	-	4
2013	2.0	2.7	2.2	2.4	1.5	1.7	1.7	2.3	1.3	-	4
2014	1.7	1.8	2.3	1.7	1.6	2.0	2.2	1.9	1.3	-	4
2015	1.6	1.4	1.5	1.6	1.4	2.5	1.9	1.8	1.4	-	4
2016	1.1	1.5	1.4	1.2	1.3	2.0	1.6	1.5	1.4	-	4
2017	1.4	1.1	1.1	1.5	1.3	1.3	1.8	2.0	0.9	1.4	4
2018	2.2	1.2	2.1	1.9	1.7	2.4	1.8	1.3	1.1	1.5	4
2019	2.1	1.5	2.0	2.3	2.0	2.4	2.3	1.7	1.3	1.9	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 Bulga Complex dust gauges. 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 2019 calendar year. The levels at the monitors show relatively similar trends over time. There was an increase in the monthly deposited dust levels at the end of 2019, likely due to the impacts of bushfire smoke, however this did not appear to have a significant impact on the 2019 annual deposited dust levels.



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 and TEOM monitors for 2019. 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 2019. The figures show high $PM_{2.5}$ levels from all directions.

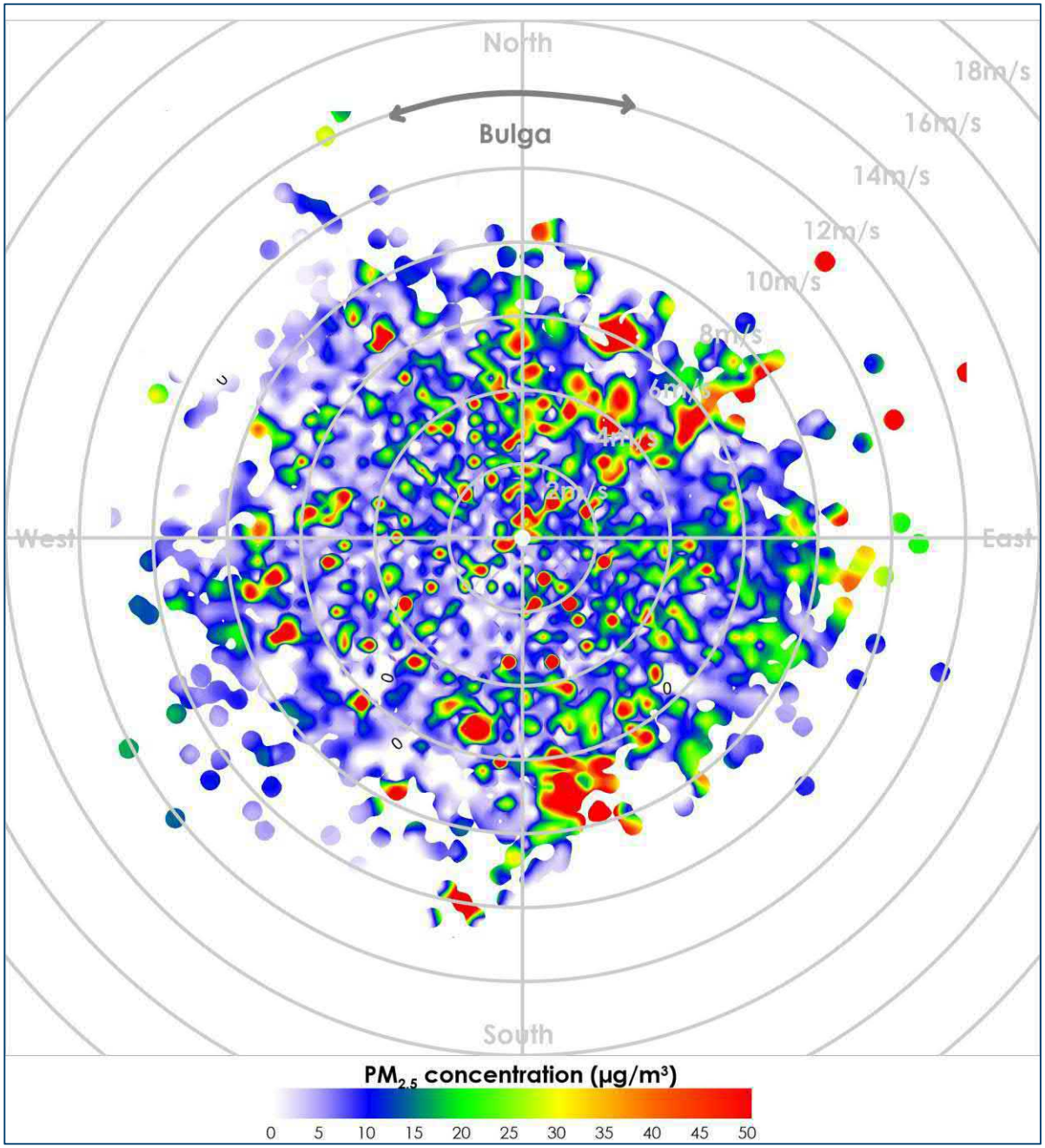


Figure 6-1: Pollution rose for D2 BAM $PM_{2.5}$ data (2019)

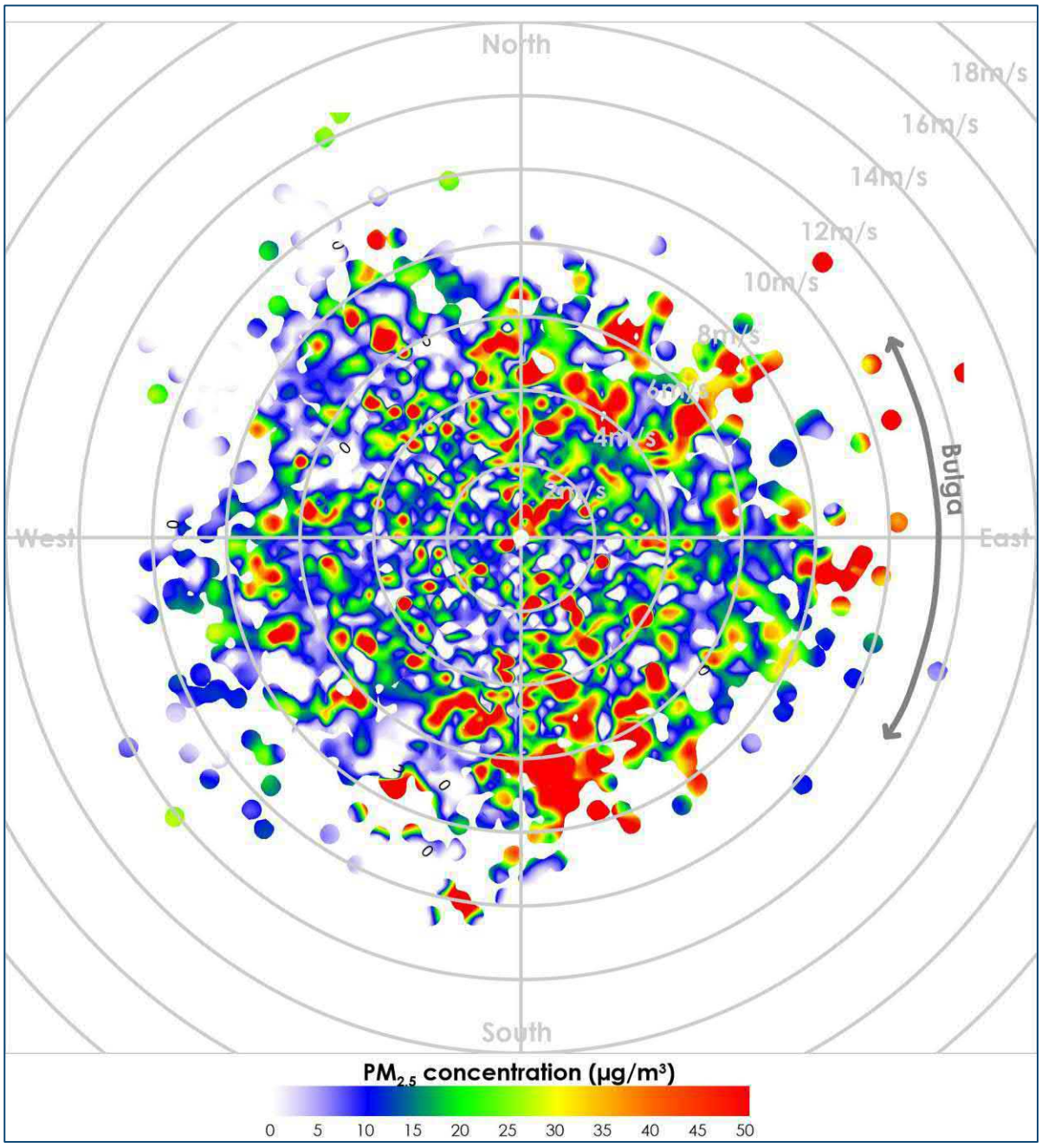


Figure 6-2: Pollution rose for D10 BAM $PM_{2.5}$ data (2019)

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 2019.

High levels occur in all directions at all monitors. While many of these likely arise from regional events, the figures do also generally show that there is a moderate effect on dust levels from the direction of the Bulga mine. It is noted that the data presented in the pollution roses include background dust and contributions from other sources.

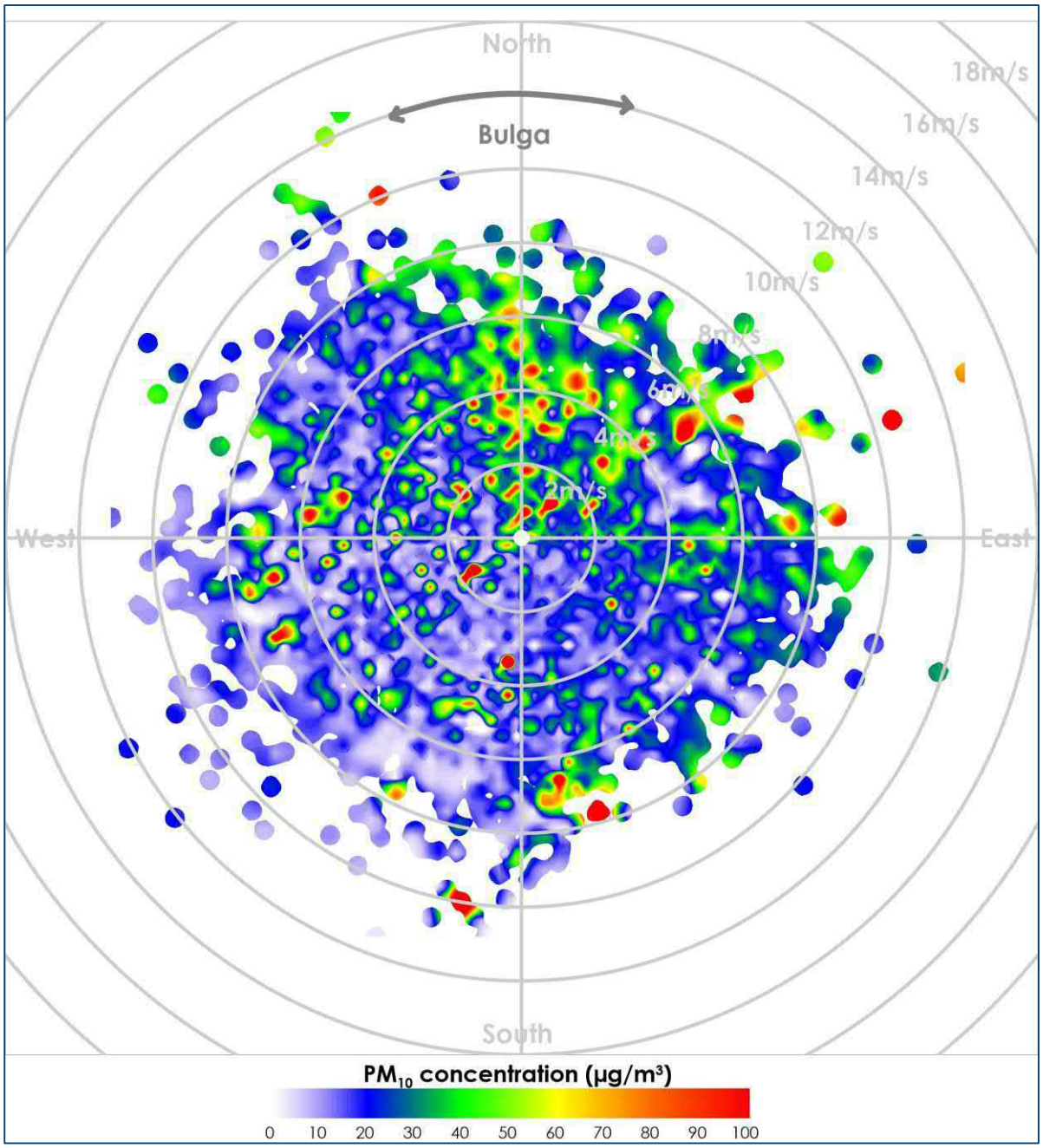


Figure 6-3: Pollution rose for D1 TEOM PM_{10} data (2019)

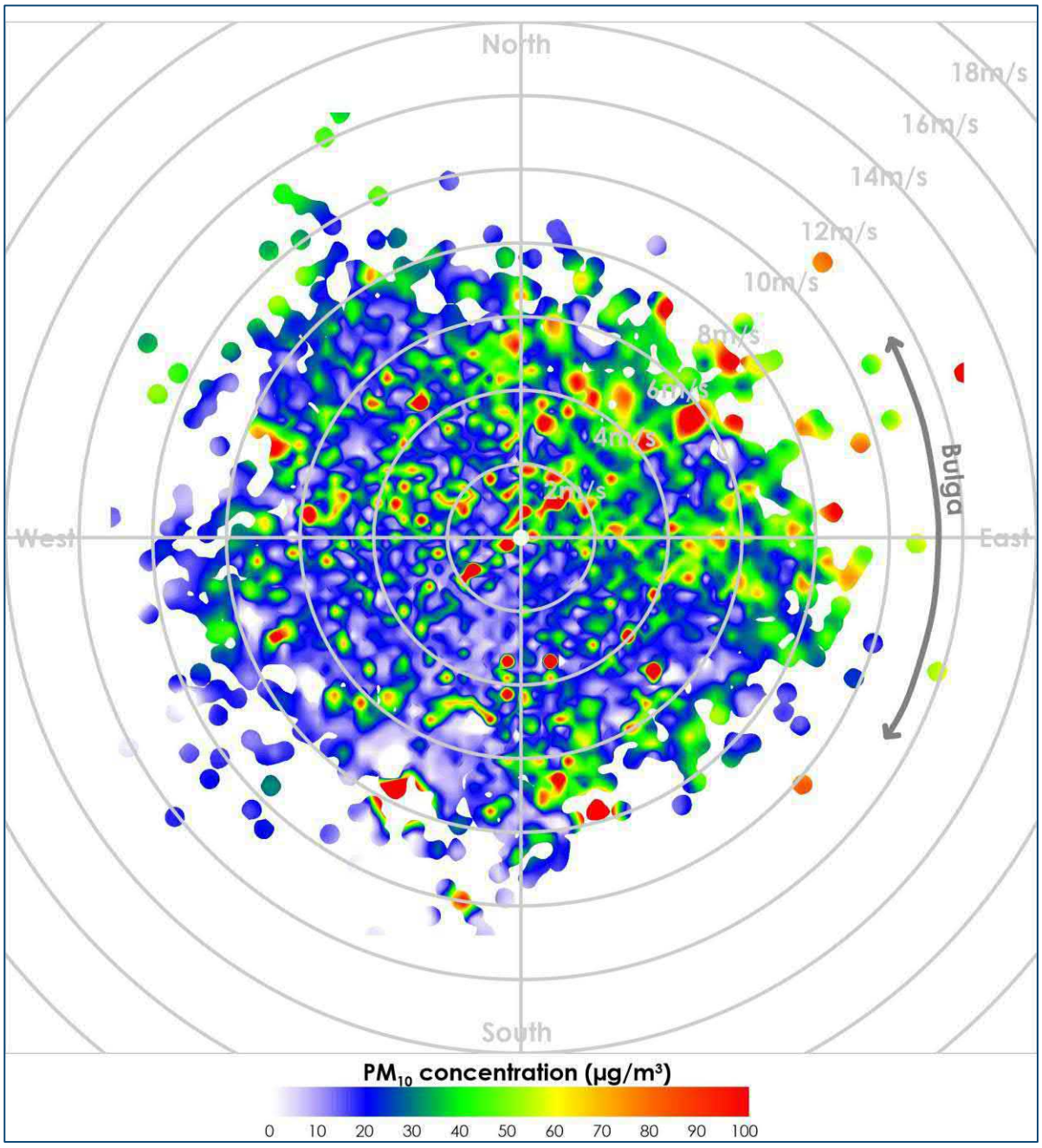


Figure 6-4: Pollution rose for D3 TEOM PM_{10} data (2019)

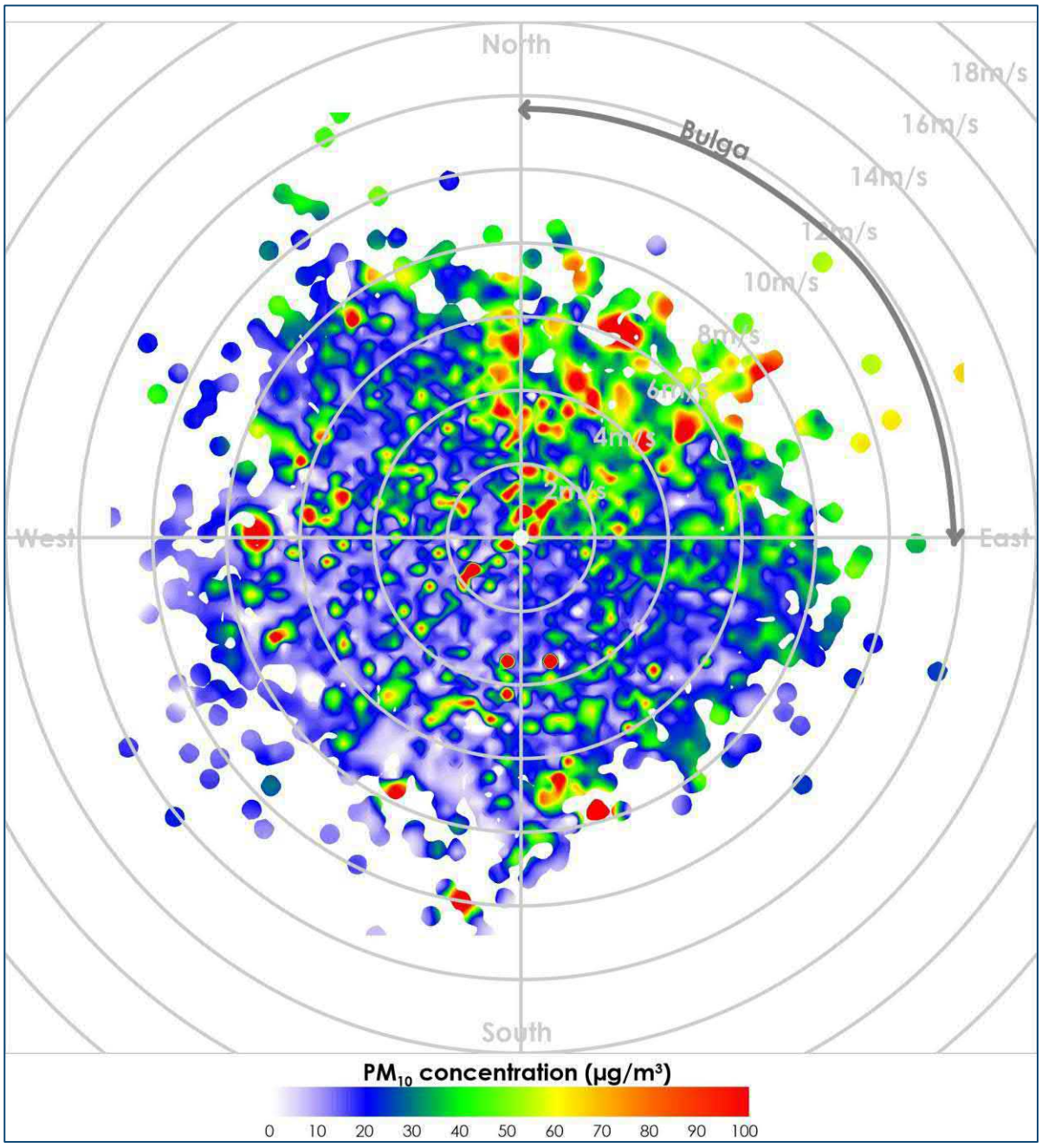


Figure 6-5: Pollution rose for D5 TEOM PM_{10} data (2019)

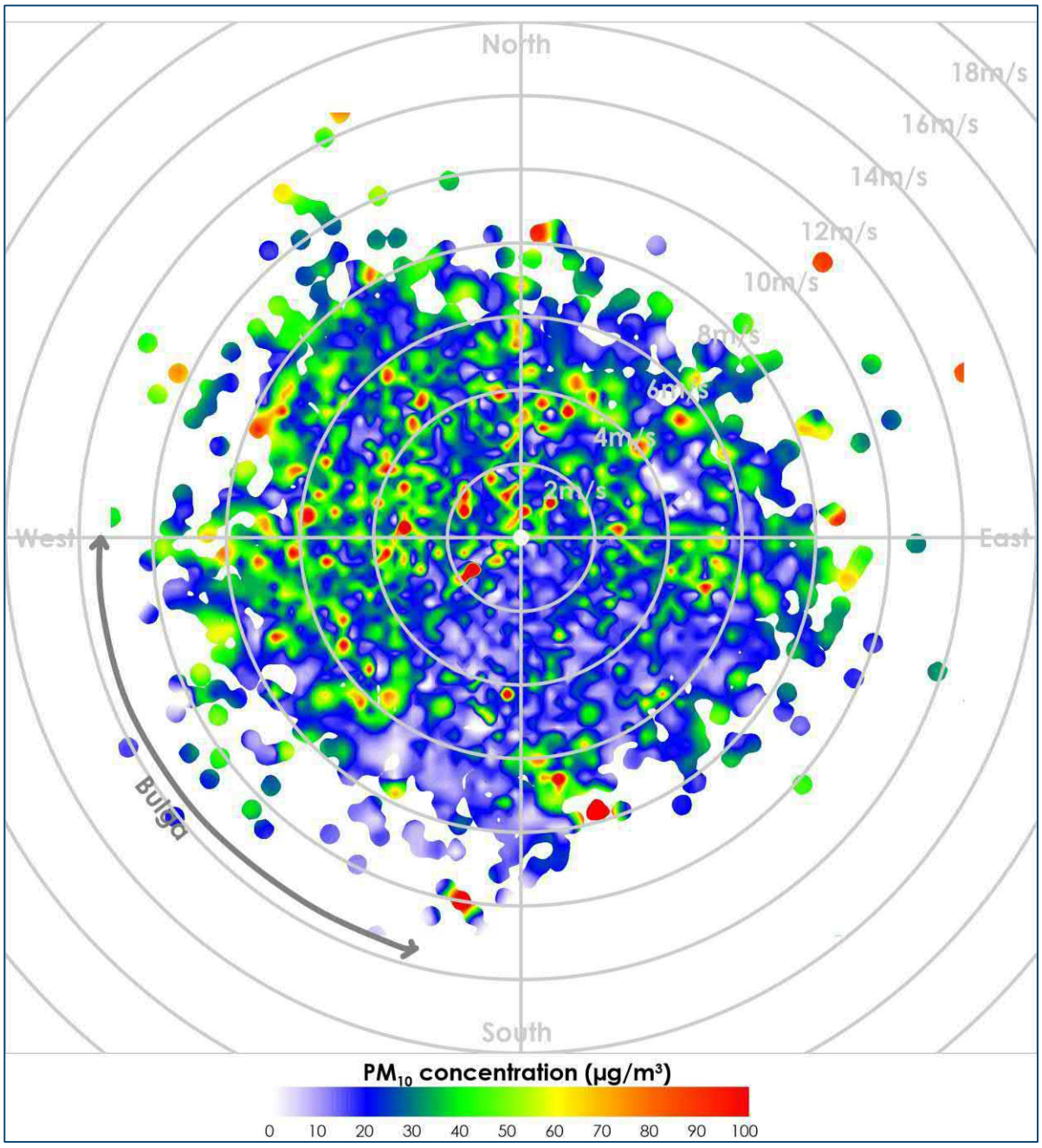


Figure 6-6: Pollution rose for D11 TEOM PM_{10} data (2019)

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 2019 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 measured annual levels for all days were higher than the predicted levels, however the analysis shows that there was generally good agreement between the modelling predictions and the measured results excluding extraordinary event days.

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 2019. The analysis shows that the annual levels were generally high compared with previous years and that there was an increase in the number of exceedances of the short term PM_{10} and $PM_{2.5}$ criteria in 2019, due to the large number of extraordinary events. The annual average levels excluding extraordinary events were similar to the previous years and below the relevant annual criteria.

An analysis of the pollution roses for 2019 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 extraordinary events.

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: Extraordinary event days

Declared extraordinary events in 2019 (Total 54)

The following days were declared as extraordinary events in 2019 for Bulga:

- 13/2/2019
- 19/2/2019
- 6/3/2019
- 31/3/2019
- 6/9/2019
- 7/10/2019
- 26/10/2019
- 27/10/2019
- 28/10/2019
- 30/10/2019
- 31/10/2019
- 1/11/2019
- 7/11/2019
- 8/11/2019
- 12/11/2019
- 16/11/2019
- 17/11/2019
- 19/11/2019
- 20/11/2019
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- 12/12/2019
- 13/12/2019
- 14/12/2019
- 15/12/2019
- 16/12/2019
- 17/12/2019
- 18/12/2019
- 19/12/2019
- 20/12/2019
- 21/12/2019
- 22/12/2019
- 27/12/2019
- 28/12/2019
- 29/12/2019
- 30/12/2019
- 31/12/2019

Appendix B: Elevated 24-hour average particulate days

Elevated 24-hour average particulate days (excluding extraordinary events)

The following elevated days in 2019 (excluding extraordinary events) were investigated to determine the likely cause of the elevated level. The likely primary cause of each elevated day was determined in individual investigation reports.

Figure B-1: Summary of elevated particulate days (excluding extraordinary events)

Date	Monitors above 24-hour criteria	Primary cause of elevated levels
5/2/2019	D3	Local cattle
10/2/2019	D3, D11	Regional dust event
8/4/2019	D11	Cause unknown
9/4/2019	D11	Cause unknown
29/4/2019	D11	Local source
22/7/2019	D3	Local rehabilitation activities
8/8/2019	D11	Strong wind conditions
9/8/2019	D3, D11	Strong wind conditions
25/10/2019	D11	Strong wind conditions
29/10/2019	D2, D10, D10 HVAS	Bushfire smoke
2/11/2019	D3, D5	Bushfire smoke

Appendix C: How to read a windrose and pollution rose

Windrose

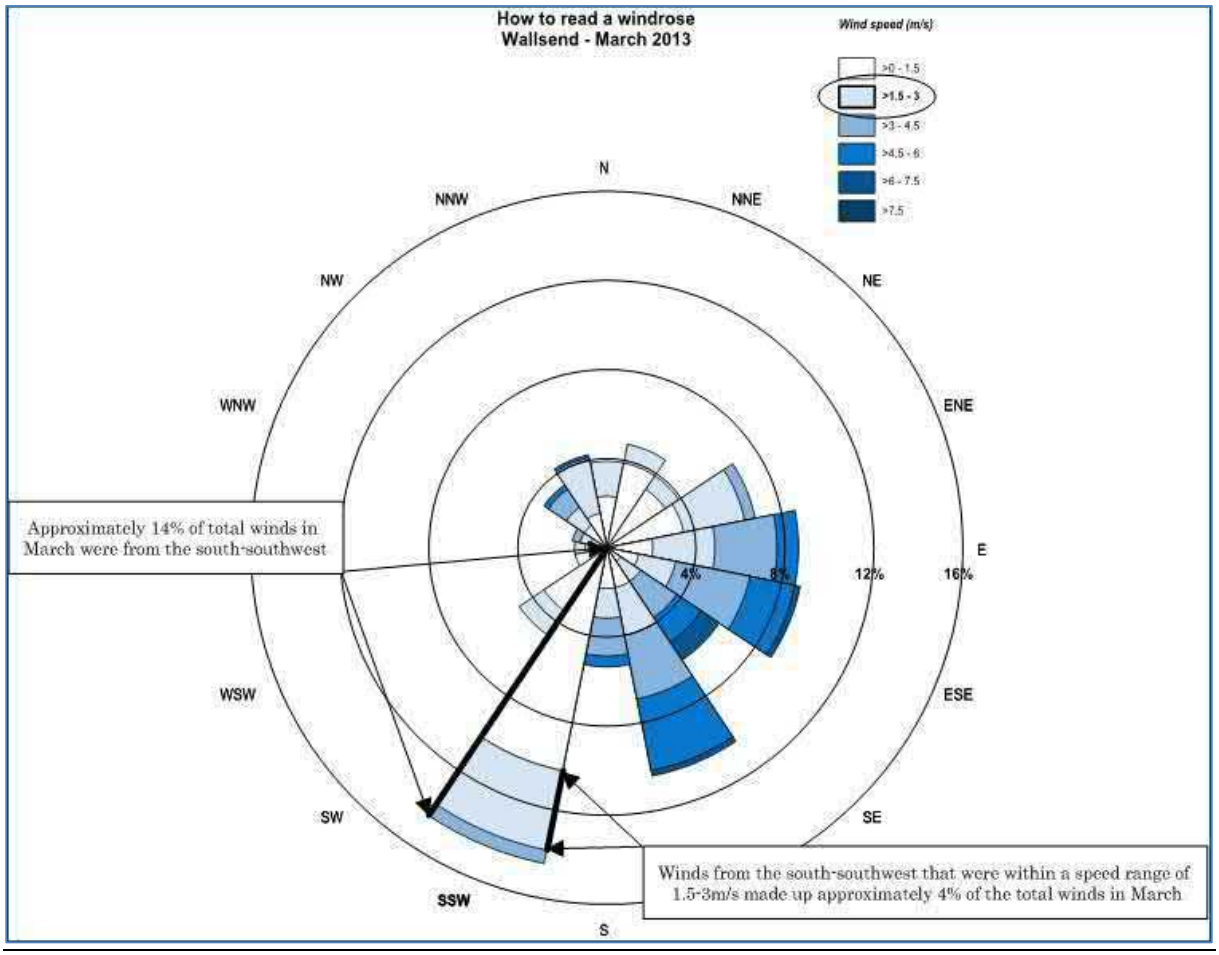

Figure C-1: How to read a windrose

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.

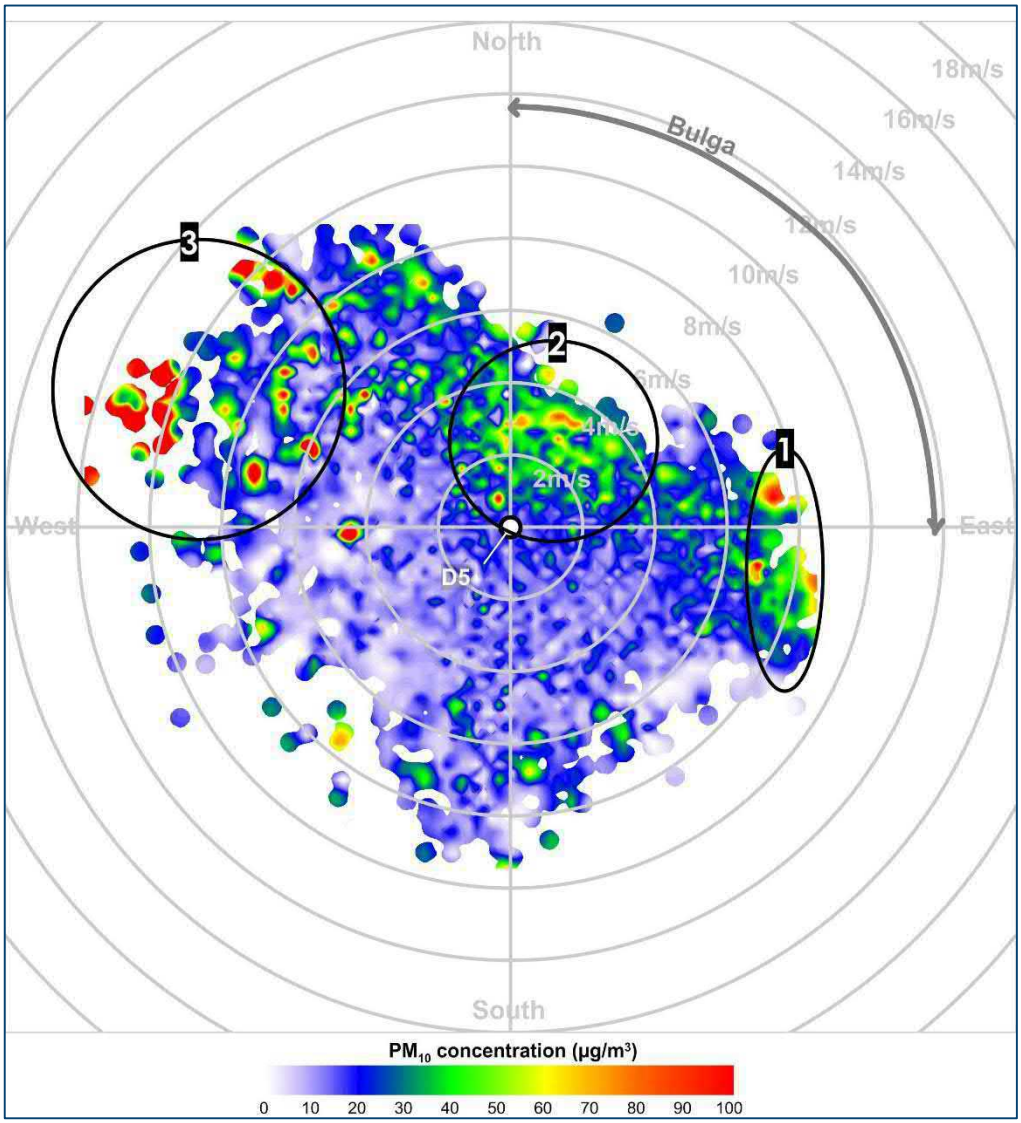

Figure C-2: Example Pollution Rose

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 C

Annual Groundwater Monitoring Report (Jacobs, 2020)

Bulga Coal Complex

2019 Annual Groundwater Monitoring Report

IH195800 | FINAL Rev1

20 March 2020

Bulga Coal Management Pty Limited

Bulga Coal Complex

Project No:	IH195800
Document Title:	2019 Annual Groundwater Monitoring Report
Document No.:	IH195800
Revision:	Rev1
Document Status:	Final
Date:	20 March 2020
Client Name:	Bulga Coal Management Pty Limited
Client No:	PO 6000418512
Project Manager:	John Barlow
Author:	John Barlow, Alex Felci
File Name:	Bulga 2019 annual GW monitoring report Final 20Mar20.docx

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Revision	Date	Description	Author	Checked	Reviewed	Approved
Rev0		Draft for client review	JB	JB	SD/RN	SD
Rev1		Final	JB	JB	SD	SD

Contents

Important note about your report

The sole purpose of this report is to present a review of the groundwater data collected during 2019 for the Bulga Coal Complex, for Bulga Coal Management Pty Ltd (BCM).

In preparing this report, Jacobs has relied upon, and presumed accurate, any information provided by BCM and other publicly available sources.

Unless otherwise stated, Jacobs has not verified the accuracy or completeness of any information provided by BCM or in publicly available reports and databases. If the information is subsequently determined to be false, inaccurate or incomplete, then it may be possible that observations and conclusions expressed in this report may be impacted. Data sources are referenced throughout the text and listed in the reference section at the end of this report.

Jacobs derived the conclusions in this report from information and data obtained from BCM and other available sources at the time this report was prepared. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report.

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1. Introduction

The factual background information within the following Sections 1 and 2 is based largely on the that presented in the 2018 annual groundwater monitoring report (David, K. 2019).

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). BCC 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 previously comprised two operations, Blakefield South (BFS) which ceased operation in 2018 and historical Beltana No.1 mine. Beltana No.1 underground mine ceased operation in 2011 and extracted coal from the Whybrow Seam directly south-west of the open cut and north-west of BFS. In 2010 BFS operations commenced extraction of the Blakefield Seam which underlays the 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 (Figure1).

The extraction of coal from BFS started in 2010 with BSFLW1A but was suspended in January 2011 due to fire. The Most recently extracted panel BFS LW1B was a continuation of BFSLW1A and was completed in April 2018. Intact coal was left in place between BFS LW1A and BFS LW1B.

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 levels following cessation of underground operations at BFS.

1.2 Study Area

The BCC is located in the Hunter Coalfields, within the north-eastern part of the Sydney Basin, NSW. BFS is situated at the southern end of the BCC and just north of the Broke township. Wollombi Brook, flowing to the north-west, comes within <500m west of the BSF. Monkey Place Creek, a tributary of the Wollombi Brook, flows west approximately 1-2km to the south past the BSF.

1.3 Geology

Geologically, the BCC is located within the Hunter Coalfield in the northern part of the Sydney Basin. A major structural feature to the east 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 2°-5° to the south-west. Strata of Late Permian age outcrop across the site but are overlain by more recent Quaternary alluvial deposits along watercourses - Wollombi Brook and Monkey Place Creek. Table 1 shows the detailed stratigrpahy of this part of the Sydney Basin.

Table 1.1: General stratigraphy of the Hunter Coalfields

Period	Stratigraphy		
Quaternary	Wollombi Brook Alluvium, Monkey Place Creek alluvium		
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 (Alcheringa seam is the basal member)
			Apple Tree Flat Subgroup
			Watts Sandstone
		Wittingham Coal Measures	Denman Formation
			Jerrys Plains Subgroup (includes the Whybrow and Blakefield seams)
			Archerfield Sandstone
			Vane Subgroup
			Saltwater Creek Formation

Table 1.2: 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

1.4.1 Hydrostratigraphy

There are three broad groups of hydrostratigraphic units:

1. Shallow groundwater system: Alluvium (and underlying regolith) associated with Wollombi Brook and Monkey Place Creek and regolith;
2. Interburden and shallow coal measures: Weathered and fractured shallow sandstone and coal measures, and

3. Coal seams: Wollombi coal measuresWittingham Coal Measures, which may be regarded as a fractured rock aquifer.

The alluvium and regolith has low to moderate hydraulic conductivity and supports local water supplies with around 20 private bores within a 3 km radius of BFS. This aquifer is used for a variety of purposes including stock and domestic, water supply and irrigation. Water quality is generally fresh.

The intermediate depth shallow coal measures exhibit relatively low hydraulic conductivity.

The coal measures fractured rock aquifer comprises sandstone, siltstone and coal seams with varying degree of fracturing and hydraulic conductivity. This hydrostratigraphic unit is characterised by generally poor-quality groundwater and low hydraulic conductivity. There are no private bores extracting from the shallow coal measures within the vicinity of BSF.

1.4.2 Recharge and Discharge

Recharge to the alluvium and shallow weathered coal measures is mainly via rainfall infiltration with topography driving the shallow groundwater flow direction. As evidenced from water pressure monitoring and water quality data, the deeper hydrostratigraphic units are confined and are recharged from vertical leakage where depressurisation induces sufficient hydraulic gradient and also from recharge zones some distance away from the BUO.

Discharge from the shallow groundwater system occurs via abstraction, evapotranspiration, leakage to deeper strata and baseflow to local watercourses. Discharge from deeper units occurs via mine dewatering and local horizontal and vertical flow driven by migration towards depressurised zones. Regional outflow may occur via horizontal migration and outflow at some distance away from the mining operation.

2. Groundwater Monitoring Network

The groundwater monitoring network for the BUO comprises a number of dedicated monitoring bores, nested piezometers and multi-level vibrating wire piezometers (VWP) (Figure 1). These are distributed throughout the three broad hydrostratigraphic groups (Section 1.4.1).

Groundwater monitoring is undertaken in accordance with the BUO Water Management Plan. Over the past 15 years a number of monitoring points have been abandoned / destroyed and new ones installed as the underground workings progressed. A summary of currently operational piezometers is provided in Table 2.1 for standpipes and Table 2.2 for vibrating wire piezometers, respectively. The locations of all currently monitored piezometers are shown on Figure 1.

The following provides a summary of the formations monitored, grouped under the three broad hydrostratigraphic groups outlined in Section 1.4.1:

Shallow Groundwater System:

- Wollombi Alluvium – twelve standpipe piezometers are located to the south and west of BFS. Three of the twelve piezometers are equipped with dataloggers;
- Monkey Place Creek (MPC) Alluvium - ten piezometers are installed to a maximum depth of 16 m to the south BFS. Nine are equipped with dataloggers;
- Regolith/volcanic sill/alluvium - two standpipe piezometers are installed in regolith/volcanic sill/alluvium of which one was equipped with datalogger in late 2017;

Interburden and shallow coal measures:

- 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 installed to the northwest and the southwest of BFS. Two piezometers were equipped with dataloggers from 2017 and 2018.

Coal Seams:

- Alcheringa Seam (Wollombi coal measures) – five standpipe piezometers are currently monitored to the northwest of BFS at depths ranging from 10-42 m. Monitoring of a sixth bore ceased in 2018. Four of the five currently monitored standpipes have dataloggers installed;
- Lower Whybrow Seam (Whittingham coal measures) - three standpipe piezometers, one of which has a datalogger installed;

In addition, four multilevel vibrating wire piezometer sites are installed west, northwest and east of the BFS to a maximum depth of 170 m below the mined Blakefield Seam.

Table 2.1: Summary of standpipe monitoring bores

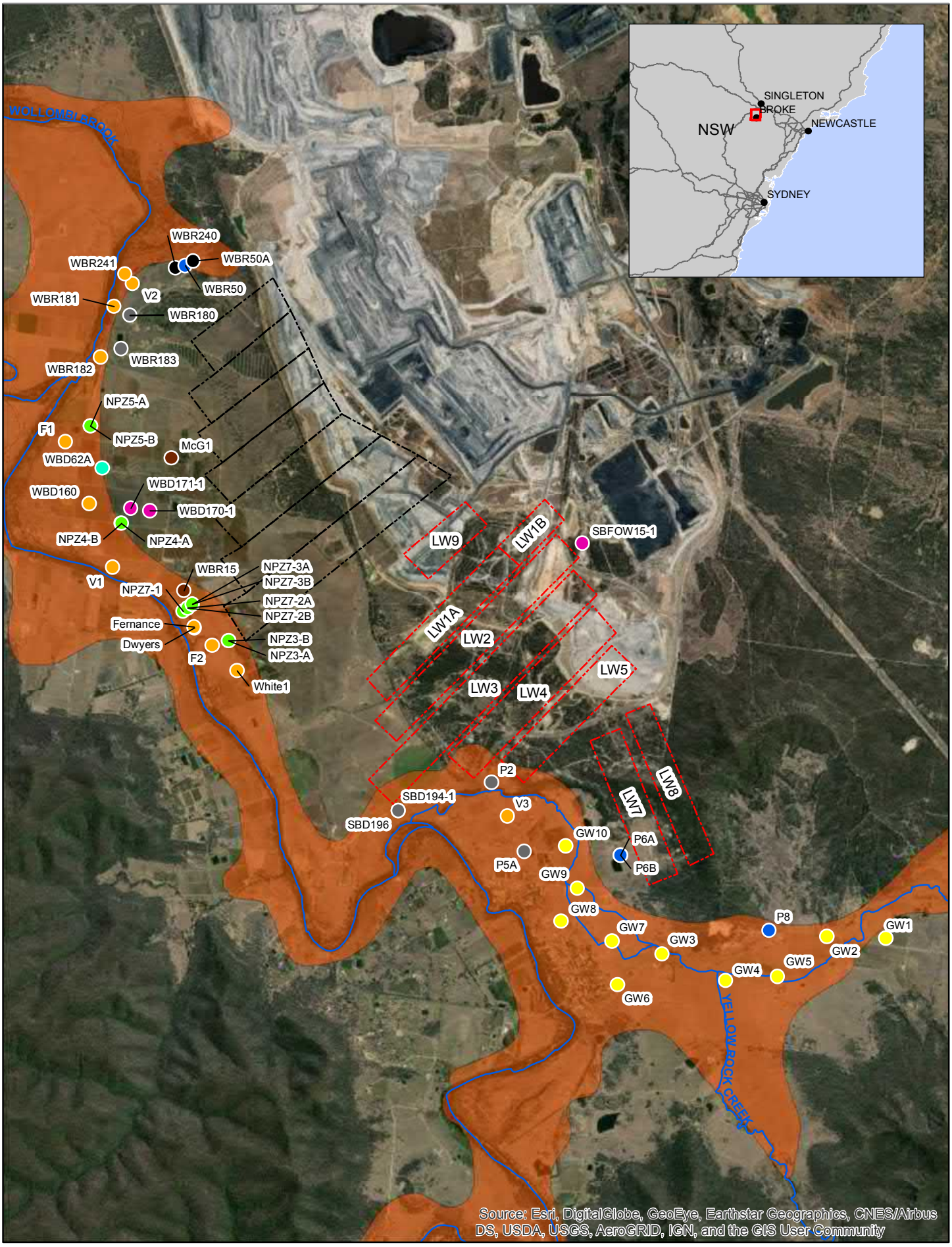
Site Name	Northing (MGA56)	Easting (MGA56)	Formation monitored	Depth of installation (m bgl)	Continuous Datalogger Monitoring
Dwyers	6379357.94	317704.52	Wollombi Alluvium	<30	
F1	6381601	316152	Wollombi Alluvium	17.4	Y
F2	6379142	317916	Wollombi Alluvium	14	Y
Fernance	6379366.74	317697.38	Wollombi Alluvium	Unknown	
V1	6380086.18	316720.3	Wollombi Alluvium	<30	
V2	6383505.26	316959.49	Wollombi Alluvium	<30	
V3	6377087.42	321479.59	Wollombi Alluvium	<30	
WBD160	6380857	316435	Wollombi Alluvium	18	
WBR181	6383229.55	316735.26	Wollombi Alluvium	9	
WBR182	6382623.04	316570.5	Wollombi Alluvium	11.5	
White1	6378942.98	318248.9	Wollombi Alluvium	Unknown	
WBR241	6383671.92	316931.63	Wollombi Alluvium	13.5	Y
GW1	6375616.55	326035.56	Monkey Place Creek alluvium	Unknown	Y
GW10	6376728.28	322177.66	Monkey Place Creek alluvium	16	Y
GW2	6375636.4	325328.77	Monkey Place Creek alluvium	Unknown	Y
GW3	6375423.79	323342.37	Monkey Place Creek alluvium	13.2	Y
GW4	6375104.12	324107.37	Monkey Place Creek alluvium	Unknown	Y
GW5	6375152.53	324731.96	Monkey Place Creek alluvium	Unknown	Y
GW6	6375050.58	322800.98	Monkey Place Creek alluvium	13.3	
GW7	6375581.53	322738.39	Monkey Place Creek alluvium	10	Y
GW8	6375817.87	322120.98	Monkey Place Creek alluvium	16	Y
GW9	6376212.93	322319.08	Monkey Place Creek alluvium	13	Y
McG1	6381405.39	317425.87	Regolith /sill/ alluvium	Unknown	
WBR15	6379805.69	317578.48	Regolith /sill/ alluvium	24	Y
WBR240	6383685	317495	Shallow Permian	9	Y
WBR50A	6383700.52	317619.47	Shallow Permian	18	Y
P2	6377492.59	321283.35	Shallow coal measures	52	
P5A	6376660.68	321682.07	Shallow coal measures	<100	
P6A	6376615.27	322839.83	Shallow coal measures	<100	
SBD196	6377155.89	320164.75	Shallow coal measures	Unknown	
WBR180	6383123.84	316926.13	Shallow coal measures	46	
WBR183	6382733.61	316802.5	Shallow coal measures	30.6	
NPZ3-B	6379199.73	318116.79	Interburden Sandstone	51.4	
NPZ4-B	6380615.32	316824.26	Interburden Sandstone	63.3	
NPZ5-B	6381790.37	316448.35	Interburden Sandstone	51.3	
NPZ7-1	6379556.28	317566.2	Interburden Sandstone	50	
NPZ7-2B	6379598.15	317623.98	Interburden Sandstone	57.5	
NPZ7-3B	6379639.51	317680.71	Interburden Sandstone	54	
NPZ3-A	6379200.51	318117.71	Alcheringa seam	17	

Site Name	Northing (MGA56)	Easting (MGA56)	Formation monitored	Depth of installation (m bgl)	Continuous Datalogger Monitoring
NPZ4-A	6380615.83	316820.6	Alcheringa seam	42.4	Y
NPZ5-A	6381790.37	316448.35	Alcheringa seam	15.7	Y
NPZ7-2A	6379598.15	317623.98	Alcheringa seam	10	Y
NPZ7-3A	6379639.51	317680.71	Alcheringa seam	17	Y
WBD62A	6381282.77	316593.58	Alcheringa seam	27	Y
P6B	6376615.27	322839.83	Lower Whybrow seam	390	
P8	6375708.24	324628.23	Lower Whybrow seam	392.4	
WBR50	6383719.6	317604.5	Lower Whybrow seam	125	Y

Table 2.2: Details of vibrating wire piezometers

VWP ID	Northing / Easting (MGA56)	Ground Level (m AHD)	Depth Drilled (m)	VWP Depth (m bgl)	Formation	Stratigraphy
WBD170	317164.3 6380768.3	93.9	220	60	Undifferentiated coal measures	
				110		
				160		
				220	Whybrow Seam	Jerry's Plains Subgroup (Wittingham Coal Measures)
WBD171	316939.8 6380797.6	85.3	223	60	Undifferentiated coal measures	
				110		
				160		
				223	Whybrow Seam	Jerry's Plains Subgroup (Wittingham Coal Measures)
SBD194	320162.1 6377154.6	73.0	367.6	35.3	Shallow Coal	
				90.8	Watt's Sandstone	
				171.4	Whybrow Seam	Jerry's Plains Subgroup (Wittingham Coal Measures)
				197.3	Redbank Creek Seam	
				227.0	Wambo Seam	
				265.9	300/301 (Blakefield) Seam	
				278.8	Glen Munro Seam	
				321.3	Woodlands Hill Seam	
				367.7	Piercefield A and B Seam	
SBFOW15*	322380.2 6380379.1	89.1	383	96	Redbank Creek Seam	Jerry's Plains Subgroup (Wittingham Coal Measures)
				122	Wambo Seam	
				158	Blakefield Seam	
				184	Glen Munro Seam	
				224	Woodlands Hill Seam	
				334	Piercefield C Seam	

*data not available for 2019



LEGEND

Monitoring Bores - Piezometers
- Alcheringa Seam
- Lower Whybrow
- Monkey Place Creek
- VW Piezometer
- Regolith-sill-alluvium
- Sandstone
- Shallow Coal
- Shallow Permian
- Wollombi Alluvium

Hydrology
- Watercourse

Geology
- Alluvium

Underground Workings
- Extracted Blakefield South workings
- Extracted Underground workings

0 1 2
Kilometres

N

A4 1:60,000

[GDA94 | MGA56]

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3. Groundwater level responses during 2019

Groundwater level and quality data collected during 2019 have been reviewed to assess the groundwater response, post underground mining, and to natural effects. The 2019 data is viewed in the context of the historic dataset extending back as far as 2003 where data is available. Hydrographs to the end of 2019 are presented in Appendix A.

3.1 Shallow Groundwater System

Groundwater levels for the alluvium are presented in Appendix A together with the rainfall excess / deficit which is calculated as the cumulative difference between actual rainfall over the monitoring period and long term mean average rainfall. A rising trend on the rainfall excess / deficit plot represents periods of above average rainfall periods and falling trends represent periods of below average rainfall. Comparison of hydrographs to the rainfall excess / deficit trend helps interpretation of groundwater level fluctuations in the context of seasonal rainfall variations vs other potential influences.

Rainfall data for the calculation of the excess / deficit trend was sourced from Bureau of Meteorology (BOM) station 061100 (Broke), located approximately 3.5km south of the BSF workings. Rainfall data for the last 128 years from station 061100 were used to calculate the long-term monthly average rainfall. Recent data (2013-2019) from the BCC weather station was used to fill gaps in the BOM record for the Broke guage.

In the 2018 annual groundwater monitoring report “hydrograph analysis using rainfall and time trend” (HARTT) was used to assess groundwater level changes for some of the alluvium monitoring bores. The HARTT methodology (R. Ferdowsian), was developed to statistically analyse and estimate trends in groundwater levels. The method aims to separate the effect of rainfall events and the lag between rainfall and groundwater response from other underlying trends. The method is essentially a simple analytical modelling technique and produces a fitted curve through the observed groundwater level data using two variables, rainfall: Accumulative Monthly (or annual) Residual Rainfall (AMRR), and time. These variables can differentiate between the effect of rainfall fluctuations and other groundwater level trends. In the 2018 groundwater monitoring report this analysis was applied to selected bores in the alluvium where groundwater levels are more responsive to rainfall trends.

As the HARTT analysis simply aims to assess the influence of rainfall on groundwater level fluctuations relative to other (unspecified), influences and is a somewhat subjective analytical tool it was not considered of value to repeat the assessment for the additional 2019 data as levels in most alluvial bores show a clear reflection of the increasing rainfall deficit during 2019.

3.1.1 Wollombi Brook Alluvium

During 2019 groundwater levels in the Wollombi Brook Alluvium continued to decline in line with the sharply increasing rainfall deficit. The trend seen in 2019 is a continuation of a general decline that started in early 2016 consistent with the steady period of rainfall deficit from that date. The groundwater levels in 2019 were the lowest observed in 8 of the 12 bores currently monitored.

Most piezometers show a steady decrease in groundwater level of around 0.2 to 0.5 m over the course of 2019 with a very similar trend. Exceptions are Dwyers and Fernance, both of which show very similar but variable trends over 2019 including a response to high rainfall in March, and WBR241 which shows a variable level and a slight increase over the course of 2019.

While it is clear from a visual review of the data that there is a correlation between rainfall excess / deficit and alluvial groundwater levels (indicating insignificant recharge or discharge from the aquifer via non-climate related stresses), HARTT analysis undertaken for the 2018 groundwater monitoring report for three Wallombi alluvium piezometers (Fernance, White and WBD160) located to the west of the BFS suggests there are other influences on alluvium groundwater levels. The HARTT analysis appeared to indicate a weaker statistical correlation to rainfall that the visual match would suggest. This is interpreted to indicate that other influences on alluvium groundwater levels such as alluvium supply bores and groundwater-surface water interaction. BCC

staff have indicated there is significant localised pumping of groundwater from the alluvium (for irrigation of pasture and for vineyards). Evidence of this is presented in Figure 2 where a localised depression in the alluvium groundwater contours for Dec 2019 is seen between bores V1 and White 1.

3.1.2 Monkey Place Creek Alluvium

There is a network of ten piezometers which monitors groundwater levels in the Monkey Place Creek Alluvium (MPCA) located to the south and south-east of the BFS (Figure 1). All but one of these bores have data loggers installed although several of the dataloggers show departures from the more consistent manual readings and some show anomalous levels.

The manually recorded groundwater levels in the MPCA piezometers all show a fall during 2019 in accordance with the increasing rainfall deficit which started in early 2016. Levels generally fall between approximately 0.2 and 0.7 m over 2019. However, most bores show steady levels over the first half of 2019 or a slight rise in response to the heavy rainfall in March followed by a decline to the end of 2019. The prolonged period of rainfall deficit since the start of 2016 has resulted in the lowest groundwater levels since the end of the Millennium drought in 2007. However, the current groundwater levels in the MPCA are generally still well above the levels recorded before the Millennium drought broke.

The HARTT analysis completed for the 2018 groundwater monitoring report included two MPCA piezometers: GW9 and GW10. As for the Wolombi Alluvium, the analysis concluded that parameters other than just rainfall appear to have some influence on groundwater levels in the MPCA. These influences are likely to include groundwater-surface water interaction (Monkey Place creek) and local irrigation across the MPCA alluvium.

3.1.3 Regolith/volcanic sill/alluvium

McG1 and WBR15 piezometers are installed in regolith/volcanic sill/alluvium and are located west of the BFS. Over the course of 2019 groundwater levels in McG1 showed a very slight overall fall in elevation with the most notable feature being the ~2m rise and fall in levels in response to the heavy rainfall in March. Groundwater levels in this bore have typically shown a similar order of seasonal variation to rainfall since the end of the Millenneum drought in 2007 before which levels were very steady.

Groundwater levels in WBR15 levelled off during 2019 with a very sight decline through the first half of the year and a slight rise through the second half of the year. Levels are now the lowest recorded by around 3m. This bore shows very different groundwater level fluctuations to those in McG1 with a much smoother seasonal changes which seem only partly relatable to rainfall excess / deficit.

3.2 Interburden and shallow coal measures

3.2.1 Interburden Sandstone

The shallow Permian piezometers are installed to depths of <20 m and the sandstone bores at a range of depths between 50 to 65 m (see Table 2.1 for details).

The sandstone piezometers show two responses. Those installed in a cluster directly to the west of BFS all show very similar responses which generally reflect the rainfall excess / deficit curve. Levels in 2019 show a continued but much slower decline than in the preceding years of rainfall deficit since 2016 with falls of between 0.15 and 0.5 m through 2019.

The two sandstone bores located further north (NPZ4-B and NPZ5-B), to the north-west of BFS, show quite a different response with a sharp decline following installation in 2005 followed by a general increase since 2010. These bores are directly west of the Beltana No.1 underground workings where extraction of coal from the Whybrow Seam ceased in 2011 and appear to show a clear recovery response. In 2019 levels in NPZ4-B showed a very slight decline which is a continuation of the slightly sharper decline since the start of the rainfall deficit period in 2016. Levels in NPZ5-B continue to show a very slight increase during 2019.

Groundwater levels in 2019 in the two shallow Permian bores show a decline of ~0.25-0.5 m in line with the continued increase in rainfall deficit although the decline through the first half of the year was reduced by the heavy rainfall in March. Levels in these bores are now the lowest recorded.

3.2.2 Undifferentiated Coal Measures

Shallow coal measures piezometers are located to the south of BFS (P2, P5A, P6A and SBD196) with two (WBR180 and WBR183) located at to the northwest at a distance of over 2 km, north-east of the northern end of the Beltana No.1 underground workings.

The four piezometers to the south all show declining groundwater levels during 2019 between 0.4 m and 3.7 m and generally show a clear trend aligned to rainfall excess / deficit. The two piezometers to the north-west of BFS both show much more subdued trends with declines of approximately 0.4 m during 2019. WBR180 has shown a steady declining trend since a sharp fall following installation in 2009 and WBR183 shows a trend which gently reflects the rainfall excess deficit.

3.3 Coal Seams

3.3.1 Alcheringa Seam (Wollombi coal measures)

Piezometers monitoring Alcheringa Seam are installed to the west of BFS and at the eastern edge of the Wollombi Brook alluvium. During 2019 the groundwater levels in both NPZ7-3A, NPZ4A and NPZ7-2A show somewhat erratic levels but a general levelling off of the steady decline over recent years which matches the increasing rainfall deficit. These piezometers have broadly matched the rainfall excess / deficit curve since installation in 2005. The trend in WBD62A for the most part reflects the rainfall excess / deficit plot with the exception of a steep decline through 2008-9 against the trend of rainfall excess. In 2019 this piezometer shows a continuation of the decline in line with rainfall deficit since 2016 (with the exception of some anomalous levels in early 2018).

Recent responses in piezometers NPZ5A and NPZ3A are much more subdued than other piezometers in this seam with NPZ5A gently reflecting the rainfall excess deficit trend including a continued gentle decline through 2019. Following a significant decline in 2008-2011 NPZ3-A has continued to recover very slowly although no data is available for 2019.

3.3.2 Lower Whybrow (Whittingham 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 and P8 to the south of BFS and WBR50 4km north-west of BFS and just north of the Beltana workings).

In 2019 groundwater levels in P6B were somewhat erratic although there was minimal net change from the start to the end of 2019. This levelling off represents a significant change from the 80 m of depressurisation recorded between the start of 2015 and the end of 2018 and reflects the cessation of mining activity at BSF.

In P8 levels have been somewhat erratic over the course of the record with large step increases in 2005 and 2008. Since 2016 ~15 m of depressurisation has been observed although in 2019 the net decrease across the year was just 0.44 m reflecting the cessation of mining activity at BSF

At WBR50 levels were also erratic during 2019 but only show a net decrease of <0.5 m which does not mark a significant departure for the recent trend. Depressurisation of the Whybrow seam at this location occurred between 2008 and 2011 and has not yet shown any significant recovery.

3.4 Nested Standpipe Piezometers

The change in vertical hydraulic gradients and connectivity between different formations is monitored by seven nested standpipe piezometers. These are detailed below and charts showing the hydrographs for each pair of piezometers are presented in Appendix A:

- One pair (P6 A and B) installed in the shallow coal measures and Lower Whybrow Seam respectively southwest of BFS.
- Five pairs (NPZ3, NPZ4, NPZ5, NPZ7-2 and NPZ7-3) installed in the Alcheringa Seam (piezo A), and the underlying interburden sandstone (piezo B) to the west of the BFS. Note that data collection at NPZ3-A ceased in 2016 but NPZ3-B continues to be monitored.
- One pair (WBR50A and WBR50) installed 5km northwest of BFS and just northwest of the Beltana workings in the shallow coal measures and Lower Whybrow seam respectively.

3.4.1 Alcheringa seam and Interburden Sandstone Connectivity

During 2019, the vertical hydraulic gradients at these nested piezometers were as follows:

NPZ3 – the upward vertical hydraulic gradient was steadily decreasing with a falling pressure in the sandstone and a slowly increasing pressure trend in the Alcheringa up to 2016 when monitoring stopped.

NPZ4 – the downward vertical hydraulic gradient remained constant with the pressure reduction in the sandstone levelling off and matching the very slight pressure reduction seen in the Alcheringa seam pressure.

NPZ5 – the downward vertical hydraulic gradient decreased slightly with a continued gentle pressure reduction in the sandstone and slight pressure increase in the Alcheringa seam.

NPZ7-2 – the downward vertical hydraulic gradient which started increasing in 2016 continued to increase (although the rate of increase has slowed). Decreasing pressure in the sandstone continued during 2019 but slowed with no net pressure change in the overlying Alcheringa seam during 2019.

NPZ7-3 – the downward vertical hydraulic gradient which started increasing in 2016 continued to increase (although the rate of increase slowed significantly in 2019). Decreasing pressure in the sandstone continued during 2019 but slowed with minimal net pressure change in the Alcheringa seam over 2019.

The vertical hydraulic gradients between the Alcheringa seam and the underlying interburden sandstone are generally downward with the vertical head difference between these units ranging between 6-14 m. At NPZ3 there appears to be an upward vertical gradient at with a head difference of around 2 m between the .

3.4.2 Shallow and Deep Coal Measures Connectivity

There has been little change in the downward vertical hydraulic gradient (~30m pressure difference) between the shallow coal measures at WBR50A and the Lower Whybrow seam (WBR50), since depressurisation of the Whybrow seam between 2008 and 2011. This situation continued through 2019.

There is a downward vertical hgradient gradient (~80m pressure difference) between the shallow coal measures at P6A and the Lower Whybrow seam (P6B), which started to develop in 2016 presumably due to the depressurisation of the Blakefield seam at BFS to the north. The depressurisation appears to have stopped with little net change in the levels in P6B during 2019. Levels in P6A show a 3.6 m decrease during 2019 resulting in a small reduction in the vertical gradient.

Based on the data collected, including the lack of significant response in the shallow coal measures during the initial depressurisation of the Whybrow seam, there appears to be little evidence of significant hydraulic connection between these units at these two monitoring locations.

3.5 Vibrating Wire Piezometers

Vibrating wire piezometers (VWP) installed to the south-west, north-east, and north-west of the BFS measure piezometric heads at multiple depths across a vertical profile. These VWPs have between 4 and 9 pressure sensors installed at different depths, grouted into one borehole to measure vertical hydraulic gradients over time which assists in understanding vertical connectivity between HSUs. Four VWP sites are monitored as part of the groundwater network for BFS:

- WBR170 and WBR171 are installed to the north-west of the BFS and directly west of the Beltana workings, on the eastern edge of the Wollombi Alluvium;
- SBD194 is immediately adjacent to the south-west of the BFS (at the south-western end of BFSLW3); and
- SBFOW15 is the closest VWP installed immediately adjacent to the north- east of the BFS.
- Recent pressure profiles are presented for each of these VWPs in Appendix A.

The Whybrow Seam and undifferentiated Permian overburden are monitored in VWP WBR170 and WBR171 to the north-west of BFS. Each VWP has four sensors with three in the undifferentiated Permian and the lowest one in the Whybrow seam. Only limited data was available to download for these VWPs but the 2018 groundwater monitoring report includes the full record of approximately 6 monthly data going back to Dec 2007 and 2009.

At WBR170 the pressure profile shows obvious depressurisation in the lowest undifferentiated Permian overburden sensor. Comparison of the 2017 data to the 2019 data shows continued re-pressurisation at both the lowest undifferentiated Permian sensor and in the Whybrow seam. This is a continuation of the re-pressurisation trend seen in the longer term dataset since 2008 (2018 report, David, K. 2019). The shallower undifferentiated Permian sensors show a slight pressure reduction since 2017 possibly as a result of the continued rainfall deficit.

At WBR171 the pressure profile shows continued re-pressurisation at both the lowest undifferentiated Permian sensor and in the Whybrow seam. This is a continuation of the re-pressurisation trend seen in the longer term dataset going back to 2008 (2018 report, David, K. 2019). The shallowest undifferentiated Permian sensor shows a slight pressure reduction since 2017 possibly as a result of the continued rainfall deficit. The middle undifferentiated Permian sensor shows virtually no recovery over the recent monitoring period.

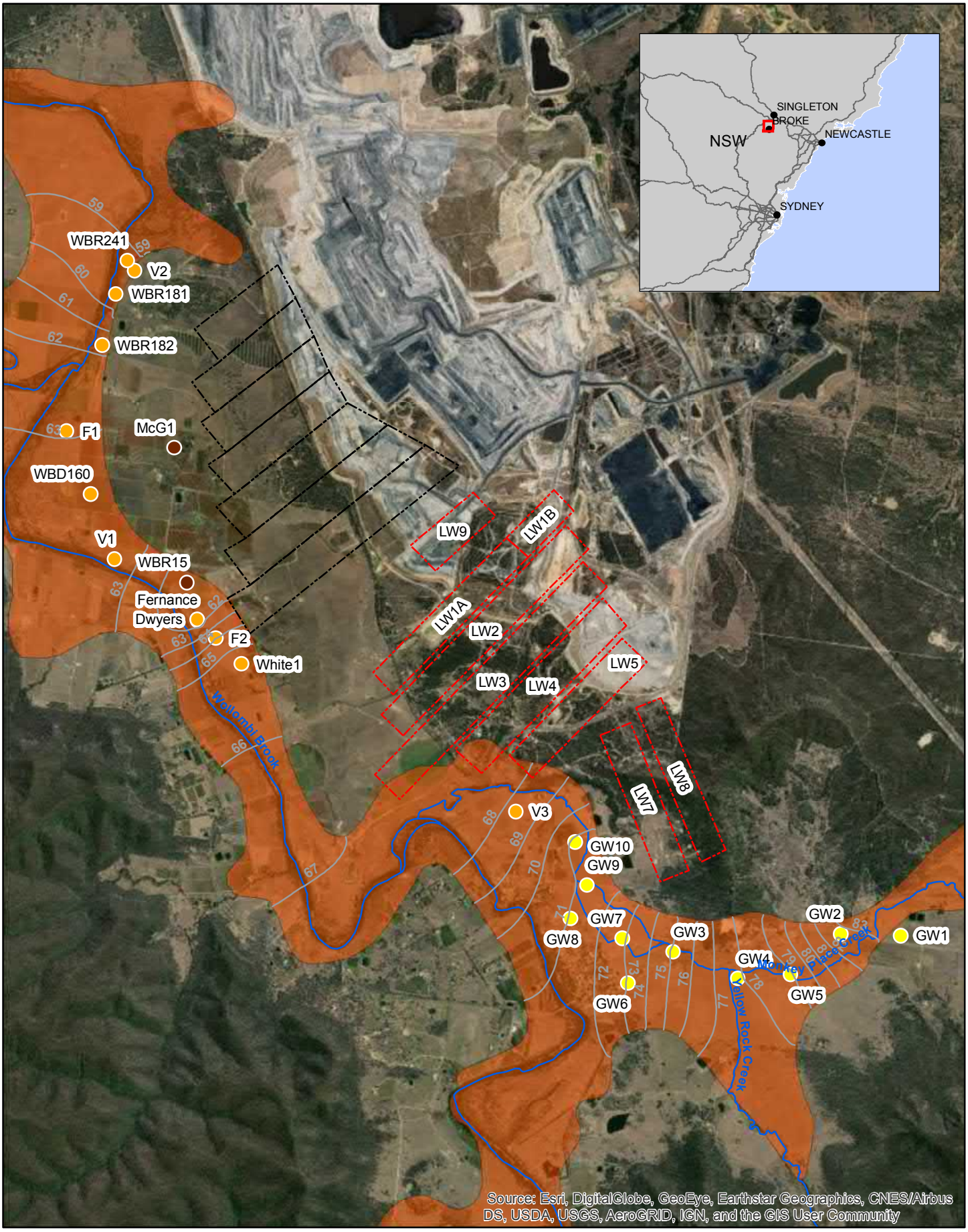
VWP SBD194 has nine vibrating wire piezometers installed in major seams including Blakefield Seam (-190 mAHD), lower Whybrow Seam (-100 mAHD) and the interburden sandstone. Following the completion of mining, there has been re-pressurisation of the Blakefield seam, apparently partly by depressurisation of the immediately overlying (Wambo Seam) and underlying strata (Monro Seam), which continued during 2019. The Blakefield seam itself appears to have slightly depressurised at this location through 2019 (relative to 2018), although there is still an overall re-pressurisation of 40-45 m to date.

At SBFOW15 there is a clear vertical hydraulic gradient with an obvious de-pressurisation at -70m AHD in the Blakefield seam which has not shown any significant re-pressurisation during 2019. The longer term data presented in the 2018 monitoring report also indicates there has also been a fairly uniform depressurisation of the underlying strata of approximately 20m with limited recovery to date.

3.6 Groundwater Flow in Alluvium

Groundwater contours for the Wollombi Alluvium and Monkey Creek Alluvium, based on data for December 2019, are presented in Figure 2. Groundwater flow in alluvium is essentially in the downstream direction to the west and then north-west along the track of alluvium. Groundwater levels are generally slightly lower compared to Dec 2018. A groundwater depression is interpreted from the data in the vicinity of Dwyers piezometer (Figure 2) west of BFS, which is considered most likely due to local groundwater extraction from the alluvium for stock and domestic or irrigation purposes. The hydraulic gradient along the Monkey Place Creek alluvium is a little steeper than that along the Wollombi Brook alluvium suggesting lower hydraulic conductivity.

Figure 2: Groundwater contours for the alluvium (December 2019)



LEGEND

Monitoring Bores - Piezometers
- Monkey Place Creek Alluvium
- Wollombi Alluvium
- Regolith / Alluvium

Groundwater
- Water Level - Dec 2019

Hydrology
- Watercourse

Geology
- Alluvium

Underground Workings
- Extracted Blakefield South workings
- Extracted Beltana underground workings

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Kilometres
N
A4 1:60,000
[GDA94 | MGA56]

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3.7 Groundwater Chemistry

Groundwater quality sampling and analysis is undertaken on a six monthly basis, while field water quality data (electrical conductivity (EC) and pH) is collected every 2 months from all standpipe piezometers. EC data has been used 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, this data is presented in Appendix A. A Piper plot comparing major ion chemistry data for Dec 2019 for coal seams, alluvium and sandstone/regolith is presented in Figure 3.1.

The time series EC data for the alluvium bores displays trends that reflect the rainfall excess / deficit trend with drier periods resulting in higher EC in alluvial groundwater and higher rainfall periods resulting in lower EC. This trend continued during 2019 with slightly increasing EC observed in many bores in response to the increasing rainfall deficit. One exception is WBR181 which shows erratic EC with some spikes much higher (> double) that observed historically.

Figure 3.1 presents major ion chemistry data for groundwater samples from bores screened in alluvium, coal seams and sandstone/regolith, collected in December 2019. Piper plots present the relative abundance of common ions in water samples and group samples by their major ion chemistry into facies.

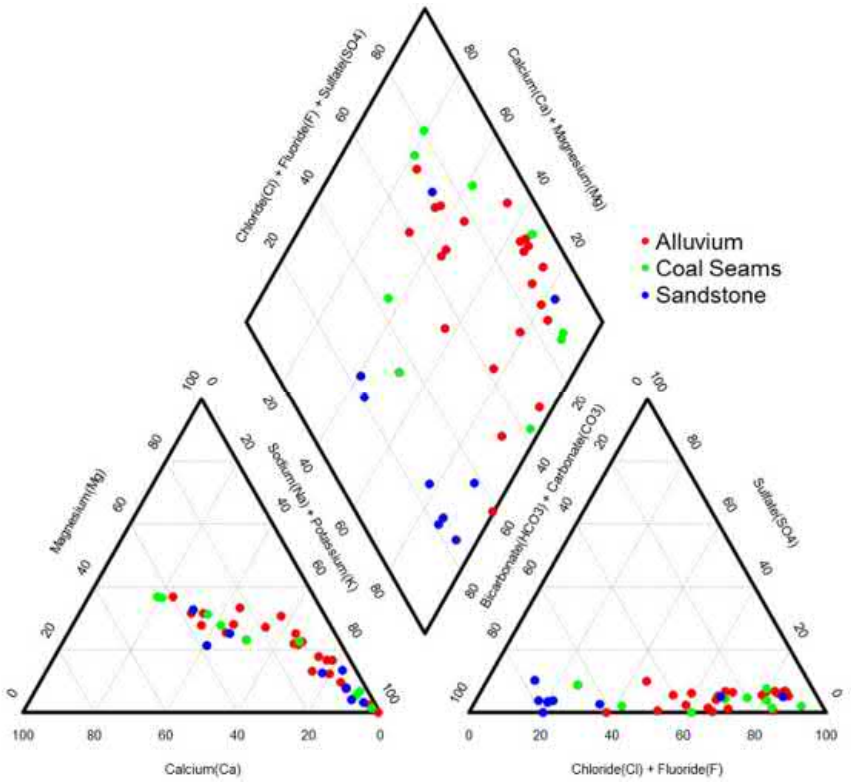


Figure 3.1: Piper plot comparison of major ion groundwater chemistry for the alluvium, coal seams and sandstone interburden (samples collected 18-19th Dec 2019).

The Piper plot shows that:

- Shallow alluvium water samples generally cluster in the Na-CL facies (with some samples showing "mixed" major ion chemistry i.e. no dominant ions);
- Intermediate zone water samples generally cluster in the Na-HCO3 to Mg-HCO3 type waters; and
- The coal seam samples plot across several facies including "mixed" but also show some overlap with the alluvium samples.

4. Summary and Conclusions

This groundwater report documents groundwater conditions following the cessation of BFS mining in April 2018. The potential impact on groundwater levels and quality has been assessed. The study found the following:

- The groundwater monitoring network 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 groundwater monitoring network is comprehensive and includes 48 monitoring locations in the alluvium, overburden strata (sandstone and coal seams), Whybrow Seam, Blakefield Seam and underlying and overlying strata. Four VWPs monitor the changing vertical gradients (re-pressurisation and depressurisation) above and below the Blakefield Seam;
- Overburden pressures in the top 50 to 100 m from surface remain relatively stable following the cessation of extraction at BFS in 2018 with a decline in head observed in shallow coal measures strata likely related to the increasing rainfall deficit during 2019.
- The vertical head profiles In the VWPs show continued re-pressurisation of the Whybrow seam at WBDR170 and WBD171 but with some lowering of pressures at the shallowest sensors likely related to the increasing rainfall deficit during 2019.
- At SBD194 re-pressurisation of the Blakefield Seam continues at the same time as depressurisation of the overlying Wambo Seam and underlying Monro Seam until pressures equilibrate. Re-pressurisation of around 40-45 m is observed to date in the Blakefield Seam at SBD194 to the west of BFS.
- Shallow groundwater in the alluvium (Wollombi and MPC), generally shows a continued decline through 2019 in line with the increasing rainfall deficit recorded since 2016. Hydrograph analysis of selected alluvial bores (using the HAART method) in the 2018 monitoring report indicates that there may be other influences on groundwater levels in the alluvium such as irrigation, extraction and surface water-groundwater interaction. However, rainfall is the major influence on alluvium groundwater levels;
- Field measured EC in alluvial groundwater shows a close relationship to rainfall with EC measured during 2019 continuing to show a slight increasing trend in line with the increasing rainfall deficit since 2016;
- The major ion chemistry for groundwater samples collected in December 2019 is very similar to the December 2018 data. Sandstone/regolith samples generally cluster in the Na-HCO3 to Mg-HCO3 type waters and are different to groundwater from the alluvium which generally clusters in the Na-CL facies with some samples showing “mixed” major ion chemistry i.e. no dominant ions. The coal seam samples plot across several facies including “mixed” but also show some clustering with the alluvium samples.

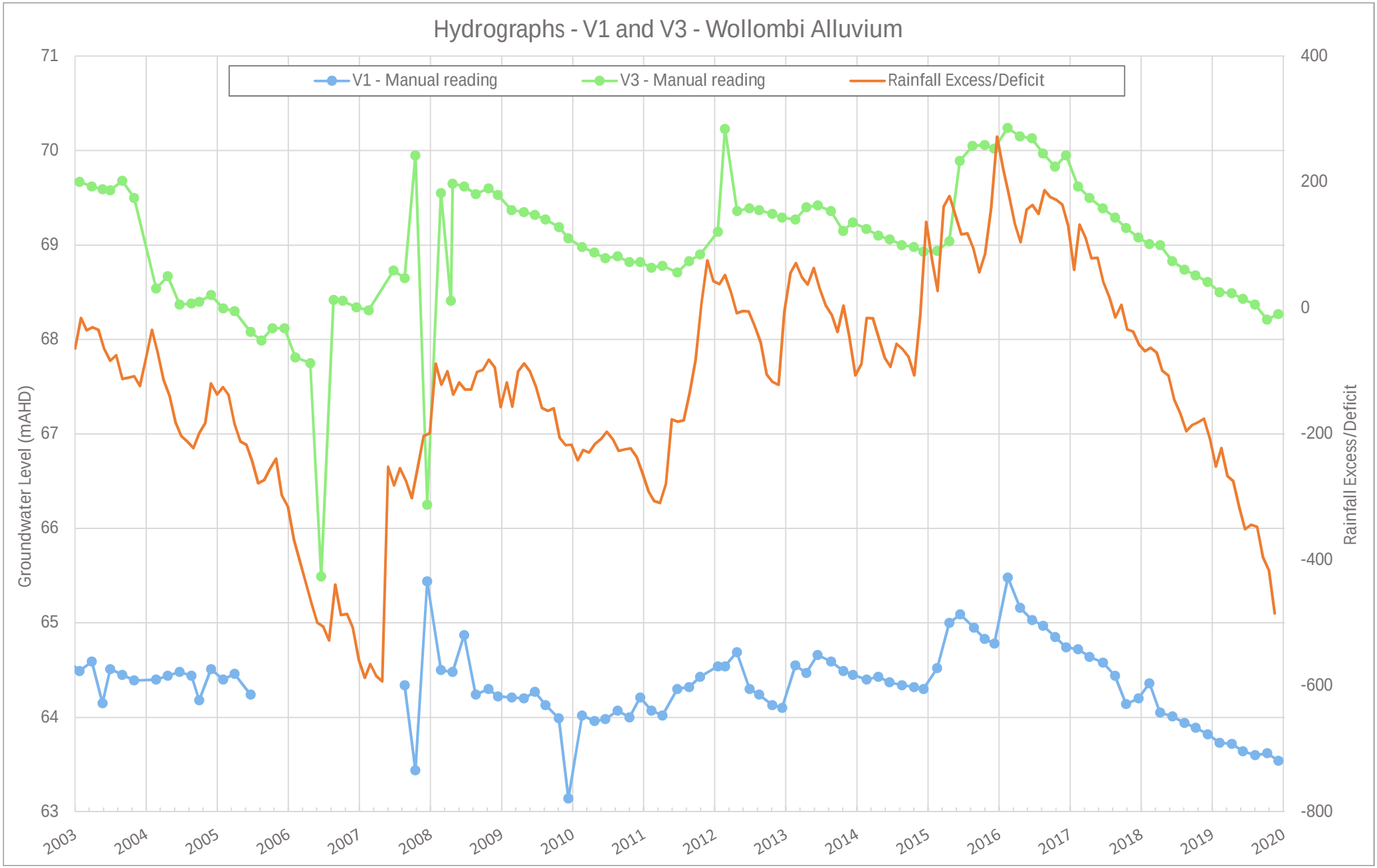
5. References

David, K. March 2019. Annual Groundwater Report for Blakefield South [2018], for Bulga Underground Operation Pty Ltd. Report KD2018/11 March 2019.

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 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, VWP pressure profiles and field measured EC in the alluvium


Hydrographs - V1 and V3 - Wollombi Alluvium
V1 - Manual reading
V3 - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit
71
70
69
68
67
66
65
64
63
400
200
0
-200
-400
-600
-800
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2018
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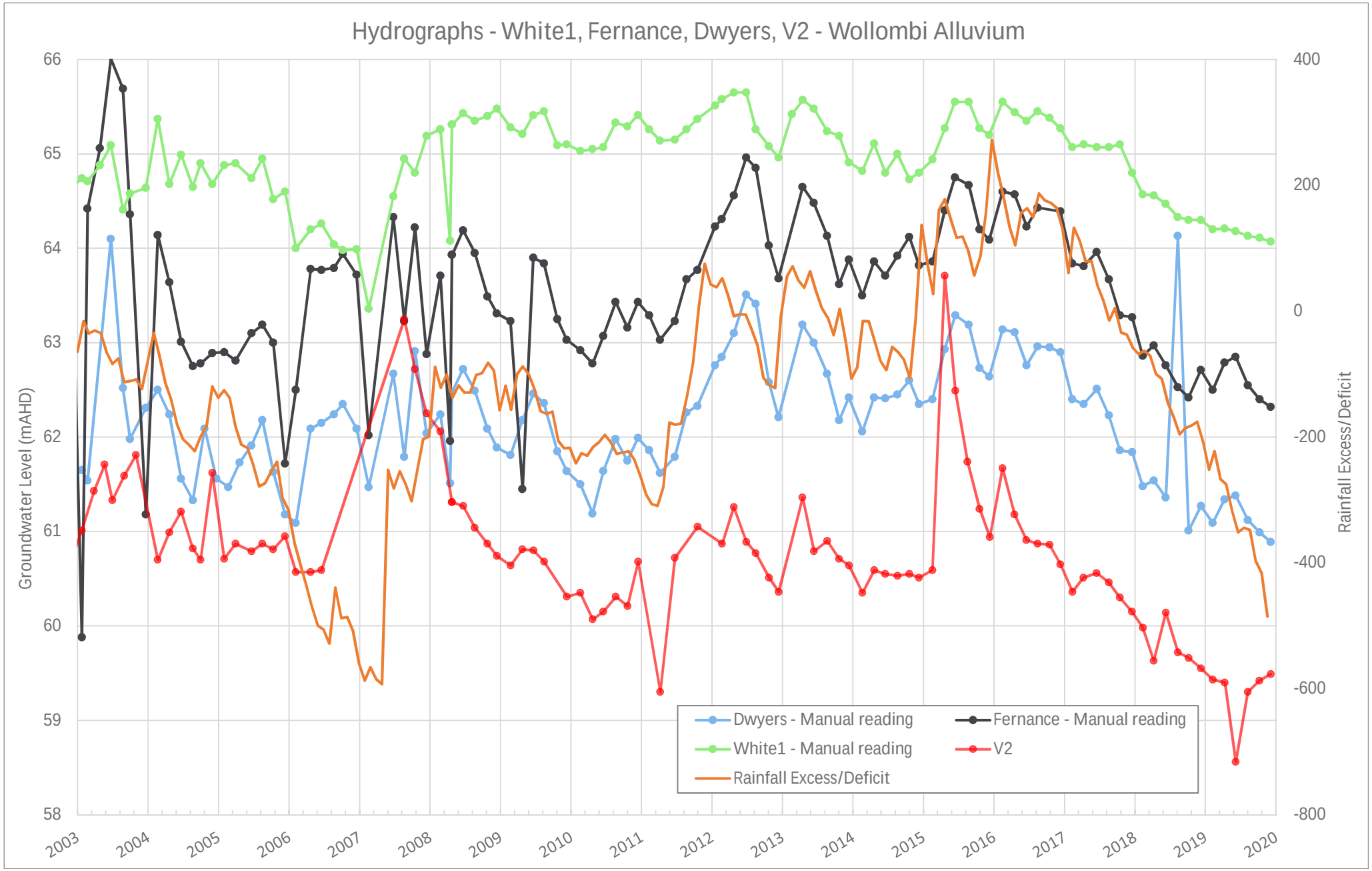
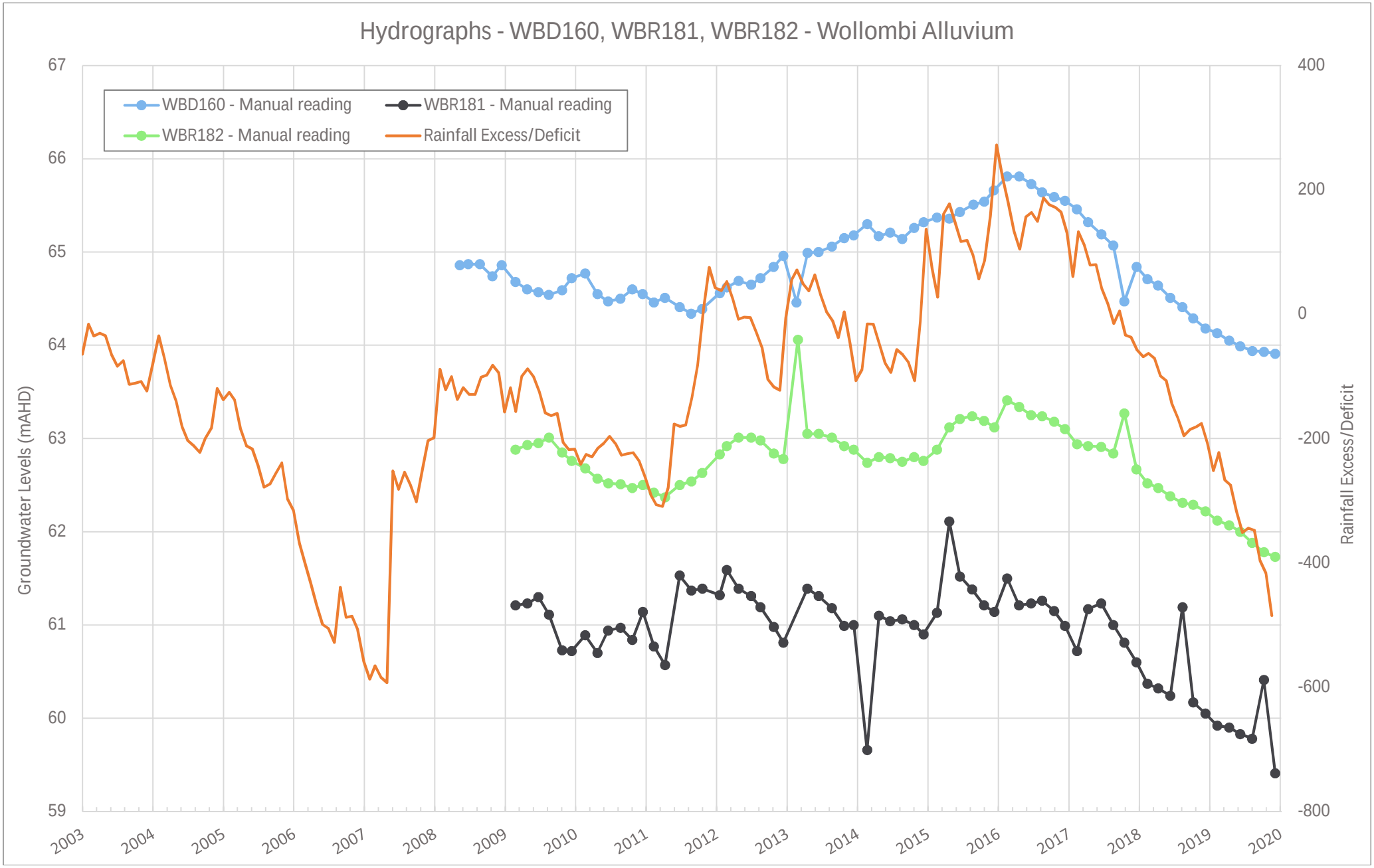
2020


Hydrographs - White1, Fernance, Dwyers, V2 - Wollombi Alluvium
Groundwater Level (mAHD)
Rainfall Excess/Deficit
66
65
64
63
62
61
60
59
58
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Dwyers - Manual reading
Fernance - Manual reading
White1 - Manual reading
V2
Rainfall Excess/Deficit


Hydrographs - WBD160, WBR181, WBR182 - Wollombi Alluvium
WBD160 - Manual reading
WBR181 - Manual reading
WBR182 - Manual reading
Rainfall Excess/Deficit
Groundwater Levels (mAHD)
Rainfall Excess/Deficit
67
66
65
64
63
62
61
60
59
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
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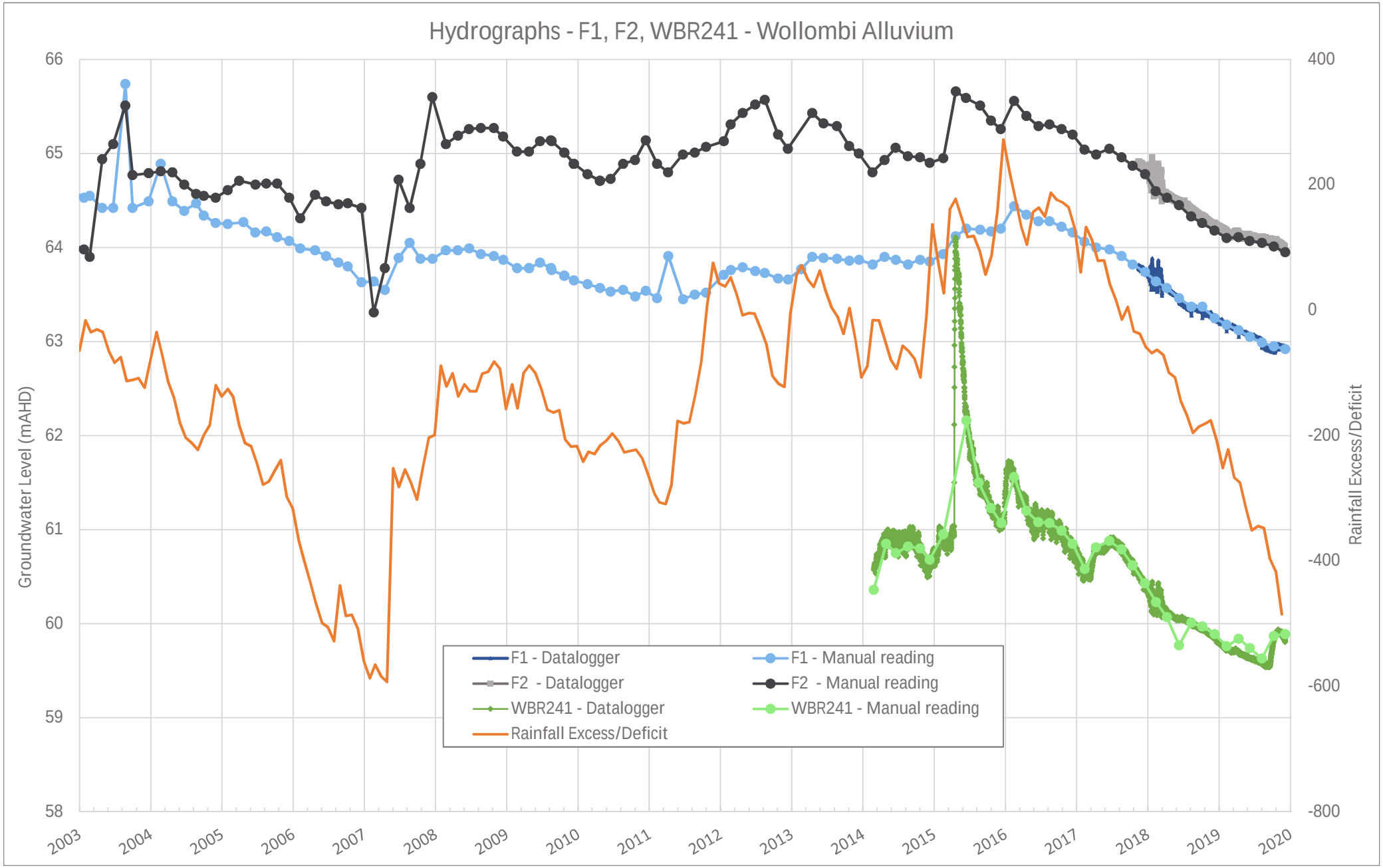
2019
2020


Hydrographs - F1, F2, WBR241 - Wollombi Alluvium
Groundwater Level (mAHD)
Rainfall Excess/Deficit
66
65
64
63
62
61
60
59
58
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
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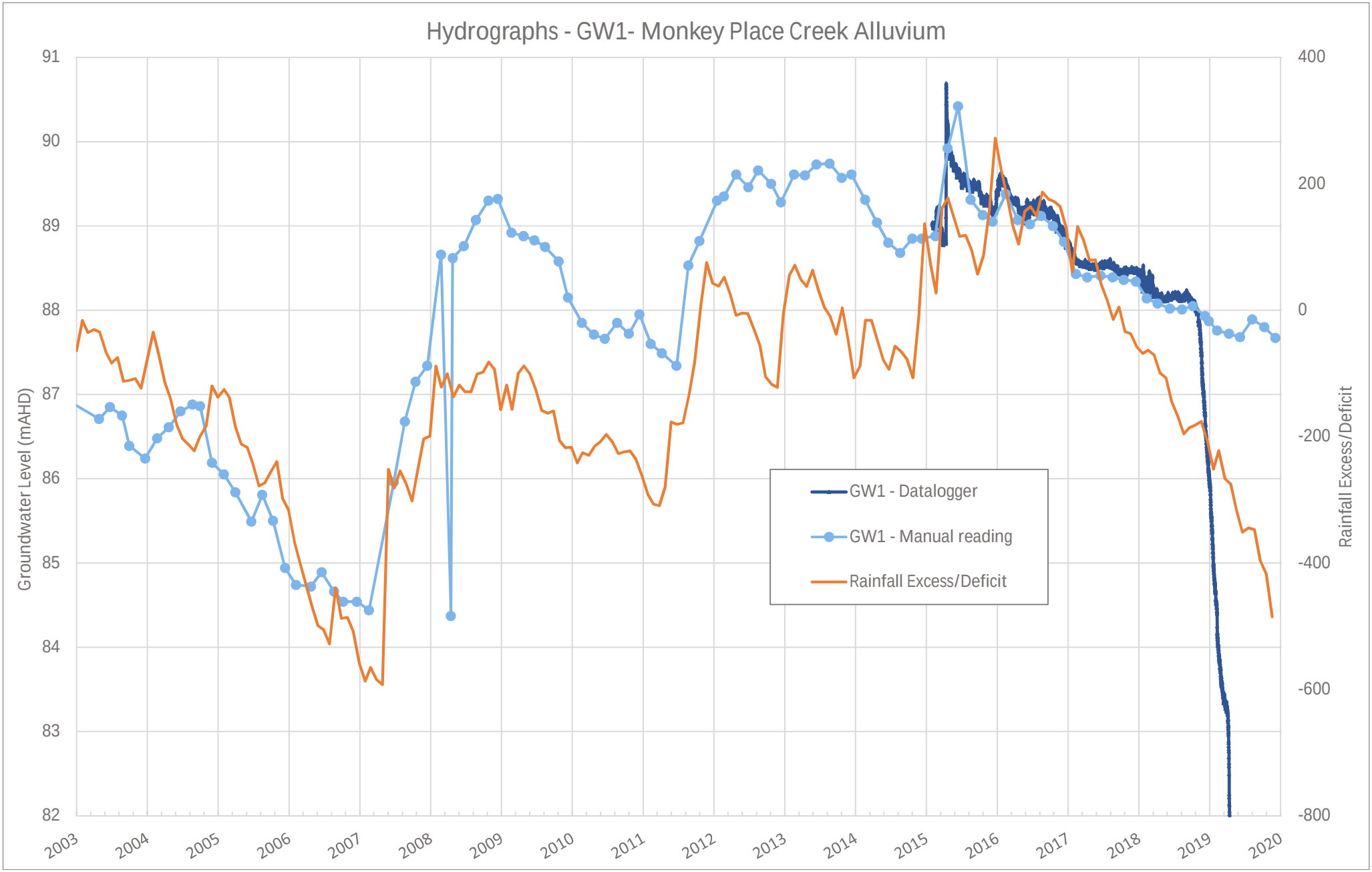
2016
2017
2018
2019
2020
F1 - Datalogger
F1 - Manual reading
F2 - Datalogger
F2 - Manual reading
WBR241 - Datalogger
WBR241 - Manual reading
Rainfall Excess/Deficit


Hydrographs - GW1- Monkey Place Creek Alluvium
Groundwater Level (mAHD)
Rainfall Excess/Deficit
91
90
89
88
87
86
85
84
83
82
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
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2015
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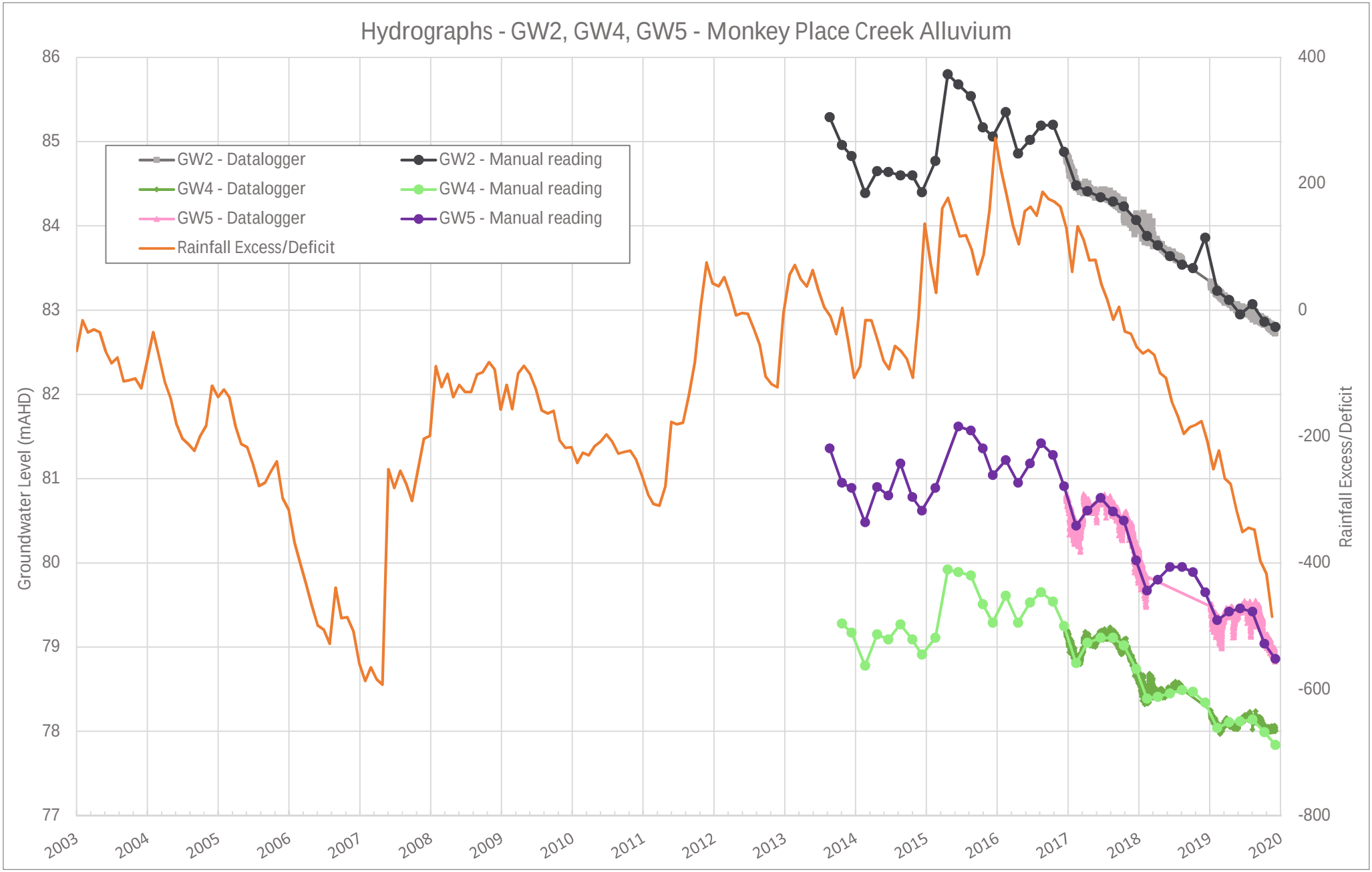
2017
2018
2019
2020
GW1 - Datalogger
GW1 - Manual reading
Rainfall Excess/Deficit


Hydrographs - GW2, GW4, GW5 - Monkey Place Creek Alluvium
GW2 - Datalogger
GW2 - Manual reading
GW4 - Datalogger
GW4 - Manual reading
GW5 - Datalogger
GW5 - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit
86
85
84
83
82
81
80
79
78
77
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
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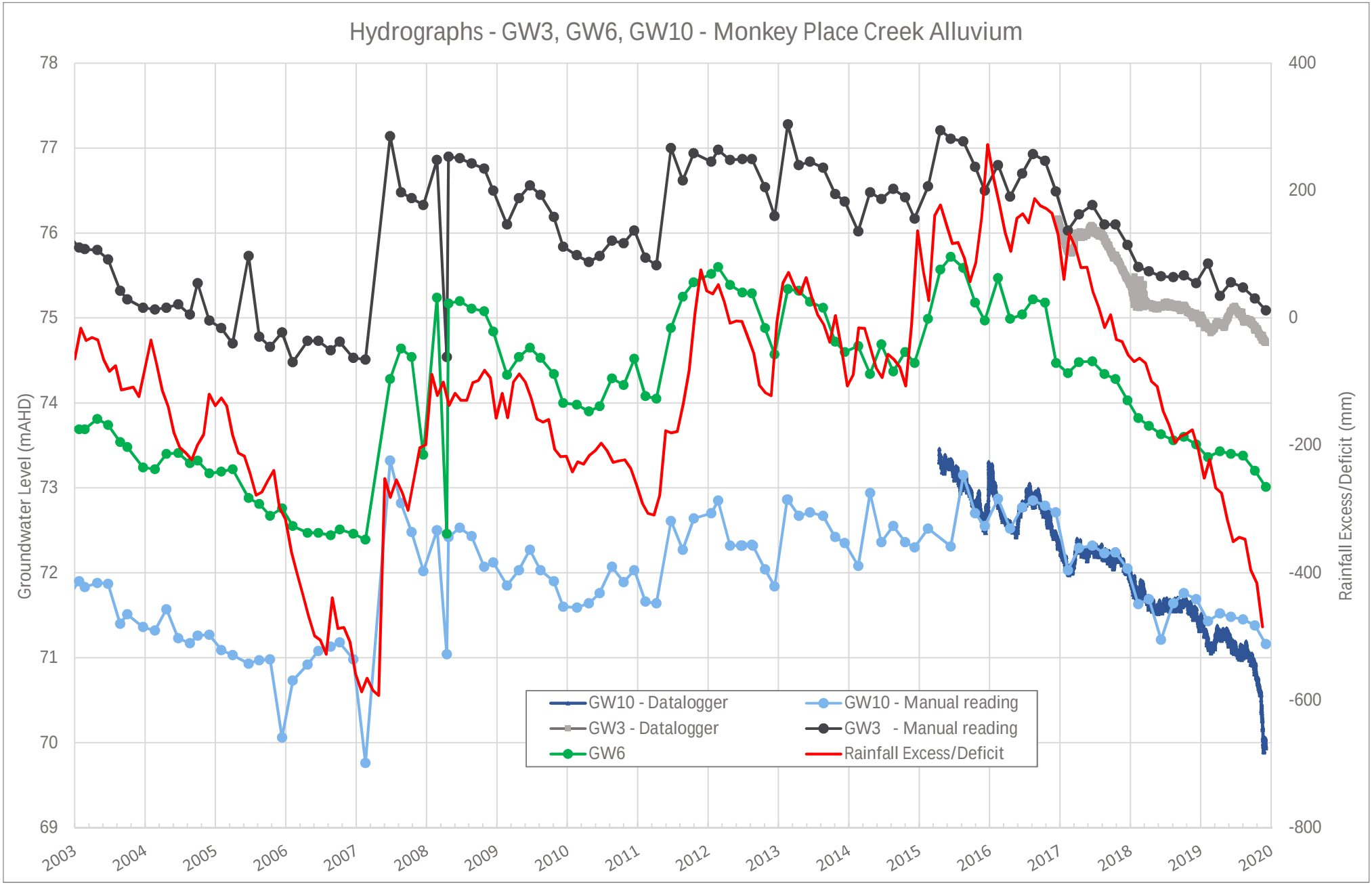
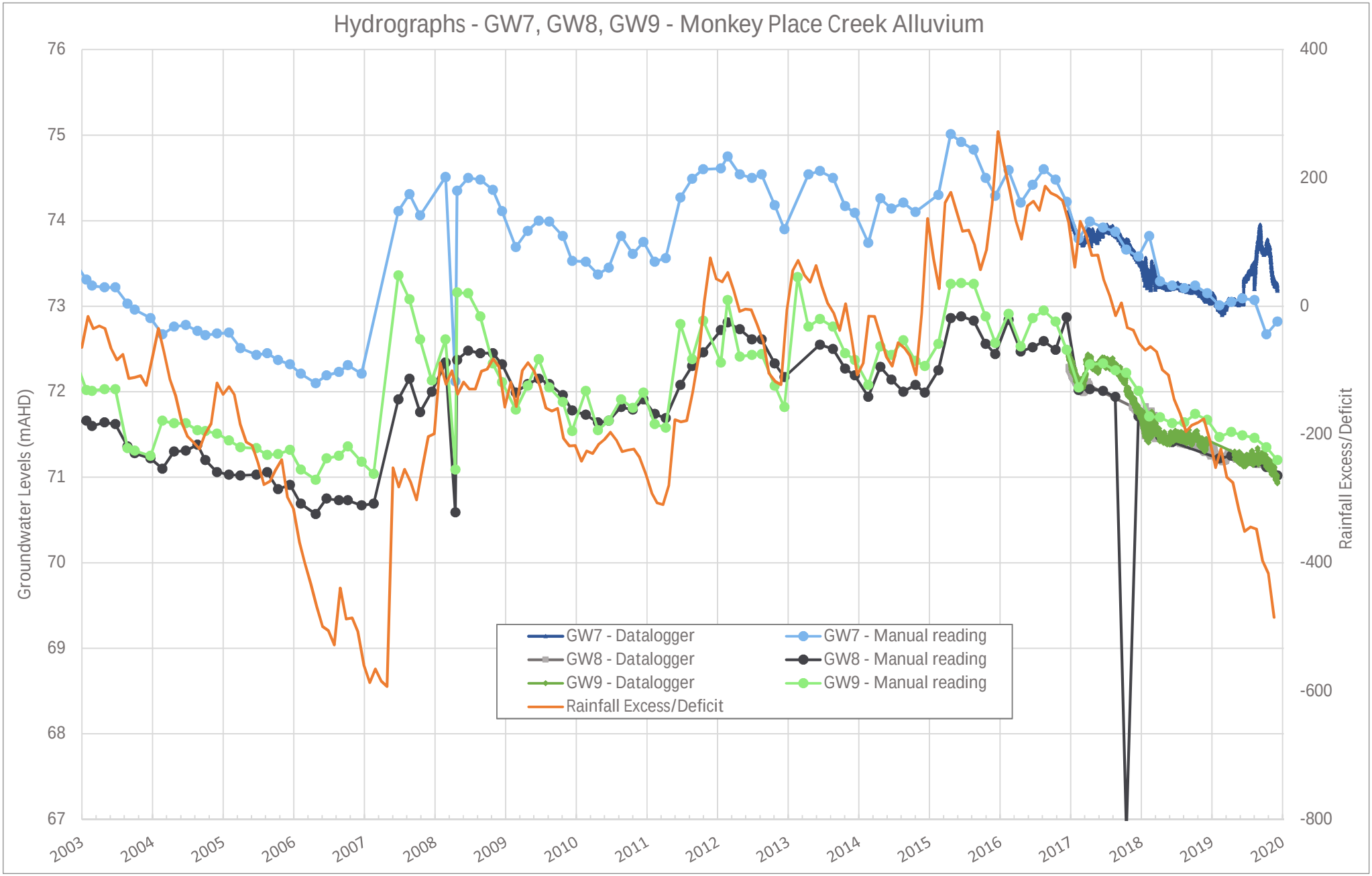
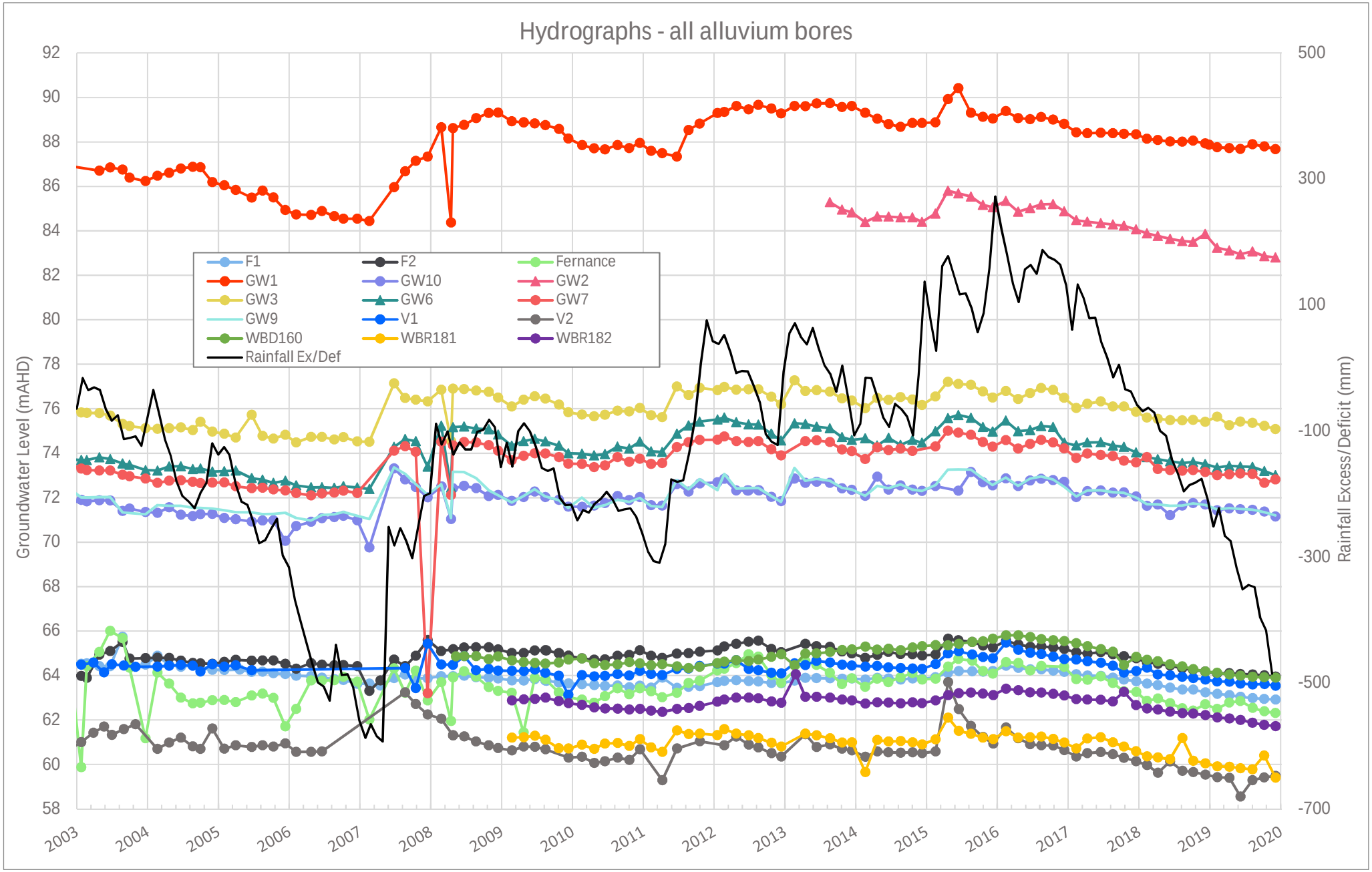
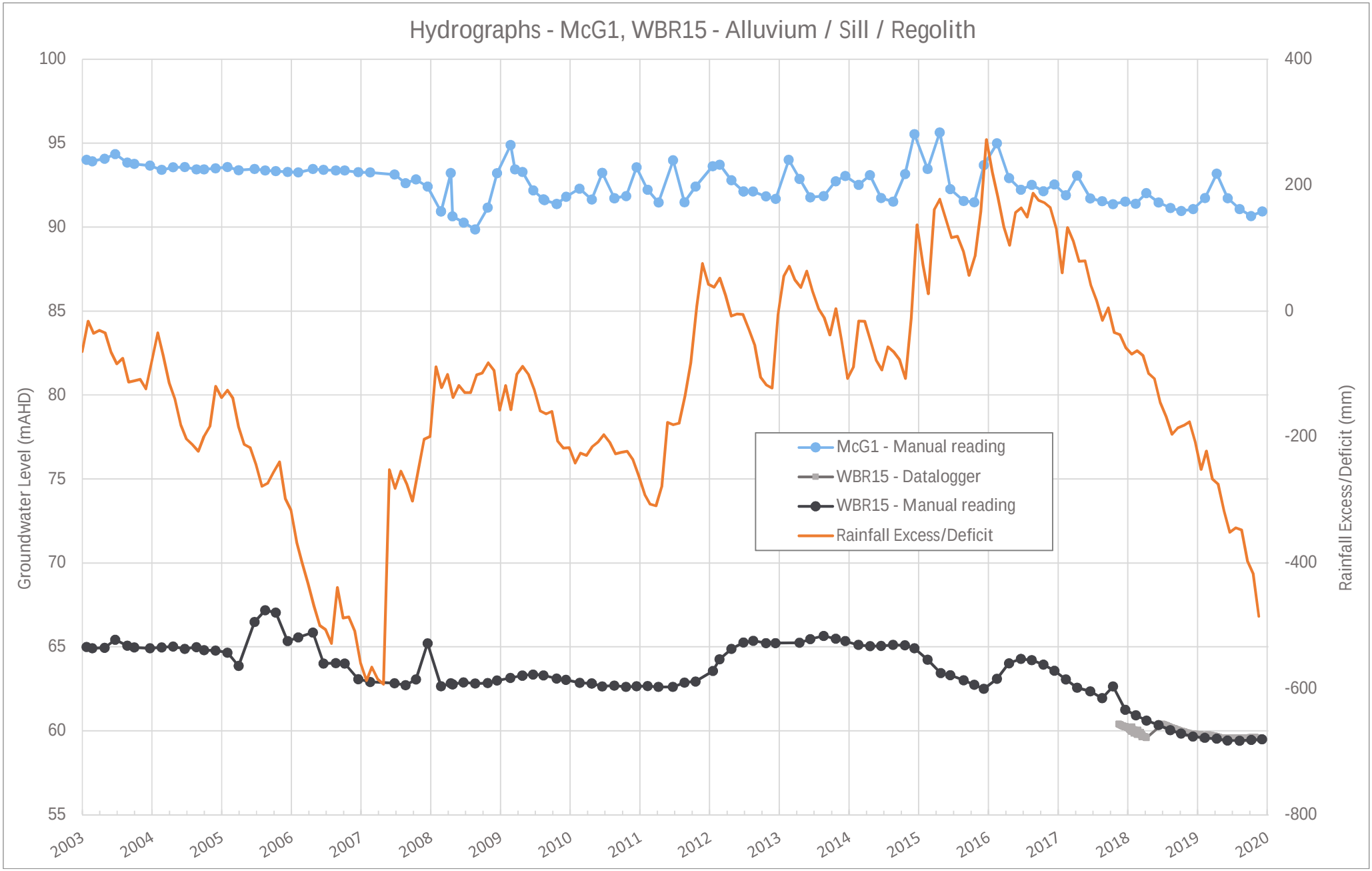
2016
2017
2018
2019
2020


Hydrographs - GW3, GW6, GW10 - Monkey Place Creek Alluvium
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
78
77
76
75
74
73
72
71
70
69
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
GW10 - Datalogger
GW10 - Manual reading
GW3 - Datalogger
GW3 - Manual reading
GW6
Rainfall Excess/Deficit


Hydrographs - GW7, GW8, GW9 - Monkey Place Creek Alluvium
Groundwater Levels (mAHD)
Rainfall Excess/Deficit
76
75
74
73
72
71
70
69
68
67
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
GW7 - Datalogger
GW7 - Manual reading
GW8 - Datalogger
GW8 - Manual reading
GW9 - Datalogger
GW9 - Manual reading
Rainfall Excess/Deficit


Hydrographs - all alluvium bores
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
500
300
100
-100
-300
-500
-700
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
F1
F2
Fernance
GW1
GW10
GW2
GW3
GW6
GW7
GW9
V1
V2
WBD160
WBR181
WBR182
Rainfall Ex/Def


Hydrographs - McG1, WBR15 - Alluvium / Sill / Regolith
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
100
95
90
85
80
75
70
65
60
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
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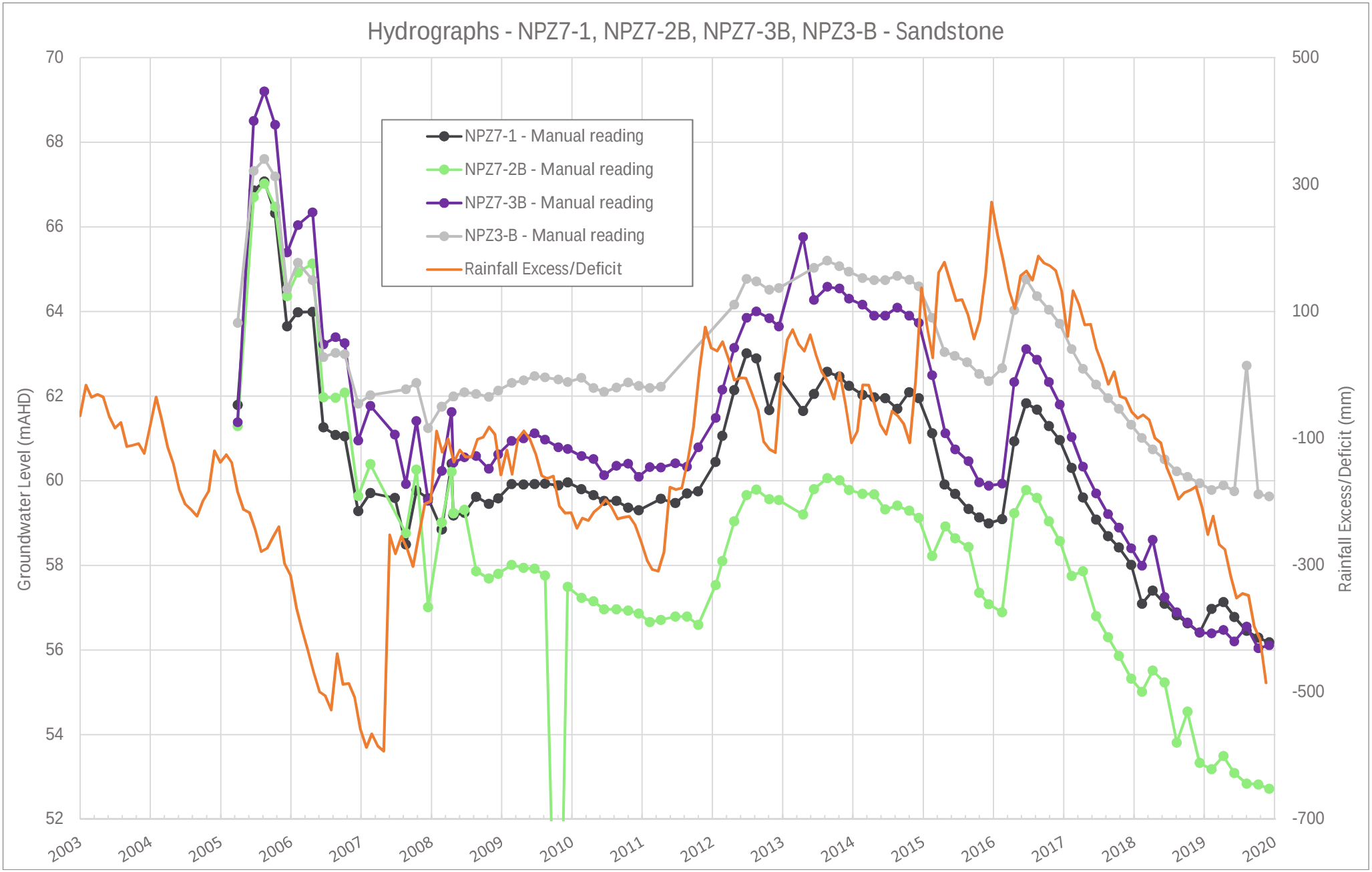
2017
2018
2019
2020
McG1 - Manual reading
WBR15 - Datalogger
WBR15 - Manual reading
Rainfall Excess/Deficit


Hydrographs - NPZ7-1, NPZ7-2B, NPZ7-3B, NPZ3-B - Sandstone
NPZ7-1 - Manual reading
NPZ7-2B - Manual reading
NPZ7-3B - Manual reading
NPZ3-B - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
70
68
66
64
62
60
58
56
54
52
500
300
100
-100
-300
-500
-700
2003
2004
2005
2006
2007
2008
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2010
2011
2012
2013
2014
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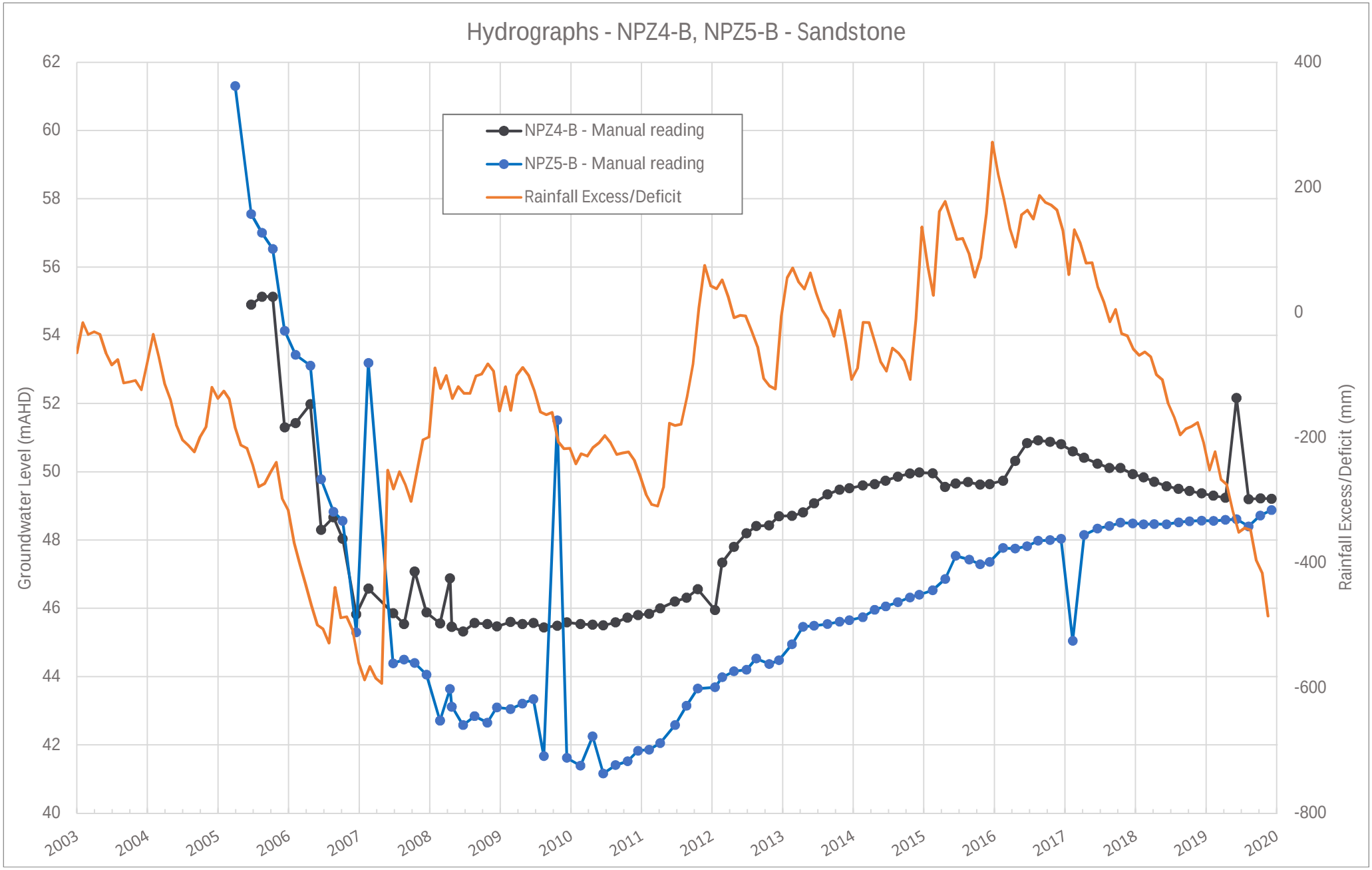
2017
2018
2019
2020


Hydrographs - NPZ4-B, NPZ5-B - Sandstone
NPZ4-B - Manual reading
NPZ5-B - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
62
60
58
56
54
52
50
48
46
44
42
40
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
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2011
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2015
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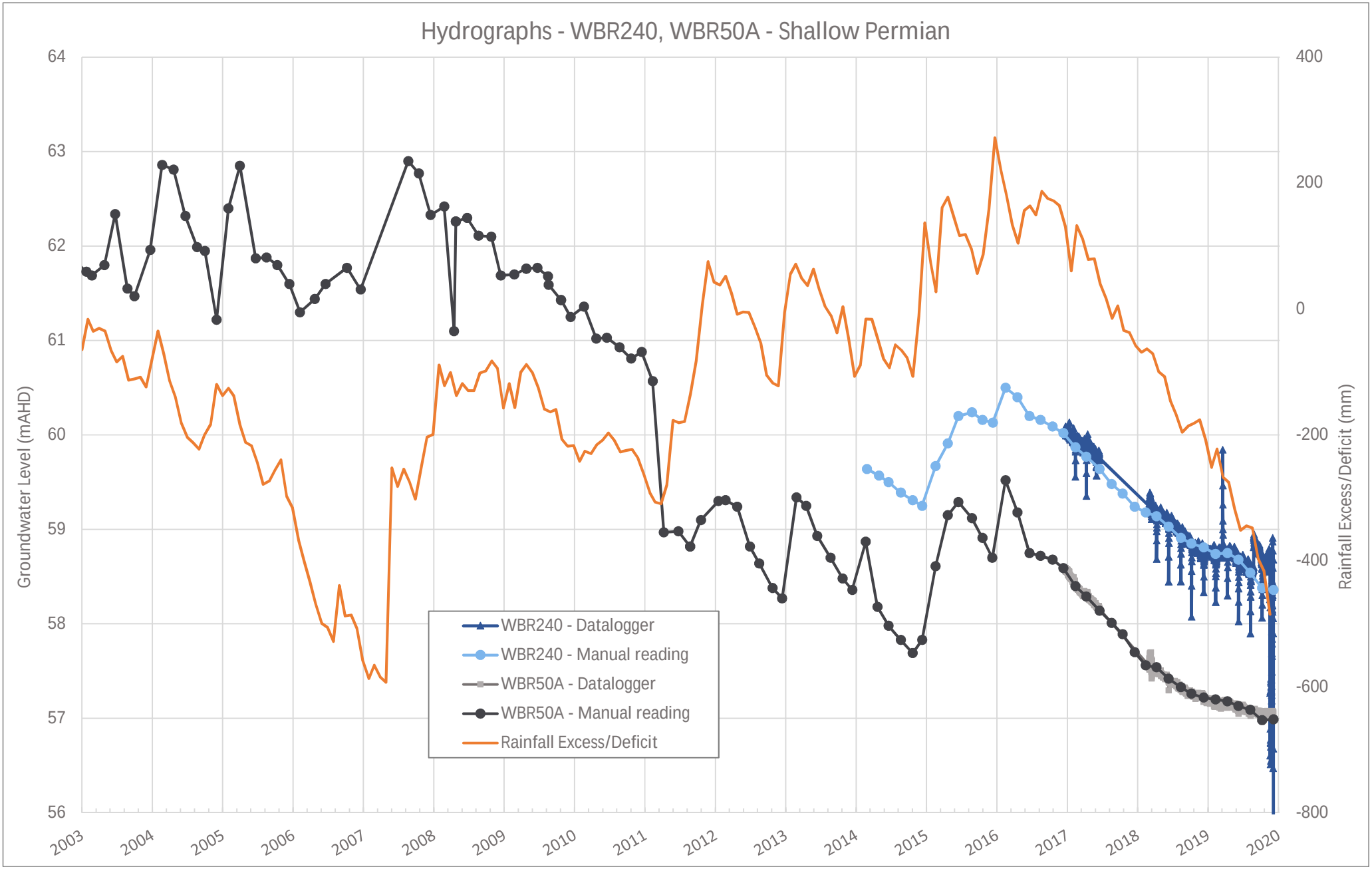
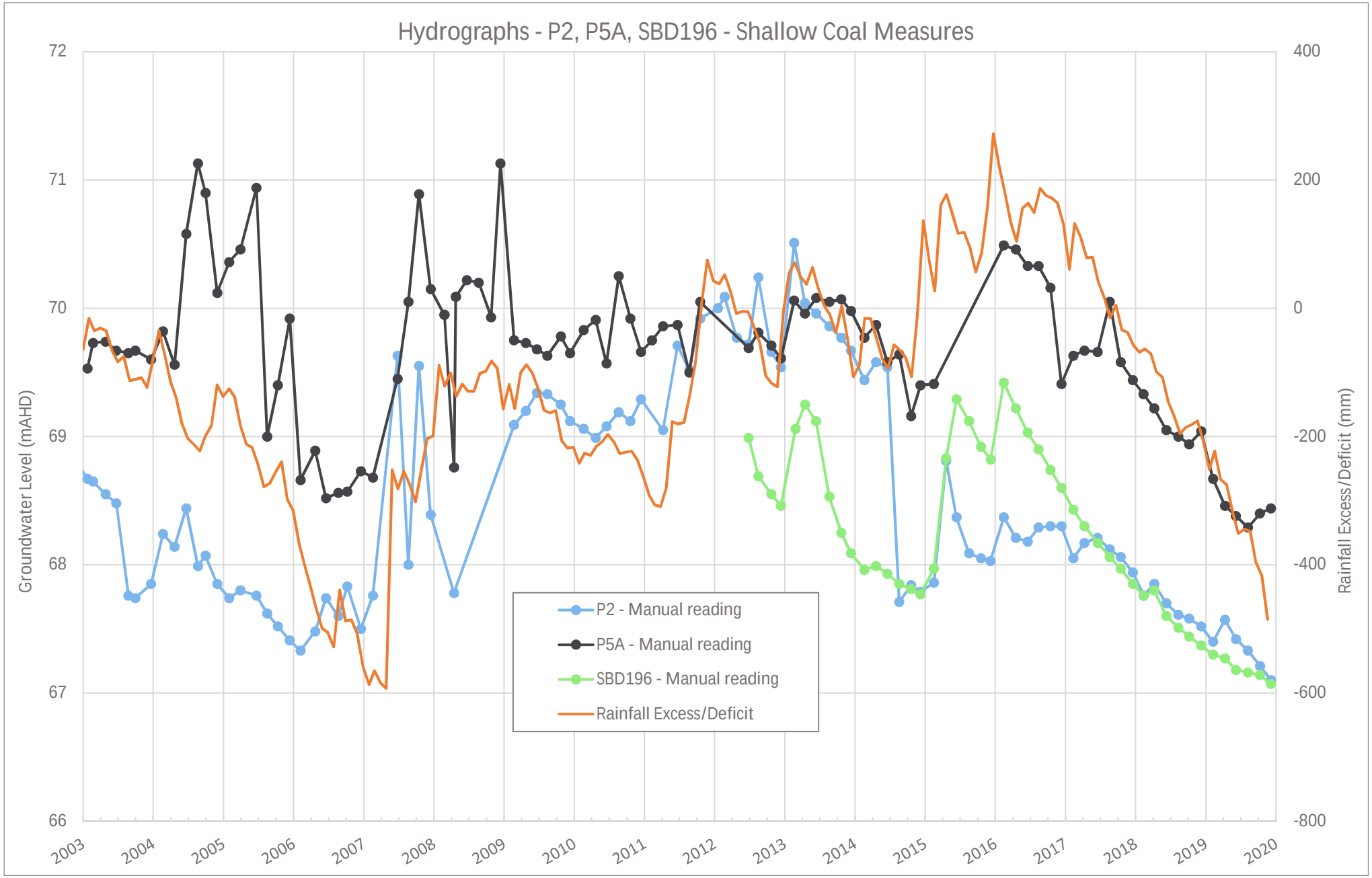
2017
2018
2019
2020


Hydrographs - WBR240, WBR50A - Shallow Permian
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
64
63
62
61
60
59
58
57
56
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
WBR240 - Datalogger
WBR240 - Manual reading
WBR50A - Datalogger
WBR50A - Manual reading
Rainfall Excess/Deficit


Hydrographs - P2, P5A, SBD196 - Shallow Coal Measures
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
72
71
70
69
68
67
66
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
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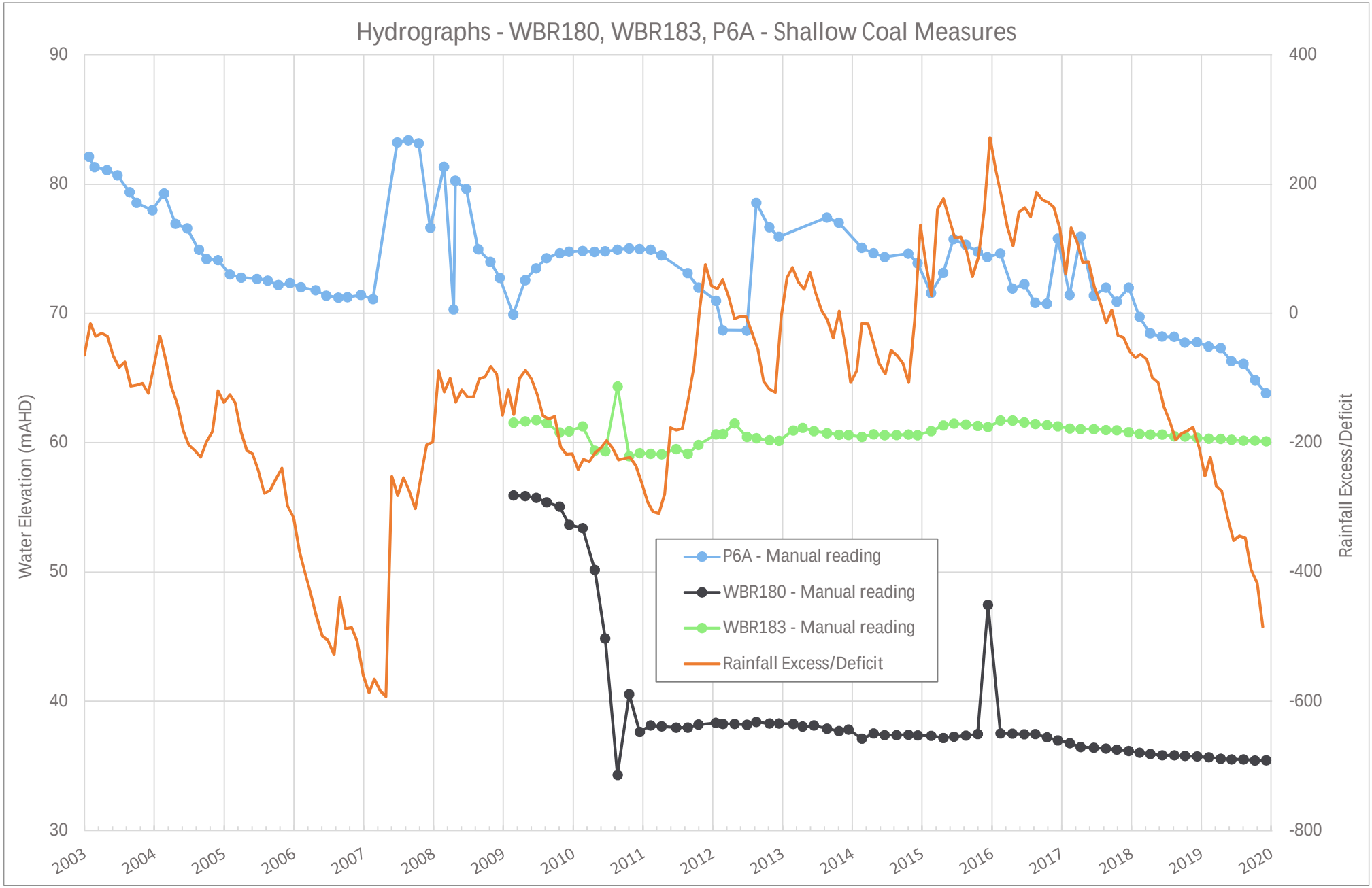
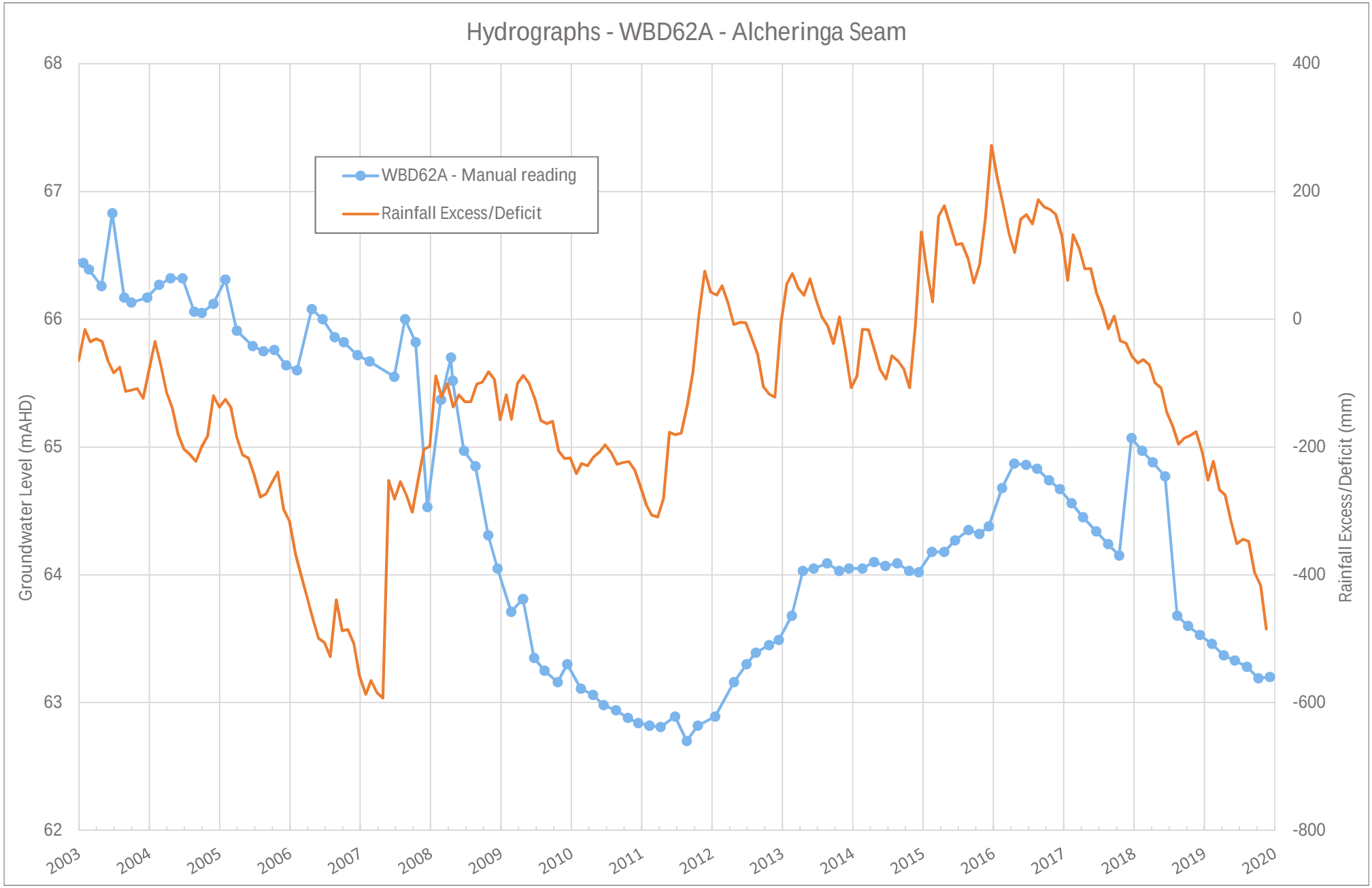
2019
2020
P2 - Manual reading
P5A - Manual reading
SBD196 - Manual reading
Rainfall Excess/Deficit


Hydrographs - WBR180, WBR183, P6A - Shallow Coal Measures
Water Elevation (mAHD)
Rainfall Excess/Deficit
90
80
70
60
50
40
30
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
P6A - Manual reading
WBR180 - Manual reading
WBR183 - Manual reading
Rainfall Excess/Deficit


Hydrographs - WBD62A - Alcheringa Seam
WBD62A - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
68
67
66
65
64
63
62
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
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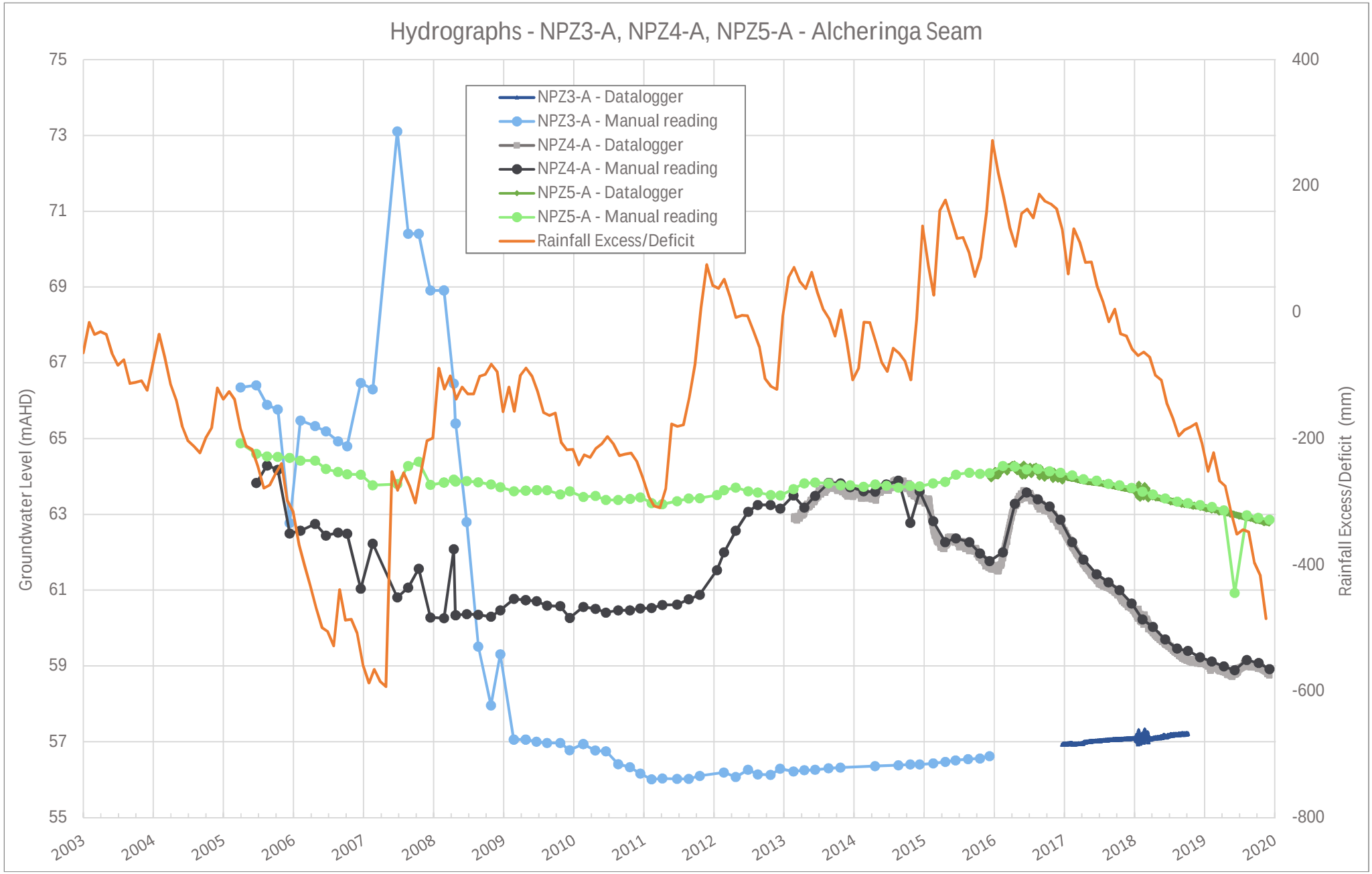
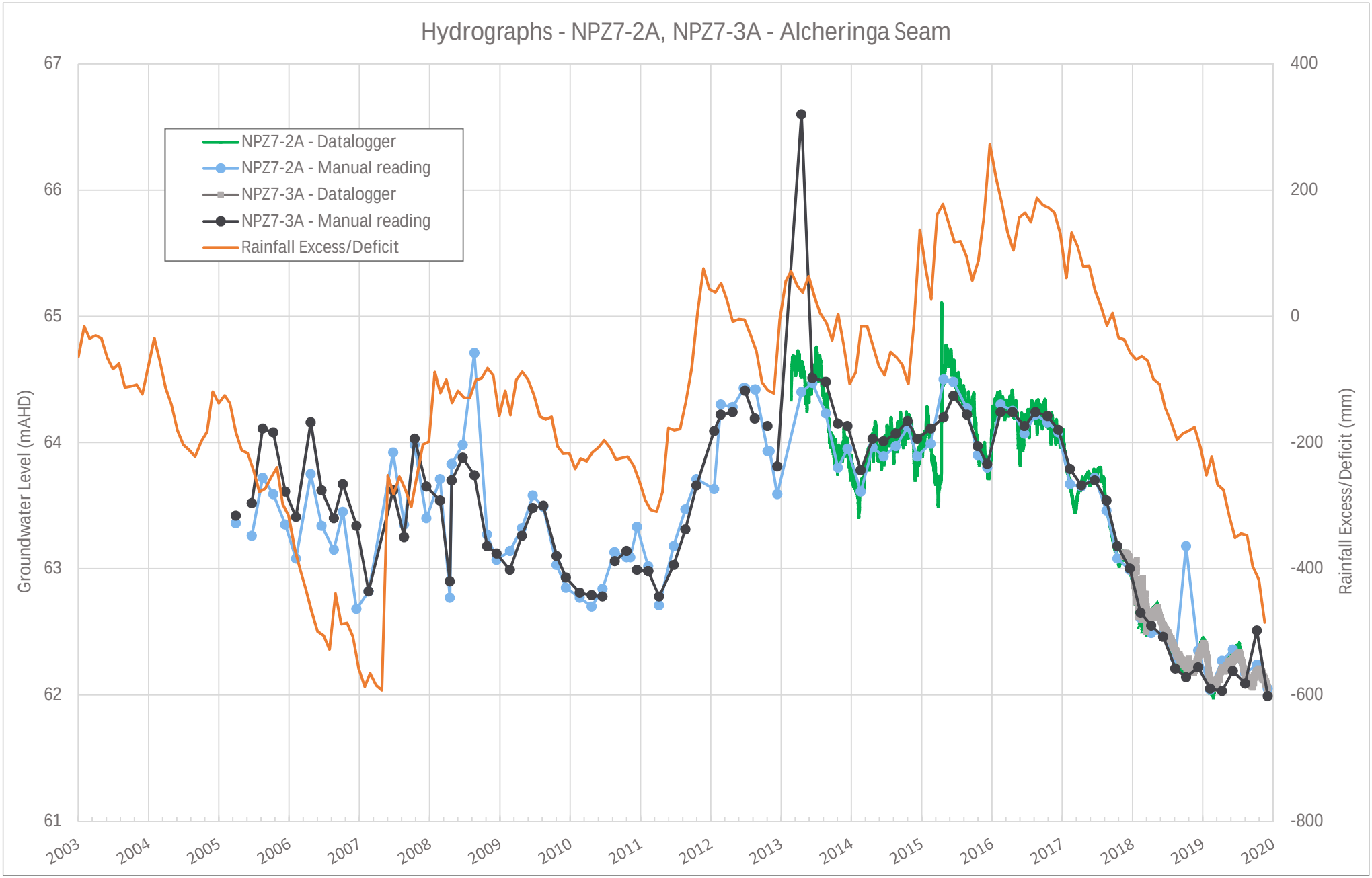
2017
2018
2019
2020


Hydrographs - NPZ3-A, NPZ4-A, NPZ5-A - Alcheringa Seam
NPZ3-A - Datalogger
NPZ3-A - Manual reading
NPZ4-A - Datalogger
NPZ4-A - Manual reading
NPZ5-A - Datalogger
NPZ5-A - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
75
73
71
69
67
65
63
61
59
57
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


Hydrographs - NPZ7-2A, NPZ7-3A - Alcheringa Seam
NPZ7-2A - Datalogger
NPZ7-2A - Manual reading
NPZ7-3A - Datalogger
NPZ7-3A - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
67
66
65
64
63
62
61
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
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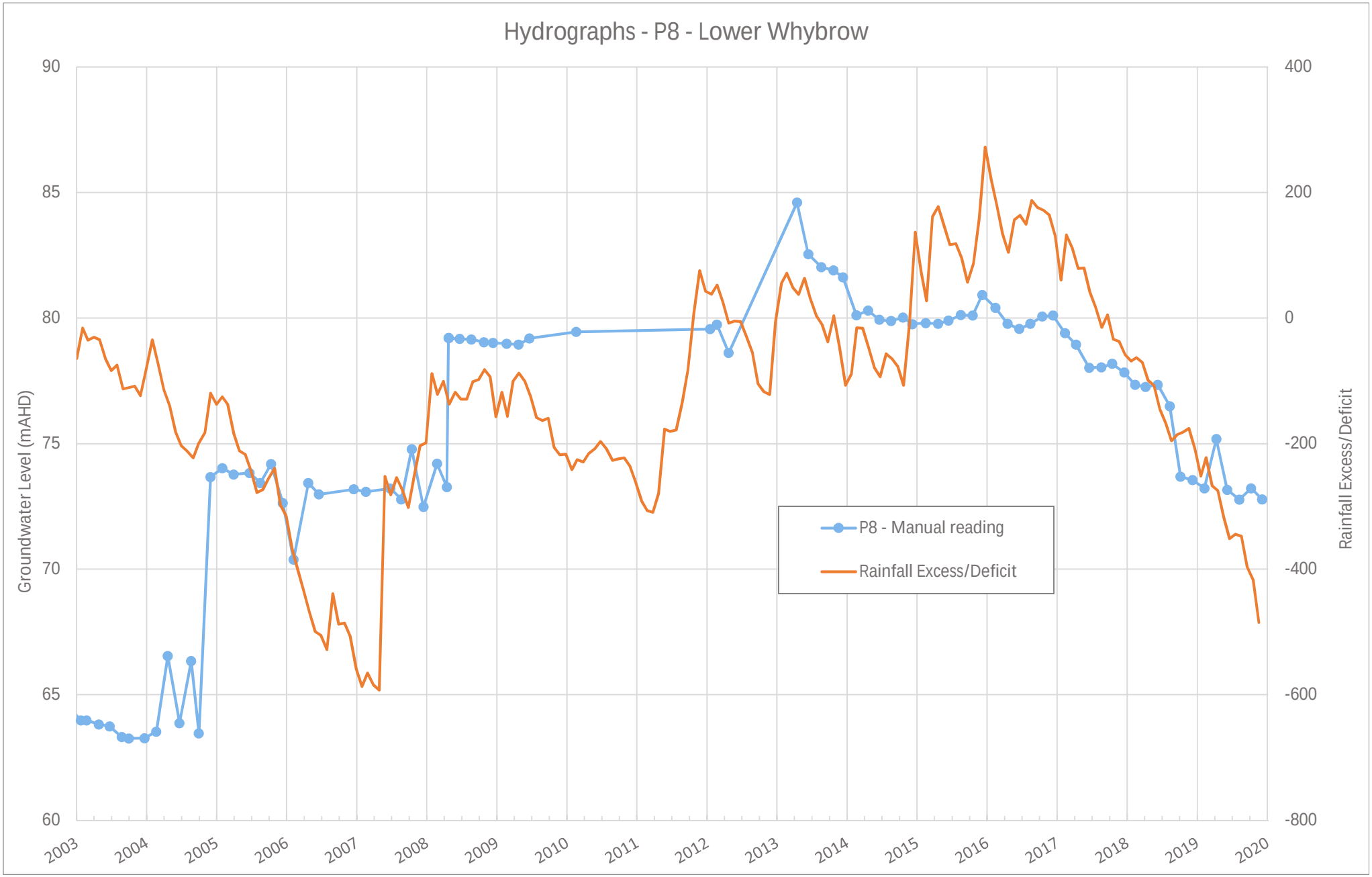
2015
2016
2017
2018
2019
2020


Hydrographs - P8 - Lower Whybrow
Groundwater Level (mAHD)
Rainfall Excess/Deficit
90
85
80
75
70
65
60
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
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2012
2013
2014
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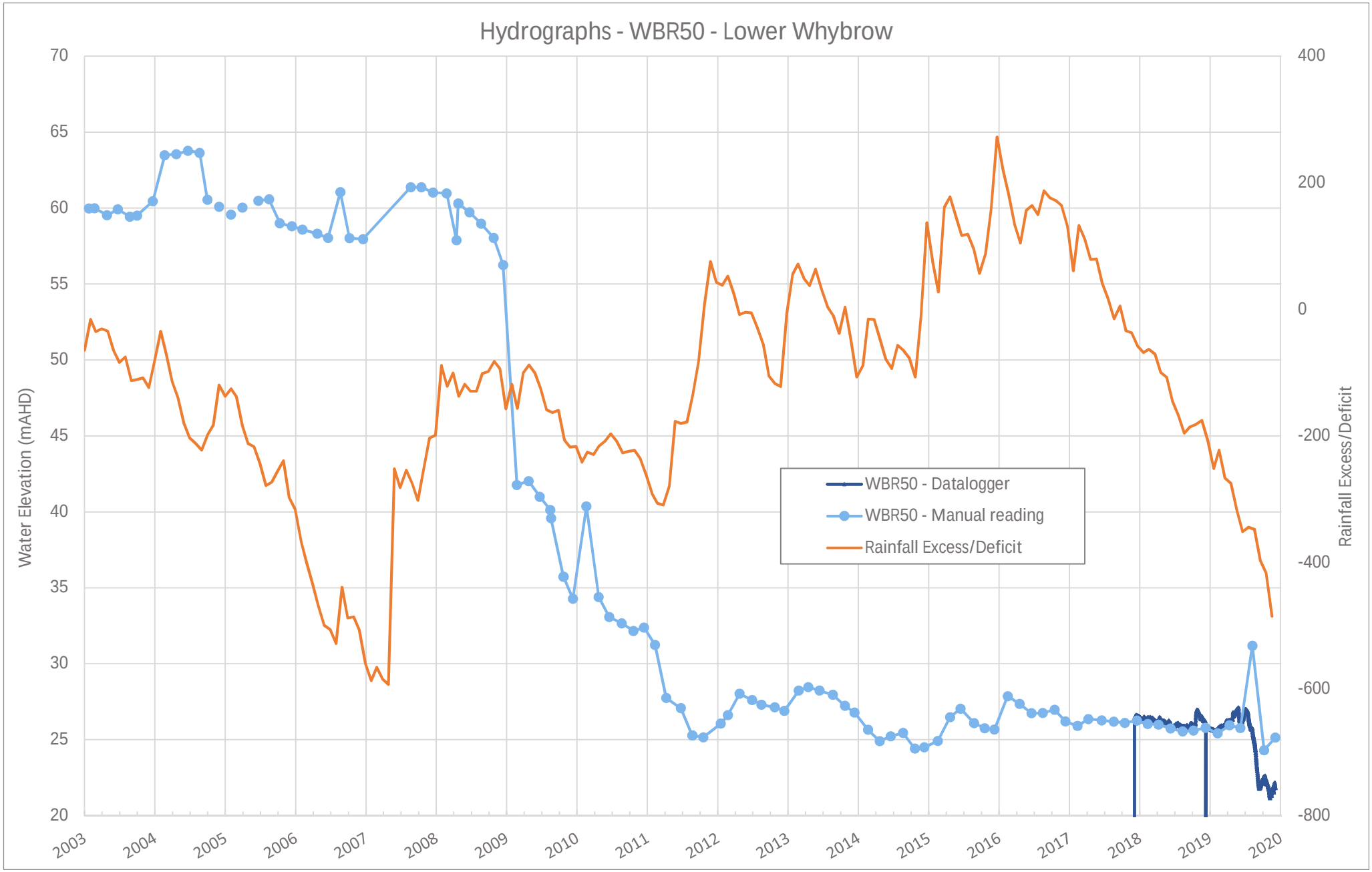
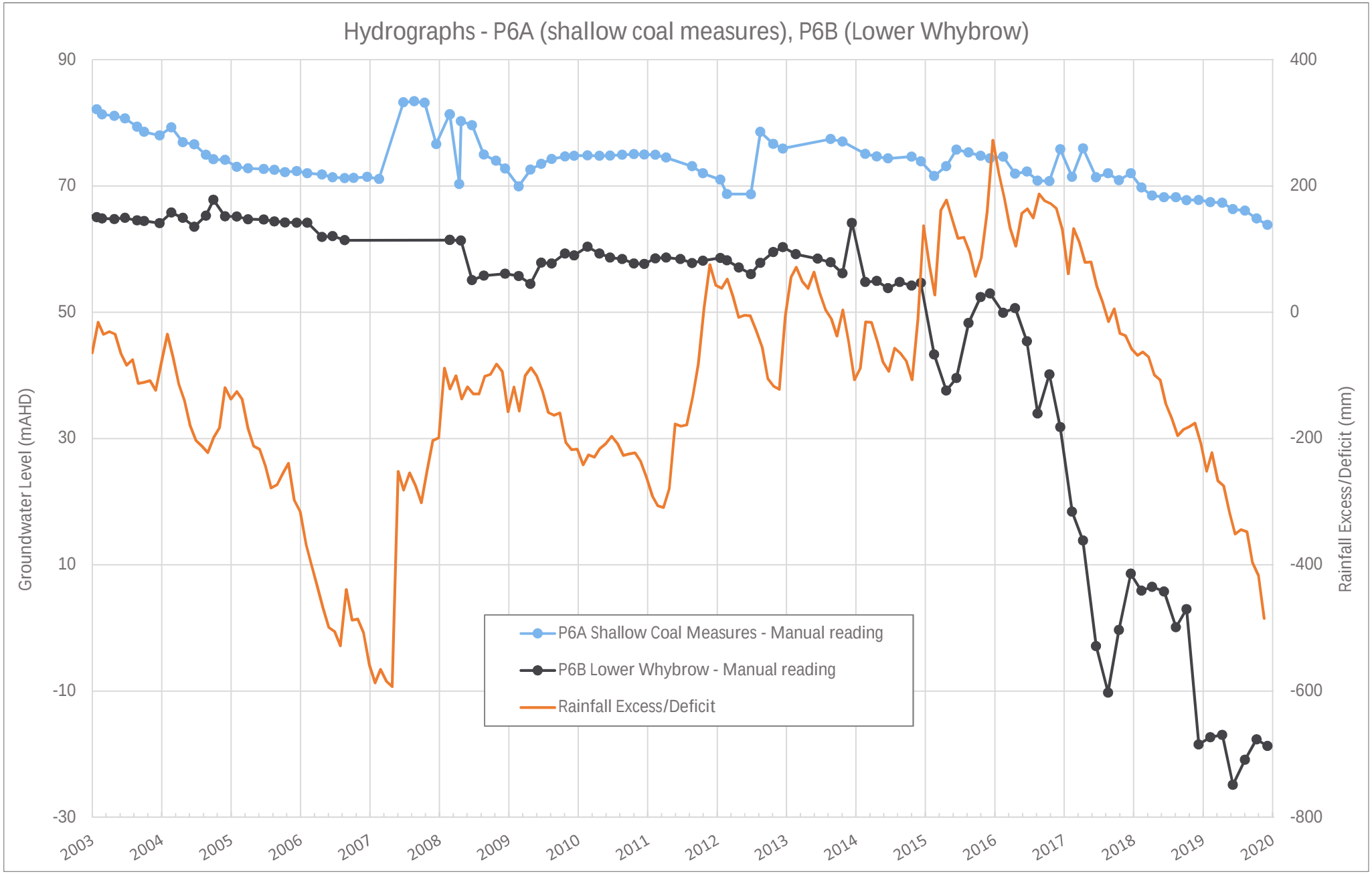
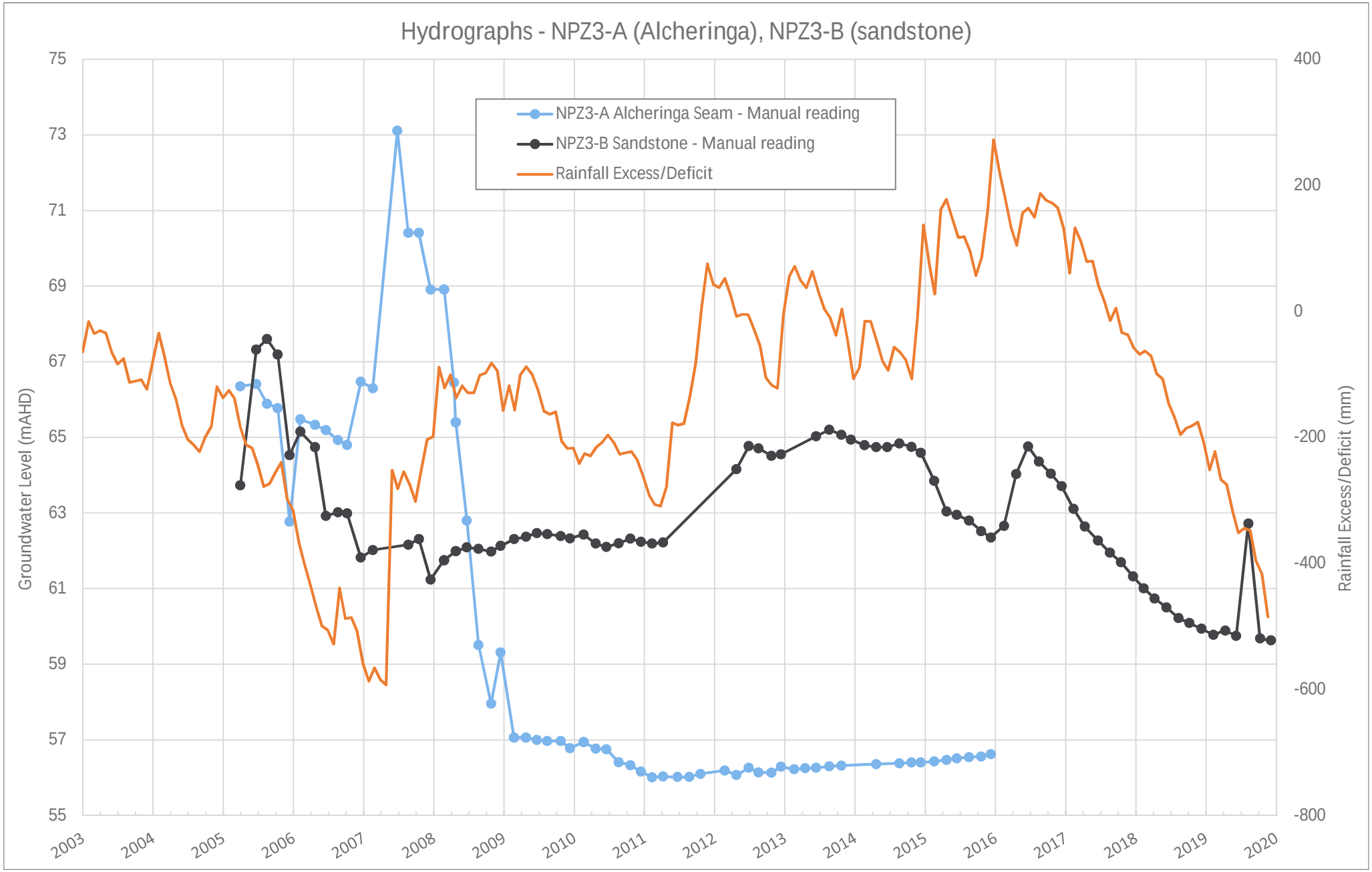
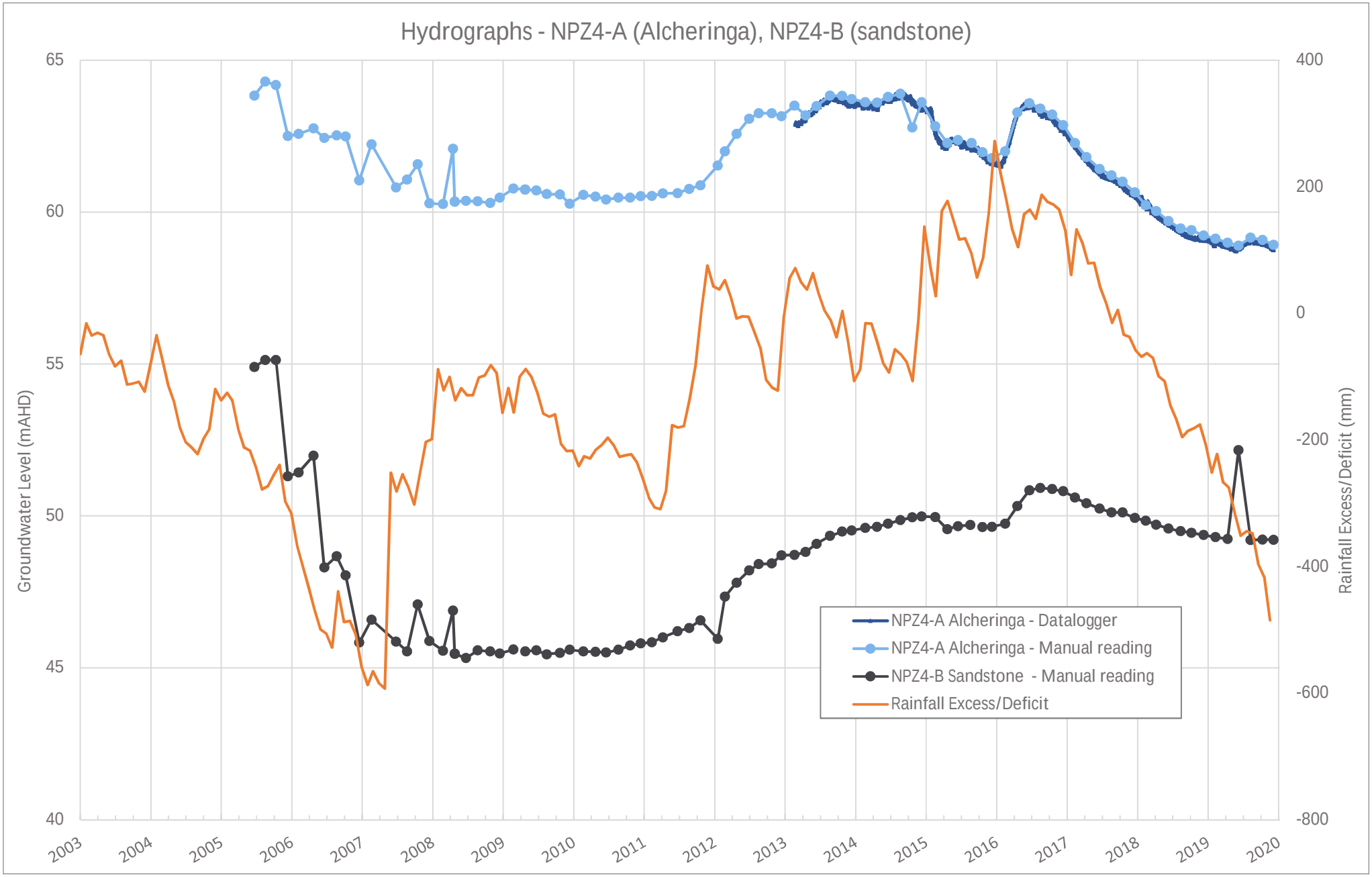
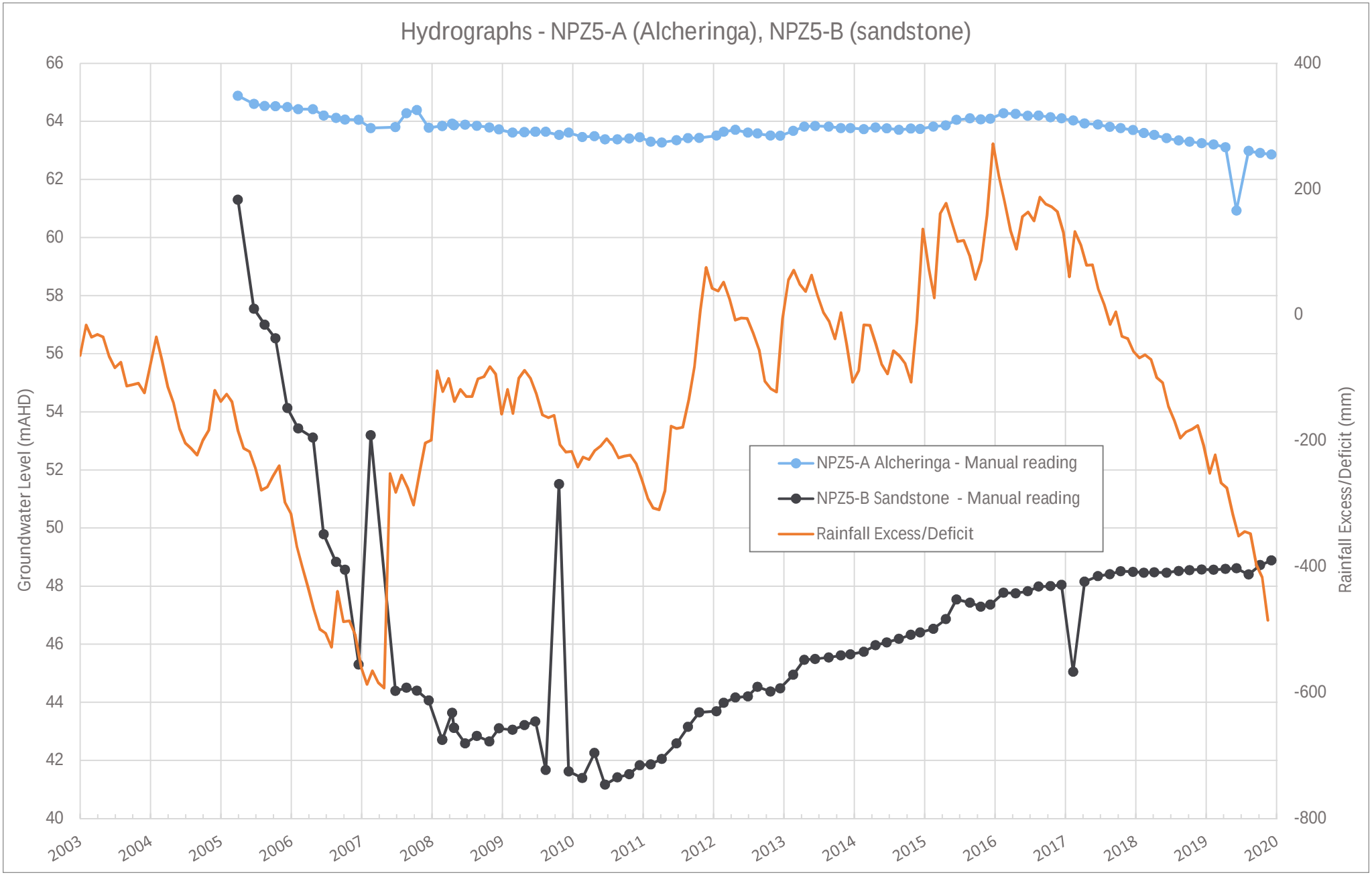
2016
2017
2018
2019
2020
P8 - Manual reading
Rainfall Excess/Deficit

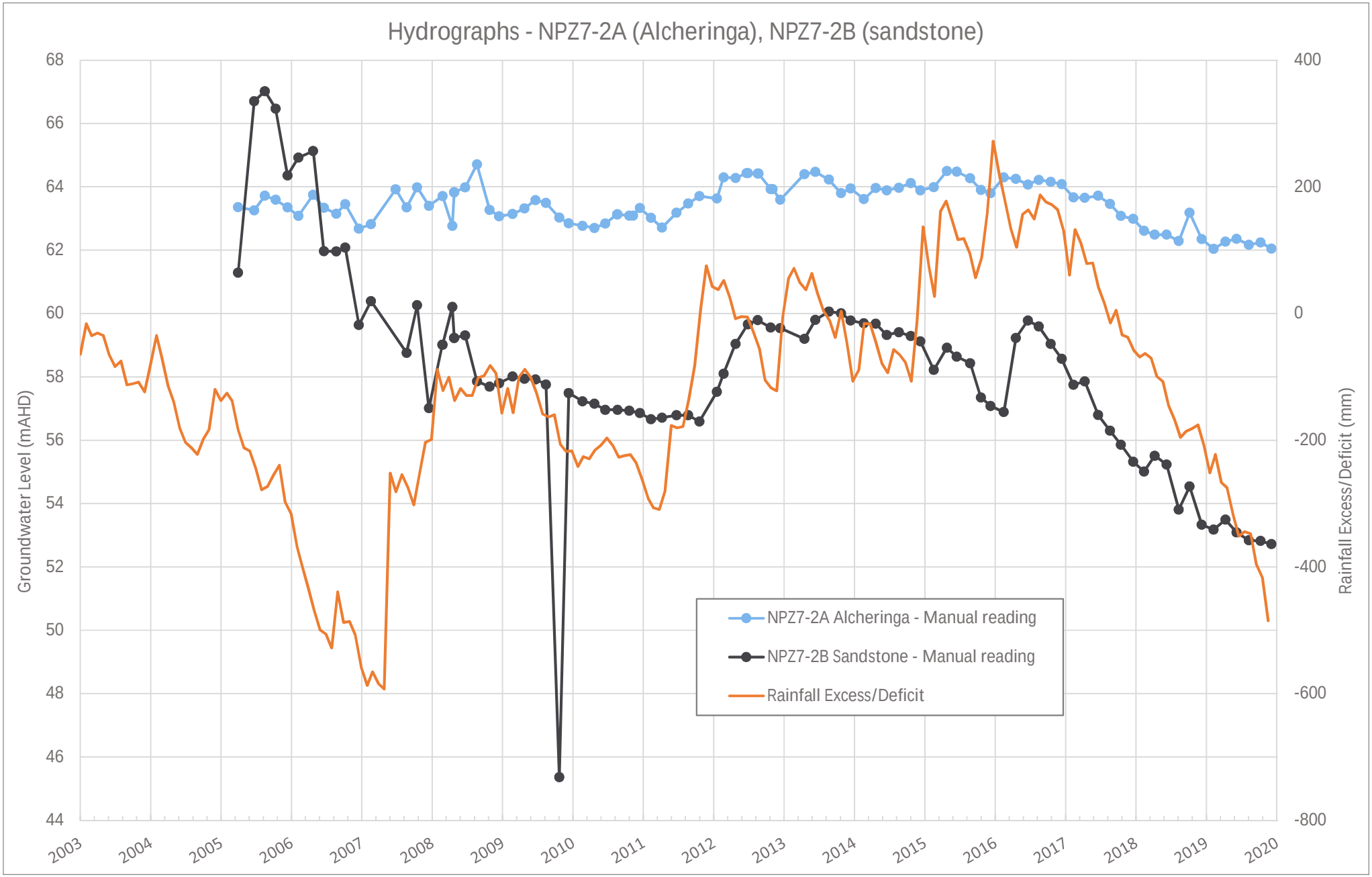

Hydrographs - WBR50 - Lower Whybrow
Water Elevation (mAHD)
Rainfall Excess/Deficit
70
65
60
55
50
45
40
35
30
25
20
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
WBR50 - Datalogger
WBR50 - Manual reading
Rainfall Excess/Deficit

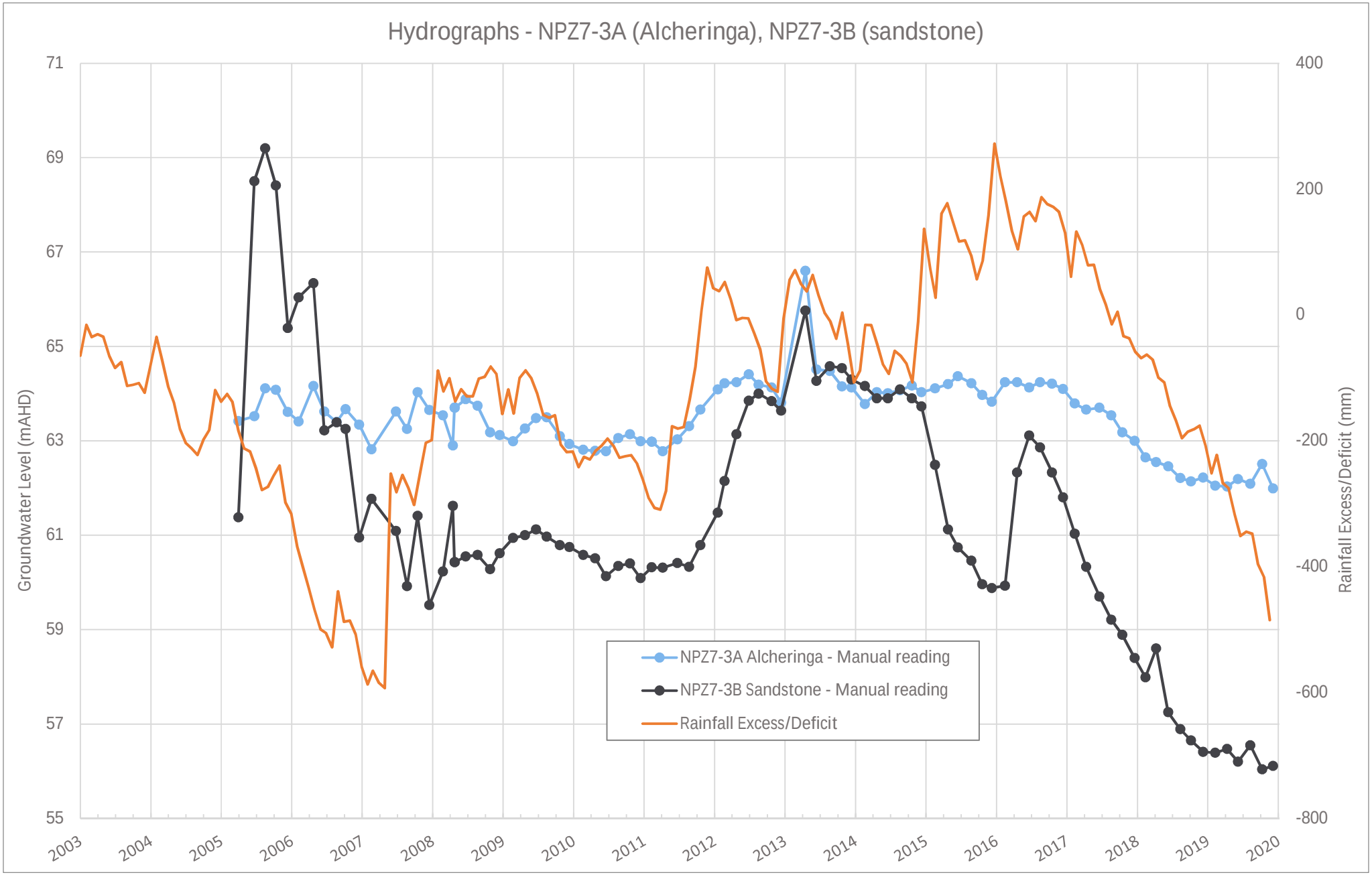

Hydrographs - P6A (shallow coal measures), P6B (Lower Whybrow)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
90
70
50
30
10
-10
-30
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
P6A Shallow Coal Measures - Manual reading
P6B Lower Whybrow - Manual reading
Rainfall Excess/Deficit

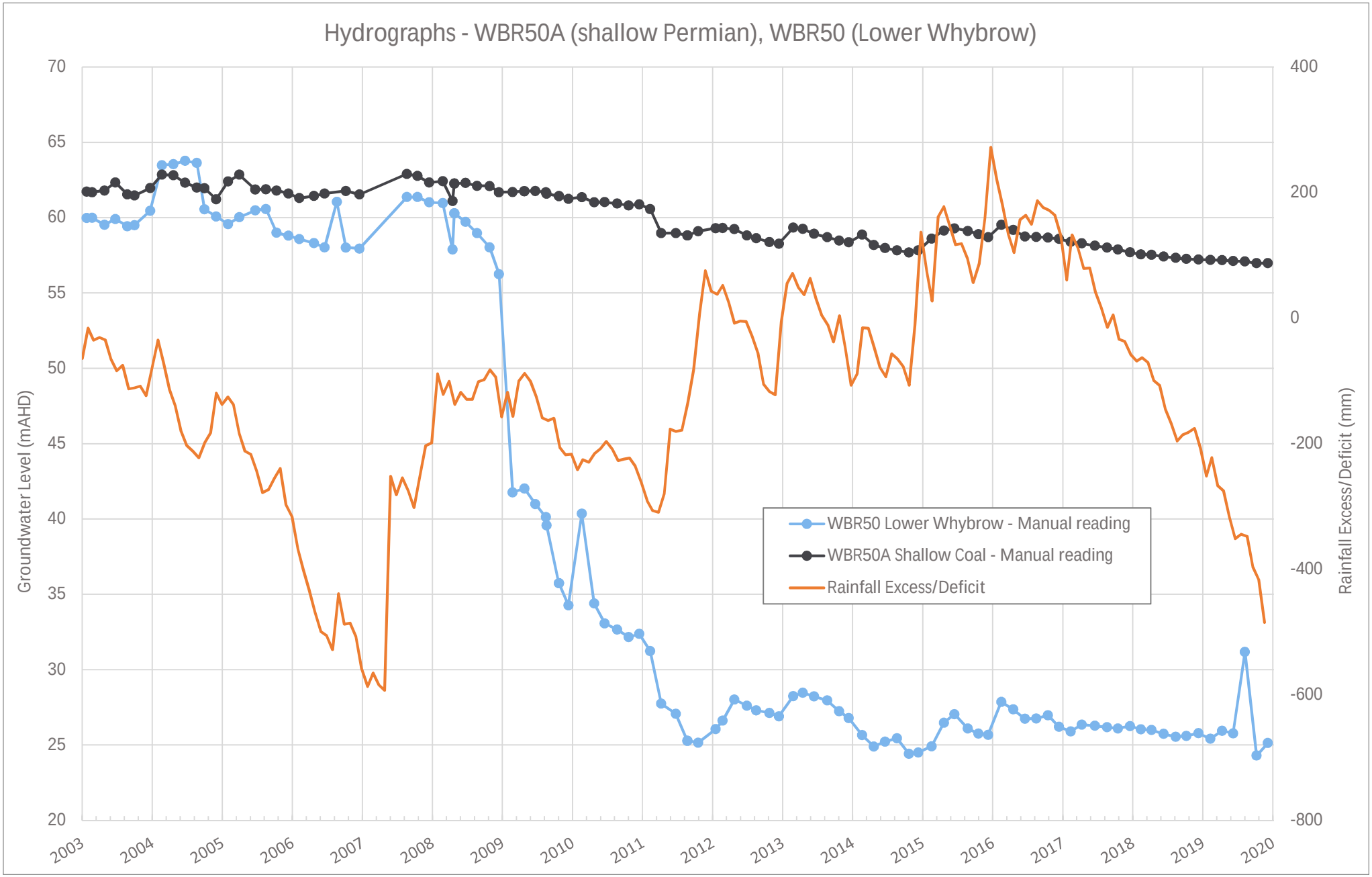

Hydrographs - NPZ3-A (Alcheringa), NPZ3-B (sandstone)
NPZ3-A Alcheringa Seam - Manual reading
NPZ3-B Sandstone - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
75
73
71
69
67
65
63
61
59
57
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


Hydrographs - NPZ4-A (Alcheringa), NPZ4-B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
65
60
55
50
45
40
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
NPZ4-A Alcheringa - Datalogger
NPZ4-A Alcheringa - Manual reading
NPZ4-B Sandstone - Manual reading
Rainfall Excess/Deficit


Hydrographs - NPZ5-A (Alcheringa), NPZ5-B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
66
64
62
60
58
56
54
52
50
48
46
44
42
40
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
NPZ5-A Alcheringa - Manual reading
NPZ5-B Sandstone - Manual reading
Rainfall Excess/Deficit


Hydrographs - NPZ7-2A (Alcheringa), NPZ7-2B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
68
66
64
62
60
58
56
54
52
50
48
46
44
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
NPZ7-2A Alcheringa - Manual reading
NPZ7-2B Sandstone - Manual reading
Rainfall Excess/Deficit


Hydrographs - NPZ7-3A (Alcheringa), NPZ7-3B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
71
69
67
65
63
61
59
57
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
NPZ7-3A Alcheringa - Manual reading
NPZ7-3B Sandstone - Manual reading
Rainfall Excess/Deficit


Hydrographs - WBR50A (shallow Permian), WBR50 (Lower Whybrow)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
70
65
60
55
50
45
40
35
30
25
20
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
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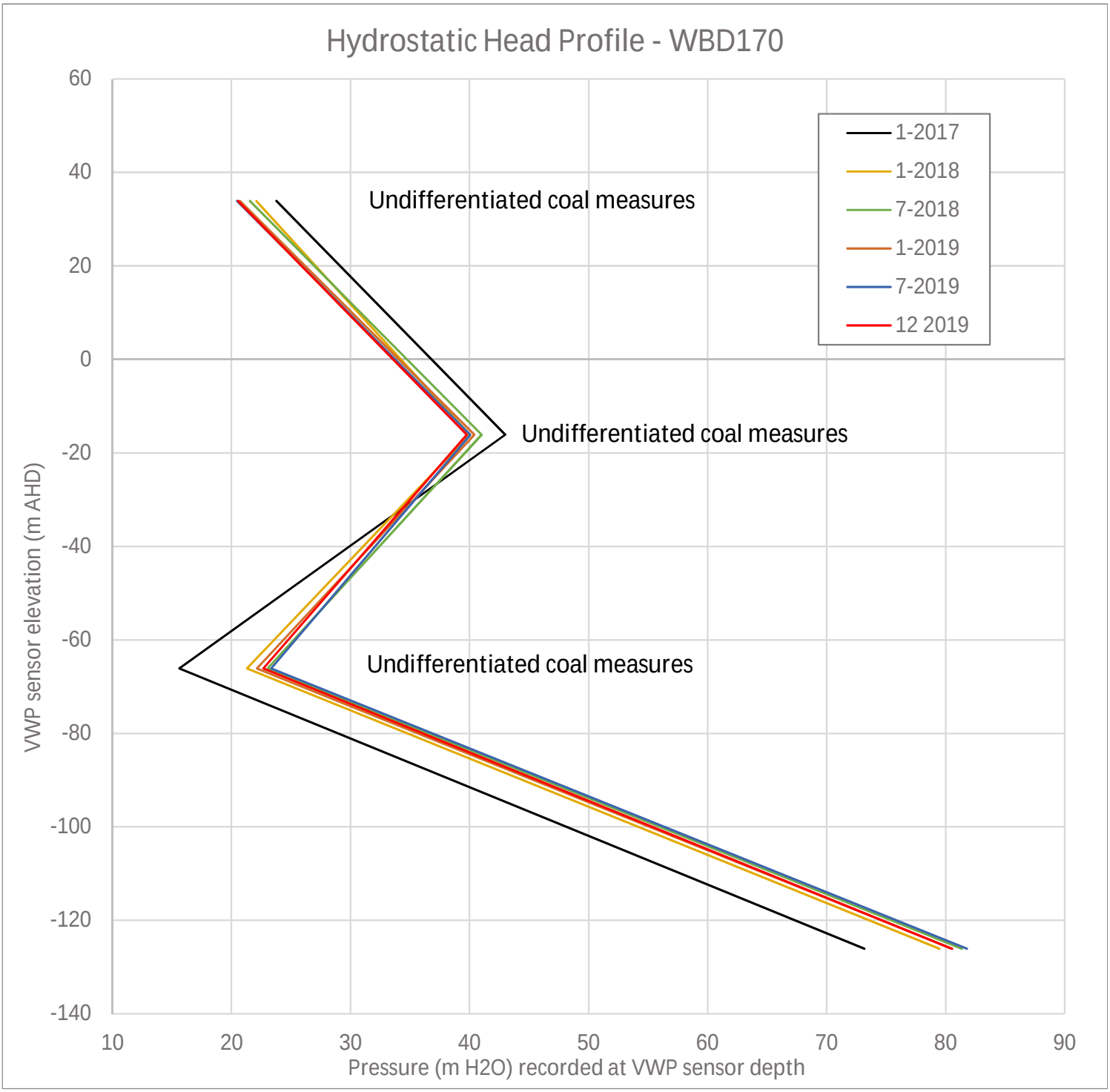
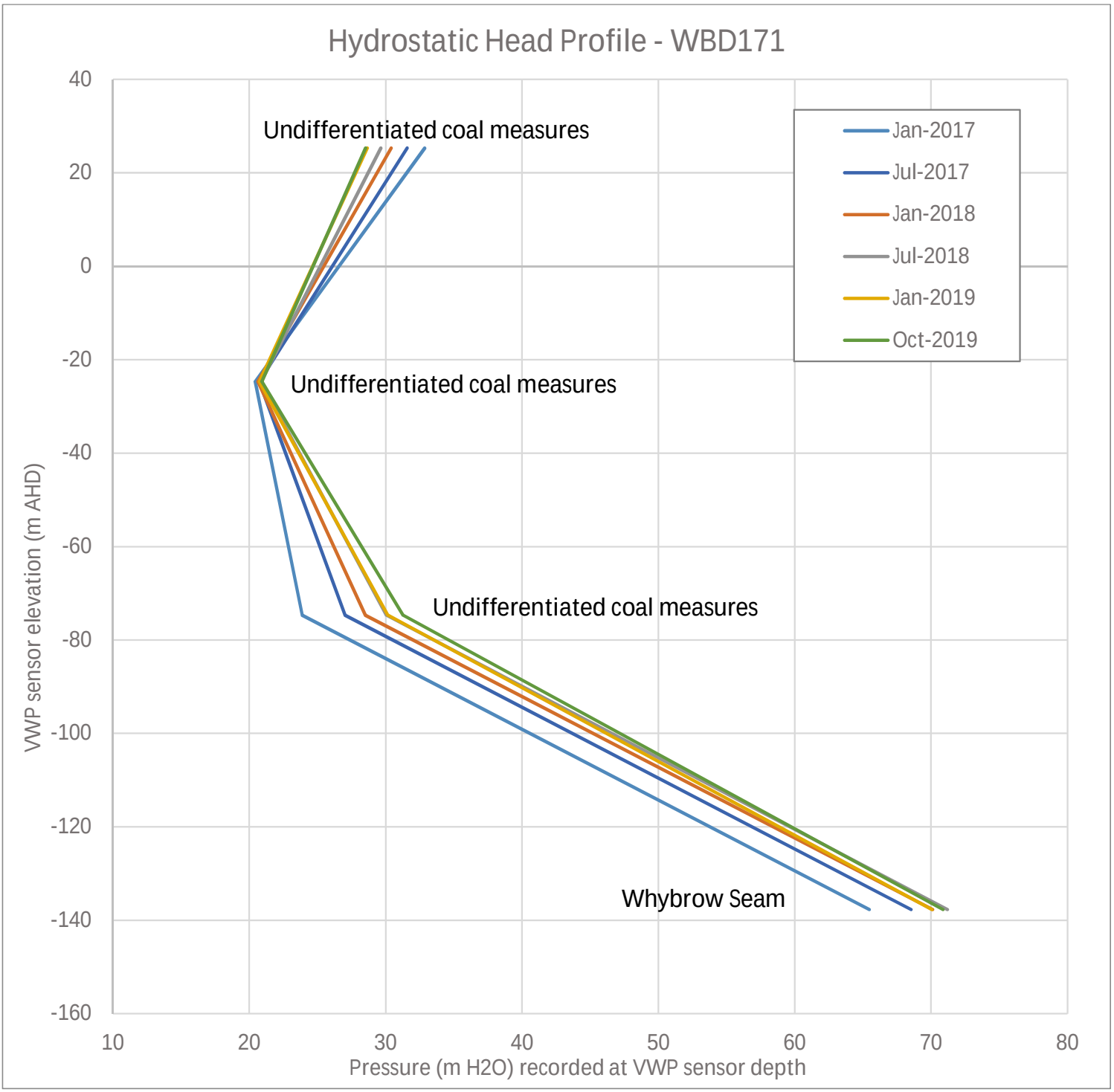
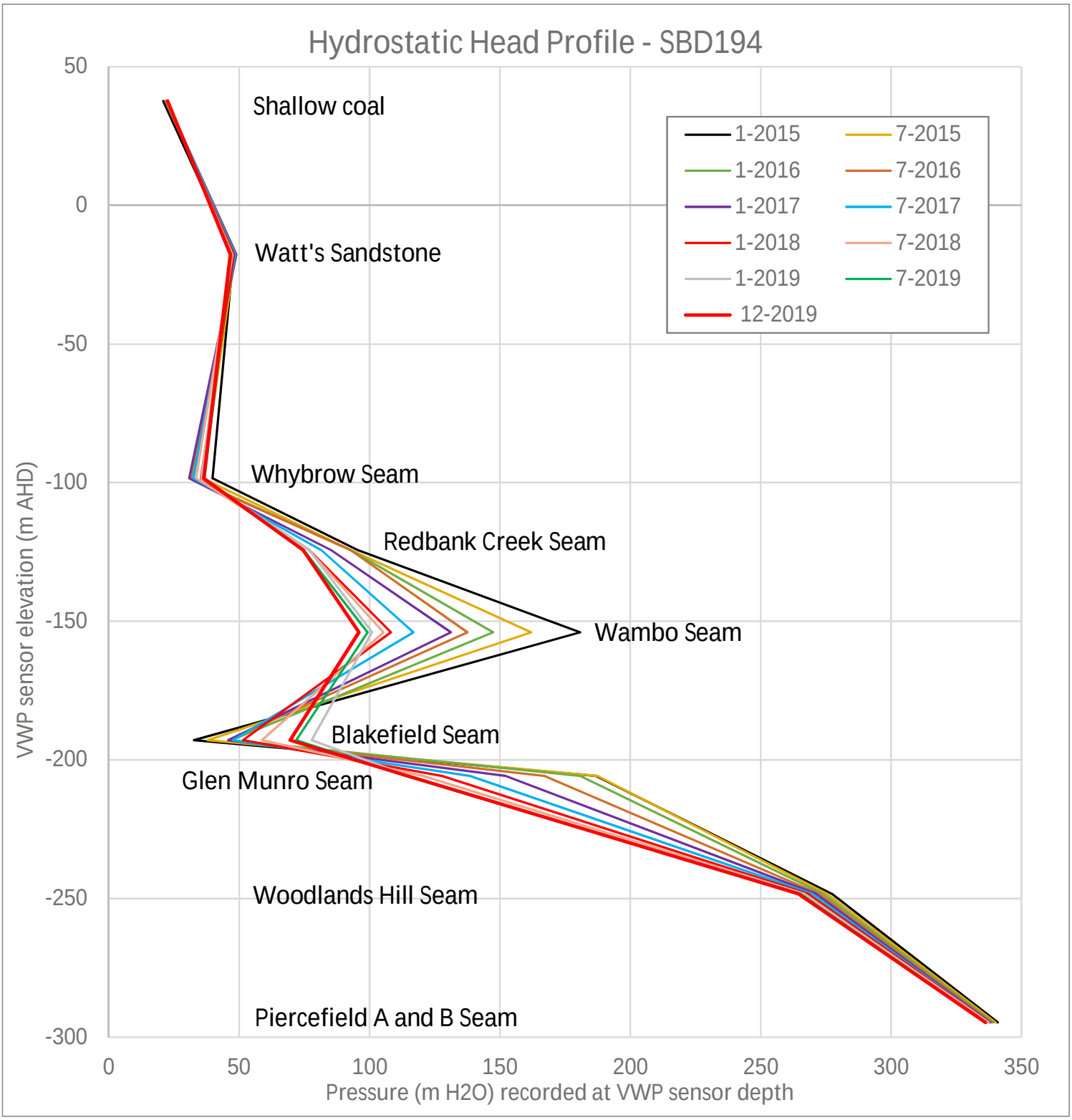
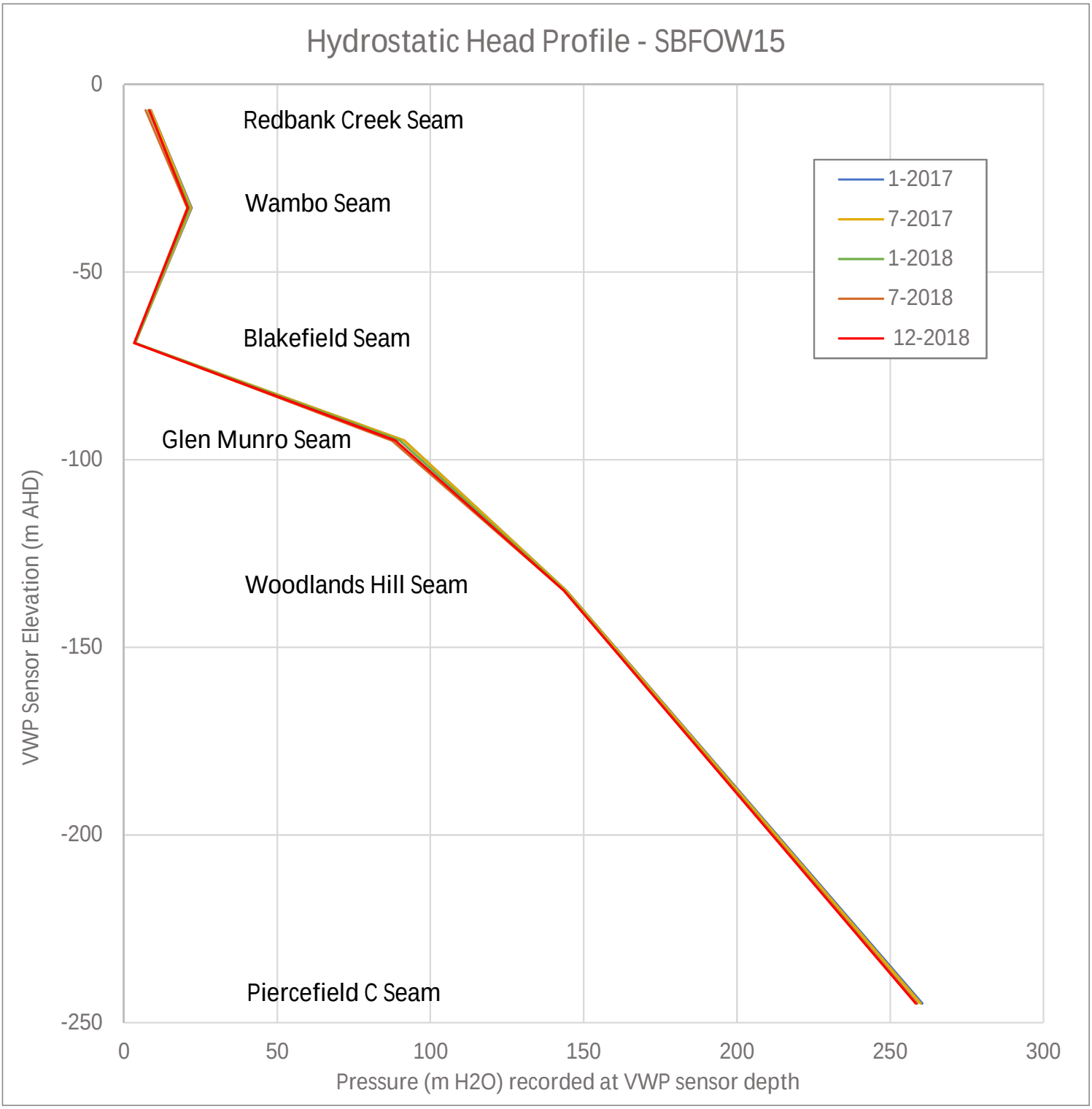
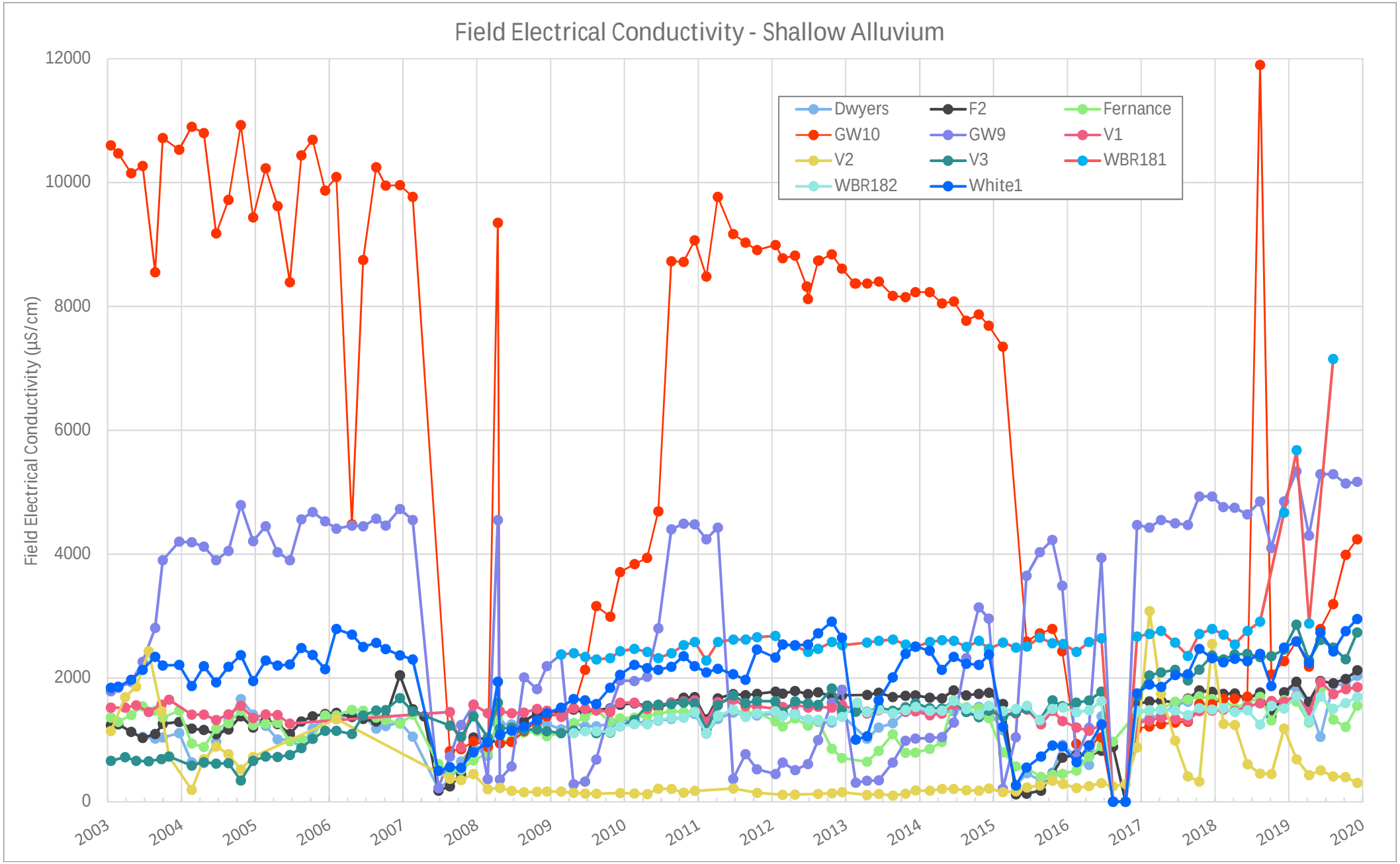
2015
2016
2017
2018
2019
2020
WBR50 Lower Whybrow - Manual reading
WBR50A Shallow Coal - Manual reading
Rainfall Excess/Deficit


Hydrostatic Head Profile - WBD170
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
VWP sensor elevation (m AHD)
10
20
30
40
50
60
70
80
90
Pressure (m H2O) recorded at VWP sensor depth
1-2017
1-2018
7-2018
1-2019
7-2019
12 2019
Undifferentiated coal measures
Undifferentiated coal measures
Undifferentiated coal measures


Hydrostatic Head Profile - WBD171
Undifferentiated coal measures
Undifferentiated coal measures
Undifferentiated coal measures
Whybrow Seam
Jan-2017
Jul-2017
Jan-2018
Jul-2018
Jan-2019
Oct-2019
VWP sensor elevation (m AHD)
Pressure (m H2O) recorded at VWP sensor depth
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
10
20
30
40
50
60
70
80


Hydrostatic Head Profile - SBD194
50
0
-50
-100
-150
-200
-250
-300
VWP sensor elevation (m AHD)
0
50
100
150
200
250
300
350
Pressure (m H2O) recorded at VWP sensor depth
Shallow coal
Watt's Sandstone
Whybrow Seam
Redbank Creek Seam
Wambo Seam
Blakefield Seam
Glen Munro Seam
Woodlands Hill Seam
Piercefield A and B Seam
1-2015
7-2015
1-2016
7-2016
1-2017
7-2017
1-2018
7-2018
1-2019
7-2019
12-2019


Hydrostatic Head Profile - SBFOW15
0
-50
-100
-150
-200
-250
VWP Sensor Elevation (m AHD)
Redbank Creek Seam
Wambo Seam
Blakefield Seam
Glen Munro Seam
Woodlands Hill Seam
Piercefield C Seam
1-2017
7-2017
1-2018
7-2018
12-2018
0
50
100
150
200
250
300
Pressure (m H2O) recorded at VWP sensor depth


Field Electrical Conductivity - Shallow Alluvium
Field Electrical Conductivity (µS/cm)
12000
10000
8000
6000
4000
2000
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Dwyers
F2
Fernance
GW10
GW9
V1
V2
V3
WBR181
WBR182
White1

APPENDIX D

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							
							EEA1	EEA2	EEA6	NVB1	NVB3	OTD1	OTD5	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	n/a - no bare areas >400m2							
		Native Woodland	Soil properties do not affect the ongoing health of desired vegetation	Landform Function	LFA stability index is comparable to or trending towards that of the local	LFA								

Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site							
							EEA1	EEA2	EEA6	NVB1	NVB3	OTD1	OTD5	SE1
			species		remnant vegetation									
					LFA infiltration index is comparable to or trending towards that of the local remnant vegetation	LFA								
					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
					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

Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site							
							EEA1	EEA2	EEA6	NVB1	NVB3	OTD1	OTD5	SE1
					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
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
				Weed Species	Weed presence is within ranges found at reference sites and does not	BAM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

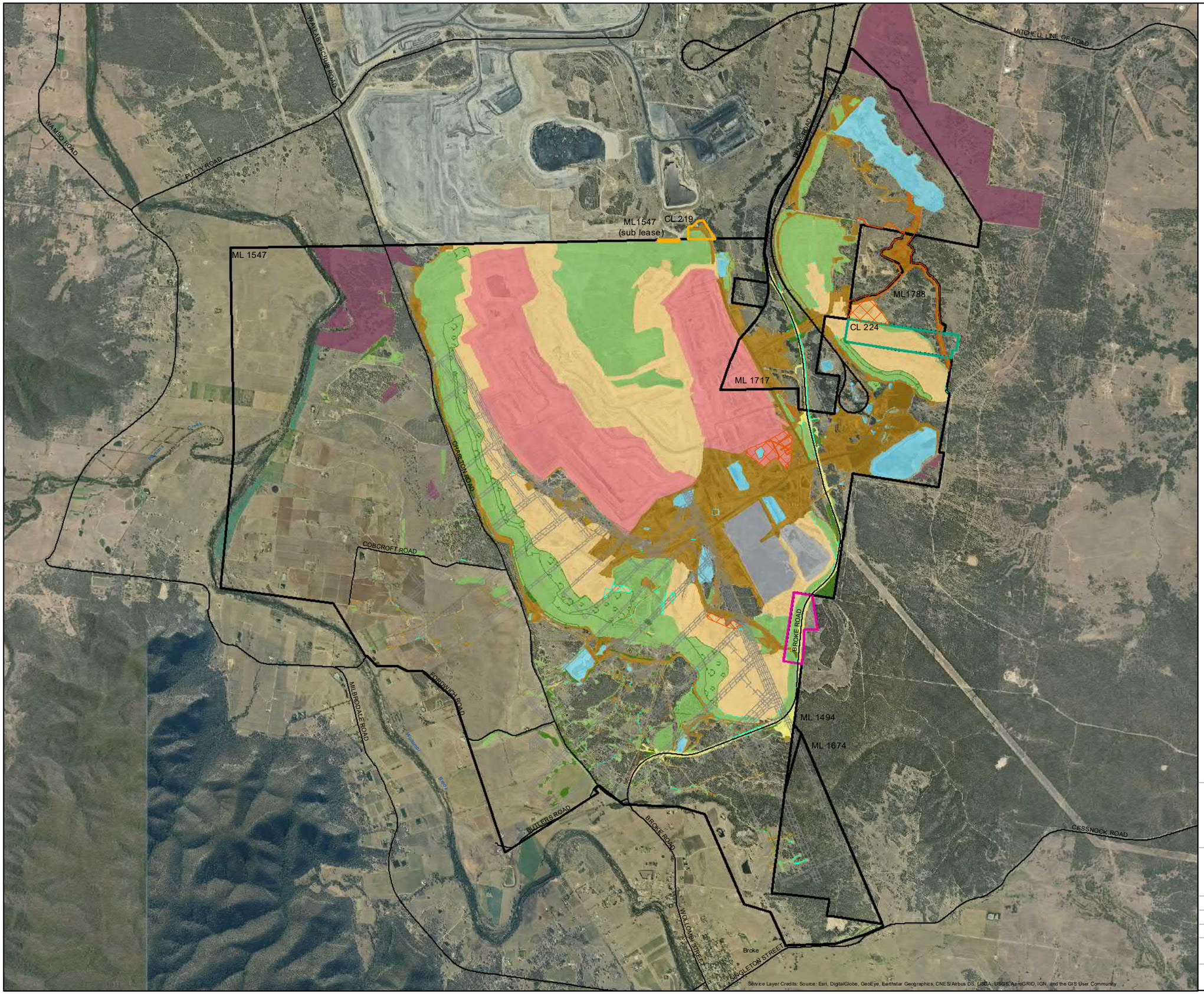
Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site							
							EEA1	EEA2	EEA6	NVB1	NVB3	OTD1	OTD5	SE1
					present a risk to rehabilitation areas									
			Ground cover is greater than 70%	Protective Ground Cover	Ground cover provided 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
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								

Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site							
							EEA1	EEA2	EEA6	NVB1	NVB3	OTD1	OTD5	SE1
					Native ground cover (shrubs) 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
					Native ground cover (other) achieves a biometric score of 2 for the relevant PCT	BAM								
			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
				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								

Phase	Objective	Domain	Completion Criteria	Criteria Aspect	Completion Indicator	Monitoring Method Used	Monitoring Site							
							EEA1	EEA2	EEA6	NVB1	NVB3	OTD1	OTD5	SE1
			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
			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

APPENDIX E

Annual Review Plan



Legend

- Mining Lease
- Sub Lease
- Coal Lease
- Commonwealth Licence Agreement
- Road
- Railway
- Blakefield Seam Workings

2019 Rehabilitation and Disturbance Activities

- 2019 Rehabilitation Woodland
- 2019 Disturbance
- 2019 Dehab

Rehabilitation Domains (31 December 2019)

- 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_Dec2019_RGB_20cm_no_smoke.ecw

RGB

- Red: Red
- Green: Green
- Blue: Blue

Bulga Coal
Annual Review
2019
Domain Plan

GLENCORE

N

Date: 28-Feb-2020	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

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