



Mt Arthur Coal

Annual Review FY20



25 September 2020

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Table 1: Annual Review title block

Document Details	
Name of Operation	Mt Arthur Coal
Name of Operator	Hunter Valley Energy Coal Pty Ltd
Project Approvals	PA 09_0062 (MOD 1) PA 06_0091
Name of holder of project approvals	Hunter Valley Energy Coal Pty Ltd
Mining Leases	CCL 744, CL 396, ML 1358, ML 1487, ML 1548, ML1593, ML1655, ML 1739, ML 1757, MPL 263
Name of holder of mining leases	Hunter Valley Energy Coal Pty Ltd; Mt Arthur Coal Pty Limited
Water Licences	WAL 917, WAL 918, WAL 1296, WAL 18141, WAL 18247, WAL 41495, WAL 41556
Name of holder of water licences	Hunter Valley Energy Coal Pty Ltd
Mining Operations Plan Commencement Date	1 July 2019 (amendment as approved 20 December 2019)
Mining Operations Plan Completion Date	30 June 2022
Annual Review Commencement Date	1 July 2019
Annual Review Completion Date	30 June 2020
<p>I, James Nixon, certify that this audit report is a true and accurate record of the compliance status of Mt Arthur Coal for the period 1 July 2019 to 30 June 2020 and that I am authorised to make this statement on behalf of Hunter Valley Energy Coal Pty Ltd.</p> <p>Note.</p> <p>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.</p> <p>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).</p>	
Name of authorised reporting officer	James Nixon
Title of authorised reporting officer	Principal HSE – Mt Arthur Coal
Signature of authorised reporting officer	
Date	21/09/2020

1. Statement of Compliance

A statement of Mt Arthur Coal's compliance with its project approvals and mining leases is presented in Table 2 with four identified non-compliances during the reporting period being discussed in Table 3.

Table 2: Statement of compliance

Were all conditions of the relevant approval(s) complied with?	
PA 09_0062	NO
EPL 11457	YES
EPBC 2011/5866	YES
EPBC 2014/7377	YES
ML	YES

Table 3: Non-compliance summary

Relevant approval	Condition	Description Summary	Compliance Status	Comment	Report Reference
PA 09_0062	10 (Schedule 3)	Blast monitoring	Non-compliant (Low)	Blast overpressure exceedance of the 120dBL criteria was recorded on 8 August 2019.	Section 11
PA 09_0062	24 (Schedule 3)	Implementation of Air Quality Management Plan	Non-compliant (Low)	Failure to comply with Schedule 3, Condition 24 of MP09_0062 by failing to implement the approved Air Quality Management plan to the satisfaction of the Secretary on 10, 11 and 16 December 2019.	Section 11
PA 09_0062	40 (Schedule 3)	Disturbance outside of ancillary disturbance boundary	Non-compliant (Low)	Failure to comply with Schedule 3, Condition 40 of Project Approval MP 09_0062 by failing to implement the approved Biodiversity Management Plan (BMP) to the satisfaction of the Secretary.	Section 11
PA 09_0062	29 (Schedule 3)	Groundwater monitoring	Non-compliant (Low)	Groundwater monitoring not undertaken in accordance with the approved Plan	Section 11

Note: Compliance Status key for Table 3

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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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	Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions)

Acronyms

Acronyms	
AHMP	Aboriginal Heritage Management Plan
ARA	Annual rapid assessment
BioMP	Biodiversity Management Plan
BMP	Blast Management Plan
CASA	Civil Aviation Safety Authority
CCC	Community Consultative Committee
CCL	Consolidated coal lease
CHPP	Coal handling and preparation plant
CL	Coal lease
CRD	Cumulative rainfall departure
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DoEE	Former Federal Department of the Environment and Energy is now part of DAWE
DP&E	Former NSW Department of Planning and Environment now DPIE
DPIE	NSW Department of Planning, Industry and Environment. The change occurred on 1 July 2019
DRE	Former Division of Resources and Energy
DRG	Former Division of Resources and Geoscience
EA	Environmental assessment
EIS	Environmental impact statement
EL	Exploration licence
EMS	Environmental management system
EPA	NSW Environment Protection Authority
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPL	Environment Protection Licence
FY	Financial year
GPA	Ground pasture assessment
HRSTS	Hunter River Salinity Trading Scheme

Acronyms	
HSE	Health, Safety and Environment
HVAS	High volume air sampler
HVEC	Hunter Valley Energy Coal (Mt Arthur Coal)
IROC	Integrated Remote Operations Centre
MAC	Mt Arthur Coal
ML	Mining lease
MOP	Mining Operations Plan
MSC	Muswellbrook Shire Council
NGER	<i>National Greenhouse and Energy Reporting Act 2007</i>
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
PA	Project Approval
RACI	Responsible, accountable, consult and inform
RAW	Rapid assessment walkover
RBGS	Royal Botanic Gardens Sydney
ROM	Run of mine
UAV	Unmanned aerial vehicle
VPA	Voluntary Planning Agreement
VWP	Vibrating wire piezometers

2. Introduction

The Mt Arthur Coal Complex, located approximately five kilometres south west of Muswellbrook in the Upper Hunter Valley in New South Wales (NSW) includes the Mt Arthur Coal Open Cut, the Mt Arthur Coal Underground Project (no underground operations are currently taking place), Coal Handling and Preparation Plant (CHPP), rail loop and rail load out. The Mt Arthur Coal Complex (including biodiversity offset areas) and surrounding region is shown in Figure 1 and Figure 2.

This Annual Review details the environmental and community performance for the period from 1 July 2019 to 30 June 2020 for operations at the Mt Arthur Coal Complex.

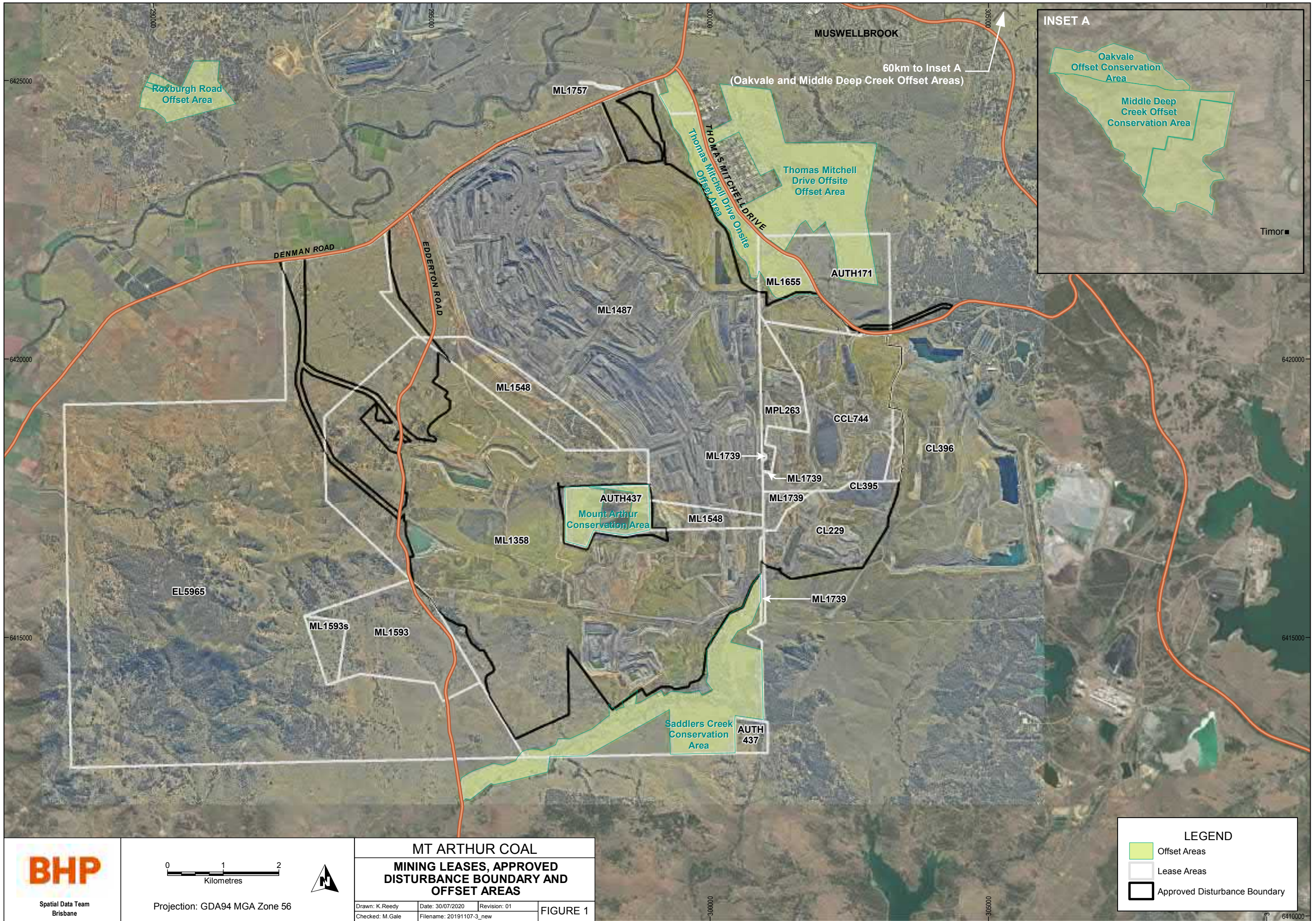
This document has been prepared in accordance with the Annual Review guidelines issued by the former NSW Department of Planning and Environment (DPIE) in October 2015 and fulfils statutory reporting requirements required in mining leases and Schedule 5 Condition 3 of the Mt Arthur Coal Mine Open Cut Consolidation Project Approval Modification 1 (09_0062 MOD 1).

This report was prepared in consultation with the NSW Resources Regulator, the Department of Planning, Industry and Environment (DPIE), Muswellbrook Shire Council (MSC), NSW Environment Protection Authority (EPA) and Department of Industry – Lands & Water. The report is distributed to a range of external stakeholders and is available on the BHP website at <https://www.bhp.com/sustainability/environment/regulatory-information/>.

Contact details for personnel associated with environmental management at Mt Arthur Coal can be found in Table 4.

Table 4: Mt Arthur Coal management contact details

Name and role	Phone contact details
Adam Lancey, General Manager, BHP Mt Arthur Coal	(02) 6544 5800
James Nixon, Superintendent Health, Safety and Environment Business Partner, Mt Arthur Coal	(02) 6544 5800



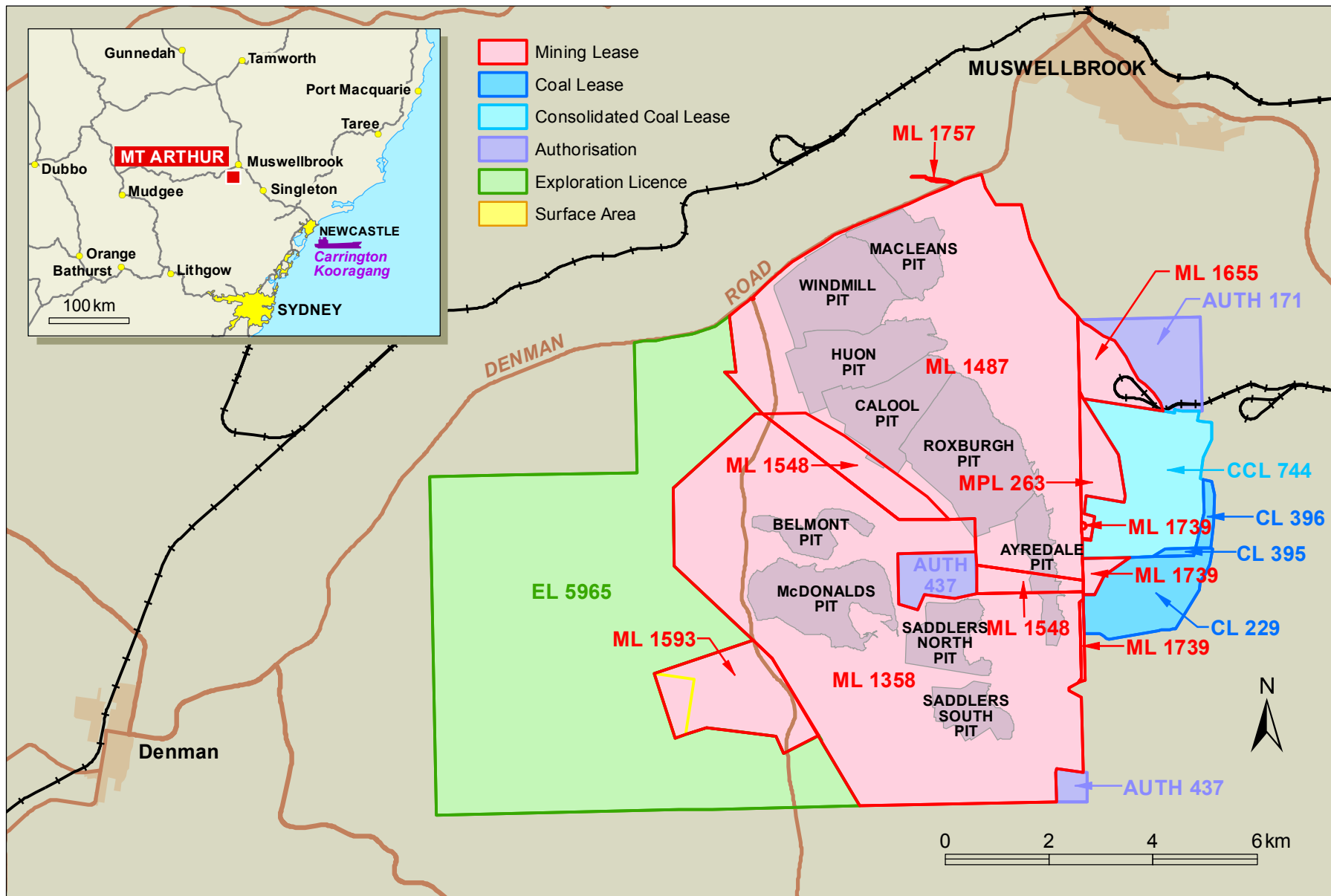


Figure 2: Mt Arthur Coal Locality Plan

3. Approvals

Mt Arthur Coal has a number of statutory approvals, leases and licences that regulate activities on site. During the reporting period, the following approval modifications occurred:

- An amended Mining Operations Plan (MOP) was approved by the Resources Regulator on 20 December 2019 for FY20-FY22 mining operations.

Table 5 shows Mt Arthur Coal's existing statutory approvals as at 30 June 2020.

Table 5: Mt Arthur Coal's existing statutory approvals as at 30 June 2020

Description	Issue date	Expiry date
Project approvals issued by the DPIE		
Mt Arthur Coal Mine Open Cut Consolidation Project Modification 1 (09_0062 MOD 1)	26/09/2014	30/06/2026
Mt Arthur Coal Mine Underground Project (06_0091)	02/12/2008	31/12/2030
Mining leases and exploration licences issued by the DRG		
CCL 744	03/07/1989	21/01/2028
CL 396	23/06/1992	03/02/2024
ML 1358	21/09/1994	21/09/2036
ML 1487	13/06/2001	12/06/2022
ML 1548	31/05/2004	30/05/2025
ML 1593	30/04/2007	29/04/2028
ML 1655	03/03/2011	03/03/2032
ML 1739	25/07/2016	25/07/2037
ML1757	07/07/2017	07/07/2038
MPL 263	17/10/1990	17/10/2032
A 171	18/10/2004	18/10/2020
A 437	04/03/1991	^
EL 5965	14/07/2007	*
Drayton sublease CL 395	13/04/2006 (registered 14/06/2013)	21/01/2029
Drayton sublease CL 229	13/04/2006 (registered 14/06/2013)	02/02/2024
EPL issued by the EPA		

Description	Issue date	Expiry date
EPL 11457	09/10/2001 (varied on 17/10/2018)	Not specified
EPBC approval issued by the DAWE		
EPBC 2011/5866	30/04/2012 (varied on 29/06/2017)	30/06/2022
EPBC 2014/7377	05/12/2016	30/06/2026

^ Application for renewal lodged with the DRG and renewal is currently pending.

* The renewal application was lodged in June 2017 and was deemed adequate. On the 16 December 2019, HVEC received a Notice of Proposed Decision to renew EL 5965 in full, draft conditions and a request for increased Security. HVEC accepted all draft conditions and the Security has now been increased. On 15 May 2020, NSW DPIE confirmed via email that there is nothing outstanding and that EL 5965 is in the final stages of being processed.

4. Operations Summary

4.1 Mining Operations

Mining and processing operations at Mt Arthur Coal continued 24 hours a day, seven days a week during the reporting period. Mining continued within the Ayredale, Calool, Huon, Roxburgh, Saddlers and Windmill open cut pits. Thiess, a subsidiary of the CIMIC Group, operates under a total services contract to mine the Ayredale and Roxburgh pits, located in the southern areas of the Mt Arthur Coal mine. Overburden and interburden material was removed by excavator / shovel and transported via rear dump truck to overburden emplacements, including visual dumps 4 to 5 (VD4 to VD5), contingency dumps 1 to 5 (CD1 to CD5), conveyor corridor dump (CC1) and Saddlers dump. Raw coal was extracted by excavator and transported to the CHPP by rear dump truck.

Raw coal was processed at the CHPP, with approximately 15.3 million tonnes of product coal being railed to the port of Newcastle for export and approximately 0.6 million tonnes of product coal being transported to the Bayswater power station via overland conveyor, as shown in Appendix 4. The domestic coal conveyor used for transport of coal to the Bayswater Power Station was dismantled at end of FY20. Coarse coal waste (rejects) was co-disposed within overburden emplacements and fine coal waste (tailings) was pumped to the tailings storage emplacement in East Pit. Production figures for raw, product and waste materials produced during the reporting period are summarised in Table 6.

Table 6: Production summary

Material	Unit	Approved limit	Previous reporting period (actual)	This reporting period (actual)	Next reporting period (estimate)
Overburden	bank cubic meters	N/A	128,723,000	107,966,000	121,489,000
Run-of-mine coal	tonnes	32,000,000	24,969,000	21,293,000	22,903,000
Coarse and fine reject	tonnes	N/A	4,599,000	3,971,000	4,880,000
Tailings	tonnes (dry)	N/A	2,232,000	1,489,000	2,249,000
Product (saleable) coal	tonnes	27,000,000 (by rail)	18,257,000	16,052,000	16,585,000

4.2 Other Operations

Other operations at Mt Arthur Coal during the reporting period included:

- *Exploration:* 58 boreholes (totalling 18,513 metres) were drilled in ML1358, ML1487 and ML 1548 to further define coal seam geology and geotechnical parameters of the resource. Rehabilitation and sealing of 64 boreholes was completed.
- *Land Preparation:* During the reporting period approximately 154,200 cubic metres of topsoil was recovered from 281 hectares of clearing ahead of mining and for additional dump space using excavators, dozers and trucks. Material was either stockpiled, or placed directly onto reshaped areas to be rehabilitated where able to, with the remaining topsoil being stockpiled. Between 100 to 300 millimetres of topsoil was recovered during stripping.
- *Infrastructure Construction and Management:* The following major projects were commenced, progressed or completed during the reporting period:
 - The first phase of the Tailings Dam Stage 2 raise project involving the downstream raising of an existing embankment by 10 meters to provide ongoing tailings storage capacity;

- Relocation of infrastructure to facilitate the approved extension of Windmill Pit, including detailed planning and design work for the realignment of Edderton Road in accordance with alignment Option 2 presented in PA 09_0062 originally granted in 2010;
- Relocation of powerlines to facilitate the forward mine plan;
- Installation of sediment control structures downstream of the southern conveyor corridor overburden emplacement area prior to dump construction;
- Construction of a temporary deployment facility including carparks, bathhouse and ablutions and office buildings on the north western side of the main pit; and

During the reporting period there were no variations from the current MOP related to construction works on site.

4.3 Employment Details

As at 30 June 2020, Mt Arthur Coal employed 992 permanent and fixed-term contract employees and approximately 1155 contractors on a full-time equivalent basis. Approximately 73 per cent of Mt Arthur Coal's employees resided in the local government areas of Muswellbrook, Upper Hunter and Singleton as at 30 June 2020.

4.4 Next Reporting Period

Forecast operations for the next reporting period, in particular significant changes in the mine, include:

- Complete relocation of infrastructure to facilitate the approved extension of Windmill Pit, including the opening of the realigned Edderton Road in accordance with alignment Option 2 presented in PA 09_0062 originally granted in 2010;
- Complete relocation of infrastructure to facilitate pit progression – EME Pad and Orica facilities;
- Complete construction of new explosives and magazine facility north of Belmont pit – involves a new semi-modular explosive facility and relocate magazine;
- Complete removal of circa 3.8km of old conveyor up to AGL Boundary including removal of redundant coal bin and associated structures;
- Monocline will have significant impact on dump height for a few hundred metres, due to steeply dipping floor;
- Establish an out of pit dump (OP1N) to cater for insufficient dump capacity on low wall over five year plan, particularly with impact of monocline;
- Relocation of powerlines to facilitate the forward mine plan;
- 13 new boreholes – involves installation of monitoring bores and with vibrating wire piezometers (VWP) and 14 monitoring boreholes at 13 new locations;
- 8 water monitoring boreholes (at 4 locations) for North Cut Tailings Storage Facility and 6 water monitoring boreholes at Tailings Storage Facility near Saddlers Creek;
- Installation of sediment control structures downstream of the southern conveyor corridor and OP1N overburden emplacement areas prior to dump construction;
- Installation of additional water pipelines and associated pumps to support ongoing water management strategies;
- Drayton Void pumping and pipeline upgrade works – involves approximately 16 kilometres of pipeline, two 150 L/s electric pontoon pumps and associated electrical works;
- Commencement of the second phase of the Tailings Dam Stage 2 raise project involving the downstream raising of an existing embankment by 10 meters to provide ongoing tailings storage capacity;
- Closure works for the Main Dam and Northcut TSF, comprising:
 - Closure of the Northcut TSF through, dewatering, surface capping and construction of a buttress along the western perimeter of the facility to final landform requirements.

- Planning and works to move toward de-prescription and risk reduction of the Main Dam through installation of a Culvert
 - Removal of Dam 4.
- Fencing upgrades to conservation areas;
- Denman Rd and Thomas Mitchell Drive intersection upgrade works; and
- Noise and dust monitoring equipment upgrades.

5. Actions Required from Previous Annual Review

The DPIE notified HVEC by letter dated 18 November 2019 that the amended FY19 Annual Review was considered by the Department to satisfy the requirements of the Project Approval and the Department's Annual Review Guideline, October 2015.

The NSW Resources Regulator acknowledged receipt of the FY19 Annual Review on 12 November 2019.

Regulator feedback following review of the FY19 Annual Review is summarised in Table 7. Regulator feedback on additional requirements to be considered during the preparation of the FY20 Annual Review is also summarised in Table 7.

Table 7: Actions required from FY19 Annual Review and additional requirements for FY20 Annual Review

Action required	Requested by	Action taken by HVEC	FY20 Annual Review section
Regulator Feedback from FY19 Annual Review			
No specific feedback from FY19 has been provided for consideration in the development of the FY20 Annual Review.	NSW Resources Regulator, DPIE	N/A	N/A
Regulator Feedback on additional requirements for FY20 Annual Review			
Provide a summary of the results analysis and further investigation associated with notified groundwater trigger level exceedances.	DPIE	Exceedance investigation has been undertaken by a groundwater specialist.	Appendix 2 – Ground Water Monitoring Results and Groundwater Level Drawdown Analysis

6. Environmental Performance

6.1 Noise

Environmental Management

Noise management at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-MTP-032 Noise Management Plan; and
- MAC-ENC-PRO-056 Noise Monitoring Program.

The Noise Management Plan was prepared to fulfil the requirements of project approval, meet conditions of Environmental Protection Licence (EPL) 11457, as well as manage and minimise mine noise impact on the community and environment.

Mt Arthur Coal has eight statutory monitoring locations as detailed in the Noise Monitoring Program and four real-time monitoring locations utilised for internal use. Noise monitoring locations are shown in Figure 3.

A revised Noise Management Plan was submitted to the DPIE in June 2019 and approved on 17 July 2020.

Environmental Performance

An analysis of monthly attended noise monitoring results indicates Mt Arthur Coal's operations did not exceed the $L_{Aeq(15min)}$ or the $L_{A1(1min)}$ limits during the reporting period. A summary of results from Mt Arthur Coal's attended noise monitoring in the reporting period is provided in Table 8. Where a remeasure was required on the same night to determine the sustained noise level, only the remeasure result has been used to calculate tabulated results.

A comparison of FY20 noise monitoring results to previous reporting years is presented in Table 9. FY20 $L_{Aeq(15min)}$ noise levels are generally higher than historical results, with the exception of the maximum $L_{Aeq(15min)}$ at NP04, NP12 and NP13 being generally lower than previous years. Data capture was 100 per cent at all attended noise monitoring sites. On nine occasions noise levels from Mt Arthur Coal were audible but too low to measure at particular sites.

$L_{Aeq(15min)}$ noise level predictions modelled for 2022 in the 2013 noise impact assessment were used for comparison with monitoring results for this reporting period, as shown in Table 8. Maximum $L_{Aeq(15min)}$ noise results are below modelled predictions with the exception of NP10 and NP16.

The additional impact of low frequency noise was assessed in accordance with the EPA's 2017 Noise Policy for Industry. None of the noise measurements recorded during the reporting period satisfied the conditions outlined in the Noise Policy for Industry to require assessment of low-frequency noise.

Complaints and Reportable Incidents

During the reporting period, 19 noise complaints were received from three complainants. This is higher than FY19 (16 noise complaints).

Mt Arthur Coal did not receive any government fines or penalties related to noise during the reporting period and there were no related reportable incidents.

Proposed Improvements

Operational noise will continue to be managed and monitored in accordance with the Noise Management Plan and associated procedures.

Table 8: Monthly attended night time noise monitoring results in decibels

Noise Monitoring Location	L _{Aeq} (15min) dB			L _{A1} (1min) dB		Trend / key management implications	Implemented / proposed management actions
	Approval criteria	2022 prediction	Reporting period performance (min/log ave/max^)	Approval criteria	Reporting period performance (min/log ave/max^)		
NP04	38	38	24*/30/35*	45	25/34/40*	No valid exceedances	Continuation of management and monitoring in accordance with Noise Management Plan
NP07	39	38	25*/31/34*	45	28*/35/37		
NP10	39	36	25/33/37*	45	25/34/39*		
NP12	39	39	28*/32/34*	45	29*/33/35*		
NP13	35	N/A	20/24/27	45	20/28/34		
NP14	35	35	20/30/34*	45	28/38/43		
NP15	35	36	25*/30/32*	45	25*/39/43		
NP16	37	36	25/31/37*	45	25/35/41*		

^ Measurable noise levels only – does not include *inaudible* or *not measurable* results

* Noise emission limits do not apply due to winds greater than three metres per second (at a height of 10 metres), or temperature inversion conditions greater than or equal to four degrees Celsius per 100 metres.

Table 9: Attended noise monitoring results in decibels in comparison to previous years

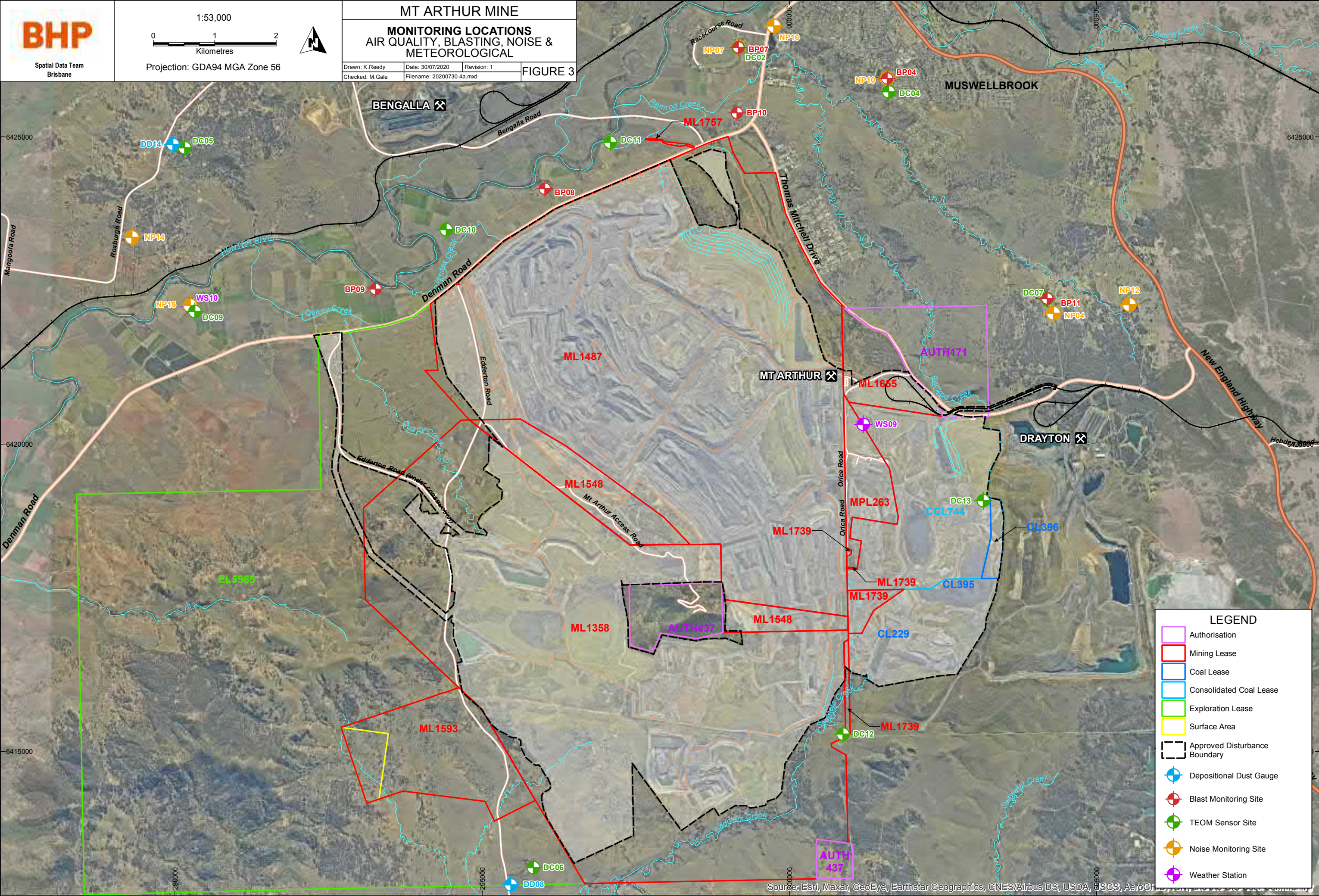
Monitoring Site	FY20		FY19		FY18	
	Min	Max	Min	Max	Min	Max
L _{Aeq} (15 min) dB						
NP04	IA	35*	IA	37*	IA	35*
NP07	IA	34*	IA	33	IA	34
NP10	IA	37*	IA	<30*	IA	39*
NP12	IA	34*	IA	35*	IA	36
NP13	IA	27	IA	<30*	IA	30*
NP14	IA	34*	IA	32*	IA	34*
NP15	IA	32*	IA	31*	IA	34*
NP16	IA	37*	IA	32*	IA	32
L _{Aeq} (1 min) dB						
NP04	IA	40*	IA	47*	IA	50*
NP07	IA	37	IA	37*	IA	45
NP10	IA	39*	IA	35*	IA	43*

Monitoring Site	FY20		FY19		FY18	
	Min	Max	Min	Max	Min	Max
NP12	IA	35*	IA	42*	IA	40
NP13	IA	34	IA	31	IA	32*
NP14	IA	43	IA	34*	IA	41*
NP15	IA	43	IA	34*	IA	44*
NP16	IA	41*	IA	35	IA	42

* Noise emission limits do not apply due to winds greater than three metres per second (at a height of 10 metres), or temperature inversion conditions greater than or equal to four degrees Celsius per 100 metres.

IA – Mt Arthur Coal's operations were inaudible.

NM – Mt Arthur Coal's operations were audible but not measurable.



6.2 Blasting

Environmental Management

Blasting at Mt Arthur Coal is managed in accordance with MAC-ENC-MTP-015 Blast Management Plan.

The Blast Management Plan details the relevant blast overpressure and vibration impact assessment criteria and compliance procedures and controls related to open cut blasting activities. It includes the blast monitoring program, as well as public infrastructure monitoring requirements, and road closures. It also includes the blast fume management strategy, which aims to minimise visible blast fume and reduce potential for offsite fume migration.

Mt Arthur Coal has five statutory blast monitors:

- BP04 (South Muswellbrook);
- BP07 (Sheppard Avenue);
- BP09 (Denman Road West);
- BP10 (Yammanie North); and
- BP11 (Balmoral Road).

Blast monitoring locations are shown in Figure 3.

The modification project approval states a ground vibration limit for public infrastructure of 50 millimetres per second (mm/s), unless Mt Arthur Coal has a written agreement with the relevant owner of the public infrastructure to exceed these criteria and advised the former DPIE in writing of the terms of the agreement. Written agreements with Roads and Maritime Services (RMS), Telstra and Ausgrid are in place allowing increases in the ground vibration blast impact assessment criteria as follows:

- 150 mm/s with no allowable exceedances (RMS, Ausgrid);
- 10 per cent of the total number of blasts over a period of 12 months are allowed to exceed 100 mm/s (Telstra, Ausgrid); and
- Notification prior to blasting for blasts predicted to exceed 100 mm/s at Denman Road (RMS).

Environmental Performance

During the reporting period 183 blasts were undertaken. Blast data capture rates for the reporting period were 100 per cent at all statutory sites.

Blasting was undertaken between 8 am and 5 pm Monday to Saturday, with no blasts being undertaken on Sundays or public holidays. No blast ground vibration monitoring results above the maximum 10 mm/s limit were recorded at any of the statutory blast monitors during the reporting period. One blast recorded an airblast overpressure result above the maximum 120 dBL limit on 8 August 2019 at 2:17 pm, recording 124.4 dBL at the Sheppard Avenue monitor (BP07). Investigations determined that the overpressure level was not a valid result as it was the result of wind impact on the microphone, not overpressure from the blast event.

Of the 183 blast events fired during the reporting period, four (2.19 per cent) exceeded the airblast overpressure criteria of 115 dBL and one (0.55 per cent) exceeded the ground vibration criteria of 5 mm/s, hence remaining below the five per cent allowable exceedance limits.

Results reflect predictions made in the modification environmental assessment and do not show a significant difference in average or maximum results compared to previous reporting periods. A comparison of FY20 blast monitoring results with previous years is provided in Table 10.

In accordance with the Blast Management Plan, potential impacts to public infrastructure were calculated for blasts in Windmill and Roxburgh pits with all blasts meeting the agreed criteria.

Table 10: Summary of statutory blast monitoring results

Parameter	Statistic	FY20	FY19	FY18
Ground vibration (mm/s)	Average	0.21	0.27	0.25
	Maximum valid result	5.96 (at BP09)	5.51 (at BP09)	9.78 (at BP09)
	Valid blasts above 5 mm/s threshold	1	2	2
Airblast overpressure (dBL)	Average	95.3	95.1	97.2
	Maximum valid result	117.7(at BP10)	120.6 (at BP09)	118.4 (at BP09)
	Valid blasts above 115 dBL threshold	4	5	6

Complaints and Reportable Incidents

During the reporting period, 7 blast complaints were recorded. These complaints are discussed further in Section 9. Reportable blast incidents are discussed in Section 11.

Proposed Improvements

Continued updates on the Site Law database and improvements to the predictive model, which is periodically audited externally, will be undertaken in FY21, allowing for increased accuracy in determining the vibration and overpressure at the design stage.

A review of the Blast Matrices, Pre Blast Approval procedure and Approval to Blast Form will be undertaken in FY21. This will improve the blast impact risk identification process undertaken prior to each blast and reduce the risk of impacts to community and environment as a result of the blasting.

6.3 Meteorological Data

Environmental Management

Meteorological monitoring at Mt Arthur Coal is managed in accordance with MAC-ENC-MTP-040 Air Quality Management Plan.

Mt Arthur Coal's primary statutory real-time meteorological station located at the mine's industrial area (WS09) is an essential component of the operation's environmental monitoring system. Wind speed, wind direction, temperature, rainfall, solar radiation and humidity data is collected at 15 minute intervals and relayed using radio telemetry.

A secondary statutory real-time meteorological station, located off site to the north west of the mine at Wellbrook (WS10), also provides representative weather data for the mine site, including prevailing wind conditions, and is used in conjunction with WS09 to determine the presence and strength of temperature inversions in the local atmosphere as part of the pre-blast environmental assessment. These meteorological stations are shown on Figure 3.

Both statutory meteorological stations comply with the Australian Standard 2923-1987 *Ambient Air – Guide for measurement of horizontal wind for air quality applications* and the EPA's 2017 Noise Policy for Industry.

Environmental Performance

Meteorological data capture rate for the reporting period was 100 per cent at WS09 and 95 percent at WS10.

Total rainfall for the reporting period was 469 mm, which is approximately 24 per cent lower than the long-term average of 619 mm. Wind direction at Mt Arthur Coal (WS09) during the reporting period was predominantly from the north-west (Winter/Spring) and south-east (Summer/Autumn).

Proposed Improvements

Mt Arthur Coal will continue to record and utilise meteorological data from its two statutory monitors during the next reporting period.

6.4 Air Quality

Environmental Management

Air quality at Mt Arthur Coal is managed in accordance with MAC-ENC-MTP-040 Air Quality Management Plan.

Mt Arthur Coal operates an air quality monitoring network consisting of:

- Two statutory dust deposition gauges recording dust deposition, which are derived from mining and non-mining activities. These provide a measure of changing air quality;
- Six statutory real-time dust monitors, referred to as tapered element oscillating microbalance samplers (TEOMs), which record PM₁₀ levels on a continuous basis;
- Five additional TEOMs, which also record continuous PM₁₀ levels are included in the monitoring network. These are non-statutory and are used for proactive internal management purposes; and
- A Dust Control System, which is monitored 24 hours a day, seven days a week by the Integrated Remote Operations Centre (IROC) in Brisbane who contact site Operations to activate the Dust Trigger Action Response Plan (TARP) when dust trigger levels are exceeded. Operational responses are recorded in the Dust Control System.

Air Quality monitoring locations are shown in Figure 3.

Mt Arthur Coal utilises a predictive dust model that predicts meteorological conditions and PM₁₀ concentrations up to 72 hours in advance. This tool is used for operational dust management planning and notification of mining supervisors when adverse weather conditions are predicted.

Environmental Performance

Air dispersion modelling completed for the 2022 representative mining scenario, as part of the 2013 environmental assessment, has been used to evaluate monitoring results for the reporting period.

Depositional Dust Gauges

The results from the statutory depositional dust monitoring results are summarised in Table 11. Depositional dust gauge data capture rates for the reporting period were 100 per cent at all statutory sites.

For the reporting period, no statutory depositional dust gauges exceeded the annual average assessment criteria, as shown in Table 11.

Monitoring results for the reporting period were generally higher than predictions modelled for 2022 in the 2013 air quality assessment, indicating that the dry conditions experienced throughout the reporting period and other local dust producing sources have had an influence on monitoring results.

Table 11: Comparison of annual average deposited dust results

Monitor Location	Approval criteria (annual average)	Annual average depositional dust (g/m ² /month)			Trend / key management implications	Implemented / proposed management actions
		FY20	FY19	FY18		
Edderton Homestead (DD08)	4 g/m ² /month	2.0	2.0	1.4	No exceedances	Continue dust management in accordance with AQMP
Roxburgh Road (DD14)		3.0	2.6	2.3		

Tapered Element Oscillating Microbalance Samplers

A summary of the non-validated results from the statutory real-time TEOM PM₁₀ monitoring sites for the reporting period is provided in Table 12.

The Edderton Homestead monitor (DC06) had a data capture rate of 85.9 per cent due to an equipment issue and access to rectify the issue being delayed as a result of safety considerations. All other monitors were above the 90% target.

During the reporting period, the short term 24-hour cumulative impact assessment criteria was exceeded 312 times at statutory TEOM monitoring sites over a total of 90 days. All exceedances of the cumulative criteria were reported to the DPIE, as recorded in Table 14.

Table 13 shows the days that were declared extraordinary events by the Secretary. An extraordinary event may be determined due to sources such as extended bushfires, prolonged drought conditions and dust storms. Extraordinary event days contributed to a significant number of alerts and exceedances throughout the FY20 period for Mt Arthur Coal. PM₁₀ data recorded on extraordinary event days are not used in the calculation of the long-term annual average.

On the 10th and 16th of December 2019 at DC09 the 24-hour impact assessment criteria of 50 µg/m³ was exceeded due to extraordinary weather events as agreed by the Secretary, therefore these results are excluded from application of the criterion. For the remaining recorded exceedances (excluding extraordinary events declared by Secretary) it was determined that the incremental increase in concentrations due to the Mt Arthur Coal project was less than 50 µg/m³.

After the removal of the extraordinary event days, Mt Arthur Coal's statutory TEOM monitoring sites remained below the long-term annual impact assessment criteria.

Air dispersion modelling predictions for the 2022 mining scenario have been used to evaluate annual average TEOM PM₁₀ results for the reporting period, as summarised in Table 12.

Table 12: Summary of TEOM PM₁₀ monitoring results using validated data

Monitor location	Approval criteria (µg/m³)	2022 – predicted cumulative (µg/m³) +	TEOM PM ₁₀ monitoring results (µg/m³)						Trend / key management implications	Implemented / proposed management actions
			FY20		FY19		FY18			
			Max 24-hour avg	^Annual Ave µg/m³	Max 24-hour avg	Annual Ave µg/m³	Max 24-hour avg	Annual Ave µg/m³		
Sheppard Avenue (DC02)	Short term 24-hour average: 50 Long term annual average: 30	18	217#	27	223#	30	92*	29	No valid exceedances of the incremental impact assessment criteria due to the Mt Arthur Coal project. All TEOMs experienced a drop in the average, or remained consistent with previous years.	Continue dust management in accordance with AQMP
South Muswellbrook (DC04)		19	194#	20	163*	25	65*	22		
Roxburgh Road (DC05)		19	213#	13	124*	21	68*	19		
Edderton Homestead (DC06)		N/A	215#	14	107*	19	46	14		
Antiene (DC07)		18	209#	20	146#	20	67*	18		
Wellbrook (DC09)		17	194#	23	168*	25	78*	21		

* This result, which includes air emissions from all sources, was investigated as it exceeded the short term 24-hour impact assessment criterion of 50 µg/m³. Investigations found the incremental increase in concentrations due to the Mt Arthur Coal project was less than the criterion.

The 24-hour impact assessment criteria of 50 µg/m³ was exceeded due to an extraordinary weather event as agreed by the Secretary, therefore this result is excluded from application of the criterion.

^adjusted long term average. The adjusted value is after the removal of all extraordinary event days where criterion does not apply.

* these predictions were modelled in 2013, Emissions from Bengalla Mine are not included in these cumulative predictions as detailed emissions information for the Bengalla Continuation Project were not publicly available for inclusion in the modelling for 2022. This has led to the predicted cumulative levels being potentially artificially low.

Table 13: Days that were declared extraordinary events by the Secretary

Months	Dates
July 19	No days
August 19	No days
September 19	No days
October 19	7 th , 8 th , 18 th , 19 th , 24 th , 25 th , 26 th , 27 th , 28 th , 30 th , 31 st .
November 19	1 st , 2 nd , 7 th , 8 th , 12 th , 16 th , 17 th , 19 th , 20 th , 21 st , 22 nd , 23 rd , 26 th , 27 th , 28 th , 29 th , 30 th .
December 19	1 st , 2 nd , 3 rd , 4 th , 5 th , 6 th , 7 th , 8 th , 9 th , 10 th , 11 th , 12 th , 13 th , 14 th , 15 th , 16 th , 17 th , 18 th , 19 th , 20 th , 21 st , 22 nd , 23 rd , 27 th , 28 th , 29 th , 30 th , 31 st .
January 20	1 st , 2 nd , 3 rd , 4 th , 5 th , 6 th , 7 th , 8 th , 9 th , 10 th , 11 th , 12 th , 13 th , 14 th , 15 th , 16 th , 20 th , 21 st , 22 nd , 23 rd , 24 th , 25 th .
February 20	2 nd , 4 th , 19 th , 20 th .
March 20	No days
April 20	No days
May 20	No days
June 20	No days

Table 14: 24-hour PM₁₀ exceedances and calculated Mt Arthur Coal incremental impact for statutory TEOMs

Date of event	Monitor location	24-hour PM ₁₀ result (µg/m ³)	Mt Arthur Coal contribution (µg/m ³) (incremental impact) *	Declared extraordinary event by Secretary *
08/08/2019	DC02	81.2	0.0	No
	DC09	61.5	0.0	
09/08/2019	DC02	62.3	0.0	No
	DC09	61.0	0.0	
19/08/2019	DC02	62.2	0.1	No
25/08/2019	DC02	63.4	2.7	No
06/09/2019	DC02	102.2	0.0	No
	DC04	79.3	0.0	
	DC05	71.1	0.0	
	DC07	123.8	47.4	
	DC09	89.6	0.1	
10/09/2019	DC02	97.1	8.3	No
13/09/2019	DC02	58.4	0.8	No
	DC09	50.5	1.7	
16/09/2019	DC02	68.7	0.0	No
27/09/2019	DC02	57.0	0.0	No
03/10/2019	DC02	70.2	0.7	No
04/10/2019	DC02	67.6	0.0	No
07/10/2019	DC02	81.0	N/A	Yes
	DC04	61.9	N/A	
	DC07	66.0	N/A	
	DC09	58.8	N/A	
08/10/2019	DC02	51.4	N/A	Yes
	DC07	55.4	N/A	
17/10/2019	DC02	61.2	0.0	No
	DC04	52.8	0.0	

Date of event	Monitor location	24-hour PM ₁₀ result (µg/m³)	Mt Arthur Coal contribution (µg/m³) (incremental impact) *	Declared extraordinary event by Secretary *
	DC07	56.2	6.6	
18/10/2019	DC02	59.7	N/A	Yes
19/10/2019	DC02	60.1	N/A	Yes
24/10/2019	DC02	62.4	N/A	Yes
25/10/2019	DC02	58.0	N/A	Yes
26/10/2019	DC02	146.5	N/A	Yes
	DC04	89.8	N/A	
	DC07	114.3	N/A	
	DC09	80	N/A	
27/10/2019	DC02	77.7	N/A	Yes
	DC04	62.9	N/A	
	DC07	68.8	N/A	
	DC09	58.2	N/A	
28/10/2019	DC02	74.9	N/A	Yes
	DC04	58.0	N/A	
	DC05	54.3	N/A	
	DC07	66.3	N/A	
	DC09	62.7	N/A	
29/10/2019	DC02	63.2	1.3	No
	DC04	54.2	0.2	
30/10/2019	DC02	113.6	N/A	Yes
	DC04	69.4	N/A	
	DC05	60.3	N/A	
	DC06	56.5	N/A	
	DC07	71.6	N/A	
	DC09	68.6	N/A	
31/10/2019	DC02	77.8	N/A	Yes
	DC04	57.1	N/A	
	DC05	57.3	N/A	
	DC06	62.5	N/A	
	DC07	56.5	N/A	
	DC09	86.1	N/A	
01/11/2019	DC02	98.1	N/A	Yes
	DC04	81.0	N/A	
	DC05	79.1	N/A	
	DC06	71.9	N/A	
	DC07	78.7	N/A	
	DC09	93.8	N/A	
02/11/2019	DC02	68.6	N/A	Yes
	DC09	50.2	N/A	
03/11/2019	DC02	59.7	30.5	No
07/11/2019	DC02	95.2	N/A	Yes
	DC04	75.3	N/A	
	DC07	85.2	N/A	
	DC09	71.3	N/A	

Date of event	Monitor location	24-hour PM ₁₀ result (µg/m³)	Mt Arthur Coal contribution (µg/m³) (incremental impact) *	Declared extraordinary event by Secretary *
08/11/2019	DC02	86.8	N/A	Yes
	DC04	71.7	N/A	
	DC07	76.1	N/A	
	DC09	70.6	N/A	
12/11/2019	DC02	119.0	N/A	Yes
	DC04	93.3	N/A	
	DC05	55.6	N/A	
	DC06	69.3	N/A	
	DC07	95.5	N/A	
	DC09	55.5	N/A	
13/11/2019	DC02	54.1	0.7	No
14/11/2019	DC02	60.8	0.0	No
15/11/2019	DC02	64.3	0.0	No
16/11/2019	DC02	79.7	N/A	Yes
	DC04	63.4	N/A	
	DC07	59.1	N/A	
	DC09	58.1	N/A	
17/11/2019	DC02	92.4	N/A	Yes
	DC04	56.7	N/A	
	DC05	73.2	N/A	
	DC06	59.7	N/A	
	DC07	72.0	N/A	
	DC09	63.4	N/A	
18/11/2019	DC02	57.8	0.0	No
	DC04	54.5	0.1	
	DC09	51.1	0.3	
19/11/2019	DC02	64.3	N/A	Yes
	DC07	50.3	N/A	
	DC09	57.9	N/A	
20/11/2019	DC02	74.6	N/A	Yes
	DC04	64.9	N/A	
	DC05	61.2	N/A	
	DC06	67.7	N/A	
	DC07	61.5	N/A	
	DC09	79.6	N/A	
21/11/2019	DC02	118.5	N/A	Yes
	DC04	97.6	N/A	
	DC05	76.7	N/A	
	DC06	96.5	N/A	
	DC07	67.7	N/A	
	DC09	92.0	N/A	
22/11/2019	DC02	142.0	N/A	Yes
	DC04	104.0	N/A	
	DC05	75.8	N/A	

Date of event	Monitor location	24-hour PM ₁₀ result (µg/m³)	Mt Arthur Coal contribution (µg/m³) (incremental impact) *	Declared extraordinary event by Secretary *
	DC07	111.5	N/A	
	DC09	116.4	N/A	
23/11/2019	DC02	63.2	N/A	Yes
	DC04	64.5	N/A	
	DC05	54.1	N/A	
	DC06	103.3	N/A	
	DC07	62.9	N/A	
	DC09	63.4	N/A	
26/11/2019	DC02	216.9	N/A	Yes
	DC04	193.7	N/A	
	DC05	99.5	N/A	
	DC06	214.6	N/A	
	DC07	209.2	N/A	
	DC09	193.9	N/A	
27/11/2019	DC02	95.7	N/A	Yes
	DC04	97.0	N/A	
	DC06	76.6	N/A	
	DC07	88.6	N/A	
	DC09	64.4	N/A	
28/11/2019	DC02	94.2	N/A	Yes
	DC04	80.5	N/A	
	DC05	85.2	N/A	
	DC06	187.0	N/A	
	DC07	71.0	N/A	
	DC09	107.1	N/A	
29/11/2019	DC02	122.2	N/A	Yes
	DC04	107.8	N/A	
	DC05	76.6	N/A	
	DC06	177.1	N/A	
	DC07	110.9	N/A	
	DC09	123.1	N/A	
30/11/2019	DC02	92.0	N/A	Yes
	DC04	71.6	N/A	
	DC06	94.1	N/A	
	DC07	66.1	N/A	
	DC09	90.2	N/A	
01/12/2019	DC02	90.9	N/A	Yes
	DC04	63.5	N/A	
	DC06	110.4	N/A	
	DC07	70.3	N/A	
	DC09	99.4	N/A	
02/12/2019	DC04	89.9	N/A	Yes
	DC06	63.2	N/A	
	DC07	99.1	N/A	

Date of event	Monitor location	24-hour PM ₁₀ result (µg/m³)	Mt Arthur Coal contribution (µg/m³) (incremental impact) *	Declared extraordinary event by Secretary *
	DC09	94.7	N/A	
03/12/2019	DC02	74.0	N/A	Yes
	DC04	61.9	N/A	
	DC07	60.8	N/A	
	DC09	74.2	N/A	
04/12/2019	DC02	79.0	N/A	Yes
	DC04	56.0	N/A	
	DC07	58.6	N/A	
	DC09	56.3	N/A	
05/12/2019	DC02	87.7	N/A	Yes
	DC04	58.1	N/A	
	DC07	65.8	N/A	
	DC09	74.2	N/A	
06/12/2019	DC02	113.6	N/A	Yes
	DC04	73.3	N/A	
	DC07	79.7	N/A	
	DC09	111.1	N/A	
07/12/2019	DC02	123.99	N/A	Yes
	DC04	106.0	N/A	
	DC05	131.0	N/A	
	DC06	195.5	N/A	
	DC07	104.4	N/A	
	DC09	177.7	N/A	
08/12/2019	DC02	62.8	N/A	Yes
	DC04	50.7	N/A	
	DC06	57.2	N/A	
	DC07	50.1	N/A	
	DC09	59.7	N/A	
09/12/2019	DC02	99.7	N/A	Yes
	DC04	101.4	N/A	
	DC05	75.1	N/A	
	DC06	85.7	N/A	
	DC07	85.4	N/A	
	DC09	93.8	N/A	
10/12/2019	DC02	145.0	N/A	Yes
	DC04	110.6	N/A	
	DC05	134.1	N/A	
	DC07	106.8	N/A	
	DC09	120.3	N/A	
11/12/2019	DC02	130.0	N/A	Yes
	DC04	97.0	N/A	
	DC05	134.4	N/A	
	DC07	98.1	N/A	
	DC09	170.3	N/A	

Date of event	Monitor location	24-hour PM ₁₀ result (µg/m³)	Mt Arthur Coal contribution (µg/m³) (incremental impact) *	Declared extraordinary event by Secretary *
12/12/2019	DC02	104.3	N/A	Yes
	DC04	62.0	N/A	
	DC05	62.6	N/A	
	DC06	88.8	N/A	
	DC07	59.5	N/A	
	DC09	89.9	N/A	
14/12/2019	DC02	76.4	N/A	Yes
	DC04	53.0	N/A	
	DC06	81.5	N/A	
	DC07	57.0	N/A	
	DC09	63.1	N/A	
15/12/2019	DC02	62.5	N/A	Yes
	DC04	50.6	N/A	
	DC06	53.6	N/A	
	DC07	54.1	N/A	
	DC09	63.1	N/A	
16/12/2019	DC02	97.8	N/A	Yes
	DC04	58.5	N/A	
	DC07	95.7	N/A	
	DC09	188.1	N/A	
18/12/2019	DC02	53.8	N/A	Yes
	DC09	67.3	N/A	
19/12/2019	DC02	140.3	N/A	Yes
	DC04	110.9	N/A	
	DC05	56.2	N/A	
	DC06	67.1	N/A	
	DC07	107.3	N/A	
	DC09	135.1	N/A	
20/12/2019	DC02	102.1	N/A	Yes
	DC04	52.3	N/A	
	DC06	56.4	N/A	
	DC07	52.8	N/A	
	DC09	73.8	N/A	
21/12/2019	DC02	182.3	N/A	Yes
	DC04	110.6	N/A	
	DC05	74.6	N/A	
	DC06	116.9	N/A	
	DC07	81.8	N/A	
	DC09	144.1	N/A	
22/12/2019	DC02	181.9	N/A	Yes
	DC04	58.3	N/A	
	DC06	69.7	N/A	
	DC07	61.7	N/A	
	DC09	68.0	N/A	

Date of event	Monitor location	24-hour PM ₁₀ result (µg/m ³)	Mt Arthur Coal contribution (µg/m ³) (incremental impact) *	Declared extraordinary event by Secretary *
24/12/2019	DC02	62.1	N/A	No
27/12/2019	DC02	52.4	N/A	Yes
	DC09	51.9	N/A	
28/12/2019	DC02	74.4	N/A	Yes
	DC06	38.7	N/A	
	DC09	111.7	N/A	
29/12/2019	DC02	84.7	N/A	Yes
	DC04	60.9	N/A	
	DC07	58.7	N/A	
30/12/2019	DC02	154.2	N/A	Yes
	DC07	71.3	N/A	
	DC09	94.9	N/A	
31/12/2019	DC02	94.4	N/A	Yes
	DC04	59.3	N/A	
	DC05	69.7	N/A	
	DC07	52.8	N/A	
	DC09	82.7	N/A	
01/01/2020	DC02	145.7	N/A	Yes
	DC04	96.9	N/A	
	DC05	72.8	N/A	
	DC07	102.2	N/A	
	DC09	138.8	N/A	
02/01/2020	DC02	75.1	N/A	Yes
	DC09	52.3	N/A	
03/01/2020	DC02	59.8	N/A	Yes
	DC04	52.9	N/A	
	DC09	51.3	N/A	
04/01/2020	DC02	97.4	N/A	Yes
	DC09	60.6	N/A	
05/01/2020	DC04	120.4	N/A	Yes
	DC05	73.9	N/A	
	DC07	117.8	N/A	
	DC09	136.1	N/A	
08/01/2020	DC04	50.9	N/A	Yes
	DC07	56.7	N/A	
	DC09	56.8	N/A	
11/01/2020	DC02	157.3	N/A	Yes
	DC04	134.6	N/A	
	DC05	76.2	N/A	
	DC07	75.2	N/A	
	DC09	128.7	N/A	
12/01/2020	DC02	89.6	N/A	Yes
	DC04	54.1	N/A	
	DC07	55.5	N/A	

Date of event	Monitor location	24-hour PM ₁₀ result (µg/m ³)	Mt Arthur Coal contribution (µg/m ³) (incremental impact) *	Declared extraordinary event by Secretary *
	DC09	61.9	N/A	
20/01/2020	DC04	58.3	N/A	Yes
	DC07	53.7	N/A	
	DC09	52.4	N/A	
	DC02	66.1	N/A	
21/01/2020	DC04	55.8	N/A	Yes
	DC07	56.9	N/A	
	DC09	54.5	N/A	
	DC02	81.4	N/A	
23/01/2020	DC04	58.9	N/A	Yes
	DC07	58.8	N/A	
	DC09	59.0	N/A	
	DC02	67.2	0.0	
01/02/2020	DC02	64.3	N/A	No
02/02/2020	DC02	57.0	0.2	Yes
03/02/2020	DC02	74.1	N/A	No
04/02/2020	DC02	58.0	N/A	Yes
	DC09	54.4	N/A	
19/02/2020	DC07	52.4	N/A	Yes
	DC09	52.6	N/A	
	DC02	50.6	0.7	
02/03/2020	DC02			No

Note: The results reported in this table are based on non-validated data, as reported to regulators.

* Criterion doesn't apply under extraordinary event as agreed by the Secretary, as per Note d of Schedule 3, Condition 20 of PA 09_0062. Calculation of the Mt Arthur Coal contribution is not applicable for these declared events.

Total Suspended Particulates

TEOM PM₁₀ monitoring data is used to calculate annual average total suspended particulate (TSP) levels. TSP results were calculated by multiplying the annual average PM₁₀ results by 2.5, in accordance with the approved AQMP. During the reporting period, TSP remained below the long-term annual impact assessment criteria at all statutory sites, as shown in Table 15. TSP at each of the monitoring locations were below the reported values for FY19 and FY18, which can primarily be attributed to the removal of significant number of extraordinary event days experienced throughout the bushfire season.

Table 15: Summary of total suspended particulate results

Site name	Approval criteria	TSP annual average monitoring results (µg/m ³)			Trend / key management implications	Implemented / proposed management actions
		FY20	FY19	FY18		
Sheppard Avenue (DC02)	Long term annual average: 90 µg/m ³	68	75	71	No exceedances	Continue dust management in accordance with AQMP
South Muswellbrook (DC04)		50	61	55		
Roxburgh Road (DC05)		33	53	47		
Edderton Homestead (DC06)		35	46	35		
Antiene (DC07)		50	51	44		
Wellbrook (DC09)		58	61	51		

Complaints and Reportable Incidents

During the reporting period, 6 dust-related complaints were received from five complainants, which is 71 per cent lower than previous year (21 dust-related complaints). These complaints are discussed further in Section 9.

Proposed Improvements

In line with the principles of continuous improvement that are integral to the site Environmental Management System, Mt Arthur Coal will continue upgrades to the Dust Control System in the next reporting period to improve system accuracy and reliability.

6.5 Biodiversity

Environmental Management

Flora and fauna at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-MTP-047 Rehabilitation Strategy;
- MAC-ENC-MTP-050 Biodiversity Management Plan (BioMP);
- MAC-ENC-PRO-012 Land Management (internal document);
- MAC-ENC-PRO-080 Rehabilitation and Ecological Monitoring Procedure (internal document); and
- MAC-HSE-PRO-002 Pest Animal Management Procedure (internal document).

The BioMP outlines Mt Arthur Coal's biodiversity management and monitoring approach, addressing both State and Commonwealth approval conditions in relation to biodiversity management.

The biodiversity offset areas managed by Mt Arthur Coal, as per the BioMP, are as follows:

- Mt Arthur Conservation Area (99 hectares);
- Saddlers Creek Conservation Area (431.3 hectares);
- Thomas Mitchell Drive Offset Area (on-site) (219.4 hectares);
- Thomas Mitchell Drive Offset Area (off-site) (495 hectares);
- Roxburgh Road 'Constable' Offset Area (109 hectares); and
- Middle Deep Creek Offset Area (1245.5 hectares).

In accordance with the modification project approval, long-term security for the Mt Arthur Coal biodiversity offset areas is provided through conservation agreements, formally registered on title.

Mt Arthur Coal undertakes annual flora and fauna monitoring to track progress against the BioMP and MOP objectives. The monitoring program tracks the condition of habitat areas over time and ensures that the BioMP's established performance indicators and project approval requirements are being met. The program includes 24 active monitoring sites throughout site woodland rehabilitation areas and remnant vegetation areas onsite and within offset areas. Remnant vegetation monitoring sites are used to assess mine impact and natural regeneration, as well providing reference data for comparative assessment of rehabilitation monitoring sites.

FY20 planting for all offset areas was delayed to early FY21 due to forecast conditions improving in the short term.

Weed Assessment and Treatment

Mt Arthur Coal conducted an annual weed assessment in FY20. This included:

- Remote sensing of transects across VD1 rehabilitation, operational areas adjacent the Enviro Dam and the Thomas Mitchell Onsite Offset;
- Rehabilitation specific weed assessment work completed by independent consultants as part of the Rehabilitation and Ecological Monitoring Program; and
- A whole of site weed survey.

The above work was combined into a site weed action plan to used to inform weed treatment works.

Mt Arthur Coal's weed treatment programs are guided by the *Hunter Regional Strategic Weed Management Plan 2017 – 2022* (Hunter Local Land Services, 2017). Mt Arthur Coal primarily targets Weeds of National Significance, as well as State Priority weeds and Regional Priority weeds for the Hunter Region, declared under the *Biosecurity Act 2015*.

Pest Animal Control

Feral animal presence is continually monitored through scheduled inspections and workforce feedback. Information from these sources is used to plan the feral animal control programs across the mine site and all biodiversity offset and conservation areas.

The vertebrate pest management program continued during the reporting period, with the annual campaign utilising 1080 baiting to target wild dogs (*Canis lupus familiaris*) and foxes (*Vulpes vulpes*). Additional programs introduced and conducted in FY20 included:

- Kangaroo harvesting in operational areas;
- A shooting program targeting wild dogs (*Canis lupus familiaris*), foxes (*Vulpes vulpes*), feral cats (*Felis catus*), rabbits (*Oryctolagus cuniculu*) and hares (*Leporidae lepus*);
- Rabbit and hare baiting program; and
- Live rabbit trapping using traps and ferrets.

Environmental Performance

The annual ecological development monitoring program, consisting of vegetation community assessment and fauna surveys, was undertaken in November/December 2019 by independent consultants. The annual survey assessed diversity and habitat condition across five sites in accordance with the rotational schedule of the monitoring program. Those sites consisted of:

- One rehabilitation site in the mine site woodland corridor (Dump 11[Export]);
- Two remnant revegetation reference sites in adjacent areas (ED1 and MACT); and
- One remnant revegetation and one natural revegetation reference site on the Roxburgh Offset (RX1 and RX2 respectively).

Four nest box monitoring locations were also monitored (MACT, TMD Onsite, Saddlers Creek and Mt Arthur).

Biodiversity Monitoring Results

Improvements were made to the Rehabilitation and Ecological Development Monitoring Program (REMP). The REMP was modified so that it can be better aligned or made more consistent to other Mt Arthur Coal monitoring requirements. Specifically, this includes:

- Ecological monitoring required within Conservation Agreement (CA) conservation areas that commenced in this reporting period;
- Aligning the collection of floristic plot data between the REMP and the CAs;
- Transitioning the methodology to the Biodiversity Assessment Method (BAM) for the REMP monitoring and CAs. BAM is the current methodology supported by the NSW Office of Environment and Heritage (OEH) under the NSW Biodiversity Conservation Act 2016; and
- Increasing the number of monitoring locations of existing rehabilitation monitoring sites whilst removing redundant sites (i.e. areas of rehabilitation that are scheduled to be re-disturbed in the future mine plan) from the monitoring schedule.

Results of flora and vertebrate fauna species for the monitoring sites are provided in Table 16, along with a condition assessment score, which indicates ecological health based on condition attributes such as dieback, canopy health,

erosion, vegetation patch shape, epicormic growth, weed invasion, mid strata native density, ground strata native density and connectivity of vegetation.

Results for the one rehabilitation site, a new monitoring area brought online this reporting period after reaching the requisite 3m in growth.

Table 16: Flora and fauna species recorded and condition assessment scores

Item	Rehabilitation Site	Reference Site			Reference (Regeneration) Site
Flora					
	Export	ED1	RX1	MACT	RX2
Native species (No.)	11	29	30	30	16
Native species (% of total)	50	97	86	86	64
Introduced species (No.)	11	1	5	5	9
Introduced species (% of total)	50	3	14	14	36
Total species	22	30	35	35	25
Total condition score out of 32	20 (63%)	27 (84%)	26 (81%)	25 (78%)	25 (78%)
Fauna					
Native Species					
Amphibians	0	0	1	0	0
Reptiles	1	4	5	1	3
Mammals*	1	15	15	5	10
Birds	9	21	21	10	24
Total No. of Native Species	11	40	42	16	37
Introduced Species					
Mammals	1	0	0	1	1
Total Species (Native and Introduced)	12	40	42	17	38
Total Threatened^	0	5	5	2	2

*Does not include migratory- or marine-listed species declared under the EPBC Act.

^Does not include introduced species

Dump 11 (Export)

This monitoring site is a rehabilitation site located in the east rehabilitation woodland corridor near Thomas Mitchell Drive. Rehabilitation of the site commenced prior to 1995; however, the target vegetation community being rehabilitated was unable to be verified. Based on the area being within the rehabilitation woodland corridor and consideration of the dominant canopy species (*Corymbia maculata* and *Eucalyptus blakelyi*) recorded, the rehabilitation area is most consistent with Central Hunter Ironbark – Spotted Gum – Grey Gum Forest. The monitoring site was established in FY20 and therefore FY20 represents the first monitoring event for this site.

The vegetation canopy is dominated by *Corymbia maculata* (Spotted Gum) and *Eucalyptus blakelyi* (Blakely's Red Gum) with trees up to 15 metres in height (15% cover). No small trees are present. The shrub layer is sparse with a cover of approximately 1% and a height of 0.5-3 metres tall. Native shrubs include regrowth canopy trees while exotic shrubs include *Gomphocarpus fruticosus* (Narrow-Leaved Cotton Bush) and *Opuntia stricta* (Common Prickly Pear). The ground layer has a cover of 65% that is dominated by exotic grasses and forbs up to 0.3 metres in height. Dominant exotic groundcovers include *Hyparrhenia hirta* (Coolatai Grass), *Panicum maximum* var. *maximum* (Guinea Grass), *Chloris gayana* (Rhodes Grass) and *Asphodelus fistulosus* (Onion Weed). Native groundcovers are

present in low numbers and include the grasses *Cymbopogon refractus* (Barbed Wire Grass), *Bothriochloa decipiens* var. *decipiens* (Pitted Bluegrass), *Rytidosperma setaceum* (Smallflower Wallaby Grass) and the forb *Sida corrugata* (Corrugated Sida).

The total fauna species diversity recorded at Export in FY20 was 12 species. The low species diversity is attributed to the area being on an exposed slope with limited foraging resources, few refugia sites and minimal connectivity to larger areas of habitat. No threatened fauna species were recorded at Export.

One introduced species was recorded and included the European Rabbit (*Oryctolagus cuniculus*).

ED1

This monitoring site is a reference site located within the Edderton Road Revegetation Area. The monitoring site was established in FY18 within Central Hunter Box-Ironbark Woodland (Box dominated) vegetation. FY20 represents the second monitoring event for this site.

The vegetation canopy is dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark). The canopy comprises trees up to 20 metres in height (30% cover) and includes younger regenerated trees with heights ranging from 8-14 metres. The shrub layer is sparse (approximately 2%) and between 0.5-3 metres tall, comprising regrowth *Eucalyptus crebra* (Narrow-leaved Ironbark), *Notelaea microcarpa* (Native Olive) and *Brachychiton populneus* (Kurrajong). The ground layer is characterised by a diverse and moderate cover (60%) of mixed native grasses and forbs up to 0.4 metres in height. This layer is dominated by the native *Aristida ramosa* (Purple Wiregrass), *Cymbopogon refractus* (Barbed Wire Grass), *Bothriochloa decipiens* var. *decipiens* (Pitted Bluegrass), *Calotis lappulacea* (Yellow Burr-daisy) and *Eremophila debilis* (Winter Apple). Exotic groundcovers include *Lepidium africanum* (Common Peppergrass).

The total fauna species diversity recorded at ED1 in FY20 was 40 species. The relatively high species diversity is attributed to moderate level of foraging resources and refugia sites due to the presence of logs, woody debris and hollow-bearing trees. The area also has connectivity to larger areas of habitat.

Five threatened species were recorded at ED1 and included the following:

- Eastern Bentwing-bat (*Miniopterus orianae oceanensis*) listed as Vulnerable under the BC Act;
- Eastern Cave Bat (*Vespadelus troughtoni*) listed as Vulnerable under the BC Act;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) listed as Vulnerable under the BC Act and EPBC Act;
- Southern Myotis (*Myotis macropus*) listed as Vulnerable under the BC Act; and
- Speckled Warbler (*Pyrrholaemus sagittatus*) listed as Vulnerable under the BC Act.

No introduced species were recorded at ED1.

RX1

This monitoring site is a reference site located at the Roxburgh Offset Area. The monitoring site was established in FY16 within Central Hunter Box-Ironbark Woodland (Ironbark dominated) vegetation. FY20 represents the third monitoring event for this site.

The vegetation canopy is dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark). The canopy comprises trees up to 15 metres in height (40% cover) and includes younger regenerated trees with heights ranging from 7-13 metres. The shrub layer is sparse (approximately 3%) and between 0.5-3 metres tall, comprising regrowth canopy trees and *Acacia paradoxa* (Kangaroo Thorn), *Notelaea microcarpa* (Native Olive) and *Brachychiton populneus* (Kurrajong). Exotic shrubs present include *Opuntia aurantiaca* (Tiger Pear) and *Lycium ferocissimum* (African Boxthorn). The ground layer is characterised by a diverse and moderate cover (55%) of mixed native grasses and forbs up to 0.3 metres in height. This layer is dominated by *Aristida ramosa* (Purple Wiregrass). Other native forbs and grasses include *Cymbopogon refractus* (Barbed Wire Grass), *Austrostipa scabra* (Speargrass), *Calotis lappulacea* (Yellow Burr-daisy), *Eremophila debilis* (Winter Apple) and *Stackhousia viminea* (Slender Stackhousia). Exotic groundcovers present include *Senecio madagascariensis* (Fireweed) and *Sida spinosa*.

The total fauna species diversity recorded at RX1 in FY20 was 42 species. The relatively high species diversity is attributed to moderate level of foraging resources and refugia sites due to the presence of logs, woody debris, and hollow-bearing trees. The area also has connectivity to larger areas of habitat.

Five threatened species were recorded at RX1 and included the following:

- Eastern Cave Bat (*Vespadelus troughtoni*) listed as Vulnerable under the BC Act;
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) listed as Vulnerable under the BC Act;
- Eastern Freetail-bat (*Mormopterus norfolkensis*) listed as Vulnerable under the BC Act;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) listed as Vulnerable under the BC Act and EPBC Act; and
- Southern Myotis (*Myotis macropus*) listed as Vulnerable under the BC Act.

No introduced species were recorded at RX1.

RX2

This monitoring site is a natural regeneration site located at the Roxburgh Offset Area. The monitoring site was established in FY16 within Central Hunter Box-Ironbark Woodland (Ironbark dominated) (State 2) vegetation and thus comprises derived native grassland vegetation dominated by a mix of native ground cover species. FY20 represents the third monitoring event for this site.

The is monitoring site lacks a canopy but includes scattered low shrubs (2% cover to 1.5m tall) of *Maireana microphylla* (Small-leaf Bluebush) and weeds such as *Lycium ferocissimum* (African Boxthorn) and *Opuntia stricta* (Common Prickly Pear).

The ground cover is dense (approximately 90%) and typically less than 50 cm tall. It is dominated by the native species *Aristida ramosa* (Purple Speargrass) and *Panicum effusum* (Hairy Panic). Other native grasses and forbs were also recorded, including *Chloris ventricosa* (Plump Windmill Grass) and *Vittadinia cuneata* (Fuzzweed). Exotic groundcovers present include *Plantago lanceolata* (Lamb's Tongue), *Asphodelus fistulosus* (Onion Weed) and *Carthamus latus* (Saffron Thistle).

The total fauna species diversity recorded at RX2 in FY20 was 38 species. Although the monitoring site is within open grassland, the relatively high species diversity is attributed to the monitoring site being located adjacent to woodland habitat that contains a moderate level of foraging resources and refugia sites due to the presence of logs, woody debris, and hollow-bearing trees. The adjacent woodland habitat also has connectivity to larger areas of habitat.

Two threatened species were recorded at RX2 and included the following:

- Eastern Bentwing-bat (*Miniopterus orianae oceanensis*) listed as Vulnerable under the BC Act; and
- Southern Myotis (*Myotis macropus*) listed as Vulnerable under the BC Act.

One introduced species was recorded and included the European Rabbit (*Oryctolagus cuniculus*).

MACT

This monitoring site is a reference site located near the Bayswater Rail-loading Facility along Thomas Mitchell Drive, approximately 3 kilometres east of the Mt Arthur access road. The monitoring site was established in 2007 within Grey Box - White Box- Ironbark - Blakely's Red Gum vegetation. FY20 represents the fifth monitoring event for this site.

The vegetation canopy includes *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus blakelyi* (Blakely's Red Gum) and *Eucalyptus albens x moluccana* (White Box – Grey Box Intergrade). The canopy comprises trees up to 18 metres in height (40% cover) and includes younger regenerated trees with heights ranging from 8-14 metres. The shrub layer is sparse (approximately 5%) and between 0.5-5 metres tall, comprising regrowth canopy trees and *Acacia paradoxa* (Kangaroo Thorn) and *Acacia falcata* (Hickory Wattle). Exotic shrubs present include *Opuntia stricta* (Common Prickly Pear). The ground layer is characterised by a diverse and moderate cover (65%) of mixed native grasses and forbs up to 0.4 metres in height. This layer is dominated by *Aristida ramosa* (Purple Wiregrass) and *Cymbopogon refractus* (Barbed Wire Grass). Other native forbs and grasses include *Austrostipa scabra* (Speargrass), *Calotis lappulacea* (Yellow Burr-daisy), *Eremophila debilis* (Winter Apple) and *Stackhousia viminea* (Slender Stackhousia). Exotic groundcovers present include *Sida rhombifolia* (Paddy's Lucerne), *Richardia stellaris* and *Conyza bonariensis* (Flaxleaf Fleabane).

The total fauna species diversity recorded at MACT in FY20 was 17 species. Although the area has connectivity to larger areas of habitat, contains a moderate level of foraging resources and refugia sites in the form of logs, woody

debris and hollow-bearing trees, the low species diversity is attributed to the area being exposed to edge effects as it is located between the rail corridor, Thomas Mitchell Drive and an access road.

Two threatened species were recorded at MACT and included the following:

- Eastern Bentwing-bat (*Miniopterus orianae oceanensis*) listed as Vulnerable under the BC Act; and
- Southern Myotis (*Myotis macropus*) listed as Vulnerable under the BC Act.

One introduced species was recorded and included the European Rabbit (*Oryctolagus cuniculus*).

Nest Box Monitoring Results

Nest box monitoring was conducted at MACT, TMD Onsite, Saddlers Creek and Mt Arthur in FY20. Table 17 contains a summary of the nest box occupancy rates recorded in FY20.

The results of the FY20 nest box monitoring were broadly comparable with the previous year of monitoring. Fluctuations in fauna diversity and abundance as observed through monitoring are considered to be natural variations and/or a result of the current condition of the nest boxes, and not attributable to mining-related activities.

Overall, the condition of the nest boxes monitored in FY20 was considered to be low with 14 boxes or approximately 25% of boxes requiring replacement or repair. This is an increase of nest boxes requiring replacement or repair identified in the FY18 and FY19.

A summary of the next box monitoring for each site is provided below.

Table 17: Nest box occupancy rates and species

Nest Box Site	Number of Nest Boxes	Number of Nest Boxes Occupied	Occupancy Rate (%)
MACT	14	3	21
TMD Onsite	6	1	17
Saddlers Creek	8	0	0
Mt Arthur	25	13	52

Assessment against MOP Completion Criteria

Export is located within Domain D Rehabilitation – Native Woodland. Vegetation at this site is at least 24 years old. It is considered that rehabilitation at Export is now at Phase 4 Ecosystem and Landuse Establishment.

An assessment of the rehabilitation site Export against specific performance and completion criteria for rehabilitated vegetation is shown in Table 18 and is taken from the MOP.

The conservation and offset areas are intended to be set aside and be naturally regenerated and/or revegetated to improve ecological values, threatened ecological communities and habitat for threatened species. The remnant vegetation monitoring sites established in the conservation and offset areas are also used as references sites against which rehabilitation sites can be measured.

Performance indicators relevant to the first four years of management of the conservation and offset areas are provided in the MOP under Domain F - Onsite Conservation and Offset Areas. Note that although the MOP specifies “onsite” Conservation and Offset Areas, the same criteria are considered to apply to offsite offset areas, such as the Roxburgh Offset Area. The compliance with these performance indicators and the relevant management actions in the BioMP is evaluated in Table 19. Compliance with the broader scope and requirements of the BioMP will be evaluated through the Independent Environmental Audit and/or Biodiversity Audit process.

Table 18: Status of rehabilitation sites against MOP completion criteria

Relinquishment Criteria	Export (Domain D)
Phase – 4. Ecosystem and Landuse Establishment	
All areas shown as Native Woodland vegetation community in Plan 4, planted with a native species mix (seed or tubestock) targeted at establishing an open grassy woodland vegetation community.	Partially compliant for isolated stand of woodland at this monitoring site. On a whole of site basis, this criterion will not be fully compliant until all rehabilitation has been undertaken in the woodland corridor.
Rehabilitation species composition (seedmix or tubestock) drawn from the species list in Section 7.2 for Central Hunter Box – Ironbark Woodland or Central Hunter Ironbark - Spotted Gum – Grey Box Forest	Partially compliant with Central Hunter Ironbark - Spotted Gum – Grey Box Forest. Site lacks ironbark and box canopy species on species list and contains no shrub species and minimal groundcover species listed on species list.
All structural dominant species represented compared with analogue site	Not compliant
The diversity, percentage and density of shrubs and juvenile trees with a stem diameter <5cm is comparable to that of the local remnant vegetation.	Not compliant
The total number of live native plant species is greater than or comparable to the local remnant vegetation	Not compliant
The number of tree, shrub and sub-shrub species is comparable to that of the local remnant vegetation	Not compliant
Species composition for revegetation will be aimed at establishing a complex community structure consisting of groundcover, understory and canopy.	Not compliant. Species composition planted is unknown, but community structure is not complex.
Nesting boxes (various bird, squirrel glider, possum and bat) and natural habitat features (including large rocks, logs/coarse woody debris, hollow bearing timber) are placed in established native woodland rehabilitation.	Not compliant
Number of weed species and surface area comparable to reference sites	Not compliant
Program implemented for fuel load assessment and reduction, with advice from NSW Rural Fire Service	Unknown
Pest animal infestation comparable to reference sites, with ongoing control program in place.	Compliant
Where adjacent to selected grazing or operational mining land, adequate fencing and signage is installed and maintained to prevent unintentional vehicle and livestock access.	Compliant
Rehabilitated native vegetation distribution will link areas of onsite and near-site native vegetation and be consistent with the biodiversity corridors consistent with the latest version of the DRE Synoptic Plan.	Compliant

Relinquishment Criteria	Export (Domain D)
The Box-Gum reestablishment area based on the north-eastern slope of Visual Dump 1, and shown on Plan 4, will be established with a species mix (seed or tubestock) drawn from the species list presented in Section 7.2 for Central Hunter Box - Ironbark Woodland or Central Hunter Ironbark - Spotted Gum – Grey Box Forest.	N/A

Table 19: Status of remnant vegetation sites against MOP completion criteria and BioMP management actions

	RX1	RX2
MOP Relinquishment Criteria for Phase – 5. Ecosystem and Landuse Sustainability (for Domain F – Onsite Conservation and Offset Areas)		
Compliance with management actions presented in the site Biodiversity Management Plan, as evidenced through the most recent Independent Environmental Audit and/or Biodiversity Audit.	Unknown	Unknown
BMP Section 5.1 – Offset Area Revegetation/Regeneration Works		
Natural regeneration encouraged and facilitated through livestock exclusion, fencing and access control, weed and pest management and bushfire management	Compliant	Compliant (natural regeneration phase)
All active revegetation works will be designed with structural and floristic diversity suitable to meet the benchmark vegetation community targets	N/A – no active revegetation required at this stage.	N/A – no active revegetation required at this stage.
All active revegetation will involve use of local provenance seed.	N/A – no active revegetation required at this stage.	N/A – no active revegetation required at this stage.
Revegetation areas will be subject to a monitoring program developed.	N/A – no active revegetation required at this stage.	N/A – no active revegetation required at this stage.
BMP Section 5.2 – General Offset Area Management Measures		
Fencing will only be used within the offset and conservation areas to replace existing fencing, or where potential vegetation disturbance by land use impacts warrants additional protection	Compliant	Compliant
Identification of areas with potential for impact on ecological values from human, vehicle or stock access	Compliant	Compliant
Fencing will be used to delineate those areas that are being actively regenerated, to exclude grazing impacts and allow vegetation to regenerate naturally	N/A – no active revegetation required at this stage.	N/A – no active revegetation required at this stage.
Appropriate signage will be used at key access points to the offset and conservation area to identify that the areas are of high ecological significance.	Not compliant	Not compliant

	RX1	RX2
A weed control program has been implemented to limit the spread and colonisation of noxious and environmental weeds at the Mt Arthur Coal Complex.	Compliant. However, additional focus recommended for <i>Opuntia stricta</i> (Common Prickly Pear) and <i>Hyparrhenia hirta</i> (Coolatai Grass)	Compliant. However, additional focus recommended for <i>Senecio madagascariensis</i> (Fireweed), <i>Opuntia stricta</i> (Common Prickly Pear) and <i>Lycium ferocissimum</i> (African Boxthorn).

Weed Control

FY20 weed assessment work consisted of the following elements

- Aerial Assessment: High resolution image processing of data collected by Unmanned aerial vehicle (UAV) of transects across VD1 rehabilitation, operational areas adjacent the Enviro Dam and the Thomas Mitchell Onsite Offset (results presented in Appendix 6);
- Biodiversity monitoring weed assessment work completed by independent consultants as part of the Rehabilitation and Ecological Monitoring Program and Conservation Agreement monitoring; and
- A whole of site weed survey.

All this work was combined into a Weed Management Action Plan. This represents a focus on independent advice and an increased effort in the assessment process to obtain measurable data.

Aerial Assessment data allows individuals of each species and plot changes in numbers over time. The original flyover occurred in May 2019 with three transects of approximately 10ha flown: one over operational area to the west of the Enviro Dam (Transect 3) and two transects across the VD1 (Transects 1 and 2) rehab. Data indicated that prickly pear and boxthorn were the species to focus on and were the species treated in FY19. The monitoring completed in May 2020 substituted one transect flown over VD1 with a new transect over the Thomas Mitchell Drive Onsite Offset (Transect 4). Comparison with the FY19 data indicated that the FY19 and FY20 treatment programs were successfully controlling Prickly Pear with 29% reduction in transect 2 VD1 rehab) and an 81% reduction in transect 3 (the Operational Area). The difference in reduction rates is explained by differing methodologies used by two different contractors have variable success. African Boxthorn results were more varied with an 11% reduction on VD1 and a 5% increase in the Operational Area transect. The difference can be explained due to a delay in treatment in the vicinity of the Operational Area transect to source a better methodology for treatment. Following the flyover a remotely operated forestry mulcher was sourced to treat thick patches. Other key species identified for focus of treatment from the FY20 assessment:

- Galenia (*Galenia pubescens*)
- African Turnip weed (*Sisymbrium thellungii*).
- Blue heliotrope (*Heliotropium amplexicaule*);
- Cotton bush (*Gomphocarpus sp.*);

The reason for the increased prevalence of the above weed species is believed to be the result of increased rainfall in FY20, giving these fast growing species the opportunity to germinate over the reporting period.

As a result of the above monitoring the weed treatment program for FY20 was increased. The following weed species were targeted during the reporting period:

- African boxthorn (*Lycium ferocissimum*);
- Prickly Pear (*Opuntia stricta*);
- Tiger pear (*Opuntia aurantiaca*);
- Blue heliotrope (*Heliotropium amplexicaule*);
- Mother of millions (*Bryophyllum* species)
- Bathurst burr (*Xanthium spinosum*)
- Marshmallow weed (*Malva parviflora*)
- Artichoke thistle (*Cynara cardunculus* L.)
- Sweet briar (*Rosa rubiginosa*)
- Cobblers pegs (*Bidens pilosa*)
- Cotton bush (*Gomphocarpus sp.*);
- Galenia (*Galenia pubescens*)
- Silver-leaved Nightshade (*Solanum elaeagnifolium*); and
- African Turnip weed (*Sisymbrium thellungii*).

Mt Arthur Coal targeted over 442 hectares of land for weed treatment during the reporting period, an increase of 50 hectares in the previous reporting period. The treatment focused in the north eastern portion of the site, including the VD1 and CD1 rehabilitation areas, operational area surrounding the Environmental Dam and western areas of the site off of Edderton Rd. Weed treatment for Biodiversity Offset Areas treated for included:

- Thomas Mitchell Drive Onsite Offset Area
- Thomas Mitchell Drive Offsite Offset Areas
- Saddlers Creek Offset Area
- Middle Deep Creek Offset Area

Refer to Appendix 6 for figures showing weed treatment locations.

Pest Animal Control

During June 2020 a 1080 baiting campaign with the intent of targeting wild dog and fox baiting was completed across the Mt Arthur Coal mine site and adjacent conservation areas. During the campaign 150 baits were laid across 50 locations, with 17 baits taken. Table 20 shows the breakdown of species and baits taken.

Table 20: 1080 Baiting control program results for FY20

Species	Count
Fox	5
Wild Dog	8
Feral Pig	1

Additional rabbit control programs were undertaken in FY20 targeting all rehabilitation areas across site. The results of these programs are presented in Table 21. Mt Arthur Coal has continued the trial into the use of ferrets in the trapping of rabbits with improvements from the FY20 program. The trial is on hold while during a contractor management review.

Table 21: Rabbit control program results for FY20

Methodology	Count
Baiting	20
Trapping	29

Kangaroo harvesting continued at Mt Arthur Coal in FY20 within operational areas. The program humanely destroyed 12 kangaroos, providing over 521 kilograms of consumable meat. The program is on hold due to operational changes requiring a review into how to complete the work safely.

Complaints and Reportable Incidents

There were no biodiversity complaints received in FY20. Mt Arthur Coal did not receive any government fines or penalties related to flora and fauna during the reporting period and there were no related reportable incidents.

Proposed Improvements

Mt Arthur Coal will continue to implement the REMP during the next reporting period, with monitoring of woodland rehabilitation, remnant woodland community sites and revegetation/regeneration areas within conservation areas. Mt Arthur Coal will also continue to implement annual landform stability assessments of existing rehabilitation in the next reporting period. Investigate the use of remote sensing in the assessment of landform stability as part of the review of the REMP and complete the review of the aerial weed assessment.

Mt Arthur Coal will continue removing waste items and repairing sections of fence that require maintenance in conservation and biodiversity offset areas during the next reporting period.

During the next reporting period, Mt Arthur Coal will also implement another vertebrate pest management program on site and across all conservation and offset areas. Improvements in the management of rabbits will be a particular focus, with expanded shooting, trapping and baiting programs to be completed.

6.6 Visual Amenity and Lighting

Environmental Management

Visual amenity and lighting management at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-PRO-071 Visual Assessment Procedure;
- MAC-PRD-PRO-073 Procedure for Lighting Plant Movement and Setup; and
- MAC-ENC-PRO-077 Light Management Procedure.

Mt Arthur Coal's visual assessment procedure ensures overburden emplacement development is monitored and assessed against modelled predictions in the environmental assessment.

Management measures presented in the Light Management Procedure aim to control and reduce the impact of lighting on the surrounding area. The procedure is used in conjunction with the procedure for lighting plant movement and setup, which advises operational staff on correct alignment of lights to avoid offsite impact.

Environmental Performance

Visual impact inspections were completed in July and November of 2019 and January and April 2020. Inspections indicated that locations to the east of Mt Arthur Coal have extensive views of rehabilitated overburden dumps, with reduced visual contrast to surrounding non-mined landforms and peripheral visual impact from active mining activities. From locations to the north and west, a distinct visual contrast between mining activity and the surrounding non-mined landscape is evident due to exposure to low wall overburden dumps. For all locations the shape and size of the overburden dumps are within the predicted model shown in the environmental assessment.

Complaints and Reportable Incidents

During the reporting period, 18 lighting complaints were received from three complainants, which is lower than FY19 (23 complaints). On notification of the complaints, immediate action was taken to locate and redirect the offending lights, in response to addressing the complainant's concerns. These complaints are discussed further in Section 9.

Mt Arthur Coal did not receive any government fines or penalties related to lighting or visual amenity during the reporting period and there were no related reportable incidents.

Proposed Improvements

During the reporting period Mt Arthur Coal continued to incorporate fluvial geomorphic principles into the design of overburden emplacements. Rehabilitated landforms were reshaped to facilitate natural surface flow processes, resulting in a final shape that more closely mimics the adjacent non-mined landscape and reduces visual impact. This process will be developed further in subsequent reporting periods.

Lighting from Mt Arthur Coal will continue to be implemented in accordance with the Light Management Procedure and managed to minimise impacts on the local community whilst maintaining the minimum level necessary for operational and safety needs.

6.7 Aboriginal Cultural Heritage

Environmental Management

Aboriginal cultural heritage at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-MTP-042 Aboriginal Heritage Management Plan.

Mt Arthur Coal has implemented a management plan that provides the framework to identify, assess, monitor, conserve and manage Aboriginal cultural heritage. The management plan assists Mt Arthur Coal to mitigate the impacts of its operations on Aboriginal cultural heritage, comply with the requirements of the *National Parks and Wildlife Act 1974*, *Environmental Planning and Assessment Act 1979* and the modification project approval and continue its active partnership with the Aboriginal community.

Environmental Performance

Minor survey and / or salvage activities were also successfully completed and recorded during the reporting period for the following site works in accordance with the methodology detailed in the Aboriginal Heritage Management Plan:

- Edderton Road Windmill Project - EME Pad & Secondary Access Road
- Windmill Project 11kv & 66kv Power Pole Installation
- Legacy Drill Rehabilitation: Stage 1 due diligence, Stage 2 field inspection, Stage 3 salvage
- Ground Water Monitoring bores & Vibrating Wire Piezometers
- Construction of Pit Dump Haul Road
- Saddlers Central Expansion
- Saddlers Central Topsoil Stockpile and Legacy Survey Area
- Off Lease Hydrogeological Drilling

Complaints and Reportable Incidents

Mt Arthur Coal did not receive any complaints, government fines or penalties related to Aboriginal cultural heritage during the reporting period and there were no related reportable incidents.

Proposed Improvement

A major review of the Mt Arthur Coal cultural heritage management plan commenced in March 2020 and will be completed during the next reporting period, as agreed in consultation with the DPIE, to update the disturbance boundary, cultural heritage site data as well as information about the grinding groove relocation. Visual inspections of the other grinding grooves will be undertaken.

6.8 European Cultural Heritage

Environmental Management

European cultural heritage at Mt Arthur Coal is managed in accordance with the:

- MAC-ENC-MTP-046 European Heritage Management Plan;
- MAC-ENC-MTP-048 Edinglassie and Rous Lench Conservation Management Plan - Volume 1;
- MAC-ENC-MTP-049 Edinglassie and Rous Lench Conservation Management Plan - Volume 2; and
- MAC-ENC-PRG-004 Edinglassie and Rous Lench Heritage Management Program.

Mt Arthur Coal has implemented several management plans that provide the framework to identify, assess, monitor, conserve and manage European cultural heritage. Mt Arthur Coal owns and manages five heritage-listed homesteads as follows:

- Edinglassie Homestead (state significance);
- Rous Lench Homestead (state significance);
- Edderton Homestead Complex (local significance);

- Belmont Homestead Complex (local significance); and
- Balmoral Homestead (local significance).

The two State-significant historic heritage items with possible impacts from the Mt Arthur Coal operation are the Edinglassie and Rous Lench homesteads.

The European heritage management plan assists Mt Arthur Coal to coordinate and manage the European heritage items affected or potentially affected by its operations, comply with the requirements of the *Heritage Act 1977* and the modification project approval and mitigate impacts of its operations on European cultural heritage.

Environmental Performance

During the reporting period, Mt Arthur Coal inspected all of its historic homesteads and related buildings located on freehold land to ensure properties were maintained to an acceptable standard.

Complaints and Reportable Incidents

Mt Arthur Coal did not receive any complaints, government fines or penalties related to European cultural heritage during the reporting period and there were no related reportable incidents.

Proposed Improvements

All heritage structures are planned to remain in situ during the next reporting period with no impacts predicted from the current mine plan. Inspections and maintenance measures will continue to be implemented during the next reporting period to conserve all historic homesteads and related buildings owned by Mt Arthur Coal.

6.9 Contaminated Land and Hydrocarbon Contamination

Environmental Management

Contaminated land at Mt Arthur Coal is managed in accordance with the following internal documents:

- MAC-ENC-PRO-028 Storage of Fuels and Chemicals;
- MAC-ENC-PRO-029 Spill Response;
- MAC-ENC-PRO-074 Contaminated Land Management; and
- MAC-STE-PRO-013 Hazardous Materials Management Procedure.

Hydrocarbons and other hazardous substances are kept in designated storage compounds designed and managed in accordance with relevant standards and procedures. Monitoring and inspection programs are maintained for these facilities to ensure hazardous materials and wastes are being adequately stored and disposed of and that any spills or leaks are promptly reported and managed.

Environmental Performance

During the reporting period, all spills were controlled and contained immediately using emergency spill kits or earthmoving equipment to form a temporary bund. Small spills were disposed of offsite by Mt Arthur Coal's waste contractor. Mt Arthur Coal is considering options regarding management of larger scale contaminated soils on site.

Complaints and Reportable Incidents

Mt Arthur Coal did not receive any complaints, government fines or penalties related to contaminated land or hydrocarbon contamination during the reporting period and there were no related reportable incidents.

Proposed Improvements

Mt Arthur Coal will continue to manage contaminated land and hydrocarbon contamination in accordance with project approval and legislative requirements.

6.10 Spontaneous Combustion

Environmental Management

Spontaneous combustion at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-PRG-002 Spontaneous Combustion Control Program.

Mt Arthur Coal has implemented a spontaneous combustion control program to prevent, monitor, control and report outbreaks of spontaneous combustion.

Environmental Performance

Spontaneous combustion at Mt Arthur Coal is predominantly confined to old mining areas at Bayswater No. 2 and the Drayton sublease area. This is a result of the higher levels of carbon and sulphuric material in the coal seams mined in these Greta measures in comparison to those mined in current active mining areas.

During the reporting period there was an increase in the area recorded as being affected by spontaneous combustion at Mt Arthur Coal. A total of 3776 m² of land was treated for spontaneous combustion in the reporting period. A summary of spontaneous combustion in the reporting period is shown in Table 22.

The increase may be attributed to a number of things:

- Improved monitoring and survey with the implementation of drone technology for spontaneous combustion survey. This has also lead to an increase in treatment.
- There is more active mining in the southern portion of the operations. These areas are related to the Bayswater No.2 and Drayton Sublease area. These areas are generally managed quickly as they are within active mining areas so are treated with active pit progression.
- The list to the tailings dam wall has lead to exposure of spontaneous combustion prone material. These areas are being actively monitored and are schedule to be covered with the second stage lift of the wall.

Table 22: Summary of spontaneous combustion at Mt Arthur Coal in FY20

Month	Area affected at start of month (m ²)	Area naturally extinguished (m ²)	Area treated (m ²)	New or recurring areas (m ²)	Area affected at end of month (m ²)
July	2246	0	0	504	2750
August	2750	0	1282	290	1758
September	1758	0	4	9	1763
October	1763	0	12	0	1751
November	1751	0	0	0	1751
December	1751	0	0	76	1827
January	2246	0	0	1651	3478
February	3478	0	155	4037	7360
March	7360	0	0	5	7365
April	7365	0	1140	1101	7326
May	7326	0	1101	1814	8039
June	8039	0	82	2036	10201
Total		0	3776	11524	

Complaints and Reportable Incidents

During the reporting period, one complaint was received regarding odour from spontaneous combustion. This complaint is discussed further in Section 9.

Mt Arthur Coal did not receive any government fines or penalties related to spontaneous combustion during the reporting period.

Proposed Improvements

Mt Arthur Coal will continue to monitor spontaneous combustion during the next reporting period, and cap readily accessible areas.

In accordance with the approved mine operations plan, overburden material will continue to be emplaced over current emplacement areas at Bayswater No. 2. This will be carried out in alignment with the design of the extension of the existing tailings storage facility, which is planned to encompass most of this area, and will ultimately treat a significant portion of identified spontaneous combustion areas.

6.11 Bushfire

Environmental Management and Performance

Bushfire at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-PRO-076 Bushfire Prevention Procedure (internal document); and
- MAC-STE-PRO-010 Emergency Procedure – Bushfires (internal document).

Specific prevention and fire suppression control measures are implemented in order to protect remnant vegetation communities as well as Mt Arthur Coal infrastructure. Preventative measures include fuel load assessment and reduction programs, the establishment and maintenance of fire breaks and the prevention of ignition sources. Fire suppression and control is achieved through on-site fire-fighting equipment, including a rescue truck and water carts, facilitated by a network of roads and vehicle access trails, which provide access to all areas of Mt Arthur Coal owned land. Mt Arthur Coal also maintained a trained emergency response team on each shift, and fire extinguishers are fitted in vehicles and buildings.

No grass or bushfires occurred on site or at the conservation or offset areas during the reporting period.

Complaints and Reportable Incidents

Mt Arthur Coal did not receive any complaints, government fines or penalties related to bushfire during the reporting period and there were no related reportable incidents.

Proposed Improvements

During the next reporting period Mt Arthur Coal will continue to manage bushfire risk in accordance with relevant procedures.

6.12 Greenhouse Gas and Energy

Environmental Management

Greenhouse gas and energy at Mt Arthur Coal are managed in accordance with the MAC-ENC-MTP-040 Air Quality Management Plan.

Mt Arthur Coal undertakes regular reviews and monitoring of greenhouse gas emissions and energy efficiency initiatives to ensure that greenhouse gas emissions per tonne of product coal are kept to the minimum practicable level. During the reporting period Mt Arthur Coal continued greenhouse gas and energy consumption monitoring with the use of a centralised database to assist with monthly tracking and reporting of key emission sources. A key focus during the reporting period was to ensure the operation complied with the regulations under the *National Greenhouse and Energy Reporting (NGER) Act 2007*.

Environmental Performance

Total emissions were 605 kt CO₂-e in the FY20 reporting period, of which direct (scope 1) emissions accounted for 87 per cent, and scope 2 emissions from the use of grid-based electricity accounted for the remaining 13 per cent. As in the previous reporting period, Mt Arthur Coal used NGER Method 2 measurement of its open fugitive emissions, which increased in absolute terms (to 45 kt CO₂-e) and as a proportion of total scope 1 emissions (nine per cent). Fugitive emissions are expected to continue increasing over time as mining progresses into areas with higher in-situ methane contents.

Fuel combustion will continue to constitute the bulk of emissions from Mt Arthur Coal, accounting for 91 per cent of scope 1 emissions and 80 per cent of total emissions in the reporting period. Energy use was similarly dominated by diesel fuel (95 per cent), with other fuels accounting for one per cent and electricity making up the balance.

Complaints and Reportable Incidents

Mt Arthur Coal did not receive any complaints, government fines or penalties related to greenhouse gas or energy during the reporting period and there were no related reportable incidents.

Proposed Improvements

BHP is committed to reducing its operational emissions globally and has established a company-wide short-term target to maintain FY2022 emissions at or below FY2017 levels while it continues to grow its business. The company also has set a longer term goal of achieving net-zero operational GHG emissions in the latter half of this century, consistent with the Paris Agreement. In 2019, BHP announced a five-year US\$400M Climate Investment Program to support funding of initiatives to reduce the company's operational emissions and those related to its value chain.

Mt Arthur Coal will continue to investigate and, where feasible, implement projects to reduce fossil fuel energy consumption and greenhouse gas emissions in accordance with BHP's sustainability commitments, including the company's greenhouse gas emission targets.

6.13 Waste Management

Environmental Management

Waste at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-PRO-033 Waste Handling and Disposal (internal document).

Environmental Performance

During the reporting period Mt Arthur Coal's activities, generated approximately 3977 tonnes of both recycled and non-recycled waste sent off site for management. This is a decrease of approximately 26% per cent on the FY19 total of 5,444 tonnes. Approximately 2,962 tonnes (74 per cent) of the total waste produced and sent off site for management was recycled during the reporting period, as shown in Figure 4. This is consistent with the FY19 percentage recycled off site total of 4,457 tonnes (82 per cent).

Complaints and Reportable Incidents

Mt Arthur Coal did not receive any complaints, government fines or penalties related to waste during the reporting period and there were no related reportable incidents.

Proposed Improvements

During the next reporting period Mt Arthur Coal will continue to manage waste in accordance with relevant procedures.

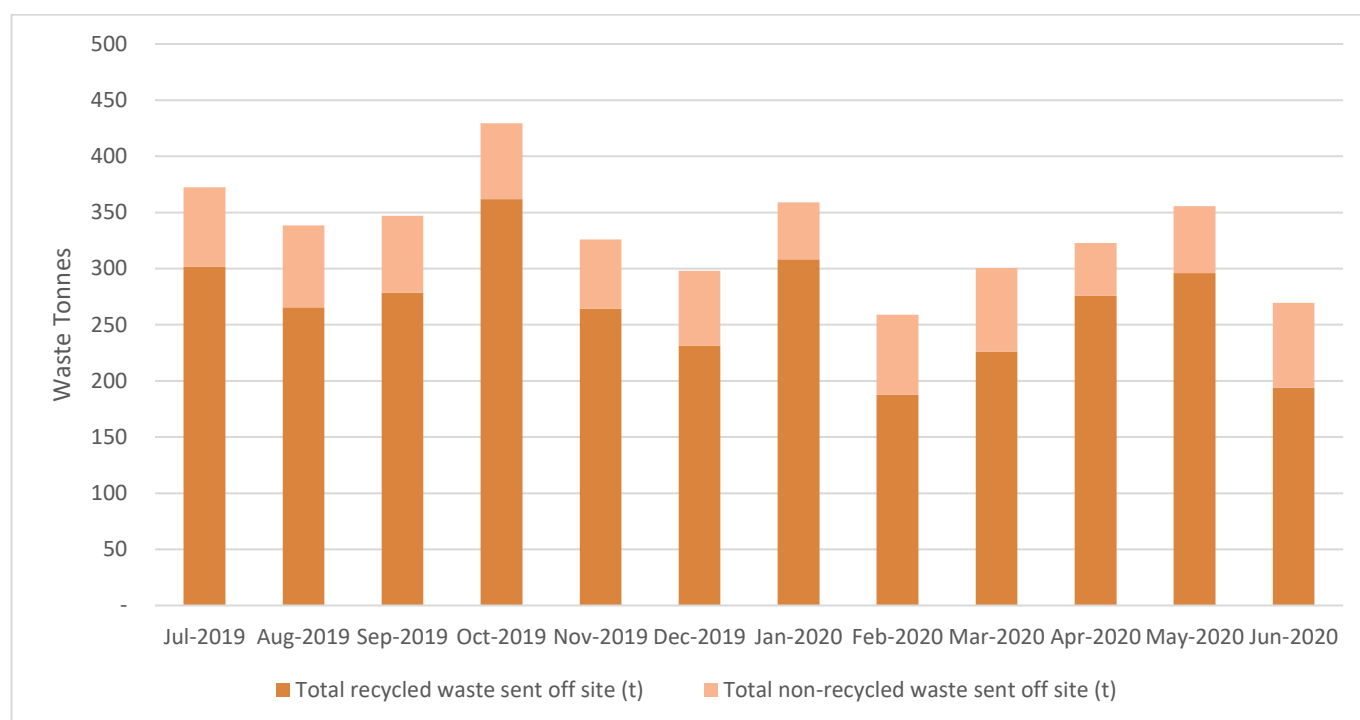


Figure 4: Waste disposal from Mt Arthur Coal

6.14 Public Safety

Environmental Management / Performance

During the reporting period Mt Arthur Coal maintained a boundary security fence around much of the perimeter of its site to ensure no unauthorised access to mining areas. A number of boom gates also exist to restrict unauthorised or unintentional access to the active mining and infrastructure areas. Routine patrols of these boundaries and access points are conducted through the engagement of third party security specialists and by internal statutory compliance personnel with no identified security or access breaches occurring during the reporting period.

During the reporting period Mt Arthur Coal maintained a permanent emergency response team consisting of BHP Emergency Services Officers and Paramedics. These personnel, along with the existing volunteer emergency response team, provide a professional emergency response service to site. The team are dedicated to ongoing continuous improvement, standardisation and preventative work.

Complaints and Reportable Incidents

Mt Arthur Coal did not receive any complaints, government fines or penalties related to public safety during the reporting period and there were no related reportable public safety incidents.

Proposed Improvements

Mt Arthur Coal will continue to maintain and monitor site security and ensure public safety during the next reporting period.

7. Water Management

7.1 Water Balance

Mt Arthur Coal maintains a site water balance model incorporating surface and groundwater inputs and outputs. The model is used to interpret current conditions and forecast future mine water inventories and use. The model build generally aligns to the Minerals Council of Australia Water Accounting Framework.

Mt Arthur Coal did not discharge water into the Hunter River from its licensed discharge point under the Hunter River Salinity Trading Scheme (HRSTS) during the reporting period.

Water use totaled 8,100 ML during the reporting period. The use is a total of model outputs including evaporation, product entrainment and task loss. This is an increase in water usage compared to the 7,200 ML used in FY19. The change in water use is primarily related to increased dust suppression use as a result of climatic conditions.

The largest input to site is typically rainfall as outlined in the modification project environmental assessment, however this was not the case during the reporting period due to ongoing drought conditions and depletion of stored water on site. The largest input to the site was licensed extraction from the Hunter River of approximately 4,509 ML, as shown in Table 23.

Mt Arthur Coal continued to source water from the Muswellbrook Shire Council treated effluent scheme to reduce the demand from other external sources. An estimated 700 ML of recycled effluent was brought onto site for reuse in site operations. This supply contract renewal is anticipated to be executed early in the next reporting.

Table 23: Water take for FY20

Water Licence number	Water sharing plan, source and management zone	Entitlement (Unit Shares)	Passive take / inflows (ML)	Active pumping (ML)	Total (ML)
WAL 917	Hunter Regulated River Water Source (High Security), Zone 1A Management Zone	2,197	-	1,686.9	1686.9
WAL 918	Hunter Regulated River Water Source (General Security), Zone 1A Management Zone	3,564	-	3,060.5	3,060.5
WAL 1296	Hunter Regulated River Water Source (Supplementary), Zone 1A Management Zone	301	-	0	0
WAL 18141	Hunter Regulated River Alluvial Water Source, U/S Glennies Creek Management Zone	104	50*	-	50*
WAL 18247	Hunter Regulated River Alluvial Water Source, U/S Glennies Creek Management Zone	247	191*	-	191*
WAL 41495	Sydney Basin-North Coast Groundwater Source	750	750^	-	750^
WAL 41556	Sydney Basin-North Coast Groundwater Source	250	58^	-	58^

* Alluvial inflow has been calculated, based on predicted flux to and from alluvium (ML/day) as reported in the EIS, to be a total of 241 ML, which has been allocated across the two alluvial licences.

^ Groundwater seepage has been calculated, based on predicated average inflow to the pits (ML/day) as reported in the EIS, to be a total of 808 ML, which has been allocated across the two groundwater licences.

Proposed Improvements

Mt Arthur Coal will continue to use site water collected in both in-pit and out-of-pit storages prior to the use of water from the Hunter River. Where plans indicate that there would be sufficient water stored on site, water allocations for the Hunter River will continue to be offered to leaseholders and near neighbours as a temporary transfer.

7.2 Erosion and Sediment

Environmental Management

Erosion and sediment at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-PRO-060 Erosion and Sediment Control Plan;
- MAC-ENC-PRO-061 Surface Water Monitoring Program; and
- MAC-ENC-PRO-063 Surface and Ground Water Response Plan.

Environmental Performance

Total suspended solids (TSS) results remained low during the reporting period at the majority of statutory sites with below average rainfall limiting the number of samples collected as monitoring points were recorded as dry or water level was too low to sample. The TSS results were mostly consistent compared with results from previous financial years. TSS results are summarised in Table 25, with further results presented in Appendix 1 – Surface Water Quality Monitoring Results. Water management structures were also routinely inspected after rain events > 25mm and maintained to ensure they are performing to design and prevent impacts on downstream waters.

During the reporting period monitoring of riparian vegetation was undertaken as part of the annual riparian vegetation and channel stability assessment, in accordance with the Surface Water Monitoring Program. Table 24 summarises the results of the riparian vegetation assessment undertaken at the monitoring sites. The results of the FY20 channel stability assessment are generally consistent with previous monitoring years' findings. Most sites showed a decrease native and introduced species likely attributable to the current drought condition scores. No active remediation or treatment is recommended at this stage (except for control of priority woody weeds in some sections of Quarry Creek and Ramrod Creek), although these areas should be monitored routinely as part of current programs and potentially after heavy rainfall events.

Table 24: Riparian vegetation assessment - species diversity and total condition scores for FY20

Site	SW03 (Saddlers Creek)			SW04 (Quarry Creek)			SW12 (Ramrod Creek)			SW15 (White's Creek Diversion)		
	FY20	FY19	FY18	FY20	FY19	FY18	FY20	FY19	FY18	FY20	FY19	FY18
Number of native species (% of total)	34 (79)	46 (68)	59 (76)	9 (60)	15 (47)	15 (56)	17 (61)	30 (65)	17 (46)	8 (40)	16 (41)	8 (31)
Number of introduced species (% of total)	9 (21)	22 (32)	19 (24)	6 (40)	17 (53)	12 (44)	11 (39)	16 (35)	20 (54)	12 (60)	20 (59)	18 (69)
Total number of species	43	68	78	15	32	27	28	46	37	20	36	26
Total condition score (% of 32)	25 (78)	27 (84)	26 (81)	21 (78)	25 (81)	25 (81)	25 (81)	25 (81)	25 (81)	24 (75)	24 (75)	24 (75)

Improvements that occurred during the reporting period include:

- The amelioration of dispersive soils were made as part of the FY20 rehabilitation program;
- New sediment controls including sediment control ponds; and
- Erosion and sediment controls are implemented as part of the Permit to Disturb process and inspected on an as needed basis.

Complaints and Reportable Incidents

Mt Arthur Coal did not record any erosion or sediment control complaints or incidents during the reporting period.

Proposed Improvements

New sediment dams constructed for expanded overburden emplacements in the conveyor corridor and upper Saddlers Creek catchment, and the out of pit emplacement area, will be constructed in accordance with the provisions for sediment retention basins in the Managing Urban Stormwater – Soil and Construction Volume 2E – Mines and Quarries Guidelines (DECC, 2008).

Areas prone to erosion with exposed dispersive soils are focused in freshly established rehabilitation areas. These areas undergo annual landform stability assessments as per MAC-ENC-PRO-080 Rehabilitation and Ecological Monitoring Procedure. Plans for improvements to soil amelioration as per the response to the NSW Resources Regulator were developed in the reporting period for execution in FY21. Refer to Section 8 for further details.

7.3 Surface Water

Environmental Management

Surface water at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-MTP-034 Site Water Management Plan (WMP);
- MAC-ENC-PRO-061 Surface Water Monitoring Program;
- MAC-ENC-PRO-059 Site Water Balance;
- MAC-ENC-PRO-063 Surface and Ground Water Response Plan (SWMP); and
- MAC-ENC-PRO-032 Water Management (internal document).

The MAC-ENC-MTP-034 Site Water Management Plan was revised during the reporting period, submitted to DPIE in April 2020 and was under assessment at the time of writing this report. The revised WMP incorporates each of the site water management documents referenced above into a single consolidated WMP.

Water quality downstream of Mt Arthur Coal's operation is currently monitored by an independent consultant at five statutory monitoring sites, plus Mt Arthur Coal's licensed discharge point.

Mt Arthur Coal's Site Water Management Plan outlines measures for managing water on site, while the Surface Water Monitoring Program establishes impact assessment criteria against which monitoring results are compared. Impact assessment criteria are presented as trigger values which, if exceeded, lead to a response such as more intensive monitoring, investigation and if required, remedial action.

Environmental Performance

A summary of the surface water quality data for statutory sites during the reporting period is provided in Table 25, with further results provided in Appendix 1 – Surface Water Quality Monitoring Results.

Water quality parameters in natural watercourses surrounding the mine including Saddlers Creek (SW02 and SW03), Quarry Creek (SW04), Ramrod Creek (SW12) and Whites Creek (SW15) were subject to normal variations in response to the ephemeral nature of the creeks, local geology and weather conditions. Water quality parameters are only recorded at the HRSTS discharge point (SW28) during discharge, and no HRSTS discharge occurred during the reporting period.

Surface water pH measured at individual statutory sites remained relatively constant during the reporting period and within the impact assessment trigger levels of 6.5-9.0 at all times. Surface water EC measured at individual statutory sites remained below impact assessment trigger levels during the reporting period with the exception of SW03 which

recorded an elevated result in December 2019 this results however was determined to be invalid due to a prolonged drought leading no flow in the creek and the pool being close to empty at the time of sampling. Surface water TSS measured at individual statutory sites remained below impact assessment trigger levels during the reporting period at all statutory sites. Results are summarised in Table 25.

SW02 was dry during the reporting period. SW03 was too low to sample for three months. SW04 was too low to sample in eight months. SW12 was too low to sample for three months. SW15 was dry for five months.

Surface water monitoring locations are shown in Figure 5.

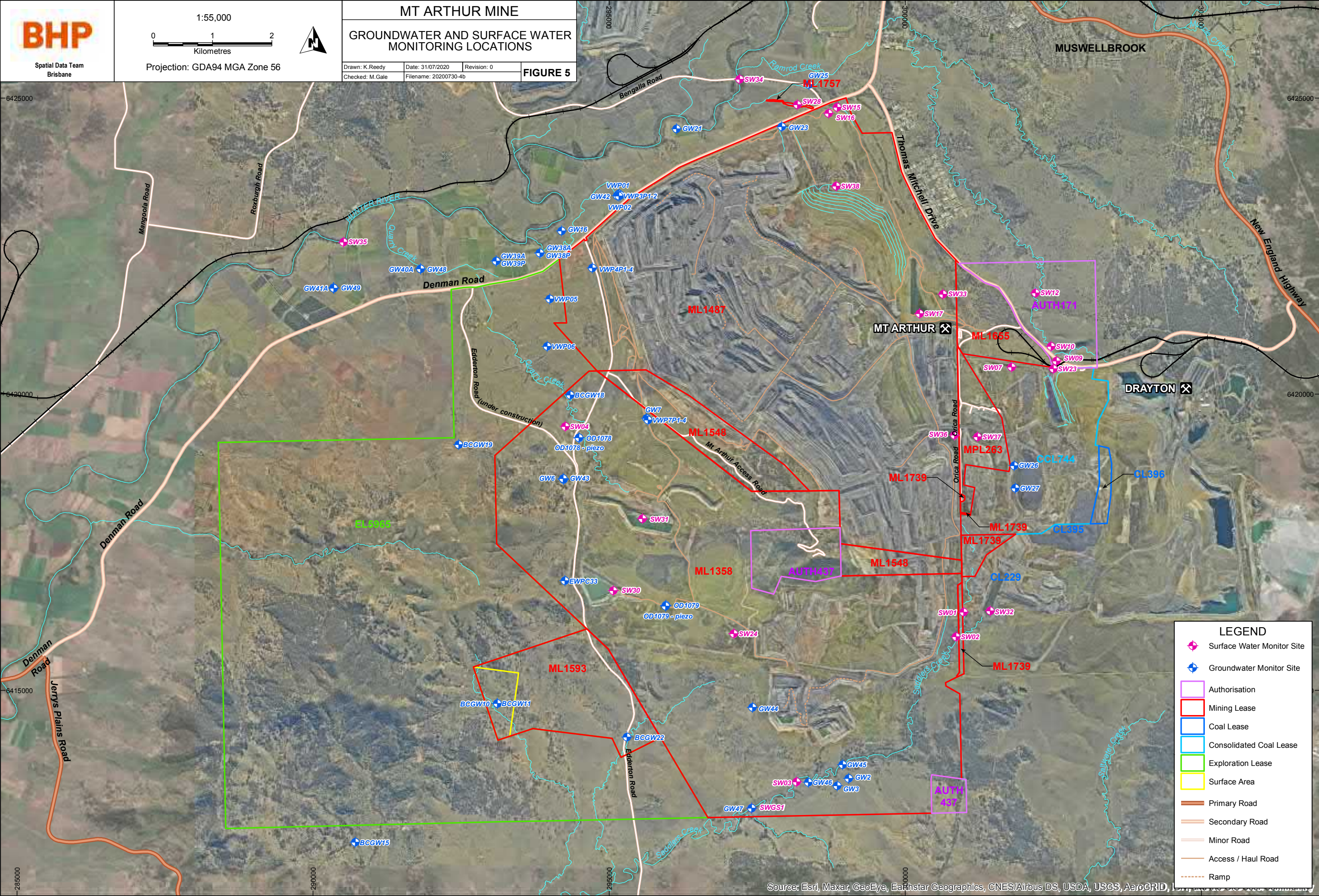


Table 25: Summary of statutory surface water quality monitoring results

Site	Impact Assessment Criteria Trigger Values			Monitoring Results			Trend/ key management implications	Implemented / proposed management actions
				min	ave	max		
SW02	pH	6.5 – 9.0		-	-	-	No assessment criteria triggered. Dry during the reporting period	Gain approval of the revised WMP. Continue managing surface water in accordance with site WMP
	EC (µS/cm)	Stage 1	12,365	-	-	-		
		Stage 2	13,900	-	-	-		
	TSS (mg/L)	Stage 1	219	-	-	-		
		Stage 2	277	-	-	-		
SW03	pH	6.5 – 9.0		7.5	7.7	8.0	No assessment criteria triggered	
	EC (µS/cm)	Stage 1	10,133	3,905	7,018	12,300	Stage 1 criteria exceeded on one occasion (not a reportable exceedance) Stage 2 criteria exceeded on one occasion 17/12/2019 determined to be in invalid result. Below average rainfall not mine activity. SW03 was an isolated pond with low volume at the time of sampling (not a reportable exceedance).	
		Stage 2	11,402					
	TSS (mg/L)	Stage 1	37	<5	12	19	No assessment criteria triggered	
		Stage 2	46					
	SW04	pH	6.5 – 9.0		7.4	8.0	8.5	
EC (µS/cm)		Stage 1	13,959	474	1381	3620	No assessment criteria triggered	
		Stage 2	15,509					
TSS (mg/L)		Stage 1	82	8	15	22	No assessment criteria triggered	
		Stage 2	104					
SW12	pH	6.5 – 9.0		7.0	7.4	7.7	No assessment criteria triggered	
	EC (µS/cm)	Stage 1	6,659	7.89	2,551	4,640	No assessment criteria triggered	
		Stage 2	7,153					
	TSS (mg/L)	Stage 1	555	<5	19	44	No assessment criteria triggered	
		Stage 2	708					
SW15	pH	6.5 – 9.0		7.5	7.6	7.9	No assessment criteria triggered	
	EC (µS/cm)	Stage 1	7,128	508	772	1,360		
		Stage 2	8,262					
	TSS (mg/L)	Stage 1	103	<5	11	14		
		Stage 2	130					

Complaints and Reportable Incidents

Mt Arthur Coal did not have any complaints relating to surface water.

Mt Arthur Coal had two reportable incidents relating to surface water. Both relating to a discharge from site as a result of a break in a mine water pipe. Both incidents were reported to the EPA and DPIE. These incidents are discussed further in Section 11.

Proposed Improvements

Mt Arthur Coal will finalise the update to the site Water Management Plan during the next reporting period.

7.4 Ground Water

Environmental Management

Ground water at Mt Arthur Coal is managed in accordance with:

- MAC-ENC-MTP-034 Site Water Management Plan;
- MAC-ENC-PRO-062 Ground Water Monitoring Program (GWMP); and
- MAC-ENC-PRO-063 Surface and Ground Water Response Plan.

Mt Arthur Coal's Site Water Management Plan aims to minimise any adverse impacts on aquifers in proximity to the operation, including the two major aquifer areas, the hard rock coal measures and the shallow alluvial deposits associated with the Hunter River.

The Ground Water Monitoring Program outlines program requirements for monitoring of potential groundwater impacts from mining operations. A program to upgrade ground water monitoring bores, and improve monitoring accuracy, was completed during the FY16 reporting period. Following this a two year interim monitoring program as outlined in Appendix 3 of the GWMP was undertaken, concluding during the FY18 reporting period.

An assessment and analysis of interim monitoring program data was undertaken during the FY19 reporting period by an independent consultant in order to determine if a sufficient reference dataset had been collected to revise and set new groundwater triggers. Following review of the interim monitoring program Mt Arthur Coal revised the groundwater monitoring program with a quarterly sampling schedule (increased from biannual) and revised trigger values, as well as observations and other recommendations from the review. This will form part of the update of the site Water Management Plan, which is currently being undertaken. The revised site Water Management Plan was submitted to DPIE for approval during the this reporting period and is still under assessment.

Although the FY19 Annual Review stated that groundwater trigger values were revised following the completion of the interim monitoring program and would be applied from the FY20 monitoring period, instead the currently approved GWMP dated 28 April 2015 is applicable for the FY20 monitoring period. The revised triggers will not be applied until further review and subsequent approval by the DPIE.

In anticipation of moving to the revised site Water Management Plan, Mt Arthur Coal adjusted the sampling frequency to quarterly instead of bi-monthly (which is beyond the requirements of the currently approved GWMP) and also adjusted the sampling requirements at some of the sites as recommended by the independent consultant. This proactive implementation of the revised site Water Management Plan did result in the following non-compliances with requirements in the currently approved Groundwater Monitoring Program:

- Manual water level data was not collected at all monitoring sites every two months as required. Water level data was collected quarterly for reporting period;
- Water level data collection for GW26 and GW27 were prematurely removed from the monitoring program;
- Water quality samples were collected for total phosphorus and the full suite of metals (aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, selenium and zinc) only once rather than twice during the reporting period.
- Water quality data was not collected at all during the reporting period at sites GW6, GW7, GW26, GW42 and GW43 as required.

The Surface and Ground Water Response Plan outlines the response actions to be implemented, should ground water monitoring trigger values be exceeded. Management measures associated with the alluvial ground water cut-off wall and flood levee constructed parallel to Denman Road along the northern boundary of the site to prevent both surface and subsurface migration from the Hunter River to the active pit, have also been incorporated into the Surface and Ground Water Response Plan.

Environmental Performance

A groundwater review was undertaken by an external specialist consultant for the reporting period. The scope of work included:

- Comparison between modelled and observed water levels to June 2020;

- Compare monitoring data to drawdown predictions for the Mt Arthur Coal Consolidation Project Environmental Assessment and the current modelling for the approved operations;
- Review site water quality monitoring data, field reports and laboratory reports and check performance;
- Review of groundwater triggers and report on any trigger exceedances, where review will be based on both the current established groundwater triggers for the site; and
- Review performance of the cut-off wall using available data.

The full Annual Groundwater assessment report is included as Appendix 2.

Drawdown and cut off wall performance

Water level data collected from July 2019 to June 2020 have been compared to the trigger values outlined in the GWMP 2015. The general purpose of these plans is to minimise any adverse impacts on aquifers in proximity to the operation and early indication of adverse impacts. Five bores recorded a water level exceedance over the reporting period: GW23, BCGW18, OD1078P (IW4028), OD1078-Piezo, VWP2 and VWP3.

An analysis of the trigger exceedances is included in Table 26.

A cut-off bentonite barrier wall was constructed between the Huon Open Cut and the Hunter River alluvium in the vicinity of the F4 fault. The purpose of the cut-off wall is to minimise drawdown within the alluvium. VWPs were installed near the cut-off wall to monitor the Permian coal measures underlying the Hunter River alluvium.

Groundwater levels have declined 83 m in the F4 Fault, 97 m in the Edinglassie Seam and 103 m in the Ramrod Creek Seam since installation in 2011. Bore GW42 intersects alluvium and shallow weathered sandstone (regolith) and is located adjacent to the VWPs. Groundwater levels at GW42 remained fairly stable, with a minor increase of 0.32 m since February 2016. As noted in previous reviews, bore GW42 fluctuates in response to rainfall and streamflow trends. Depressurisation observed in the Permian coal measures has not impacted on alluvium and regolith groundwater levels at GW42.

Depressurisation observed in the Permian coal measures also does not appear to have impacted on alluvium groundwater levels as shown by the relatively stable groundwater level trends shown by bores GW16 and GW21. However, as noted earlier these bores may also be influenced by local agricultural land use with enhanced recharge through irrigation. Regardless, the alluvial monitoring shows no adverse impact on the alluvial groundwater conditions and beneficial use of groundwater.

Table 26: Summary of ground water monitoring results by aquifer

Bore ID	Screened Lithology	Location	Comment
GW2	Woodlands Hill Seam	Saddlers Creek/ Saddlers Pit	The 2015 trigger level is set at 145.4 mAHD for bore GW2, and levels has been recorded below 145.4 mAHD from 2008 to 2011, and since 2015. The bore intersects the Woodlands Hill Seam at around 110 m depth. The bore is located within 700 m of Saddlers Pit and within the extent of predicted depressurisation within the Permian coal measures.
GW3	Woodlands Hill Seam	Saddlers Creek/ Saddlers Pit	The 2015 trigger level is set at 145.3 mAHD for bore GW3, and levels has been recorded below 145.3 mAHD from 2017. The bore intersects the Woodlands Hill Seam at around 120.4 m depth. The bore is located within 730 m of Saddlers Pit and around 250 m downslope of GW2, and within the extent of predicted depressurisation within the Permian coal measures.
GW21	Alluvium	Hunter River	Groundwater levels at bore GW21 that intersects the Hunter River alluvium fell below the groundwater level trigger in Q1 and for two consecutive readings in Q3 and Q4. Groundwater levels at GW21 have regularly fluctuated, and show no clear correlation to rainfall trends but show a close correlation to Hunter River levels. The bore is located within 200 m of the Hunter River, and

			demonstrates the influence of the river on the adjacent alluvium. No impacts due to mining are visible in the trends.
GW23	Coal (Ramrod Creek)	On site - north of Mt Arthur North (off Denman Rd)	<p>Groundwater levels have remained below the 2015 trigger level of 132.5 mAHD since monitoring began in 2008. Water levels have remained relatively stable since 2016, with a slight (1-2m) rise in water levels in 2016.</p> <p>It is noted that the logger within GW23 shows instrument drift, with levels deviating from manual dipped levels by as much as 6 m since June 2019. This is the first annual review where the issue of instrument drift has been identified. It is recommended that the datalogger be replaced to assist in correlating groundwater trends with rainfall and streamflow trends.</p>
GW39P	Warkworth Seam	Off Denman Rd - Denman Road West	<p>The 2015 trigger level is set at 120.9 mAHD, and levels have been recorded below 120.9 mAHD since 2016.</p> <p>The bore is constructed as a nested bore with a 75 mm screen to 25.5 m within coal (potentially Mt Arthur Seam), and 25 mm casing to 42.1 m just above the Warkworth Seam. It is assumed the results for GW39P are representative of the larger diameter bore to 25.5 m depth, but this should be verified in the field. The bore is located within an irrigated paddock (central pivot) near the Hunter River, approximately 2 km south-west of MAC open pit and within the extent of predicted depressurisation within the Permian coal measures. The bore is near an alluvial bore (GW39A) and previously recorded an upward gradient from the coal measures to the overlying alluvium. Since 2014 a downward gradient has been shown, with groundwater levels within the coal measures declining over time. This decline likely relates to depressurisation of the coal measures with progression of mining. In contrast bore GW39A has recorded relatively stable groundwater levels at around 221.3 mAHD (± 0.1 m), with a recent slight rise in levels in response to above average rainfall.</p>
BCGW18	Arrowfield	On site – south of MAC open pit and along Quarry Creek	<p>The 2015 trigger level is set at 174.4 mAHD and denoted as being at the base of the bore. The GWMP trigger appears to be erroneous and should be set at 147.7 mAHD, which is the actual elevation for the base of the screen in the bore.</p> <p>The bore has recorded a gradual decline in groundwater levels over time, which became more pronounced since 2016, with the bore potentially dry, with levels at or below 147.7 mAHD since January 2019. The bore is located approximately 2 km south of the active mine pit, within the extent of predicted depressurisation within the Permian coal measures.</p>
OD1078-piezo	Bowfield	On site - south west of Mt Arthur North, beside the drainage coming from the Belmont Pit	<p>Groundwater levels have declined by over 33 m since the start of monitoring in 2008. The rate of decline in levels increased rapidly during March 2017 until June 2020 with groundwater levels declining by 25 m during this period. Water levels declined below the 2015 trigger level of 142.3 mAHD in September 2017. The bore is located approximately 2 km south of the active mine pit, within the extent of predicted depressurisation within the Permian coal measures.</p> <p>It is noted that the logger within OD1078-piezo shows instrument drift, with levels deviating from manual dipped levels by as much as 92 m since October 2017. This is the first annual review where the issue of instrument drift has been identified. It is recommended that the datalogger be replaced to assist in correlating groundwater trends with rainfall and streamflow trends.</p>
OD1078 P (IW4028)	Arrowfield	On site - south west of Mt Arthur North	<p>Groundwater levels have declined over 15 m since February 2016. Water levels have remained below the 2015 trigger level of 153.5 mAHD since monitoring began. The bore is located approximately 2 km south of the active mine pit, within the extent of predicted depressurisation within the Permian coal measures.</p> <p>It is noted that the logger within OD1078P (IW4028) shows instrument drift, with levels deviating from manual dipped levels by as much as 13 m since November 2018. This is the first annual review where the issue of instrument drift has been reported. It is recommended that the datalogger be replaced to assist in correlating groundwater trends with rainfall and streamflow trends.</p>

VWP2	F4 fault	North of MAC open pit, adjacent to cut-off wall	Levels in the F4 fault exceeded the 2015 trigger level since 2013, with trends consistent with the decline in groundwater head in the coal measures recorded at nearby VWP1 and VWP3. The continuing declining groundwater level trend represents mining induced depressurisation in the Permian coal measures. It is recommended that the water level trigger be reviewed.
VWP3 – 227 m VWP3 – 241m	Edinglassie Ramrod Creek	North of MAC open pit, adjacent to cut-off wall	Levels in both the Edinglassie and Ramrod Creek seams have exceeded the 2015 trigger level since 2013. The continuing declining groundwater level trend represents mining induced depressurisation as is predicted for the approved operations. It is recommended that the water level trigger be reviewed.

* TLE = Trigger Level Exceedance

Groundwater Quality

A summary of the ground water quality data for each key aquifer during the reporting period is provided in Table 27. Assessment criteria for groundwater monitoring results consists of a two stage trigger process for EC, and pH results outside the trigger range of 6.5 to 9.0 over three consecutive readings.

Table 27: Summary of ground water monitoring results by aquifer

Bore ID	Screened Lithology	Location	Comment
BCGW22P (IW4026)	Glen Munro	On site - south west of Bayswater No. 3	The bore is over 2 km from the active mine areas and 1 km from a historical rehabilitated pit. EC has an increasing trend, ranging from 8960 $\mu\text{S}/\text{cm}$ in November 2017 to 16270 $\mu\text{S}/\text{cm}$ in June 2020. It is noted that groundwater levels declined over early 2018 but then rapidly rose by 2.66 m between July 2018 and December 2018. The 2015 1 st stage trigger level of 15526 $\mu\text{S}/\text{cm}$ was exceeded in March and June 2020. Further review of water quality and potential water sources in the area is recommended. This includes the backfilled pit and water storage within Belmont Pit.
GW2	Woodlands Hill Seam	Saddlers Creek	EC has an increasing trend since June 2015 with fluctuations. Exceeded the EC 2015 1 st stage trigger level of 4266 $\mu\text{S}/\text{cm}$ in March 2020 and 2 nd stage trigger level of 4440 $\mu\text{S}/\text{cm}$ in June 2020. Groundwater levels declined from 2017 to 2019 in line with below average rainfall; however, levels have remained relatively stable since 2019 despite continued below average rainfall. Further review of the water quality data and water types is recommended.
GW21	Alluvium (Hunter River)	Off Denman Rd - Edinglassie Homestead	pH has been relatively stable since monitoring began, but fell below the 1 st stage 2015 trigger level of 6.5 in June 2020 (6.39). EC was relatively stable since monitoring began. Bore GW21 is an alluvial bore and the groundwater level trends show no clear correlation to rainfall trends. As with bore GW16, the bore appears to be within an irrigated farm paddock and the trends may relate to local land use. It is recommended that the condition of the bore and site land use be checked, with information on local irrigation practices collected.
GW39A	Alluvium (Hunter River)	Off Denman Rd - Denman Road West	EC has fluctuated seasonally since monitoring began. Since December 2019 EC has increased and exceeded 2015 2 nd stage trigger level of 6740 $\mu\text{S}/\text{cm}$ in March and June 2020. Bore GW39A is an alluvial bore and the groundwater level trends show no clear correlation to rainfall trends. As with bore GW16 and GW21, the bore appears to be within an irrigated farm paddock (central pivot) and the trends may relate to local land use. It is also noted that the bore was hand bailed when sampled, which may have influenced the results. It is recommended that sampling technique be reviewed and the condition of the bore and site land use be checked, with information on local irrigation practices collected.

GW40A	Alluvium (Hunter River)	Hunter River alluvium, west of Mt Arthur Open Cut	<p>EC has fluctuated seasonally since monitoring began. Since September 2019 EC has increased and exceeded the 2015 2nd stage trigger level of 4587 $\mu\text{S}/\text{cm}$ in March and June 2020.</p> <p>Review of water level trends shows a general decline in levels since 2013, despite periods of above average rainfall from 2013 to 2017. The bore is located over 3 km from Mt Arthur mine and the decline in levels is unique compared to bores closer to the mine area (i.e. GW16). The bore is positioned on a private property with infrastructure (houses and sheds). It is recommended that the condition and use of the bore is checked, and water supply use in the area verified.</p>
GW41A (IW4029)	Alluvium (Hunter River)	Hunter River alluvium, west of Mt Arthur Open Cut, west of GW40A	<p>Bore GW41A is located over 5 km from the mine area, and within an agricultural area. The bore log indicates GW41A intersects alluvium and is screened shallower (4.5 to 7.5 mbgl) than the original bore (4.5 to 11.6 mbgl). The original GW41A had a relatively stable EC of 3520 $\mu\text{S}/\text{cm}$ to 5060 $\mu\text{S}/\text{cm}$ from 2008 to 2018, until the bore was decommissioned in July 2018. The replacement bore has recorded an increasing trend in EC since monitoring began in 2016, rising from 815 $\mu\text{S}/\text{cm}$ to 10600 $\mu\text{S}/\text{cm}$. GW41A EC has exceeded the 2015 2nd stage trigger level of 4120 $\mu\text{S}/\text{cm}$ since July 2019.</p> <p>Since January 2020 the bore recorded a decline in pH from 7.5 to 6.5 and a rise in EC from 815 $\mu\text{S}/\text{cm}$ to a peak of 10600 $\mu\text{S}/\text{cm}$ in March 2020. This trend is unique to the bore, and due to this and the distance from the mine, likely relates to local agricultural land use practices. It is also noted that the bore was hand bailed when sampled, which may have influenced the results. It is recommended that sampling technique be reviewed and the condition of the bore is recommended, along with information about local land use and irrigation.</p>

Proposed Improvements

- Undertake a review of the groundwater monitoring program be rationalised based on recent findings and additional newly installed bores.
- Review the WMP to ensure consistency between the field program and management plan.
- Review the condition and instrumentation of groundwater bores based on the recommendations the of the annual review assessment report.

8. Rehabilitation

8.1 Buildings and Infrastructure

The former Bayswater conveyor was decommissioned this reporting period. The area now forms part of the Conveyor Corridor overburden dump.

8.2 Topsoil

Topsoil management at Mt Arthur Coal focuses on maintaining the quality of the topsoil resource as a rehabilitation growth medium. Activities undertaken during the reporting period included:

- Prioritising direct placement of topsoil;
- Testing topsoil to determine appropriate depths for stripping and recovery as well as ameliorant requirements;
- Felling and mulching trees in situ on disturbance areas to increase organic content within the topsoil that was used directly on rehabilitation areas; and
- Reusing felled trees from disturbance areas on new rehabilitation areas to provide habitat.

Additional measures generally undertaken when stockpiling topsoil include:

- Restricting stockpile height to generally three metres or less, consistent with the MOP, to minimise compaction and anaerobic conditions within topsoil stockpiles;
- Locating stockpiles so as to reduce the requirement for re-handling and establishing cover crops; and
- Spraying topsoil stockpiles to manage weeds.

Topsoil was placed and spread to an approximate depth of 200 to 300 millimetres on rehabilitation areas. The newly spread topsoil surface was contour cultivated prior to sowing to provide a suitable environment that encourages water infiltration in the soil.

8.3 Landform Design

Mt Arthur Coal aims to create rehabilitation that is safe, stable and non-polluting, that is self-sustaining and comparable to the surrounding natural landscape. Landform and rehabilitation incorporates natural micro-relief and natural drainage lines for landforms designed and constructed post the current modification project approval. The proposed design methodology chosen is an adaptation of the GeofluvTM approach (geomorphic design). The geomorphic design uses the characteristics of stable natural alluvial landforms in the local environment as an analogue on which to base the design of overburden landforms. Importantly, the approach does not replicate existing landforms, but rather uses the key characteristics that make these landforms stable in a new design. Natural landforms in alluvial materials are characterised by an integrated network of drainage channel, typically with slopes initially convex close to ridge lines, becoming concave and progressively flattening with increasing catchment area. The aim is to establish landforms consistent with the erosion rate of natural features in the area.

Future use of areas disturbed by active mining is closely linked to landform design and general vegetation strategies found in the Synoptic Plan. The Environmental Assessment states 'the conceptual final landform provides an integrated landscape that is consistent with the Synoptic Plan and aims to link existing vegetation communities with mine rehabilitation areas to provide fauna movement corridors for the movement of fauna'. These proposed corridors are consistent with, and will further complement, both the Synoptic Plan and the final landforms of surrounding areas.

Management measures designed to reduce the visual impact created by the overburden emplacement have been incorporated into the mine plan. Such measures include:

- The integration of tree corridors on overburden emplacements as part of progressive rehabilitation;
- The retention of the eastern flank of MacLean's Hill to assist in creating landscape diversity at the foot of overburden emplacements;

- Modifying final void high walls and low wall slopes to minimise final disturbance;
- Incorporating micro relief features (stag trees, ripping, rock features and habitat trees) throughout overburden emplacements to provide an enhanced naturally appearing landform and fauna habitat;
- The practical consideration of 'Geofluv type' designs on emplacements to sustainably manage water and create a natural looking and stable landform;
- The strategic design and rehabilitation of overburden emplacements for increased visual shielding of operations;
- Establishing visual and ecological planting patterns of native trees to achieve landscape patterns that complement the existing spatial distribution of tree and grass cover in a grazing landscape; and
- Minimising exposure of work areas to sensitive receivers where possible, largely through the timely rehabilitation of visible overburden emplacements.

The final landform design can be seen in Figure 6. Figure 6 shows bulk shaping prior to topsoil placement. Although this geomorphic design has been implemented on other sites within NSW and also worldwide there are many defining characteristics that restrict its use such as space, waste characterisation, rainfall, availability of suitable rock, availability of mulch, final landuse, landform height and steepness of the landform. Mt Arthur Coal has larger higher landforms than other sites in the Hunter Valley, and is also space constrained for emplacement area. The resultant design aligns with industry best practice, but will be monitored over the coming years to ensure further natural landform design incorporates learnings and improvement from the current work.

The MAC-ENC-MTP-047 Rehabilitation Strategy with updated designs was submitted to the former DP&E and former DRG in 2018 with updated information in relation to the design use and void management.



Figure 6: Rehabilitation at Saddlers Central emplacement using natural landform design

8.4 Disturbed Land

Rehabilitation of land is carried out in accordance with:

- MAC-ENC-MTP-052 Mt Arthur Coal Mining Operations Plan;
- MAC-ENC-MTP-047 Rehabilitation Strategy;
- MAC-ENC-MTP-050 Biodiversity Management Plan;
- MAC-ENC-PRO-080 Rehabilitation and Ecological Monitoring; and
- MAC-ENC-PRO-012 Land Management Procedure.

Rehabilitation is designed to achieve a stable final landform compatible with the surrounding environment and to meet the landform commitments presented in the MOP.

This reporting period saw Mt Arthur Coal increased volume and quality of newly established rehabilitation. During the reporting period Mt Arthur Coal completed (achieved Phase 4 – Ecosystem and Landuse Establishment) 81 hectares of rehabilitation across four areas (VD5, VD4, Drayton Void and Saddlers Central). An additional 31.3 hectares entered Phase 3 – Growing Media Development with topsoil being spread. This was aligned to the MOP target of 81 hectares to Phase 4 – Ecosystem and Landuse Establishment, as shown in Table 28. Areas of rehabilitation

undertaken during the reporting period are shown in Appendix 5. The final area entering rehabilitation of 112.3 ha is a significant increase in annual rehabilitation at Mt Arthur Coal.

The trial of using Unmanned Aerial Vehicle (UAV) continued for the early part of the reporting period. The UAV seeding was found to be difficult to manage for large areas. As a result Mt Arthur Coal utilised a plane to complete seeding in FY20. This allowed Mt Arthur Coal to target ideal seeding period (April) and conditions with rainfall occurring within two weeks of seeding, thus improving the chances of quality rehab establishing.

Both woodland and pasture seed mixes and rates have been revised in consultation with an independent specialist, as specified in the MOP.

Table 29 provides the Mt Arthur Coal rehabilitation summary for the operation.

Table 28: Mt Arthur Coal rehabilitation claimed for FY20

Rehabilitation phase	FY20 MOP rehabilitation commitments (hectares)	FY20 areas in active rehabilitation phases (hectares)
Phase 2 – Landform Establishment	0	4.4
Phase 3 – Growing Media Development	0	26.9
Phase 4 – Ecosystem and Landuse Establishment	81	81
Total	81	112.3

Note: All areas calculated using GDA1994 Zone 56 coordinate system

Table 29: Mt Arthur Coal rehabilitation summary

Mine area type	Previous reporting period (FY19 actual)	This reporting period (FY20 actual)	Next reporting period (FY21 forecast)
A. Total mine footprint ¹	5,171	5,333	5,609
B. Total active disturbance ²	3,871*	4,152	4,662
C. Land being prepared for rehabilitation ³	89	31.3	5
D. Land under active rehabilitation ⁴	1,211*	1181	947**
E. Completed rehabilitation ⁵ (as formally certified by NSW Government)	0	0	0

Note: All areas calculated using GDA1994 Zone 56 coordinate system

* Reconciled via survey from FY19

** FY19 actuals, minus FY20 forecast dehab plus FY20 rehabilitation target

1 Total mine footprint includes all areas within a mining lease that either have at some point in time or continue to pose a rehabilitation liability due to mining and associated activities.

2 Total active disturbance includes all areas ultimately requiring rehabilitation.

3 Land being prepared for rehabilitation includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growing media development (as defined in DRE MOP/Rehabilitation Management Plan Guidelines).

4 Land under active rehabilitation includes areas under rehabilitation and being managed to achieve relinquishment.

5 Completed rehabilitation requires formal signoff by the NSW Resources Regulator that the area has successfully met the rehabilitation land use objectives and completion criteria.

8.5 Other Activities

During the reporting period other rehabilitation related activities undertaken included weed spraying, soil management, minor earthworks repairs and feral animal control.

During the reporting period Mt Arthur Coal appointed a dedicated Rehabilitation Specialist role, which is responsible for collaborating with and influencing mine planning to achieve MOP rehabilitation targets using industry best practice methods, as well as implementing the rehabilitation maintenance and improvement program of works.

A project of improvement of VD1 rehabilitation including:

- Targeted spot weed treatment in higher value areas as presented in Future Harvest 2019
- Stem density reduction in areas dominated by spotted gum;
- Construction of terrestrial fauna habitat; and
- Detailed weed mapping to aid planning works.

Further improvement works can be found in Table 33, as recommended in various consultant reports for the site.



Figure 7: VD5 natural landform design showing FY18-FY20 rehabilitation. Image collected in November 2019 prior to rainfall.



Figure 8: VD5 natural landform design showing FY18-FY20 rehabilitation. Image collected in April 2020 following rainfall.

Drought impacted the first half of the reporting period limiting revegetation efforts. Significant rainfall was received on site in the second half of the reporting period increasing vegetation cover (see Figure 7 and Figure 8 for comparison). This has helped to stabilise the landform but will need intense weed treatment in the short term to keep on track.

A significant review of the Rehabilitation and Ecological Monitoring procedure (REMP) was undertaken in the reporting period. The review included:

- Transitioning the methodology to the Biodiversity Assessment Method (BAM);
- Increased monitoring locations of established rehabilitation;
- An increase in routine inspections as part of land form stability monitoring (Routine Walkover Inspection);
- Independent revegetation inspection aligned with the ecological development monitoring;
- Aligning visual amenity monitoring with rehabilitation goals; and
- Formalising the Ground & Pasture Assessment (GPA) methodology.

In the reporting period Mt Arthur Coal completed the five yearly GPA monitoring. The assessment found:

In general all rehabilitated sites had excellent levels of groundcover and had a good diversity of perennial grass pasture species present. Established rehabilitated sites, excepting the recently established Drayton North, are capable of supporting beef cattle grazing given their established perennial grass species composition and groundcover percentages.

Rehabilitation Management Plan (RMP) trigger points are presented in Table 30 and GPA monitoring results are summarised in Table 31.

Table 30 Ground and Pasture Assessment Rehabilitation Management Plan Trigger points

Component	Lowest	Ideal	Comment
Ground Cover	70%	90-100%	80% cover on steeper slopes
Perennial grass component of pasture	Minimum 40%	60-80%	Provides stable grassland base, must maintain some diversity
Dominant grasses (% of total pasture cover)	>40% of total cover	<40% of total cover	Lack of diversity, often the least palatable grass dominates

Table 31 Ground and Pasture Assessment Results

Site	Groundcover %	Perennial Grass %	Dominant Grass	Action
R1	+95	70	Red Grass 30%	Nil
R2	+95	65	Wire Grass 25%	Nil
R3	+95	70	Wire Grass 35%	Nil
ME	+95	75	Kikuyu 25%	Nil
MW2	+95	80	Rhodes Grass 50%	Strategic grazing of Rhodes grass
BS	80	70	Red Grass 30%	Control rabbits
DN	+95	65	Kikuyu 25%	Nil

Full GPA results are presented in Appendix 5.

Mt Arthur Coal has commenced a project to investigate and rehabilitate legacy exploration sites (mining and exploration leases) from the previous 20 years. These sites are rehabilitated to achieve the following goals:

1. Prevent contaminating water tables with exposed aquifers via boreholes that are not sealed (grouted);
2. Rehabilitation of land for beneficial use;
3. Prevent injury to wildlife / livestock; and
4. Preservation of local biodiversity – preventing the growth of weeds on the pad.

The methodology aligns with the NSW Department of Planning & Environment Exploration Code of Practice: Rehabilitation. This can be summarised as:

1. All sites ground truthed;
2. Random selection dug down to investigate rehabilitation status;
3. Holes grouted where appropriate; and
4. Rehabilitation (i.e. sumps, disturbed ground) methodology aligns with the NSW Department of Planning & Environment Exploration Code of Practice: Rehabilitation.

The results of the project are summarised in Table 32.

Table 32 Summary of the legacy borehole rehabilitation project

	Investigation Findings					
	Total Sites Visited	Sites removed from program	Sites deemed Rehab complete	Sites requiring surface rehab Only	Sites requiring grouting	Survey dig down sample selection
No of Boreholes	1,148	696	561	216	297	72
	Works Completed in FY20					
	Sites rehabbed			Sites Grouted		
No of Boreholes	20			36		

This project will continue in FY21.

Table 33: Mt Arthur Coal rehabilitation maintenance and improvement program

Area	Item		Notes	Results	Follow up monitoring
1. All areas	1.1	Improve and increase monitoring	Changes have been made to the REMP as detailed in Section 8.5. In the next reporting period Mt Arthur Coal will expand flyovers to increase the frequency that rehabilitation areas are captured in aerial routine aerial imagery and LiDAR scans. Mt Arthur Coal will also investigate the usage of LiDAR in monitoring erosion and in using aerial imagery in assessing vegetation health.	See Section 6.5 Future TARP responses to be reported in Section 8.5 of future Annual reviews	Annual ecological development monitoring, aerial imagery and LiDAR scans
	1.2	Kangaroo management	Kangaroo harvesting continued in operational areas in FY20, focusing on VD1 and surrounding area. Mt Arthur Coal plans to continue kangaroo harvesting in FY21.	See Section 6.5	Recording of animals taken and as part of the annual ecological development monitoring.
	1.3	Rabbit management	Rabbit management continued in FY20. The following key activities have been undertaken as part of the rabbit management program: 1. Rabbit baiting using Pindone poison was conducted across site; 2. Rabbit trapping was using ferrets carried out in the VD1 area. This program was not successful and will not be repeated; and 3. Opportunistic shooting of pest species was conducted as part of the kangaroo harvesting program. Targeted pest species shooting will occur in FY20. Rabbit control using a broad baiting will be carried out in FY21 with results reported in the next Annual Review.	See Section 6.5	Annual ecological development monitoring.
	1.4	Replace hand sowing	Work to date has included: 1. Trialling of UAV seeding; and 2. Aerial seeding from a plane FY21 will also include seeding using a tractor pulled spreader.	See Section 8	Annual revegetation inspections and Rapid Assessment Walkover (RAW).
	1.5	Characterisation of rehabilitation materials be completed prior to use	FY20 soil sampling targeted topsoils and waste rock material used in the specific rehabilitation projects. This was due to most projects utilising a combination of direct placement and stockpiled materials. Further soil sampling of stockpiles and rehabilitation materials is planned in FY21	Soil sampling results and report can be supplied on request.	Ongoing sampling of stockpiles and directly placed topsoil.

Area	Item		Notes	Results	Follow up monitoring
	1.6	Use successful examples of rehabilitation success from around site and develop standard practice	Work to date has focussed on centralising data to establish previous methodologies. Work on a new spatial tracking system incorporating graphical representation commenced in June 2019. This work has been incorporated into the recently submitted Forward Program and is part of a broader project covering all of BHPs Australian operations. Routine monitoring (such as RAW) will be spatially represented to improve tracking of maintenance and improvement requirements. Improvements to the Rehabilitation Management Plan have been submitted with the Forward Program, including the incorporation of more quantitative closure criteria.	Updates to RMP	Continual improvement and updating GIS database, RAW and revegetation inspections
	1.7	Weed treatment	Weed assessment completed and weed works commenced for the reporting period. Focus of weed treatment continued to VD1, however treatment was also completed on CD1. A broader list of weed species was targeted in FY20. Mt Arthur Coal continued to trial the into high resolution image processing to quantify weed infestations. This trial will continue into FY21.	See Section 6.5 and Appendix 6.	Annual ecological development monitoring and annual weed assessment.
	1.8	Mulching	The initial application of mulch has been delayed Q2 FY21. Recommendations were originally for the use of hay mulch as temporary stabilisation. Sourcing this material was not possible. A new vendor was onboarded as the supplier and spreader of mulch products in FY20. Mt Arthur Coal intends to utilise temporary stabilisation in newly established rehabilitation in areas where there is a high risk of erosion	N/A	RAW and Revegetation Inspections
	1.9	Contour drain removal	Design requirements assessment scheduled for completion in 2020 will be an ongoing design process due to the complexity of the work. As areas undergo maintenance each area will be assessed for removal contour drains.	N/A	To be confirmed
	1.10	Translocation of key species	Work was assessed in this reporting period and was determined not to be cost effective.	N/A	N/A
	1.11	QA/QC procedures	Processes for tracking and improving the quality of Mt Arthur Coal have been improved rehab over the reporting period by the following: <ul style="list-style-type: none"> Update of monitoring program occurred in FY20 (see Section 6.5) Update of Closure Criteria provided in the recently submitted Rehabilitation Strategy Planned work in the next reporting period includes: <ul style="list-style-type: none"> Investigation of utilising site LiDAR for erosion monitoring; Development of new Performance Standards; and Developing performance standards advancements will be made each reporting period in the RMP. This will be a staged approach as it will require review of all existing rehabilitation. 	TARP responses provided in future Annual Reviews in Section 8.5	Updated management plans and procedures

Area	Item		Notes	Results	Follow up monitoring
2. VD1	2.1	Excavate soil from the sediment dam at VD1 to re-establish its design functionality	VD1 sed dam will be excavated in FY21 as part of maintenance work in the area including application of stabilising mulch and re-seeding.	N/A	RAW and Revegetation Inspections
	2.2	Fill erosion gullies at VD1 (FY17 rehabilitation) to the landform design surface	Work scheduled for completion FY21 after onboarding vendors in FY20. Work will be completed as part of maintenance work in the area including application of stabilising mulch and re-seeding.	See Appendix 5 for Revegetation Inspection results	
	2.3	Weed treatment Trials identified in the Future Harvest 2019 report	<p>Weed treatment trials were delayed to allow for integration with the Royal Botanic Gardens Sydney (RBGS) collaboration work. The partnership with the RBGS will no longer go ahead</p> <p>The scopes for these trials will be reviewed in FY21 with the intent to focus on the most cost effective solution and progress in the next reporting period.</p> <p>Area 1 scope includes:</p> <ol style="list-style-type: none"> 1. Slashing 2. Rip contours 3. Spray emergent weeds early Spring 4. Re-seed 5. Spot treatment for weeds <p>Area 2 scop includes:</p> <ol style="list-style-type: none"> 1. Secure area and conduct burn in early Spring 2019 2. Rip contours 3. Spray emergent weeds early Spring 4. Re-seed 5. Spot treatment for weeds (Autumn 2020) 6. Tube stock planting 	N/A	RAW and Revegetation Inspections
	2.4	Habitat and water availability	Schedule of this work will be determined by removal of contour drains (see 1.9).	N/A	To be confirmed
	2.5	All weather road access	This work will be incorporated into individual projects across the VD 1 rehab. Additional track to be installed as part of 2.1 and 2.2 above.	N/A	N/A

Area	Item		Notes	Results	Follow up monitoring
	2.6	Installation of habitat features such as stag trees	The Cumberland Ecology 2019 report recommended nest boxes. Mt Arthur Coal will focus on bringing more stag trees, larger felled timber and rock piles to the rehabilitation areas in the interim. Stag trees have been stockpiled at the top of VD1 and initial installations scheduled for FY21.	To be provided in future Annual Reviews in Section 8.5	Annual ecological development monitoring
	2.7	Application of ameliorants	A significant amount of fertiliser and gypsum is to be applied to VD1 based on the soil assessment (see 2.4). This work was scoped in the reporting period to determine the most efficient means of application. Initial it was planned that an aerial application of gypsum would provide the most efficient methodology. The advice on fertiliser application has been reviewed and determined that this may result in increase of weed infestation. It was determined that individual project areas (see 2.9-2.13 below) will have appropriate ameliorants applied.	N/A – follow up soil sampling may be required as determined by monitoring results.	RAW, Revegetation Inspections and soil sampling
	2.8	Irrigation	Broad acre irrigation was deemed as impractical in the last reporting period. Mt Arthur will investigate the use of tanks and drip lines to aid in the establishment of tube stock over FY21.	To be provided in future Annual Reviews in Section 8.5	RAW and Revegetation Inspections
	2.9	Spotted Gum / Box forest	<p>Future Harvest 2019 scope:</p> <ol style="list-style-type: none"> 1. Stem density reduction – Work was completed in to reduce stem density to approximately 250 stems per ha. 2. Ripping and seeding with native grasses – This is deemed as impractical as areas accessible for machinery is densely covered in exotic grass used in the initial establishment 3. Treatment of exotic grasses – slashing and spraying of exotic grass is described in 2.9 below. 4. Tube stock planting – Will be utilised within areas that have undergone stem thinning. Timing will be dependent on irrigation (2.8 above) and treatment of exotic grasses (2.10 below). FY19 ecological development monitoring recommended planting of characteristic canopy, shrub and groundcover species identified in Table 10 of the MOP. Note that tube stock planting in recent years has had a low success rate due to drought and predation. <p>FY21 works will include continued spot weed treatment. Dependent on the timing of irrigation (see 2.8 above) tube stock planting is scheduled for FY22.</p>	To be provided in future Annual Reviews in Section 8.5	Annual ecological development monitoring, RAW and Revegetation Inspections

Area	Item	Notes	Results	Follow up monitoring
	2.10	<p>Exotic and depleted grasslands</p> <p>Approximately 118ha of VD1 has a significant cover of exotic grasses. Future Harvest 2019 scope: 1. Segmenting areas into projects of between 5 to 10 ha. 2. Project areas will be slashed, ripped and sprayed to reduce exotic grasses 3. Appropriate ameliorants will be applied with temporary surface stabilisation of a composted mulch being applied 4. Box Gum woodland species mix will be seeded in the areas 5. Follow up spot weed treatment 6. Tube stock planting as required</p> <p>Efforts over the reporting period focussed on spot weed treatment in areas adjacent to the Spotted Gum / Box forest (2.9 above). FY21 will commence with approximately 5 ha in the designated Trial Area 1 above. Other areas will be investigated based on resources availability.</p>	<p>Spot weed treatment results presented in section 6.5. To be provided in future Annual Reviews in Section 8.5</p>	<p>Annual ecological development monitoring, RAW and Revegetation Inspections</p>
	2.11	<p>Native grasslands with emergent Box - Gum canopy and mid-storey</p> <p>The increase in rainfall over the reporting period has increased the presence of perennial exotic grasses such as Green Panic (<i>Panicum maximum</i> var. <i>trichoglume</i>). These areas were originally seeded with exotic pasture crop. Ground cover diversity seeding projects were scheduled to commence in Autumn 2020. However, the increased exotic grass cover indicates that strategy would not have been effective. These areas will be categorised as per 2.10 above in future reports.</p>	<p>Spot weed treatment results presented in section 6.5. To be provided in future Annual Reviews in Section 8.5</p>	<p>Annual ecological development monitoring, RAW and Revegetation Inspections</p>
	2.12	<p>Emergent Box – Gum woodland</p> <p>Future Harvest 2019 scope: 1. Targeted weed treatment program commenced in the reporting period 2. Monitor for need for stem thinning 3. Consider cool burns 4. Water availability</p> <p>Weed treatment in this area will continue in FY21. Any works regarding water availability will be aligned with significant earth works as per 1.9 above. Revegetation Inspection conducted late in the reporting period indicates that despite weed treatment efforts establishment of target species has been poor. Monitoring of the area will continue</p>	<p>Spot weed treatment results presented in section 6.5. Revegetation Inspections completed in FY20. To be provided in future Annual Reviews in Section 8.5</p>	<p>Annual ecological development monitoring, RAW and Revegetation Inspections</p>

Area	Item		Notes	Results	Follow up monitoring
	2.13	Mixed eucalypt forest with exotic canopy and mid storey	<p>Future Harvest 2019 scope:</p> <ol style="list-style-type: none"> 1. Targeted stem thinning of inappropriate species 2. Monitor for need for stem thinning 3. Consider cool burns 4. Water availability <p>Targeted spot weed treatment is planned for FY21. Other works listed above are planned for FY22-23.</p>	<p>Spot weed treatment results presented in section 6.5.</p> <p>To be provided in future Annual Reviews in Section 8.5</p>	Annual ecological development monitoring, RAW and Revegetation Inspections
3. VD5	3.1	Application of mulch	<p>See 1.8 above.</p> <p>An initial application of mulch will to higher risk areas in FY21.</p>	N/A	RAW and Revegetation Inspections
	3.2	Erosion	RAW inspections have identified erosion gulleys formed over the previous reporting periods. These will be reworked in		
	3.3	Re-rip, seed and fertilise	A revegetation inspection scheduled for the reporting period was conducted late in the reporting due to impacts of Covid-19. As such ripping work will be determined following the and be re-scheduled for FY20. Areas will be progressively seeded following mulching with a composted mulch from FY21. The use of a composted mulch product is intended to negate the need for a chemical fertiliser.	See Appendix 5 for Revegetation Inspection results	Landform stability monitoring – Annual Rapid Assessment
4. CD1	4.1	Application of ameliorants	<p>A significant amount of fertiliser and gypsum is to be applied to CD1 based on the soil assessment (see 2.4). This work is to be scoped to determine the most efficient means of application.</p> <p>Scoping was to be completed by the end of September 2020 however, has been delayed until further progress is made on VD1 and VD5. As such work is not expected to commence until FY23-24.</p>	N/A	Landform stability monitoring and ecological development monitoring.
	4.2	Stem density reduction	To be completed following 2.9. Focus is currently on VD1 improvements. As such work is not expected to commence until FY23-24.	N/A	Annual ecological development monitoring.
	4.3	Habitat and water availability	To be completed following 4.2. Focus is currently on VD1 improvements. As such work is not expected to commence until FY23-24.	N/A	N/A
	4.4	Understory planting	<p>To be completed following 4.2. Focus is currently on VD1 and VD5 improvements. As such work is not expected to commence until FY23-24.</p> <p>Species to include <i>Notelaea microcarpa</i> var. <i>microcarpa</i> (Native Olive), <i>Bursaria spinosa</i> (Blackthorn), <i>Acacia falcata</i> (Hickory Wattle) and <i>Acacia paradoxa</i> (Kangaroo Thorn). Note that tube stock planting in recent years has had a low success rate due to drought and predation. Any planting will require the controls listed in 1.1 and 1.2 as well as an assessment on weather conditions and the efficacy of irrigation. Estimated to commence in Autumn 2022 (note this has been delayed by 12 months to focus on VD1).</p>	N/A	Annual ecological development monitoring and Revegetation Inspections.

Area	Item		Notes	Results	Follow up monitoring
EME Pad	5.1	Rip, seed and fertilise FY17 rehabilitation	Formerly reported on as part of the MacDonalds and Belmont areas. This area was dehabbed as part of the construction of the new Earth Moving Equipment (EME) Build Pad. Area surrounding the EME Pad will be rehabbed in FY21.	To be provided in future Annual Reviews in Section 8.5	Annual ecological development monitoring and Revegetation Inspections.
6. Macdonalds and Belmont area	6.2	Fill erosion gullies at MacDonald's to the landform design surface	This work is to be re-assessed based on the longer term plan as some of the areas will be required for further dumping.	N/A	N/A
	6.3	Remove contour drains			
	6.4	Fill erosion gullies at MacDonald's Void (2000 rehabilitation) to the landform design surface			
7. Dump 11 (Export)	7.1	Revegetation Works	Monitoring occurred in this location for the first time in this reporting period. A revegetation plan was included in the monitoring results. Further monitoring results are presented in Revegetation Inspection (see Appendix 5). The area requires reduction in exotic grasses, establishment of native ground cover and mid storey species and increase in the density of native canopy species. As this area is currently stable works will be delayed until VD1 and VD5 works have progressed further, estimated top commence in FY24.	Section 6.5 and Appendix 5 for Revegetation Inspection results	Annual ecological development monitoring and RAW and Revegetation Inspections.
8. Drayton Void	8.1	Weed treatment	The 5 yearly ground pasture assessment (GPA) recommended that broad leaf weed control occur. Scheduled to occur in Spring FY22 to allow for equipment availability.	See Appendix 5 for Ground and Pasture Assessment	RAW and Revegetation Inspections.
9 Saddlers Central (SDc)	9.1	Initial monitoring	Independent revegetation inspection was conducted in this area for the first time this reporting period Ecological development monitoring is planned to commence in FY21 to gain data for planning maintenance work	N/A	Annual ecological development monitoring and RAW and Revegetation Inspections.

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Area	Item		Notes	Results	Follow up monitoring
	9.2	Weed treatment	Spot weed treatment is scheduled for the SDc area in FY21	N/A	Annual ecological development monitoring and RAW and Revegetation Inspections.

8.6 Rehabilitation Activities for Next Reporting Period

The FY20-FY22 Forward Program was submitted to the NSW Resources Regulator for the period 1 July 2019 to 30 June 2022. Performance indicators and completion criteria were developed for the MOP and are representative of current site techniques and information derived from monitoring data. This will be dynamic over the life of the mine, in consultation with the NSW Resources Regulator, progressing towards rehabilitation being self-sustaining on site.

Rehabilitation activities for the FY21 reporting period include the continuation of natural landform design rehabilitation techniques and the inclusion of habitat in new areas as they become available. FY21 has an annual rehabilitation area target of 73 hectares.

New rehabilitation of land will be carried out in accordance with:

- Mt Arthur Coal's FY20-FY22 Forward Program;
- Mt Arthur Coal's Rehabilitation Management Plan;
- MAC-ENC-MTP-047 Rehabilitation Strategy;
- MAC-ENC-MTP-050 Biodiversity Management Plan; and
- MAC-ENC-PRO-012 Land Management Procedure.

Additional focus on improving the quality of rehabilitation of VD1 will continue in FY21 with the aim of establishing self-sustaining Box Gum woodland based vegetation community as described in the MOP.

Details of planned maintenance and improvement are provided in the Mt Arthur Coal Rehabilitation Maintenance and Improvement Program presented in Table 33.

Mt Arthur Coal will investigate the further use of remote sensing to assess erosion, vegetation health and ecological development. This will potentially provide a more detailed assessment of ecological development at Mt Arthur Coal and help guide improvement practices.

During the next reporting period Mt Arthur Coal will continue to utilise the Rehabilitation Specialist role, which is responsible for collaborating with and influencing mine planning to achieve MOP rehabilitation targets using industry best practice methods, as well as implementing the rehabilitation maintenance and improvement program of works presented in Table 33.

9. Community

9.1 Community Engagement

Mt Arthur Coal continues to actively engage and build relationships with key stakeholders and support the local community through its program of community consultation. Mt Arthur Coal's community consultation process was ongoing throughout the reporting period with the following consultation measures undertaken

- Quarterly Community Consultative Committee (CCC) meetings
- MAC representatives attendance at Muswellbrook Chamber of Commerce and Industry events
- Participation in the Upper Hunter Mining Dialogue and several of its working groups
- Telephone and face-to-face engagement with neighbouring landholders as well as written correspondence
- Coal Community Connect newsletter, distributed to key community stakeholders (including surrounding landholders), providing an update on business activities, issued in April, May and June 2020
- The CSIRO Local Voices program is a three year program, launched in 2019 to provide the local community ways to provide feedback to Mt Arthur Coal on its business activities via monthly pulse surveys
- 24 hour BHP Mt Arthur Coal Community Response Line 1800 882 044

Community Response Line

Mt Arthur Coal invites feedback about its activities through a free-call 24-hour Community Response Line (1800 882 044), which is advertised in the local newspapers and at <https://www.bhp.com/sustainability/environment/regulatory-information/>.

During the reporting period, Mt Arthur Coal received 54 complaints from community members and near neighbours. A comparison of complaints received during the reporting period against previous financial years is shown in Figure 9 and a complete register of complaints is presented in Appendix 3.

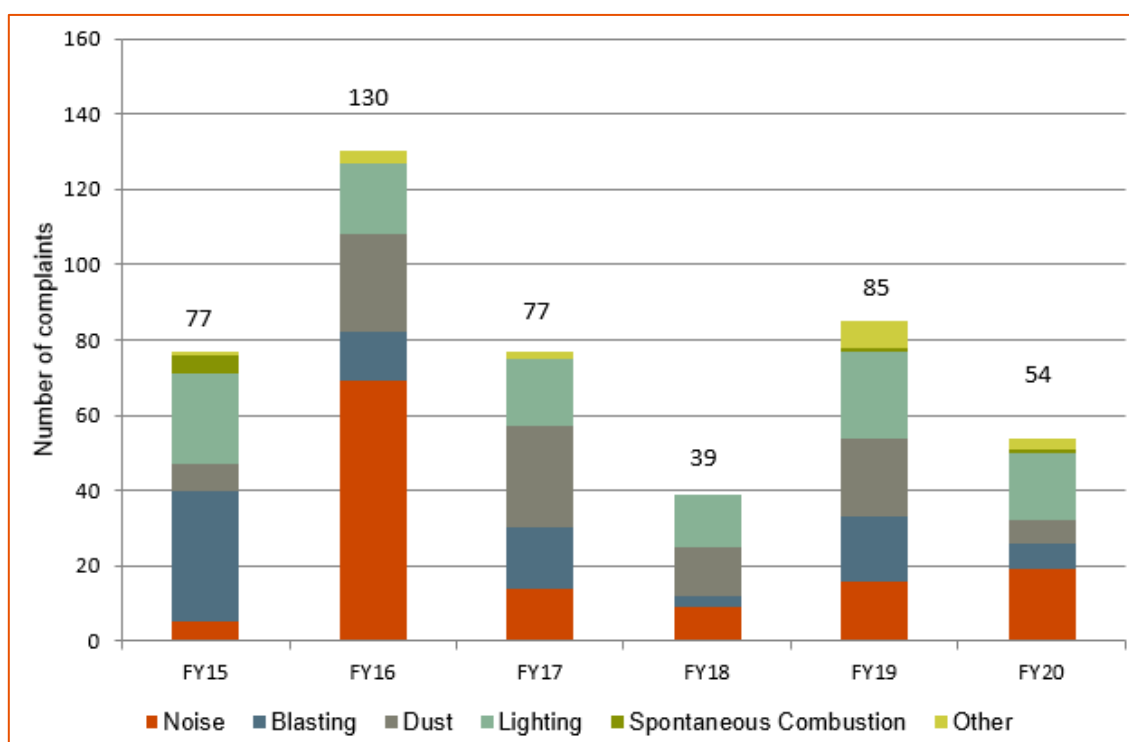


Figure 9: Comparison of complaints received during current and previous financial years

Noise Complaints

During the reporting period, 19 noise complaints were received from three complainants. This is higher than FY19 (16 noise complaints). All complaints were investigated, with noise levels generated by Mt Arthur Coal being measured within internal management benchmarks at the nearest real-time monitor, whenever noise data was available.

Blasting Complaints

During the reporting period, 7 blast vibration complaints were recorded. This is a decrease from 17 complaints in FY19. All investigations revealed weather conditions were suitable for blasting at the time and results indicated overpressure noise and ground vibration levels were within regulatory criteria on dates when the complaints were received.

Air Quality Complaints

During this reporting period it is important to note that NSW experienced extreme bushfire, heat and drought conditions during the October 2019 to January 2020 period. As a result the DPIE identified there were a number of days that the air quality was impacted by these regional events.

Six dust-related complaints were received from five complainants during the reporting period, which is 71 per cent lower than previous year (21 dust-related complaints). With the exception of four dust complaints, two complaint investigations indicated that real-time dust levels and 24-hour averages remained within regulatory limits at the monitoring location nearest to the complainants.

One complaint received on 8 August 2019 was from the Muswellbrook area, the DPIE also issued a notice to Mt Arthur Coal. An investigation was undertaken and a response provided to the DPIE, which is further detailed in Section 11.

Three complaints were received on the dates the DPIE identified that air quality may have been impacted by regional events (dates of 7 November, 12 November and 14 December). At the time of these complaints PM₁₀ results were elevated, however Mt Arthur Coal's incremental contribution to the 24-hour PM₁₀ result was minimal, as shown in Table 14. Throughout the period Mt Arthur Coal continued to implement all reasonable and feasible measures to minimise dust generation on site.

In 2019, Mt Arthur Coal implemented a new real time dust monitoring system, which has improved the site's capability to better monitor and manage its dust performance, which is evidenced in the reduction in the number of dust related complaints during this reporting period.

Lighting Complaints

During the reporting period, 18 lighting complaints were received from three complainants, which is lower than FY19 (23 complaints). On notification of the complaints, immediate action was taken to locate and redirect the offending lights, in response to addressing the complainant's concerns.

Spontaneous Combustion Complaints

During the reporting period, one complaint was received regarding odour from spontaneous combustion on 13 August 2019. Investigation revealed spontaneous combustion activity at the time of the complaint. Mining operations were altered to reduce spontaneous combustion related activity in response to the complaint. One spontaneous combustion complaint was received in FY19.

Other Complaints

During the reporting period, three complaints were received from three complainants in relation to non-operational activities. Two of these complaints were in relation to a bus service pick up/drop off location and the bus route. On notification of these complaints, immediate action was undertaken to address the concerns raised. The third complaint was in relation to alleged damage to a light vehicle windscreen as a result of a coal train. The incident was investigated and determined the coal train did not cause the damage as it was not loaded at the time of the incident.

Website

Mt Arthur Coal provides information about the operation through the BHP website at <https://www.bhp.com/sustainability/environment/regulatory-information/>, including project approval documents, blast schedules, coal transport information, Community Consultative Committee (CCC) meeting minutes, community complaint records, environmental monitoring information, independent environmental audits, environmental management plans, EPBC compliance reports and Annual Reviews. Note that the Annual Coal Transport Report is now provided as part of this Annual Review in Appendix 4.

Community Consultative Committee

During the reporting period, Mt Arthur Coal coordinated four CCC meetings in accordance with the Community Consultative Committee Guidelines (DPIE, 2016). In the reporting period, the CCC meetings were held:

- 9 September 2019
- 22 November 2019
- 13 February 2020
- 7 May 2020

Mt Arthur Coal also participated in two Joint CCC meetings with Maxwell Infrastructure Malabar Coal held on:

- 11 December 2019
- 10 June 2020.

9.2 Community Investment

During the reporting period Mt Arthur Coal voluntary contributed \$237,085 USD to the local community. Central to Mt Arthur Coal's commitment to the local community is its Voluntary Planning Agreement (VPA) with MSC, of which an additional \$583,824 USD is provided annually toward the Mt Arthur Coal Community Fund. Established under the *Environmental Planning and Assessment Act 1979*, the VPA contributes to public amenities and services that may be impacted by the growth of mining operations.

BHP Vital Resources Fund

In response to COVID-19, BHP established the Vital Resources Fund to support regional communities in areas in which it operates which are facing the challenges of the COVID-19 pandemic. Through the Fund, BHP contributed almost \$1million to the Hunter Region to support nine projects to address immediate impacts from the COVID-19 pandemic. The projects focussed on emergency services, business capability, health, education and community services.

Local Buying Program

Through the Local Buying Program, Mt Arthur Coal continues to engage and support small eligible local businesses through procuring goods and services, with \$18 million of approved spend in FY20 across the three shires of Muswellbrook, Upper Hunter and Singleton.

10. Independent Audit

An independent environmental audit was undertaken at Mt Arthur Coal in June 2017, covering the audit period between 1 July 2014 and 30 June 2017. The audit was undertaken by an audit team led by Peter Horn from Jacobs, approved by the former DPIE. The audit assessed the environmental performance of the project and compliance with the conditions of the project approval, EPL and mining leases including associated assessments, plans or programs. It also reviewed the adequacy of strategies, plans or programs required under these approvals.

The following summary of the audit results was provided in the audit report (Jacobs, April 2018):

“A total of 1,446 conditions and commitments were assessed as part of this audit. 41 issues resulted in 46 non-compliances, of which 33 of the non-compliances were administrative.

A basic risk assessment was conducted for all non-compliances with Low/Medium/High risk levels provided as results. For the non-compliances that were not administrative, there were 8 Low and 5 Medium results. No High risk non-compliances were identified in the audit.

Complaints have reduced over the previous few years results (apart from a spike in complaints in 2015-16). Reportable incidents totalled 7 in the audit period, with the incidents closed out adequately.”

The audit report together with Mt Arthur Coal's response to audit issues resulting in non-compliances and audit recommendations is available on the BHP website. Audit actions completed during the reporting period are presented in Table 34. Progress on audit actions that are still outstanding is presented in Table 35. Audit actions reported as completed in the FY19 Annual Review have not been included in this report.

Of the 32 actions agreed with the DPIE 18 of them have been completed. The remaining actions will be completed in FY21.

Preparations for the next Independent Environmental Audit commenced during the reporting period for the period between 1 July 2017 and 30 June 2020. The audit is expected to be completed and submitted to DPIE during FY21.

Table 34: Completed 2017 Independent Environmental Audit issues

Audit report reference	Issue	Audit finding	Conditions and commitments found not compliant	Status
Section 4.1, Table 5 Item 1 (page 9) / Section 4.2, Table 6 Item 2 (page 12)	Due to an administrative Non-compliance in the Noise Management Plan, the DPIE consider it not implemented.	Not Compliant Administrative	PA 09_0062 Schedule 3 Condition 9	Complete The revised Noise Management Plan was submitted to the DPIE for approval in June 2019.
Section 4.1, Table 5 Item 5 (page 9) / Section 4.2, Table 6 Item 5 (page 12)	The site was not able to demonstrate the coordination of air quality management with neighbouring mines Drayton, Mangoola and Bengalla. MAC is involved in the Upper Hunter Mining Dialogue.	Not Compliant Low Risk	PA 09_0062 Schedule 3 Condition 23(g)	Complete A protocol to coordinate air quality management was developed in August 2019.
Section 4.1, Table 5 Item 6 (page 10) / Section 4.2, Table 6 Item 6 (page 13)	Due to a Non-compliance in the Air Quality Management Plan, DPIE consider it not implemented.	Not Compliant Low Risk	PA 09_0062 Schedule 3 Condition 24	Complete The revised Air Quality Management Plan was approved by the DPIE on 25 January 2019.
Section 4.1, Table 5 Item 9 (page 10) / Section 4.2, Table 6 Item 9 (page 13)	Due to an administrative Non-compliance in the Biodiversity Management Plan, DPIE consider it not implemented.	Not Compliant Administrative	PA 09_0062 Schedule 3 Condition 40	Complete The revised Biodiversity Management Plan was approved by the DPIE on 22 May 2019.
Section 4.1, Table 5 Item 5 (page 9) / Section 4.2, Table 6 Item 10 (page 12)	The Biodiversity Management Plan does not include: 1) Details for targeted rehabilitation efforts in creeks and drainage lines. 2) Detail on the proposed landscaping associated with public roads.	Not Compliant Administrative	PA 09_0062 Schedule 3 Condition 40(c)	Complete The revised Biodiversity Management Plan was approved by the DPIE on 22 May 2019. The revised Plan includes Section 11.3.2 Management of landscaping to reduce visual impacts and Section 11.3.3 Rehabilitation of creeks and drainage lines following mining.
Section 4.1, Table 5 Item 24 (page 11) / Section 4.22, Table 12 Item 3 (page 21)	Evidence was not provided of the submission of an air quality report with the EPL 11457 Annual return.	Not Compliant Administrative	AQGGMP S5	Complete No specific air quality monitoring report is required by the EPA to be submitted with the Annual Return. Any exceedances or non-compliances are detailed in the Annual Return forms. The revised Air Quality Management Plan was approved by the DPIE on 25 January 2019.
Section 4.1, Table 5 Item 25 (page 11) / Section 4.24, Table 13 Item 2 (page 21)	No evidence of the audit of the Blast Management Plan (every 3 years) in the audit period.	Not Compliant Administrative	BMP App 5 S8	Complete The Mt Arthur Coal Document Management System records all required reviews of management plans listed in PA 09_0062.

Audit report reference	Issue	Audit finding	Conditions and commitments found not compliant	Status
				The revised Blast Management Plan was approved by the DPIE during the previous reporting period.
Section 4.1, Table 5 Item 26 (page 11) / Section 4.24, Table 13 Item 1 (page 21)	Contractors engaged in undertaking drill and blast tasks at MAC are required to understand and follow the Blast Management Plan but no evidence of this was able to be provided.	Not Compliant Low Risk	BMP App 5 S7	Complete In line with the site's training matrix relevant contractors have been trained in blast procedures relevant to their role in FY19.
Section 4.1, Table 5 Item 30 (page 11) / Section 4.28, Table 15 Item 3 (page 23)	The audit team were not able to determine whether all reviews required by Section 7 of the AHMP had been completed.	Not Compliant Administrative	AHMP S7.0	Complete The Mt Arthur Coal Document Management System records all required reviews of management plans listed in PA 09_0062.
Section 4.1, Table 5 Item 31 (page 11) / Section 4.29, Table 16 Item 1 (page 24)	It was not able to be established if all the required reviews of the European Heritage Management plan had taken place.	Not Compliant Administrative	EHMP S6	Complete The Mt Arthur Coal Document Management System records all required reviews of management plans listed in PA 09_0062.
Section 4.1, Table 5 Item 34 (page 11) / Section 4.32, Table 18 Item 1 (page 23) / Section 4.45, Table 26 Item 2 (page 30)	The audit team were not able to verify that all of the required reviews of the NMP had taken place.	Not Compliant Administrative	NMP S9.2	Complete Mt Arthur Coal submitted the NMP to the DPIE for approval in January 2019. The Mt Arthur Coal Document Management System records all required reviews of management plans listed in PA 09_0062.
		Not Compliant Administrative	EA 2013 S4.10.3	
Section 4.1, Table 5 Item 36 (page 11) / Section 4.36, Table 20 Item 1 (page 26)	The audit team were not able to verify that all of the required reviews of the WMP had taken place.	Not Compliant Administrative	Site WMP S10	Complete DPIE requested the management plans be submitted in a controlled manner rather than as a group and Mt Arthur Coal remains in consultation with DPIE for the approval of the Noise Management Plan. The revised Water Management Plan is awaiting submission. The Mt Arthur Coal Document Management System records all required reviews of management plans listed in PA 09_0062.
Section 4.1, Table 5 Item 37 (page 11) / Section 4.37, Table 21 Item 1 (page 27)	Evidence of the annual review of the Surface Water and Groundwater Response Plan was not able to be provided.	Not Compliant Administrative	Surface Water and Ground Water Response Plan S1.2	Complete DPIE requested the management plans be submitted in a controlled manner rather than as a group and Mt Arthur Coal remains in consultation with DPIE for the approval of the Noise Management Plan. The revised Water Management Plan, which now incorporates the Surface

Audit report reference	Issue	Audit finding	Conditions and commitments found not compliant	Status
				Water and Groundwater Response Plan, is awaiting submission. The Mt Arthur Coal Document Management System records all required reviews of management plans listed in PA 09_0062.
Section 4.1, Table 5 Item 38 (page 11) / Section 4.38, Table 22 Item 1 (page 27)	Evidence of the annual review of the Surface Water Monitoring Program was not able to be provided.	Not Compliant Administrative	Surface WMP S1.2	Complete DPIE requested the management plans be submitted in a controlled manner rather than as a group and Mt Arthur Coal remains in consultation with DPIE for the approval of the Noise Management Plan. The revised Water Management Plan, which now incorporates the Surface Water Monitoring Program, is awaiting submission. The Mt Arthur Coal Document Management System records all required reviews of management plans listed in PA 09_0062.
Section 4.1, Table 5 Item 39 (page 12) / Section 4.40, Table 23 Item 1 (page 28)	Evidence of the annual review of the Biodiversity MP was not able to be provided.	Not Compliant Administrative	Biodiversity MP S11	Complete The revised Biodiversity Management Plan was approved by the DPIE on 22 May 2019.
Section 4.1, Table 5 Item 1 (page 9) / Section 4.2, Table 6 Item 1 (page 12)	A comprehensive system utilising meteorological monitoring and predictive forecasting for noise management was not in place at the time of the audit.	Not Compliant Low Risk	PA 09_0062 Schedule 3 Condition 8(b)	Complete A noise forecasting tool has been developed and implemented.
Section 4.1, Table 5 Item 35 (page 11) / Section 4.35, Table 19 Item 1 (page 26)	The site water balance requires updating and has not been updated since 2012.	Not Compliant Low Risk	Site Water Balance S2.2.2	Completed The site water balance model was updated and a calibration completed in January 2018. The corresponding Site Water Balance management document has been updated accordingly with the WMP. Action assigned (completion of WMP review DPIE dependent).

Audit report reference	Issue	Audit finding	Conditions and commitments found not compliant	Status
Section 4.1, Table 5 Item 33 (page 11) / Section 4.31, Table 17 Item 1 (page 25)	Evidence of an annual review of the Groundwater Monitoring Program was not able to be provided.	Not Compliant Administrative	GMP S1.2	<p>Completed</p> <p>The Mt Arthur Coal Document Management System records all required reviews of management plans listed in PA 09_0062.</p> <p>The Interim Monitoring Program of the upgraded monitoring network concluded February 2018. An assessment and analysis of interim monitoring program data has been completed. Sufficient reference dataset has been collected to revise and set new groundwater triggers and monitoring frequency. A further review of the GW model has been under taken in 2020. The Groundwater Monitoring Program has been revised and submitted with the updated WMP. DPIE are currently assessing the submitted WMP.</p> <p>Action assigned (completion of WMP review DPIE dependent).</p>

Table 35: Progress on outstanding 2017 Independent Environmental Audit issues

Audit report reference	Issue	Audit finding	Conditions and commitments found not compliant	Status
Section 4.1, Table 5 Item 7 (page 10) / Section 4.2, Table 6 Item 7 (page 13)	Due to a Non-compliance in the Water Management Plan, DPIE consider it not implemented	Not Compliant Low Risk	PA 09_0062 Schedule 3 Condition 29	<p>In progress</p> <p>A draft revised Water Management Plan (WMP) was submitted to DPIE in April 2020 and is currently under assessment. There have been delays in progressing management plan reviews as DPIE have requested that the revised management plans be submitted sequentially to avoid overloading the reviewers.</p> <p>Action assigned (completion of WMP review DPIE dependent).</p>
Section 4.1, Table 5 Item 12 (page 10) / Section 4.2, Table 6 Item 12 (page 15)	Due to an administrative Non-compliance in the Aboriginal Heritage Management Plan, DPIE consider it not implemented.	Not Compliant Administrative	PA 09_0062 Schedule 3 Condition 45	<p>In progress</p> <p>The Aboriginal Heritage Management Plan (AHMP) is currently being reviewed and revised by Mt Arthur Coal, in consultation with OEH, the Aboriginal community, MSC and relevant landowners.</p> <p>The DPIE have requested that the revised management plans for review be submitted sequentially to avoid overloading the reviewers.</p>

Audit report reference	Issue	Audit finding	Conditions and commitments found not compliant	Status
				The Management plan reviews have been completed in FY2020 however due to Covid 19 consultation with the Aboriginal community has not been able to be conducted. Feedback from DPIE has been that the submission of the AHMP be delayed till consultation with the community is able to be undertaken. Action assigned (completion of AHMP review DPIE dependent).
Section 4.1, Table 5 Item 13 (page 10) / Section 4.2, Table 6 Item 13 (page 15)	Due to an administrative Non-compliance in the Environmental Management Strategy, DPIE consider it not implemented.	Not Compliant Administrative	PA 09_0062 Schedule 5 Condition 1	In Progress A draft revised Environmental Management Strategy was submitted to DPIE in August 2020 and is currently under assessment. There have been delays in progressing management plan reviews as DPIE have requested that the revised management plans be submitted sequentially to avoid overloading the reviewers. Action assigned (completion of WMP review DPIE dependent).
Section 4.1, Table 5 Item 16 (page 10) / Section 4.7, Table 8 Items 1 and 5 (page 17) / Section 4.8, Table 9 Items 1 (page 18)	There was no evidence of the approval of flow metering devices by NSW Office of Water (or DPI Water).	Not Compliant Low Risk	Water Licence 20BL171995 C2	In progress Further investigation into this groundwater licence condition and Mt Arthur Coal's compliance with it will be undertaken. The Office of Water will be notified of the outcomes of the investigation and any specific actions/due dates that come out of it. Action assigned
		Not Compliant Administrative	Water Licence 20BL171995 C8	
		Not Compliant Administrative	Water Licence 20BL168155 C7	
Section 4.1, Table 5 Item 17 (page 10) / Section 4.7, Table 8 Item 2 (page 17)	There was no evidence of the provision of maps or plans showing the location of works associated with water licences.	Not Compliant Administrative	Water Licence 20BL171995 C3	In progress Further investigation into this groundwater licence condition and Mt Arthur Coal's compliance with it will be undertaken. The Office of Water will be notified of the outcomes of the investigation and any specific actions/due dates that come out of it. Action assigned
Section 4.1, Table 5 Item 18 (page 10) / Section 4.7, Table 8 Item 3 (page 17)	Not all documents developed by the site to address the requirement to minimise ongoing seepage of alluvial groundwater to the mine works were approved by the NSW Office of Water (or DPI Water), specifically the MOP.	Not Compliant Administrative	Water Licence 20BL171995 C5	In progress Further investigation into this groundwater licence condition and Mt Arthur Coal's compliance with it will be undertaken. The Office of Water will be notified of the outcomes of the investigation and any specific actions/due dates that come out of it. Action assigned

Audit report reference	Issue	Audit finding	Conditions and commitments found not compliant	Status
Section 4.1, Table 5 Item 19 (page 10) / Section 4.7, Table 8 Item 4 (page 17)	Water licence compliance reports were not submitted.	Not Compliant Medium Risk	Water Licence 20BL171995 C7	<p>In progress</p> <p>Further investigation into this groundwater licence condition and Mt Arthur Coal's compliance with it will be undertaken. The Office of Water will be notified of the outcomes of the investigation and any specific actions/due dates that come out of it.</p> <p>Action assigned</p>
Section 4.1, Table 5 Item 27 (page 11) / Section 4.26, Table 14 Item 1 (page 22)	The EMS needs to be updated as it quotes procedures that were no longer used and could not be found.	Not Compliant Administrative	EMS Table 2	<p>In Progress</p> <p>A draft revised Environmental Management Strategy with an updated document register was submitted to DPIE in August 2020 and is currently under assessment. There have been delays in progressing management plan reviews as DPIE have requested that the revised management plans be submitted sequentially to avoid overloading the reviewers. The DPIE also prioritised post approval document review for sites requiring critical updates</p> <p>Action assigned (completion of WMP review DPIE dependent).</p>
Section 4.1, Table 5 Item 28 (page 11) / Section 4.28, Table 15 Item 1 (page 22)	The Thomas Mitchell Drive offset area has been fenced in accordance with the AHMP but the access protocols were not determined through consultation with the Indigenous Stakeholders.	Not Compliant Administrative	AHMP S5.1	<p>In Progress</p> <p>The Aboriginal Heritage Management Plan (AHMP) is currently being reviewed and revised by Mt Arthur Coal, in consultation with OEH, the Aboriginal community, MSC and relevant landowners.</p> <p>The DPIE have requested that the revised management plans for review be submitted sequentially to avoid overloading the reviewers.</p> <p>Additional delays have occurred due to Covid restricting consultation with Stakeholders.</p> <p>Action assigned (completion of AHMP review DPIE dependent).</p>
Section 4.1, Table 5 Item 29 (page 11) / Section 4.28, Table 15 Item 2 (page 23)	The commitments from Section 5.8 of the AHMP are not followed through in the site induction package.	Not Compliant Administrative	AHMP S5.8	<p>In Progress</p> <p>Mt Arthur Coal is going through the process of updating induction requirements for all of site in a complete overhaul of the induction process. This will include assigning requirements for all levels of staff regarding environmental and cultural heritage awareness.</p> <p>Mt Arthur Coal will update the site induction package accordingly.</p> <p>In the interim a site-wide notice was issued on 22 August 2019 communicating cultural heritage requirements on site, the purpose being to refresh everyone on the commitments outlined in Section 5.8 of the Aboriginal Heritage Management Plan.</p> <p>Action assigned</p>

Audit report reference	Issue	Audit finding	Conditions and commitments found not compliant	Status
Section 4.1, Table 5 Item 31 (page 11) / Section 4.28, Table 15 Item 4 (page 23)	The offset management plans do not refer to Cultural Heritage issues.	Not Compliant Administrative	AHMP App 4	<p>In progress</p> <p>The Aboriginal Heritage Management Plan (AHMP) is currently being reviewed and revised by Mt Arthur Coal, in consultation with OEH, the Aboriginal community, MSC and relevant landowners.</p> <p>The DPIE have requested that the revised management plans for review be submitted sequentially to avoid overloading the reviewers.</p> <p>Additional delays have occurred due to Covid restricting consultation with Stakeholders. Action assigned (completion of AHMP review DPIE dependent).</p>
Section 4.1, Table 5 Item 41 (page 12) / Section 4.45, Table 26 Item 1 (page 30)	The Aboriginal Heritage Management Plan should have been updated in consultation with the Aboriginal community and the OEH to specify management and mitigation measures relevant to the 2013 Modification area.	Not Compliant Administrative	EA 2013 S4.7.3	<p>In progress</p> <p>The Aboriginal Heritage Management Plan (AHMP) is currently being reviewed and revised by Mt Arthur Coal, in consultation with OEH, the Aboriginal community, MSC and relevant landowners.</p> <p>The DPIE have requested that the revised management plans for review be submitted sequentially to avoid overloading the reviewers.</p> <p>Action assigned (completion of AHMP review DPIE dependent).</p>

11. Incidents and Non-compliances

Blast Overpressure Exceedance

On 8 August 2019 there was an exceedance of the 120dBL overpressure limited recorded at Sheppard Ave (120.5dBL).

An investigation was undertaken by external blasting experts which determined that there was significant wind interference which caused the elevated level.

The exceedance was report to the EPA and DPIE. DPIE have undertaken an investigation with no further regulatory action being undertaken.

Implementation of Air Quality Management Plan

Air quality investigation reports were submitted to DPIE for 10 and 11 of December 2019. The reports showed that there were no recorded actions in response to a level 3 alarm from the dust monitoring system.

DPIE have undertaken an investigation and determined that this was a failure to comply with Schedule 3, Condition 24 of MP09_0062 by failing to implement the approved Air Quality Management plan to the satisfaction of the Secretary on 10, 11 and 16 December 2019.

DPIE have issued an official caution in relation to this matter.

Clearing outside of Ancillary disturbance boundary

In early January 2020, a contractor undertaking clearing at MAC cleared an area of approximately 250m² beyond the pegged disturbance limit, which was also beyond the approved MAC disturbance boundary.

This has been assessed to be a failure to comply with Schedule 3, Condition 40 of Project Approval MP 09_0062 by failing to implement the approved Biodiversity Management Plan (BMP) to the satisfaction of the Secretary.

Section 11.3.1 of the approved BMP refers to the MAC Land Management Procedure, which details control measures to be implemented during vegetation clearing.

DPIE have issued an official caution in relation to this matter.

Uncontrolled Discharge of Water

On 23 January a leak from the Environment Dam to Belmont pit line was identified. Water was observed flowing along the inside of the Denman Rd visual bund, then through a rock lined drainage point and silt fence to a set of culverts under Denman Rd. Assessment determined that there was no material harm to the environment.

The incident was reported to the EPA and DPIE. DPIE have determined that the EPA is the appropriate regulatory authority to administer the incident investigation.

At the time of reporting the investigation is still underway with the EPA. MAC have provided information to the EPA and an action plan to reduce the risk of a similar events occurring in the future.

Uncontrolled Discharge of Water

On 6 February, an excavator was burying a mine water pipeline across the old conveyor access road. As the excavator was completing the task, the bucket clipped the pipe causing it to rupture. The pump connected to the pipe was switched off and the pipeline was not in use at the time the event occurred. Therefore, there was only a minimal amount of residual water in the pipe at the time it was damaged. Water contained within the pipe at the time of the event flowed 160m down the conveyor corridor with a small volume entering Saddlers Creek. The majority of the

water discharged from the line was contained within the conveyor corridor. Saddlers Creek had no water in it at the time of the event. There was no pooling due to the small volume of water that reached the creek which immediately soaked into the soil. Water samples were collected directly from the pipe and sent for analysis. An assessment was completed which found no material harm to the environment.

The incident was reported to the EPA and DPIE, there has been no regulatory action undertaken by either agency at this time.

Groundwater Management Plan Monitoring Schedule

A number of non-compliances with regards to collection of manual water level data and collection of water quality sample data. Although the FY18 Annual Review stated that groundwater trigger values were revised following the completion of the interim monitoring program and would be applied for the FY19 monitoring period, instead the currently approved GWMP dated 28 April 2015 is applicable for the FY19 monitoring period. The revised trigger values will not be applied until further review and subsequent approval by the DPIE.

In anticipation of moving to the revised site Water Management Plan in FY21, Mt Arthur Coal adjusted the sampling frequency to quarterly instead of bi-monthly and also adjusted the sampling requirements at some of the sites as recommended by the independent consultant. This premature implementation of the revised site Water Management Plan resulted in a number of non-compliances with regards to collection of manual water level data and collection of water quality sample data, which is discussed in further detail in Section 7.4

12. Activities during Next Reporting Period

Mt Arthur Coal has established the following targets for the next reporting period:

- Undertake update to the Site Law database and predictive blast model, allowing for increased accuracy in determining the vibration and overpressure at the design stage;
- Undertake review of the Blast Matrices, Pre Blast Approval procedure and Approval to Blast Form which will improve the blast impact risk identification process undertaken prior to each blast and reduce the risk of impacts to community and environment as a result of the blasting improvements to the sites current predictive meteorological model; and
- Investigate the use of remote sensing in the assessment of landform stability as part of the review of the
- REMP and complete the review of the aerial weed assessment.
- Undertake a review of the groundwater monitoring program be rationalised based on recent findings and additional newly installed bores.
- Review the WMP to ensure consistency between the field program and management plan.
- Review the condition and instrumentation of groundwater bores based on the recommendations the of the annual review assessment report.
- Relocate one of the environment dam to Belmont mine water lines to the toe of VD5.

These targets will be closely monitored and an update on the status of each will be reported in the next Annual Review. The above four actions have all been assigned a completion date of 30 June 2021. No changes to any management plans will be required as a result of the abovementioned actions.

Table 36 outlines a progress summary of Mt Arthur Coal's performance against targets set for the FY20 period.

Table 36: Mt Arthur Coal's performance against targets for FY20

Target	Status	Performance
Undertake flyrock modelling to assist in reducing the probability and impact of blast overpressure events	Complete	Orica undertook an investigation in January 2020
Undertake improvements to the sites current predictive meteorological model	Completed	Fume, Dust Blast Risk modelling reviewed.
Establish competency of front line leadership and Integrated Remote Operations Centre (IROC) in License to Operate risk management	Completed	IROC have a fully integrated response model.
Embed Licence to Operate risk control effectiveness testing	In Progress	To be completed in FY21
Fit for purpose monitoring systems within the Environment Data Monitoring System Project	In Progress	To be completed in FY21
Drive rehabilitation on trajectory to closure – based on ecological development monitoring	Completed	Monitoring program updated detailed tracking and maintenance scheduling included

Appendix 1 – Surface Water Quality Monitoring Results

Surface Water Quality Results

Site	Month	Date sampled	Flow (description)	Field pH	Field EC (uS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Sulfate (mg/L)	Dissolved Fe (mg/L)	Total Fe (mg/L)	Nitrate (mg/L)	O&G (mg/L)
SW02	Jul-19	16 and 17/7/2019											
	Aug-19	20 and 21/8/2019											
	Sep-19	16 and 17/9/2019											
	Oct-19	14 and 15/10/2019											
	Nov-19	18 and 19/11/2019											
	Dec-19	16 and 17/12/2019											
	Jan-20	21 and 22/01/2020											
	Feb-20	18 and 19/2/2020											
	Mar-20	16 and 17/03/2020											
	Apr-20	20, 21 and 22/04/2020											
	May-20	18 and 19/05/2020											
	Jun-20	16 and 17/06/2020											
	Impact Assessment Criteria Trigger Values		Stage 1 Trigger	6.5 < >9.0	12365		219						
			Stage 2 Trigger		13900		277						
SW03	Jul-19	16 and 17/7/2019	Still	7.89	3905	2480	19	5.5	853	0.08	1.01	0.01	<5
	Aug-19	20 and 21/8/2019	Still	7.91	4100	2830	7	2.6	894	0.06	0.26	0.02	7
	Sep-19	16 and 17/9/2019	Still	7.71	4740	3360	<5	5.2	704	0.07	0.67	0.01	<5
	Oct-19	14 and 15/10/2019	Still	7.51	5630	3900	8	5.6	1400	0.1	0.69	<0.01	<5
	Nov-19	18 and 19/11/2019	Still	7.88	7780	5840	7	5.8	1800	0.16	0.71	0.01	<5
	Dec-19	16 and 17/12/2019	Still	8.02	12300*	6980	14	12.3	2110	0.22	1.04	<0.01	<5
	Jan-20	21 and 22/01/2020											
	Feb-20	18 and 19/2/2020	Still	7.68	10400	7180	<5	6.6	2570	0.41	0.98	<0.01	<5
	Mar-20	16 and 17/03/2020	Still	7.63	7520	7420	<5	2.3	2920	0.11	0.29	<0.01	<5
	Apr-20	20, 21 and 22/04/2020											
	May-20	18 and 19/05/2020											
	Jun-20	16 and 17/06/2020	Still	7.68	6790	4410	19	8.8	1620	0.09	0.48	<0.01	<5

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Site	Month	Date sampled	Flow (description)	Field pH	Field EC (uS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Sulfate (mg/L)	Dissolved Fe (mg/L)	Total Fe (mg/L)	Nitrate (mg/L)	O&G (mg/L)
	Impact Assessment Criteria Trigger Values		Stage 1 Trigger	6.5< >9.0	10133		37						
			Stage 2 Trigger		11402		46						
SW04	Jul-19	16 and 17/7/2019											
	Aug-19	20 and 21/8/2019											
	Sep-19	16 and 17/9/2019											
	Oct-19	14 and 15/10/2019											
	Nov-19	18 and 19/11/2019											
	Dec-19	16 and 17/12/2019											
	Jan-20	21 and 22/01/2020											
	Feb-20	18 and 19/2/2020	Still	7.39	477	382	15	27.1	45	0.13	0.6	0.8	<5
	Mar-20	16 and 17/03/2020	Still	8.26	3620	2700	22	22.6	939	0.35	1.62	<0.01	<5
	Apr-20	20, 21 and 22/04/2020	Still	8.46	954	517	8	5.7	151	0.07	8.37	<0.01	<5
	May-20	18 and 19/05/2020											
	Jun-20	16 and 17/06/2020	Still	7.73	474	313	16	72.9	67	0.12	2.6	0.95	<5
	Impact Assessment Criteria Trigger Values		Stage 1 Trigger	6.5< >9.0	13959		82						
			Stage 2 Trigger		15509		104						
SW12	Jul-19	16 and 17/7/2019	Still	7.66	3001	1840	8	2.5	783	0.08	0.36	0.01	<5
	Aug-19	20 and 21/8/2019	Still	7.56	3110	1910	14	8.4	947	<0.05	1.26	0.05	<5
	Sep-19	16 and 17/9/2019	Still	7.53	3820	2580	12	4.8	702	0.3	0.9	0.06	<5
	Oct-19	14 and 15/10/2019	Still	7.45	4640	3370	36	19.7	1490	<0.05	1.33	0.01	<5
	Nov-19	18 and 19/11/2019											
	Dec-19	16 and 17/12/2019											
	Jan-20	21 and 22/01/2020											
	Feb-20	18 and 19/2/2020	Still	7.33	1185	710	17	10.1	332	0.31	0.64	<0.01	<5
	Mar-20	16 and 17/03/2020	Still	6.96	2091	1830	13	8.3	827	0.26	3.44	0.02	<5
	Apr-20	20, 21 and 22/04/2020	Still	7.07	1841	1170	8	3.8	444	0.16	4.23	<0.01	<5
	May-20	18 and 19/05/2020	Still	7.47	2489	1520	<5	0.4	558	<0.05	<0.05	<0.01	<5
	Jun-20	16 and 17/06/2020	Still	7.33	789	490	44	104	254	0.06	1.96	1.92	<5

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Site	Month	Date sampled	Flow (description)	Field pH	Field EC (uS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Sulfate (mg/L)	Dissolved Fe (mg/L)	Total Fe (mg/L)	Nitrate (mg/L)	O&G (mg/L)
	Impact Assessment Criteria Trigger Values		Stage 1 Trigger	6.5< >9.0	6659		555						
			Stage 2 Trigger		7153		708						
SW15	Jul-19	16 and 17/7/2019	Dam	7.76	1068	595	<5	3	145	0.33	1.03	<0.01	<5
	Aug-19	20 and 21/8/2019	Dam	7.92	1360	801	8	3.8	221	0.34	1.47	0.03	6
	Sep-19	16 and 17/9/2019											
	Oct-19	14 and 15/10/2019											
	Nov-19	18 and 19/11/2019											
	Dec-19	16 and 17/12/2019											
	Jan-20	21 and 22/01/2020											
	Feb-20	18 and 19/2/2020	Dam	7.72	508	312	12	42.4	63	0.18	0.85	0.47	<5
	Mar-20	16 and 17/03/2020	Dam	7.48	671	472	14	5.4	26	0.63	1.55	<0.01	<5
	Apr-20	20, 21 and 22/04/2020	Dam	7.49	575	372	<5	2.6	56	0.28	0.64	<0.01	<5
	May-20	18 and 19/05/2020	Dam	7.48	547	350	<5	0.8	45	0.13	0.23	<0.01	<5
	Jun-20	16 and 17/06/2020	Dam	7.65	676	328	<5	13.5	72	0.12	0.7	0.04	<5
	Impact Assessment Criteria Trigger Values		Stage 1 Trigger	6.5< >9.0	7128		103						
			Stage 2 Trigger		8262		130						

Unable to sample due to dry or low water level

* invalid due to level.

Appendix 2 – Ground Water Monitoring Results and Groundwater Level Drawdown Analysis

MT ARTHUR COAL

Annual Groundwater Review - 2019/2020

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with BHP (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
660.20103.00000-R01-v3.0	23 September 2020	Kirsty Cooksey	Claire Stephenson	Claire Stephenson
660.20103.00000-R01-v3.0	23 September 2020	Kirsty Cooksey	Claire Stephenson	Claire Stephenson
660.20103.00000-R01-v2.0	18 September 2020	Kirsty Cooksey	Claire Stephenson	Claire Stephenson
660.20103.00000-R01-v1.0	11 August 2020	Kirsty Cooksey	Claire Stephenson	Claire Stephenson

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1 Introduction

1.1 Overview

Mt Arthur Coal (MAC) Mine is located approximately 5 kilometres south-west of Muswellbrook within the Muswellbrook Shire Local Government Area in the Upper Hunter Valley of NSW. MAC consists of open cut pits, a coal handling preparation plant, a rail loop and associated rail loading facilities, in addition to an approved underground operation.

SLR Consulting Pty Ltd (SLR) have been engaged to undertake a review of the groundwater monitoring data collected from July 2019 to June 2020 to satisfy the conditions of approval relating to groundwater, and as a requirement of MACs 2019/2020 Annual Environmental Management Review (AEMR).

1.2 Scope of Works

The scope of works involves preparation of a standalone compliance report for MAC groundwater annual review from July 2019 to June 2020, including:

- Comparison between modelled and observed water levels to June 2020;
- Compare monitoring data to drawdown predictions for the Mt Arthur Coal Consolidation Project Environmental Assessment and the current modelling for the approved operations;
- Review site water quality monitoring data, field reports and laboratory reports and check performance;
- Review of groundwater triggers and report on any trigger exceedances, where review will be based on both the current established groundwater triggers for the site; and
- Review performance of the cut-off wall using available data.

2 Hydrogeological Setting

2.1 Climate

The climate at MAC is sub-tropical with higher temperatures, higher rainfall and higher evaporation occurring over the summer months (December to February). Bureau of Meteorology (BoM) data has been obtained for site (Latitude -32.35 Longitude 150.85) and used to evaluate the climatic conditions at MAC and surrounds using the long-term data (**Table 1**). The data was obtained through the Scientific Information for Landowners (SILO) database, from 01/01/1900 to 31/12/2019. The SILO database provides the most complete long term dataset and is therefore the most useful for assessing long term rainfall trends in the vicinity of the Project Area. Based on the SILO dataset, average annual rainfall is 654 mm, with slightly higher rainfall over the summer months, from December to February.

Table 1 Average Monthly Rainfall (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
SILO*	77	71	62	46	41	50	44	38	43	55	60	67	654

Note: * Based on SILO dataset date range January 1900 to May 2020

2.2 Terrain and Drainage

The surface topography at MAC varies between approximately 127 metres (m) Australian Height Datum (AHD) to the north-west of site along Whites Creek and rises up to a maximum approximately 465 mAHD on the top of Mt Arthur to the south of the site. Within the Project Area, the surface areas are drained by Saddlers Creek and its tributaries to the south-east, as well as Quarry Creek, Whites Creek and Ramrod Creek. All creeks drain toward the Hunter River, Ramrod Creek, Quarry Creek and Whites Creek.

2.2.1 Saddlers Creek

Saddlers Creek is generally 5 m to 10 m wide and consists of sand, silt and scattered woody debris (EcoLogical, 2019). Saddlers Creek is classified as ephemeral, with the creek bed dry much of the year, with shallow (20 cm deep) pools of water in isolated areas. Saddlers Creek generally acts as a losing stream. However, within the lower reaches of the creek, near the confluence with the Hunter River, gaining conditions may occur. Historically, high flow events occurred in response to rainfall events, with available data indicating the majority of stream flow occurred in the summer months, from January to March, with negligible flows from July to December.

2.2.2 Hunter River

Within the region, the Hunter River is around 20 m to 50 m wide, and the river flows in a south to south-easterly direction. Flows within the Hunter River are monitored at gauging stations under the Hunter Integrated Telemetry System (HITS) operated by WaterNSW. Hunter River has perennial flows, with flows generally ranging between 100 ML/day and 1,000 ML/day. Recent high flow/flood events, with flows over 2,000 ML/day, were recorded along the Hunter River in May 2001, June 2007, September 2008, June 2011 and March 2013.

2.3 Hydrogeology

2.3.1 Hunter River Alluvium

Unconfined aquifer that comprises surficial clays, basal sands and gravels. Groundwater flow generally follows the Hunter River flow direction and topography. Groundwater is around 5 m to 10 m below surface and generally 2 m below the base of the river, indicating losing conditions. However, this can vary spatially and temporally dependent on peak flood events. Fresh to brackish water quality.

2.3.2 Saddlers Creek Alluvium

Unconfined aquifer recharged from rainfall and occasional streamflow, as well as potential recharge from water storage in localised areas. Water levels around 3 m to 10 m below surface, with potential baseflow contributions at lower reaches near confluence with Hunter River. Generally moderately saline water quality.

2.3.3 Permian Coal Measures

Hydrogeologically 'tight' interburden units with aquitard properties and coal sequences that exhibit water bearing properties associated with secondary porosity through cracks and fissures. Confined to semi-confined where occur at subcrop to the north and east of MAC. Recharged by rainfall and downward seepage from overlying strata (alluvium, regolith and backfilled spoil). Regionally the hydraulic gradient in the coal measures is towards the south, but locally influenced by mining at Drayton, MAC and Bengalla. Drawdown currently extends around 2 km south-west of MAC. Groundwater is generally moderately saline.

3 Groundwater Monitoring Program

3.1 Management Plan and Triggers

Over the review period groundwater monitoring and reporting was conducted at Mt Arthur in accordance with the Mt Arthur Coal Groundwater Monitoring Program (GWMP), MAC-ENC-PRO-062, released 28th April 2015.

Comparison of the trigger levels from the GWMP 2015 are presented in **Table 2**. The trigger levels for electrical conductivity (EC) include Stage 1 and Stage 2 triggers as part of the exceedance protocol. Stage 1 are preliminary triggers for early detection of changes in water quality, while Stage 2 trigger exceedances require notification to DPIE of an 'interim exceedance' and consultation on whether a written report on the exceedances is required. The groundwater monitoring network is further discussed in **Section 3.2** and presented in **Appendix A**.

This annual review focuses on the network and triggers within the current approved 2015 GWMP. A review of the triggers was previously conducted and recommendations to update the triggers documented by AGE (2018). Since then additional work has been conducted on site, including installation of new monitoring bores and review of the condition of bores and data. It is understood that further review of the triggers will be conducted in 2020.

Table 2 Trigger Levels

Analyte	GWMP 2015
Water level	Individual bore drawdown trigger levels and groundwater elevation trigger: i. three or more alluvial bore water levels all below the specified trigger values in one round of monitoring OR water levels in any alluvial bore fall below the specified trigger values for three consecutive readings; or ii. water levels in any fractured rock bore fall below the specified trigger values for two consecutive readings.
pH	pH value is outside the range of 6.5 – 9.0 for three consecutive readings.
Electrical Conductivity (EC)	Stage 1 EC: measured values that have a 95% probability of being different from those already measured.
	Stage 2 EC: measured values that have a 99% probability of being different from those already measured.

3.2 Groundwater Monitoring Network

The groundwater monitoring network at MAC is comprised of a series of monitoring bores and vibrating wire piezometers (VWPs), as presented in **Appendix A** and shown in **Figure 1**. The groundwater monitoring network outlined within the 2015 GWMP include:

- 38 monitoring bores, including:
 - Three bores along Saddlers Creek alluvium, one of which intersects both alluvium and regolith (GW46);

- Eight bores within Hunter River alluvium, one of which intersects both alluvium and regolith (GW42);
- 25 monitoring bores predominantly targeting coal seams down to the Ramrod Creek Seam;
- Two bores within tailings (GW26, GW27);
- Seven VVPs with sensors in the interburden and coal seams, including:
 - Three sites (VVP1, VVP2 and VVP3) around mapped F4 fault with sensors from 30 m to 66 m depth in Ramrod Creek Seam, Eddinglassie Seam and the fault zone; and
 - Four sites (VVP4 to VVP7) south-west of MAC open cut with sensors in the different coal seams.

Monitoring of groundwater levels and groundwater quality is to be undertaken at the bores/piezometers specified in the 2015 GWMP, MAC-ENC-PRO-062 and defined below:

- Groundwater Level – manual groundwater elevation/depth to groundwater every two months, pressure transducers continuous every six hours, VVP data logger download, and verification and validation of instrument drift and correction;
- Groundwater Quality Analysis (Standard) – 6 monthly – water temperature, pH, EC, TDS, TSS, iron, sulphate, chloride, calcium, magnesium, potassium, sodium, carbonate and bicarbonate; and
- Groundwater Quality Analysis (Comprehensive) – 6 monthly – Total phosphorus, aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, selenium and zinc. All metals and metalloids required as dissolved analytes.

Data loggers have been installed in representative monitoring bores in the alluvial aquifers and Permian coal measures for continuous depth to water measurement via either a pressure transducer (with barometric pressure correction) or vibrating wire piezometers (VVP). The monitoring schedule allows groundwater levels to be assessed in terms of impacts on regional aquifers, alluvial aquifers (Hunter River and Saddlers Creek alluvial aquifers) and private users. According to the 2015 GWMP regional background monitoring is to be completed at bores GW25 (north of site), GW41A and GW41P (north west of site), BCGW10, BCGW11, BCGW22 (west of site) and BCGW05 and BCGW15 (south west of site)

3.3 Data Recovery

The 2015 GWMP specifies the monitoring frequency and trigger levels for groundwater level and groundwater quality for the monitoring network. This includes water quality monitoring at 30 bores and water level monitoring at 40 bores and seven VVPs, as shown in **Appendix A**.

Over the reporting period 26 of the 40 bores to be monitored for water level, and 18 of the 30 bores to be monitored for water quality were monitored as specified in the 2015 GWMP. The sites with a data capture rate of less than 100 per cent are also outlined in **Table 3**. Discussion on where data was not recovered is included below:

- Requirements for monitoring at bores BCGW05, BCGW10, BCGW11 and BCGW15 was contingent on landholder access in the GWMP, and over the monitoring period these bores were not accessible. The inability to access these bores was assessed in the AGE (2018) report and determined that they could be removed from the monitoring network with no detrimental impact to the program.
- Bore GW8 is located on the highwall of the open cut pit and was mined out.

- Bore GW22 was found to be in poor condition and the bore decommissioned around 2016.
- Bore GW23 was reviewed by AGE (2018) and found to be constructed with screen at three intervals (16.2 – 19.2, 30.2 – 34.2 and 46 – 49 mbgl) and therefore recommended to be removed from the network for water quality monitoring but maintained for water levels.
- Bore BCGW18 was also found to be dry over the reporting period, and bore GW25 blocked from Q3.
- No data was provided for the two tailings bores GW26 and GW27 as replacement bores were proposed by AGE (2018) for improved long-term monitoring. These replacement bores were installed in 2020.
- Bore GW42 that intersects both alluvium and regolith was not monitored over the reporting period. This was based on the findings from the AGE (2018) report that recommended bore GW42 be removed from the groundwater monitoring network due to its construction, and a replacement bore installed. Additional alluvial bores were installed in the area in 2020.
- It is noted that bores GW40P and GW41P were not specified in the 2015 GWMP monitoring schedule for water quality, but do have a trigger assigned. Due to this discrepancy it is unclear if the bores should or should not be included in the network. Review of the bore logs shows they were constructed with 25 mm casing, but decommissioned in 2005 and grouted up.

The sites with a data capture rate of less than 100 per cent are also outlined in **Table 3**.

Table 3 Groundwater Monitoring Data Recovery

Location	Type	Data Recovery	Comprehensive Analysis Done	Comments
BCGW05	SWL, WQ	0%	No	No bore access, previously reviewed by AGE (2018)
BCGW10	SWL, WQ	0%	No	No bore access, previously reviewed by AGE (2018)
BCGW11	SWL, WQ	0%	No	No bore access, previously reviewed by AGE (2018)
BCGW15	SWL, WQ	0%	No	No bore access, previously reviewed by AGE (2018)
BCGW18	WQ	0%	No	Insufficient water to sample for comprehensive analysis
BCGW19	SWL	75%	-	Logger failed in Q4 and since replaced
BCGW22A	WQ	0%	No	Unknown reason for no comprehensive analysis
EWPC33	WQ	0%	No	Insufficient water to sample for comprehensive analysis
GW7	SWL	75%	-	Logger failed in Q4, but manual dipped levels provided
GW8	SWL, WQ	0%	No	Mined out
GW22	SWL, WQ	0%	No	Decommissioned bore
GW23	WQ	0%	No	Water level recorded only. Recommended by AGE (2018) to discontinue water quality monitoring due to bore construction issues.
GW25	SWL, WQ	50%	No	Bore blocked in Q3 and Q4
GW26	SWL, WQ	0%	No	No data provided, replacement bores installed in 2020
GW27	SWL, WQ	0%	No	No data provided, replacement bores installed in 2020
GW43	WQ	0%	No	Water level recorded only. Recommended by AGE (2018) to discontinue water quality monitoring but purpose of bore undergoing further review.

GW44	WQ	0%	No	Water level recorded only. Recommended by AGE (2018) to discontinue water quality monitoring due to bore construction issues.
GW42	WQ	0%	No	Bore previously recommended by AGE (2018) to be replaced as crosses alluvium and regolith. New bores installed in 2020 in area.
VWP1	SWL	0%	-	Logger not functioning. Sensor within Edinglassie Seam that is also monitored at adjacent VWP3.
Barometric Logger	Barometric Pressure	50%	-	Barometric logger failed, replacement logger to be installed. Logger data has been adjusted using manual dip data to enable representative groundwater level trend analysis for the annual review.

4 Groundwater Levels

Groundwater levels for the 2015 GWMP compliance bore network are summarised in **Table 4** and in **Appendix B**. The monitoring locations are shown on **Figure 1**. **Appendix B** summarises:

- Bore details – surveyed location, elevation, depth and target formation;
- Groundwater levels measured in each bore (initial measurement, July 2019 and June 2020);
- Change in groundwater levels since records commenced and for the period July 2019 to June 2020;
- Monitoring bores where triggers have been exceeded for July 2019 to June 2020;
- Groundwater levels predicted by the numerical model for July 2019 to June 2020; and
- Difference in groundwater levels predicted by the numerical model and measured in the monitoring network.

Table 4 Groundwater Level Monitoring Results

Aquifer	Bore ID	Depth to Water (mBTOC)		
		Min	Max	Avg
Hunter River Alluvium	GW16	9.43	9.65	9.58
	GW21	9.38	9.74	9.60
	GW25	10.48	10.86	10.58
	GW38A (IW4030)	9.97	10.03	10.00
	GW39A	9.23	9.40	9.35
	GW40A	10.33	10.44	10.37
	GW41A (IW4029)	7.45	7.54	7.51
	GW42 (alluvium and regolith)	9.65	10.35	10.00
Saddlers Creek Alluvium	GW45	12.32	12.55	12.45
	GW47	7.90	8.14	8.06
	GW46 (alluvium and regolith)	9.26	9.68	9.48
	BCGW05	No bore access, previously reviewed by AGE (2018)		
	BCGW10	No bore access, previously reviewed by AGE (2018)		
	BCGW11	No bore access, previously reviewed by AGE (2018)		
	BCGW15	No bore access, previously reviewed by AGE (2018)		
Permian Coal Measures	BCGW18	11.16	11.46	11.38
	BCGW19	6.40	7.50	7.00
	BCGW22P (IW4026)	6.16	6.65	6.45
	EWPC33	33.21	33.69	33.49
	GW2	11.49	11.81	11.65
	GW3	11.30	11.70	11.50
	GW6	24.00	24.41	24.19
	GW7	46.29	46.48	46.41
	GW8	Mined out		
	GW22	Decommissioned		
	GW23	49.93	49.96	49.95
	GW26	No data provided, replacement bores installed in 2020		
	GW27	No data provided, replacement bores installed in 2020		
	GW38P	10.18	10.41	10.31

Aquifer	Bore ID	Depth to Water (mBTC)		
		Min	Max	Avg
	GW39P	10.35	11.60	10.76
	GW43	29.74	30.42	30.14
	GW44	106.75	109.79	108.25
	GW48	10.88	10.97	10.92
	GW49	7.85	7.97	7.93
	OD1078 (IW4028)	35.20	35.90	35.70
	OD1078-piezo	50.00	51.90	51.00
	OD1079-piezo	58.40	60.80	60.00
Spoil	OD1079S (IW4031)	39.70	40.00	39.90

4.1 Drawdown

Observed drawdown based on site observation bore levels from the start of monitoring and June 2020. Drawdown in the alluvium is shown in **Figure 2** and drawdown in the Permian coal measures is shown in **Figure 3**. **Figure 3** shows that observed drawdown in the Permian coal measures extends to the west of the active mining area and is moving to the south-west with progression of the mining activities to the south-west. The extent of drawdown is reduced in some locations associated with in-pit water storage (Belmont and MacDonald pits).

4.1.1 Trigger Exceedances

Water level data collected from July 2019 to June 2020 have been compared to the trigger values outlined in the GWMP 2015. The general purpose of these plans is to minimise any adverse impacts on aquifers in proximity to the operation and early indication of adverse impacts. Five bores recorded a water level exceedance over the reporting period: GW23, BCGW18, OD1078P (IW4028), OD1078-Piezo, VWP2 and VWP3.

Trigger exceedances have been reviewed by comparing water level and climatic indicated by a monthly cumulative rainfall departure plot. A cumulative rainfall departure (CRD) rainfall plot is provided on all graphs to illustrate long term climate trends in the MAC area. The CRD graphically shows trends in recorded rainfall compared to long-term averages and provides a historical record of relatively wet and dry periods. A rising trend in slope in the CRD graph indicates periods of rainfall above the long term average, whilst a declining slope indicates periods when rainfall is below the long term average. A level slope indicates average rainfall conditions. Graphs of groundwater elevation for all monitoring bores are contained in **Appendix C**. An analysis of the trigger exceedances is included in **Table 5**.

**MT ARTHUR COAL
AEMR - 2019/2020**

**Groundwater Drawdown between
Start of Monitoring and June 2020
Alluvium**

FIGURE 2

- Alluvium Monitoring Locations
- Spoil Monitoring Location
- Cut-off Wall
- Watercourses
- MAC Extent
- Surrounding Mines
- Revised Alluvium Extent (SLR)



0 0.5 1 km

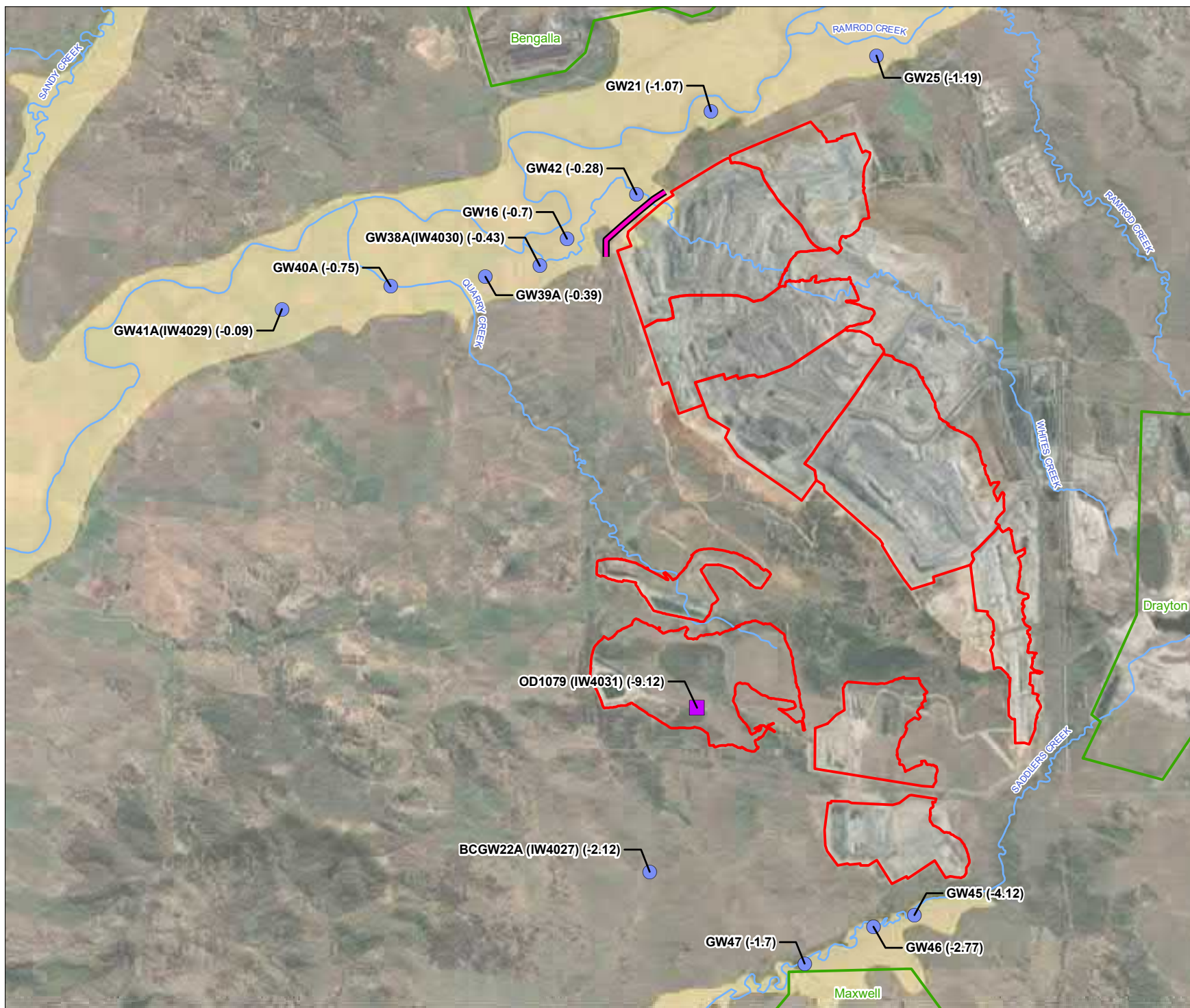
Coordinate System: GDA 1994 MGA Zone 56

Scale: 1:70,000 at A4

Project Number: 660.20103

Date: 10-Aug-2020

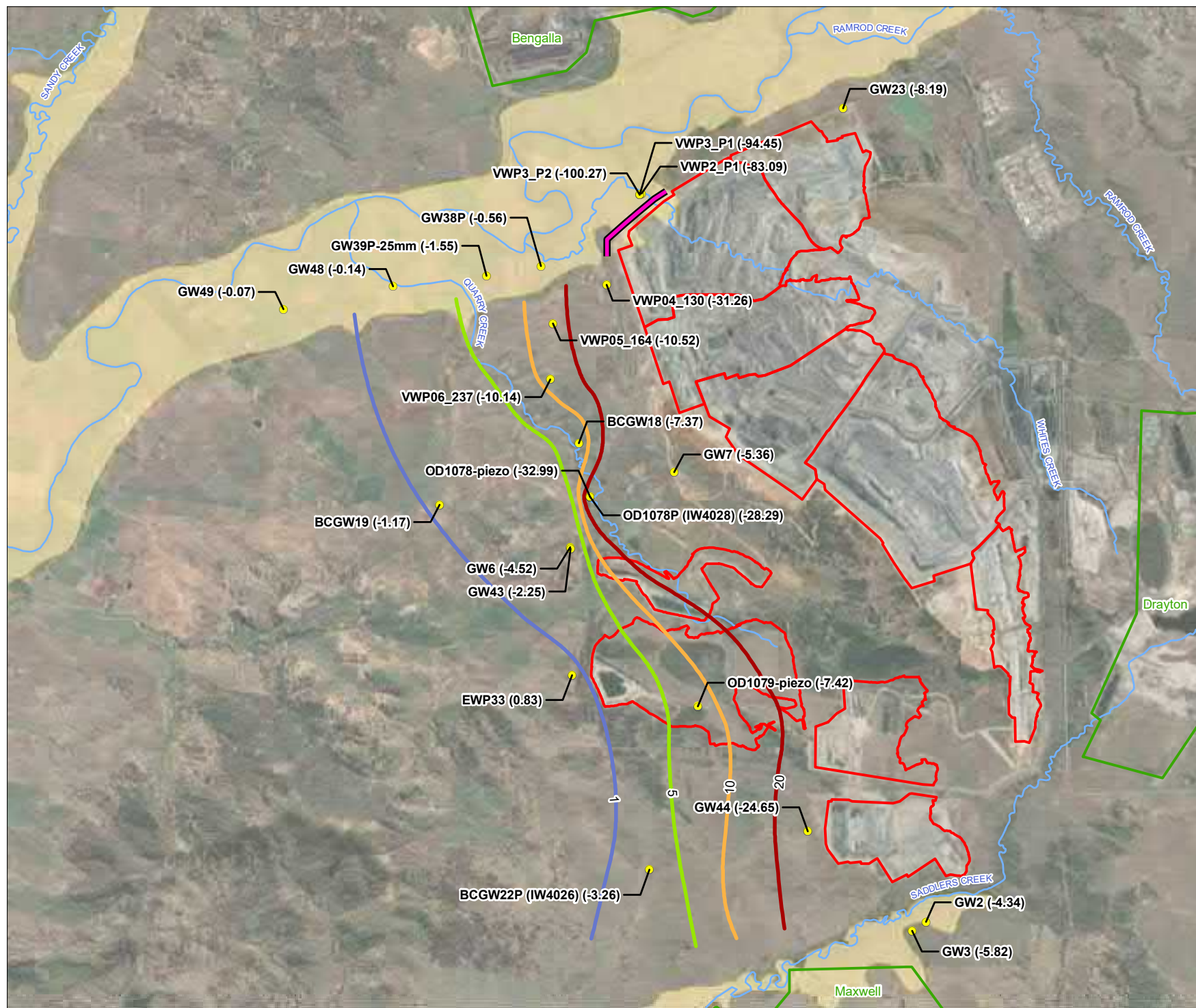
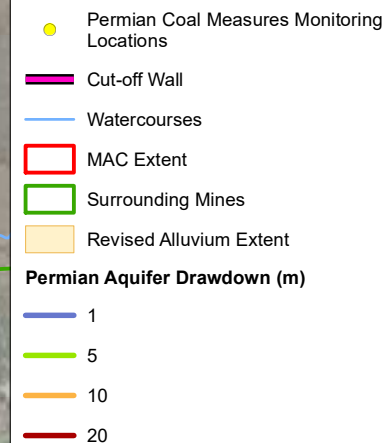
Drawn by: JG



MT ARTHUR COAL AEMR - 2019/2020

Groundwater Drawdown between Start of Monitoring and June 2020 Permian Coal Measures

FIGURE 3



0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 56
Scale: 1:70,000 at A4
Project Number: 660.20103
Date: 10-Aug-2020
Drawn by: JG



Table 5 Groundwater Level Trigger Exceedances

Bore ID	Screened Lithology	Location	Comment
GW2	Woodlands Hill Seam	Saddlers Creek/ Saddlers Pit	The 2015 trigger level is set at 145.4 mAHD for bore GW2, and levels has been recorded below 145.4 mAHD from 2008 to 2011, and since 2015. The bore intersects the Woodlands Hill Seam at around 110 m depth. The bore is located within 700 m of Saddlers Pit and within the extent of predicted depressurisation within the Permian coal measures.
GW3	Woodlands Hill Seam	Saddlers Creek/ Saddlers Pit	The 2015 trigger level is set at 145.3 mAHD for bore GW3, and levels has been recorded below 145.3 mAHD from 2017. The bore intersects the Woodlands Hill Seam at around 120.4 m depth. The bore is located within 730 m of Saddlers Pit and around 250 m downslope of GW2, and within the extent of predicted depressurisation within the Permian coal measures.
GW21	Alluvium	Hunter River	Groundwater levels at bore GW21 that intersects the Hunter River alluvium fell below the groundwater level trigger in Q1 and for two consecutive readings in Q3 and Q4. Groundwater levels at GW21 have regularly fluctuated, and show no clear correlation to rainfall trends but show a close correlation to Hunter River levels. The bore is located within 200 m of the Hunter River, and demonstrates the influence of the river on the adjacent alluvium. No impacts due to mining are visible in the trends.
GW23	Coal (Ramrod Creek)	On site - north of Mt Arthur North (off Denman Rd)	Groundwater levels have remained below the 2015 trigger level of 132.5 mAHD since monitoring began in 2008. Water levels have remained relatively stable since 2016, with a slight (1-2m) rise in water levels in 2016. It is noted that the logger within GW23 shows instrument drift, with levels deviating from manual dipped levels by as much as 6 m since June 2019. This is the first annual review where the issue of instrument drift has been identified. It is recommended that the datalogger be replaced to assist in correlating groundwater trends with rainfall and streamflow trends.
GW39P	Warkworth Seam	Off Denman Rd - Denman Road West	The 2015 trigger level is set at 120.9 mAHD, and levels have been recorded below 120.9 mAHD since 2016. The bore is constructed as a nested bore with a 75 mm screen to 25.5 m within coal (potentially Mt Arthur Seam), and 25 mm casing to 42.1 to just above the Warkworth Seam. It is assumed the results for GW39P are representative of the larger diameter bore to 25.5 m depth, but this should be verified in the field. The bore is located within an irrigated paddock (central pivot) near the Hunter River, approximately 2 km south-west of MAC open pit and within the extent of predicted depressurisation within the Permian coal measures. The bore is near an alluvial bore (GW39A) and previously recorded an upward gradient from the coal measures to the overlying alluvium. Since 2014 a downward gradient has been shown, with groundwater levels within the coal measures declining over time. This decline likely relates to depressurisation of the coal measures with progression of mining. In contrast bore GW39A has recorded relatively stable groundwater levels at around 221.3 mAHD (± 0.1 m), with a recent slight rise in levels in response to above average rainfall.

Bore ID	Screened Lithology	Location	Comment
BCGW18	Arrowfield	On site – south of MAC open pit and along Quarry Creek	<p>The 2015 trigger level is set at 174.4 mAHD and denoted as being at the base of the bore. The GWMP trigger appears to be erroneous and should be set at 147.7 mAHD, which is the actual elevation for the base of the screen in the bore.</p> <p>The bore has recorded a gradual decline in groundwater levels over time, which became more pronounced since 2016, with the bore potentially dry, with levels at or below 147.7 mAHD since January 2019. The bore is located approximately 2 km south of the active mine pit, within the extent of predicted depressurisation within the Permian coal measures.</p>
OD1078-piezo	Bowfield	On site - south west of Mt Arthur North, beside the drainage coming from the Belmont Pit	<p>Groundwater levels have declined by over 33 m since the start of monitoring in 2008. The rate of decline in levels increased rapidly during March 2017 until June 2020 with groundwater levels declining by 25 m during this period. Water levels declined below the 2015 trigger level of 142.3 mAHD in September 2017. The bore is located approximately 2 km south of the active mine pit, within the extent of predicted depressurisation within the Permian coal measures.</p> <p>It is noted that the logger within OD1078-piezo shows instrument drift, with levels deviating from manual dipped levels by as much as 92 m since October 2017. This is the first annual review where the issue of instrument drift has been identified. It is recommended that the datalogger be replaced to assist in correlating groundwater trends with rainfall and streamflow trends.</p>
OD1078P (IW4028)	Arrowfield	On site - south west of Mt Arthur North	<p>Groundwater levels have declined over 15 m since February 2016. Water levels have remained below the 2015 trigger level of 153.5 mAHD since monitoring began. The bore is located approximately 2 km south of the active mine pit, within the extent of predicted depressurisation within the Permian coal measures.</p> <p>It is noted that the logger within OD1078P (IW4028) shows instrument drift, with levels deviating from manual dipped levels by as much as 13 m since November 2018. This is the first annual review where the issue of instrument drift has been reported. It is recommended that the datalogger be replaced to assist in correlating groundwater trends with rainfall and streamflow trends.</p>
VWP2	F4 fault	North of MAC open pit, adjacent to cut-off wall	<p>Levels in the F4 fault exceeded the 2015 trigger level since 2013, with trends consistent with the decline in groundwater head in the coal measures recorded at nearby VWP1 and VWP3.</p> <p>The continuing declining groundwater level trend represents mining induced depressurisation in the Permian coal measures. It is recommended that the water level trigger be reviewed.</p>
VWP3 – 227 m VWP3 – 241m	Edinglassie Ramrod Creek	North of MAC open pit, adjacent to cut-off wall	<p>Levels in both the Edinglassie and Ramrod Creek seams have exceeded the 2015 trigger level since 2013.</p> <p>The continuing declining groundwater level trend represents mining induced depressurisation as is predicted for the approved operations. It is recommended that the water level trigger be reviewed.</p>

* TLE = Trigger Level Exceedance

5 Groundwater Quality

Groundwater quality monitoring is undertaken to manage any impacts of mining of coal measures and associated alluvial aquifers. While under the 2015 GWMP monitoring is required six monthly, samples were collected on a quarterly basis from 18 of the 30 bores that form the current groundwater monitoring network (refer **Appendix A**). A comprehensive water quality analysis is undertaken annually. Discussion on where data was not collected was included in **Section 3.3**, and summarised in **Table 6**.

A summary of groundwater quality (field pH and field EC) for the review period is presented in **Table 6** and a detailed summary of groundwater quality results for the review period are summarised in **Appendix D**.

Table 6 Groundwater Quality Monitoring Results

Aquifer	Bore ID	Field pH			EC (µS/cm)		
		Min	Max	Avg	Min	Max	Avg
Hunter River Alluvium	GW16	6.4	7.4	7.0	3220	4690	3930
	GW21	6.4	7.2	6.9	792	1212	1082
	GW25	6.9	7.1	7.0	6530	6710	6620
	GW38A (IW4030)	6.5	7.5	7.1	3520	4900	4293
	GW39A	6.3	7.1	6.9	5710	7910	6840
	GW40A	6.5	7.4	7.2	3870	5650	4758
	GW41A (IW4029)	6.6	7.6	7.2	4720	10600	7728
	GW42 (<i>alluvium and regolith</i>)	Bore to be decommissioned					
Saddlers Creek Alluvium	GW45	6.3	6.7	6.5	6640	11380	8988
	GW47	7.0	7.2	7.1	3540	4670	4235
	GW46 (<i>alluvium and regolith</i>)	6.9	7.2	7.0	5370	7400	6830
Permian Coal Measures	BCGW05	No bore access, previously reviewed by AGE (2018)					
	BCGW10	No bore access, previously reviewed by AGE (2018)					
	BCGW11	No bore access, previously reviewed by AGE (2018)					
	BCGW15	No bore access, previously reviewed by AGE (2018)					
	BCGW18	Insufficient water to sample					
	BCGW22P (IW4026)	7.1	9.9	8.3	14100	16270	15343
	EWPC33	6.9	7.2	7.0	2456	3040	2845
	GW2	7.4	7.9	7.6	4150	4830	4500
	GW22	Bore decommissioned					
	GW23	No data provided, previously reviewed by AGE (2018)					
	GW26	No data provided, replacement bores installed in 2020					
	GW38P	7.1	7.8	7.5	2157	3040	2646
	GW39P	6.7	7.6	7.3	5030	6750	5920

Aquifer	Bore ID	Field pH			EC (µS/cm)		
		Min	Max	Avg	Min	Max	Avg
	GW43	Water level recorded only, previously reviewed by AGE (2018)					
	GW44	Water level recorded only, previously reviewed by AGE (2018)					
	GW48	6.8	7.7	7.4	3410	4750	4065
	GW49	6.1	7.0	6.7	5200	7530	6223

5.1 Trigger Exceedances

Water quality data collected from July 2019 to June 2020 have been compared to the trigger values outlined in the GWMP 2015. The general purpose of these plans is to minimise any adverse impacts on aquifers in proximity to the operation and early indication of adverse impacts. Seven bores recorded a water quality exceedance over the reporting period: GW2, GW21, GW39A, BCGW22P, GW40A, and GW41A.

Trigger exceedances have been reviewed by comparing water level and climatic indicated by a monthly cumulative rainfall departure plot. Graphs of pH and EC for all monitoring bores are contained in **Appendix E**. An analysis of the trigger exceedances is included in **Table 7**.

Table 7 Groundwater Quality Trigger Exceedances

Bore ID	Screened Lithology	Location	Comment
BCGW22P (IW4026)	Glen Munro	On site - south west of Bayswater No. 3	<p>The bore is over 2 km from the active mine areas and 1 km from a historical rehabilitated pit. EC has an increasing trend, ranging from 8960 $\mu\text{S}/\text{cm}$ in November 2017 to 16270 $\mu\text{S}/\text{cm}$ in June 2020. It is noted that groundwater levels declined over early 2018 but then rapidly rose by 2.66 m between July 2018 and December 2018.</p> <p>The 2015 1st stage trigger level of 15526 $\mu\text{S}/\text{cm}$ was exceeded in March and June 2020.</p> <p>Further review of water quality and potential water sources in the area is recommended. This includes the backfilled pit and water storage within Belmont Pit.</p>
GW2	Woodlands Hill Seam	Saddlers Creek	<p>EC has an increasing trend since June 2015 with fluctuations. Exceeded the EC 2015 1st stage trigger level of 4266 $\mu\text{S}/\text{cm}$ in March 2020 and 2nd stage trigger level of 4440 $\mu\text{S}/\text{cm}$ in June 2020. Groundwater levels declined from 2017 to 2019 in line with below average rainfall; however, levels have remained relatively stable since 2019 despite continued below average rainfall. Further review of the water quality data and water types is recommended.</p>
GW21	Alluvium (Hunter River)	Off Denman Rd - Edinglassie Homestead	<p>pH has been relatively stable since monitoring began, but fell below the 1st stage 2015 trigger level of 6.5 in June 2020 (6.39). EC was relatively stable since monitoring began.</p> <p>Bore GW21 is an alluvial bore and the groundwater level trends show no clear correlation to rainfall trends. As with bore GW16, the bore appears to be within an irrigated farm paddock and the trends may relate to local land use. It is recommended that the condition of the bore and site land use be checked, with information on local irrigation practices collected.</p>
GW39A	Alluvium (Hunter River)	Off Denman Rd - Denman Road West	<p>EC has fluctuated seasonally since monitoring began. Since December 2019 EC has increased and exceeded 2015 2nd stage trigger level of 6740 $\mu\text{S}/\text{cm}$ in March and June 2020.</p> <p>Bore GW39A is an alluvial bore and the groundwater level trends show no clear correlation to rainfall trends. As with bore GW16 and GW21, the bore appears to be within an irrigated farm paddock (central pivot) and the trends may relate to local land use. It is also noted that the bore was hand bailed when sampled, which may have influenced the results. It is recommended that sampling technique be reviewed and the condition of the bore and site land use be checked, with information on local irrigation practices collected.</p>

Bore ID	Screened Lithology	Location	Comment
GW40A	Alluvium (Hunter River)	Hunter River alluvium, west of Mt Arthur Open Cut	<p>EC has fluctuated seasonally since monitoring began. Since September 2019 EC has increased and exceeded the 2015 2nd stage trigger level of 4587 $\mu\text{S}/\text{cm}$ in March and June 2020.</p> <p>Review of water level trends shows a general decline in levels since 2013, despite periods of above average rainfall from 2013 to 2017. The bore is located over 3 km from Mt Arthur mine and the decline in levels is unique compared to bores closer to the mine area (i.e. GW16). The bore is positioned on a private property with infrastructure (houses and sheds). It is recommended that the condition and use of the bore is checked, and water supply use in the area verified.</p>
GW41A (IW4029)	Alluvium (Hunter River)	Hunter River alluvium, west of Mt Arthur Open Cut, west of GW40A	<p>Bore GW41A is located over 5 km from the mine area, and within an agricultural area. The bore log indicates GW41A intersects alluvium and is screened shallower (4.5 to 7.5 mbgl) than the original bore (4.5 to 11.6 mbgl).</p> <p>The original GW41A had a relatively stable EC of 3520 $\mu\text{S}/\text{cm}$ to 5060 $\mu\text{S}/\text{cm}$ from 2008 to 2018, until the bore was decommissioned in July 2018. The replacement bore has recorded an increasing trend in EC since monitoring began in 2016, rising from 815 $\mu\text{S}/\text{cm}$ to 10600 $\mu\text{S}/\text{cm}$. GW41A EC has exceeded the 2015 2nd stage trigger level of 4120 $\mu\text{S}/\text{cm}$ since July 2019.</p> <p>Since January 2020 the bore recorded a decline in pH from 7.5 to 6.5 and a rise in EC from 815 $\mu\text{S}/\text{cm}$ to a peak of 10600 $\mu\text{S}/\text{cm}$ in March 2020. This trend is unique to the bore, and due to this and the distance from the mine, likely relates to local agricultural land use practices. It is also noted that the bore was hand bailed when sampled, which may have influenced the results. It is recommended that sampling technique be reviewed and the condition of the bore is recommended, along with information about local land use and irrigation.</p>

*TLE = Trigger Level Exceedance

6 Quality Assurance Review

The GWMP requires an assessment of the quality assurance measures implemented by Carbon Based Environmental Pty Ltd (CBE) for the quarterly groundwater sampling to identify potential errors with either the sampling methodology or chemical analytical techniques. This review includes:

- Comparison of duplicate samples and calculation of Relative Percentage Difference (RPD) for the laboratory analysis results for each sampling round;
- Review of the CBE groundwater sampling field sheets for assessment of field parameter stabilisation and purging volume for collection for a representative water sample; and
- Review of sample holding times prior to being dispatched to the Australian Laboratory Services Pty Ltd (ALS).

The results of this review are presented in **Appendix D** and summarised in **Table 8**. The results of the QA review are summarised as follows:

- Duplicate sample – duplicate samples were collected and field parameters for pH, electrical conductivity (EC), and temperature (°C) were recorded for each duplicate sample. Improvement in sample naming/records to assist identification of the corresponding bore is recommended.
- Relative Percentage Difference – an exceedance of the RPD greater than 20% was determined for total suspended solids (TSS) in September and December 2019. Assuming the duplicate samples were collected at the same time as the original sample, this would suggest there is a slight variation in suspended solids in the field samples, which may relate to sediment at the base of the bore stirred up. The difference did not impact on the analysis for the reporting period. Generally, even with the RPD exceedances, the duplicate analyses are considered to be representative of one another.
- Holding times – the holding times for all samples ranged from between one and five days, which is within the specified holding times for the parameters analysed. The exception to this is laboratory pH; however, the samples were all analysed for field pH, which is considered a more reliable source of data and has been used for the trigger level review in this report.

Field Parameter Stabilisation – CBE provided sample stabilisation data for all sampling events, except for the 13th and 16th of September 2019. Stabilisation criteria for the field determinations were suitable, with temperature being set at ($\pm 0.2^{\circ}\text{C}$), pH (± 0.1 pH units) and EC ($\pm 5\%$). While September monitoring event did not include stabilisation information, purge volumes were recorded and indicated representative samples were collected. Review of the purge volume data indicates that, on average, three bore volumes were purged for each bore before sampling. Bores where less than three bore volumes of water were purged were most commonly due to dry bores or when hand bailing was implemented. Bore BCGW22 (new) could only be pumped to 44% of the required volume before going dry in every sampling round. Water samples were collected over two weeks following the initial purge.

- In each monitoring round the bores were monitored in a consistent manner and the samples are considered representative of the aquifer at each monitoring location.
- Bore GW25 was unable to be sampled in March and June 2020 as the bore was blocked. Bore BCGW18 was unable to be sampled at all in July 2019 to June 2020 as there was insufficient water.

Table 8 Summary of Quality Assurance Review

Monitoring Round	Field Data	Field Parameter Stabilisation	Frequency of Analyses	Analysis Parameters	Holding Time (days)	Duplicate Sample	Relative Percentage Difference	Comments
Sep-19	WL, T (°C), pH, EC	All samples within parameters.	Quarterly	All samples: pH, EC, TSS, TDS, Cl, Ca, Mg, K, Na, SO ₄ , Alkalinity, Dissolved Fe.	All samples arrived at lab within holding times, except for pH analysis.	EPWC33	Total Suspended Solids: 100%	<p>All bores purged 3 x bore volumes prior to sampling except GW38A, GW39A, GW39P, GW41A (hand bailed), BCGW22 (pumped dry), BCGW18 (dry), EWP33 (issue with pump).</p> <p>Improvements in field records for identifying nested bores (i.e. BCGW22) and duplicate samples are recommended.</p> <p>All samples reached lab below specified temperature of 4 °C, except GW16, GW21, GW38A, GW38P which arrived at 4.2 °C. This variation is unlikely to have impacted on the water quality results, and field pH was recorded during sampling.</p> <p>Field calibration sheets provided except for the 13th and 16th of September 2019. However, purge volumes indicate representative samples were collected.</p> <p>IW4027 - Cl – laboratory MS recovery not determined, background level greater than or equal to 4 x spike level. And IW4027 and GW2 - SO₄ – laboratory MS recovery not determined, background level greater than or equal to 4 x spike level. No exceedances for these analytes were identified during the monitoring round.</p>

Monitoring Round	Field Data	Field Parameter Stabilisation	Frequency of Analyses	Analysis Parameters	Holding Time (days)	Duplicate Sample	Relative Percentage Difference	Comments
Dec-19	WL, T (°C), pH, EC	All samples within parameters.	Quarterly	All samples: pH, EC, TSS, TDS, Cl, Ca, Mg, K, Na, SO ₄ , Alkalinity, Dissolved Fe.	All samples arrived at lab within holding times, except for pH analysis.	GW48	Total Suspended Solids: 100%	<p>All bores purged 3 x bore volumes prior to sampling. Bores GW49 and BCGW22 were sampled after pumped dry, so considered representative. BCGW18 was dry and GW25, GW38A, GW39A, GW38P, GW41A were hand bailed. The hand bailed alluvial bores recorded a rise in EC that may be influenced by the sampling methodology.</p> <p>Improvements in field records for identifying nested bores (i.e. BCGW22) and duplicate samples are recommended.</p> <p>All samples reached lab below specified temperature of 4 °C. Field calibration sheets provided.</p> <p>Comment on field sheet: EWPC33 possibly drawing water from same source as nearby windmill</p>
Mar-20	WL, T (°C), pH, EC	All samples within parameters.	Quarterly	All samples: pH, EC, TSS, TDS, Cl, Ca, Mg, K, Na, SO ₄ , Alkalinity, Dissolved Fe.	All samples arrived at lab within holding times, except for pH analysis.	GW48	No RPDs greater than 20%	<p>All bores purged 3 x bore volumes prior to sampling except GW38A, GW39P, GW41A (hand bailed). Bore GW25 was identified as blocked and BCGW18 as dry.</p> <p>All samples reached lab below specified temperature of 4 °C. Field calibration sheets provided.</p> <p>Duplicate sample site not noted on field sheets.</p>

Monitoring Round	Field Data	Field Parameter Stabilisation	Frequency of Analyses	Analysis Parameters	Holding Time (days)	Duplicate Sample	Relative Percentage Difference	Comments
Jun-20	WL, T (°C), pH, EC	All samples within parameters.	Quarterly	<p>All samples: pH, EC, TSS, TDS, Cl, Ca, Mg, K, Na, SO₄, Alkalinity, Dissolved Fe.</p> <p>BCGW22, GW2, GW16, GW21, GW45, GW46, GW47:</p> <p>Additional analysis of Total P and dissolved metals: As, Cd, Cr, Cu, Ni, Pb, Zn, Hg, Al, Sb, Ba, B, Mo, Se.</p>	All samples arrived at lab within holding times, except for pH analysis.	EPWC33	No RPDs greater than 20%	<p>All bores purged 3 x bore volumes prior to sampling except GW38A, GW39A, GW39P, GW41A, BCGW22 (hand bailed). Bore GW25 recorded as blocked and BCGW18 as dry.</p> <p>Improvements in field records for identifying nested bores (i.e. BCGW22) and duplicate samples are recommended.</p> <p>All samples reached lab below specified temperature of 4 °C. Field calibration sheets provided.</p>

7 Cut-off Wall Performance

A cut-off bentonite barrier wall was constructed between the Huon Open Cut and the Hunter River alluvium in the vicinity of the F4 fault. The purpose of the cut-off wall is to minimise drawdown within the alluvium. VWPs were installed near the cut-off wall to monitor the Permian coal measures underlying the Hunter River alluvium. The sensors monitor:

- VWP1 - Edinglassie Seam (Footwall) to 204.5 m depth (-69.0 mAHD);
- VWP2 - F4 fault to 216.5 m depth (-81.1 mAHD);
- VWP3 - Sensor 1 - Edinglassie Seam (Hanging wall) to 227.0m depth (-91.6 mAHD); and
- VWP3 - Sensor 2 - Ramrod Creek Seam to 241 m depth (-105.6 mAHD).

The location of the VWPs and nearby monitoring bores are shown on **Figure 1**. Although the VWPs were installed in 2011, continuous data has been captured since the end of December 2013. However, the footwall of the Edinglassie Seam is no longer monitored as VWP1 failed in January 2017. The sensor should be replaced to continue monitoring in this area.

Figure 4 shows groundwater levels have declined 83 m in the F4 Fault, 97 m in the Edinglassie Seam and 103 m in the Ramrod Creek Seam since installation in 2011. Bore GW42 intersects alluvium and shallow weathered sandstone (regolith) and is located adjacent to the VWPs. Groundwater levels at GW42 remained fairly stable, with a minor increase of 0.32 m since February 2016 (**Figure 5**). As noted in previous reviews, bore GW42 fluctuates in response to rainfall and streamflow trends. Depressurisation observed in the Permian coal measures has not impacted on alluvium and regolith groundwater levels at GW42.

Depressurisation observed in the Permian coal measures also does not appear to have impacted on alluvium groundwater levels as shown by the relatively stable groundwater level trends shown by bores GW16 and GW21. However, as noted earlier these bores may also be influenced by local agricultural land use with enhanced recharge through irrigation. Regardless, the alluvial monitoring shows no adverse impact on the alluvial groundwater conditions and beneficial use of groundwater.

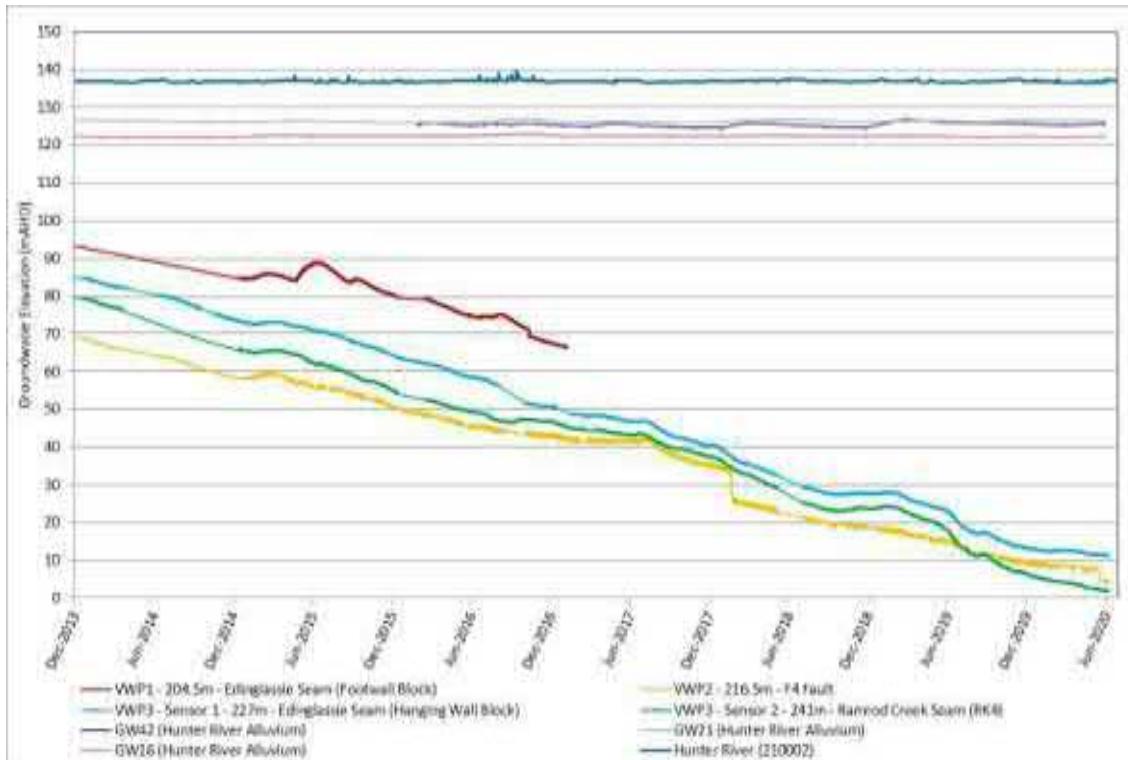


Figure 4 Permian Coal Measures Groundwater Levels Adjacent to Cut-off Wall

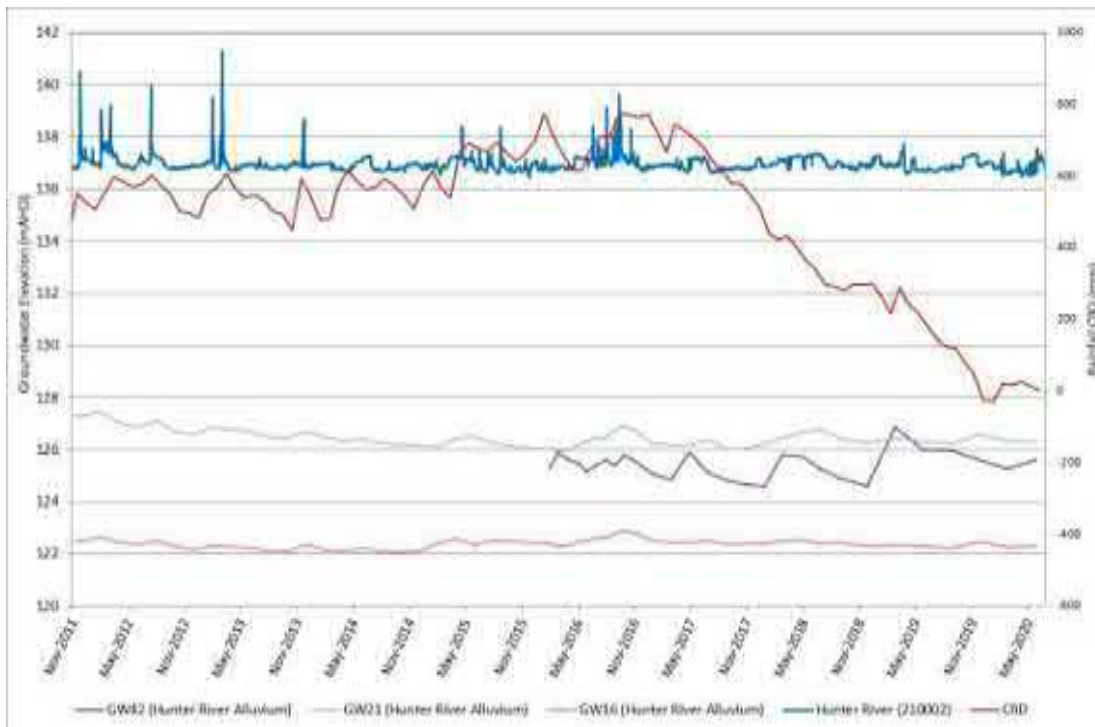


Figure 5 Hunter River Alluvium Groundwater Levels Adjacent to Cut-off Wall

8 Review of Numerical Model Predictions

The WMP requires a review of groundwater level predictions, which are calculated using a groundwater model to support the current mining. To validate the model, the predictions are required to be compared on an annual basis to the measured groundwater level data obtained from the monitoring program.

A groundwater assessment was conducted by AGE (2013) that captured all approved open cut and underground mining at Mt Arthur Mine, and included approved operations at Bengalla Mine. AGE (2013) concluded that approved operations at the Mt Arthur Mine would drawdown groundwater levels within 2 km of active mine operations. AGE (2013) also found that drawdown associated with operations at Bengalla Mine, to the north of Mt Arthur Mine, would not interact with drawdown at Mt Arthur Mine. There were no reported potential impacts on GDEs as a result of the Mt Arthur Mine (AGE, 2013). Drawdown at privately owned bores due to operations at Mt Arthur Mine was predicted. Less than 1 m drawdown was predicted at all privately owned bores intersecting alluvium and used for stock water supply and irrigation (**Figure 6**). Greater than 2 m drawdown was predicted at some privately owned bores intersecting the Permian coal measures and used for stock water supply (**Figure 7**).

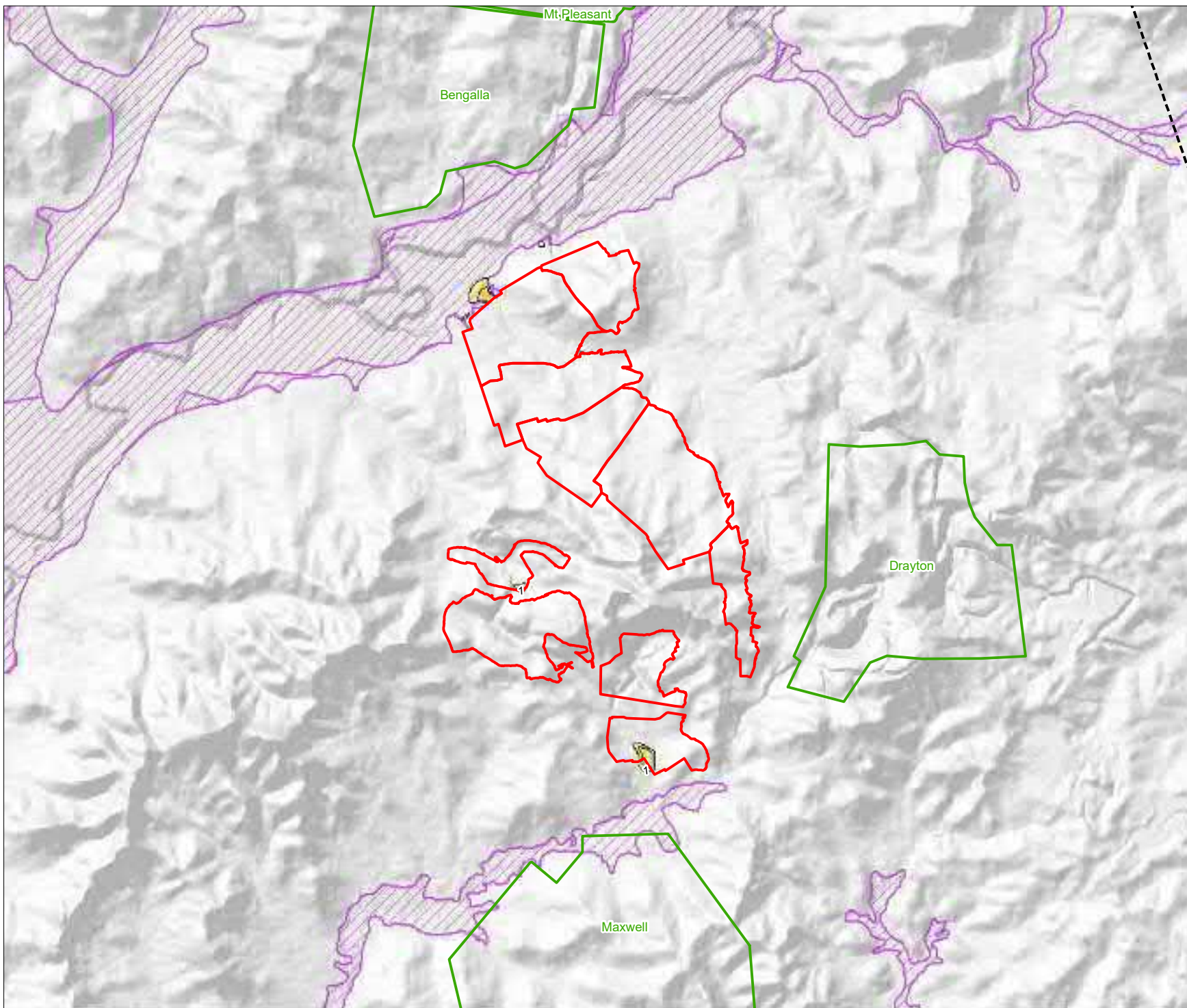
A review of the groundwater model was conducted by AGE (2020) and found that improvements could be made to the hydrogeological layers, model domain, geology and structure features, layer pinching/continuity, and surface water/groundwater interaction. SLR (2020) were engaged by BHP to develop a numerical groundwater model for Mt Arthur mine that included calibration of observed groundwater levels to June 2020. The model was developed in MODFLOW-USG with steady state and transient calibration with a good fit to historical water level and mine inflow data. The updated model predicted:

- Negligible groundwater drawdown in the alluvial of Saddlers Creek consistent with previous predictions;
- Localised drawdown of up to 5 m within the alluvium along Hunter River. The extent of predicted water table drawdown is consistent compared to the previous predictions for approved operations by AGE (2013);
- No impacts predicted on landholder bores intersecting alluvium; predicted reduction in groundwater levels at three BHP owned bores that intersect the Permian coal measures;
- Negligible reductions in surface water flows/balance resulting from changes in groundwater baseflows to surface stream systems in Saddlers Creek;
- Up to 13.2 ML/year leakage (indirect take) from the Hunter River as a result of depressurisation with mining, which is lower than previously predicted;
- Reduction in upward leakage from the Permian coal measures to the overlying alluvium of the Hunter River by a maximum of 82 ML/year (0.22 ML/day) which is lower than previously predicted by AGE (2013) that predicted between 0.63 ML/day to 0.72 ML/day leakage from Hunter River; and
- Total groundwater inflows to the MAC open cut of approximately 657.5 ML/year on average (between 2020 to 2027) and ranging up to a peak in the order of 1,114 ML/year in 2026. The predicted inflow is largely consistent with the previously predicted average inflows by AGE (2013), which ranged between 711 ML/year to 912 ML/year from 2020 to 2026.

Overall, the updated model predictions are consistent or slightly lower than previously predicted impacts on groundwater by AGE (2013). Further details on the up to date site groundwater model are included in the model report by SLR (2020).

Measured groundwater level elevations for June 2020 were compared to groundwater levels predicted in the current site model (SLR, 2020). The calculated difference between the model prediction and measured levels (residuals) are shown in **Figure 8**. Where the model over predicted levels the values are negative; under prediction is indicated by positive values. **Figure 8** shows that the groundwater model predictions in the Hunter River alluvium compare well to the measured levels. Overall, the residual in the Hunter River alluvium is approximately 5 m. This can be seen in bores GW16, GW25, GW38A, and GW39A. The model also showed a good fit (i.e. less than 1 m difference) between observed and modelled groundwater levels for bore GW42 that intersects alluvium and regolith on the west side of the barrier wall that separates MAC open cut from the Hunter River alluvium. At the same location (i.e. VWP2 and VWP3) modelled groundwater levels in underlying coal seams show a good fit with observed depressurisation. This highlights that the barrier wall has been adequately captured in the model, and the model is able to replicate the vertical gradient and interaction between alluvium/regolith and depressurisation from mining. The model also replicates well the water level for bores within the Saddler Creek Alluvium to the south west of pit. For example, the modelled levels are within 5 m of observed levels at GW45, GW46 and GW47.





With regard to Permian bores, the response to mining is well represented around the MAC pits such as GW38P, GW39P, GW3, VWP04 and GW44. To the west of pit, however, it appears that the model overpredicts water levels at bores GW6 and GW43 and underpredicts at bore GW7. With regards to bore GW6 and GW43, the over-prediction may relate to how water storage is modelled for Belmont Pit, where recharge from in-pit water storage to the surrounding coal measures may be greater than modelled. The reasoning for underprediction in GW7 is not clear and it is recommended that the condition of bore GW7 be checked, including the condition of surface casing and the total depth of the bore.










MT ARTHUR GROUNDWATER

Predicted Maximum Drawdown in Alluvium and Regolith – Project Only

FIGURE 6

-  Model Extent
-  MAC Extent
-  Surrounding Mines
-  Revised Alluvium Extent (SLR)

Maximum Drawdown

-  1 - 2
-  2 - 5
-  5 - 10
-  10 - 20
-  20 - 50
-  50 - 100
-  100 - 200



0 0.5 1
km

Coordinate System: GDA 1994 MGA Zone 56

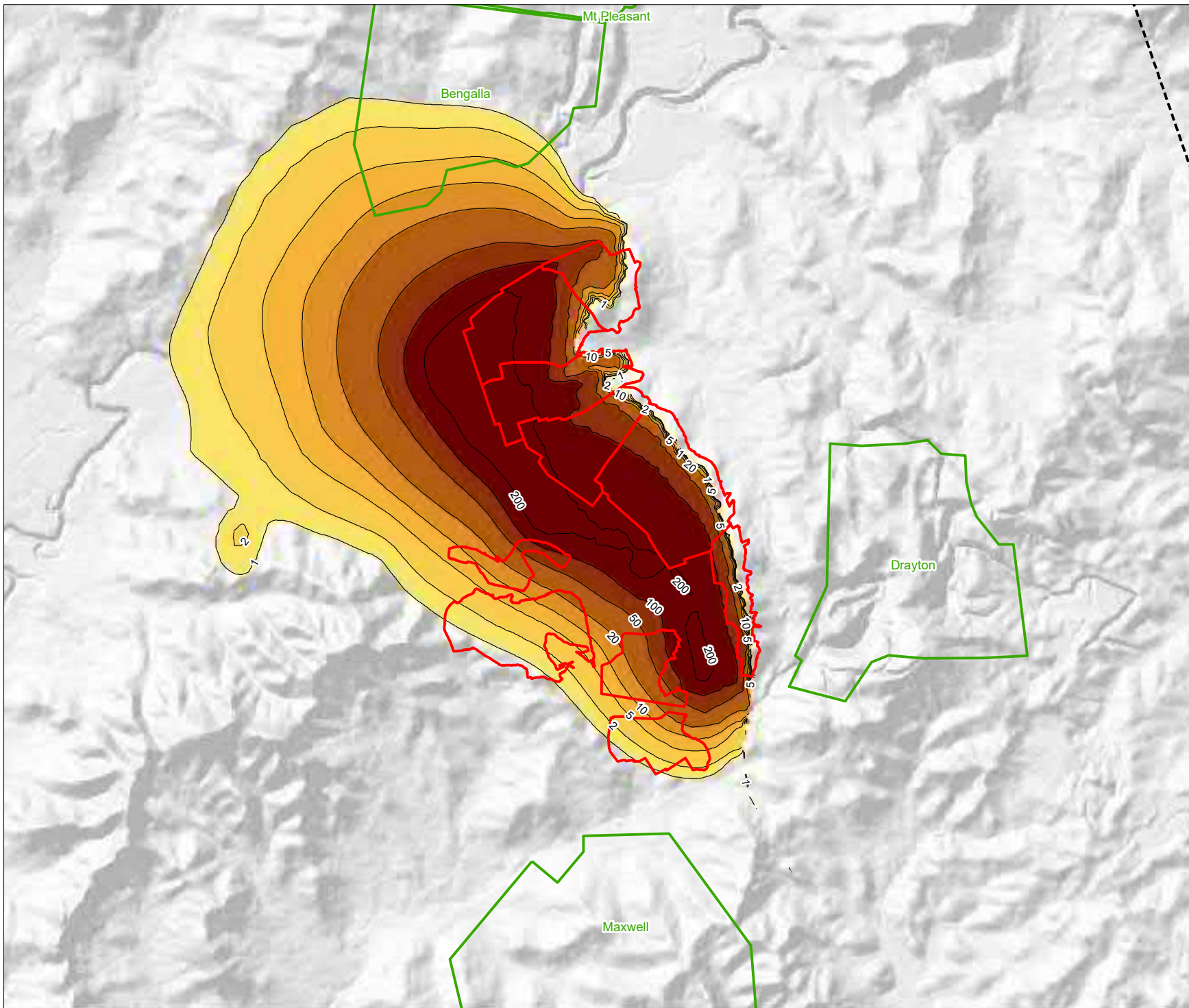
Scale: 1:100,000 at A4

Project Number: 660.20103

Date: 20-Jul-2020

Drawn by: JG

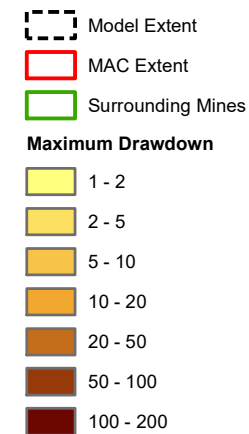




MT ARTHUR GROUNDWATER

Predicted Maximum Drawdown in Ramrod Creek Seam - Project Only

FIGURE 7



0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 56

Scale: 1:100,000 at A4

Project Number: 660.20103

Date: 20-Jul-2020

Drawn by: JG



MT ARTHUR COAL AEMR - 2019/2020

Modelled Heads vs. Measured Heads (June 2020)

FIGURE 8

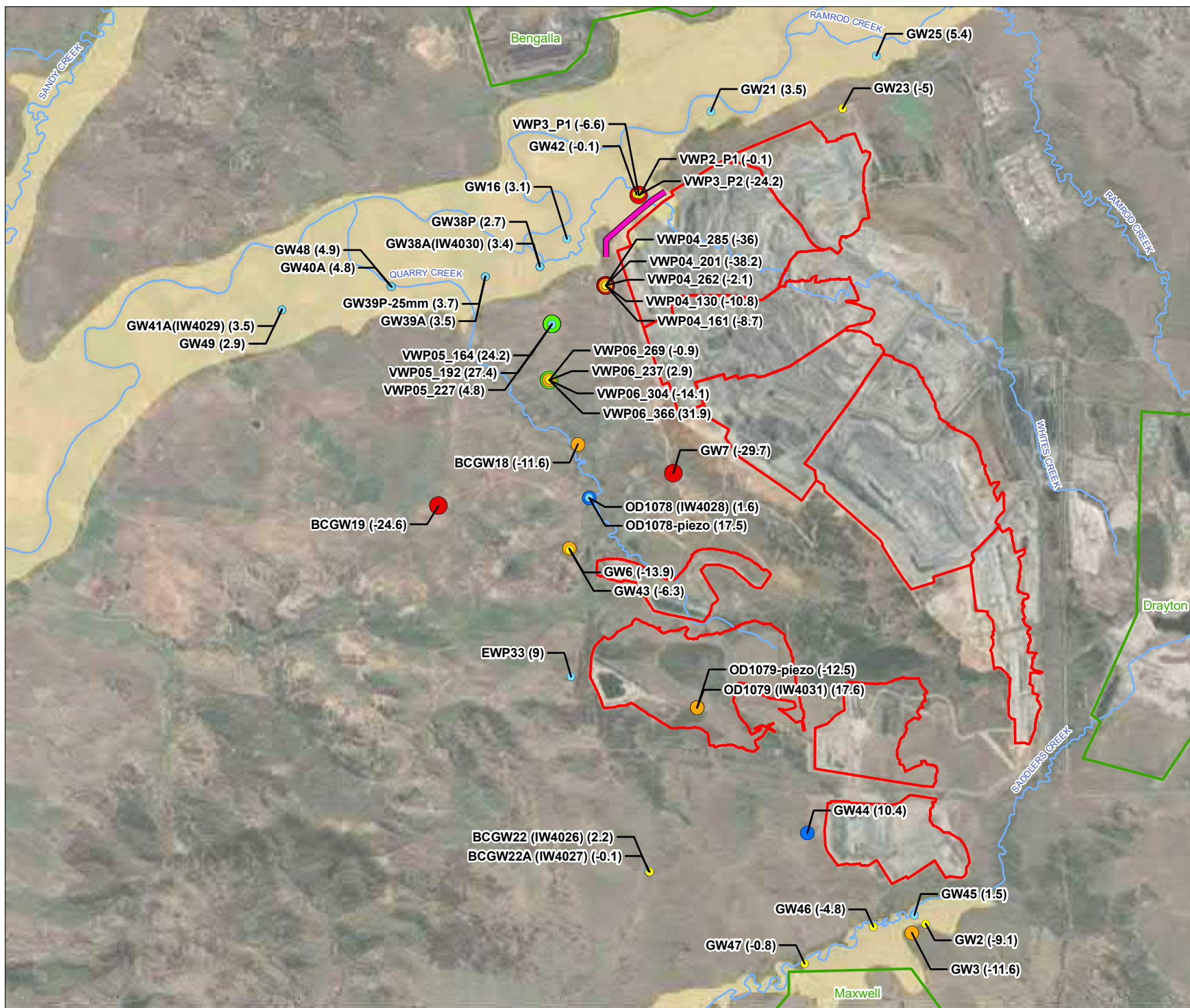
Modelled vs Measured Heads (m)

- -40 to -20
- -20 to -10
- -10 to 0
- 0 to 10
- 10 to 20
- 20 to 40
- Cut-off Wall
- Watercourses
- MAC Extent
- Surrounding Mines
- Revised Alluvium Extent (SLR)



0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 56
Scale: 1:70,000 at A4
Project Number: 660.20103
Date: 10-Aug-2020
Drawn by: JG



9 Recommendations

The following improvements to the groundwater monitoring program are recommended:

- The 2015 GWMP specifies that a comprehensive water quality analysis be undertaken annually for 30 of the monitoring bores and water level monitoring at 40 monitoring points. Review of the GWMP identified that two decommissioned bores (GW40P and GW41P) had triggers assigned. Other bores specified in the GWMP have also been found to be mined out, decommissioned or inaccessible due to landholder restrictions, and therefore not monitored. A review of the network was conducted by AGE (2018) and a range of recommendations made, including installation of replacement bores that was completed in 2020. It is recommended that the monitoring program be reviewed and rationalised based on recent findings and additional newly installed bores, and updates made to the GWMP to ensure consistency between the field program and management plans.
- Bores GW23, OD1078-piezo and OD1078P show instrument drift in the installed dataloggers. It is recommended that the dataloggers be replaced to assist in correlating groundwater trends with rainfall and streamflow trends.
- Bores GW16, GW21, GW39A, GW41A, GW40A - it is recommended that the condition of the bores and site land use be checked, with information on local irrigation practices collected.
- Check the condition of bore GW25 that was identified as blocked from Q3.
- Bore GW39P be reviewed during the next field event to verify which standpipe monitoring is being conducted in.
- Bore GW2 - further review of the water quality data and water types is recommended.
- Bore BCGW22P - further review of water quality and potential water sources in the area is recommended. This includes the backfilled pit and water storage within Belmont Pit.
- Barometric logger – the logger failed in 2020 and was removed in June 2020. Therefore, logger data for Q3 and Q4 of July 2019 to June 2020 was not able to be compensated. This did not impact on the analysis of data as the logger data collected during 2020 has been adjusted using manual dip water levels to analyse groundwater level trends. However, it is recommended that a second source of barometric data, possibly from a neighbouring mine, be sourced in case of barometric logger failures in the future.
- VWP1 – this sensor stopped recording in January 2017. Consistent with the recommendation by AGE (2019), it is recommended that the installation of the logger be checked. A first assessment with a hand reader for VWP frequency can be made to confirm the integrity of the sensor and cables. VWP01 is located adjacent to VWP02 and VWP03, with the VWPs initially installed to test the performance of the cutoff wall and fault. With progression of mining in the area, the purpose of the VWP should be reviewed and the monitoring network rationalised.

The following improvements to the field monitoring and sampling programme by CBE are recommended:

- Chilled groundwater lab samples – during July 2019 to June 2020 one of the groundwater sample batches received by ALS was above the recommended temperature of 4°C. It is recommended that all samples should be chilled sufficiently to reach the lab below of 4°C.

-
- Metals analysis – field filtration should be undertaken and noted on field sheets for samples analysed by ALS for dissolved metals.
 - Sampling – bores that are pumped dry during purging have not been sampled for over two weeks following purging. It is recommended that the time between purging and sampling be reduced if possible.

10 References

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APPENDIX A

Groundwater Monitoring Network

Bore ID	Easting	Northing	RL (mAHD)	Screen/ Sensor (mAHD)	Unit	Stratigraphy	GWMP 2015		
							Monitor	SWL	WQ
BCGW05	291053	6410764	139.781	123.192 - 126.192	GM	Coal	■	D	6M(T)
BCGW10	293115	6414781	185.391	120.025 - 123.025	WDH	Coal	■	D	6M(T)
BCGW11	293117	6414779	185.43	146.704 - 149.704	GM	Coal	■	D	6M(T)
BCGW12	293143	6414688	153.058	138.833 - 141.833	GM	Coal	*	*	*
BCGW15	290717	6412432	153.25	124.712 - 127.712	GM	Coal	■	D	6M(T)
BCGW18	294345	6419985	158.301	147.701 - 151.701	AFS	Coal	■	D(T)	6M(T)
BCGW19	292462	6419152	186.997	160.273 - 177.403	GM	Coal	■	(T)	*
BCGW22P (IW4026)	295304	6414211	143.389	-	GM	Coal	■	D(T)	6M(T)
BCGW22A (IW4027)	295304	6414211	143.389	-	Qa – Saddlers/ Regolith	Alluvium – likely Regolith			
EWPC33	294253	6416847	229.05	174.623 - 177.623	BKF	Coal	■	D(T)	6M(T)
GW2	299045	6413511	153.691	40.473 - 43.473	WDH	Coal	■	D(T)	6M(T)
GW3	298856	6413389	151.287	30.887 - 33.887	PCM	PCM	■	D(T)	
GW6	294227	6418579	196.099	171.113 - 177.113	GM	Coal	■	D(T)	6M(T)
GW7	295635	6419595	214.573	169.265 - 177.265	GM	Coal	■	D(T)	6M(T)
GW8	296991	6419491	207.242	185.565 - 138.127	PCM	Coal	■	D(T)	*
GW16	294197	6422759	131.441	120.369 - 126.269	Qa - Hunter	Alluvium	■	D(T)	6M(T)
GW21	296141	6424483	135.996	124.963 - 128.963	Qa - Hunter	Alluvium	■	D(T)	6M(T)
GW22	296930	6423998	153.742	67.959 - 133.759	RC	Coal	■	D(T)	6M(T)
GW23	297919	6424515	180.874	132.273 - 135.273	RC	Coal	■	D(T)	6M(T)
GW25	298376	6425231	139.706	127.869 - 130.869	Qa - Hunter	Alluvium	■	D(T)	6M(T)
GW26	301841	6418792	234.16	141.152 - 144.152	Tailings	Tailings	■	D	6M(T)
GW27	301863	6418412	234.952	119.843 - 122.843	Tailings	Tailings	■	D	*
GW38A	293831	6422377	131.24 131.57	-	Qa - Hunter	Alluvium	■	D(T)	6M(T)
GW38P	293832	6422384	131.16	99.86 - 102.86	Warkworth	Coal		D(T)	6M(T)
GW39A	293094	6422248	130.306	120.402 - 130.302	Qa - Hunter	Alluvium	■	D	6M(T)
GW39P	293094.7	6422251	130.35	-	Warkworth	Coal		D	6M(T)
GW40A	291816	6422119	128.815	116.296 - 128.896	Qa - Hunter	Alluvium	■	D(T)	6M(T)
GW40P	-	-	-	-	-	-	*	(T)	6M(T)
GW41A	290354	6421789	125.96	-	Qa - Hunter	Alluvium	■	D(T)	6M(T)
GW41P	-	-	-	-	-	-	-	(T)	(T)
GW42	295139	6423356	135.618	124.576 - 130.576	Qa – Hunter/ Regolith	Alluvium and regolith	■	D	6M
GW43	294233	6418560	197.33	133.83 - 139.83	WDH	Coal	■	D	6M
GW44	297445	6414733	211.031	80.5 - 86.5	WDH	Coal	■	D	6M
GW45	298890	6413630	151.886	138.394 - 141.394	Qa - Saddlers	Alluvium	■	D	6M

Bore ID	Easting	Northing	RL (mAHD)	Screen/ Sensor (mAHD)	Unit	Stratigraphy	GWMP 2015		
							Monitor	SWL	WQ
GW46	298337	6413469	143.632	125.629 - 128.629	Qa - Regolith	Alluvium and regolith	■	D	6M
GW47	297409	6412974	136.505	120.012 - 123.012	Qa - Saddlers	Alluvium	■	D	6M
GW48	291830	6422111	129.695	94.417 - 97.417	BFS	Coal	■	D	6M
GW49	290346	6421798	125.553	91.52 - 94.52	AFS	Coal	■	D	
OD1046-PIEZO	297442	6414742	211.048	-	WDH	Coal	*	*	*
OD1049-SURFACE	294498	6413753	156.111	-	GM	Coal	*	*	*
OD1049-WH	294498	6413753	156.509	-	WDH	Coal	*	*	*
OD1073	293000	6418750	215.207	-	AFS	Coal	*	*	*
OD1073-PIEZO	293000	6418750	215.207	-	-	-	*	*	*
OD1074	296501	6417756	233.567	-	PCM	PCM	*	*	*
OD1074-PIEZO	296501	6417756	233.567	-	BFS	Coal	*	*	*
OD1078	294495	6419259	171.003	107.965 - NA	AFS	Coal	■	D(T)	*
OD1078-PIEZO	294496	6419259	171.048	82 - 92.048	BFS	Coal	■	D(T)	*
OD1079	295956	6416427	226.004	167.348 - NA	GM	Coal	■	D	*
OD1079-PIEZO	295956	6416427	225.362	142.013 - 145.013	GM	Coal	■	D(T)	*
OD1082	295485	6416726	219.512	-	WDH	Coal	*	*	*
OD1082-PIEZO	295485	6416726	219.512	-	WDH	Coal	*	*	*
OR2051	293718	6417262	229.075	-	GM AFS	Coal	*	*	*
OR2051-PIEZO	293718	6417262	229.075	-	GM AFS	Coal	*	*	*
VWP1_P1	295166.6	6423381	135.46	- 69.04	EG	Coal	■	D(T)	
VWP2_P1	295194.8	6423364	135.412	- 81.088	Fault	-	■	D(T)	
VWP3_P1	295165.9	6423349	135.38	- 91.62	EG	Coal	■	D(T)	
VWP3_P2	295165.9	6423349	135.38	- 105.62	RK	Coal	■	D(T)	
VWP04_130	294719	6422132	140.84	10.84	VU	Coal	■	D	
VWP04_161	294719.2	6422132	140.84	- 20.16	BU	Coal	■	D	
VWP04_201	294719.2	6422132	140.84	- 60.16	ED	Coal	■	D	
VWP04_262	294719.2	6422132	140.84	- 121.66	EG	Coal	■	D	
VWP04_285	294719.2	6422132	140.84	144.16	RC	Coal	■	D	
VWP05_164	293993.3	6421605	161.4	2.6	VU	Coal	■	D	
VWP05_192	293993.3	6421605	161.4	30.6	BU	Coal	■	D	
VWP05_227	293993.3	6421605	161.4	65.6	ED	Coal	■	D	
VWP05_288	293993.3	6421605	161.4	126.6	EG	Coal	■	D	
VWP05_311	293993.3	6421605	161.4	149.6	RC	Coal	■	D	
VWP06_237	293960.3	6420850	179.64	- 57.36	VU	Coal	■	D	
VWP06_269	293960.3	6420850	179.64	- 89.36	BR	Coal	■	D	

Bore ID	Easting	Northing	RL (mAHD)	Screen/ Sensor (mAHD)	Unit	Stratigraphy	GWMP 2015		
							Monitor	SWL	WQ
VWP06_304	293960.3	6420850	179.64	- 124.36	ED	Coal	■	D	
VWP06_366	293960.3	6420850	179.64	- 186.36	EG	Coal	■	D	
VWP06_388	293960.3	6420850	179.64	- 208.86	RC	Coal	■	D	
VWP07_223	295656.1	6419565	215.95	- 7.05	PF	Coal	■	D	
VWP07_271	295656.1	6419565	215.95	- 55.05	VU	Coal	■	D	
VWP07_286	295656.1	6419565	215.95	- 70.55	BU	Coal	■	D	
VWP07_326	295656.1	6419565	215.95	- 110.05	ED	Coal	■	D	
VWP07_418	295656.1	6419565	215.95	- 202.05	RC	Coal	■	D	

Note: Coordinates in MGA94 Zone 56

Qa – Alluvium

JV – Jurassic Volcancis

GCM – Greta Coal Measures

PCM – Permian coal measures

JPS – Jerrys Plains Subgroup

MG – Maitland Group

GW – Glen Munro Seam

WDH – Woodland Hill Seam

AFS – Arrowfield Seam

BFS – Bowfield Seam

BR – Broonie Seam

VU – Vaux Seam

BU – Bayswater Seam

ED – Edderton Seam

RC – Ramrod Creek Seam

EG – Edinglassie Seam

■ – Included in monitoring program

D – Daily (6 hourly) water level data from logger, downloaded two monthly and manual reading two monthly

(T) – Trigger level defined (water level or quality)

6M – six monthly water quality monitoring for full suite

* bore abandoned or not monitored during upgrade works for water level, water quality or both (as indicated by column)

Q – groundwater level monitoring, manual reading/download quarterly, pressure transducers 6 hourly

Q/A – Quarterly standard water quality analysis and Annual comprehensive water quality analysis

APPENDIX B

Groundwater Level Monitoring Data

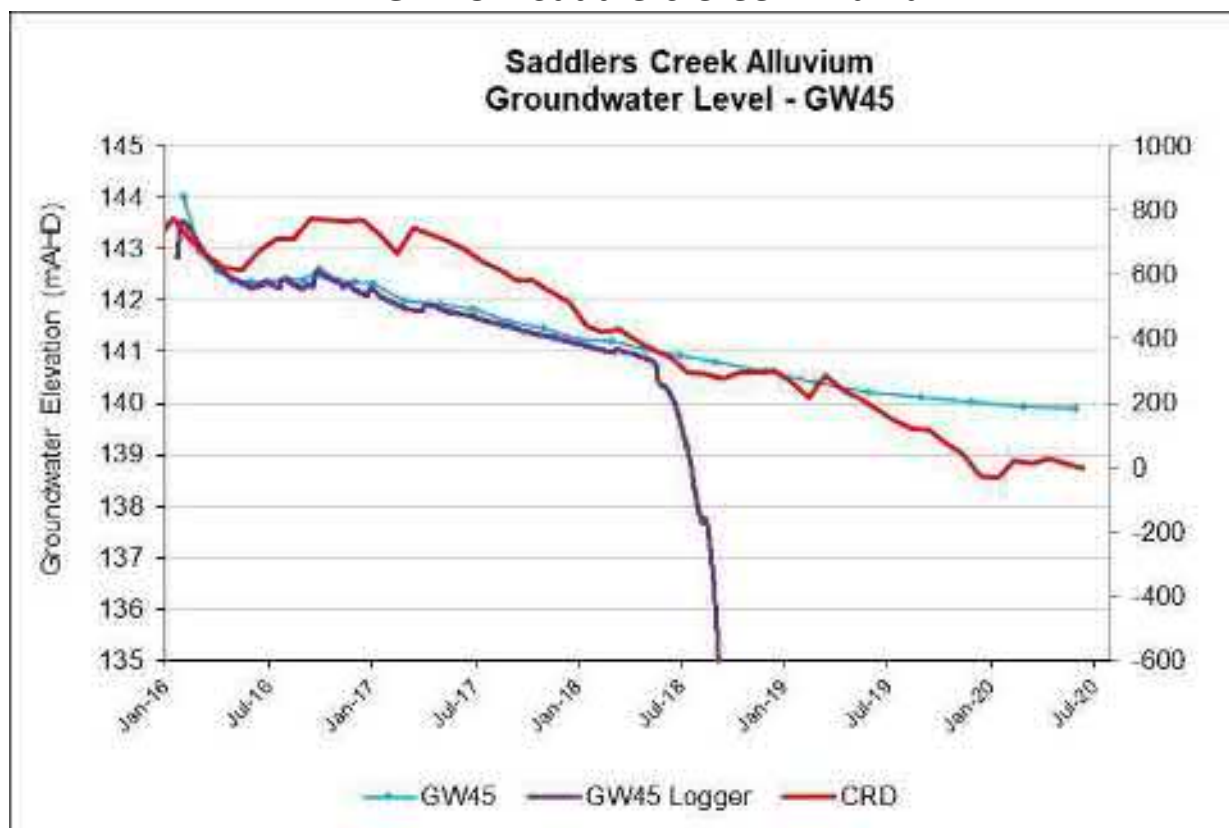
Construction							Triggers	Modelled Levels	Measured Groundwater Levels						Drawdown				
Bore ID	Easting (m)	Northing (m)	TOC Elev 2014 Survey (mAHD)	TOC Elev 2018 Survey (mAHD)	Bore Depth (m)	Target Formation	WMP Trigger (2015) (mAHD)	MAC consolidation project June 2020 modelled head (mAHD)	First Record			June 2019		June 2020		Head Difference Modelled vs Measured June 2020 (m) ²	Measured Drawdown First Record vs Measured June 2020 (m) ³	Expected Drawdown First Record vs Modelled June 2020 (m) ³	FY19-20 Measured Drawdown (m) ⁴
									WL Date	Depth to Water (mBTOC)	WL Elevation (mAHD)	Depth to Water (mBTOC)	WL Elevation (mAHD)	Depth to Water (mBTOC)	WL Elevation (mAHD)				
VWP06_269	293960.3	6420850.4	-	179.64	-	Broonie	-	85.10	Dec-15	179.49	89.99	87.4	92.24	175.34	85.98	-0.89	-4.01	-4.89	6.26
VWP06_304					-	Edderton	-	60.44		214.63	90.08	98.68	80.96	198.93	74.57	-14.13	-15.51	-29.64	6.39
VWP06_366					-	Edinglassie	-	103.68		272.85	86.33	102.38	77.26	258.15	71.79	31.89	-14.54	17.35	5.47
VWP06_388					-	Ramrod Creek	-	106.72		-	-	-	-	-	-	-	-	-	-
VWP07_223	295656.1	6419564.9	-	215.95	-	Piercefield	-	122.48	Dec-15	130.65	123.55	112.81	103.14	NM	NM	NM	NM	NM	NM
VWP07_271					-	Vaux	-	122.48		171.33	116.15	116.02	99.93	NM	NM	NM	NM	NM	NM
VWP07_286					-	Bayswater	-	79.85		175.42	104.89	128.7	87.25	NM	NM	NM	NM	NM	NM
VWP07_326					-	Edderton	-	29.80		204.93	94.78	128.42	87.53	NM	NM	NM	NM	NM	NM
VWP07_418					-	Ramrod Creek	-	147.01		264.50	154.32	Faulty		NM	NM	NM	NM	NM	NM

- Notes: 1 TOC Elev – Top of Casing elevation; mAHD metres above Australian Height Datum; WL – water level; mBTOC – metres below top of casing.
2 Negative values indicate the measured piezometric level is higher than modelled – this means the model is over-predicting effects at this site for FY20.
3 Negative values indicate drawdown.
4 Negative values indicate drawdown over the last year. NM – Not monitored / data not available.

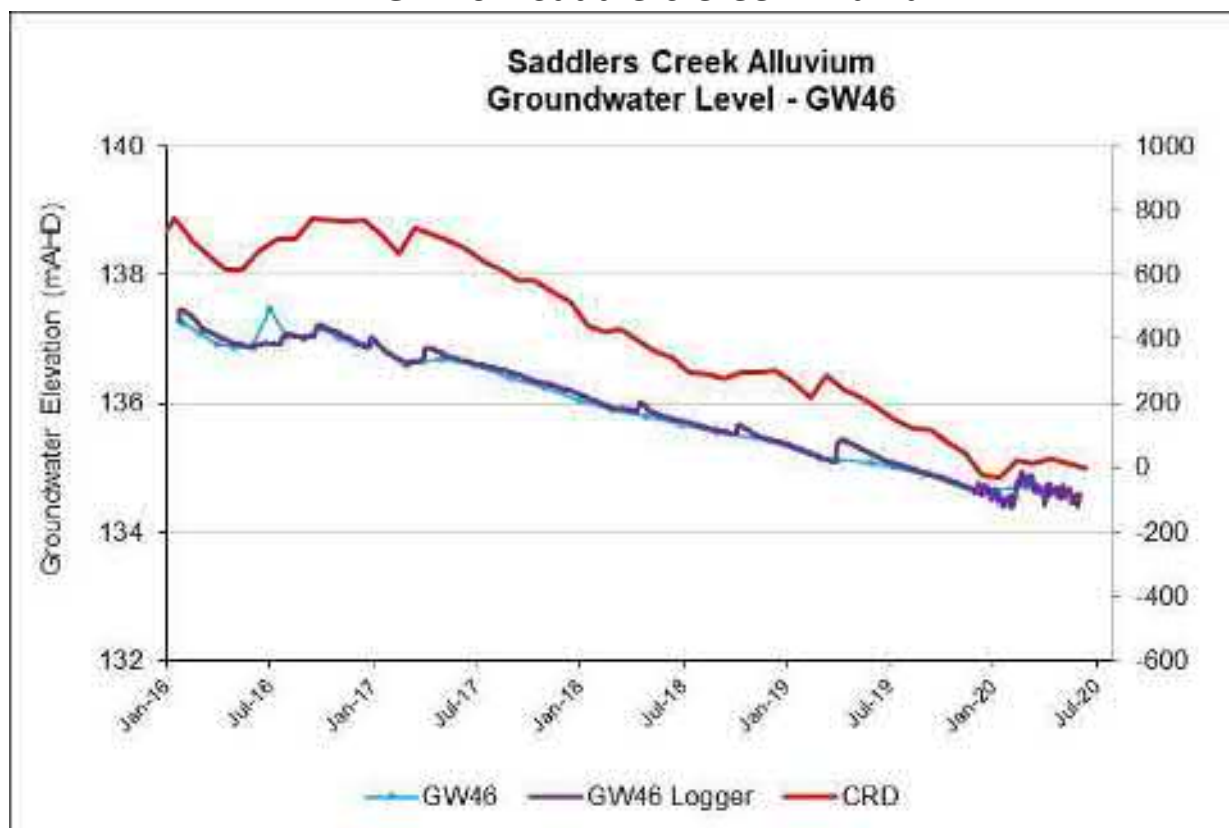
APPENDIX C

Groundwater Level Graphs

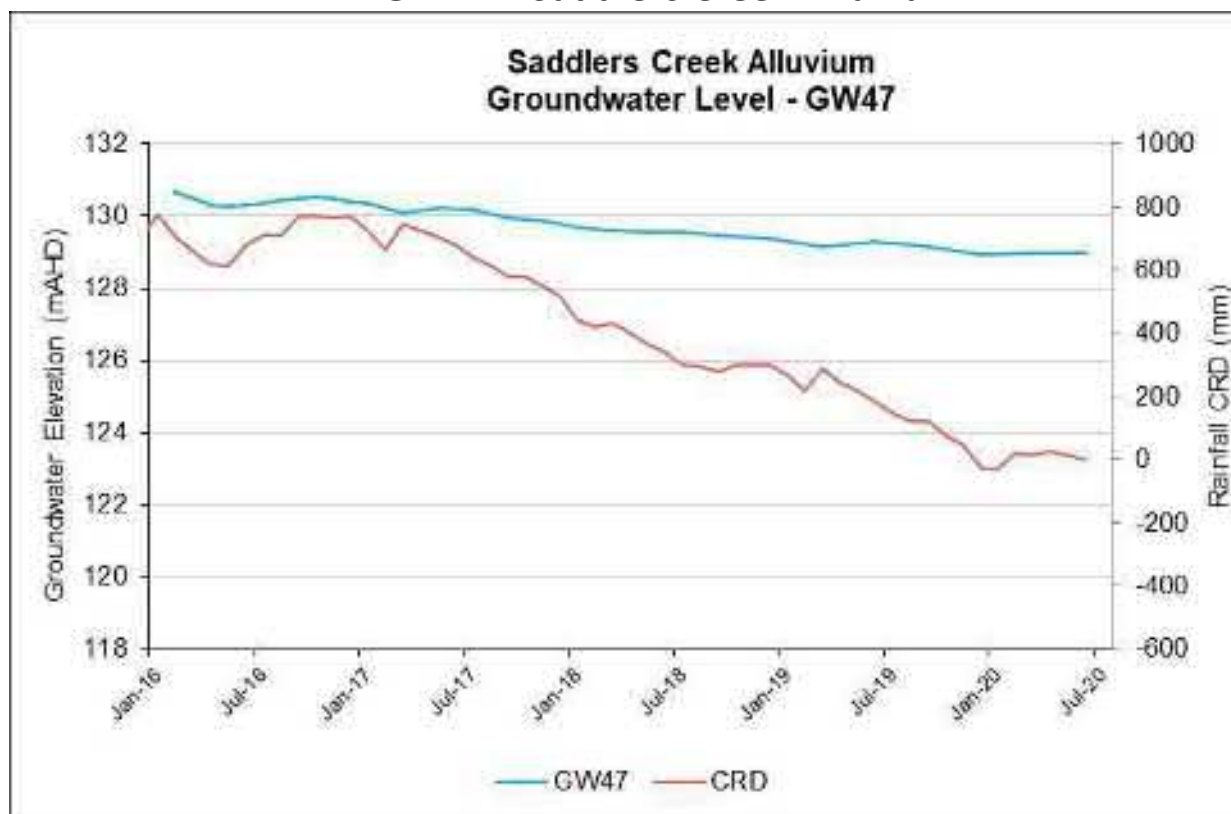
GW45 – Saddlers Creek Alluvium



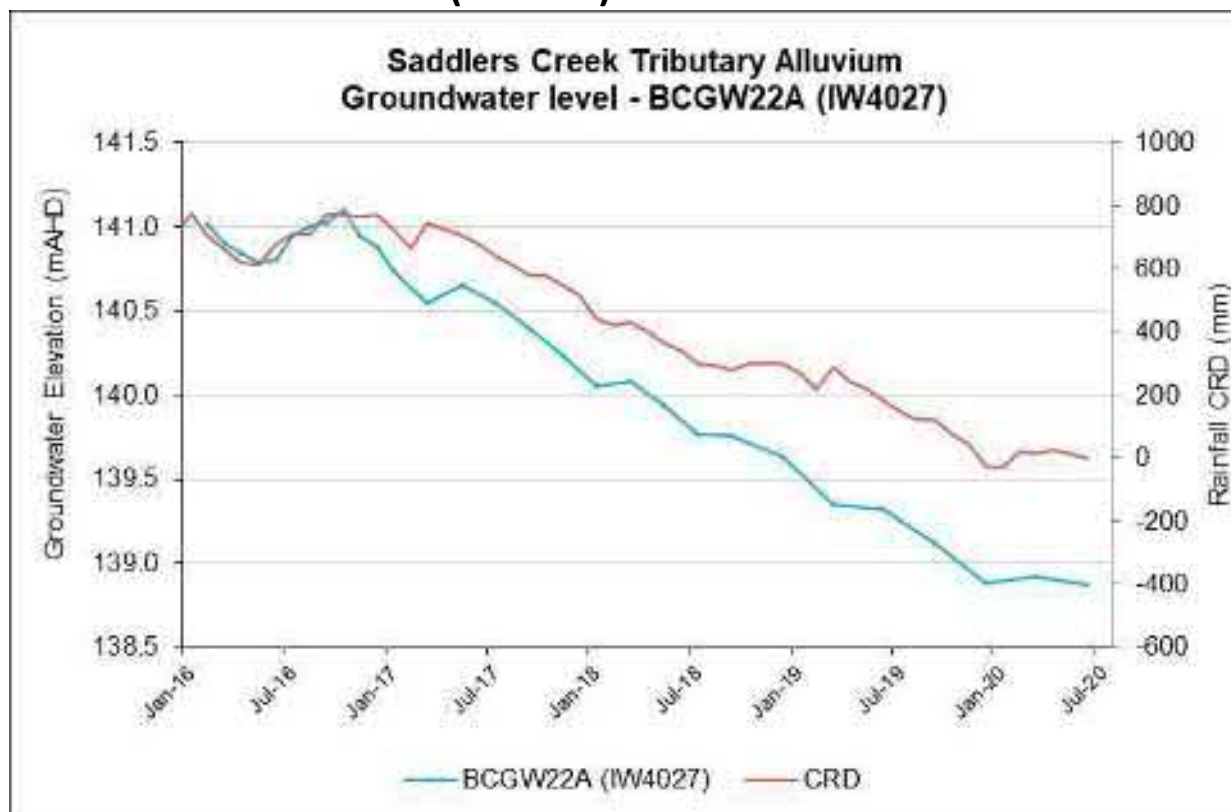
GW46 – Saddlers Creek Alluvium



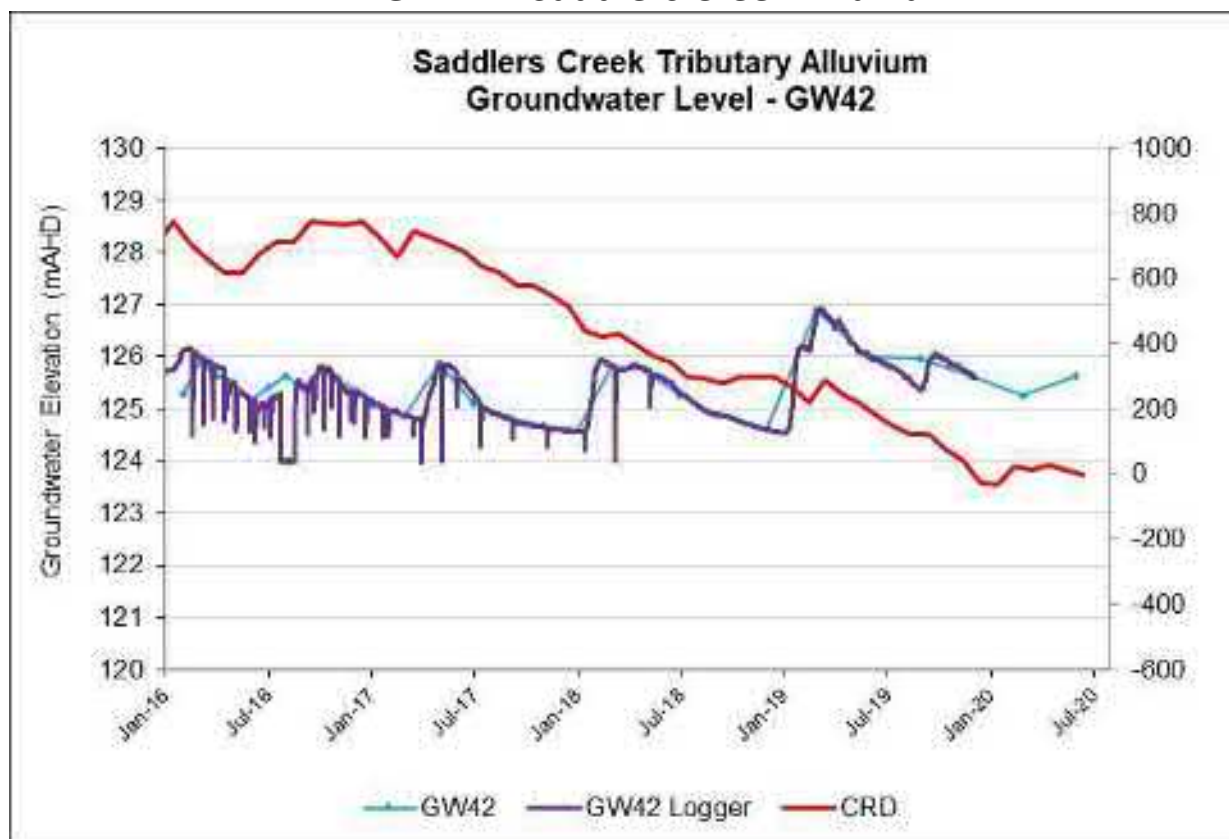
GW47 – Saddlers Creek Alluvium



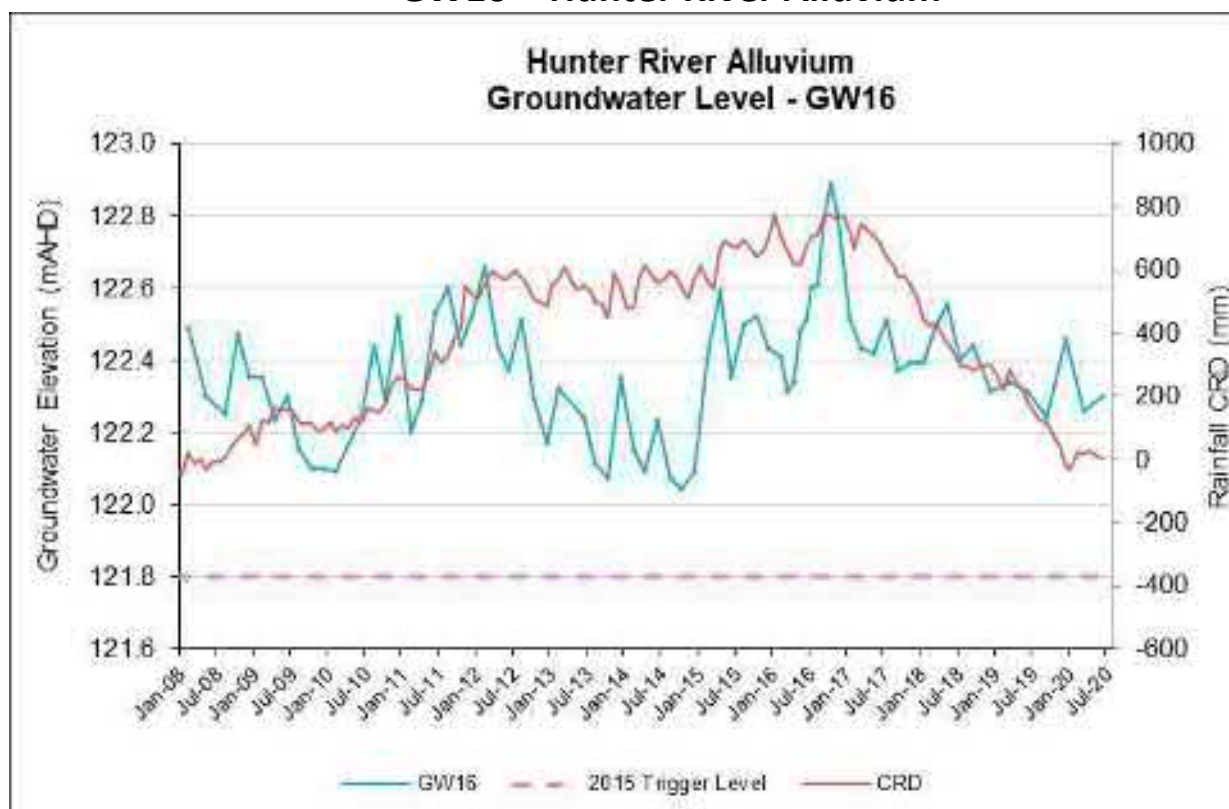
BCGW22A (IW4027) – Saddlers Creek Alluvium



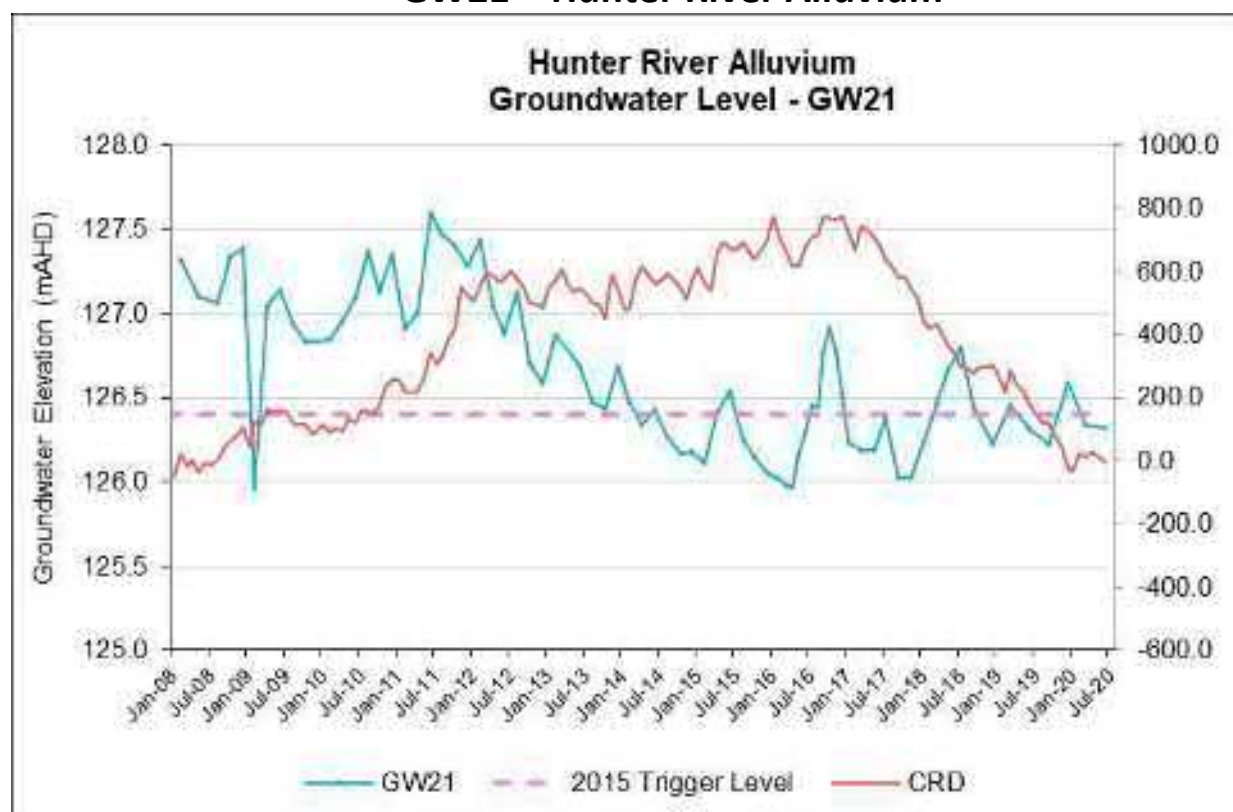
GW42 – Saddlers Creek Alluvium



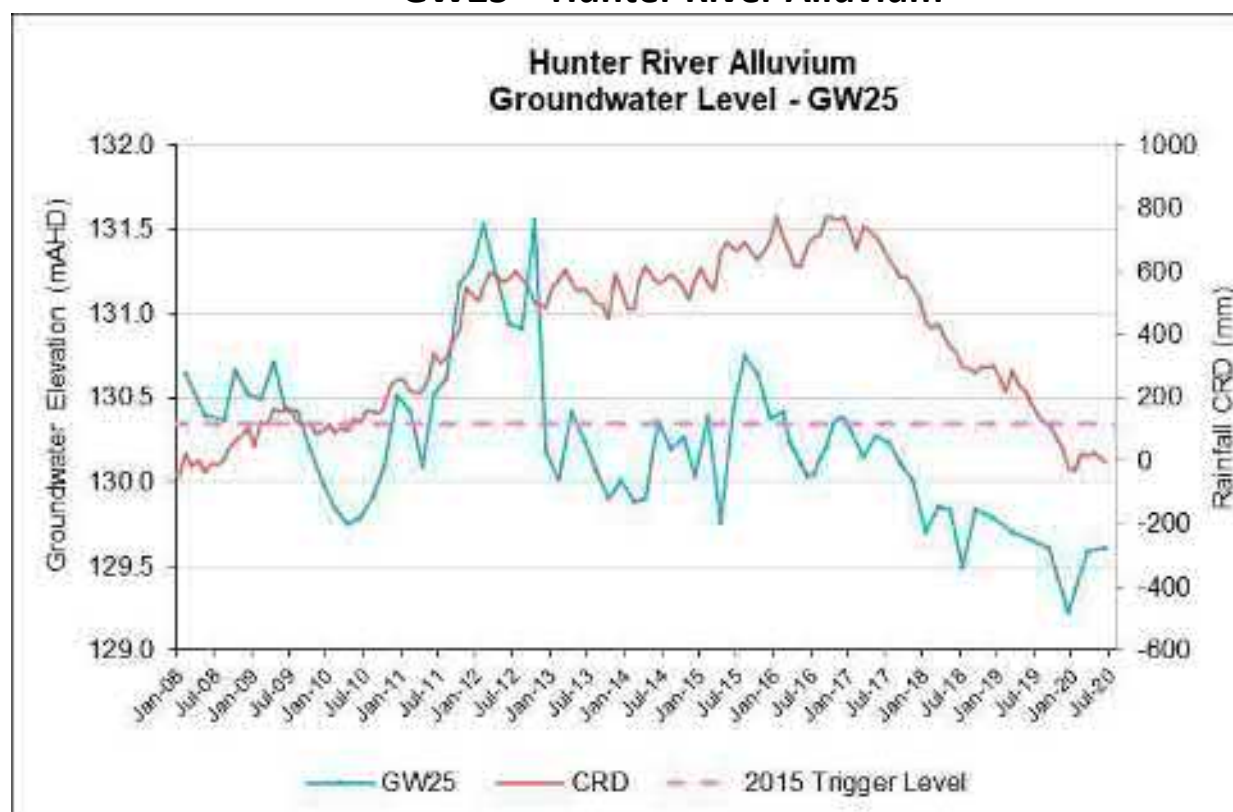
GW16 – Hunter River Alluvium



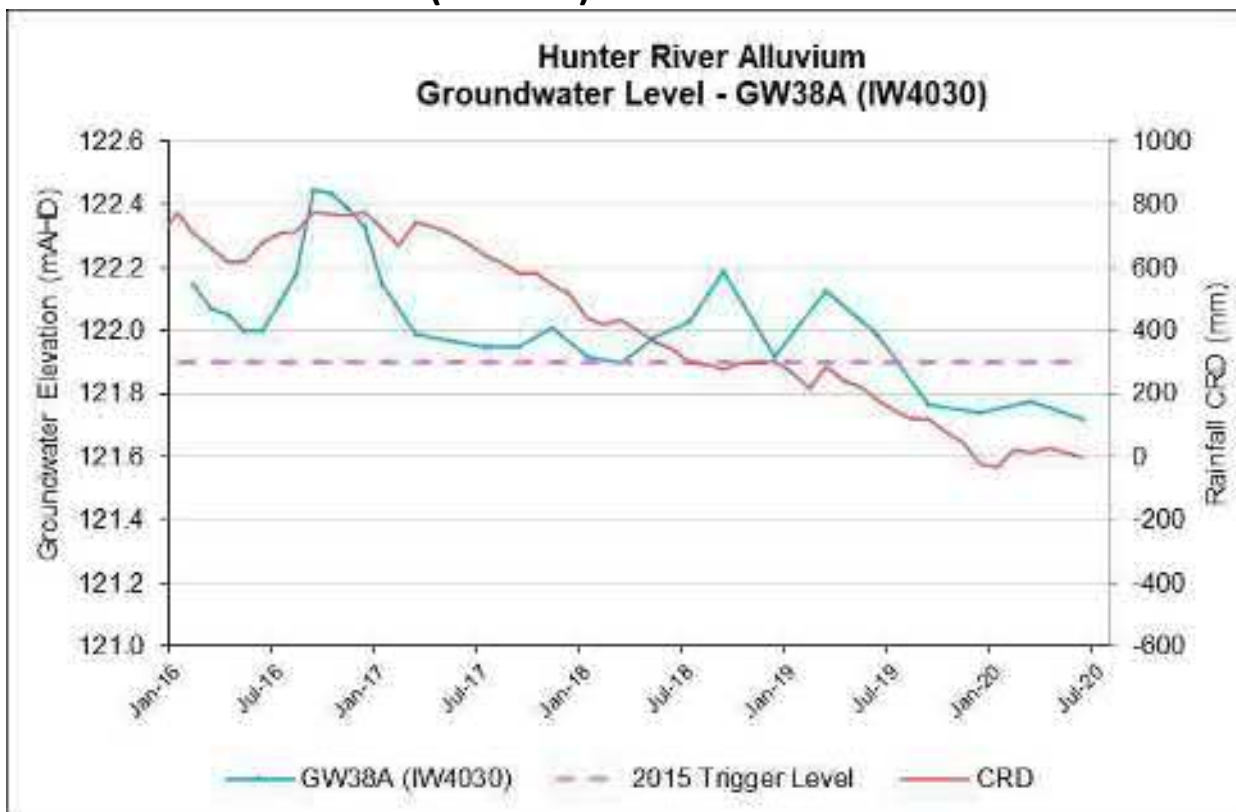
GW21 – Hunter River Alluvium



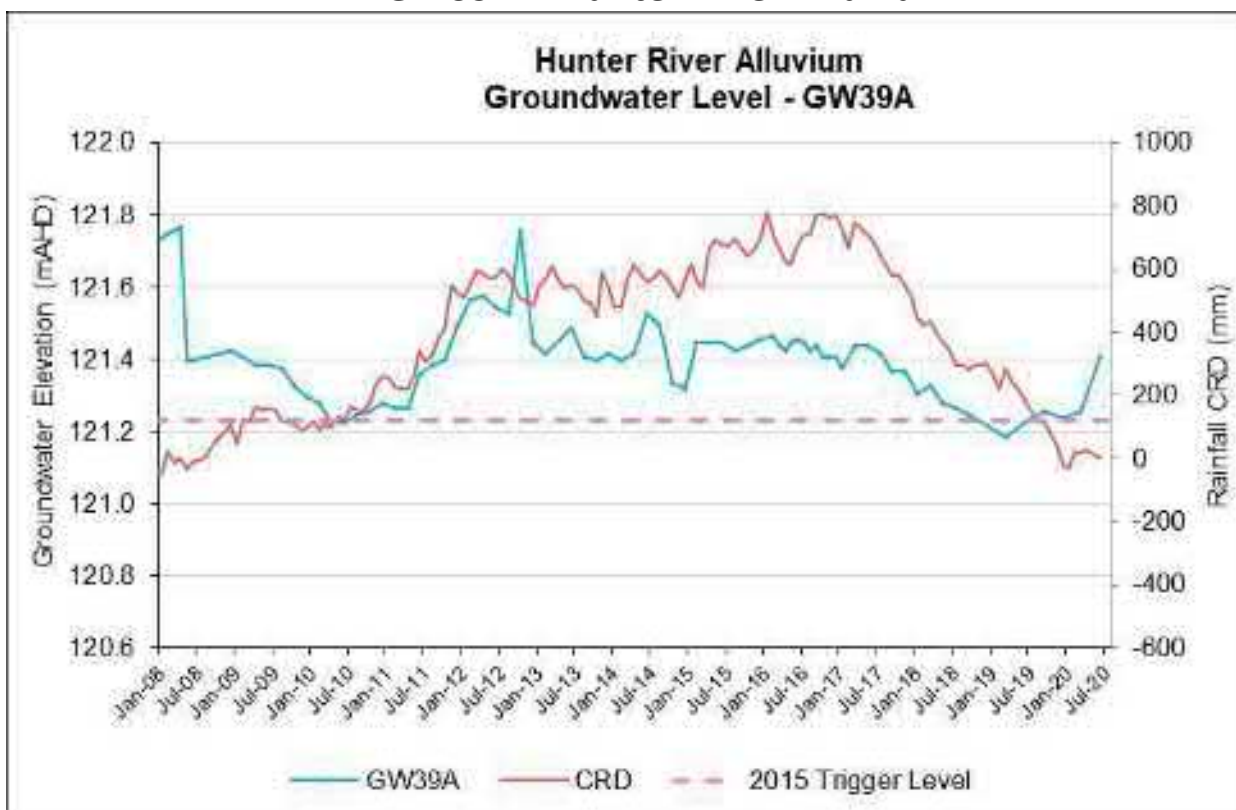
GW25 – Hunter River Alluvium



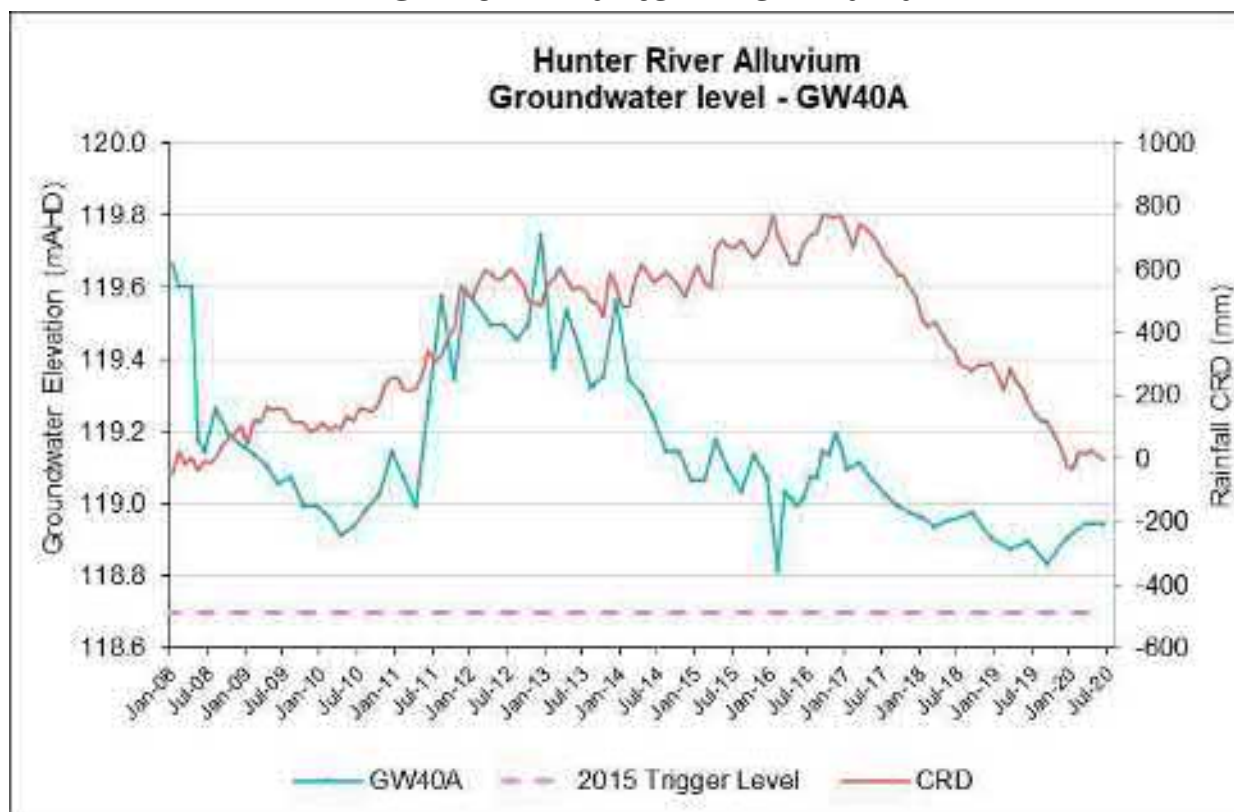
GW38 (IW4030) – Hunter River Alluvium



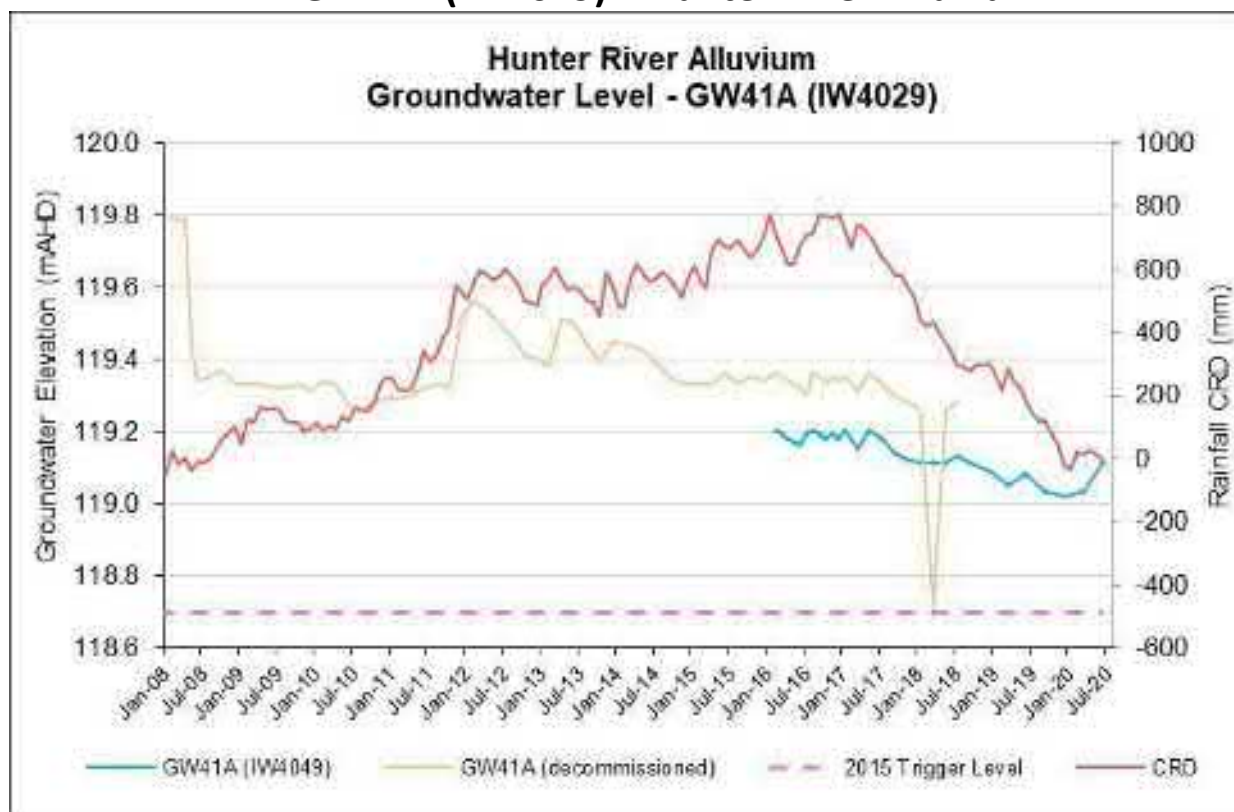
GW39A – Hunter River Alluvium



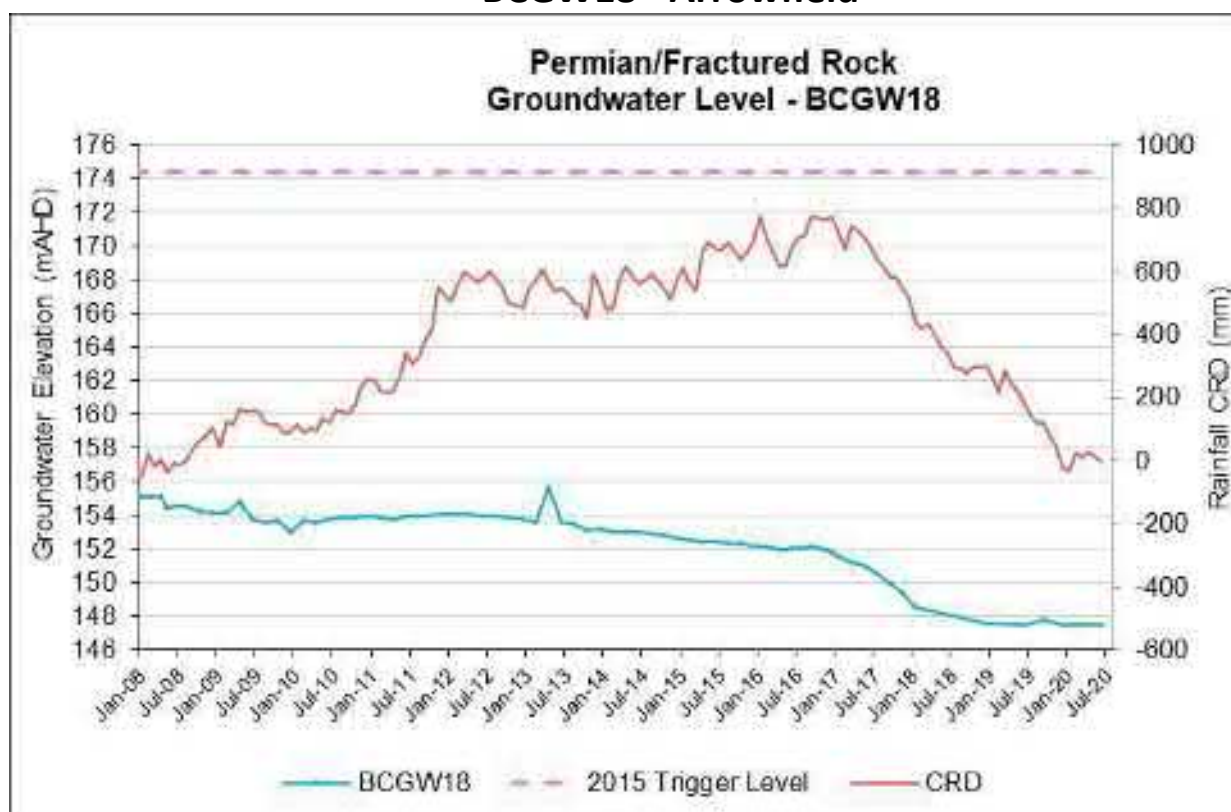
GW40A – Hunter River Alluvium



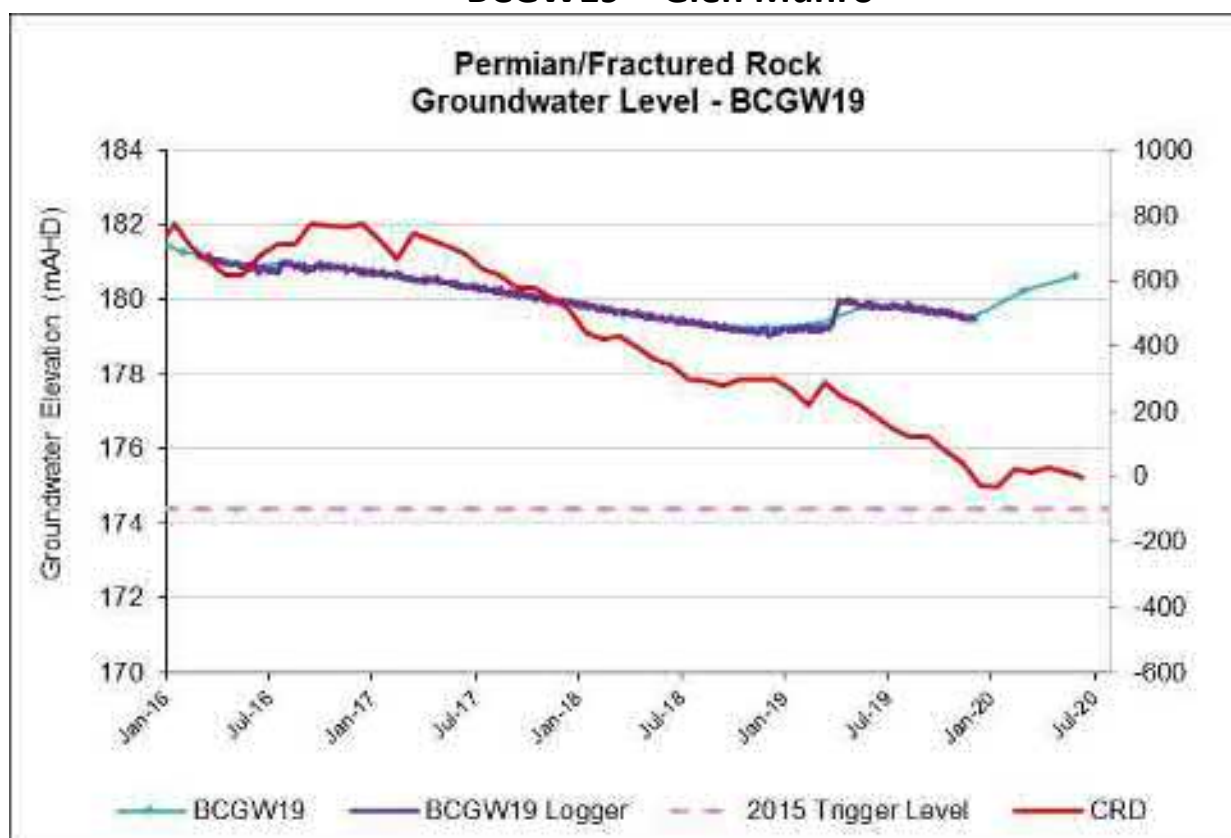
GW41A (IW4029) – Hunter River Alluvium



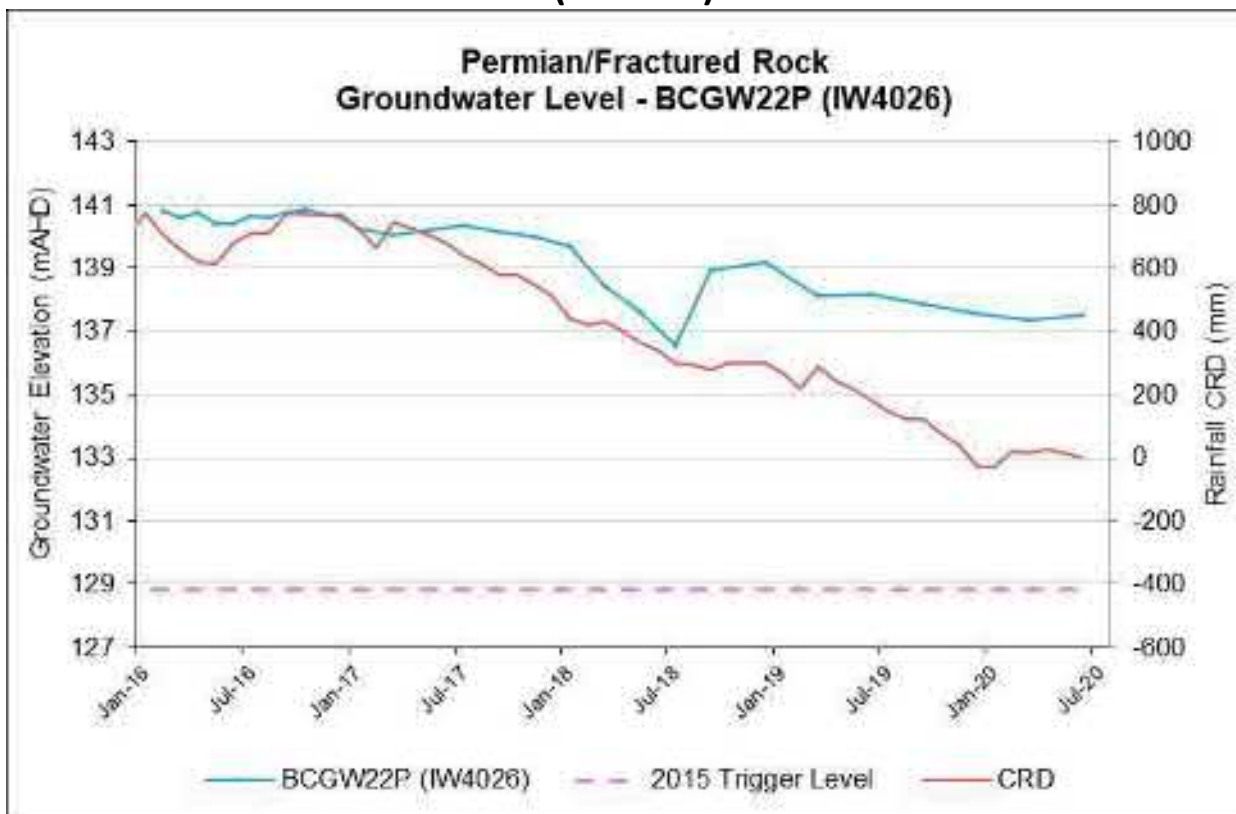
BCGW18 - Arrowfield



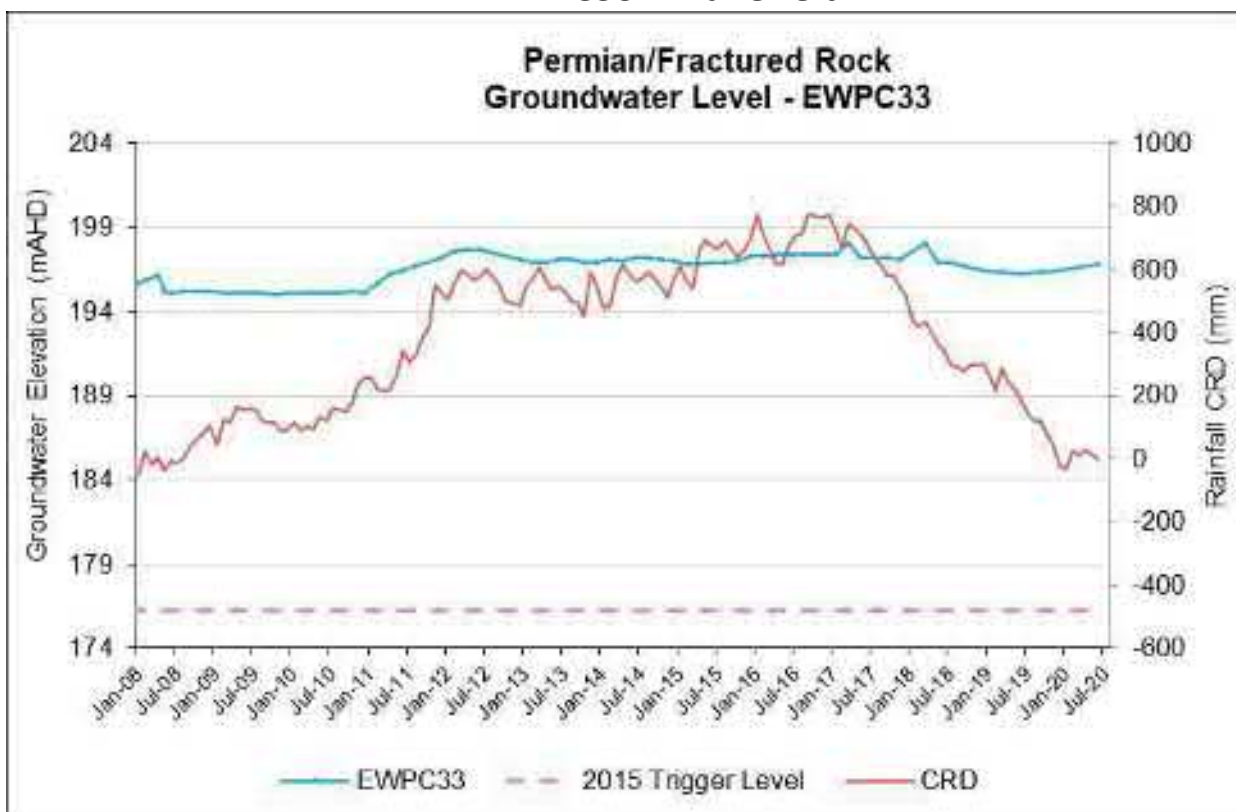
BCGW19 – Glen Munro



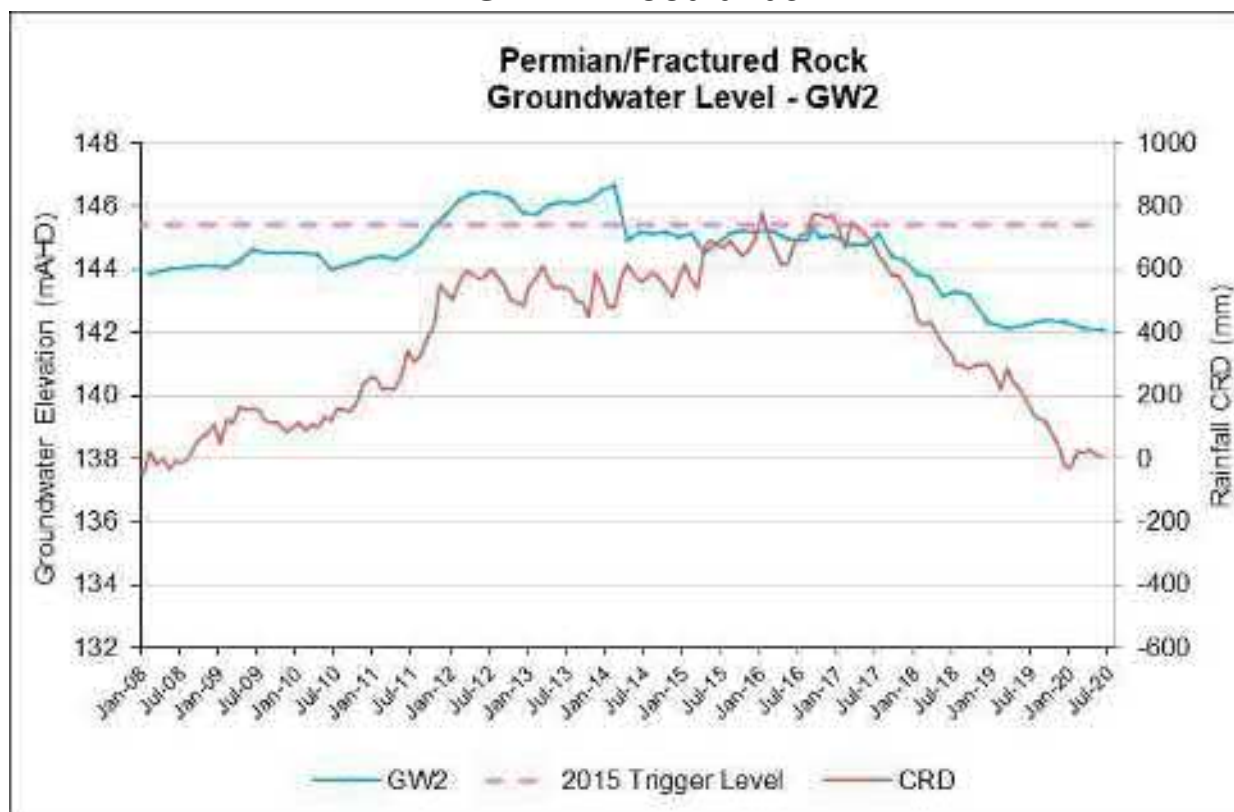
BCGW22P (IW4026) – Glen Munro



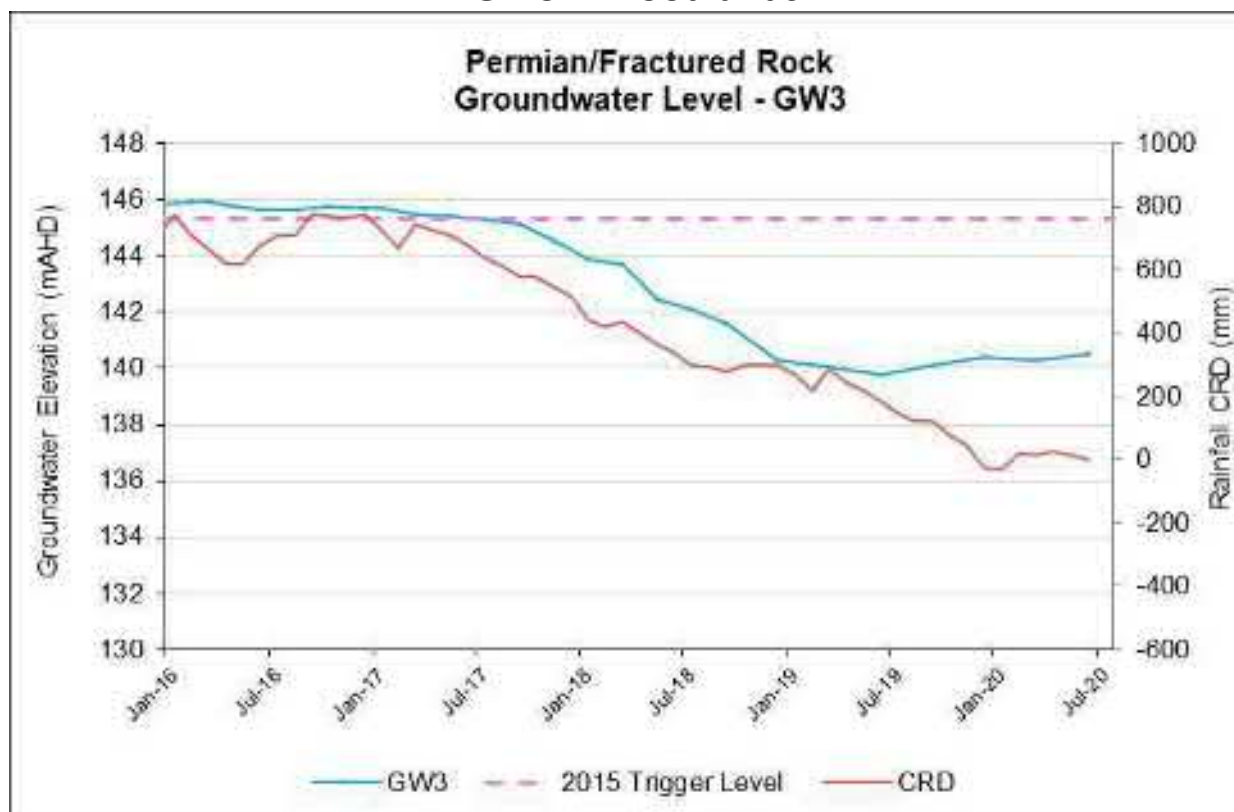
EWPC33 - Blakefield



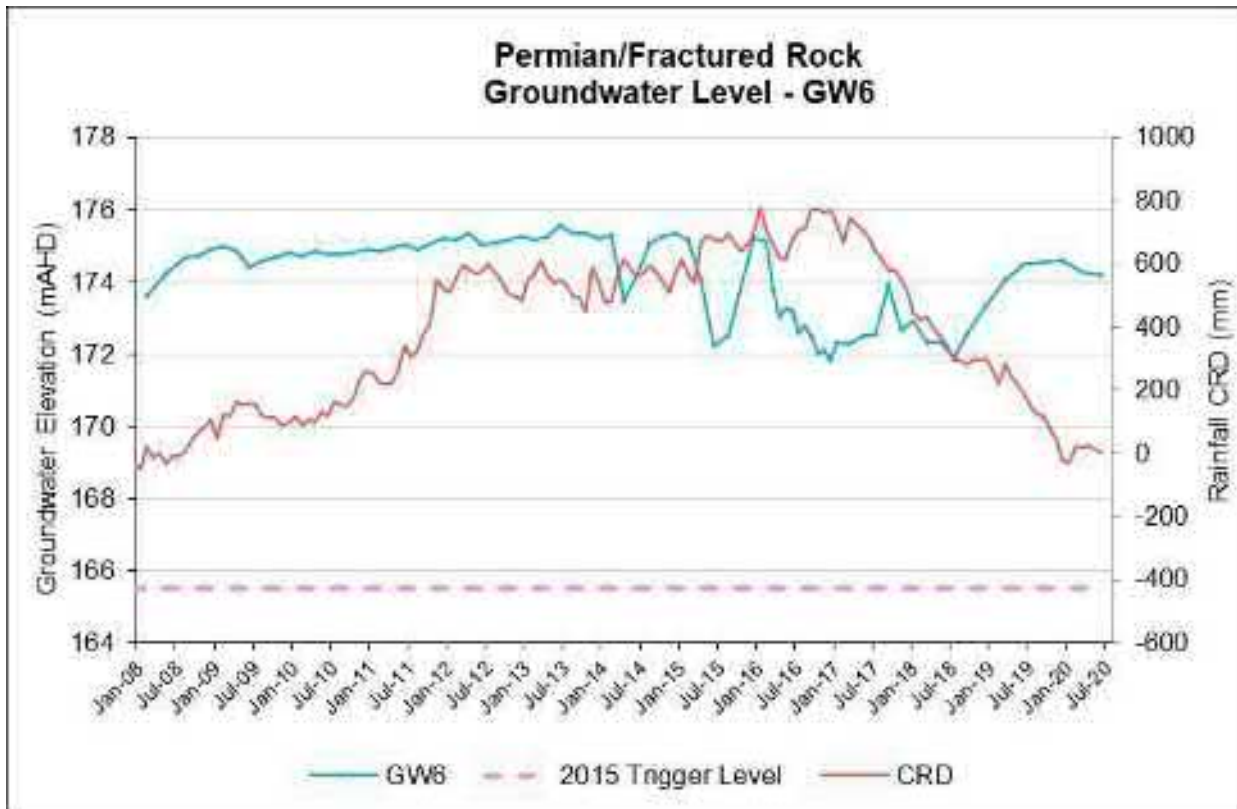
GW2 – Woodlands Hill



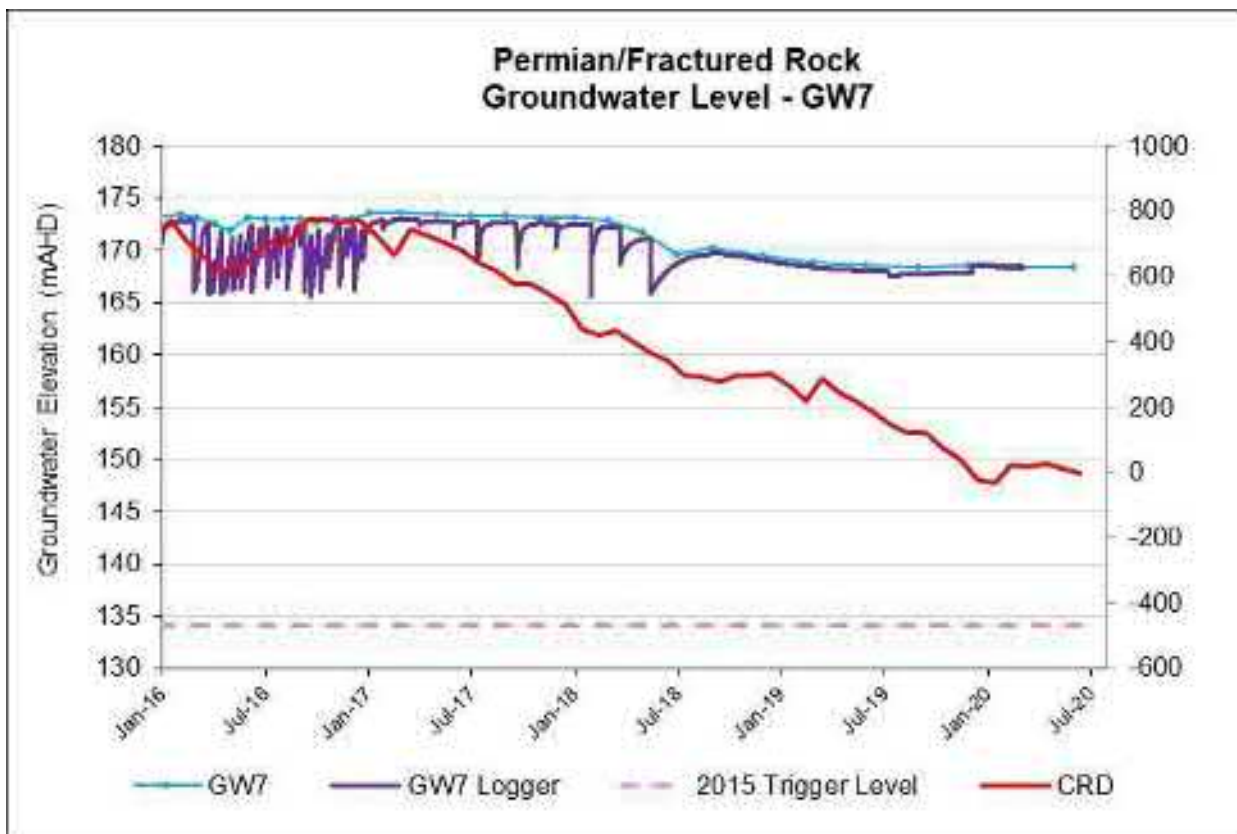
GW3 – Woodlands Hill



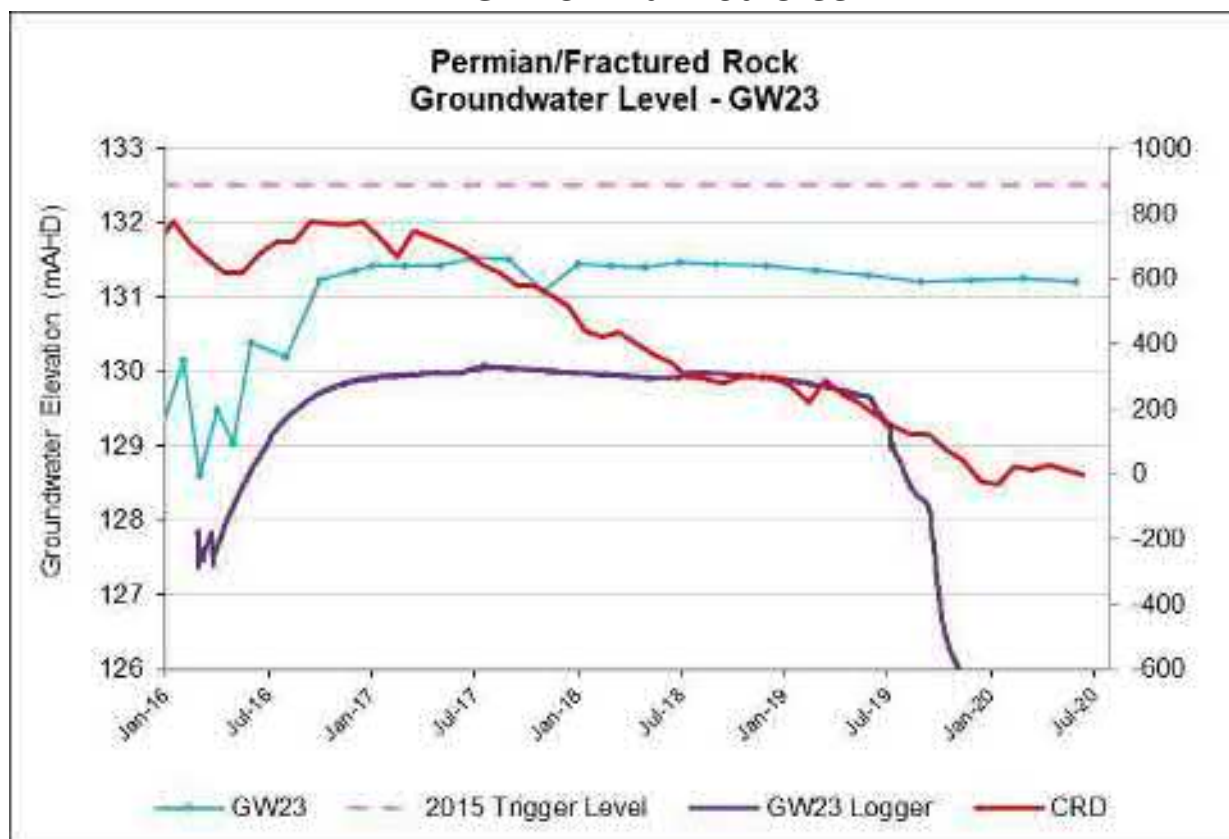
GW6 – Glen Munro



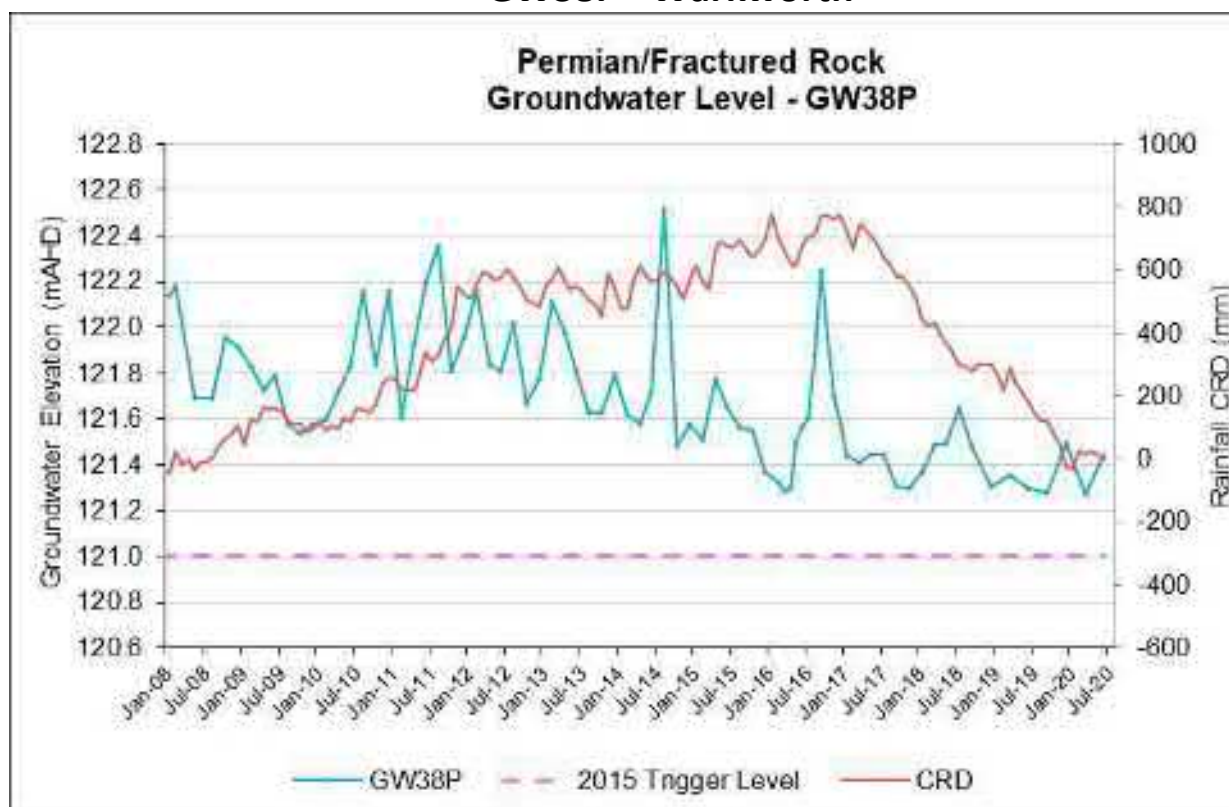
GW7 – Woodlands Hill



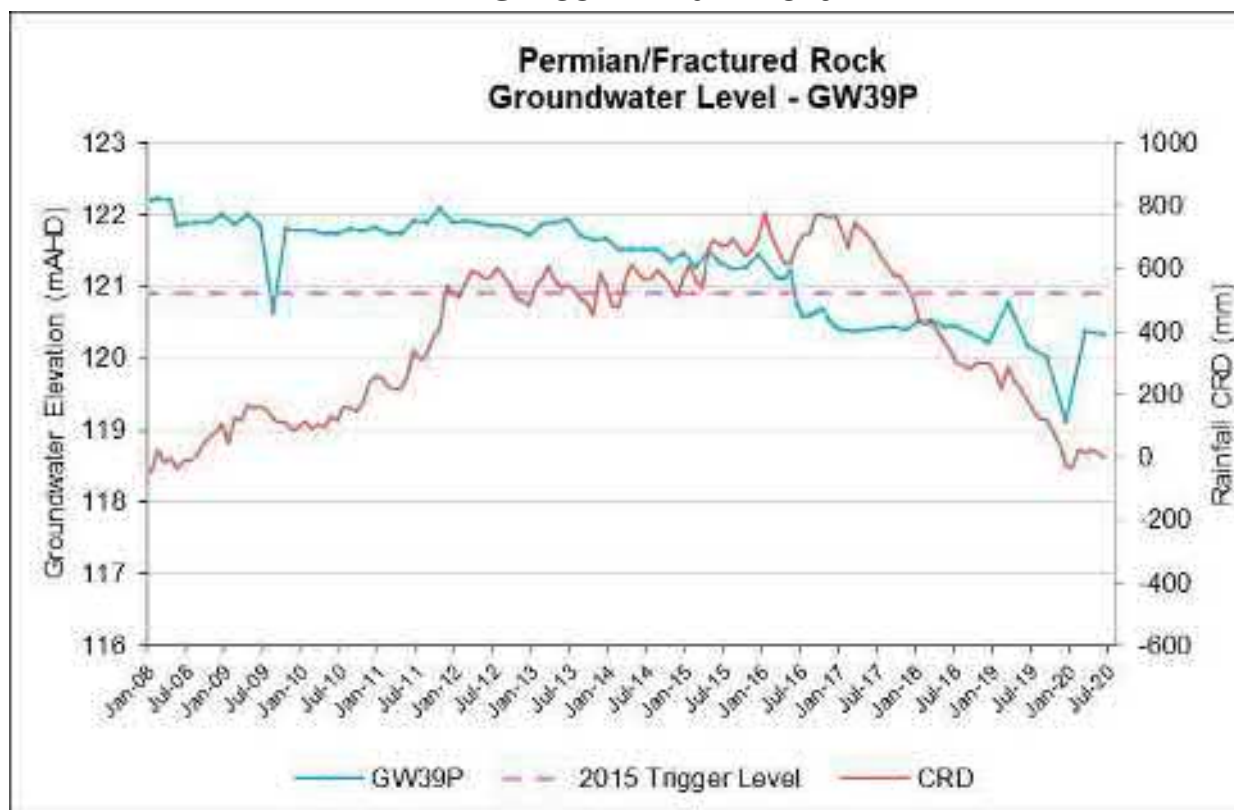
GW23 – Ramrod Creek



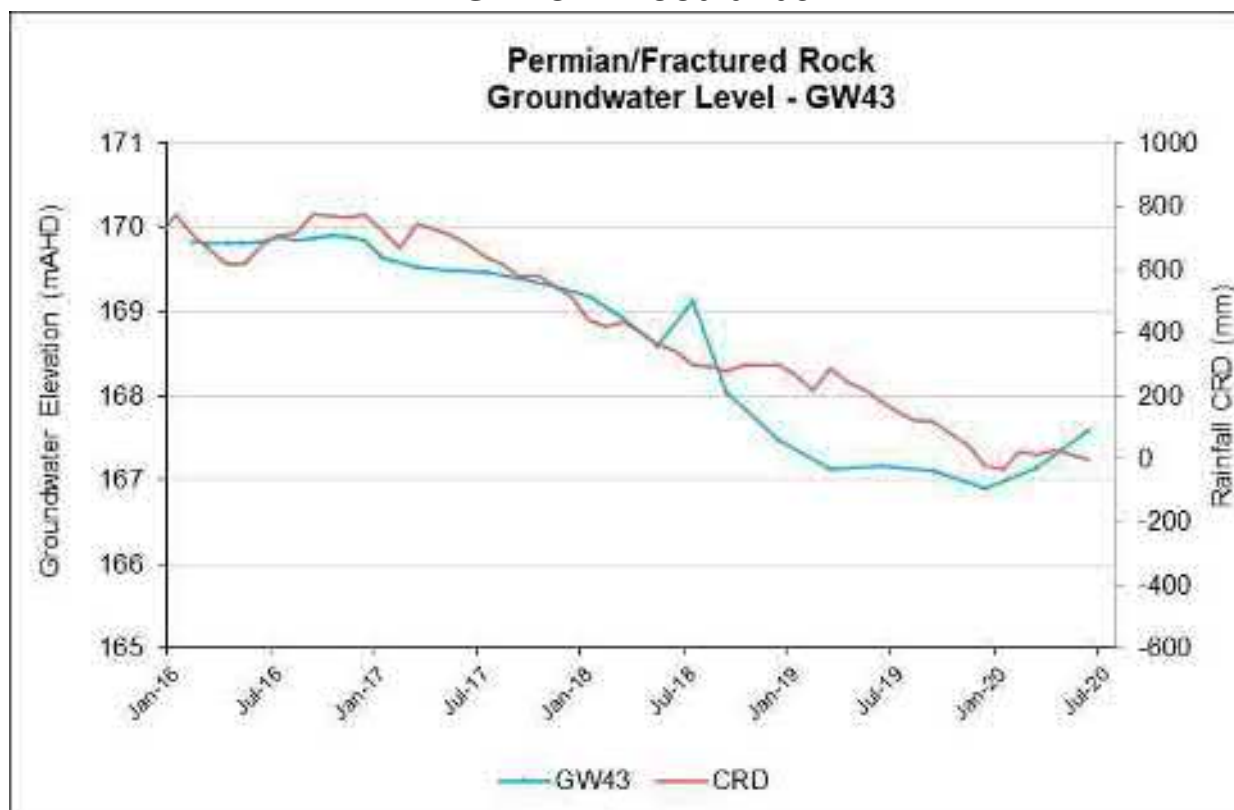
GW38P - Warkworth



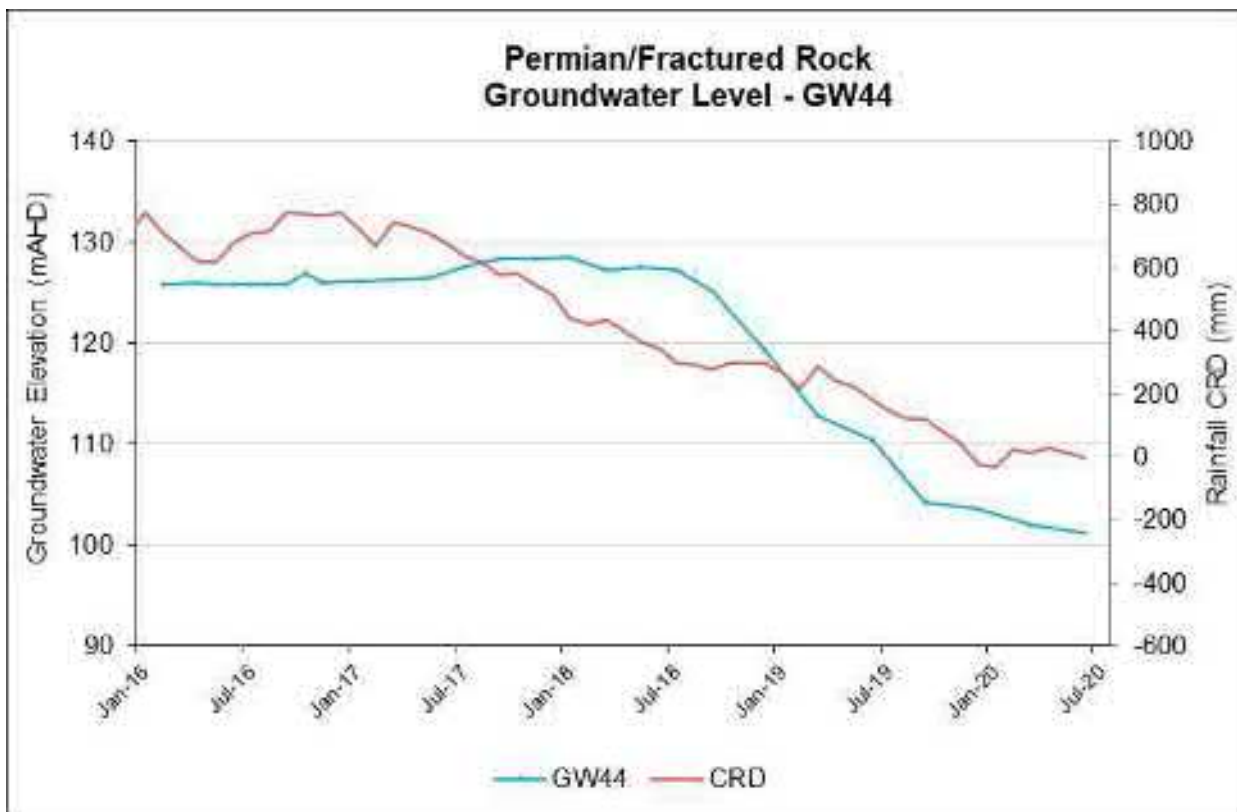
GW39P - Warkworth



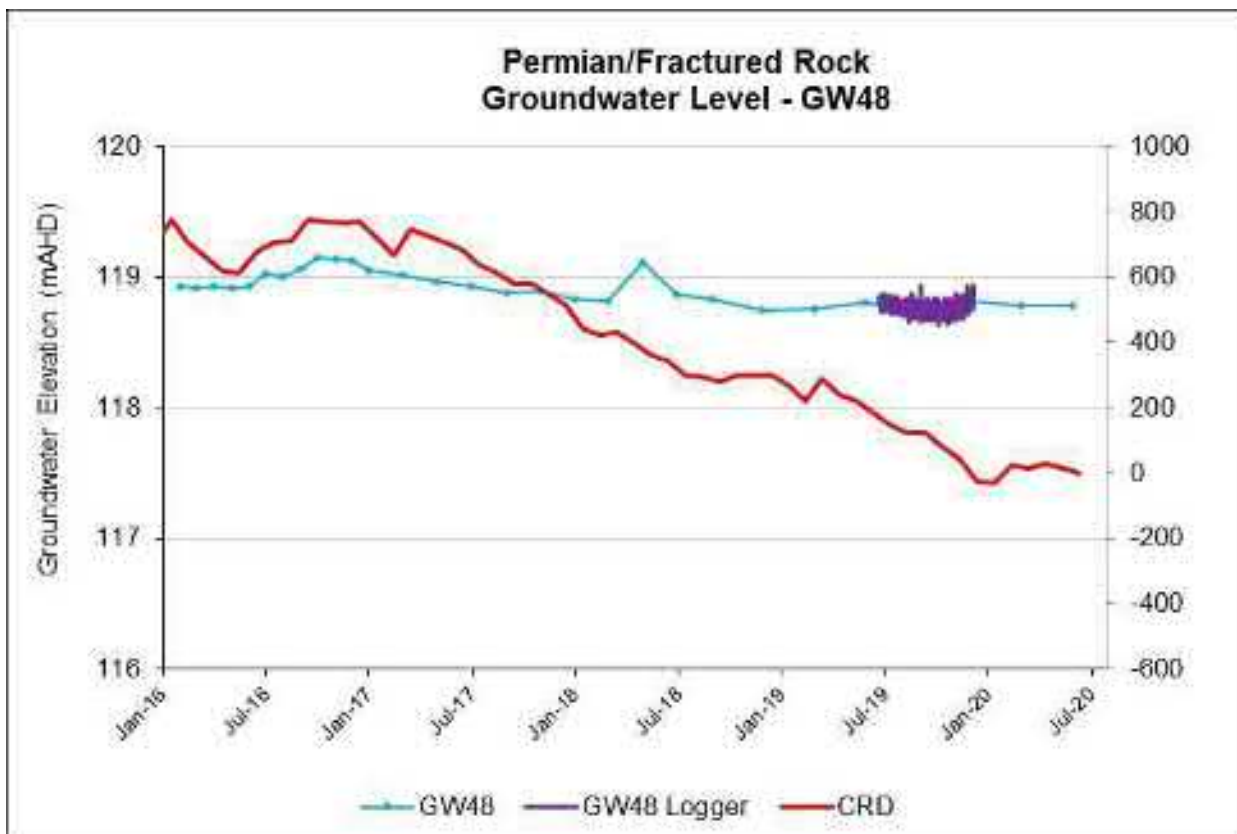
GW43 – Woodlands Hill



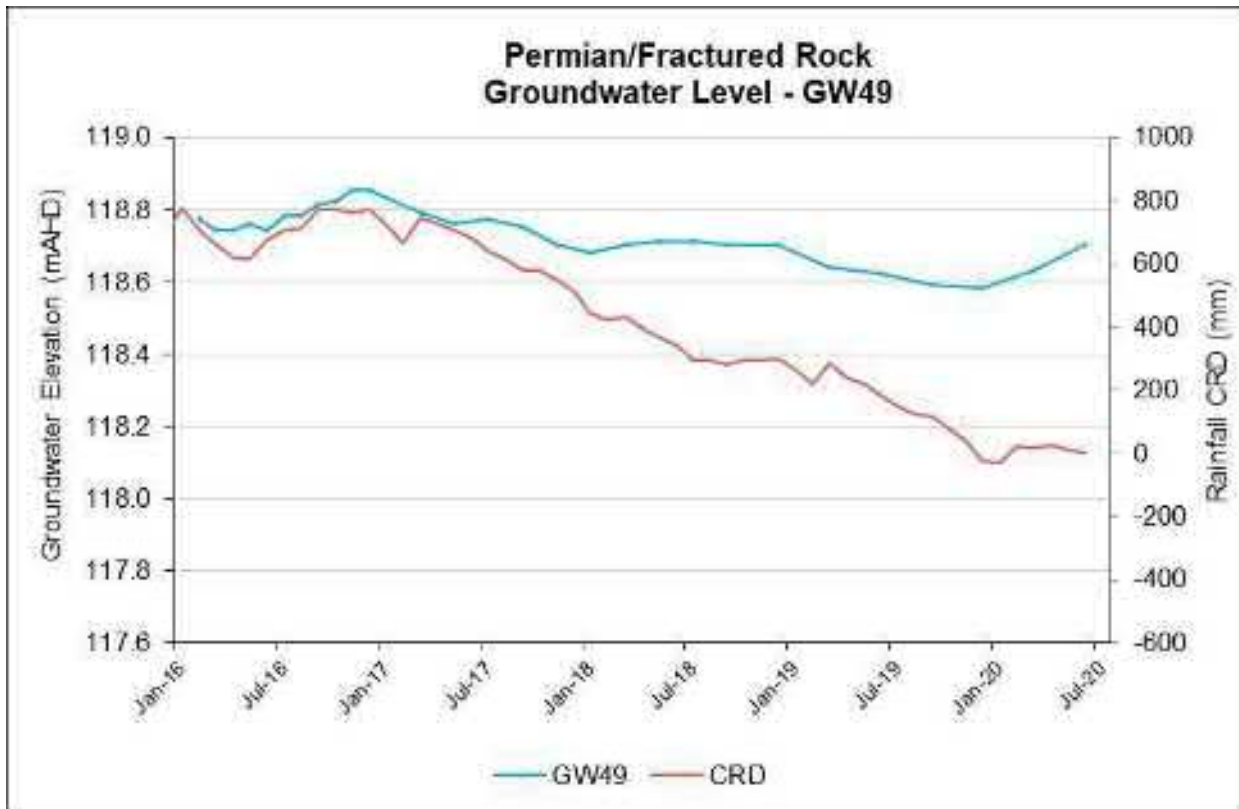
GW44 – Woodlands Hill



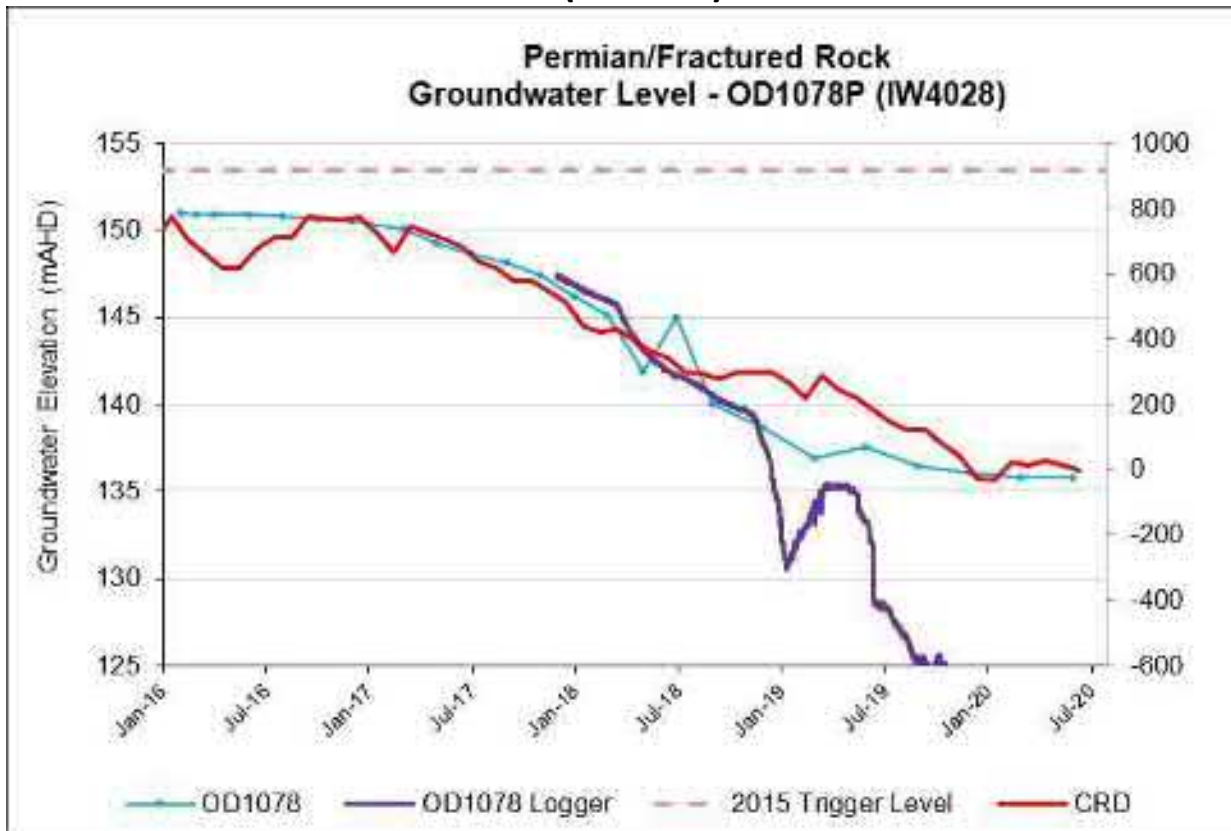
GW48 - Bowfield



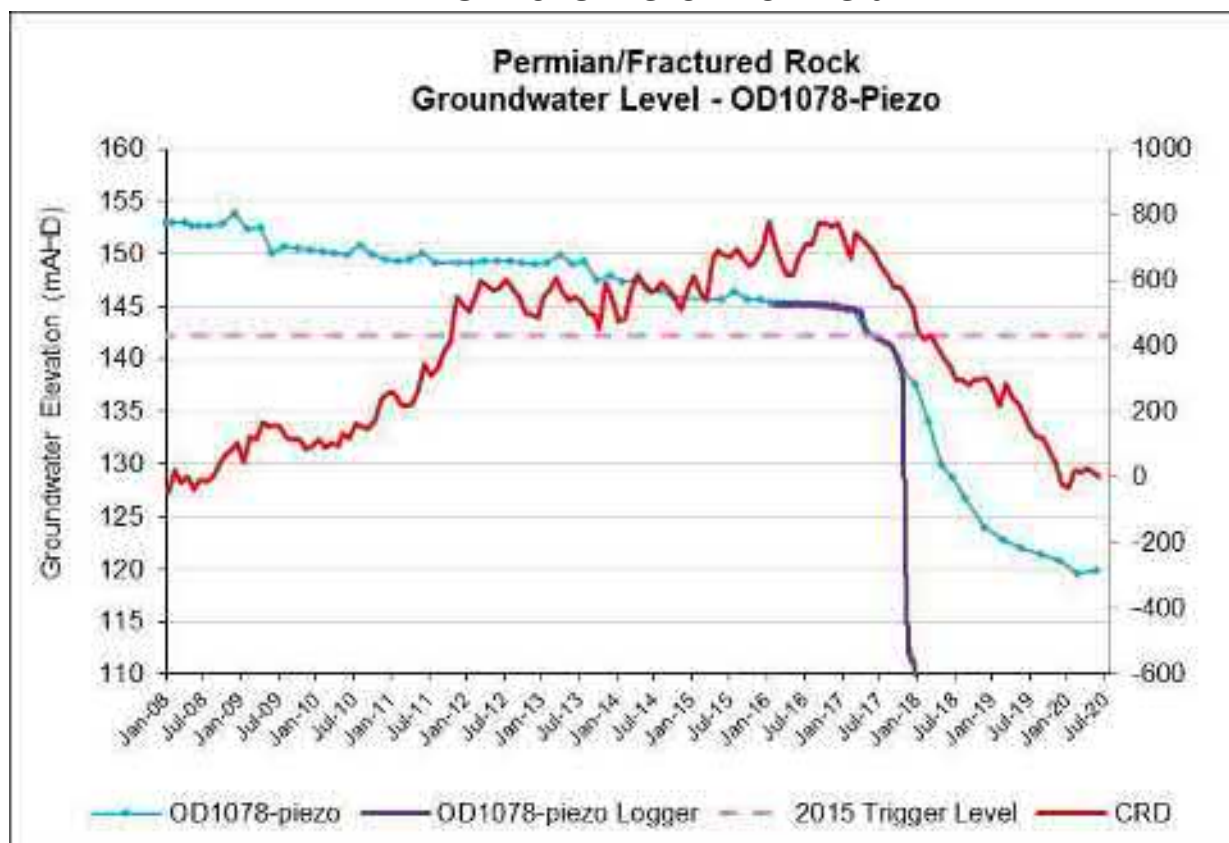
GW49 - Arrowfield



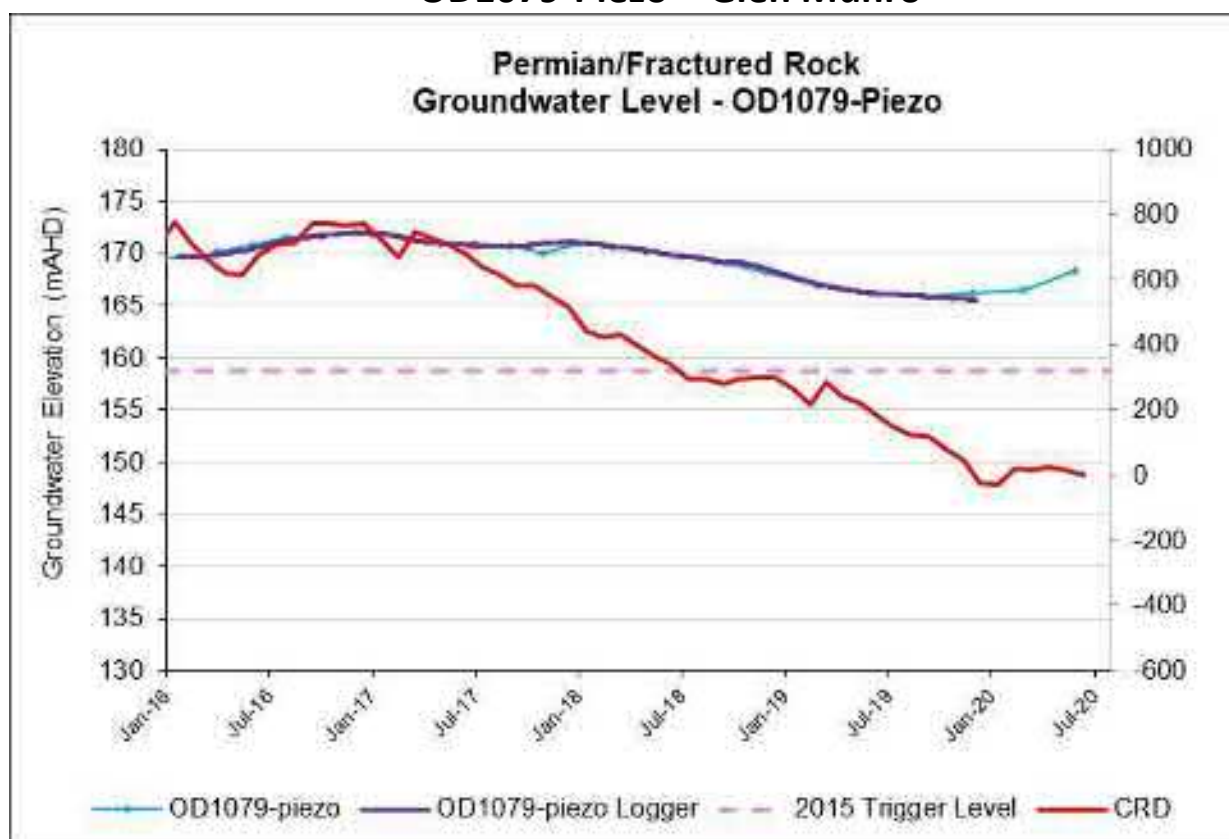
OD1078P (IW4028) - Arrowfield



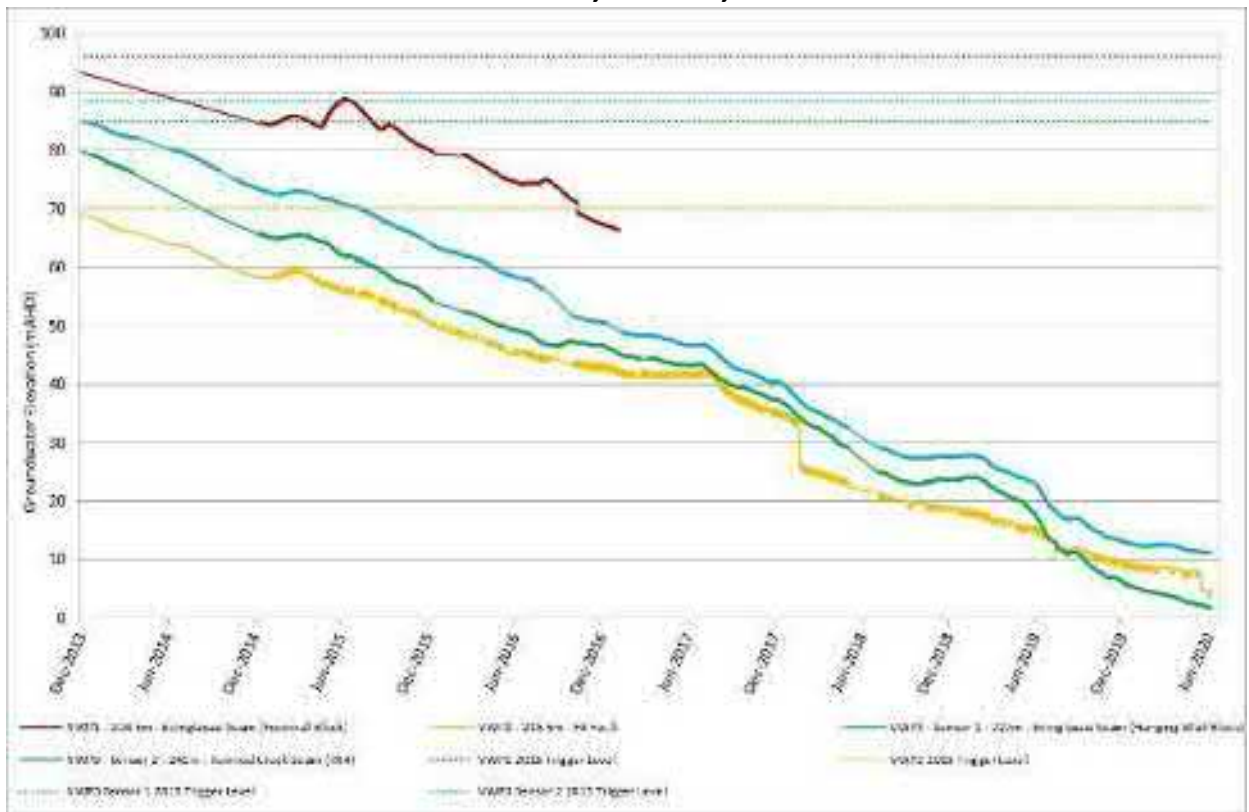
OD1078-Piezo - Bowfield



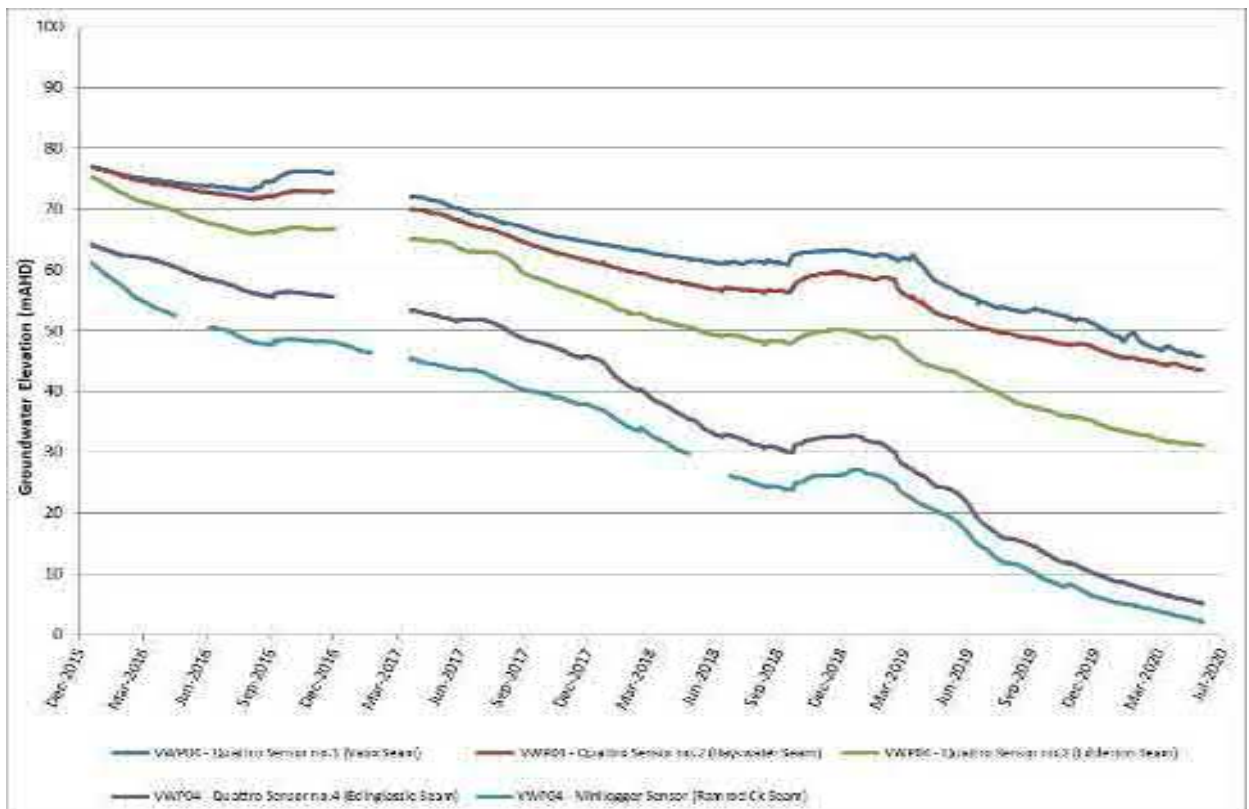
OD1079-Piezo – Glen Munro



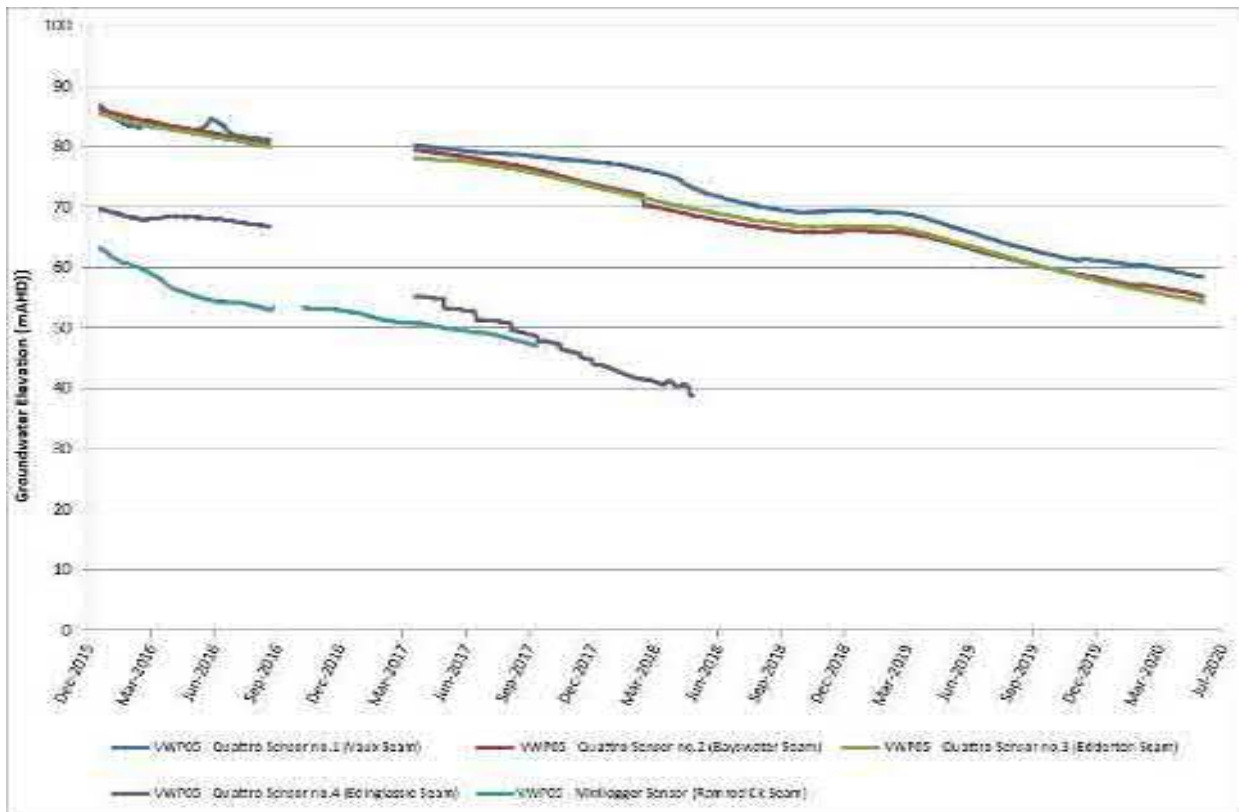
VWP1, VWP2, VWP3



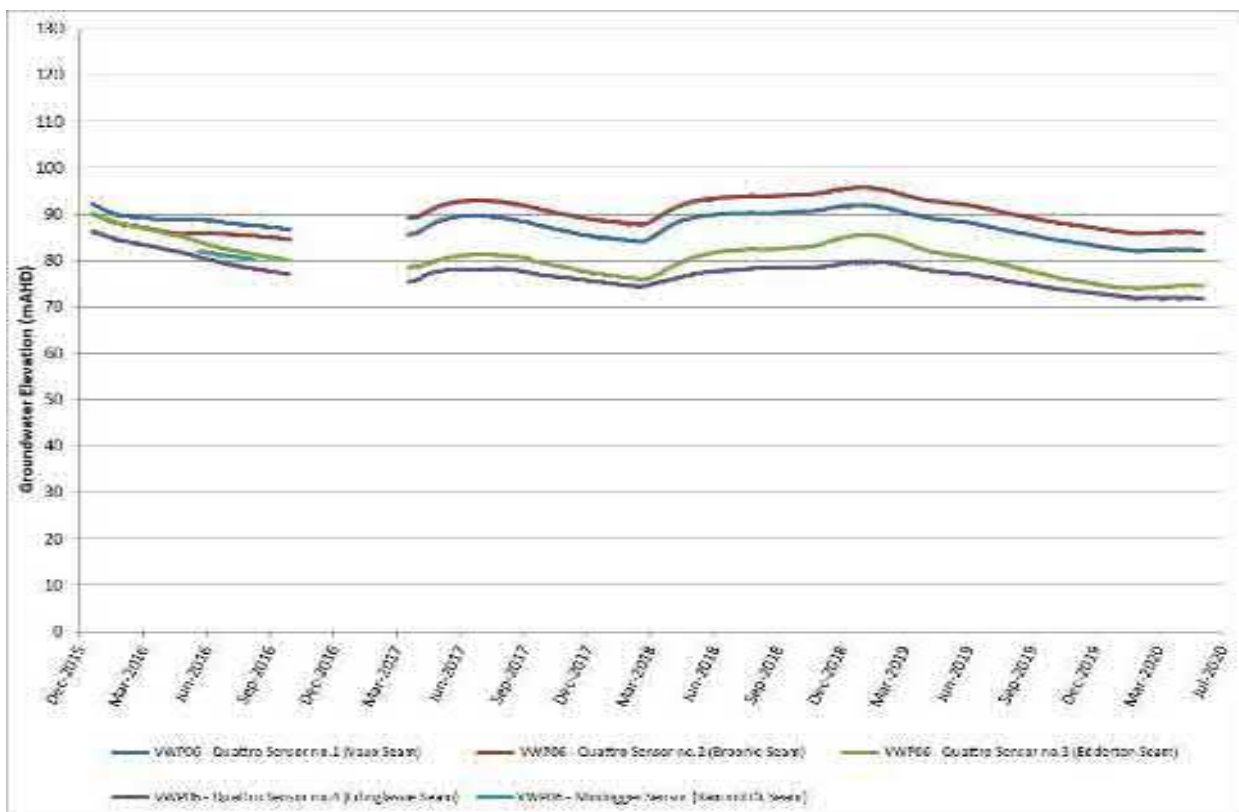
VWP4



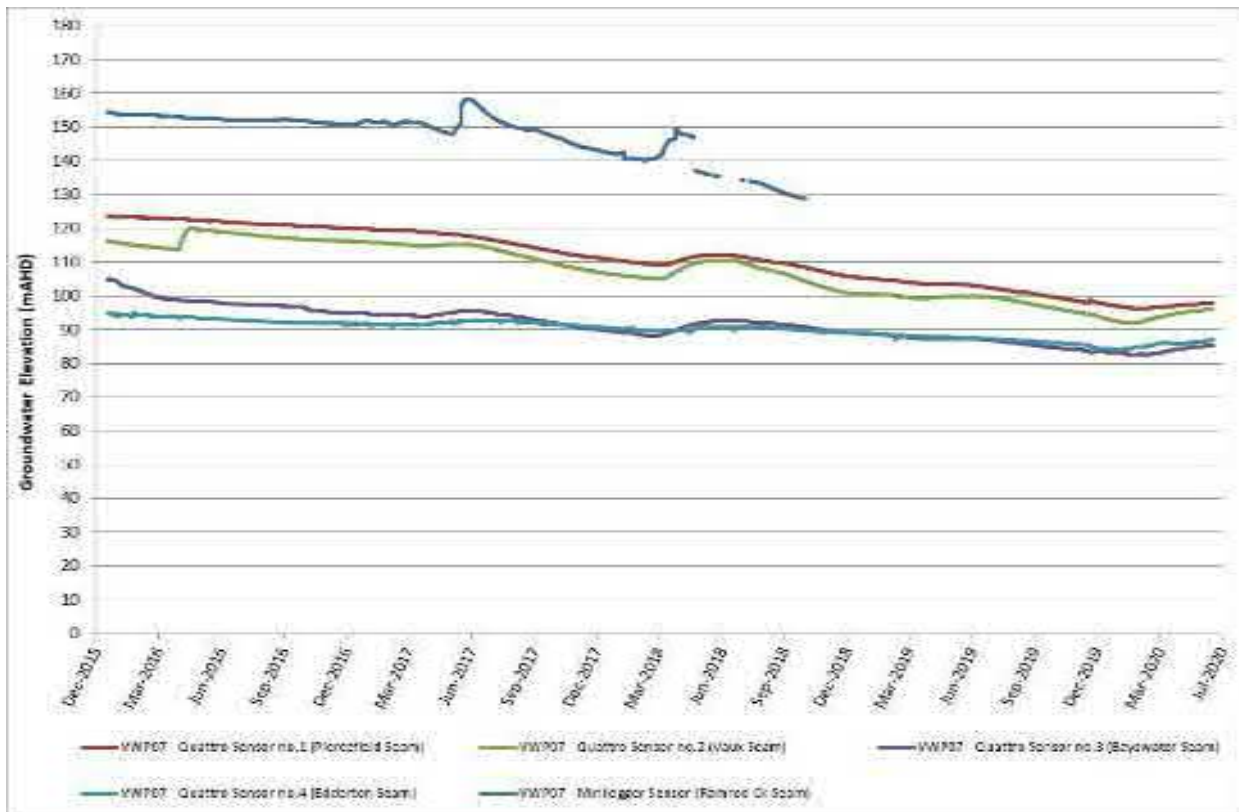
VWP5



VWP6



VWP7



APPENDIX D

Groundwater Quality Monitoring Data

Groundwater Monitoring Data with 2015 GWMP Trigger Levels

Site	GWMP SWL	GWMP WQ	Target Formation	Depth to Water (mBTOC)					Field pH					Field EC (µS/cm)					
				Trigger Level 2015	Q1 (Sep 19)	Q2 (Dec 19)	Q3 (Mar 20)	Q4 (Jun 20)	Trigger Level 2015	Q1 (Sep 19)	Q2 (Dec 19)	Q3 (Mar 20)	Q4 (Jun 20)	1 st Stage EC Trigger 10 th Percentile (µS/cm) 2015	2 nd Stage EC Trigger Maximum Value (µS/cm) 2015	Q1 (Sep 19)	Q2 (Dec 19)	Q3 (Mar 20)	Q4 (Jun 20)
GW16	Yes	Yes	Alluvium (Hunter River)	10.44	9.65	9.43	9.63	9.59	6.5 – 9.0	7.36	7.23	7.23	6.36	5666	6048	3590	3220	4220	4690
GW21	Yes	Yes		9.61	9.74	9.38	9.63	9.64	6.5 – 9.0	7.15	7.07	7.00	6.39	4469	5244	1126	792	1197	1212
GW25	Yes	Yes		20.47	10.48	10.86	10.50	10.48	6.5 – 9.0	7.13	6.94	Blocked	Blocked	9401	10120	6710	6530	Blocked	Blocked
GW38A (IW4030)	Yes	Yes		9.98	10.01	9.97	10.03	6.5 – 9.0	7.45	7.29	7.21	6.46	No Trigger		4190	3520	4560	4900	
GW39A	Yes	Yes		9.90	9.38	9.40	9.38	9.23	6.5 – 9.0	7.12	7.13	7.13	6.29	6531	6817	6630	5710	7110	7910
GW40A	Yes	Yes		10.61	10.44	10.37	10.33	10.33	6.5 – 9.0	7.36	7.35	7.36	6.54	4477	4587	3870	4230	5280	5650
GW41A (IW4029)	Yes	Yes		7.78	7.53	7.54	7.53	7.45	6.5 – 9.0	7.38	7.37	7.58	6.57	4970	5134	4720	6500	10600	9090
GW42	Yes	Yes		9.65	9.99	10.35	9.99	No Trigger				No Trigger		NM	NM	NM	NM		
GW45	Yes	Yes	Saddlers Creek Alluvium	12.32	12.43	12.50	12.55	6.5 – 9.0	6.78	6.70	6.62	6.30	No Trigger		8360	9570	6640	11380	
GW46	Yes	Yes		9.26	9.52	9.46	9.68	6.5 – 9.0	7.21	6.99	6.92	6.87	No Trigger		7300	7400	5370	7250	
GW47	Yes	Yes		7.90	8.14	8.09	8.11	6.5 – 9.0	7.19	7.09	6.99	7.00	No Trigger		4340	4390	3540	4670	
BCGW05	Yes	Yes	Permian Coal Seam	No bore access				No Trigger				No bore access				No bore access			
BCGW10	Yes	Yes		No bore access				No Trigger				No bore access				No bore access			
BCGW11	Yes	Yes		No bore access				No Trigger				No bore access				No bore access			
BCGW15	Yes	Yes		No bore access				No Trigger				No bore access				No bore access			
BCGW18	Yes	Yes		10.6*	Dry (11.16)	Dry (11.44)	Dry (11.46)	Dry (11.44)	6.5 – 9.0	Dry	Insufficient Water	Insufficient Water	Insufficient Water	7212	7885	Dry	Insufficient Water	Insufficient Water	Insufficient Water
BCGW19	Yes			13.02	7.29	7.47	7.63	6.90	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM
BCGW22P (IW4026)	Yes	Yes		15.08	6.16	6.47	6.65	-	6.5 – 9.0	7.91	8.13	9.87	7.10	15526	16212	14100	15200	15800	16270
EWPC33	Yes	Yes		54.18	33.69	33.64	33.43	33.21	6.5 – 9.0	6.90	7.21	6.99	6.96	4592	5562	2887	2456	3040	2995
GW2	Yes	Yes		8.53	11.49	11.56	11.74	11.81	6.5 – 9.0	7.86	7.67	7.67	7.35	4266	4440	4690	4150	4330	4830
GW3	Yes			6.25	11.69	11.38	11.50	11.31	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM
GW6	Yes	Yes	33.02	24.02	24.00	24.32	24.41	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM	
GW7	Yes	Yes	80.50	46.40	46.29	46.48	46.48	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM	
GW8	Yes		Permian Coal Seam	Mined out												Mined out			
GW22	Yes	Yes		Decommissioned								Decommissioned				Decommissioned			
GW23	Yes	Yes		49.19	49.96	49.94	49.93	49.96	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM
GW26	Yes	Yes			NM	NM	NM	NM		NM	NM	NM	NM			NM	NM	NM	NM
GW27	Yes				NM	NM	NM	NM		NM	NM	NM	NM			NM	NM	NM	NM
GW38P	Yes	Yes		10.54	10.40	10.18	10.41	10.24	6.5 – 9.0	7.75	7.61	7.63	7.07	3224	3512	2564	2157	2821	3040
GW39P	Yes	Yes		9.52	10.70	11.60	10.35	10.38	6.5 – 9.0	7.37	7.57	7.56	6.73	8405	9825	5730	5030	6170	6750
GW40P	Yes				NM	NM	NM	NM		NM	NM	NM	NM			NM	NM	NM	NM
GW41P	Yes	Yes			NM	NM	NM	NM		NM	NM	NM	NM			NM	NM	NM	NM
GW43	Yes	Yes			30.22	30.42	30.19	29.74	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM
GW44	Yes	Yes			106.75	107.48	108.96	109.79	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM
GW48	Yes	Yes			10.97	10.88	10.91	10.91	6.5 – 9.0	7.58	7.60	7.65	6.77	No Trigger		3410	3750	4350	4750
GW49	Yes			7.96	7.97	7.92	7.85	6.5 – 9.0	6.94	6.84	6.96	6.09	No Trigger		5200	5540	6620	7530	
OD1078P (IW4028)	Yes		18.20	35.23	35.57	35.92	35.89	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM	
OD1078-Piezo	Yes		29.11	50.03	50.58	51.85	51.50	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM	
OD1079	Yes			42.34	42.43	42.09	-		NM	NM	NM	NM			NM	NM	NM	NM	
OD1079-Piezo	Yes		68.63	60.80	60.46	60.15	58.42	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM	
OD1079S			Spoil		39.94	40.03	39.69	39.82	No Trigger	NM	NM	NM	NM	No Trigger		NM	NM	NM	NM
BCGW22A (IW4027)			Regolith		4.92	5.15	5.12	5.16	6.5 – 9.0	6.77	6.81	6.86	6.81	No Trigger		10510.00	10670.00	14500.00	14330.00

NM - not measured, as discussed in report - based on recommendations by AGE (2018) due to issues with bore condition/planned replacement bores/network review

* RED text indicates single trigger exceedance

* Red text indicates exceedance based on 2015 Impact Assessment Criteria (3 consecutive readings)

* Red text indicates EC exceedance based on 2015 Impact Assessment Criteria - 2nd Stage (1 reading)

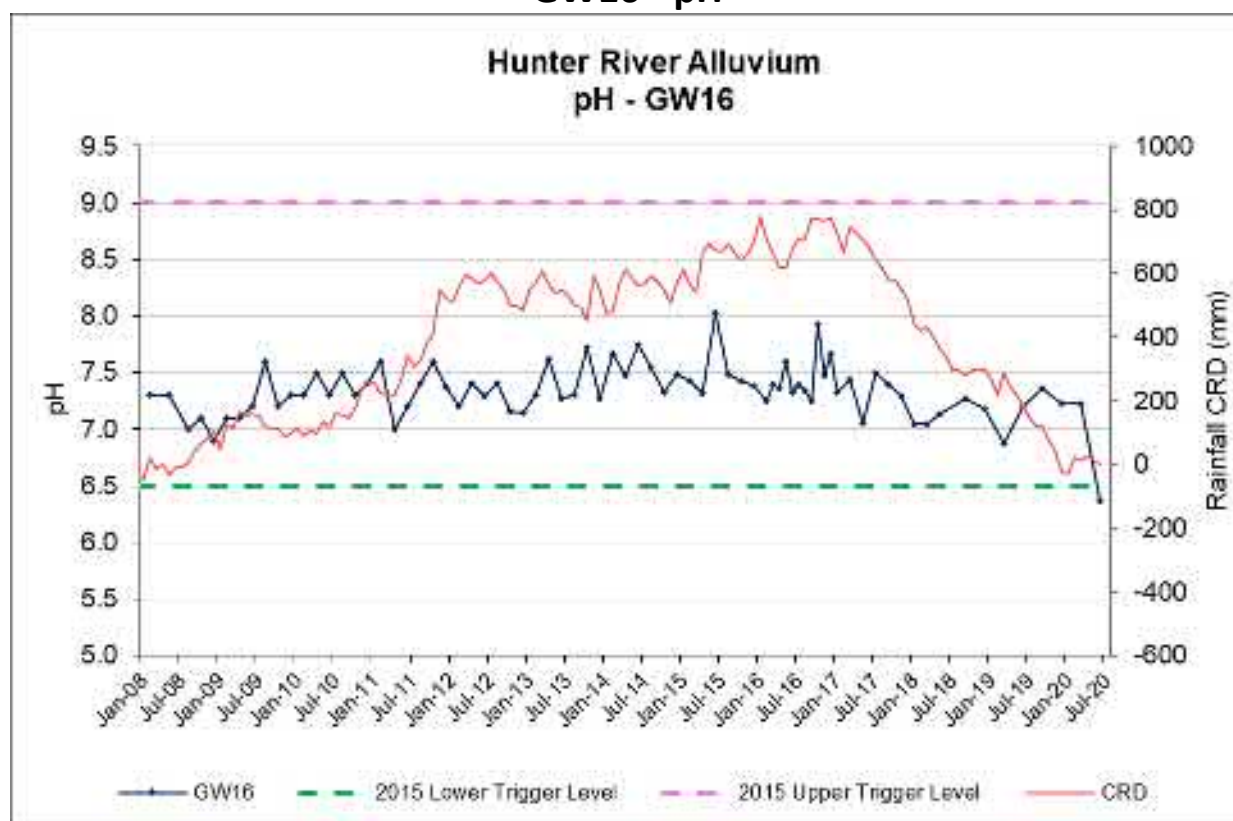
* NM = not measured

* Trigger set at base of bore

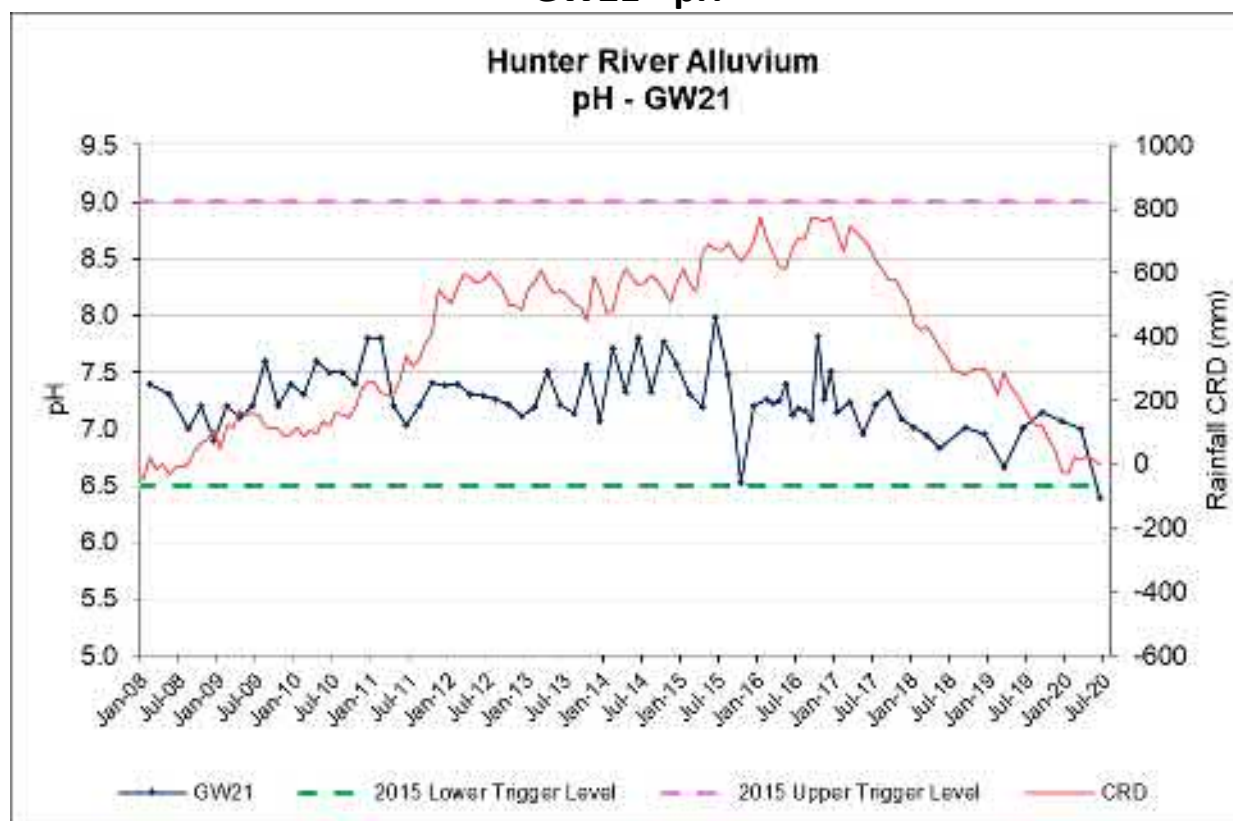
APPENDIX E

Groundwater Quality Graphs

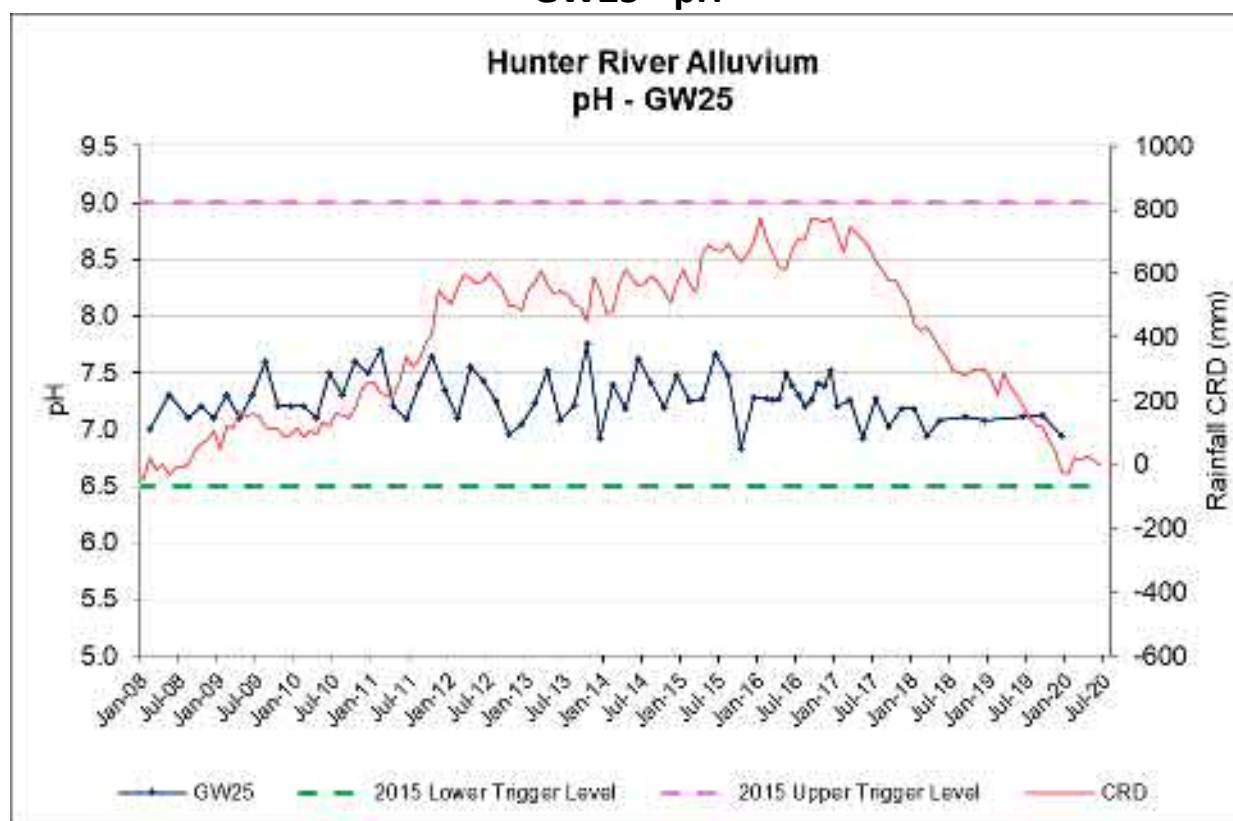
GW16 - pH



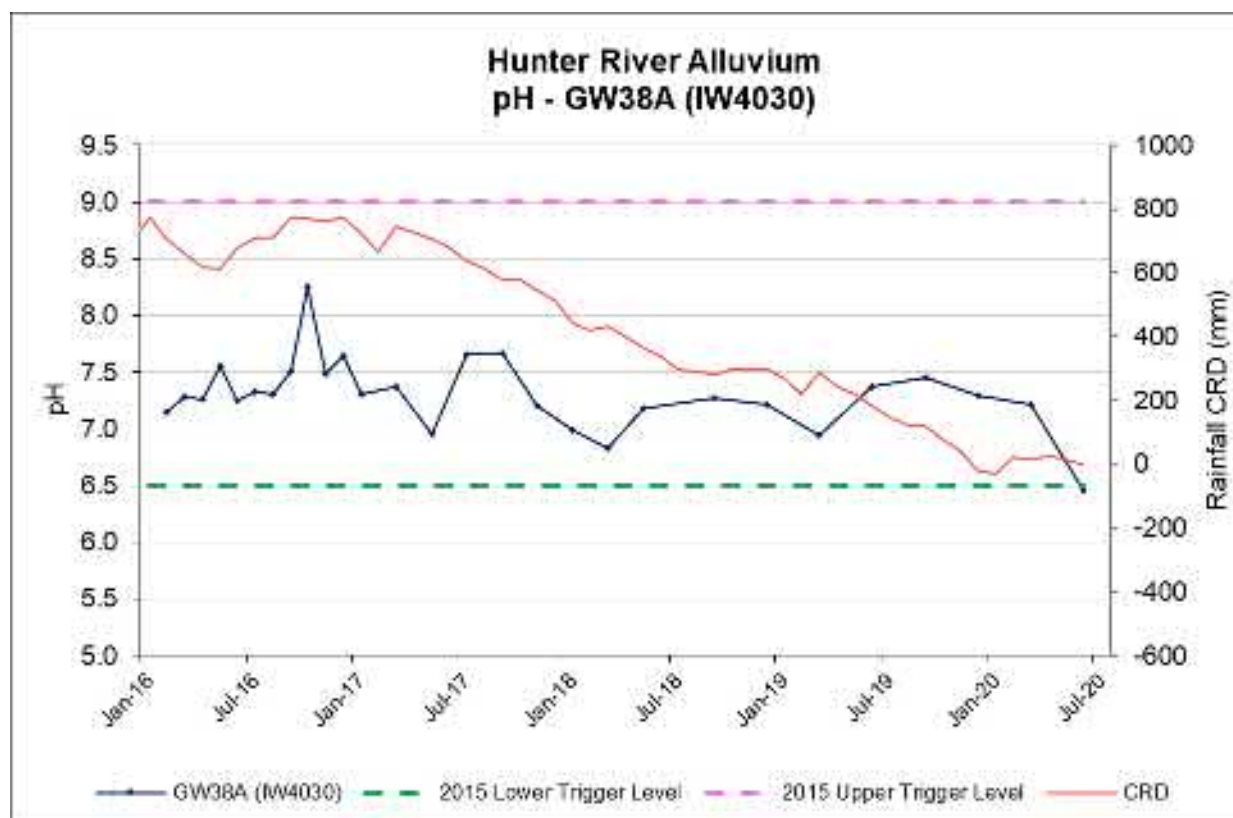
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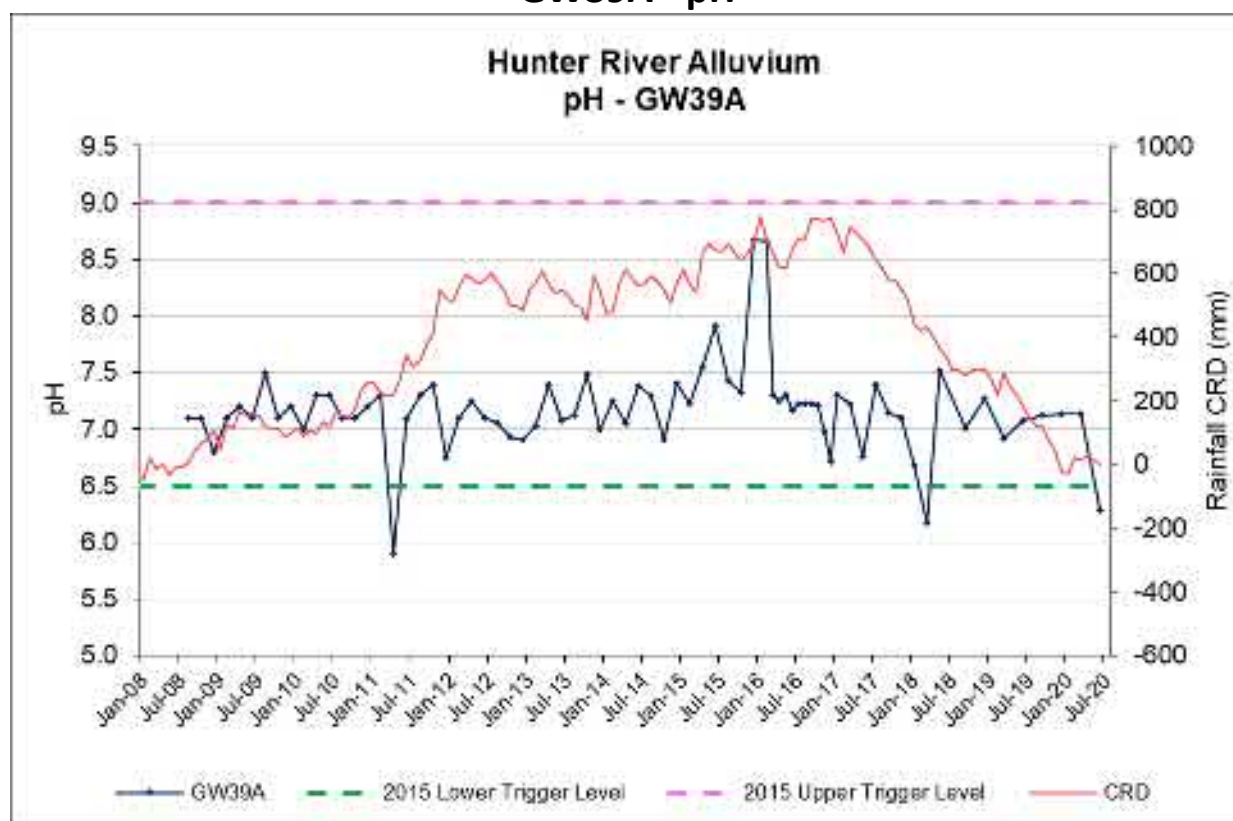
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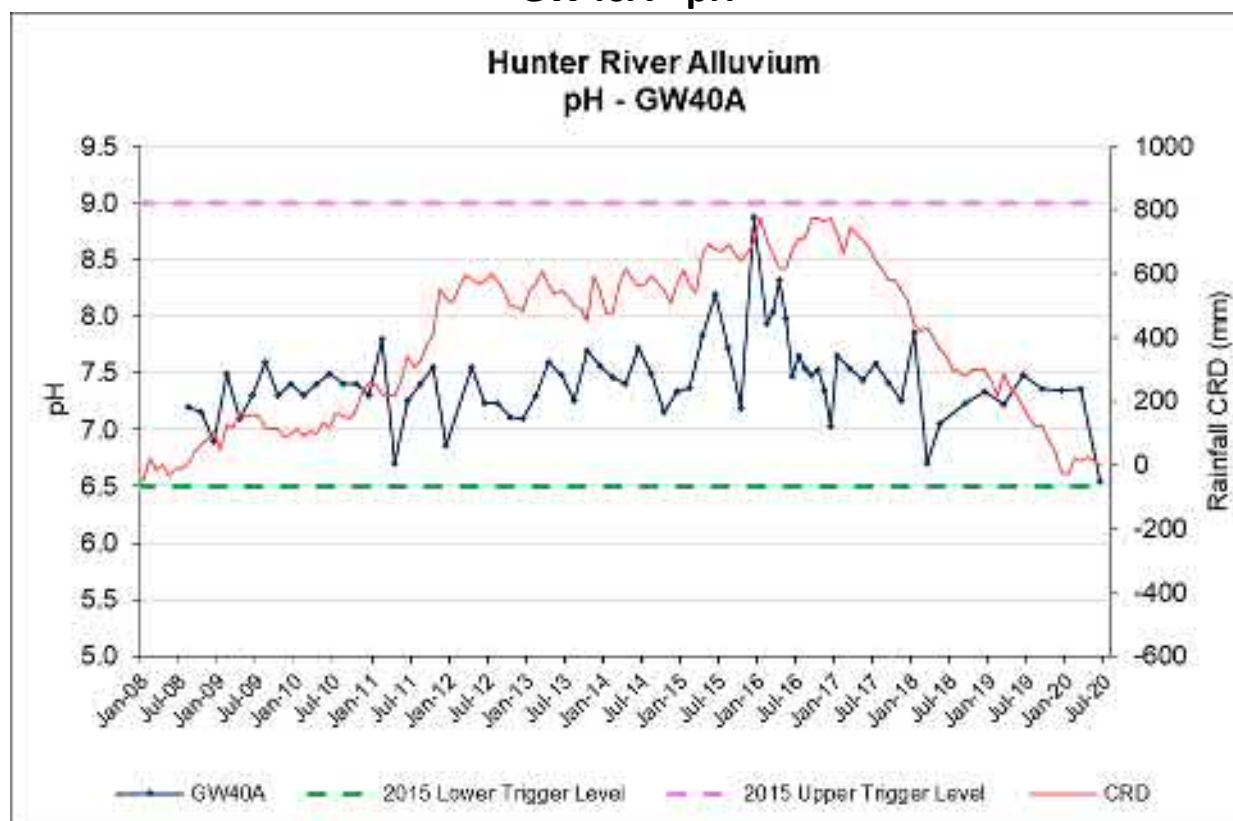
GW38A (IW4030) - pH



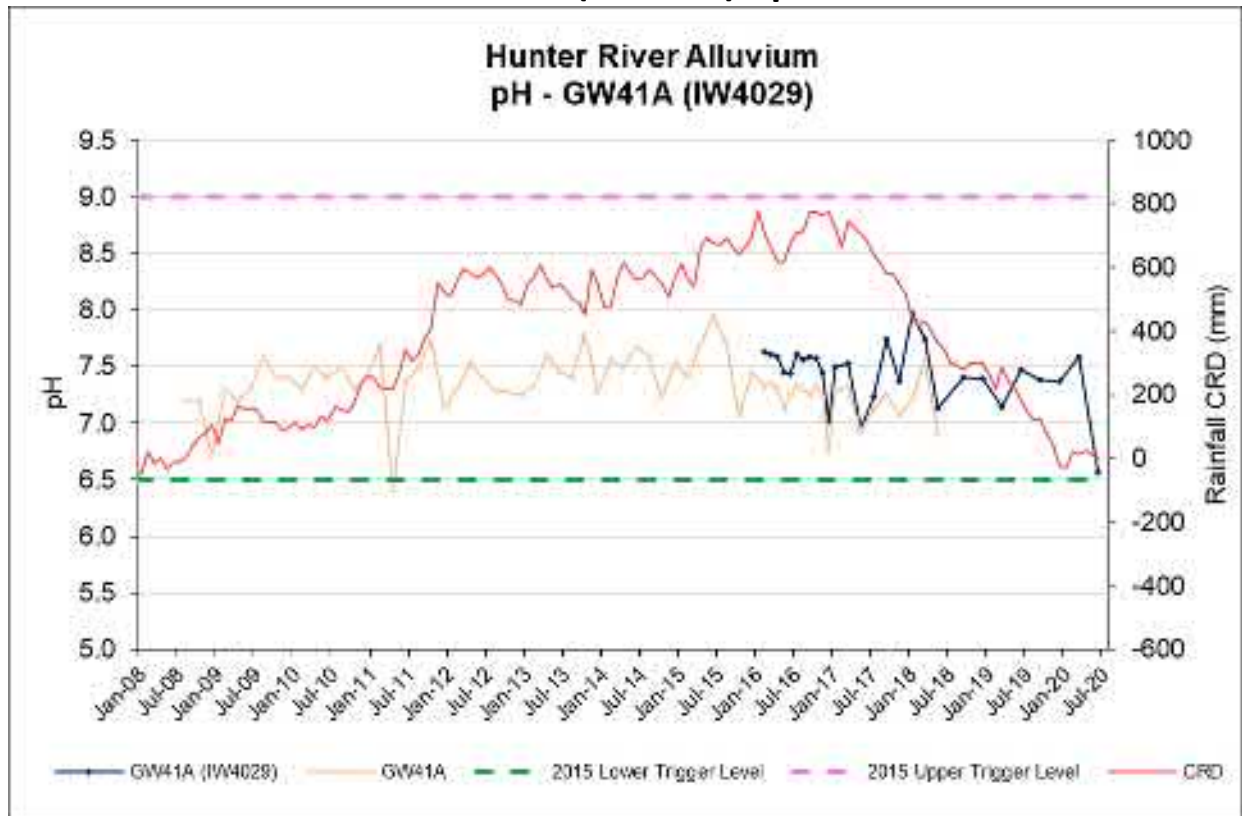
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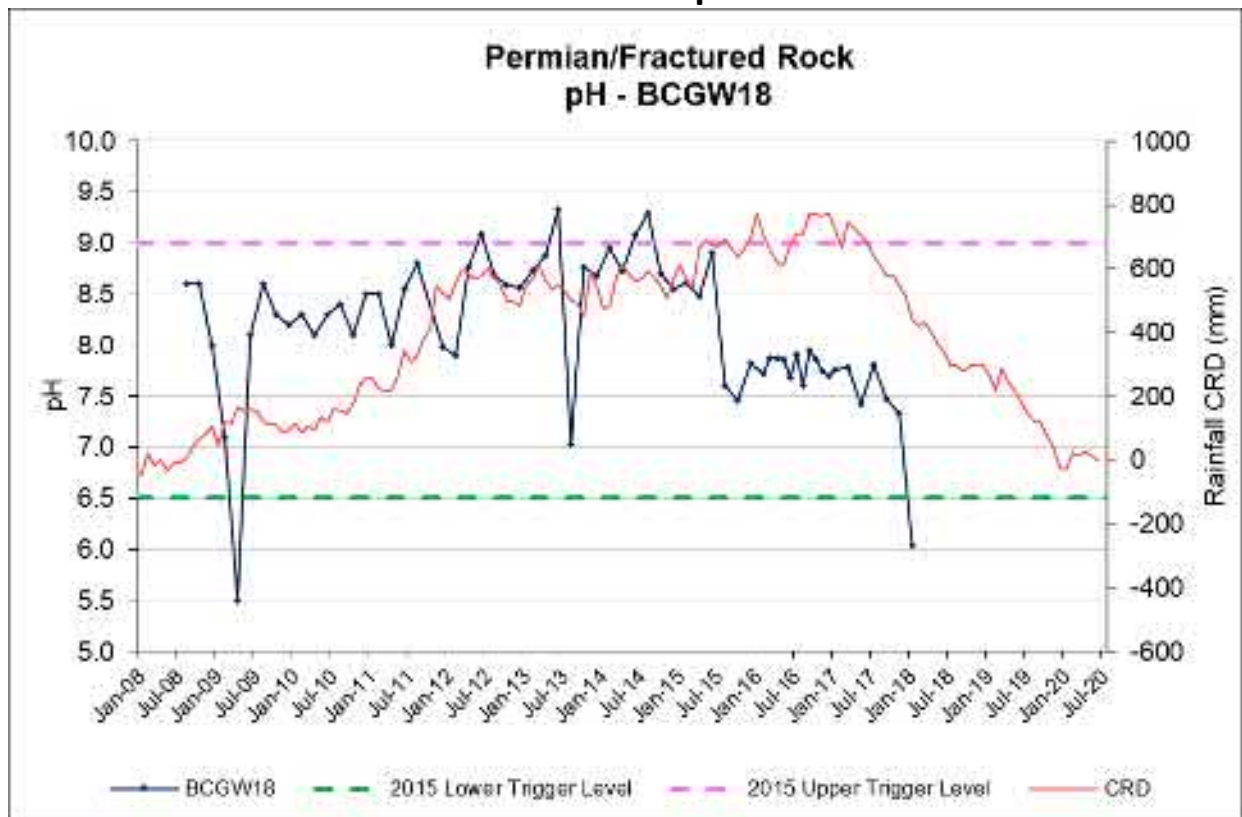
GW40A - pH



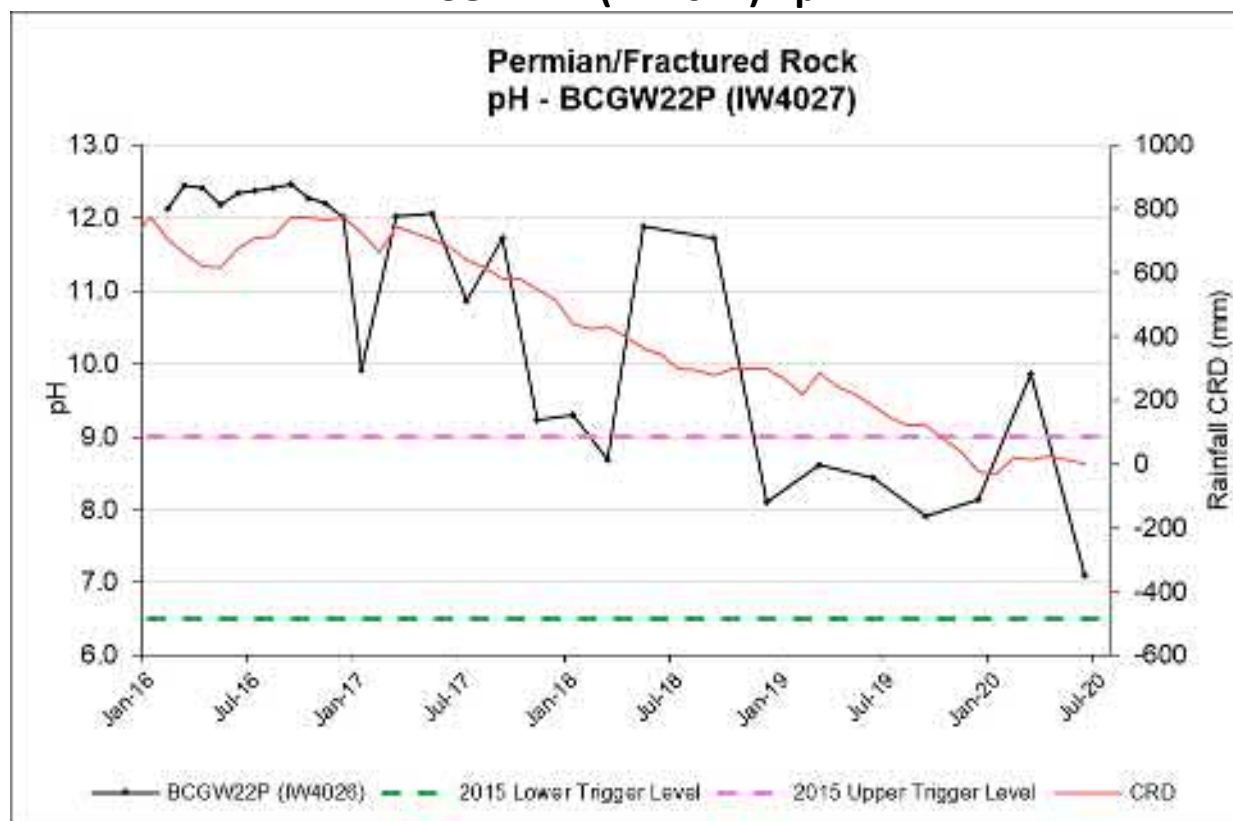
GW41A (IW4029) - pH



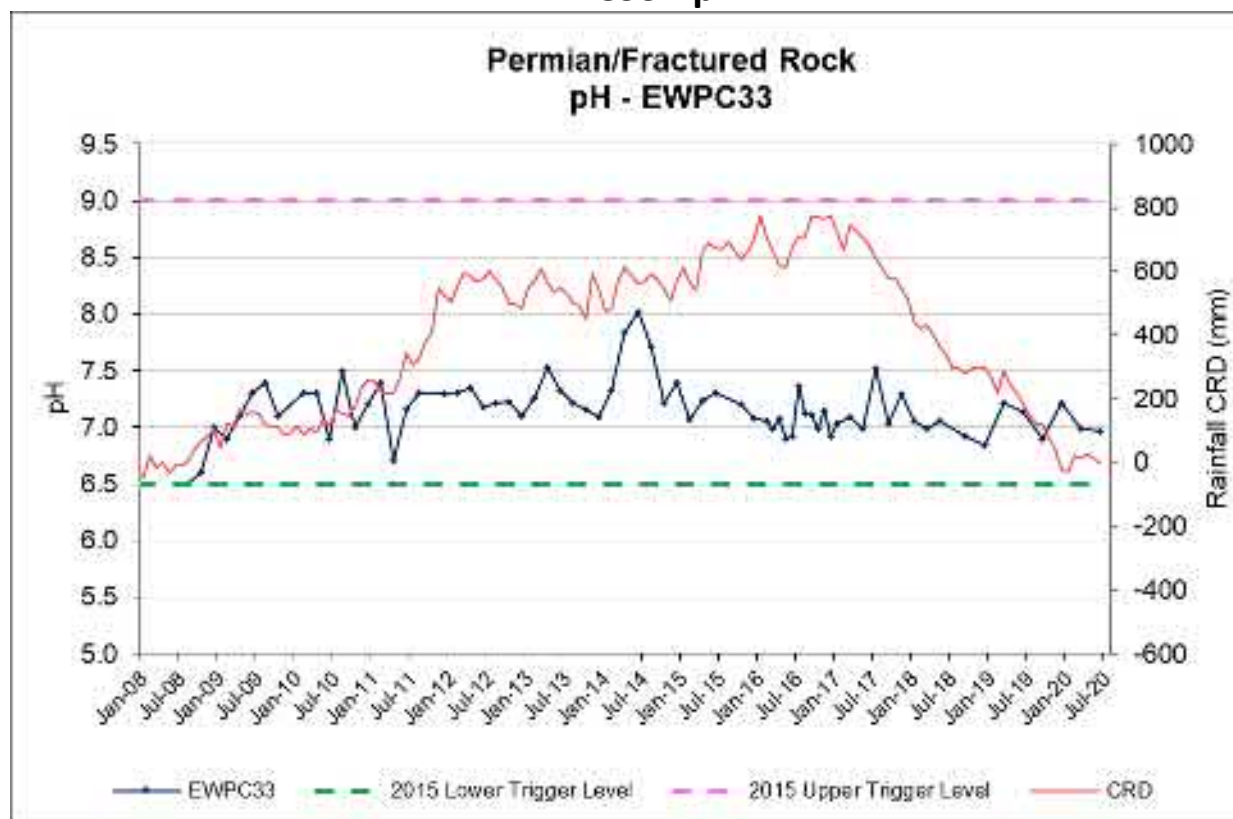
BCGW18 - pH



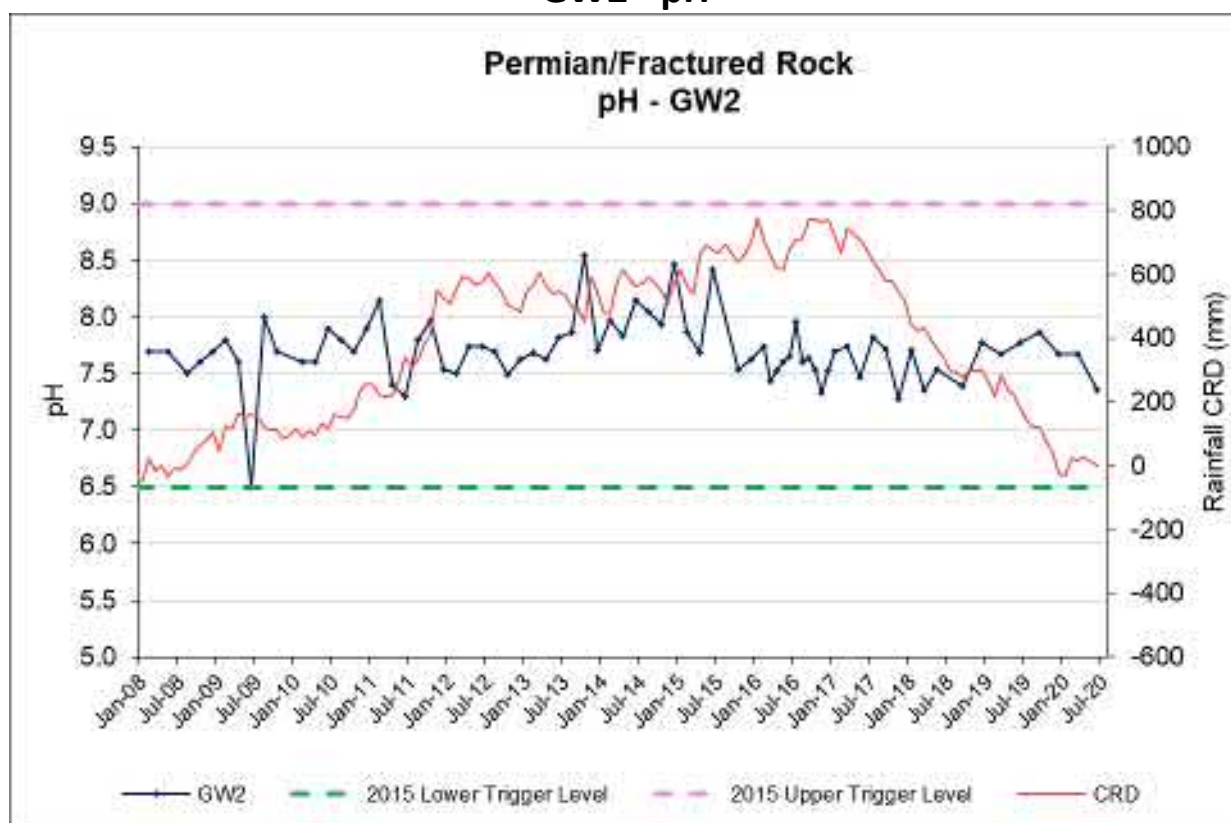
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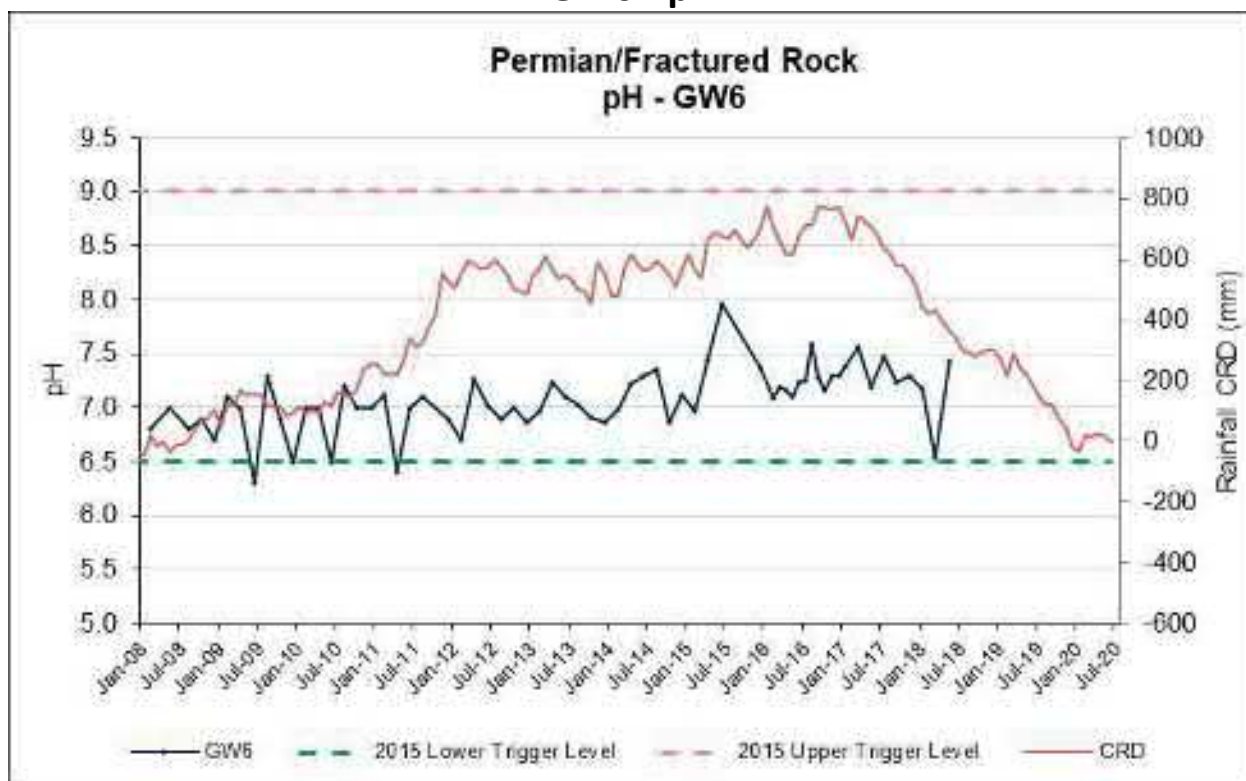
EWPC33 - pH



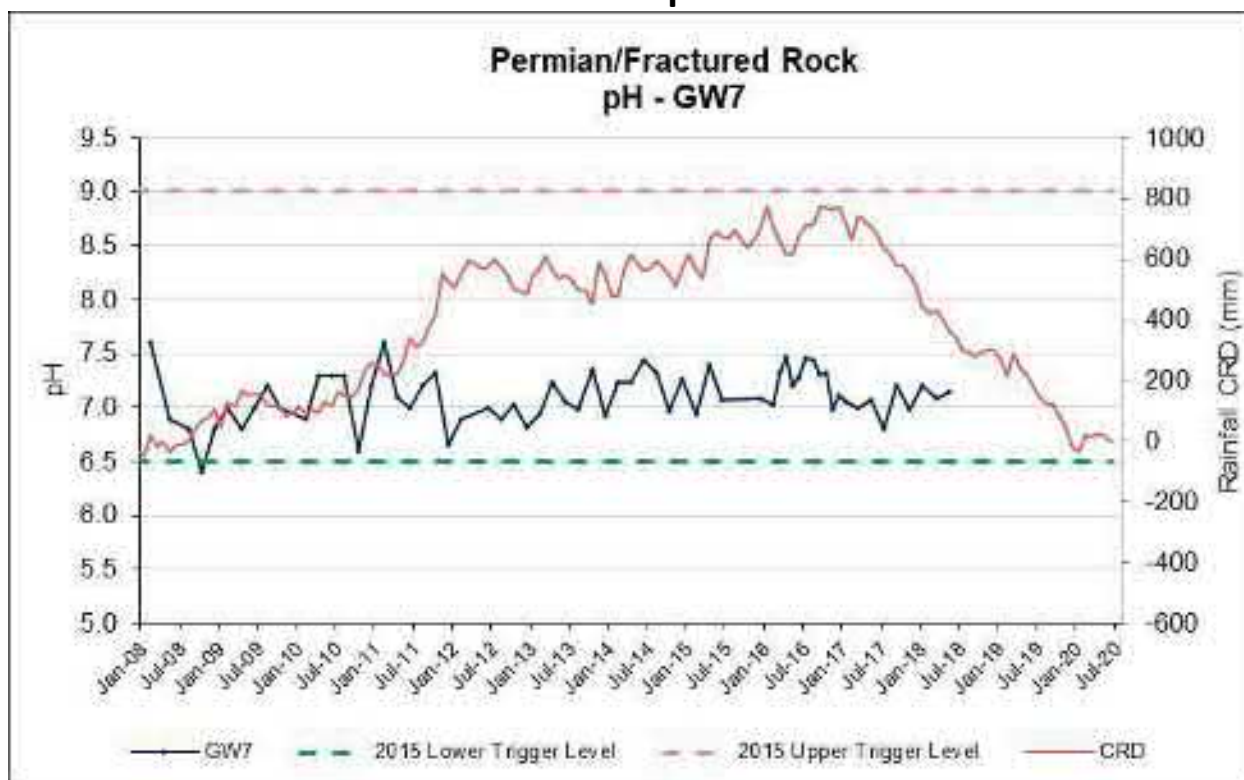
GW2 - pH



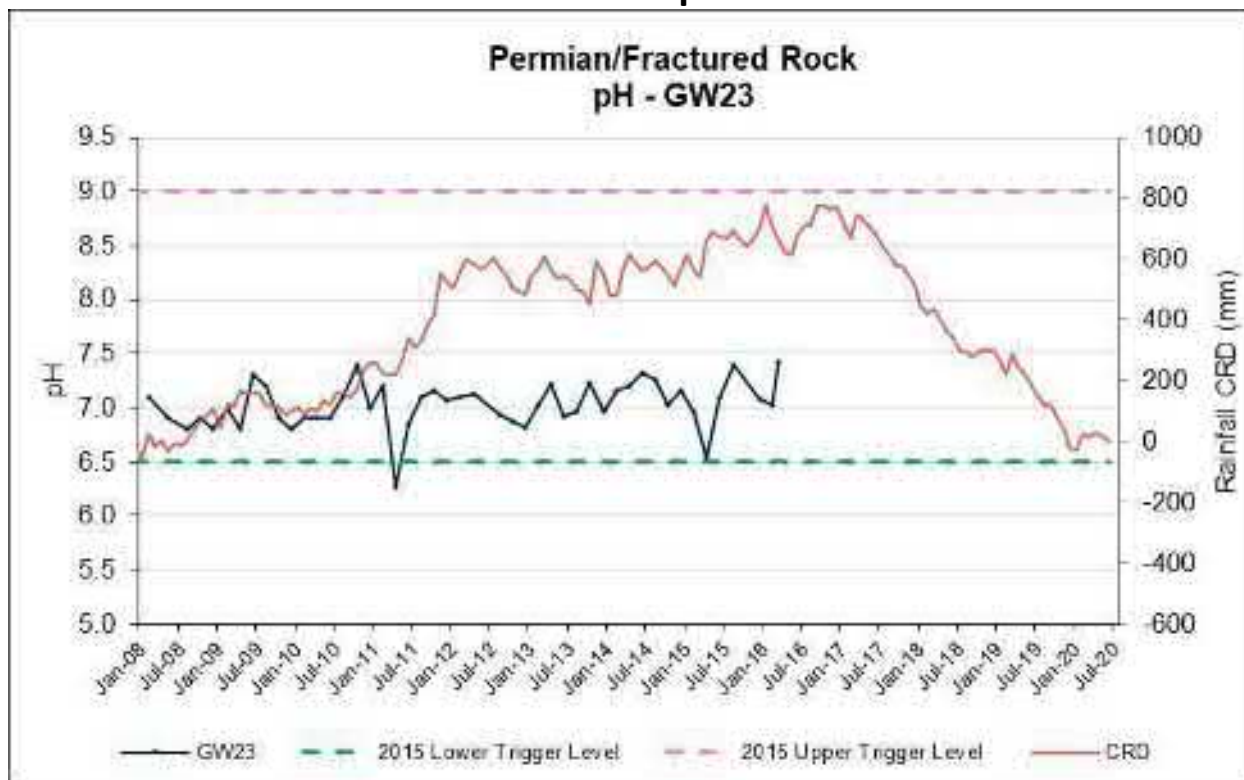
GW6 - pH



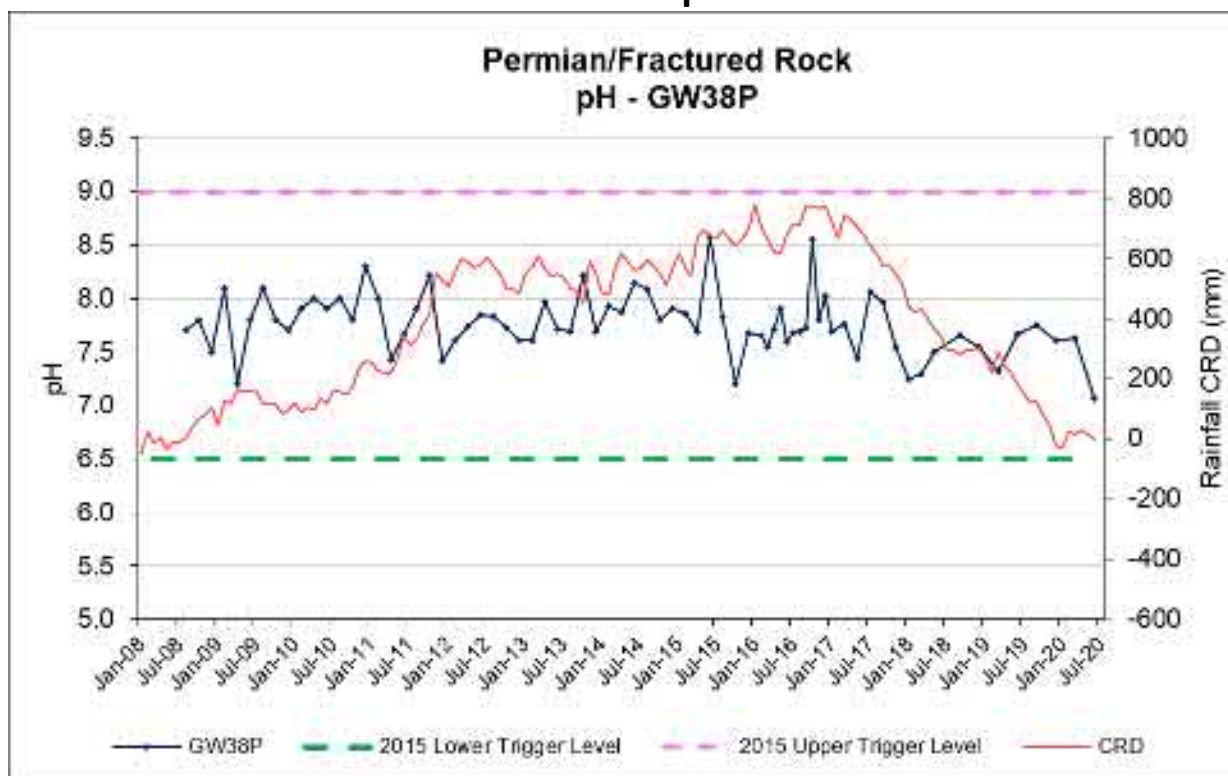
GW7 - pH



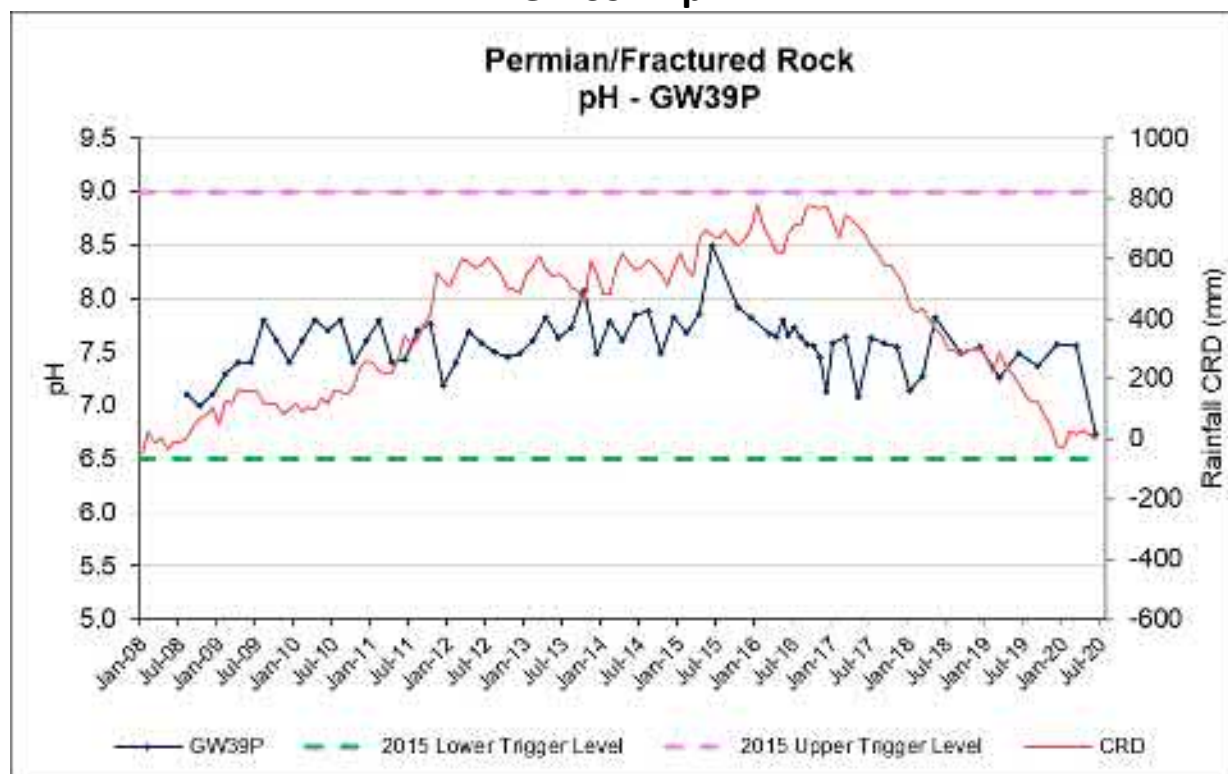
GW23 - pH



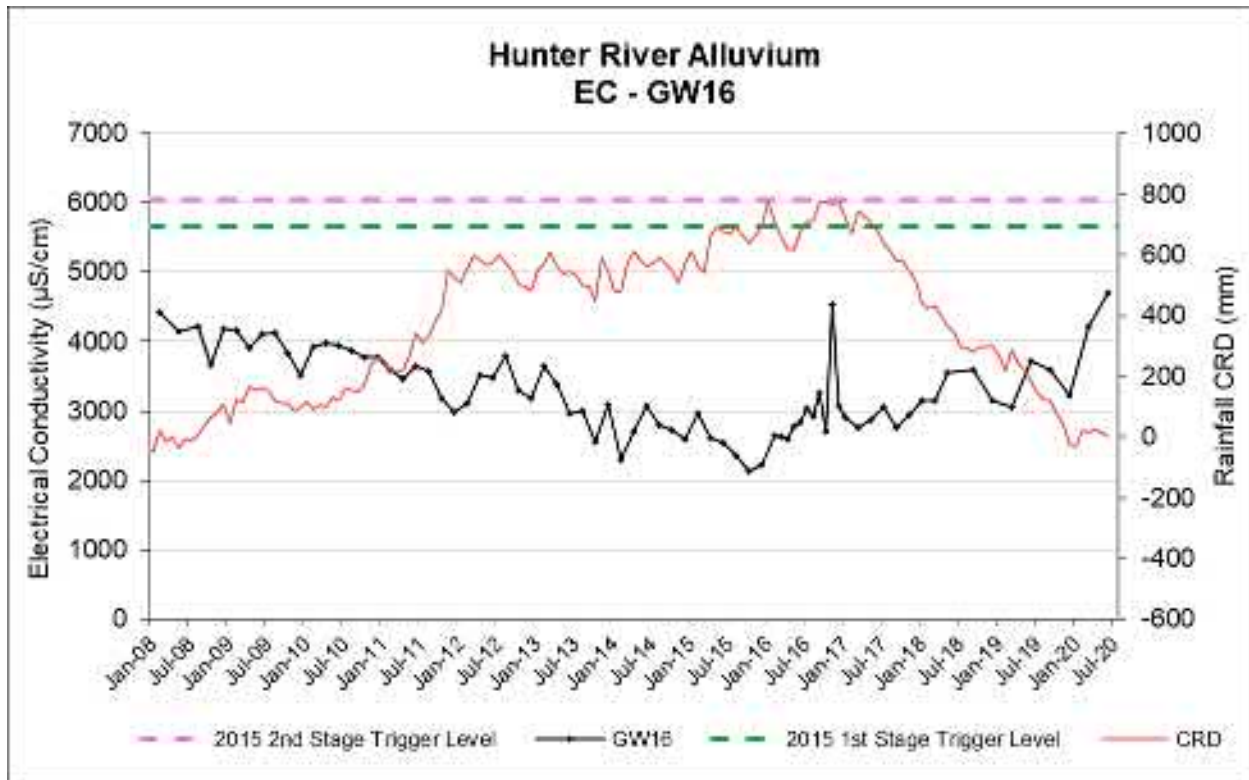
GW38P - pH



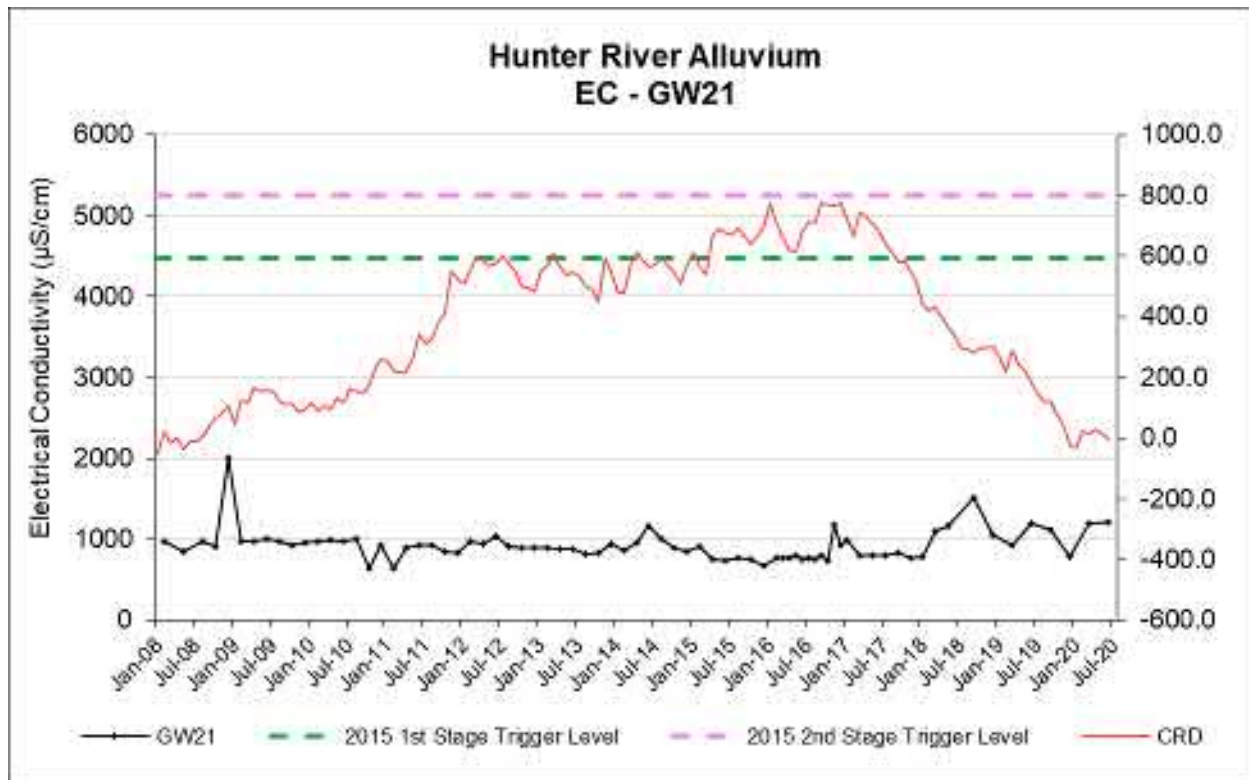
GW39P - pH



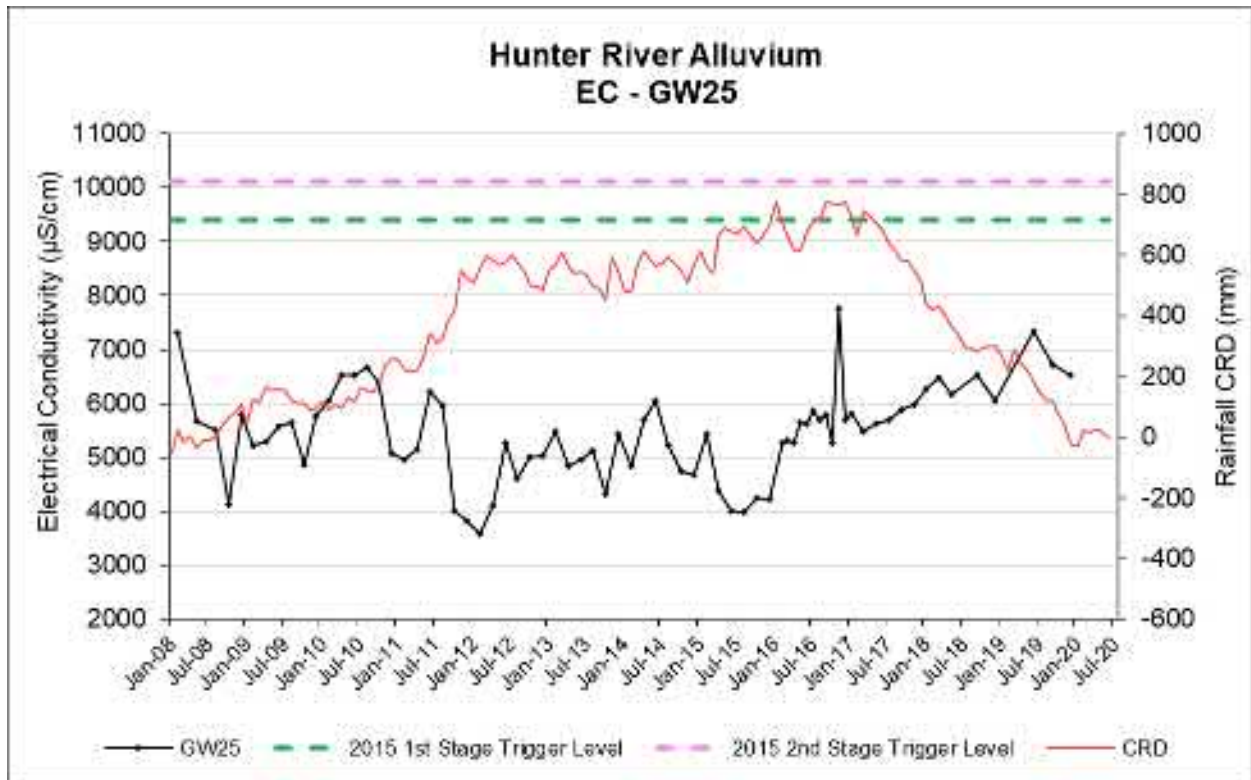
GW16 - EC



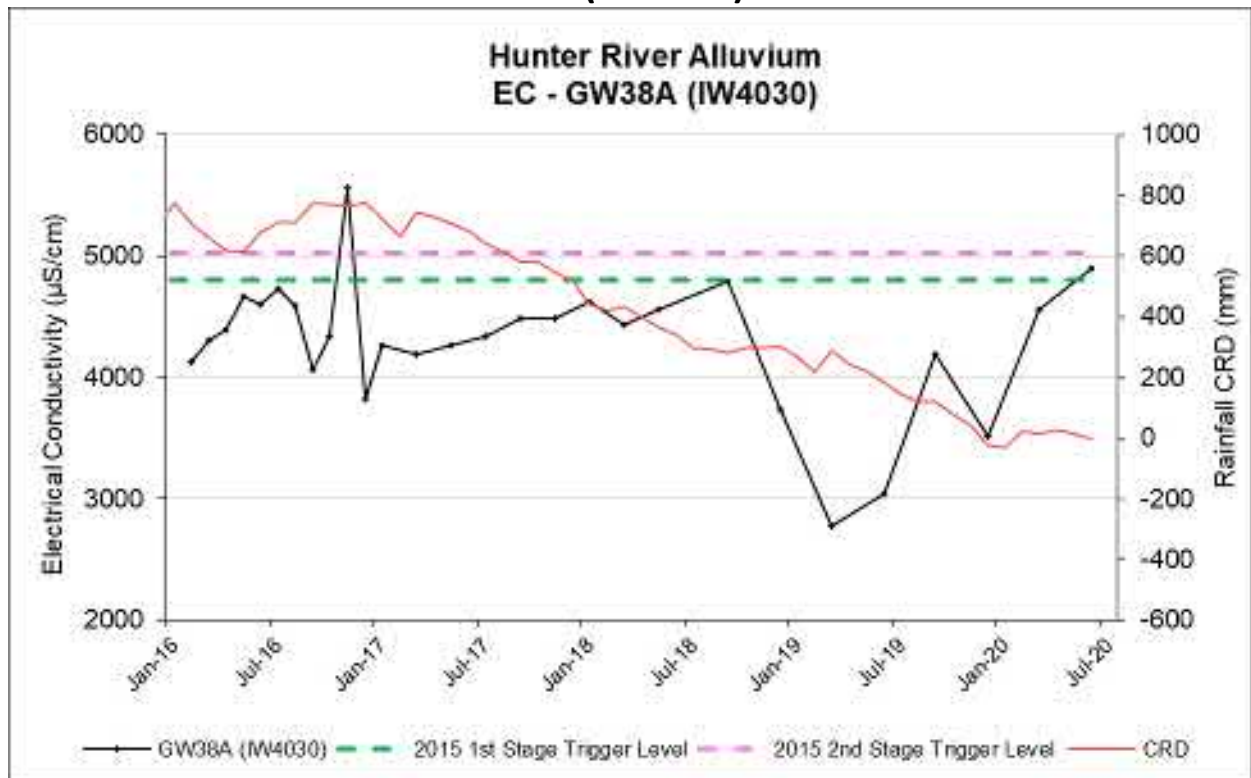
GW21 - EC



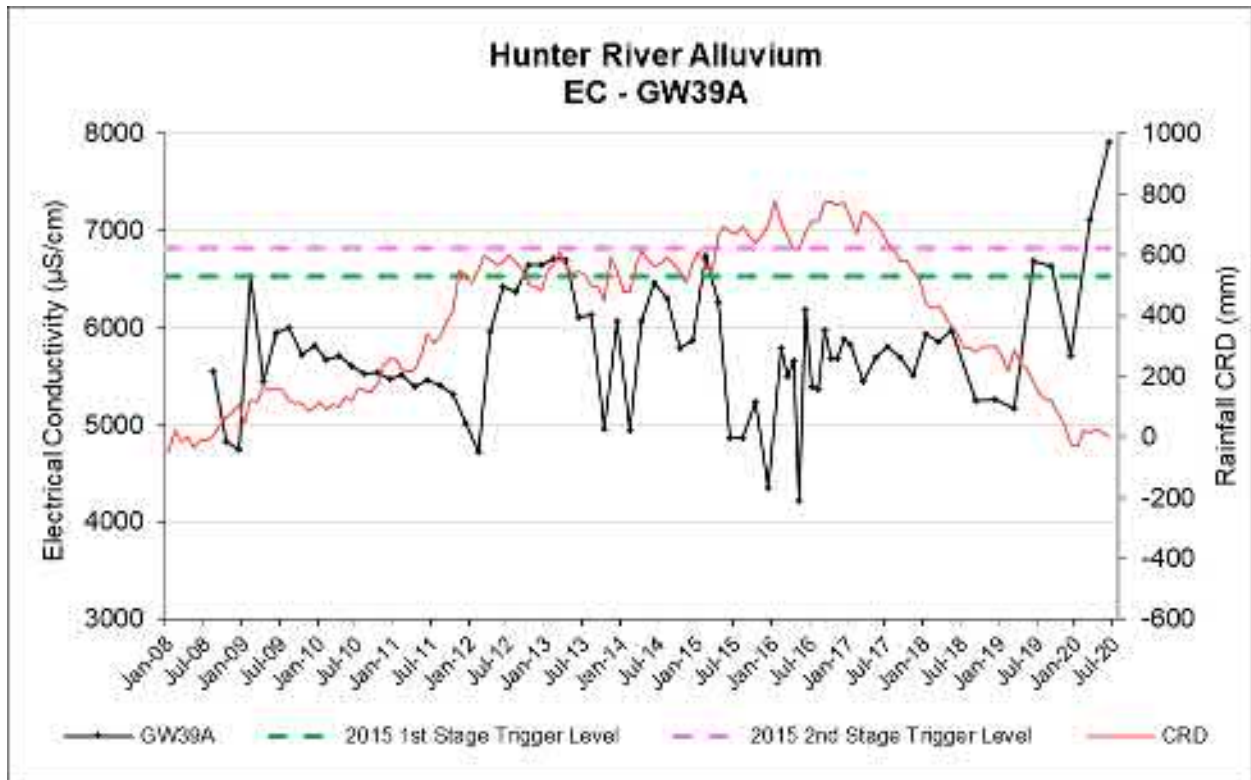
GW25 - EC



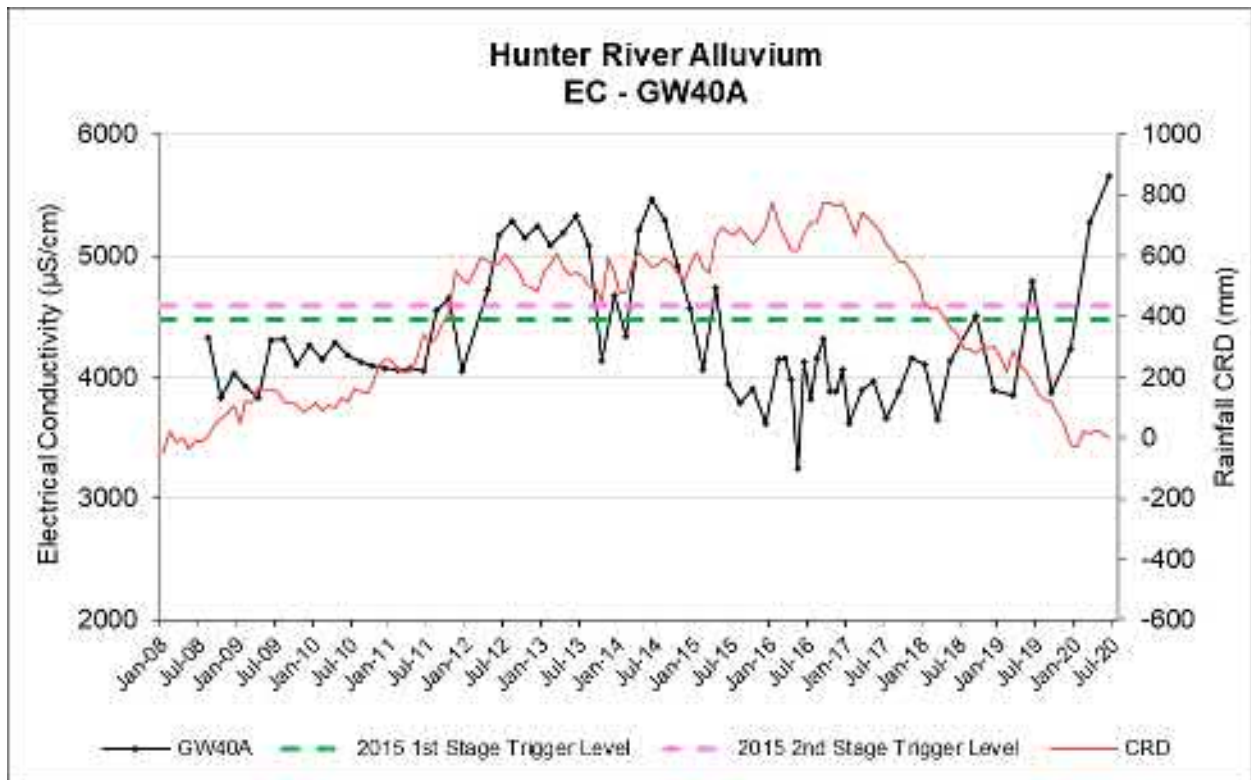
GW38A (IW4030) - EC



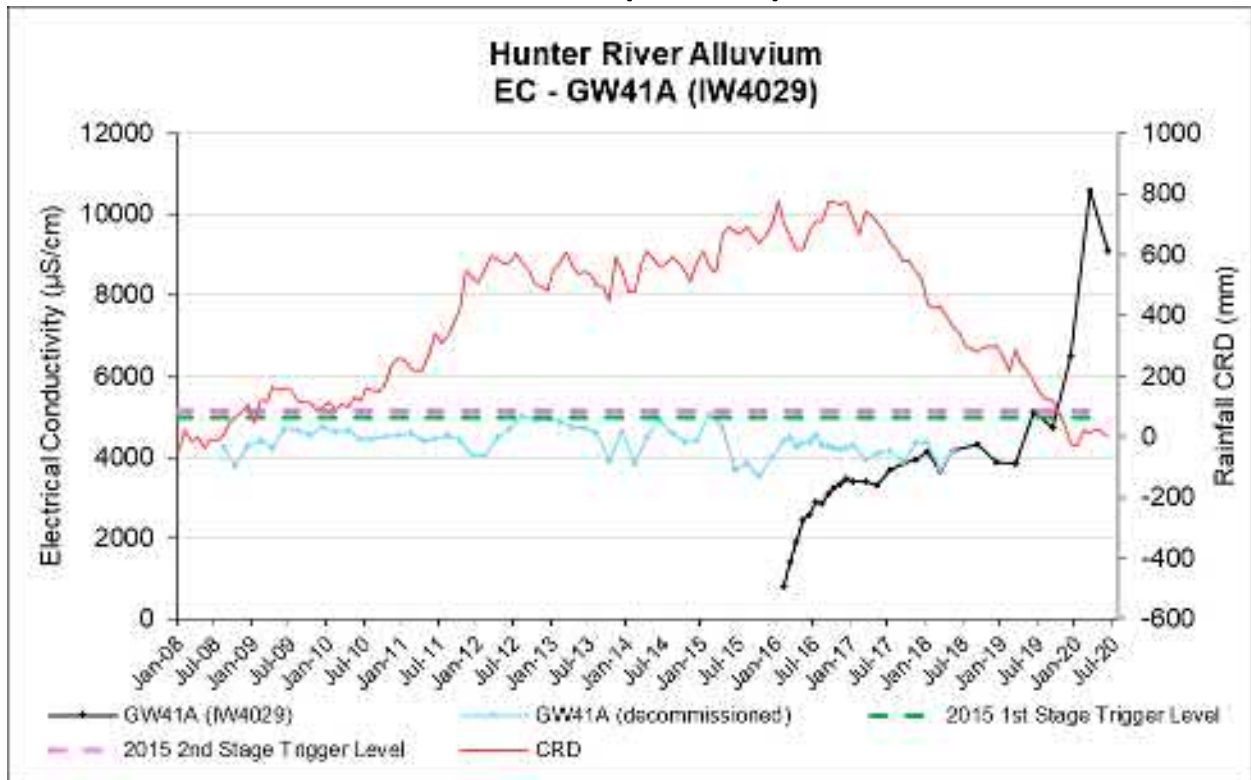
GW39A - EC



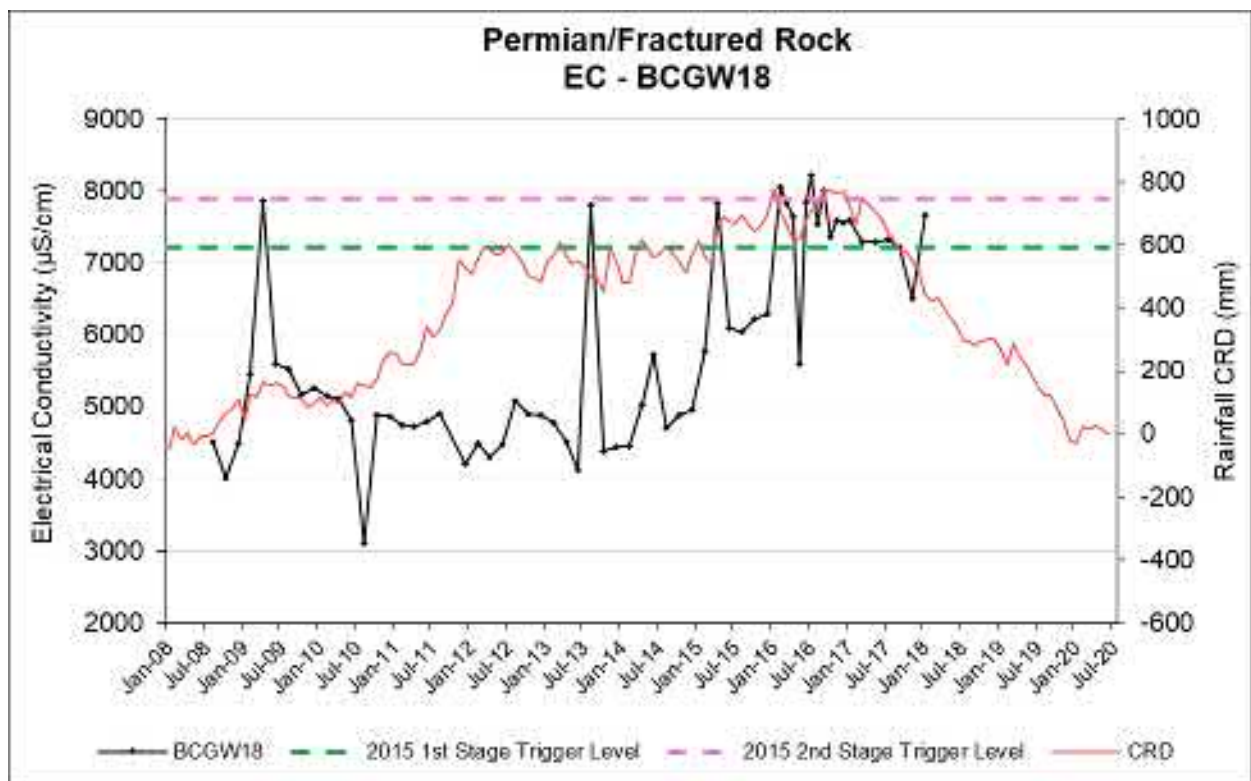
GW40A - EC



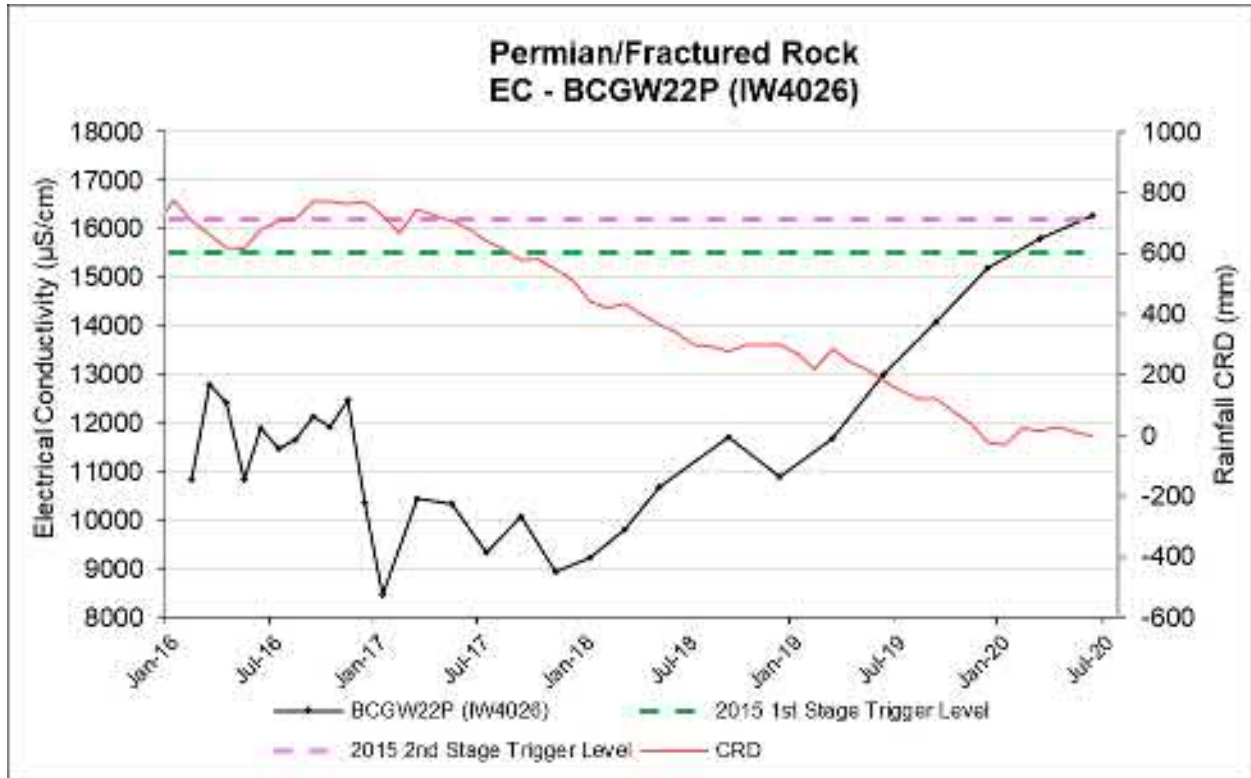
GW41A (IW4029)



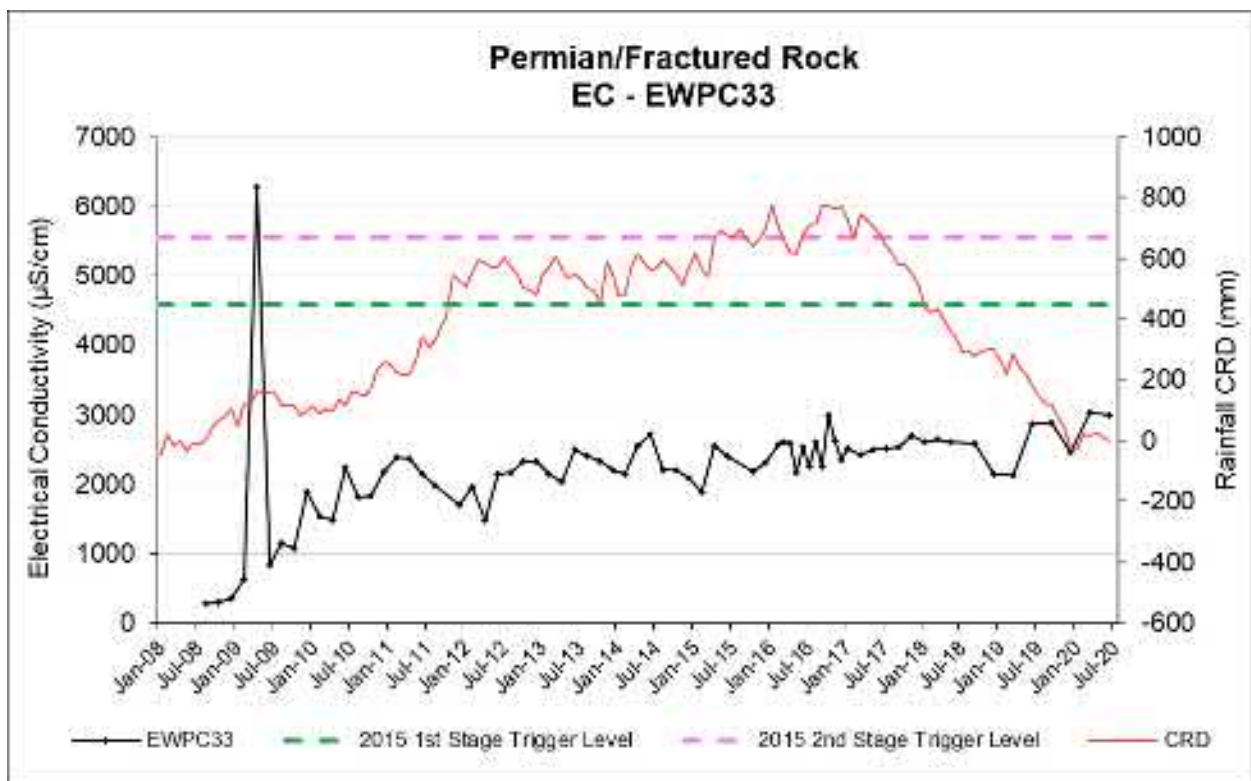
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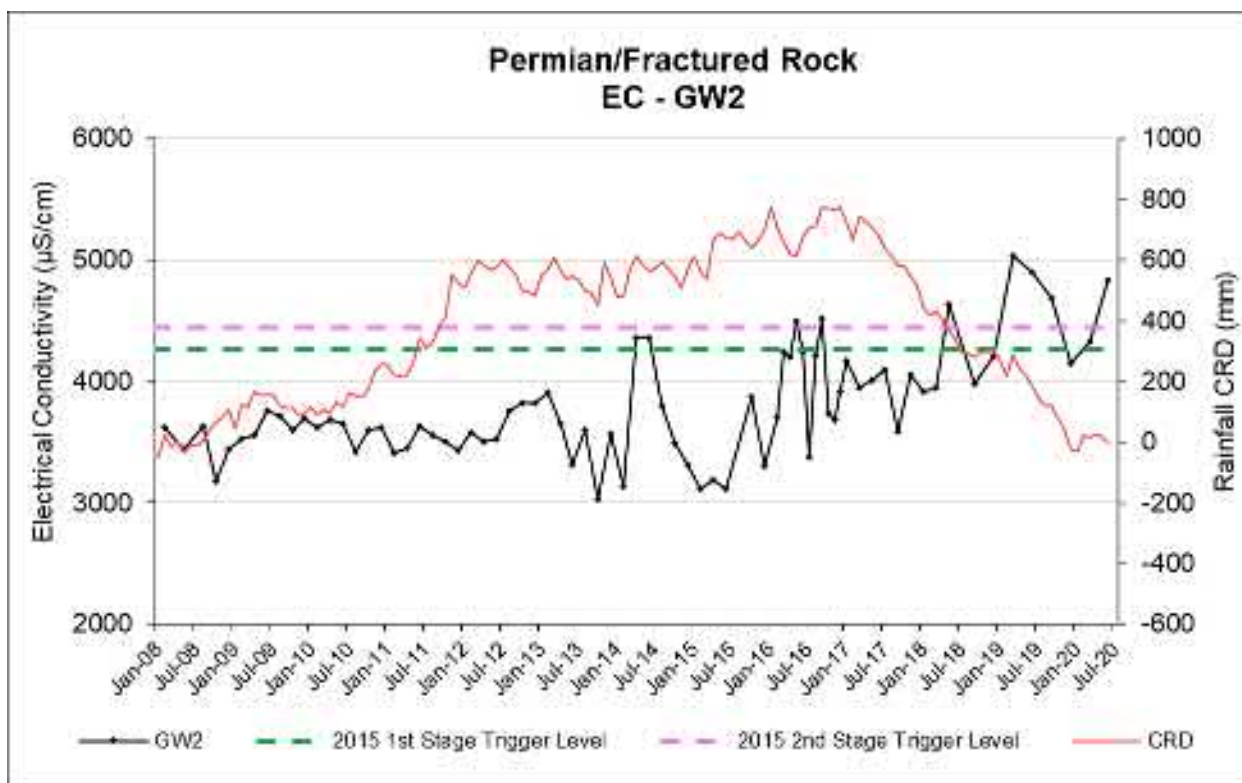
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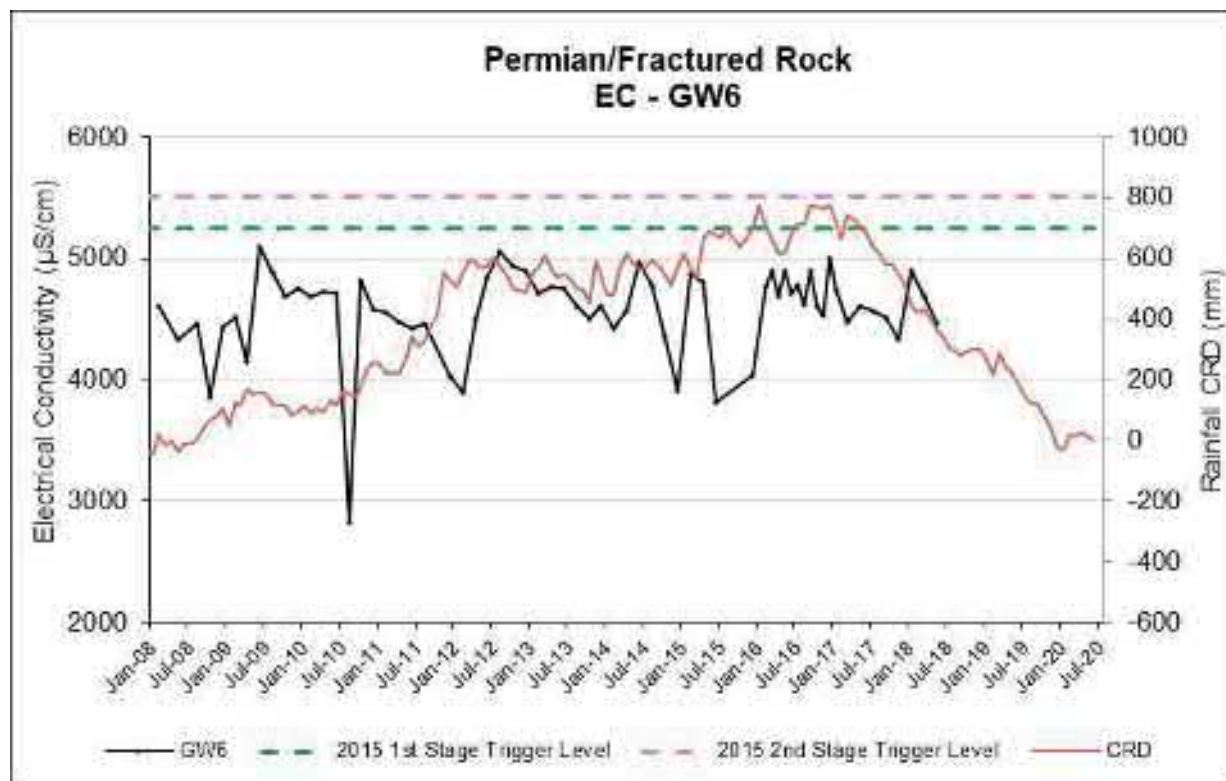
EWPC33 - EC



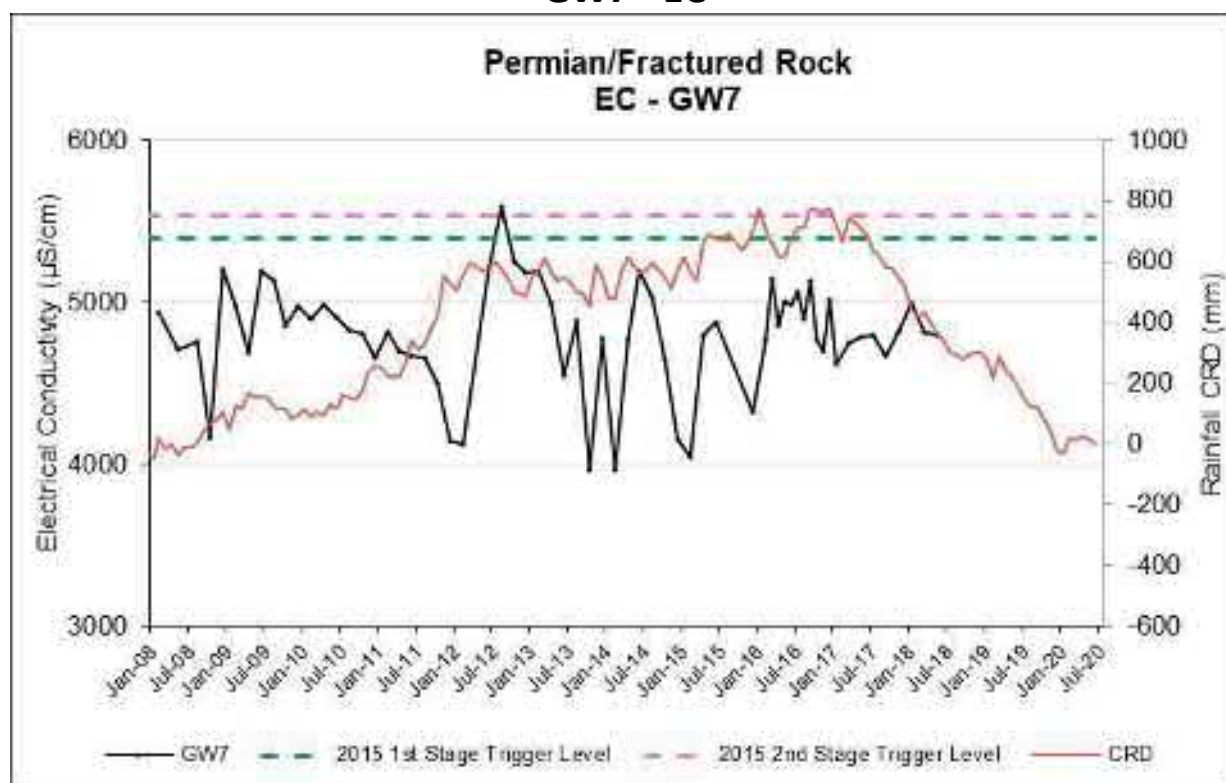
GW2 - EC



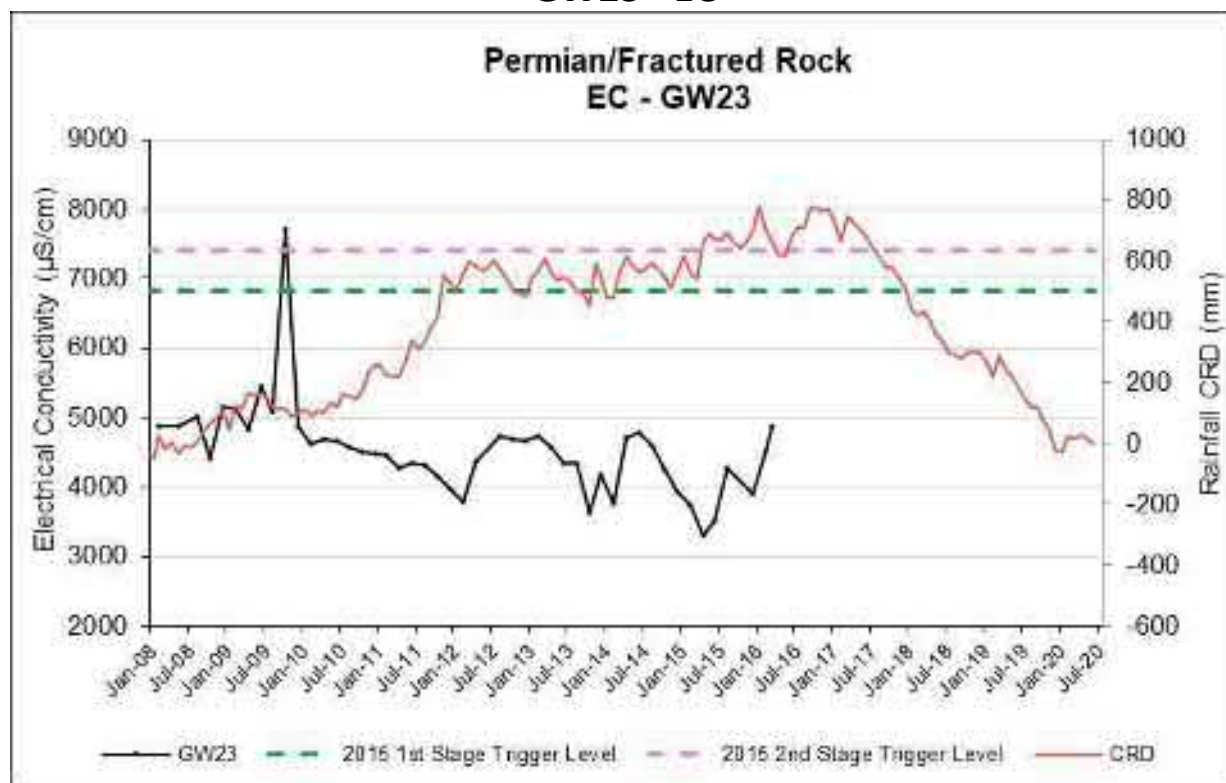
GW6 - EC



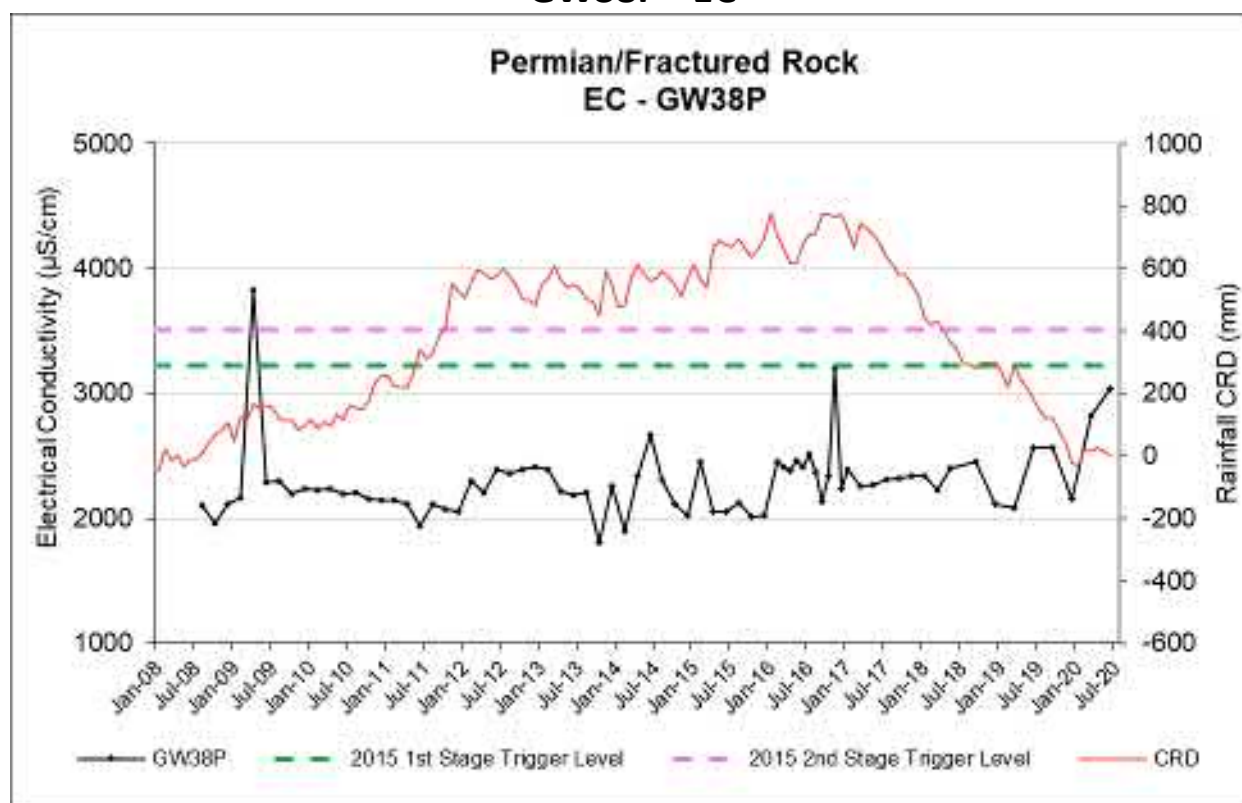
GW7 - EC



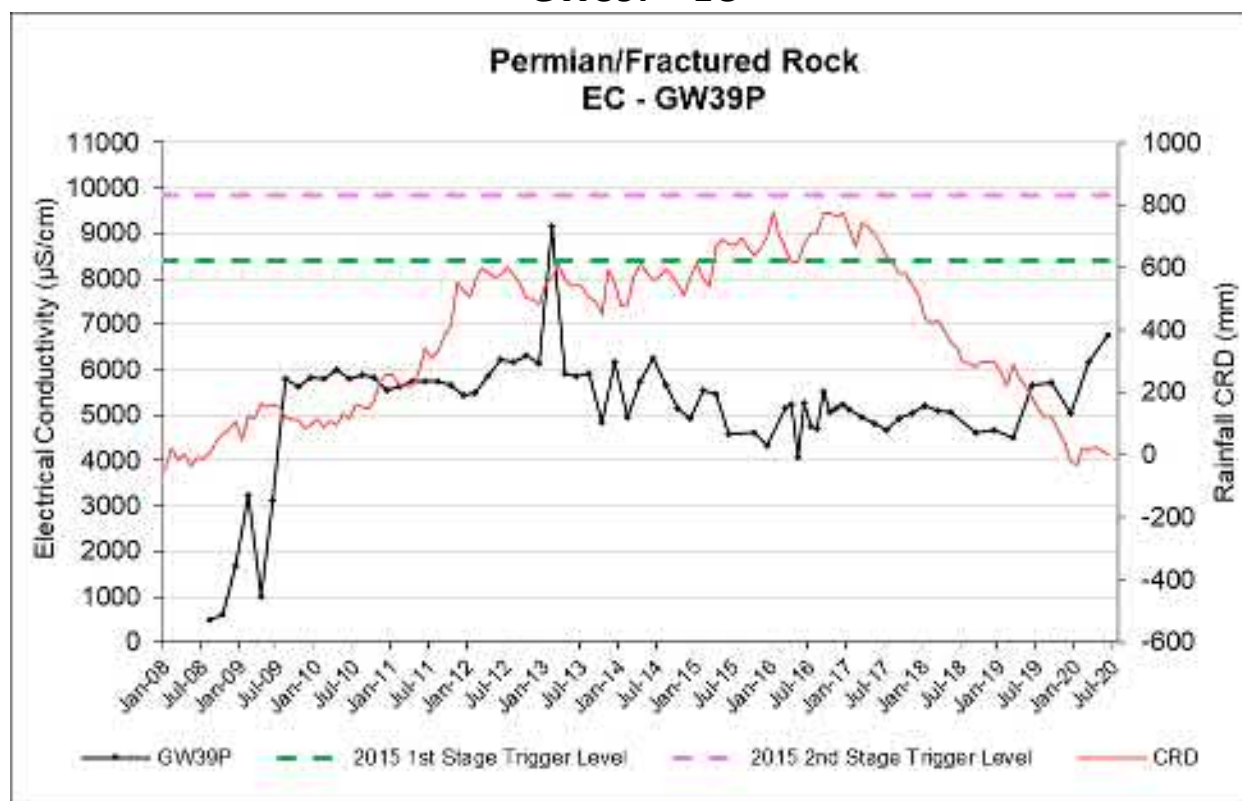
GW23 - EC



GW38P - EC



GW39P - EC



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Appendix 3 – Community Complaints

ANNUAL REVIEW FY20

Number	Month	Date	Time	From	Issue	Lodgment type	Investigation and response to caller
1	July	10/07/2019	5.57pm	Racecourse Road/Sheppard Avenue	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and issue rectified.
2		10/07/2019	9.35pm	Racecourse Road/Sheppard Avenue	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
3		13/07/2019	6.08pm	Racecourse Road/Sheppard Avenue	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and issue rectified.
4		18/07/2019	8.38pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and issue rectified.
5		19/07/2019	6.38pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and issue rectified.
6		25/07/2019	7.21pm	Racecourse Road/Sheppard Avenue	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and issue rectified.
7		27/07/2019	7.08pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and issue rectified.
8		27/07/2019	7.10pm	Racecourse Road/Sheppard Avenue	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and issue rectified.

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Number	Month	Date	Time	From	Issue	Lodgment type	Investigation and response to caller
9		29/07/2019	9.44pm	Racecourse Road/Sheppard Avenue	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
10		30/07/2019	6.09pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and issue rectified.
11		3/08/2019	6.48pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and action taken.
12	August	4/08/2019	5.52pm	Linden/Roxburgh Road	General Dust	Community Response Line	Investigation revealed no unusual mining activities were occurring at the time, however action was taken to minimise dust. Results at the nearest monitor indicated dust levels were not elevated at the time, and the 24 hour average remained within regulatory criteria. Caller was advised of investigation and actions taken.
13		7/08/2019	6.30pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and action taken.
14		8/08/2019	2.41pm	Muswellbrook	General Dust	Community Response Line	An investigation was undertaken and a response provided to the DPIE. MAC implemented all reasonable and feasible measures to minimise dust generation on site.
15		12/08/2019	10.21am	Muswellbrook	Blast vibration	Community Response Line	Investigation revealed weather conditions were suitable for blasting at the time. Results indicated overpressure Operational Noise and ground vibration levels were within regulatory criteria. Caller was advised of investigation and monitoring results.

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Number	Month	Date	Time	From	Issue	Lodgment type	Investigation and response to caller
16		12/08/2019	10.22am	Muswellbrook	Blast vibration	Community Response Line	Investigation revealed weather conditions were suitable for blasting at the time. Results indicated overpressure Operational Noise and ground vibration levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
17		12/08/2019	12.57pm	Muswellbrook	Blast vibration	Community Response Line	Investigation revealed weather conditions were suitable for blasting at the time. Results indicated overpressure Operational Noise and ground vibration levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
18		12/08/2019	7.36pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and action taken.
19		13/08/2019	4.53pm	Denman	Spontaneous Combustion	Community Response Line	Investigation revealed the operations team was managing a spontaneous combustion event in-line with the site procedure. Caller was advised of investigation.
20		15/08/2019	1:55pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and action taken.
21		27/08/2019	6.56pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and action taken.
22	September	9/09/2019	7.04pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and actions taken.
23		29/09/2019	6.04am	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated Operational Noise levels were within regulatory

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Number	Month	Date	Time	From	Issue	Lodgment type	Investigation and response to caller
							criteria. Caller was advised of investigation and monitoring results.
24		29/09/2019	9.39pm	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
25	October	6/10/2019	8.15am	Racecourse Road/Sheppard Avenue	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
26		13/10/2019	10.42am	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Operational Noise monitoring results indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
27		15/10/2019	11.06pm	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Operational Noise monitoring results indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
28		20/10/2019	10.00pm	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Operational Noise monitoring results indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.

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Number	Month	Date	Time	From	Issue	Lodgment type	Investigation and response to caller
29		24/10/2019	7.34pm	Ironbark Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Operational Noise monitoring results indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
30	November	4/11/2019	10.51am	Denman Road	Blast Vibration	Community Response Line	Investigation revealed weather conditions were suitable for blasting at the time. Results indicated overpressure Operational Noise and ground vibration levels were within regulatory criteria. Caller advised of investigation results.
31		4/11/2019	5.00pm	Singleton	Other	Community Response Line	Investigation revealed the existing bus pick up/drop off point would be better suited to a different location to allow for improved traffic flow and parking options. Caller advised of investigation results.
32		7/11/2019	12.59pm	New England Highway	General Dust	Community Response Line	Investigation revealed operations had been modified. Dust monitoring results indicated levels were within regulatory criteria. Caller advised of investigation and monitoring results.
33		10/11/2019	10.41am	Racecourse Road/Sheppard Avenue	General Dust	Community Response Line	Operations were modified. Dust monitoring results indicated levels were within regulatory criteria. Caller advised of investigation and monitoring results.
34		12/11/2019	2.29pm	Racecourse Road/Sheppard Avenue	General Dust	Community Response Line	Investigation revealed operations had been modified. Dust monitoring results indicated levels were within regulatory criteria. Caller advised of investigation and monitoring results.
35		28/11/2019	10.08pm	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Operational Noise monitoring results indicated Operational Noise levels were within regulatory criteria. Caller advised of investigation and monitoring results.

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Number	Month	Date	Time	From	Issue	Lodgment type	Investigation and response to caller
36	December	1/12/2019	9.30pm	Roxburgh Road	Lighting	Community Response Line	The on-coming night shift OCE was notified of the complaint and checked the positioning of the light to ensure it was re-directed away from the caller's location.
37		14/12/2019	7.37pm	Racecourse Road/Sheppard Avenue	General Dust	Community Response Line	Investigation revealed operations had been modified. Caller was advised of investigation and monitoring results.
38		18/12/2019	5.48am	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Operational Noise monitoring results indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
39		25/12/2019	3.51am	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Operational Noise monitoring results indicated Operational Noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
40		27/12/2019	1.03pm	Thomas Mitchell Drive	Other	Community Response Line	Investigation revealed that the coal train was not loaded at time of incident. Caller advised of investigation results.
41	January	15/01/2020	12.10pm	Racecourse Road/Sheppard Avenue	Blast Vibration	Community Response Line	Investigation revealed weather conditions were suitable for blasting at the time. Results indicated overpressure Operational Noise and ground vibration levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
42		19/01/2020	5.40am	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated Operational Noise levels were within regulatory

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Number	Month	Date	Time	From	Issue	Lodgment type	Investigation and response to caller
							criteria. Caller was advised of investigation and monitoring results.
43	February	9/02/2020	10.42pm	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
44		17/02/2020	8.00pm	Jerrys Plains Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and action taken.
45	March	5/03/2020		Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
46		9/03/2020		Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
47	May	2/05/2020	6.15pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and actions taken.
48		7/05/2020	8.36am	Muswellbrook	Off-site bus route	Email	Investigation revealed the Greyhound Bus Service was using Skellatar Stock Route to transport employees to MAC for work. When notified of issue (load limit restriction of 10T), the bus company immediately amended their bus route to exclude Skellatar Stock Route.

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Number	Month	Date	Time	From	Issue	Lodgment type	Investigation and response to caller
49		22/05/2020	7.15pm	Roxburgh Road	Lighting	Community Response Line	Investigation revealed location of lights, which were redirected or turned off. Caller was advised of investigation results and actions taken.
50	June	3/06/2020	11.25am	Dorset Road	Blast vibration	Community Response Line	Investigation revealed weather conditions were suitable for blasting at the time. Results indicated overpressure noise and ground vibration levels were within regulatory criteria. Caller was advised of investigation and monitoring results. Caller advised he was unable to find the Community Response Line phone number on the BHP website. The number is listed on the BHP website, under Environment, Regulatory Information, NSWEC Mt Arthur Coal.
51		3/06/2020	11.27am	Ridgeland Road	Blast Vibration	Community Response Line	Investigation revealed weather conditions were suitable for blasting at the time. Results indicated overpressure noise and ground vibration levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
52		8/06/2020	11.04pm	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
53		18/06/2020	11.53pm	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.
54		27/06/2020	9.56pm	Roxburgh Road	Operational Noise	Community Response Line	Investigation revealed no unusual mining operations were occurring at the time. Results at the nearest real-time monitor indicated noise levels were within regulatory criteria. Caller was advised of investigation and monitoring results.

Appendix 4 – Annual Coal Transport Report FY20

This report has been prepared in accordance with Schedule 3 Condition 46 of Project Approval 09_0062 MOD 1:

Monitoring of Coal Transport

46. The Proponent shall keep records of the:
- (a) amount of coal transported from the site in each financial year;
 - (b) number of coal haulage train movements generated by the Mt Arthur mine complex (on a daily basis); and
 - (c) make these records available on its website at the end of each financial year.

For the 12 month period ending 30 June 2020:

- Approximately 15.3 million tonnes of export product coal was transported by rail to the Port of Newcastle. This is compliant with Schedule 2 Condition 7(a) of Project Approval 09_0062 MOD 1, which restricts Mt Arthur Coal's coal transport on the Antiene rail spur to a maximum of 27 million tonnes of product coal in a financial year;
- Approximately 0.6 million tonnes of domestic product coal was transported by conveyor to the Bayswater Power Station;
- The total number of train movements was 3,590; and
- The maximum number of train movements in a single day was 22, which occurred once only throughout the reporting period. This is compliant with Schedule 2 Condition 7(b) of Project Approval 09_0062 MOD 1, which restricts Mt Arthur Coal's coal transport on the Antiene rail spur to a maximum of 30 train movements a day.

Note: Each train entering and exiting the site is classified as two train movements and a day refers to the 24 hours from midnight to midnight the next day.

Table A6.1. Daily train movements FY20

Date	Number of train movements
1/07/2019	14
2/07/2019	14
3/07/2019	10
4/07/2019	2
5/07/2019	16
6/07/2019	8
7/07/2019	8
8/07/2019	12
9/07/2019	2
10/07/2019	8
11/07/2019	8
12/07/2019	6
13/07/2019	14
14/07/2019	20
15/07/2019	6
16/07/2019	16
17/07/2019	10
18/07/2019	4
19/07/2019	14
20/07/2019	12
21/07/2019	14
22/07/2019	10
23/07/2019	8
24/07/2019	12
25/07/2019	10
26/07/2019	6
27/07/2019	12
28/07/2019	16
29/07/2019	14
30/07/2019	8
31/07/2019	6
1/08/2019	10
2/08/2019	10
3/08/2019	12
4/08/2019	14
5/08/2019	8
6/08/2019	2
7/08/2019	0
8/08/2019	0
9/08/2019	2
10/08/2019	8
11/08/2019	6

Date	Number of train movements
12/08/2019	2
13/08/2019	10
14/08/2019	6
15/08/2019	6
16/08/2019	8
17/08/2019	4
18/08/2019	14
19/08/2019	16
20/08/2019	8
21/08/2019	8
22/08/2019	14
23/08/2019	8
24/08/2019	6
25/08/2019	4
26/08/2019	14
27/08/2019	14
28/08/2019	12
29/08/2019	6
30/08/2019	4
31/08/2019	8
1/09/2019	12
2/09/2019	8
3/09/2019	10
4/09/2019	2
5/09/2019	10
6/09/2019	8
7/09/2019	8
8/09/2019	2
9/09/2019	0
10/09/2019	2
11/09/2019	4
12/09/2019	12
13/09/2019	4
14/09/2019	0
15/09/2019	0
16/09/2019	8
17/09/2019	10
18/09/2019	10
19/09/2019	6
20/09/2019	12
21/09/2019	8
22/09/2019	8
23/09/2019	10

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Date	Number of train movements
24/09/2019	0
25/09/2019	0
26/09/2019	0
27/09/2019	8
28/09/2019	10
29/09/2019	10
30/09/2019	8
1/10/2019	14
2/10/2019	6
3/10/2019	14
4/10/2019	10
5/10/2019	8
6/10/2019	8
7/10/2019	10
8/10/2019	8
9/10/2019	8
10/10/2019	6
11/10/2019	12
12/10/2019	6
13/10/2019	16
14/10/2019	2
15/10/2019	0
16/10/2019	0
17/10/2019	0
18/10/2019	2
19/10/2019	12
20/10/2019	10
21/10/2019	6
22/10/2019	10
23/10/2019	12
24/10/2019	16
25/10/2019	6
26/10/2019	14
27/10/2019	14
28/10/2019	12
29/10/2019	2
30/10/2019	4
31/10/2019	14
1/11/2019	10
2/11/2019	16
3/11/2019	14
4/11/2019	10
5/11/2019	14

Date	Number of train movements
6/11/2019	12
7/11/2019	12
8/11/2019	10
9/11/2019	12
10/11/2019	14
11/11/2019	18
12/11/2019	10
13/11/2019	10
14/11/2019	14
15/11/2019	8
16/11/2019	10
17/11/2019	10
18/11/2019	8
19/11/2019	0
20/11/2019	0
21/11/2019	0
22/11/2019	8
23/11/2019	4
24/11/2019	10
25/11/2019	8
26/11/2019	14
27/11/2019	10
28/11/2019	18
29/11/2019	6
30/11/2019	14
1/12/2019	14
2/12/2019	14
3/12/2019	16
4/12/2019	14
5/12/2019	14
6/12/2019	18
7/12/2019	18
8/12/2019	16
9/12/2019	10
10/12/2019	12
11/12/2019	10
12/12/2019	10
13/12/2019	12
14/12/2019	16
15/12/2019	12
16/12/2019	12
17/12/2019	4
18/12/2019	8

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Date	Number of train movements
19/12/2019	12
20/12/2019	6
21/12/2019	10
22/12/2019	14
23/12/2019	10
24/12/2019	2
25/12/2019	0
26/12/2019	6
27/12/2019	10
28/12/2019	14
29/12/2019	10
30/12/2019	10
31/12/2019	14
1/01/2020	18
2/01/2020	10
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5/01/2020	14
6/01/2020	14
7/01/2020	10
8/01/2020	6
9/01/2020	12
10/01/2020	4
11/01/2020	0
12/01/2020	0
13/01/2020	0
14/01/2020	8
15/01/2020	2
16/01/2020	8
17/01/2020	4
18/01/2020	8
19/01/2020	12
20/01/2020	10
21/01/2020	12
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23/01/2020	10
24/01/2020	2
25/01/2020	14
26/01/2020	12
27/01/2020	16
28/01/2020	16
29/01/2020	10
30/01/2020	10

Date	Number of train movements
31/01/2020	12
1/02/2020	12
2/02/2020	6
3/02/2020	16
4/02/2020	10
5/02/2020	10
6/02/2020	14
7/02/2020	8
8/02/2020	10
9/02/2020	0
10/02/2020	14
11/02/2020	0
12/02/2020	0
13/02/2020	0
14/02/2020	0
15/02/2020	8
16/02/2020	2
17/02/2020	6
18/02/2020	8
19/02/2020	14
20/02/2020	12
21/02/2020	12
22/02/2020	10
23/02/2020	12
24/02/2020	10
25/02/2020	8
26/02/2020	10
27/02/2020	12
28/02/2020	12
29/02/2020	12
1/03/2020	14
2/03/2020	10
3/03/2020	16
4/03/2020	12
5/03/2020	10
6/03/2020	12
7/03/2020	18
8/03/2020	16
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11/03/2020	0
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13/03/2020	0

ANNUAL REVIEW FY20

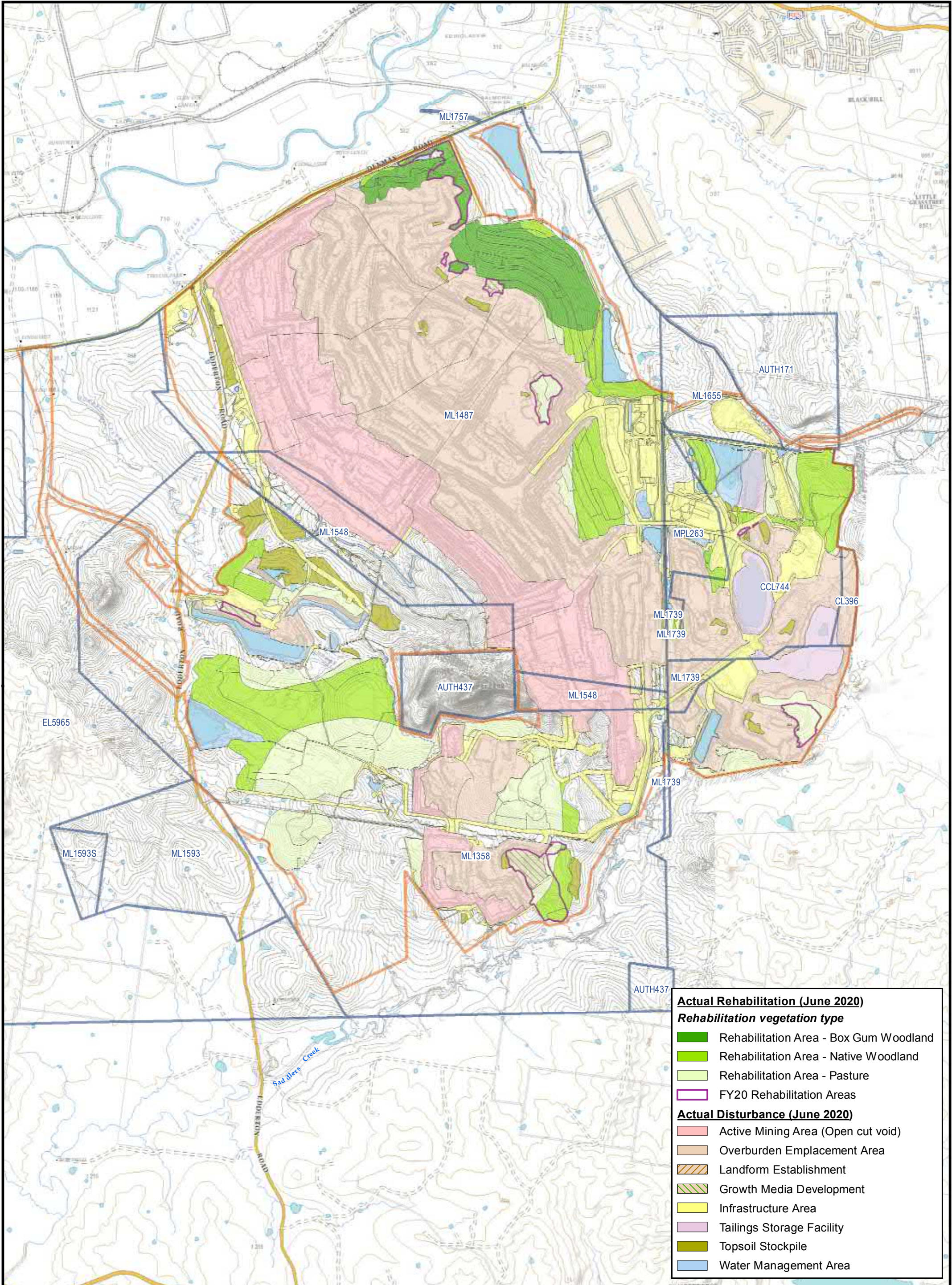
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22/03/2020	8
23/03/2020	4
24/03/2020	8
25/03/2020	6
26/03/2020	2
27/03/2020	2
28/03/2020	0
29/03/2020	4
30/03/2020	14
31/03/2020	0
1/04/2020	0
2/04/2020	0
3/04/2020	12
4/04/2020	12
5/04/2020	12
6/04/2020	8
7/04/2020	10
8/04/2020	12
9/04/2020	2
10/04/2020	4
11/04/2020	10
12/04/2020	6
13/04/2020	4
14/04/2020	14
15/04/2020	14
16/04/2020	0
17/04/2020	14
18/04/2020	10
19/04/2020	12
20/04/2020	6
21/04/2020	16
22/04/2020	12
23/04/2020	10
24/04/2020	14
25/04/2020	14

Date	Number of train movements
26/04/2020	14
27/04/2020	20
28/04/2020	14
29/04/2020	2
30/04/2020	16
1/05/2020	12
2/05/2020	12
3/05/2020	12
4/05/2020	12
5/05/2020	14
6/05/2020	6
7/05/2020	8
8/05/2020	18
9/05/2020	12
10/05/2020	16
11/05/2020	12
12/05/2020	14
13/05/2020	10
14/05/2020	16
15/05/2020	18
16/05/2020	14
17/05/2020	18
18/05/2020	10
19/05/2020	0
20/05/2020	0
21/05/2020	2
22/05/2020	8
23/05/2020	16
24/05/2020	18
25/05/2020	16
26/05/2020	12
27/05/2020	10
28/05/2020	16
29/05/2020	14
30/05/2020	12
31/05/2020	12
1/06/2020	14
2/06/2020	14
3/06/2020	16
4/06/2020	10
5/06/2020	16
6/06/2020	16
7/06/2020	18

ANNUAL REVIEW FY20

Date	Number of train movements
8/06/2020	18
9/06/2020	20
10/06/2020	8
11/06/2020	14
12/06/2020	14
13/06/2020	16
14/06/2020	16
15/06/2020	16
16/06/2020	18
17/06/2020	20
18/06/2020	18
19/06/2020	4
20/06/2020	18
21/06/2020	18
22/06/2020	22
23/06/2020	14
24/06/2020	10
25/06/2020	16
26/06/2020	18
27/06/2020	18
28/06/2020	20
29/06/2020	18
30/06/2020	12
Total	3590
Maximum daily train movements	22

Appendix 5 – Rehabilitation Plan & Ground Pasture Assessment & Revegetation Inspection 2020



Actual Rehabilitation (June 2020)
Rehabilitation vegetation type

- Rehabilitation Area - Box Gum Woodland
- Rehabilitation Area - Native Woodland
- Rehabilitation Area - Pasture
- FY20 Rehabilitation Areas

Actual Disturbance (June 2020)

- Active Mining Area (Open cut void)
- Overburden Emplacement Area
- Landform Establishment
- Growth Media Development
- Infrastructure Area
- Tailings Storage Facility
- Topsoil Stockpile
- Water Management Area

BHP

Mapping Services, Brisbane

1:6,070



Projection: GDA94 MGA Zone 56

MT ARTHUR MINE

FY20 Stem Thinning

Drawn: DEACJ

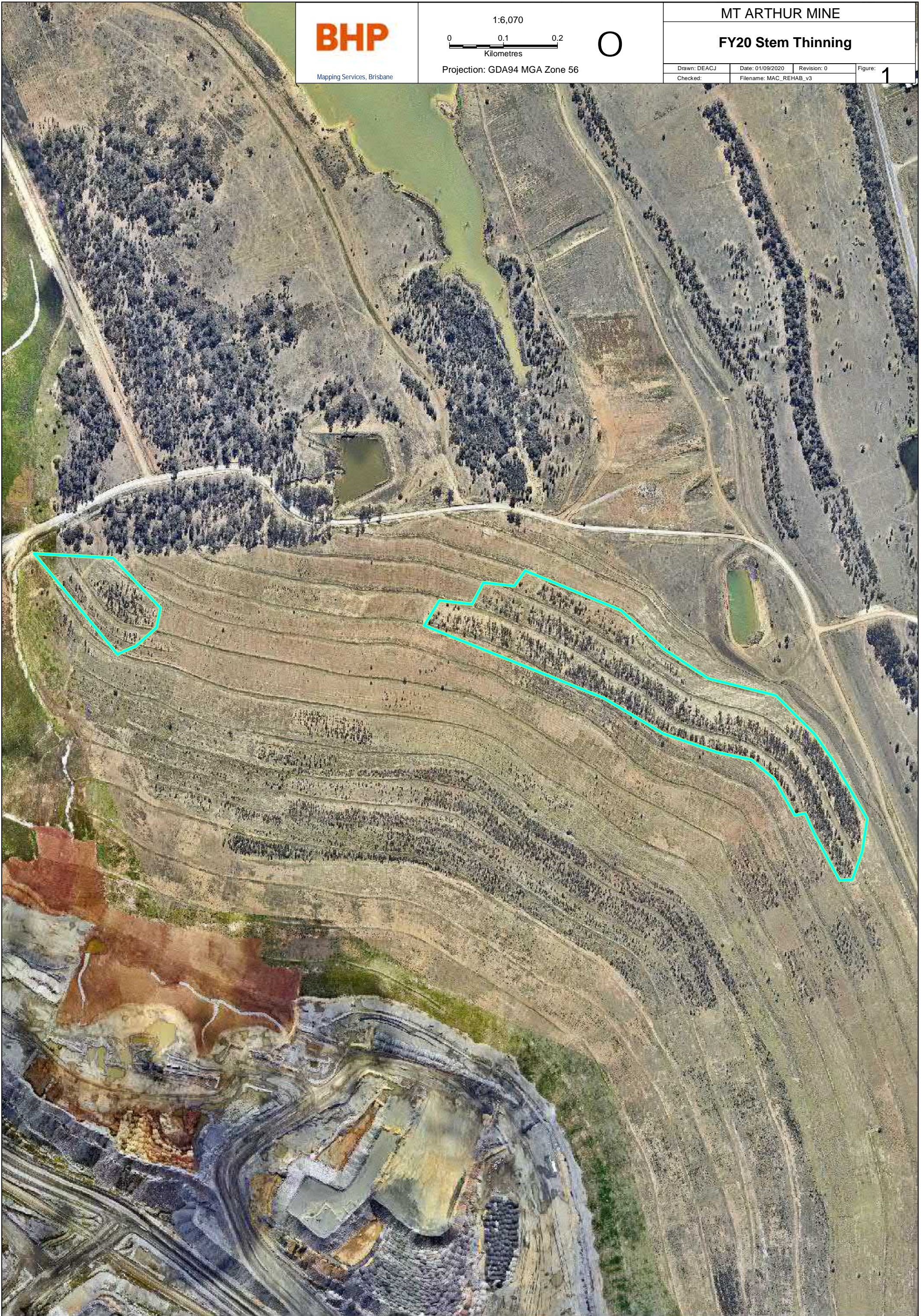
Date: 01/09/2020

Revision: 0

Figure: 1

Checked:

Filename: MAC_REHAB_v3



MT ARTHUR COAL

Ground & Pasture Assessment

Prepared for:
BHP Mt Arthur Coal

SLR Ref: 630.30014-R01
Version No: -v0.1
July 2020



PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with BHP Mt Arthur Coal (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
630.30014-R01-v0.1	August 2020	Murray Fraser	Rod Masters	Rod Masters

1	INTRODUCTION	4
2	METHODOLOGY	4
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2.2	Floristic & Condition Assessment	7
2.3	MOP Trigger Points	7
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APPENDICES

Appendix A MGA 56 Data & Floristic Composition

Appendix B Full Inspection Site Photographs

Appendix B Laboratory Certificates of Analysis

1 Introduction

Mt Arthur Coal (MAC) is an open cut coal mine located approximately five kilometres south-west of Muswellbrook, in the Upper Hunter Valley of NSW. MAC is owned and operated by Hunter Valley Energy Coal Pty Limited (HVEC), a subsidiary of BHP Billiton. MAC approvals and management plans identify that grazing areas within the mine overburden rehabilitation require monitoring to provide appropriate recommendations for management of these areas.

SLR has been engaged by HVEC to establish a Ground and Pasture Assessment (GPA) monitoring program. The aim of the GPA is to demonstrate whether the mine overburden rehabilitation has the capacity to support beef cattle grazing by assessing characteristics (such as floristic composition, soil condition and landform stability) and comparing these to non-mined cattle grazing grass pasture. Recommendations based on the outcomes of the GPA aim to provide management option to improve the grazing potential of the rehabilitated areas.

The monitoring program has been developed in accordance with appropriate approvals and management plans. The GPA project currently involves the establishment of four permanent monitoring sites within the grassland rehabilitation areas at MAC and three reference sites in non-mined grassland.

2 Methodology

The methodology for the GPA was developed in accordance with the MAC Rehabilitation and Ecological Monitoring Procedure (MAC-ENC-PRO-080) and industry standards. Four rehabilitation areas were assessed:

- MacDonalds East (ME)
- MacDonalds West 2 (MW2)
- Belmont South (BS)
- Drayton North (DN)

Drayton North is a newly established rehabilitation site. In addition, three reference sites (R1, R2 and R3) have previously been established in nearby grassland areas that have not been disturbed by mining activities.

Field surveys for GPA were undertaken on the 18th and 19th of June 2020. The location of the monitoring and reference sites is shown on **Figure 1** and the MGA 56 GPS data is in **Appendix A**.

Four rehabilitated sites from previous assessment no longer exist due to changes in the mine plan, Saddlers 1 & 2, MacDonalds West 1 and Belmont North.



2.1 Desktop Review

A review of historical aerial imagery and previous reports was undertaken to assist in assessing the historical, current and planned condition of the grassland rehabilitation areas. Analysis of historical aerial imagery allowed a review of the rehabilitated grassland growth which assisted in identifying past and present bare ground which may require remediation.

Mt Arthur Coal Mining Operations Plan FY20 – FY22

Mt Arthur Coal Mining Operation Plan (MOP) (MAC, 2020) outlines strategies for the mining operation over the period of the MOP (2020 to 2022). The MOP identifies methods for rehabilitation (including topsoil depths, ameliorants and seed mixes), target areas for rehabilitation and performance indicators. The MOP provides a relevant background to the rehabilitation program at MAC. The results from the field surveys were compared against the grassland targets for rehabilitation outlined in the MOP and were used to develop appropriate remediation recommendations.

A Study of Sustainability & Profitability of Grazing on Mine Rehabilitated Land in the Upper Hunter NSW (ACARP, 2017)

A grazing trial was established at MAC (BHP Billiton) and Hunter Valley Operations (Rio Tinto) in 2014, looking into the viability of grazing beef cattle on mine overburden rehabilitation grassland compared to grazing undisturbed grassland. The study was undertaken through the Australian Coal Association Research Program (ACARP) and ran for four years.

Results showed that mine overburden rehabilitation can support beef cattle grazing, with all cattle mobs grazing rehabilitated grassland enjoying both a kilograms per head and kilograms per hectare weight advantage over those mobs grazing undisturbed grassland.

Ground and Pasture Assessment (Emergent Ecology, 2016)

The baseline monitoring during the 2016 assessment showed that the rehabilitated grassland areas supported a diversity of native species, had an appropriate vegetation cover and soil characteristics were generally in accordance with approved guidelines. The grassland rehabilitation was found to comprise pasture characteristics that can support beef cattle production, with the addition of appropriate fencing and water.

Although the baseline data indicated that rehabilitated grassland should be able to support beef cattle grazing, recommendations were provided to increase the species diversity and cover abundance of the grassland, improve resilience and therefore reduce the risk of impacts from drought conditions.

2.2 Floristic & Condition Assessment

A methodology was developed by Emergent Ecology (2016) in accordance with Department of Primary Industries recommended assessment techniques published in *Primefacts* Vol. 957 (Bowman and Scott 2009), and adapted to suit a long-term monitoring project. This involved establishing four permanent 50 metre transects within the mine rehabilitation and three permanent 50 metre transects at the reference sites, shown in **Figure 1**. The start and end of each site was marked with GPS using iGIS software.

At each site, ten vegetation assessment quadrats (1m²) were randomly selected along the transect. At each vegetation assessment quadrat, the following information was recorded:

- Flora species present (including identifying preferred grazing species, noxious weeds, recruitment of native/weed species). Plant taxonomy followed the method adopted by the National Herbarium in Sydney.
- Cover abundance of each species (shown in **Table 1**).
- Vegetation condition, including evidence of grazing, dieback, insect attack, feral animal usage, history of disturbance (other than mining, such as fire or erosion).

At each transect quantitative foliage cover was assessed by determining how many centimetres of foliage cover occurred along each one metre length, and converting the value into a percentage.

Two permanent photo monitoring points were established at each site. Photos were taken from the start and end of the transect, facing along the length of the transect.

Full floristic composition for each monitoring site is shown in **Appendix A**.

Table 1 Modified Braun-Blanquet Cover Abundance Scale

Class	Abundance
1	Few individuals (less than 5% cover)
2	Many individuals (less than 5% cover)
3	5 – less than 20% cover
4	20 – less than 50% cover
5	50 – less than 75% cover
6	75 – 100% cover

2.3 MOP Trigger Points

The Mt Arthur Mining Operation Plan (MOP) (MAC, 2020) identifies trigger points for ground and pasture assessment. Component of the trigger points were recorded for each monitoring site, as shown in **Table 2**. Values were allocated green (within range/ideal), orange (at range, lowest outside ideal) or red (out of range).

Table 2 MOP Trigger Points

Component	Lowest	Ideal	Comment
Ground Cover	70%	90-100%	80% cover on steeper slopes
Perennial grass component of pasture	Minimum 40%	60-80%	Provides stable grassland base, must maintain some diversity
Dominant grasses (% of total pasture cover)	>40% of total cover	<40% of total cover	Lack of diversity, often the least palatable grass dominates

2.4 Soil Health Assessment

Soil sampling was undertaken at each of the seven permanent transects established for the GPA. Methods for soil sampling were in accordance with the Department of Primary Industry (DPI) described methodology (DPI 2016a).

At each site, a minimum of 20 soil samples were collected at different locations along the length of the transect. The 20 samples were bulked to provide one composite sample per site for analysis. Soil samples were collected at 0-10 centimetre depth, avoiding surface material such as leaf litter and organic matter. The soil samples were analysed for the following information:

- pH and EC
- Total Organic Carbon
- Exchangeable Cations
- Plant Available Phosphorus, Sulfur and Nitrogen

2.5 Site Walkover Assessment

A site walkover assessment was undertaken within the five rehabilitation areas, including grassland and woodland areas, as part of the annual rehabilitation inspections. For each site, a review of recent aerial photography was undertaken to determine target areas for the on-ground walkover inspection.

3 Assessment Results

3.1 Site Summaries

In general all rehabilitated sites had excellent levels of groundcover and had a good diversity of perennial grass pasture species present. Legume (clover and medic) composition can be increased through application of single superphosphate in early autumn and through better grazing management of perennial grass biomass.

Established rehabilitated sites, excepting the recently established Drayton North, are capable of supporting beef cattle grazing given their established perennial grass species composition and groundcover percentages.

Tables 3 – 9 summarise results of the floristic and condition assessment and general site walkover at each monitoring site. Broadleaf weed control is recommended at all rehabilitated sites in early spring 2020 and again in early autumn 2021.

All photographs from each inspection site are in **Appendix B**, showing north, east, south, west and groundcover for both the northern and southern photo points at each site.

Table 3 Summary: Reference Site 1


Overview	
	
Landscape Reference Site 1	
Total Species Present	15
Total Groundcover %	+95
Braun-Blanquet Cover Abundance Scale	6
Perennial Grass %	70
Main Weed Species Present	Fleabane, turnip weed, saffron thistle, capeweed
Weed Species %	<20
Dominant Grass Species	Wiregrass 20%, Red Grass 30%, Barbed Wire Grass 20%
Topsoil Texture	Light Clay
Erosion Type	Nil
Insect Attack	Nil
Plant Dieback	Nil
Recommended Actions	Nil

Table 4 Summary: Reference Site 2


Overview	
	
Landscape Reference Site 2	
Total Species Present	16
Total Groundcover %	+95
Braun-Blanquet Cover Abundance Scale	6
Perennial Grass %	65
Main Weed Species Present	Fleabane, turnip weed, saffron thistle, sedge
Weed Species %	<20
Dominant Grass Species	Wiregrass 25%, Red Grass 20%, Windmill Grass 20%
Topsoil Texture	Loam
Erosion Type	Nil
Insect Attack	Nil
Plant Dieback	Nil
Recommended Actions	Nil

Table 5 Summary: Reference Site 3


Overview	
	
Landscape Reference Site 3	
Total Species Present	15
Total Groundcover %	+95
Braun-Blanquet Cover Abundance Scale	6
Perennial Grass %	70
Main Weed Species Present	Fleabane, saffron thistle, sedge, galenia
Weed Species %	<20
Dominant Grass Species	Wiregrass 30%, Red Grass 20%, Couch 20%
Topsoil Texture	Silty Loam
Erosion Type	Nil
Insect Attack	Nil
Plant Dieback	Nil
Recommended Actions	Nil

Table 6 Summary: MacDonalds East Rehabilitation Site


Overview	
	
Landscape MacDonalds East Rehabilitation Site	
Total Species Present	20
Total Groundcover %	+95
Braun-Blanquet Cover Abundance Scale	6
Perennial Grass %	75
Main Weed Species Present	Fleabane, saffron thistle, sedge, oxalis, fireweed
Weed Species %	<20
Dominant Grass Species	Red Grass 20%, Rhodes Grass 20%, Kikuyu 25%, Couch 10%
Topsoil Texture	Loam
Erosion Type	Nil
Insect Attack	Nil
Plant Dieback	Nil
Recommended Actions	Broadleaf weed control early spring & autumn Apply single superphosphate 300 kg/ha early autumn

Table 7 Summary: MacDonalds West 2 Rehabilitation Site


Overview	
	
Landscape MacDonalds West 2 Rehabilitation Site	
Total Species Present	14
Total Groundcover %	+95
Braun-Blanquet Cover Abundance Scale	6
Perennial Grass %	80
Main Weed Species Present	Turnip weed, saffron thistle, cotton bush, marshmallow
Weed Species %	<20
Dominant Grass Species	Red Grass 20%, Rhodes Grass 40%, Wire Grass 20%
Topsoil Texture	Clay Loam
Erosion Type	Nil
Insect Attack	Nil
Plant Dieback	Nil
Recommended Actions	<p>Strategic grazing management to reduce Rhodes grass bulk and encourage legume growth</p> <p>Broadleaf weed control early spring & early autumn</p> <p>Apply single superphosphate 300 kg/ha early autumn</p>

Table 8 Summary: Belmont South Rehabilitation Site



Overview	
	
Landscape Belmont South Rehabilitation Site	
Total Species Present	22
Total Groundcover %	80
Braun-Blanquet Cover Abundance Scale	6
Perennial Grass %	70
Main Weed Species Present	Turnip weed, saffron thistle, fireweed
Weed Species %	<20
Dominant Grass Species	Red Grass 30%, Barbed Wire Grass 20%, Kikuyu 20%
Topsoil Texture	Medium Clay
Erosion Type	Minor areas of scalding exacerbated by rabbits limiting natural pasture recruitment
Insect Attack	Nil
Plant Dieback	Nil
Recommended Actions	Further control of rabbits Broadleaf weed control early spring & early autumn Apply single superphosphate 300 kg/ha early autumn

Table 9 Summary: Drayton North Rehabilitation Site

Overview	
	
Landscape Drayton North Rehabilitation Site	
Total Species Present	15
Total Groundcover %	+95
Braun-Blanquet Cover Abundance Scale	6
Perennial Grass %	65
Main Weed Species Present	Turnip weed, saffron thistle, cobblers peg, thornapple, roly poly
Weed Species %	30
Dominant Grass Species	Red Grass 20%, Rhodes Grass 20%, Kikuyu 25%
Topsoil Texture	Clay Loam
Erosion Type	Nil
Insect Attack	Nil
Plant Dieback	Nil
Recommended Actions	<p>Only recently rehabilitated, broadleaf weeds comprise 30% of plant biomass</p> <p>Broadleaf weed control early spring & early autumn</p> <p>Broadleaf weed control early spring</p>

3.2 Soil Health Assessment

Results for the soil health assessment are discussed by exception i.e. where they do not meet the guidelines from *DPI Standards for the North Coast of NSW* (DPI, 2016b), *Soil Analysis: An Interpretation Manual* (Peverill, Sparrow & Reuter, 1999). and *Soil Sense: Soil Management for North Coast Farmers* (Lines-Kelly 1994).

In general all rehabilitation sites have adequate soil characteristics for good pasture growth, being mildly to moderately alkaline, non-sodic and non-saline. All rehabilitated sites are recommended to have 300 kg/ha of single superphosphate applied in autumn, after broadleaf weed control has been undertaken.

Tables 10 – 12 below summarise soil characteristics for all reference and rehabilitated sites. Full laboratory certificates of analysis are shown in **Appendix C**.

Table 10 Soil Chemical Parameters

	pH (1:5 Water)		ESP		ECe		CEC	
	Unit	Rating	%	Rating	uS/m	Rating	cmol	Rating
R1	6.8	Neutral	1.3	Non-Sodic	0.8	Non-Sodic	21.9	Moderate
R2	6.5	Slightly Acidic	0.6	Non-Sodic	0.8	Non-Sodic	19.2	Moderate
R3	5.5	Strongly Acidic	2.2	Non-Sodic	1.0	Non-Sodic	11.3	Low
ME	7.5	Mildly Alkaline	3.4	Non-Sodic	0.6	Non-Sodic	10.0	Low
MW2	7.4	Mildly Alkaline	0.9	Non-Sodic	1.0	Non-Sodic	25.0	Moderate
BS	8.1	Moderately Alkaline	0.4	Non-Sodic	1.3	Non-Sodic	22.5	Moderate
DN	8.2	Moderately Alkaline	1.9	Non-Sodic	1.4	Non-Sodic	18.5	Moderate

pH (1:5 Water)

pH range of 5.5 to 8.5 is recommended for pasture growth, no sites are limited by pH.

Exchangeable Sodium Percentage (ESP)

All sites a non-sodic and are not limited by ESP.

ECe (Salinity)

All sites a non-saline are not limited by ECe.

Cation Exchange Capacity (CEC)

MacDonald East has low CEC, although this is expected with a loamy soil texture. CEC at MacDonalds East is equivalent to Reference Site 3, which has silty loam soil texture. CEC is not limiting for pasture growth and no action recommended at this time.

Table 11 Soil Nutrient Parameters

	Nitrate Nitrogen		Phosphorus (Bray)		Sulfur (KCl)		Total Organic Carbon	
	mg/kg	Rating	mg/kg	Rating	mg/kg	Rating	%	Rating
R1	8.1	Moderate	3.2	Low	12.1	High	2.8	High
R2	12.2	High	2.8	Low	8.2	High	3.2	High
R3	18.8	High	4.7	Low	11.6	High	4.6	High
ME	5.5	Low	3.9	Low	4.3	Low	1.2	Moderate
MW2	5.3	Low	3.0	Low	6.3	Low	2.4	High
BS	7.2	Moderate	1.8	Low	4.3	Low	1.7	Moderate
DN	11.6	High	24.1	High	9.4	High	2.3	High

Nitrate Nitrogen

Levels of nitrate nitrogen greater than 10 mg/kg are recommended for strong pasture growth. Three rehabilitation sites (MacDonalds East, MacDonalds West 2 and Belmont South) have low to moderate nitrogen levels. Nitrate nitrogen can be increased by encouraging pasture legume growth which will boost nitrogen fixation.

In previous assessments nitrogen was previously measured as total nitrogen, which is not an accurate reflection of what is available for plant uptake.

Phosphorus (Bray)

Levels of phosphorus (Bray) greater than 18 mg/kg are recommended for strong pasture growth. All sites apart from Drayton North have low phosphorus levels. Phosphorus levels can be increase with the application of single superphosphate. Increased phosphorus will boost pasture legume growth and subsequent nitrogen fixation which will become available for grass growth.

In previous assessments nitrogen was previously measured as total nitrogen, which is not an accurate reflection of what is available for plant uptake.

Sulfur (KCl)

Levels of sulfur (KCl) greater than 8 mg/kg are recommended for strong pasture growth. All sites apart from Drayton North have low sulfur levels. Sulfur levels can be increased with the application of single superphosphate. Increased sulfur will boost pasture legume growth and subsequent nitrogen fixation which will become available for grass growth.

Sulfur was not assessed previously.

Total Organic Carbon

Levels of total organic carbon greater than 2% are recommended for strong pasture growth. MacDonalds East and Belmont South both recorded moderate levels, however this is expected to increase over time with continued pasture growth. Application of single superphosphate will aid in strong pasture growth.

Table 12 Soil Exchangeable Cation Parameters

	Calcium		Magnesium		Potassium		Ca:Mg	
	%	Rating	%	Rating	%	Rating	Ratio	Rating
R1	52	Low	39	High	7	High	1.3	Low
R2	71	Balanced	22	High	6	High	3.3	Balanced
R3	54	Low	30	High	11	High	1.8	Low
ME	46	Low	43	High	7	High	1.1	Low
MW2	43	Low	51	High	5	High	0.9	Low
BS	53	Low	41	High	6	High	1.3	Low
DN	67	Balanced	23	High	8	High	3.0	Balanced

Calcium

Levels of calcium between 65% and 80% are recommended for strong pasture growth. Of the rehabilitation sites only Drayton North has balanced calcium levels. It should be noted that two of the three reference sites do not have balanced calcium levels. Calcium can be increased with the application of gypsum (and to a lesser extent single superphosphate). However, due to the generally low background calcium levels at reference sites no action is recommended at this time.

Magnesium

Levels of magnesium between 15% and 20% are recommended for strong pasture growth. All sites have elevated magnesium levels. It should be noted that all reference sites do not have balanced magnesium levels. Magnesium can be reduced with the application of gypsum (and to a lesser extent single superphosphate). However, due to the high background magnesium levels at reference sites no action is recommended at this time.

Potassium

Levels of potassium between 2% and 5% are recommended for strong pasture growth. All sites have elevated potassium levels. It should be noted that all reference sites do not have balanced potassium levels. Potassium can be reduced with the application of gypsum (and to a lesser extent single superphosphate). However, due to the high background potassium levels at reference sites no action is recommended at this time.

Calcium to Magnesium Ratio (Ca:Mg)

A calcium to magnesium ratio of between 3 and 5 is recommended for strong pasture growth. Of the rehabilitation sites only Drayton North has balanced Ca:Mg. It should be noted that two of the three reference sites do not have balanced Ca:Mg. Ca:Mg can be increased with the application of gypsum (and to a lesser extent single superphosphate). However, due to the generally low background Ca:Mg levels at reference sites no action is recommended at this time.

3.3 MOP Trigger Point Assessment

Assessment of pasture composition against the MOP trigger points are shown in **Table 13**. The only actions required when considering the MOP Trigger Points are better strategic grazing to manage Rhodes grass at MacDonalds West 2 and control of rabbits at Belmont South to increase groundcover percentage.

MOP trigger values in **Table 13** are shown as green for compliant (within range/ideal), orange for lowest (value at range but outside of ideal) and red for non-compliant (out of range).

Table 13 MOP Trigger Point Assessment

Site	Groundcover %	Perennial Grass %	Dominant Grass	Action
R1	+95	70	Red Grass 30%	Nil
R2	+95	65	Wire Grass 25%	Nil
R3	+95	70	Wire Grass 35%	Nil
ME	+95	75	Kikuyu 25%	Nil
MW2	+95	80	Rhodes Grass 50%	Strategic grazing of Rhodes grass
BS	80	70	Red Grass 30%	Control rabbits
DN	+95	65	Kikuyu 25%	Nil

When there is a large bulk of Rhodes grass, consider grazing with a large number of cattle for a short period of time to both graze and knock down standing plant material to encourage legume growth.

3.4 Summary of Recommendations

The three established rehabilitated sites (MacDonalds East, MacDonalds West 2 and Belmont South) have sufficient species diversity and vegetation cover to support a cattle grazing enterprise with normal grazing management strategies. Recommendations for further improvement of rehabilitated sites are as follows and are summarised in **Table 14**.

All Sites

Broadleaf selective spray in early spring and again in early autumn. Herbicide chosen should be selective so as to not impact clover e.g. Flumetsulam + 2,4-DB or Flumetsulam + Bromoxynil (or similar).

MacDonalds East, MacDonalds West 2 and Belmont South

Apply 300 kg/ha of single superphosphate in early autumn, after autumn broadleaf weed control has been undertaken.

Belmont South

Continue control of rabbits to allow natural recruitment of pasture species on scalded areas.

Table 14 Summary of Recommendations

Action	ME	MW2	BS	DN
Early Spring Selective Broadleaf Herbicide*	✓	✓	✓	✓
Early Autumn 300 kg/ha Single Superphosphate Application	✓	✓	✓	
Early Autumn Selective Broadleaf Herbicide*	✓	✓	✓	✓
Ongoing Rabbit Control			✓	

*Flumetsulam + 2,4-DB or Flumetsulam + Bromoxynil

4 References

- ACARP (2017) A study of sustainability and profitability of grazing on mine rehabilitated land in the Upper Hunter NSW
- Bowman & Scott (2009) Primefact Vol 957 Managing ground cover in the cropping zone of southern NSW. Report prepared for the Department of Primary Industries
- DPI (2016a). Primary Industries Agriculture soil sampling methodology
- DPI (2016b) DPI Standards for the North Coast of NSW ()
- Emergent Ecology (2016) Mt Arthur Coal Ground and Pasture Assessment
- Lines-Kelly (1994) Soil Sense: Soil Management for North Coast Farmers
- MAC (2020). Mt Arthur Coal Mining Operation Plan FY20 – FY22. Prepared for Mt Arthur Coal.
- Peverill, Sparrow & Reuter (1999) Soil Analysis: An Interpretation Manual

APPENDIX A

MGA 56 Data & Floristic Composition



Table 1 Monitoring Site GPS Data MGA 56

Site	Easting	Northing
Reference 1	296620	6415468
	296583	6415502
Reference 2	296788	6415315
	296749	6415367
Reference 3	299681	6425325
	299658	6425361
MacDonalds East	297583	6416383
	297623	6416393
MacDonalds West 2	296006	6415350
	296015	6415383
Belmont South	295729	6417347
	295700	6417372
Drayton North	302720	6417084
	302700	6417118

Table 2 Floristic Composition

Species	Common Name	R1	R2	R3	ME	MW2	BS	DN
Cymbopogon refractus	Barbed Wire Grass	✓	✓			✓	✓	
Bothriochloa biloba	Bluegrass		✓			✓	✓	✓
Medicago polymorpha	Burr Medic	✓	✓			✓		
Arctotheca calendula	Capeweed	✓						✓
Chamaesyce drummondii	Caustic Weed					✓		
Bidens pilosa	Cobblers Peg	✓					✓	✓
Sida corrugata	Corrugated Sida	✓	✓	✓				
Cynodon dactylon	Couch	✓	✓	✓	✓	✓	✓	✓
Eriochloa pseudoacrotricha	Early Spring Grass	✓			✓			
Senecio madagascariensis	Fireweed	✓	✓	✓	✓		✓	✓
Conyza bonariensis	Fleabane	✓	✓	✓				
Galenia pubescens	Galenia	✓	✓	✓	✓	✓	✓	✓
Glycine tabacina	Glycine	✓	✓	✓	✓	✓	✓	
Megathyrsus maximus var. maximus	Guinea Grass				✓	✓	✓	✓
Trifolium campestre	Hop Clover	✓	✓	✓	✓	✓	✓	✓
Dichondra repens	Kidney Weed	✓	✓		✓	✓	✓	
Pennisetum clandestinum	Kikuyu				✓	✓	✓	✓
Plantago lanceolata	Lamb's Tongues	✓	✓	✓	✓	✓	✓	✓
Medicago sativa	Lucerne				✓			
Silybum marianum	Milk Thistle	✓	✓			✓		
Solanum cinereum	Narrawa Burr	✓						
Gomphocarpus fruticosus	Narrow-Leaf Cotton Bush				✓	✓	✓	
Geranium solanderi	Native Geranium	✓			✓	✓		

Species	Common Name	R1	R2	R3	ME	MW2	BS	DN
<i>Digitaria diffusa</i>	Open Summer-Grass		✓					
<i>Oxalis perennans</i>	Oxalis				✓			
<i>Sida rhombifolia</i>	Paddy's Lucerne			✓				
<i>Paspalum dilatatum</i>	Paspalum				✓		✓	✓
<i>Portulaca oleracea</i>	Pigweed			✓				
<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	Poison Rock Fern	✓	✓	✓				
<i>Aristida ramosa</i>	Purple Wire-Grass	✓	✓	✓	✓	✓	✓	
<i>Verbena bonariensis</i>	Purpletop						✓	
<i>Bothriochloa decipiens</i> var. <i>decipiens</i>	Red Grass	✓	✓	✓	✓	✓	✓	✓
<i>Modiola caroliniana</i>	Red-Flowered Mallow	✓	✓	✓	✓	✓	✓	✓
<i>Chloris gayana</i>	Rhodes Grass				✓	✓	✓	✓
<i>Salsola australis</i>	Roly Poly							✓
<i>Enchylaena tomentosa</i>	Ruby Saltbush	✓			✓			
<i>Carthamus lanatus</i>	Saffron Thistle	✓	✓	✓	✓	✓	✓	✓
<i>Setaria parviflora</i>	Setaria			✓				
<i>Cyperus gricilis</i>	Slender Flat-Sedge	✓	✓					
<i>Sporobolus creber</i>	Slender Rat's Tail Grass	✓	✓	✓		✓	✓	
<i>Austrostipa scabra</i> subsp. <i>falcata</i>	Speargrass		✓					
<i>Sida hackettiana</i>	Spiked Sida	✓	✓	✓				
<i>Tagetes minuta</i>	Stinking Roger					✓		
<i>Datura stramonium</i>	Thornapple							✓
<i>Brassica tournefortii</i>	Turnip Weed	✓				✓		✓
<i>Panicum simile</i>	Two-Coloured Panic	✓	✓		✓	✓	✓	✓
<i>Trifolium repens</i>	White Clover				✓			
<i>Salvia verbenaca</i>	Wild Sage							✓
<i>Chloris truncata</i>	Windmill Grass		✓		✓		✓	
<i>Panicum queenslandicum</i>	Yadbila Grass		✓					
<i>Calotis lappulacea</i>	Yellow Burr-Daisy			✓				
Total Species		28	26	19	24	24	23	20

APPENDIX B

Full Inspection Site Photographs



Reference Site 1 North



Reference Site 1 South



Reference Site 2 North



Reference Site 2 South



Reference Site 3 North



Reference Site 3 South



Rehabilitated Site MacDonalds East North



Rehabilitated Site MacDonalds East South



Rehabilitated Site MacDonalds West 2 North



Rehabilitated Site MacDonalds West 2 South



Rehabilitated Site Belmont South North



Rehabilitated Site Belmont South South



Rehabilitated Site Drayton North North



Rehabilitated Site Drayton North South



APPENDIX C

Laboratory Certificates of Analysis



AGRICULTURAL SOIL ANALYSIS REPORT

7 samples supplied by SLR Consulting Australia Pty Ltd on 1/07/2020 . Lab Job No.J5478
 Analysis requested by Murray Fraser. Your Job: SLR 630.30014 Mt Arthur Pasture
 10 Kings Road NEW LAMBTON NSW 2305

10 Kings Road NEW LAMBTON NSW 2305			Sample ID:	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
			Crop:	R1	R2	R3	ME	MW2
				Soil	Soil	Soil	Soil	Soil
			Client:	Mt Arthur Coal	Mt Arthur Coal	Mt Arthur Coal	Mt Arthur Coal	Mt Arthur Coal
	Parameter		Method reference	J5478/1	J5478/2	J5478/3	J5478/4	J5478/5
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)		3.2	2.8	4.7	3.9	3.0
		**Rayment & Lyons 2011 - 9B2 (Colwell)		11	11	25	12	11
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)		8.1	12	19	5.5	5.3
	Ammonium Nitrogen (mg/kg N)			4.7	3.6	7.1	1.7	5.4
	Sulfur (mg/kg S)			13	8.3	13	4.2	5.0
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		6.76	6.48	5.46	7.51	7.40
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.090	0.088	0.102	0.058	0.114
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75		4.9	5.6	8.0	2.2	4.2
	Exchangeable Calcium	(cmol _e /kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	12	14	6.1	4.7	11
		(kg/ha)		5,169	6,117	2,732	2,090	4,873
		(mg/kg)		2,308	2,731	1,220	933	2,176
	Exchangeable Magnesium	(cmol _e /kg)		8.5	4.2	3.4	4.3	13
		(kg/ha)		2,325	1,133	928	1,168	3,445
		(mg/kg)		1,038	506	414	522	1,538
	Exchangeable Potassium	(cmol _e /kg)		1.6	1.2	1.2	0.73	1.3
		(kg/ha)		1,395	1,030	1,077	640	1,100
		(mg/kg)		623	460	481	286	491
	Exchangeable Sodium	(cmol _e /kg)		0.29	0.12	0.25	0.35	0.21
		(kg/ha)		152	60	128	178	110
		(mg/kg)		68	27	57	79	49
Exchangeable Aluminium	(cmol _e /kg)	**Inhouse S37 (KCl)	<0.01	<0.01	0.10	<0.01	<0.01	
	(kg/ha)		<1	<1	20	<1	<1	
	(mg/kg)		<1	<1	8.8	<1	<1	
Exchangeable Hydrogen	(cmol _e /kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	0.07	0.19	<0.01	<0.01	
	(kg/ha)		<1	1.5	4.3	<1	<1	
	(mg/kg)		<1	<1	1.9	<1	<1	
	Effective Cation Exchange Capacity (ECEC) (cmol _e /kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol _e /kg)		22	19	11	10	25
	Calcium (%)	**Base Saturation Calculations - Cation cmol _e /kg / ECEC x 100	52	71	54	46	43	
	Magnesium (%)		39	22	30	43	51	
	Potassium (%)		7.3	6.1	11	7.3	5.0	
Sodium - ESP (%)	1.3		0.61	2.2	3.4	0.85		
Aluminium (%)	0.02		0.02	0.87	0.04	0.02		
Hydrogen (%)	0.00		0.34	1.7	0.00	0.00		
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol _e /kg)		1.3	3.3	1.8	1.1	0.86
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	2.3	1.2	4.4	1.7	2.1	
	Manganese (mg/kg)		15	5.5	30	8.6	6.3	
	Iron (mg/kg)		27	21	393	19	14	
	Copper (mg/kg)		1.1	0.27	0.69	0.47	0.72	

AGRICULTURAL SOIL ANALYSIS REPORT

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Analysis requested by Murray Fraser. Your Job: SLR 630.30014 Mt Arthur Pasture
10 Kings Road NEW LAMBTON NSW 2305

		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Sample ID:		R1	R2	R3	ME	MW2
Crop:		Soil	Soil	Soil	Soil	Soil
Client:		Mt Arthur Coal	Mt Arthur Coal	Mt Arthur Coal	Mt Arthur Coal	Mt Arthur Coal
Parameter	Method reference	J5478/1	J5478/2	J5478/3	J5478/4	J5478/5
Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot CaCl ₂)	0.72	0.49	0.89	0.33	0.49
Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl ₂)	64	58	76	39	50
Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	2.8	3.2	4.6	1.2	2.4
Total Nitrogen (%)		0.18	0.24	0.31	0.07	0.17
Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	16	13	15	19	14
Basic Texture	**Inhouse S65	Clay	Clay	Clay Loam	Clay	Clay
Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish
Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	57	56	65	37	73
pH	**Rayment & Lyons 2011 - 4B4 (CaCl ₂)	6.2	6.0	4.8	6.8	6.8
Sulfur (mg/kg S)	**Rayment & Lyons 2011 - 10D1 (KCl 40)	12	8.2	12	4.3	6.3

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
- Conversions for 1 cmol_e/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
- ** NATA accreditation does not cover the performance of this service.
- Analysis conducted between sample arrival date and reporting date.
- This report is not to be reproduced except in full. Results only relate to the item tested.
- All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal).
- This report was issued on 08/07/2020.

Quality Checked: Kris Saville
Agricultural Co-Ordinator

KS



AGRICULTURAL SOIL ANALYSIS REPORT

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 Analysis requested by Murray Fraser. Your Job: SLR 630.30014 Mt Arthur Pasture
 10 Kings Road NEW LAMBTON NSW 2305

		Sample ID:	Sample 6 BS	Sample 7 DN	Heavy Soil	Medium Soil	Light Soil	Sandy Soil
		Crop:	Soil	Soil				
		Client:	Mt Arthur Coal	Mt Arthur Coal	Clay	Clay Loam	Loam	Loamy Sand
Parameter		Method reference	J5478/6	J5478/7	Indicative guidelines - refer to Notes 6 and 8			
Phosphorus (mg/kg P)		**Rayment & Lyons 2011 - 9E2 (Bray 1)	1.8	24	45 ^{note 8}	30 ^{note 8}	24 ^{note 8}	20 ^{note 8}
		**Rayment & Lyons 2011 - 9B2 (Colwell)	8.6	199	80	50	45	35
Nitrate Nitrogen (mg/kg N)		**Inhouse S37 (KCl)	7.2	12	15	13	10	10
Ammonium Nitrogen (mg/kg N)			4.0	3.0	20	18	15	12
Sulfur (mg/kg S)			3.8	8.3	10.0	8.0	8.0	7.0
pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	8.05	8.18	6.5	6.5	6.3	6.3
Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.170	0.158	0.200	0.150	0.120	0.100
Estimated Organic Matter (% OM)		**Calculation: Total Carbon x 1.75	3.0	4.0	> 5.5	>4.5	> 3.5	> 2.5
Exchangeable Calcium	(cmol _e /kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	12	12	15.6	10.8	5.0	1.9
	(kg/ha)		5,355	5,588	7000	4816	2240	840
	(mg/kg)		2,391	2,495	3125	2150	1000	375
Exchangeable Magnesium	(cmol _e /kg)		9.1	4.2	2.4	1.7	1.2	0.60
	(kg/ha)		2,484	1,145	650	448	325	168
	(mg/kg)		1,109	511	290	200	145	75
Exchangeable Potassium	(cmol _e /kg)		1.4	1.5	0.60	0.50	0.40	0.30
	(kg/ha)		1,192	1,288	526	426	336	224
	(mg/kg)		532	575	235	190	150	100
Exchangeable Sodium	(cmol _e /kg)		0.08	0.34	0.3	0.26	0.22	0.11
	(kg/ha)		41	177	155	134	113	57
	(mg/kg)		18	79	69	60	51	25
Exchangeable Aluminium	(cmol _e /kg)	**Inhouse S37 (KCl)	<0.01	<0.01	0.6	0.5	0.4	0.2
	(kg/ha)		<1	1.5	121	101	73	30
	(mg/kg)		<1	<1	54	45	32	14
Exchangeable Hydrogen	(cmol _e /kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	0.6	0.5	0.4	0.2
	(kg/ha)		<1	<1	13	11	8	3
	(mg/kg)		<1	<1	6	5	4	2
Effective Cation Exchange Capacity (CEC) (cmol _e /kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol _e /kg)	22	18	20.1	14.3	7.8	3.3
Calcium (%)		**Base Saturation Calculations - Cation cmol _e /kg / CEC x 100	53	67	77.6	75.7	65.6	57.4
Magnesium (%)			41	23	11.9	11.9	15.7	18.1
Potassium (%)			6.1	8.0	3.0	3.5	5.2	9.1
Sodium - ESP (%)			0.35	1.9	1.5	1.8	2.9	3.3
Aluminium (%)			0.02	0.04	6.0	7.1	10.5	12.1
Hydrogen (%)			0.00	0.00				
Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol _e /kg)	1.3	3.0	6.5	6.4	4.2	3.2
Zinc (mg/kg)		Rayment & Lyons 2011 - 12A1 (DTPA)	1.0	27	6.0	5.0	4.0	3.0
Manganese (mg/kg)			6.1	5.0	25	22	18	15
Iron (mg/kg)			8.4	18	25	22	18	15
Copper (mg/kg)			0.47	2.9	2.4	2.0	1.6	1.2

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Sample ID:	Sample 6 BS	Sample 7 DN	Heavy Soil	Medium Soil	Light Soil	Sandy Soil
Crop:	Soil	Soil				
Client:	Mt Arthur Coal	Mt Arthur Coal	Clay	Clay Loam	Loam	Loamy Sand
Parameter	Method reference	J5478/6	J5478/7	Indicative guidelines - refer to Notes 6 and 8		
Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot CaCl ₂)	0.49	0.80	2.0	1.7	1.4
Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl ₂)	34	38	50	45	40
Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.7	2.3	> 3.1	> 2.6	> 2.0
Total Nitrogen (%)		0.11	0.18	> 0.30	> 0.25	> 0.20
Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	16	13	10-12	10-12	10-12
Basic Texture	**Inhouse S65	Clay	Clay
Basic Colour		Brownish	Brownish
Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	109	101
pH	**Rayment & Lyons 2011 - 4B4 (CaCl ₂)	7.4	7.5	..		
Sulfur (mg/kg S)	**Rayment & Lyons 2011 - 10D1 (KCl 40)	4.3	9.4	..		

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil re
- Conversions for 1 cmol_e/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estima
- ** NATA accreditation does not cover the performance of this service.
- Analysis conducted between sample arrival date and reporting date.
- This report is not to be reproduced except in full. Results only relate to the item tested.
- All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer s
- This report was issued on 08/07/2020.

Quality Checked: Kris Saville
 Agricultural Co-Ordinator

KS

GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

7 soil samples supplied by SLR Consulting Australia Pty Ltd on the 1st of July, 2020 - Lab Job No. J5478

Analysis requested by Murray Fraser. Your project: SLR 630.30014 Mt Arthur Pasture.

10 Kings Road NEW LAMBTON NSW 2305

SAMPLE ID	Lab Code	MOISTURE CONTENT (% of water in air-dry sample)	TOTAL GRAVEL > 2 mm (% of total oven-dry equivalent)	COARSE SAND 200-2000 µm (0.2-2.0 mm) (% of total oven-dry equivalent)	FINE SAND 20-200 µm (0.02-0.2 mm) (% of total oven-dry equivalent)	SILT 2-20 µm ISSS (% of total oven-dry equivalent)	CLAY < 2 µm (% of total oven-dry equivalent)	Total soil fractions (incl. Gravel)
R1	J5478/1	22.0%	2.3%	1.9%	37.7%	19.3%	38.8%	100.0%
R2	J5478/2	22.2%	0.0%	3.1%	58.9%	21.0%	16.9%	100.0%
R3	J5478/3	19.7%	8.0%	21.4%	31.4%	24.9%	14.2%	100.0%
ME	J5478/4	14.7%	6.8%	35.3%	23.1%	20.5%	14.4%	100.0%
MW2	J5478/5	20.1%	7.9%	18.5%	34.2%	14.6%	24.9%	100.0%
BS	J5478/6	20.3%	2.0%	14.6%	17.1%	22.0%	44.3%	100.0%
DN	J5478/7	19.7%	4.6%	19.7%	35.6%	17.0%	23.1%	100.0%

Note:

1. The Hydrometer Analysis method was used to determine the percentage sand, silt and clay, modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986), & in Methods of Soil Analysis. Part 1 Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.
2. The texture classification was based on the hydrometer results and the appropriate texture triangle.
3. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (see EAL website: scu.edu.au/eal).
4. This report is not to be reproduced except in full.
5. This report was issued on 09/07/2020

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MOUNT ARTHUR COAL

Revegetation Inspection - 2020

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Mount Arthur Coal Pty Ltd (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
630.30010-R02-v1.1	28 August 2020	Adam Cavallaro and David Martin	Jeremy Pepper	Jeremy Pepper

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APPENDICES

Appendix A Revegetation Inspection Sheets

1 Introduction

SLR Consulting Australia (SLR) has been contracted by Mount Arthur Coal (MAC) Pty Ltd to conduct revegetation inspections at 13 revegetation sites within the Mount Arthur mine site for the purpose of identifying any potential issues (i.e. poor germination rates, tubestock mortality or predation, water stress or weed infestation) and identify any requirement for maintenance or remedial management.

The Mount Arthur mine is an open cut coal mine located within the Upper Hunter Valley. With over 60 years of mining at Mount Arthur, the site's existing environment is highly altered, including a mix of active mining pits, access roads and other associated mining infrastructure, as well as both remnant and rehabilitated areas.

The MAC weed assessment involved the completion of a site survey on the 20th and 21st of May 2020 by two SLR ecologists; Adam Cavallaro (Senior Ecologist) and David Martin (Project Consultant) (staff details provided in Section 1.1). Inspections involved the assessment of vegetation condition within rehabilitation areas established from 2016 to 2019, as shown in **Figure 1** and detailed further in **Appendix A**). Key features of revegetation condition were recorded using the Revegetation Inspection Form MAC-ENC-PRO-080 including:

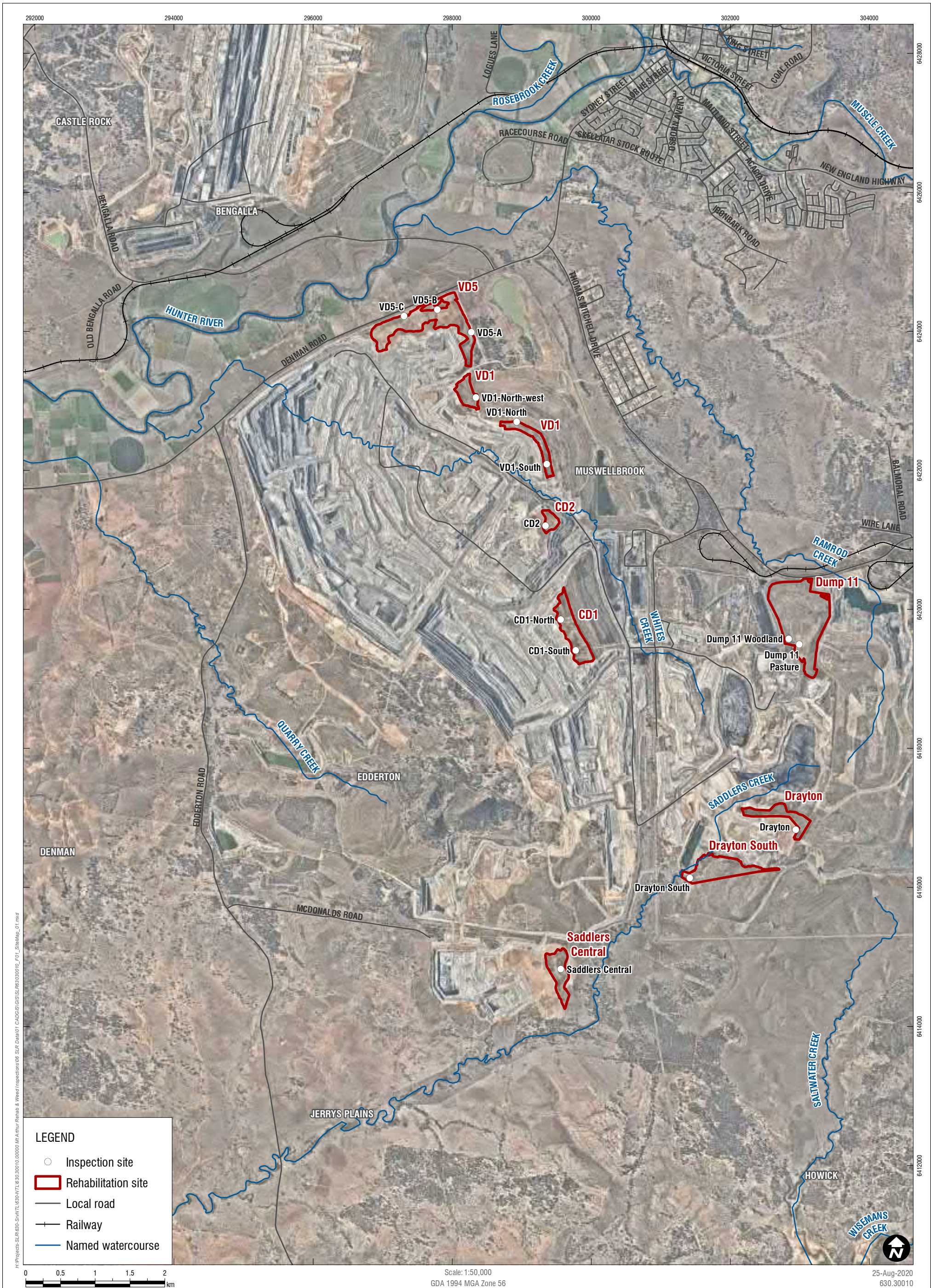
- survival and establishment of native vegetation within rehabilitation sites;
- potential management issues pertaining to each rehabilitation site (i.e. poor germination rates, tubestock mortality or predation, water stress or weed infestation); and
- suitable site-specific maintenance or remedial management actions required.

1.1 Licence and personnel

SLR Ecology currently holds a Scientific Licence (licence number SL100176), (issued under the *NSW National Parks and Wildlife Act 1974*) and an Animal Ethics Approval, which authorises SLR field staff to trap, capture, harm, hold and release plants and animals in NSW for the purposes of scientific research. The roles and qualifications of all staff responsible for preparation of this report are listed in **Table 1**.

Table 1 Staff roles and qualifications

Staff Name & Title	Qualifications and Training	Role
Jeremy Pepper Principal Ecologist	Bachelor of Science (Hons Class 1) University of NSW 1996 Cert II Bushland Regeneration, TAFE NSW Cert III Horticulture (Arboriculture), TAFE NSW BAM accredited assessor (#BAAS17104)	Project manager; Report technical review
Adam Cavallaro Senior Ecologist	Bachelor of Environmental Science, Conservation Ecology, CSU 2014 Horticulture Certificate IV, Institute of TAFE 2005 Bushland Regeneration Certificate II, Charlestown Institute of TAFE 2002 Biodiversity Assessment Method Assessor (BAAS#18056)	Field assessment, report preparation
David Martin Project Ecologist	Master of Science (Biosciences), The University of Melbourne 2018 Bachelor of Environmental Science and Management, UoN 2014	Field assessment, report preparation
Emily Mitchell CAD/GIS Technician	Bachelor of Development Studies (2008 – University of Newcastle) Cert IV Spatial Information Services, TAFE NSW Master of Information Technology, University of Newcastle 2019	Figure preparation



Site Map

FIGURE 1

2 Results

2.1 Revegetation Inspections

Results from the revegetation inspections are summarised for each rehabilitation site below in **Table 2**.

See **Appendix A** for Revegetation Inspection Sheets and detailed site-specific revegetation inspection results.

Table 2 Revegetation Inspection results summary

Site	Condition	Vegetation establishment	Impacts	Recommended actions
Dump 11	Varied	Pasture area (poor condition). Dominated by exotics. No emergent native vegetation community present.	Weeds Low Native Species cover	Targeted weed control focusing on Priority Weeds and High Threat Weeds (refer to Section Error! Reference source not found.)
		Woodland area (moderate condition). Early revegetation with low to moderate cover of native species representing all three strata (canopy, mid-storey, groundcover).	Weeds Low Native Species cover Erosion	Targeted weed control focusing on Priority Weeds and High Threat Weeds (refer to Section Error! Reference source not found.). Retention of exotic grass species for erosion and sediment control until development of pasture species mix.
Drayton Pasture	Poor (stable)	Pasture area (poor condition). Dominated by exotics. No emergent native vegetation. Low cover of native groundcover species.	Weeds Low Native Species cover Erosion	Targeted weed control focusing on Priority Weeds and High Threat Weeds (refer to Section Error! Reference source not found.). Retention of exotic grass species for erosion and sediment control until development of pasture species mix.
Drayton South	Poor (stable)	Pasture area (poor condition). Dominated by exotics. No emergent native vegetation.	Weeds Low Native Species cover Erosion	Targeted weed control focusing on Priority Weeds and High Threat Weeds (refer to Section Error! Reference source not found.). Retention of exotic grass species for erosion and sediment control until development of pasture species mix.
Saddlers (Central)	Varied	Established Woodland area (good condition). Establishing native species across all stratum, tracking towards a woodland community. Moderate weed cover inc. Priority species.	Weeds Low Canopy species diversity.	Broad weed control focusing on Priority Weeds and High Threat Weeds (refer to Section Error! Reference source not found.). Monitor rehabilitation to ensure site continues to track towards the target final land use (woodland).

Site	Condition	Vegetation establishment	Impacts	Recommended actions
		Surrounding areas (poor condition). Dominated by areas of dense exotic grass and herbaceous species	Weeds Low Native Species cover Vegetation structure	Targeted weed control focusing on Priority Weeds and High Threat Weeds (refer to Section Error! Reference source not found.) Retention of exotic grass species for erosion and sediment control until development of pasture species mix.
Visual Dump 1 (VD1) South	Poor (stable)	Woodland area (poor condition). Dominated by an exotic grass and herbaceous layer. Very sparse cover of woodland species.	Weeds Low Native Species cover Vegetation structure Pests (Rabbits)	Targeted weed control focusing on Priority Weeds and High Threat Weeds (refer to Section Error! Reference source not found.) Revegetation with native species from target Box Gum Woodland community.
Visual Dump 1 (VD1) North	Poor (stable)	Woodland area (poor condition). Dominated by an exotic grass and herbaceous layer. Very sparse cover of woodland species.	Weeds Low Native Species cover Vegetation structure Pests (Rabbits)	Targeted weed control focusing on Priority Weeds and High Threat Weeds (refer to Section Error! Reference source not found.) Revegetation with native species from target Box Gum Woodland community.
Visual Dump 1 (VD1) North West	Poor (stable)	Woodland area (poor condition). Dominated by dead or dying native Roly Poly currently supporting the establishment of native woodland species.	Weeds Low Native Species cover and diversity Erosion	Targeted weed control focusing on Priority Weeds and High Threat Weeds (refer to Section Error! Reference source not found.) Revegetation with native species from target Box Gum Woodland community. Remediate erosion, continue to monitor.
Visual Dump 5 (VD5) Area A	Poor (stable)	Woodland area (poor condition). Early stage rehab dominated by Roly Poly with low establishment of other native sp. Weeds throughout site. Minor rill erosion present. No distinct vegetation community establishing.	Weeds Low Native Species cover Vegetation structure Erosion	Targeted Weed Control focusing on woody Priority Weeds and High Threat Weeds. Revegetation with native species from target Box Gum Woodland community Remediate erosion, continue to monitor.

Site	Condition	Vegetation establishment	Impacts	Recommended actions
Visual Dump 5 (VD5) Area B	Poor (stable)	Woodland area (poor condition). Early stage rehab dominated by Roly Poly monoculture with low establishment and diversity of other native sp. Weeds throughout site. Minor rill erosion present. No distinct vegetation community establishing.	Weeds Low Native Species cover and diversity Vegetation structure Pests (Rabbits) Erosion	Targeted Weed Control focusing on woody Priority Weeds and High Threat Weeds. Revegetation with native species from target Box Gum Woodland community Remediate erosion, continue to monitor.
Visual Dump 5 (VD5) Area C	Poor (stable)	Woodland area (poor condition). Dominated by Roly Poly with a high density of weed species on lower slope. Native mid-storey and groundcover species present but at very low density. No distinct vegetation community establishing.	Weeds Low Native Species cover and diversity Vegetation structure	Targeted Weed Control focusing on woody Priority Weeds and High Threat Weeds. Revegetation with native species from target Box Gum Woodland community
Continuous Dump 1 (CD1) North	Varied	Woodland area (mixed condition). Upper slope dominated by exotics and includes large areas of exposed soil. Lower slope with lower slope inc. mixed exotic and native species cover. Rill erosion present. No distinct vegetation community establishing.	Weeds Low Native Species cover and diversity Vegetation structure Erosion and bare earth.	Targeted Weed Control focusing on woody Priority Weeds and High Threat Weeds. Revegetation with native species from target Woodland community Remediate erosion, continue to monitor.
Continuous Dump 1 (CD1) South	Varied	Woodland area (mixed condition). Early stage rehab. Higher native species cover, and establishment success compared to CD1 North, with sheltered areas constituting a moderate cover of native mid-storey species. More exposed areas with higher exotic cover. Lack of native canopy species. No distinct vegetation community establishing.	Weeds Vegetation structure Minor erosion Pests (Rabbits)	Targeted Weed Control focusing on woody Priority Weeds and High Threat Weeds. Revegetation with native species from target Woodland community Remediate erosion, continue to monitor.

Site	Condition	Vegetation establishment	Impacts	Recommended actions
Continuous Dump 2 (CD2)	Poor (stable)	Pasture area (poor condition). Dominated by moderate to high cover of exotic vegetation with scattered native species, likely colonising from local area. Weeds are providing important cover for topsoil stabilisation. No distinct vegetation community establishing.	Weeds Low Native Species cover and diversity Minor erosion Pests (Rabbits)	Targeted Weed Control focusing on woody Priority Weeds and High Threat Weeds. Retention of exotic grass species for erosion and sediment control until development of pasture species mix. Remediate erosion, continue to monitor.

3 Conclusion and Recommendations

The key findings from the revegetation and weed assessment are as follows:

- Five rehabilitation sites have very low native flora species diversity and have species compositions that do not align with a specific vegetation community (Dump 11 pasture, Drayton Pasture, Drayton South, CD1, VD5);
- Three rehabilitation sites have been identified as having only the beginnings of a native species mix comparative to their target communities (woodland or native pasture) but require active management of weeds (VD1 South, VD1 North, and CD4);
- Two rehabilitation sites were identified as having areas of native vegetation representing all three strata and constituting a species mix associated with their target community (local native woodland) (Dump 11 woodland, Saddlers Central);
- Weed management at rehabilitation sites should prioritise the control of local weed species as per the Weed Control Plan focussing on Priority Weed species identified on the site.

Recommended actions from this report include the following:

- Targeted weed management focusing on Priority Weed species, including the implementation of weed management of topsoil piles to ensure soils used in future rehabilitation sites are not introducing weed species in the early stages of site rehabilitation;
- Develop site-specific rehabilitation plans including determination of final target vegetation communities (e.g. Box Gum Woodland), appropriate native species mix, vegetation structural components requiring infill planting at each site, and strategic weed control management;
 - Develop a remediation plan for erosion identified across the rehabilitation sites; and
 - Monitor rehabilitation progress across all sites, including species composition, vegetation structure, weed species abundance and cover, erosion and soil condition to ensure rehabilitation is on track towards target communities.

APPENDIX A

Revegetation Inspection Sheets

Revegetation Inspection Form-Additional Information					
Area	Dump 11	Date:	21-05-2020	Name:	A. Cavallaro & D. Martin
Domain:		Post Mining Land Use:	Pasture		
Revegetation Date:	2016	Vegetation Type:	N/A		
Observations					
<p>Dump 11 was inspected at two revegetation areas that are distinguishable by the presences of varying vegetation cover. The first area inspected consisted of dense pasture (primarily exotic grass species) and areas of compacted soils with a lower density exotic cover.</p> <p>The second area was a more recently rehabilitated (rip lines and establishing native grasses shrubs and trees) hillslope above the pasture.</p>					
Site	Vegetation Establishment Notes				
Dump 11- Pasture	<p>The Dump 11 pasture area is predominantly exotic grass consisting of <i>Chloris gayana</i> (Rhodes Grass), <i>C. virgata</i> (Feathertop Rhodes Grass) and <i>Megathyrsus maximus</i> (Guinea Grass). In amongst the dense exotic grasses, it was observed that a very small number of native species were persisting. Species observed at very low densities included <i>Bothriochloa macra</i> (Red-leg Grass), <i>Chloris truncata</i> (Windmill Grass), <i>Eriochloa pseudoacrotricha</i> (Early Summer Grass). A tall <i>Acacia salicina</i> (Cooba) individual was observed growing amongst the grasses.</p> <p>A shift in vegetation composition and structure was observed in areas where soils were compacted. These areas were still dominated by exotic species though primarily herbaceous species that included <i>Melinis repens</i> (Red Natal Grass), <i>Galenia pubescens</i>, <i>Opuntia stricta</i> (Prickly Pear), <i>Cirsium vulgare</i> (Spear Thistle), <i>Asphodelus fistulosus</i> (Onion Weed) and <i>Senecio madagascariensis</i> (Fireweed).</p>				
	Emergent community characteristics/ecosystem function:				
	<p>Currently there is no distinct native vegetation community establishing in the area dominated by exotic pasture. The dense nature of the exotic grasses will restrict the establishment of native species in this area.</p> <p>This area may provide some refuge habitat for mobile fauna species or foraging opportunities for macropods and raptors.</p>				
	Other Impacts				
	No other major impacts observed				
Site	Vegetation Establishment Notes				
Dump 11- Woodland	<p>The gentle hill slope and ridge area above the pasture was observed to consist of a low to moderate cover of native species. There is evidence of previous site preparation works with rip lines visible and are made more evident with most covered by a mix of native and exotic flora species.</p> <p>Tree species such as <i>Corymbia maculata</i> and <i>Eucalyptus</i> sp. were scattered throughout and commonly observed to be below 500mm with the occasional individual greater than 1m. The shrub layer has a marginally higher species richness with up to five species observe establishing in the area all from small juveniles to individual up to 1.5m in height.</p> <p>The groundcover was a mix of native and exotic species that included <i>Bothriochloa macra</i>, <i>Chloris truncata</i> (Windmill Grass), <i>Enchylaena tomentosa</i> (Ruby Salt Bush) scattered amongst patches of <i>Cynodon dactylon</i> (Couch Grass) and high threat weed species <i>Chloris gayana</i> (Rhodes Grass), <i>C. virgata</i> (Feathertop Rhodes Grass), <i>Galenia pubescens</i> and <i>Megathyrsus maximus</i> (Guinea Grass).</p>				
	Emergent community characteristics/ecosystem function:				

	<p>Native flora species are represented across all three strata within the site. The species observed are associated with woodland and forest communities in the locality and with further establishment and increased species richness, the site will continue to track towards a dry sclerophyll woodland with a canopy of Spotted Gum and Ironbark.</p> <p>The vegetation is currently sparse and lacks a complex structure therefore is likely to only provide simple ecosystem functions such as stabilising substrates, providing nutrient and biomass to the topsoil and cover and protection for small fauna species.</p>
	Other Impacts
	No other major impacts observed
Recommendations	
<p>The following general rehabilitation management actions have been prepared to guide on-going management of rehabilitation:</p> <p>Targeted weed control works across both areas focusing on weeds listed under the Biosecurity Act 2017 and high threat weeds;</p> <p>Retain all exotic grass species in Dump 11 pasture until a final species composition can be determined for pasture areas.</p>	

Photos Dump 11

Dump 11 – Pasture



Dump 11 – Pasture



Dump 11 – Woodland



Dump 11 – Woodland



Revegetation Inspection Form-Additional Information					
Area	Drayton	Date:	21-05-2020	Name:	A. Cavallaro & D. Martin
Domain:		Post Mining Land Use:	Pasture		
Revegetation Date:	2016	Vegetation Type:	N/A		
Observations					
<p>Drayton rehabilitation area is a large area of exotic pasture bordered by compacted soils and spoil dumps. The area is relatively flat and no obvious signs of erosion in the areas observed.</p>					
Site	Vegetation Establishment Notes				
Drayton - Pasture	<p>The pasture area is predominantly exotic grass consisting of <i>Chloris gayana</i> (Rhodes Grass), <i>C. virgata</i> (Feathertop Rhodes Grass), <i>Megathyrsus maximus</i> (Guinea Grass) with small patches of <i>Lycium ferocissimum</i> (African Boxthorn), <i>Galenia pubescens</i>, <i>Sida Rhombifolia</i> (Paddy's Lucerne) and <i>Melinis repens</i> (Red Natal Grass) scattered throughout.</p> <p>There are some very minor occurrences of common native groundcover species hidden under the tall, dense exotic grasses. Species recorded included <i>Chloris truncata</i> (Windmill Grass), <i>Digitaria divaricatissima</i> (Umbrella Grass) and <i>Enchylaena tomentosa</i> (Ruby Salt Bush). The vegetation observed is appears to be stable exotic pasture.</p>				
	Emergent community characteristics/ecosystem function:				
	<p>Currently there is no distinct native vegetation community establishing in the area dominated by exotic pasture.</p> <p>This area may provide some refuge habitat for mobile fauna species or foraging opportunities for macropods and raptors.</p>				
Recommendations					
<ul style="list-style-type: none"> Targeted woody weed across the area focusing on weeds listed under the Biosecurity Act 2017 and high threat weeds 					

Photos Drayton

Drayton – Pasture



Drayton – Pasture



Revegetation Inspection Form-Additional Information					
Area	Drayton South	Date:	20-05-2020	Name:	A. Cavallaro & D. Martin
Domain:		Post Mining Land Use:	Pasture		
Revegetation Date:	<2017	Vegetation Type:	N/A		
Observations					
Drayton south rehabilitation area is a large area of exotic pasture with a northerly aspect.					
Site	Vegetation Establishment Notes				
Drayton South - Pasture	The pasture area is predominantly exotic grass consisting of <i>Chloris gayana</i> (Rhodes Grass), <i>C. virgata</i> (Feathertop Rhodes Grass), <i>Megathyrsus maximus</i> (Guinea Grass) with patches of <i>Galenia pubescens</i> , <i>Rapistrum rugosum</i> (Turnip Weed) and <i>Melinis repens</i> (Red Natal Grass) scattered throughout. The vegetation condition appears stable and is unlikely to change without a significant disturbance event.				
	Emergent community characteristics/ecosystem function:				
	Currently there is no distinct native vegetation community establishing in the area dominated by exotic pasture. This area may provide some refuge habitat for mobile fauna species or foraging opportunities for macropods and raptors.				
Recommendations					
<ul style="list-style-type: none"> Targeted woody and herbaceous weed across the area focusing on weeds listed under the Biosecurity Act 2017 and high threat weeds Determine the target vegetation type species composition and develop a revegetation strategy. 					

Photos Drayton South

Drayton – Pasture



Drayton – Pasture



Revegetation Inspection Form-Additional Information					
Area:	Saddlers (Central)	Date:	20-05-2020	Name:	A. Cavallaro & D. Martin
Domain:		Post Mining Land Use:	Woodland		
Revegetation Date:	2016	Vegetation Type:	Woodland		
Observations					
<p>The Saddlers Central rehabilitation site inspection focused on an area of establishing woodland with an easterly aspect and an area of the 2016 rehabilitation that is primarily exotic grass species.</p>					
Site	Vegetation Establishment Notes				
Saddlers Central	Vegetation Establishment Notes				
	<p>Vegetation establishment within the Saddlers Central rehabilitation area was observed to be patchy with some small examples of establishing vegetation with native species present across a range of stratum and varying heights, to areas of predominantly exotic grass species. There is a good example of vegetation that is showing signs of tracking towards the target woodland vegetation type in the centre of the rehab. This patch has a variety of native plants establishing with canopy, mid-storey and groundcover species well represented. Canopy species were restricted to a single species <i>Corymbia maculata</i> (Spotted Gum) that were spread across the area at an approximate rate of 1/20-30m² individuals and were observed to a height of 5m. The mid-storey was diverse with approximately seven species primarily Acacia. Species observed include <i>Acacia falcata</i> (Sickle Wattle), <i>A. salicina</i> (Cooba), <i>A. parvipinnula</i>, <i>A. implexa</i> (Hickory Wattle), <i>Dodonaea viscosa</i> (Sticky Hop Bush), <i>Swainsona galegifolia</i> (Smooth Darling-pea) and <i>Allocasuarina verticillata</i> (Drooping Sheoak). The groundcover also had a moderately diverse representation of native species with <i>Bothriochloa macra</i> (Red-leg Grass), <i>Chloris ventricosa</i> (Plump Windmill Grass), <i>Digitaria divaricatissima</i> (Umbrella Grass), <i>Eriochloa pseudoacrotricha</i> (Early Summer Grass) and <i>Enchylaena tomentosa</i> (Ruby Saltbush). This patch of vegetation had some obvious weed management issues that require treatment, species that were observed growing amongst the natives included <i>Paspalum urvillei</i>, <i>Megathyrsus maximus</i> (Guinea Grass), <i>Lycium ferocissimum</i> (Boxthorn). There are patches of <i>Bidens</i> sp. (Cobblers Peg) and <i>Tagetes minuta</i> (Stinking Roger) that cover moderately sized areas but will not cause an issue for the continued establishment of the vegetation.</p> <p>The good patch of rehabilitation is surrounded by pasture areas consisting of dense exotic grass species that include <i>Cenchrus clandestinus</i> (Kikuyu), <i>Paspalum urvillei</i>, <i>Megathyrsus maximus</i> and exotic herbaceous species <i>Galenia pubescens</i> and <i>Rapistrum rugosum</i> (Turnip Weed).</p>				
	Emergent community characteristics/ecosystem function				
	<p>The good patch of rehabilitation is tracking towards a woodland like community. There is a variety of native species established across all three stratum which is beginning to provide structure to the community. All areas surrounding the good quality patch of rehabilitation are not currently showing signs of an emergent vegetation community.</p>				
	Additional Information				
	<ul style="list-style-type: none"> The topsoil in good condition, allowing vegetation establishment. The soils are stable and are generally easily broken up when kicked and at the time of inspection retaining moisture. 				

Recommendations

- Target all weed species within the better-quality patch of rehabilitation (woodland area) focusing on weeds listed under the Biosecurity Act 2017 and high threat weeds in accordance with the Weed Control Plan (see **Appendix C**).
- Develop a detailed site-specific Rehabilitation Plan that outlines rehabilitation works required for the surrounding areas designated for a final landuse of “pasture”. Requirements at a minimum should include:
 - Develop a weed treatment plan for all Biosecurity weeds, high threat weeds to reduce the weed seed bank in the topsoils over a period of a minimum of 12mths that will ensure multiply growth cycles of weed species have been targeted;
 - Develop a revegetation plan for the pasture area including detailing an appropriate seed mix for the target final landuse of pasture. Revegetation/reseeding is to be carried out in conjunction with the weed treatment plan (mentioned above).

Photos Saddlers Central

Saddlers Central



Saddlers Central



Revegetation Inspection Form-Additional Information					
Area:	Visual Dump 1(VD1)	Date:	20-05-2020	Name:	A. Cavallaro & D. Martin
Domain:		Post Mining Land Use:	Woodland		
Revegetation Date:	2016-2019	Vegetation Type:	Box Woodland Establishment Area		
Observations					
<p>VD1 is the large visual dump to the north-east on the Mt Arthur Complex. Three different areas were inspected over VD1 with a focus on the area identified to be rehabilitated to Grassy Box Woodland.</p> <p>VD1-South and VD1-North inspection sites were both at the top of the dump within areas rehabilitated in 2016. There was a persistent weed cover at both sites with a relatively low native species cover present. Native species were often absent with the majority of vegetation consisting of exotic groundcover which are presently contributing to the stability of the substrates across most of the site. There were obvious signs of erosion where water is naturally draining from the dump. This erosion is creating incised channels where coarse spoil is being exposed due to the finer materials being carried down-slope.</p> <p>VD1 north-west inspection site is within an area rehabilitated during 2017, the inspection focused on the lower slopes of the rehabilitation area where the vegetation is predominantly <i>Sclerolaena muricata</i> with scattered occurrences of native groundcovers present. The Rehabilitation works appeared relatively stable with the occasion erosion channel (500-1000mm) forming beneath the vegetation layer where there is a nature low point in the reconstructed landform.</p>					
Site	Vegetation Establishment Notes				
VD1- South	<p>Vegetation on VD1-South is primarily <i>Cynodon dactylon</i> (Couch Grass) along the upper slope with only low priority exotic species spread throughout. As you move downslope the vegetation changes with a predominately exotic grassy and herbaceous layer stabilising the soil profile. The species that are present include <i>Chloris gayana</i> (Rhodes Grass), <i>C. virgata</i> (Feathertail Rhodes Grass), <i>Megathyrsus maximus</i> (Guinea Grass), <i>Setaria parviflora</i> (Pigeon Grass), <i>Galenia pubescens</i>, <i>Rapistrum rugosum</i> (Turnip Weed) and patchy occurrences of <i>Cenchrus clandestinus</i> (Kikuyu).</p> <p>Native species are present in this area, although are often in small clusters across the rehab. Upper and mid-storey species are relatively sparse with an estimate of 1/50m². Species observed include common woodland species such as <i>Acacia decora</i> (Showy Wattle), <i>A. paradoxa</i> (Prickly Wattle), <i>A. implexa</i> (Hickory Wattle), <i>Dodonaea viscosa</i> (Sticky Hop Bush) and juvenile eucalypt species.</p> <p>The groundcover stratum is also very sparse with clusters found growing in small depressions or around some large boulders located in the rehabilitation site. The species observed include <i>Bothriochloa macra</i> (Red-leg Grass), <i>Chloris truncata</i> (Windmill Grass), <i>Panicum simile</i> (Two-colour Panic), <i>Digitaria divaricatissima</i> (Umbrella Grass), and small senescing patches of <i>Eriochloa pseudoacrotricha</i> (Early Summer Grass).</p> <p>The vegetation condition although weed dominant is providing important cover to stabilise and develop the topsoil.</p>				
	Emergent community characteristics/ecosystem function:				
	<p>Currently there is no distinct native vegetation community establishing in the area. There are beginnings of native species aligning towards a woodland but will require significant active management to continue tracking toward the desired woodland vegetation type. Currently the vegetation would provide little ecosystem function with the exception of providing fauna refuge.</p>				
	Additional Impacts				

	<ul style="list-style-type: none"> There was evidence of rabbits utilising the site with diggings and relatively fresh scats observed. The topsoil still appears in good condition to allow vegetation establishment. The soils are stable with only minor erosional issues from water movement across the site. The soils are easily broken up when kicked and at the time of inspection were retaining moisture.
Site	Vegetation Establishment Notes
VD1- North	<p>Vegetation on VD1-North appeared similar to the south with a lower native species richness and abundance. The area is dominated by <i>Chloris gayana</i> (Rhodes Grass) and <i>Cynodon dactylon</i> (Couch Grass) with scattered tussocks of <i>Megathyrsus maximus</i> (Guinea Grass).</p> <p>Native species are present in this area at a very low density. Species richness was low with on three upper stratum species observed and only the more common grassy species (<i>Bothriochloa macra</i> (Red-leg Grass), <i>Chloris truncata</i> (Windmill Grass), <i>Digitaria divaricatissima</i>) scattered amongst the more aggressive exotic grasses.</p> <p>The vegetation condition although weed dominant is providing important cover to stabilise and develop the topsoil.</p> <p>Emergent community characteristics/ecosystem function</p> <p>Currently there is no distinct native vegetation community establishing in the area. There are beginnings of native species aligning towards a woodland but will require significant active management to continue tracking toward the desired woodland vegetation type. Currently the vegetation would provide little ecosystem function with the exception of providing fauna refuge.</p> <p>Additional Information</p> <ul style="list-style-type: none"> There was evidence of rabbits utilising the site with diggings and relatively fresh scats observed. The topsoil still appears in good condition, allowing vegetation establishment. The soils are stable with only minor erosion issues from water movement across the site and the soils are generally easily broken up when kicked and at the time of inspection retaining moisture.
Site	Vegetation Establishment Notes
VD1- North-west	<p>Vegetation within the 2017 Rehab site has a consistent native cover which is primarily dead or dying <i>Sclerolaena muricata</i> (Black Roly Poly). The vegetation cover created by the Black Roly Poly has provided opportunity for some common native midstorey and groundcover species to establish which include <i>Acacia decora</i> (Snowy Wattle), <i>A. implexa</i> (Hickory Wattle), <i>Dodonaea viscosa</i> (Sticky Hopbush), <i>Austrostipa verticillata</i> (Slender Bamboo Grass) and <i>Eriochloa pseudoacrotricha</i> (Early Summer Grass). These native species were often sparse with midstorey species spread across the area greater than 1/50m².</p> <p>Weed species were observed at a higher density across the site with patches of <i>Galenia pubescens</i>, <i>Asphodelus fistulosus</i> (Onion Weed), <i>Lycium ferocissimum</i> (Boxthorn), <i>Megathyrsus maximus</i> (Guinea Grass) and <i>Datura stramonium</i> (Common thornapple).</p> <p>As you transition into the 2018 Rehab site above there is very little native cover except for some isolated patches of <i>Sclerolaena muricata</i>.</p> <p>Emergent community characteristics/ecosystem function</p>

	<p>The Rehab in VD1 – Northwest currently has a very low diversity of native species and the current composition and structure do not align to a specific vegetation community.</p> <p>Additional Information</p> <ul style="list-style-type: none"> The area inspected had a number of erosion channels that have established in low point within the wider rehab site. These channels range in depth (500-1000mm) and width.
<p>Recommendations</p>	
<ul style="list-style-type: none"> Initially target all woody and herbaceous weed across the area focusing on weeds listed under the Biosecurity Act 2017 and high threat weeds until a revegetation plan has been established for the site Develop a detailed site-specific Rehabilitation Plan that outlines rehabilitation works required to meet the site the target vegetation type. Requirements a t a minimum should include: <ul style="list-style-type: none"> Develop a remediation plan for large erosion channels forming across the site: Develop a weed treatment plan for all Biosecurity weeds, high threat weeds to reduce the weed seed bank in the topsoils prior to reseeding refer to the Weed Control Plan (see Appendix C); Develop a revegetation plan around reseeding the site with native species from target Box Gum Woodland; and Infill plant areas with canopy species where sufficient understorey species have begun to establish. 	

Photos Visual Dump 1

Visual Dump 1 – South



Visual Dump 1 – South



Visual Dump 1 – North



Visual Dump 1 – North



Visual Dump 1 – North west



Visual Dump 1 – North-west



Revegetation Inspection Form-Additional Information					
Area:	Visual Dump 5 (VD5)	Date:	20/05-21/05 2020	Name:	A. Cavallaro & D. Martin
Domain:		Post Mining Land Use:	Woodland		
Revegetation Date:	2017-2019	Vegetation Type:	Box Woodland Establishment Area		
Observations					
<p>VD5 is located on the northern boundary of Mount Arthur Coal adjacent to Denman Rd. Three separate areas within VD5 (VD- A, VD -B & VD -C) were inspected as part of the Rehab site inspection.</p> <p>VD - A was within rehabilitation that was apparently undertaken during 2019 (MAC GIS file Layer 2020). The rehabilitation in this area has a persistent cover across the areas walked with small bare areas amongst dense <i>Sclerolaena muricata</i> (Black Roly Poly). The vegetation in this area is relatively young hence the low native species richness. It appears the rehabilitation works are relatively stable with a small number of channels establishing within low points in the landscape.</p> <p>VD - B and VD - C site inspections were primarily in the 2017 Rehab facing Denman Rd. These two sites were identical in structure. The vegetation is predominantly low growing Black Roly Poly with the occasional mid or canopy species emerging from the groundlayer vegetation. The sites in general are stable with most erosion concerns observed in the reshaped drainage channels within the rehab.</p>					
Site	Vegetation Establishment Notes				
VD5 -A	<p>Vegetation within VD5 - A is predominantly a monoculture of <i>Sclerolaena muricata</i> (Black Roly Poly) with a very low presences of other native species. In amongst the dense Black Roly Poly there is the very occasional native groundcover establishing with species such as <i>Enchylaena tomentosa</i> (Ruby Saltbush) and <i>Einadia trigonos</i> (Fishweed) found in small gaps in the Black Roly Poly. On the lower slope there was a small cluster of two juvenile <i>Eucalyptus crebra</i> (Narrow-leaved Ironbark) approximately 1.5m in height. Weeds are present throughout the site with common species seen across the Mt Arthur Col site such as <i>Galenia pubescens</i>, <i>Rapistrum rugosum</i> (Turnip Weed), <i>Argemone mexicana</i> (Mexican Poppy) and juvenile African Boxthorn. The vegetation is young and has not had time to establish further them to initial pioneer species colonising the site.</p>				
	<p>Emergent community characteristics/ecosystem function:</p> <p>Currently there is no distinct native vegetation community establishing in the area. The site is in the very early phases of establishing vegetation therefore it would be unexpected to be able to define vegetation community characteristics other than whether the species establishing are predominantly native or exotic.</p>				
	<p>Additional Information</p> <ul style="list-style-type: none"> There were a small number of minor rill and gully erosion areas observed whilst traversing the site. <p>Macropods are utilising the lower areas here there is a lack of Black Roly Poly (scats observed)</p>				
Site	Vegetation Establishment Notes				

VD5- B	<p>Vegetation observed within the VD5 - B site is consistent with all vegetation observed within VD5 and is predominantly a monoculture of <i>Sclerolaena muricata</i> (Black Roly Poly) with some bare soil areas on the lower slopes.</p> <p>The species richness was low with only a handful of native groundcover species observed in the area. There was the occasional <i>Acacia decora</i> (Showy Wattle) and <i>A. implexa</i> (Hickory Wattle) found establishing under the Black Roly Poly with small isolated patches of <i>Dichanthium sericeum</i> (Blue grass), <i>Cynodon dactylon</i>, <i>Digitaria divaricatissima</i> and <i>Panicum queenslandicum</i> (Coolabah Grass). In areas where the Black Roly Poly had not established it had provided an opportunity for exotic species to begin establishing across the site with <i>Asphodelus fistulosus</i> (Onion weed), <i>Lycium ferocissimum</i> (Boxthorn), <i>Megathyrsus maximus</i>, <i>Rapistrum rugosum</i> and <i>Datura stramonium</i> (Common thornapple).</p>
	Emergent community characteristics/ecosystem function
	<p>Currently there is no distinct native vegetation community establishing in the area.</p> <p>The site is in the very early phases of establishing vegetation therefore it would be unexpected to be able to define vegetation community characteristics other than whether the species establishing are predominantly native or exotic.</p>
	Additional Information <ul style="list-style-type: none"> There was evidence of rabbits and macropods utilising the site with diggings (rabbits) and fresh scats observed from both species. The soils appear stable with only minor erosion issues from water movement across the site. Soils were retaining moisture and were generally loose and friable.
Site	Vegetation Establishment Notes
VD5 -C (lower slopes)	<p>Vegetation within the western-section (site inspection VD5- C) of 2017 Rehab site is again dominated <i>Sclerolaena muricata</i> (Black Roly Poly) with a high density of weed species scattered throughout the lower slopes.</p> <p>The lower slopes have clusters of exotic grass species that are well established and recently developed and dropped seed. The main species recorded were <i>Chloris gayana</i>, <i>Megathyrsus maximus</i> and <i>Paspalum urvillei</i>.</p> <p>Native species richness was marginally higher in these areas although the abundance was relatively low with only scattered individuals observed across the site. Species observed include <i>Acacia decora</i>, <i>A. falcata</i>, <i>A. implexa</i> in the midstorey and <i>Chloris truncata</i>, <i>C. ventricosa</i>, <i>Digitaria divaricatissima</i>, <i>Dichanthium sericeum</i> and <i>Enchylaena tomentosa</i>.</p>
	Emergent community characteristics/ecosystem function
	<p>Currently there is no distinct native vegetation community establishing in the area.</p> <p>The site is in the very early phases of establishing vegetation therefore it would be unexpected to be able to define vegetation community characteristics other than whether the species establishing are predominantly native or exotic.</p>
	Additional Information
	<p>Erosion was limited through this area with only minor erosion channels observed. Most water appears to be moving into purpose-built drainage lines in the rehab.</p> <p>Soils appear to be soft, friable but currently stable likely due to the vegetation cover created by the dense Black Roly Poly.</p>

Recommendations

- Initially target all woody and herbaceous weed across the area focusing on weeds listed under the *Biosecurity Act 2015* and high threat weeds until a revegetation plan has been established for the site
- Develop a detailed site-specific Rehabilitation Plan that outlines rehabilitation works required to meet the site the target vegetation type.

Photos Visual Dump 5

Visual Dump 5 – A



Visual Dump 5 – A



Visual Dump 5 – B



Visual Dump 5 – B



Visual Dump 5 – C



Visual Dump 5 – C



Revegetation Inspection Form-Additional Information					
Area:	Continuous Dump 1 (CD1)	Date:	21/05/2020	Name:	A. Cavallaro & D. Martin
Domain:		Post Mining Land Use:	Woodland		
Revegetation Date:	2018	Vegetation Type:	Woodland		
Observations					
<p>CD1 inspection sites were located at the top of the current dump within Rehabilitation works undertaken in 2018 with a north-easterly aspect. Two locations were selected for inspection: CD1-North and CD1 - South.</p> <p>CD1- North focused on the upper slope of the site primarily on areas that lack topographical variation. This area had a persistent cover from a predominantly high exotic groundcover presence to a predominantly native cover with exotic species intermixed. The substrates appeared to be in good condition and were generally stable with only a small number of erosional issues observed such as early staged rilling.</p> <p>CD1 - South inspection area was primarily within a formed depression with a constructed drainage channel through the centre. Vegetation in this area was patchy with some moderate to good native cover in the lower sections in the depression, with the density of natives reducing with increase in elevation and exposure to the higher points in the site. The substrates appear consistent with CD1 -North and appear to be stable with some heavier looking clays present resulting a less friable top soil .</p>					
Site	Vegetation Establishment Notes				
CD1 -North	<p>Vegetation within CD1 -North was a mix of exotic dominated vegetation primarily in the far north and lower slopes with patchy mixed vegetation (native and exotic species) as you track towards the south.</p> <p>The exotic dominant vegetation in the far north consisted primarily of exotic herbaceous species intermixed with patches of exotic grasses. The exotic groundcovers observed were often high threat weed species that are likely to restrict the establishment of native species within the site. Species observed in varying densities include <i>Galenia pubescens</i>, <i>Argemone ochroleuca</i> var <i>ochroleuca</i> (Mexican Poppy), <i>Carthamus lanatus</i> (Saffron Thistle), <i>Rapistrum rugosum</i> (Turnip Weed), <i>Xanthium occidentale</i> (Noogoora Burr) and juvenile <i>Lycium ferocissimum</i> (African Boxthorn). Exotic grass species that were observed included <i>Cenchrus clandestinus</i> (Kikuyu), patches of <i>Megathyrus maximus</i> (Guinea Grass) and one of the only occurrences of <i>Hyparrhenia hirta</i> (Coolatai Grass) observed during the revegetation inspection. The top edge has some large areas of exposed soils with the main vegetation consisting of a monoculture of Turnip Weed with a mixed of Mexican Poppy and minor low priority weeds.</p> <p>Native species were present in very low numbers and scattered across the site. The species commonly observed in amongst dense patches of exotic vegetation included <i>Sclerolaena muricata</i> (Black Roly Poly), <i>Dichanthium sericeum</i> (Blue grass), <i>Bothriochloa macra</i> (Red-leg Grass), <i>Panicum simile</i> (Two-colour Panic) and <i>Eriochloa pseudoacrotricha</i> (Early Summer Grass). No midstorey or canopy species were observed throughout the inspection of CD1- North apart from a small cluster (10m²) at the top edge consisting of <i>Acacia salicina</i> (Cooba) A. <i>parvipinnula</i> (Silver Stemmed Wattle) and A. <i>falcata</i> (Sickle Wattle).</p> <p>Emergent community characteristics/ecosystem function:</p> <p>Currently there is no distinct native vegetation community establishing in the area. As the species composition is primarily exotic with a low species richness of common species found across many vegetation communities in the Hunter Valley.</p>				

	<p>Additional Information</p> <p>There was evidence of some rill erosion (<300m) that appears to be draining water from the top of the rehab down through the site</p>
Site	Vegetation Establishment Notes
CD1-South	<p>The inspection at CD1- South focused on vegetation in and around the constructed depression and drainage channel. In general, the vegetation within this area had a higher native species cover and abundance than CD1-North, with a higher success rate of native establishment in the lower more protected areas in the depression.</p> <p>Vegetation in the depression adjacent to the channel was observed to have a moderate cover of midstorey species primarily Acacias to a height of 1m. This additional cover provided by mid-storey species has provided opportunity for several smaller native groundcovers to colonise edges and within the patch of shrubs. The mid-storey consists of <i>Acacia salicina</i> (Cooba) <i>A. parvipinnula</i> (Silver Stemmed Wattle), <i>A. verniciflua</i> (Varnish Wattle) and <i>A. falcata</i> (Sickle Wattle) with the occasional <i>Dodonaea viscosa</i>, <i>Maireana microphylla</i> (Small-leafed Bluebush) and <i>Swainsona galegifolia</i> (Smooth Darling-pea).</p> <p>As you track up slope into areas that are regularly exposed to persistent winds, the shrub layer decreases in density with the native groundcovers intermixed with exotic species becoming more prevalent. The native species are a mix of grassy and herbaceous species that were observed growing in diverse clusters. Species recorded include <i>Cynodon dactylon</i> (Couch Grass), <i>Digitaria divaricatissima</i> (Umbrella Grass), <i>Lobelia purpurascens</i> (Whiteroot), <i>Dichondra repens</i> (Kidney Weed), <i>Plantago debilis</i> and <i>Desmodium rhytidophyllum</i>.</p> <p>There is a distinct lack of canopy species in this area as no Eucalypts were observed establishing in the area nor where there any seedlings emerging.</p> <p>Emergent community characteristics/ecosystem function</p> <p>Currently there is no distinct native vegetation community establishing in the area. The site is in the very early phases of establishing vegetation therefore it would be unexpected to be able to define vegetation community characteristics other than whether the species establishing are predominantly native or exotic.</p> <p>Additional Information</p> <p>There was evidence of rabbits and macropods utilising the site with diggings (rabbits) and fresh scats observed from both species.</p> <p>The soils appear stable with only minor erosion issues from water movement generally restricted to the constructed channel. Soils were retaining moisture and were generally heavy in sticky clays.</p>
<p>Recommendations</p> <p>Initially target all woody and herbaceous weed across the area focusing on weeds listed under the <i>Biosecurity Act 2015</i> and high threat weeds until a revegetation plan has been established for the site</p> <p>Develop a detailed site-specific Rehabilitation Plan that outlines rehabilitation works required to meet the site the target vegetation type. Requirements at a minimum should include:</p> <p>Develop a remediation plan for large erosion channels forming across the site:</p> <p>Develop a weed treatment plan for all Biosecurity weeds, high threat weeds to reduce the weed seed bank in the topsoils prior to reseeding refer to the Weed Control Plan (see Appendix C);</p> <p>Develop a revegetation plan around reseeding the site with native species from target Woodland; and</p> <p>Infill plant areas with canopy species where sufficient understorey species have begun to establish.</p>	

Photos Continuous Dump 1

Continuous Dump 1 North



Continuous Dump 1 North



Continuous Dump 1 South



Continuous Dump 1 South



Revegetation Inspection Form-Additional Information

Area:	Continuous Dump 2 (CD2)	Date:	21-05-2020	Name:	A. Cavallaro & D. Martin
Domain:		Post Mining Land Use:	Pasture		
Revegetation Date:	2019	Vegetation Type:	N/A		
Observations <p>CD2 is a small patch of rehabilitation with a north-easterly aspect located in the centre of the open cut mine. Rehabilitation commenced during 2019. There is a continuous cover of vegetation established across the site with a mix of exotic weed cover with scattered native grasses and herbaceous species.</p> <p>The site overall appears to have a stable substrate with the soils being retained in place primarily by the exotic weed cover.</p>					
Site	Vegetation Establishment Notes				

	<p>Vegetation on CD2 is predominantly exotic vegetation with a patchy mosaic of native species scattered throughout. The native species observed are common colonising species associated with various vegetation communities in the Hunter. These species were observed to be growing as individuals or small cluster amongst aggressive exotic species such as <i>Galenia pubescens</i>. Native species observed were primarily grassy and herbaceous species with the very occasional small shrub. Species recorded in the rehabilitation areas included <i>Bothriochloa macra</i> (Red-leg Grass), <i>Dichanthium sericeum</i> (Bluegrass), <i>Sporobolus elongata</i> (Slender Ra's Tail Grass), <i>Panicum effusum</i> (Hairy Panic), <i>P. simile</i> (Two-colour Panic), <i>Einadia trigonos</i> (Fish weed), <i>Cynodon dactylon</i> (Couch Grass), <i>Paspalidium distans</i>, <i>Dichondra repens</i> (Kidney Weed), <i>Maireana microphylla</i> (Small-leaf Bluebush) and <i>Sclerolaena muricata</i> (Black Roly Poly).</p> <p>Weed cover is moderate to high with many common weed species observed across the mine site. It appears that weeds have germinated from the top soil indicating topsoil that has been installed is likely to have been contaminated with the weed seed prior to spread.</p> <p>Weeds observed included <i>Galenia pubescens</i>, <i>Argemone ochroleuca</i> var <i>ochroleuca</i> (Mexican Poppy), <i>Carthamus lanatus</i> (Saffron Thistle), <i>Rapistrum rugosum</i> (Turnip Weed), <i>Hirschfeldia incana</i> (Buchan Weed), <i>Verbena rigida</i> (Creeping Verbena) and juvenile <i>Lycium ferocissimum</i> (African Boxthorn).</p> <p>Exotic grass species that were observed included small patches of <i>Megathyrsus maximus</i> (Guinea Grass) and scattered patches of dying cover crop species.</p>
	<p>Emergent community characteristics/ecosystem function</p> <p>Currently there is no distinct native vegetation community establishing in the area. There is a number of native grass species establishing across the site intermixed with some small delicate herbaceous species. These species will all contribute to attain a grassland or native pasture like community if early intervention such as weed control is carried out.</p>
	<p>Additional Information</p> <p>The topsoil still appears in good condition, allowing vegetation establishment. The soils are stable and appeared to consist of a heavy clay texture.</p>
	<p>Recommendations</p> <p>Initially target all woody and herbaceous weed across the area focusing on weeds listed under the Biosecurity Act 2015 and high threat weeds (refer to the Weed Control Plan in Appendix C) to allow for native species to further establish across the Rehabilitation site;</p> <p>As revegetation only commenced 12 months ago it is advised that careful weed control is the only management action carried out at this site for the next 1-2 yrs. to assess success of revegetation works.</p>

Photos Continuous Dump 4

CD2

CD2

Photos Continuous Dump 4



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T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE

10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH

Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY

Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE

12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG

Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND

68 Beach Road
Auckland 1010
New Zealand
T: 0800 757 695

NELSON

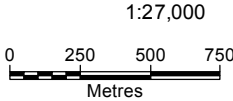
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

Appendix 6 – Weed Management Report



Source: Esri, Maxar, GeoEye,
Earthstar Geographics,
CNES/Airbus DS, USDA,
USGS, AeroGRID, IGN, and the
GIS User Community

BHP

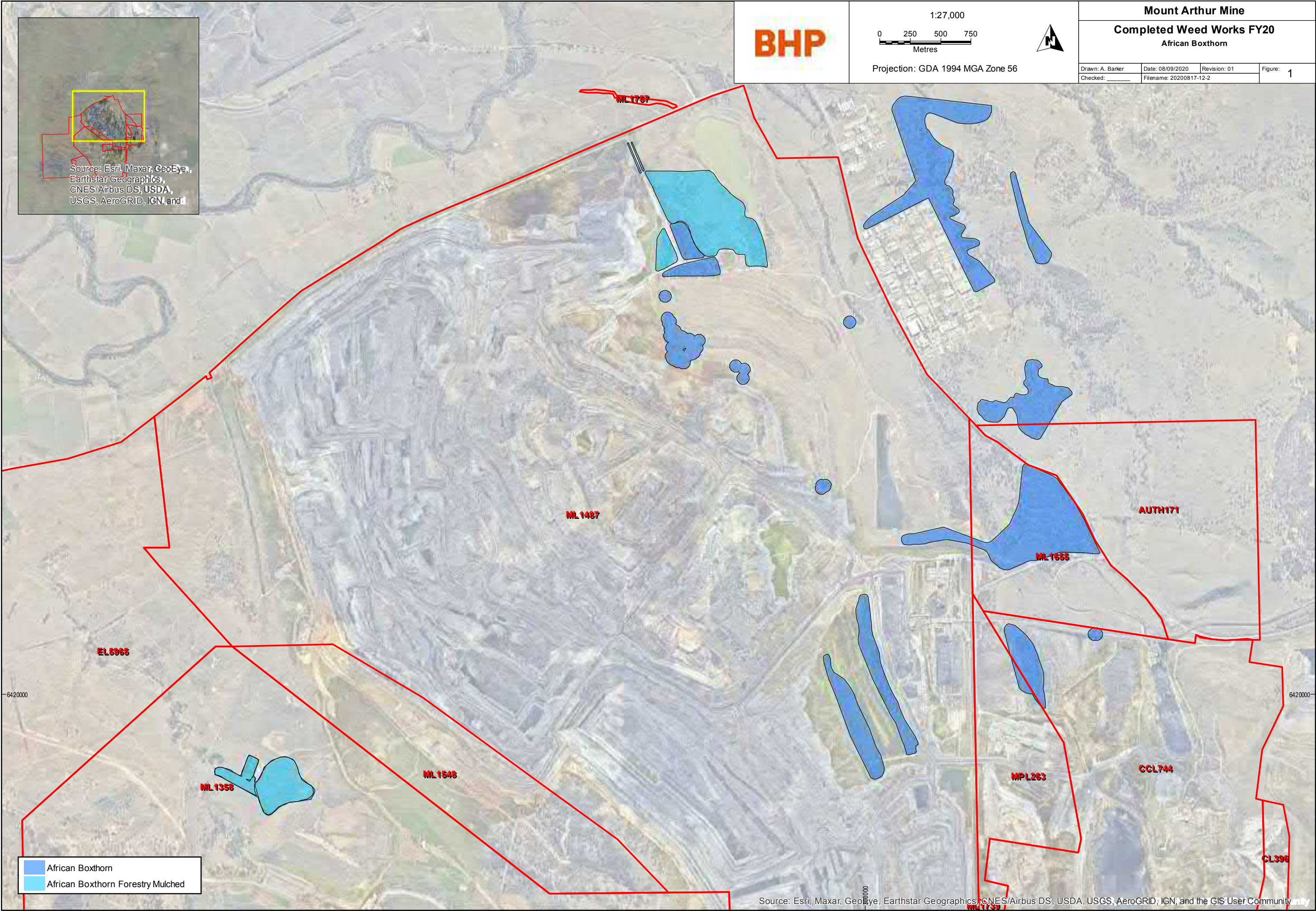


Projection: GDA 1994 MGA Zone 56

Mount Arthur Mine

Completed Weed Works FY20
African Boxthorn

Drawn: A. Barker	Date: 08/09/2020	Revision: 01	Figure: 1
Checked: _____	Filename: 20200817-12-2		



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1:24,000

0250500750

Metres

Mount Arthur Mine

Completed Weed Works FY20

African Olive

Drawn: A. Barker

Date: 08/09/2020

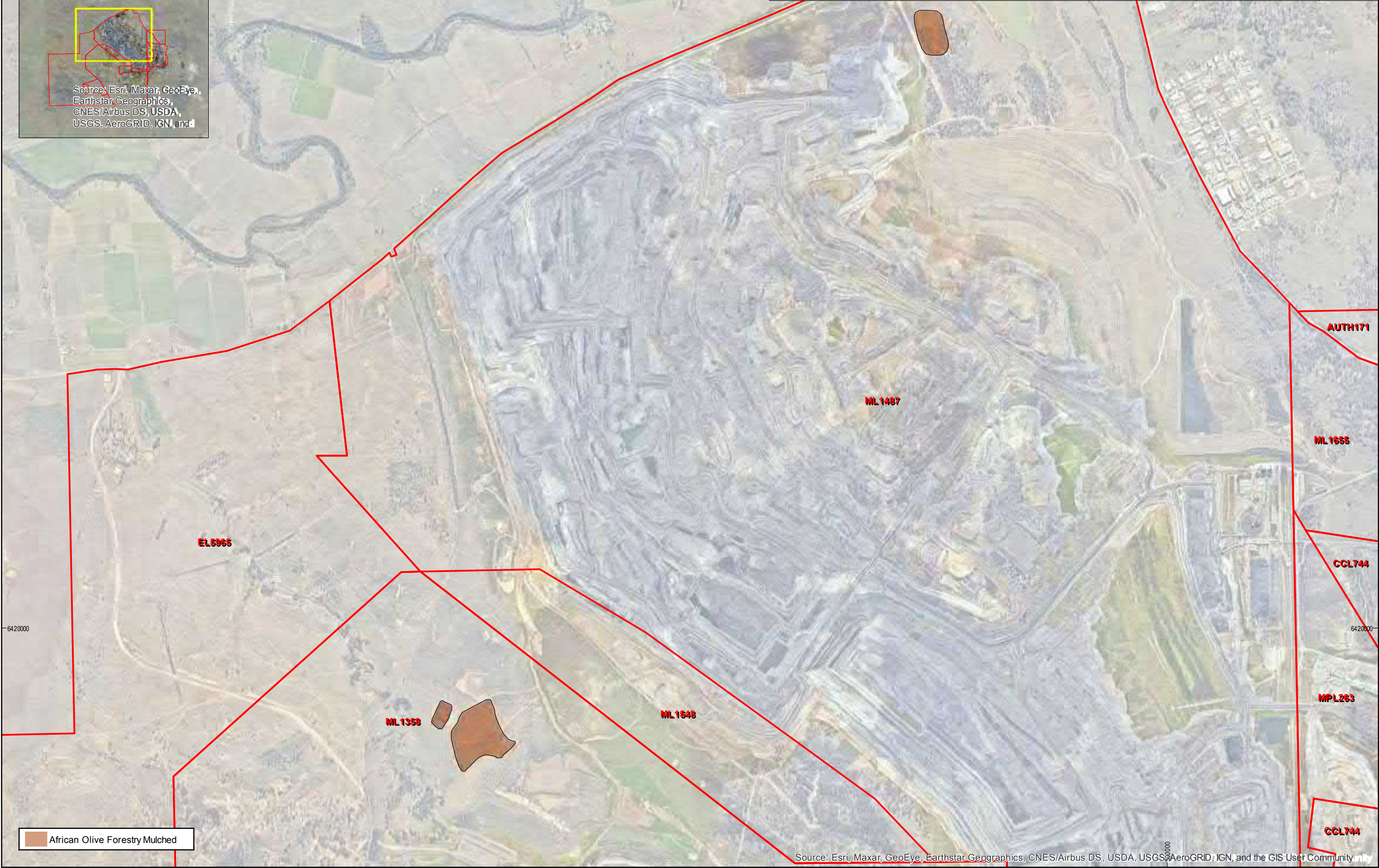
Revision: 01

Figure: 2

Checked:

Filename: 20200817-12-2

Projection: GDA 1994 MGA Zone 56



African Olive Forestry Mulched

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1:15,000

0250500

Metres

Projection: GDA 1994 MGA Zone 56

Mount Arthur Mine

Completed Weed Works FY20

Artichoke Thistle, Pampas Grass, Common Thornapple, Cotton Bush & Silverleaf Nightshade

Drawn: A. Barker	Date: 08/09/2020	Revision: 01	Figure: 3
Checked: _____	Filename: 20200817-12-2		

- Artichoke Thistle
- Pampas Grass
- Common Thornapple
- Cotton Bush
- Silverleaf Nightshade



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



1:14,000

0250500

Metres



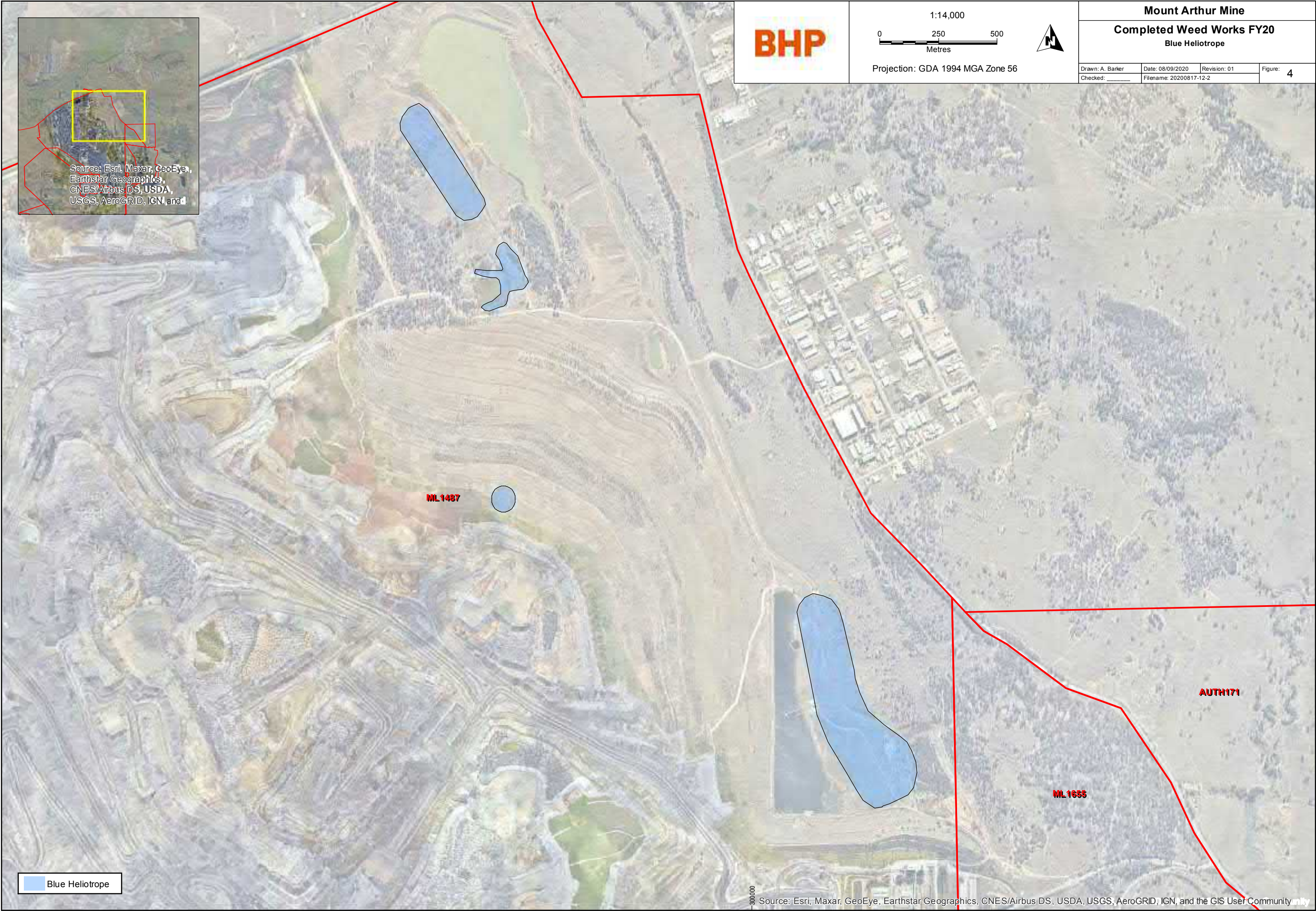
Projection: GDA 1994 MGA Zone 56

Mount Arthur Mine

Completed Weed Works FY20

Blue Heliotrope

Drawn: A. Barker	Date: 08/09/2020	Revision: 01	Figure: 4
Checked: _____	Filename: 20200817-12-2		





Source: Esri, Maxar, GeoEye,
Earthstar Geographics,
CNES/Airbus DS, USDA,
USGS, AeroGRID, IGN, and the
GIS User Community



1:14,000
0 250 500
Metres



Projection: GDA 1994 MGA Zone 56

Mount Arthur Mine

Completed Weed Works FY20 Cobblers Pegs

Drawn: A. Barker	Date: 08/09/2020	Revision: 01	Figure: 5
Checked: _____	Filename: 20200817-12-2		

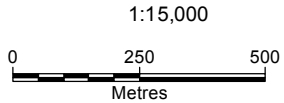
ML1487

AUTH171

ML1655

Cobblers Pegs

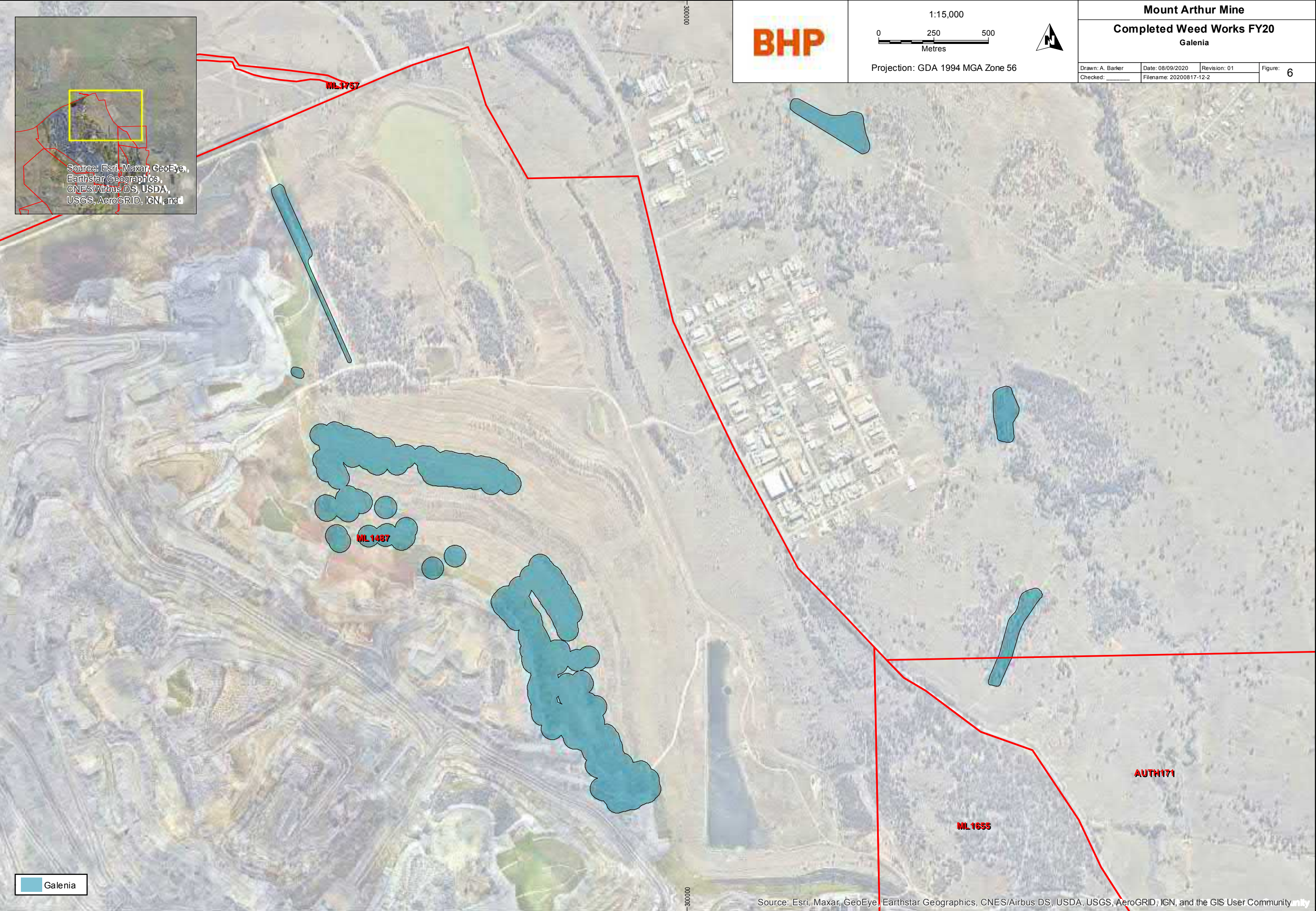
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Projection: GDA 1994 MGA Zone 56



Mount Arthur Mine			
Completed Weed Works FY20			
Galenia			
Drawn: A. Barker	Date: 08/09/2020	Revision: 01	Figure: 6
Checked: _____	Filename: 20200817-12-2		



Galenia

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1:4,000

0160

Metres

Projection: GDA 1994 MGA Zone 56

Mount Arthur Mine

Completed Weed Works FY20

Galenia

Drawn: A. Barker

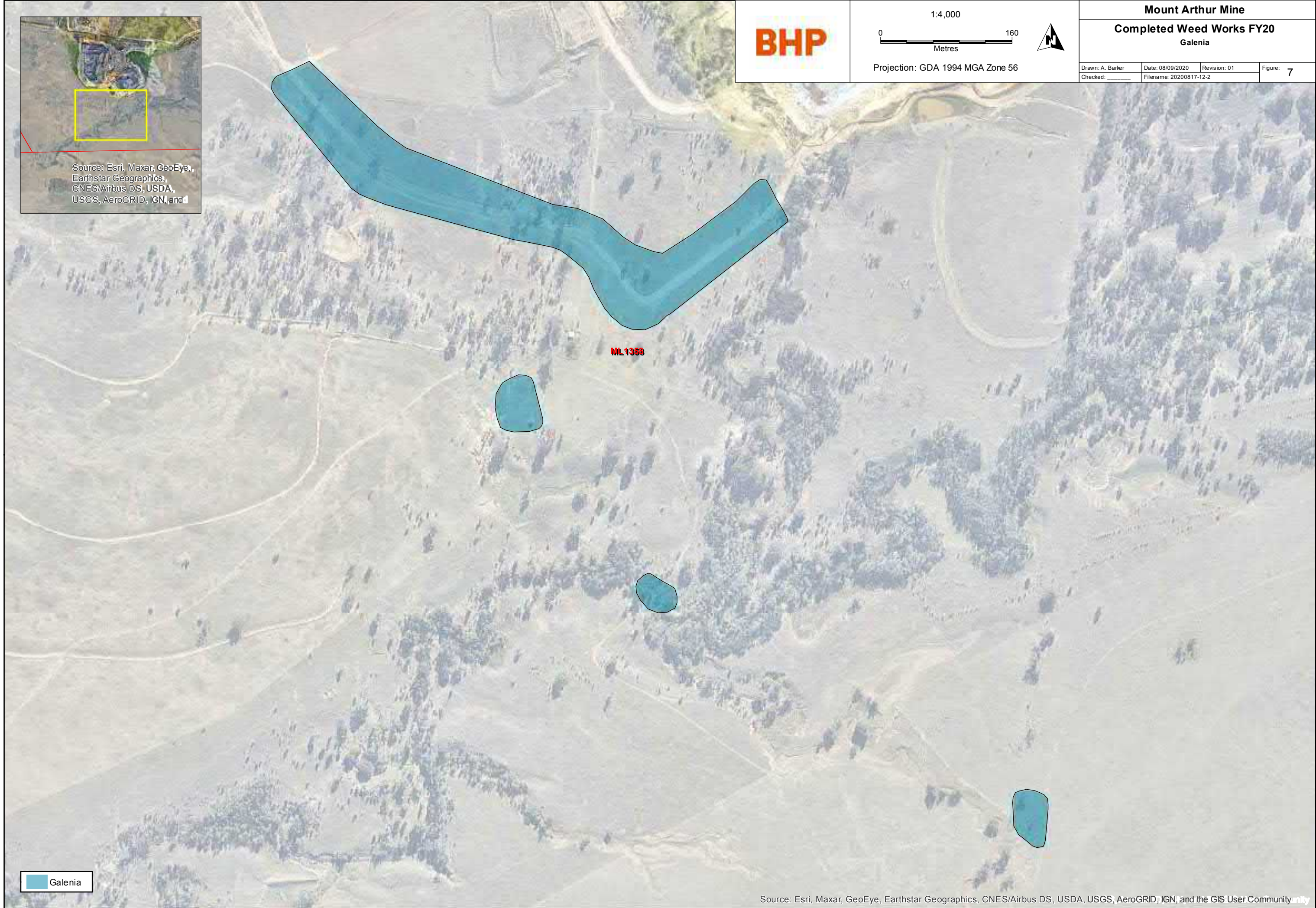
Date: 08/09/2020

Revision: 01

Figure: 7

Checked:

Filename: 20200817-12-2



Galenia

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1:7,000

0250

Metres

Projection: GDA 1994 MGA Zone 56

Mount Arthur Mine

Completed Weed Works FY20

Marshmellow Weed & Mother of Millions

Drawn: A. Barker

Date: 08/09/2020

Revision: 01

Figure: 8

Checked:

Filename: 20200817-12-2

Marshmellow Weed

Source: Esri, Maxar, GeoEye,
Earthstar Geographics,
CNES/Airbus DS, USDA,
USGS, AeroGRID, IGN, and the
GIS User Community

1:23,000

0250500750

Metres

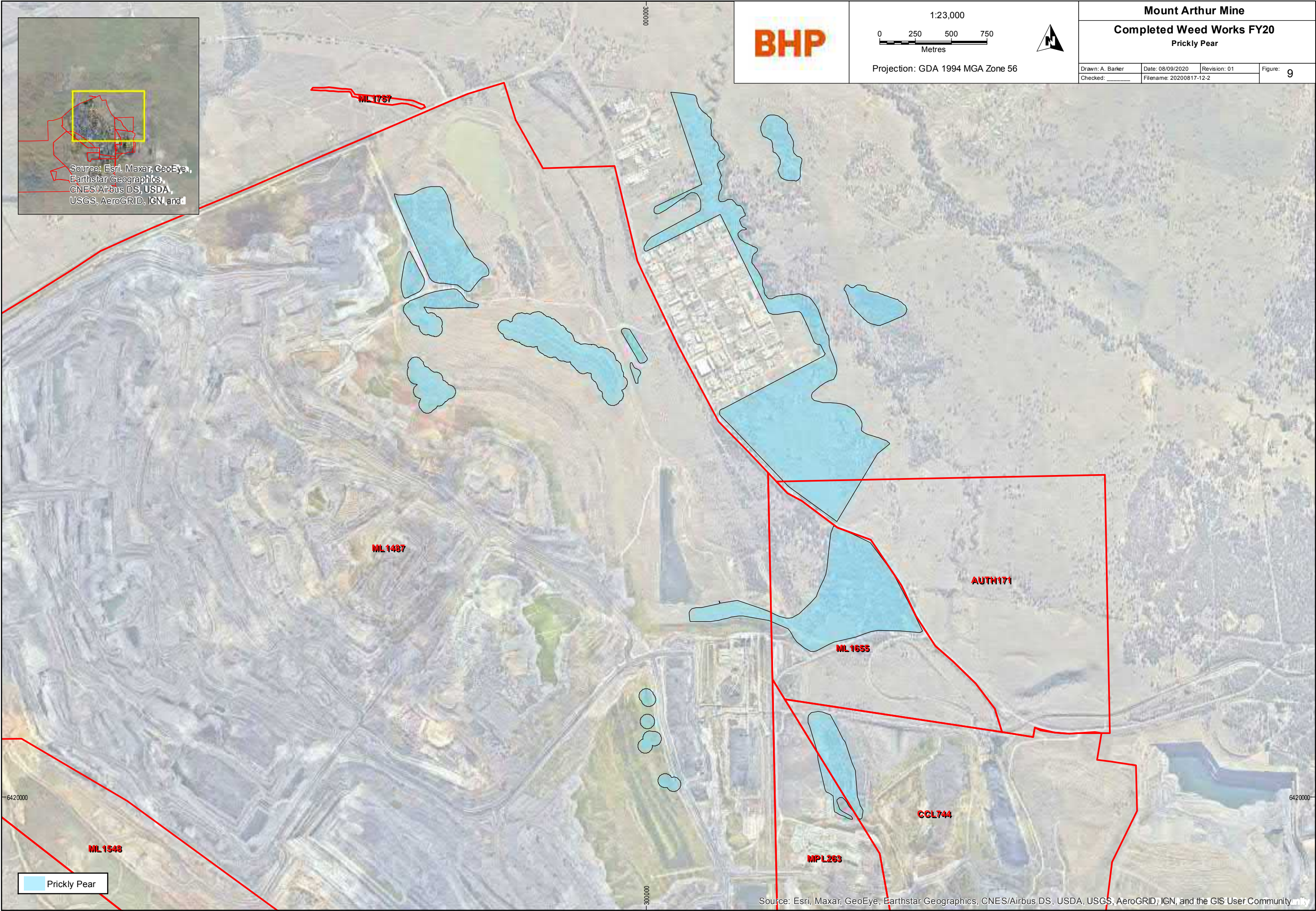
Mount Arthur Mine

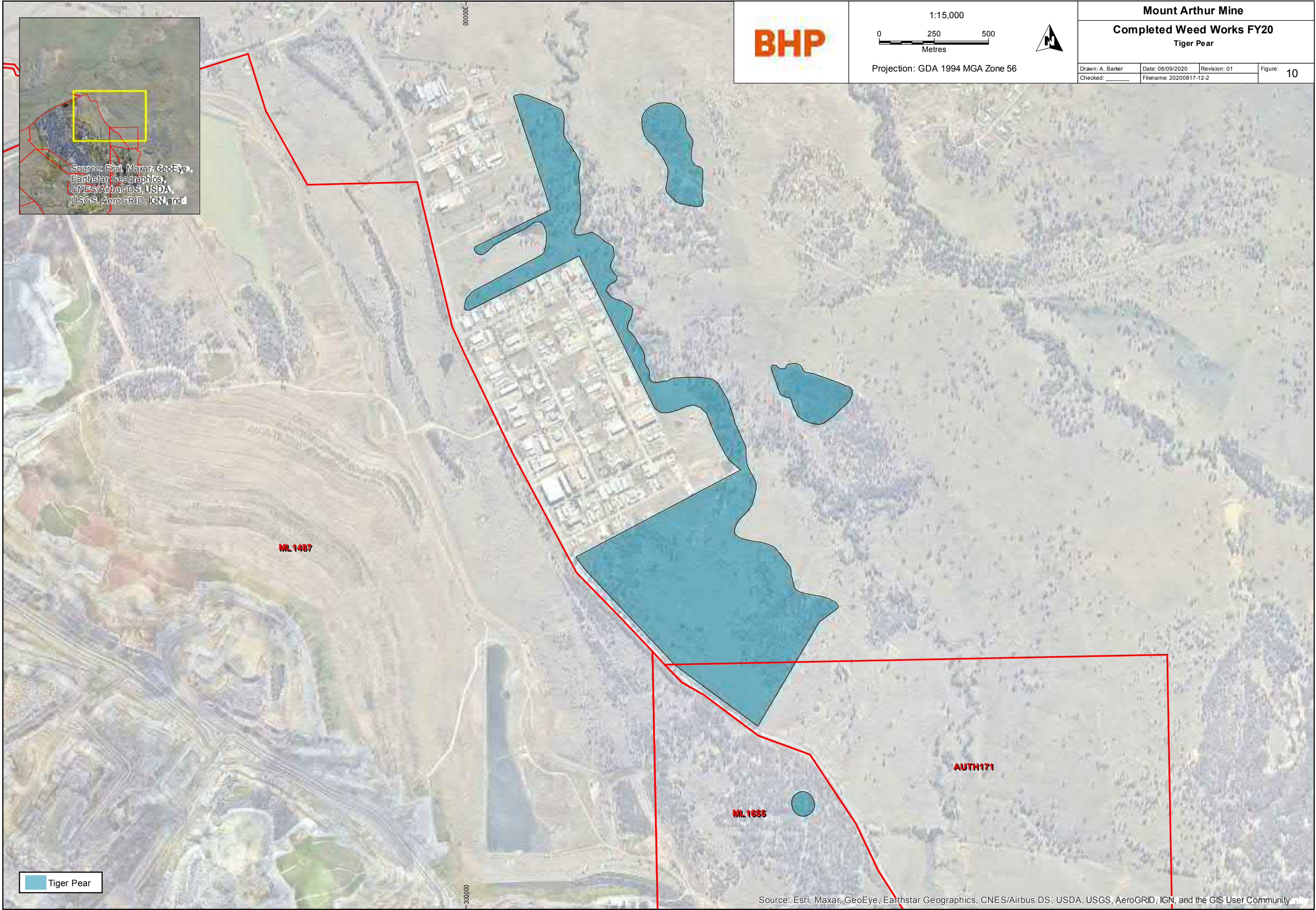
Completed Weed Works FY20

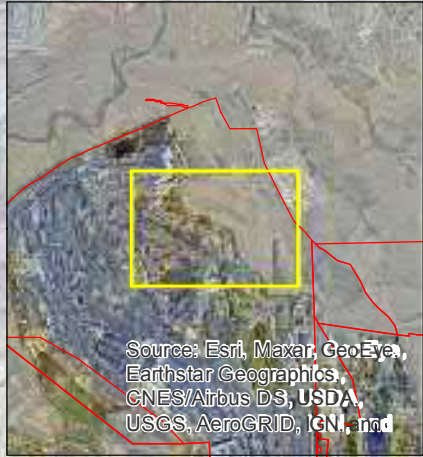
Prickly Pear

Drawn: A. Barker	Date: 08/09/2020	Revision: 01	Figure: 9
Checked: _____	Filename: 20200817-12-2		

Projection: GDA 1994 MGA Zone 56

Prickly Pear





Source: Esri, Maxar, GeoEye,
Earthstar Geographics,
CNES/Airbus DS, USDA,
USGS, AeroGRID, IGN, and the
GIS User Community

BHP

1:8,000

0 250
Metres



Projection: GDA 1994 MGA Zone 56

Mount Arthur Mine

Completed Weed Works FY20

Turnip Weed

Drawn: A. Barker
Checked: _____

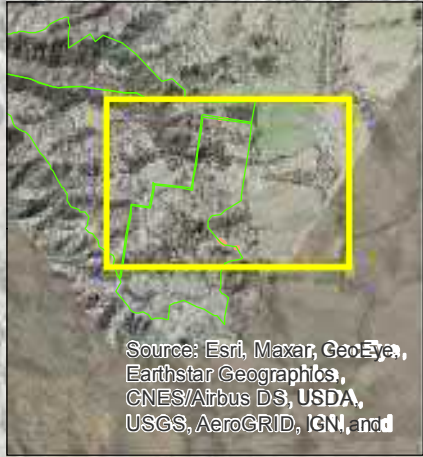
Date: 08/09/2020
Filename: 20200817-12-2

Revision: 01

Figure: 11

ML 1487

Turnip Weed



Source: Esri, Maxar, GeoEye,
Earthstar Geographics,
CNES/Airbus DS, USDA,
USGS, AeroGRID, IGN, and the

Oakvale
Offset Area

Middle Deep
Creek West
Offset Area

Middle Deep
Creek East
Offset Area

Mt Arthur Biodiversity Offset Areas

Weed

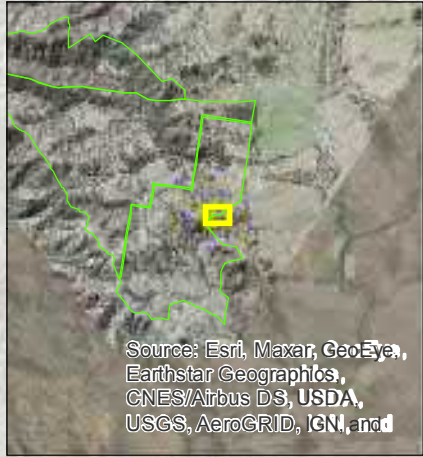
Bathurst Burr



1:10,000
0 1,500 3,000 4,500
Metres
Projection: GDA 1994 MGA Zone 56



MIDDLE DEEP CREEK			
Completed Weed Works Jan - July 2020			
Bathurst Burr			
Drawn: A. Barker	Date: 18/08/2020	Revision: 01	Figure: 15
Checked: _____	Filename: 20200817-12-2		



Source: Esri, Maxar, GeoEye,
Earthstar Geographics,
CNES/Airbus DS, USDA,
USGS, AeroGRID, IGN, and the
GIS User Community



1:1,000
0 1,500 3,000 4,500
Metres



Projection: GDA 1994 MGA Zone 56

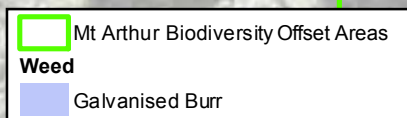
MIDDLE DEEP CREEK

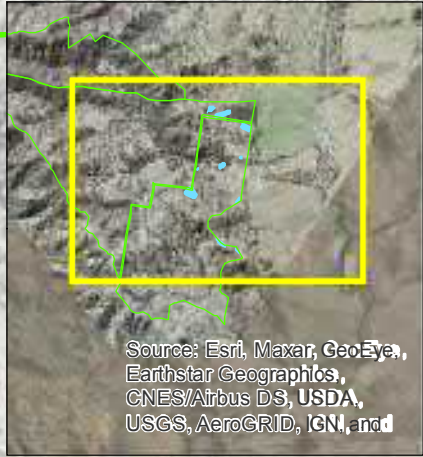
Completed Weed Works Jan - July 2020

Galvanised Burr

Drawn: A. Barker	Date: 18/08/2020	Revision: 01	Figure: 16
Checked: _____	Filename: 20200817-12-2		

Middle Deep
Creek East
Offset Area





Source: Esri, Maxar, GeoEye,
Earthstar Geographics,
CNES/Airbus DS, USDA,
USGS, AeroGRID, IGN, and the
GIS User Community

Oakvale
Offset Area

Middle Deep
Creek West
Offset Area

Middle Deep
Creek East
Offset Area

Mt Arthur Biodiversity Offset Areas

Weed

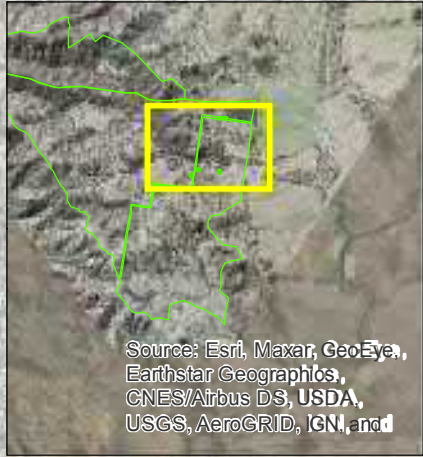
Prickly Pear



1:12,000
0 1,500 3,000 4,500
Metres
Projection: GDA 1994 MGA Zone 56



MIDDLE DEEP CREEK			
Completed Weed Works Jan - July 2020			
Prickly Pear			
Drawn: A. Barker	Date: 18/08/2020	Revision: 01	Figure: 17
Checked: _____	Filename: 20200817-12-2		



Source: Esri, Maxar, GeoEye,
Earthstar Geographics,
CNES/Airbus DS, USDA,
USGS, AeroGRID, IGN, and the



1:5,000
0 1,500 3,000 4,500
Metres

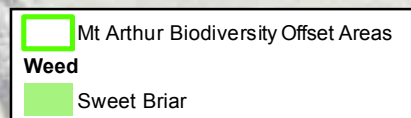


Projection: GDA 1994 MGA Zone 56

MIDDLE DEEP CREEK			
Completed Weed Works Jan - July 2020			
Sweet Briar			
Drawn: A. Barker	Date: 18/08/2020	Revision: 01	Figure: 18
Checked:	Filename: 20200817-12-2		

Middle Deep
Creek West
Offset Area

Middle Deep
Creek East
Offset Area



Offset Area



Mt Arthur Coal, 2020 Weed Management Summary

Weed Monitoring: Trends over time

Weed focus

The top weeds present in 2019 were:

- o Prickly Pear
- o Galenia
- o African Boxthorn
- o Blue Heliotrope
- o African Turnip Weed
- o Cotton Bush

Note: Blue Heliotrope was previously detected in 2019 but had not been identified. With new analysis, the 2019 data was re-analysed and is compared with the 2020 analytics.

Monitoring metrics

The metrics monitored include weed load which can be compared year on year for overall trends. Where possible, weed treatment, weed removal, and weed spread are also displayed to give the scenario breakdowns in the 5 year forecast. The density (count / Ha) and coverage metrics (% coverage) can be compared between sites independent of area analysed.

Data Capture

Data was captured on site in May 2020.

Confidentiality

The Client agrees to hold the Confidential Information in confidence, and to only use and disclose it: for the purpose of the intended corporate use; as permitted by the Supplier; or as required by applicable Laws.





Weed management: Prickly Pear (*Opuntia stricta*)

4



2019
Before



Prickly Pear (transect 3)



2020
After



Prickly Pear Removed (transect 3)

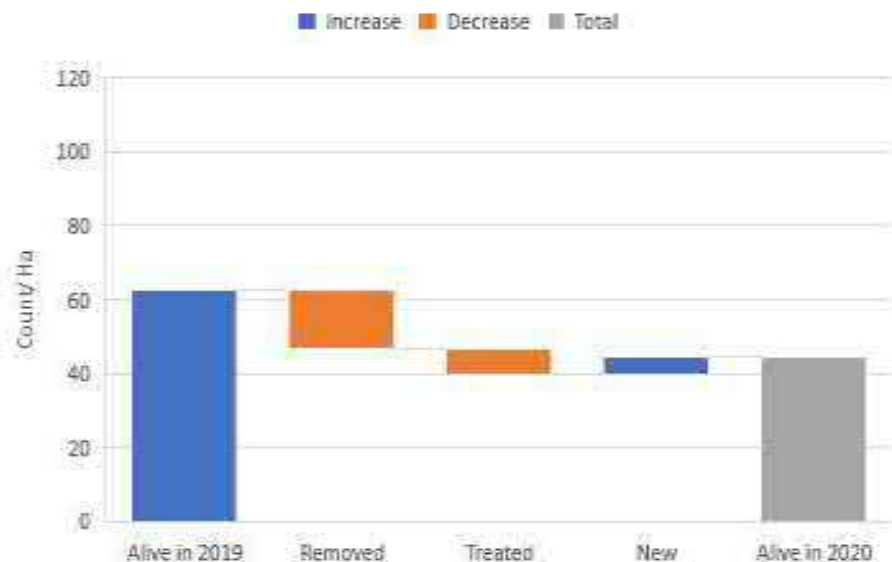
Note: Full area shown here for 2019, however only the 10 Ha transect was used in the data comparison



Weed management: Prickly Pear (*Opuntia stricta*)

5

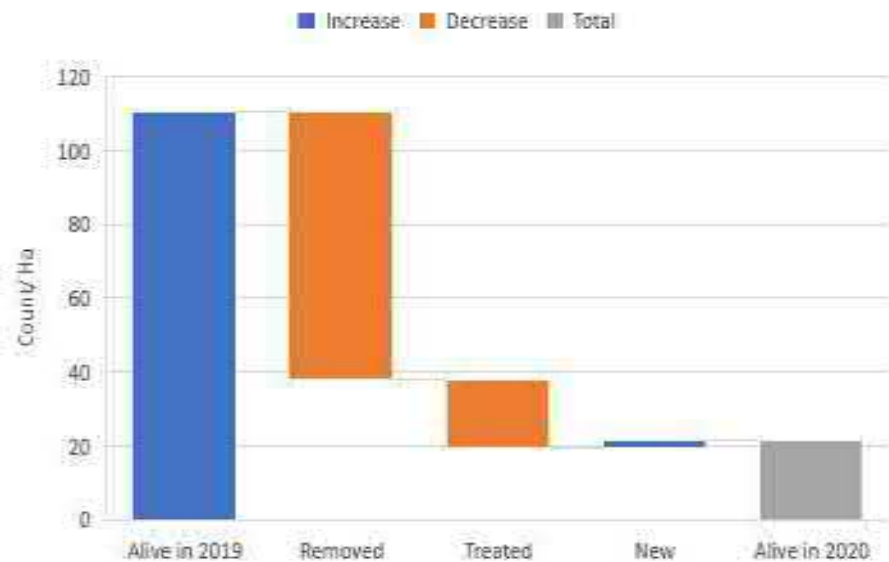
Prickly Pear Transect 2 Change/ Ha



Transect 2: 29% Prickly Pear Density Reduction

Note: 10 Ha analysed and compared per transect

Prickly Pear Transect 3 Change/ Ha



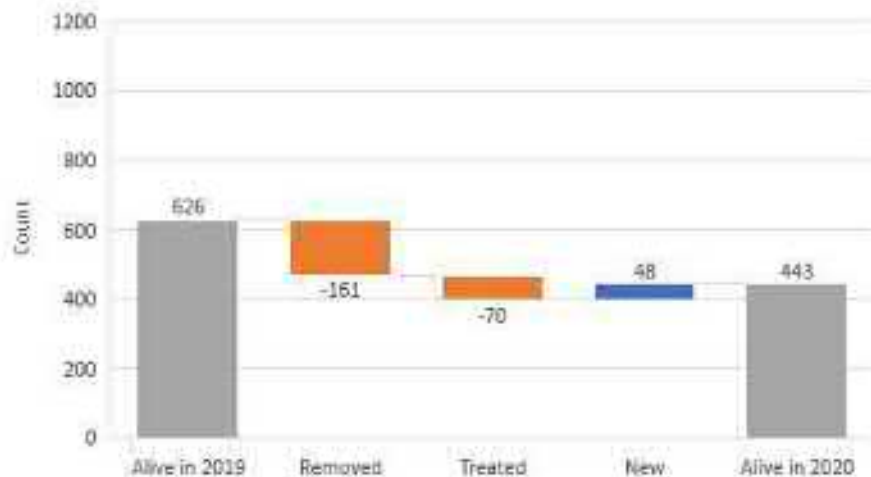
Transect 3: 81% Prickly Pear Density Reduction



Weed management: Prickly Pear (*Opuntia stricta*)

Prickly Pear Transect 2 Change

■ Increase ■ Decrease ■ Total

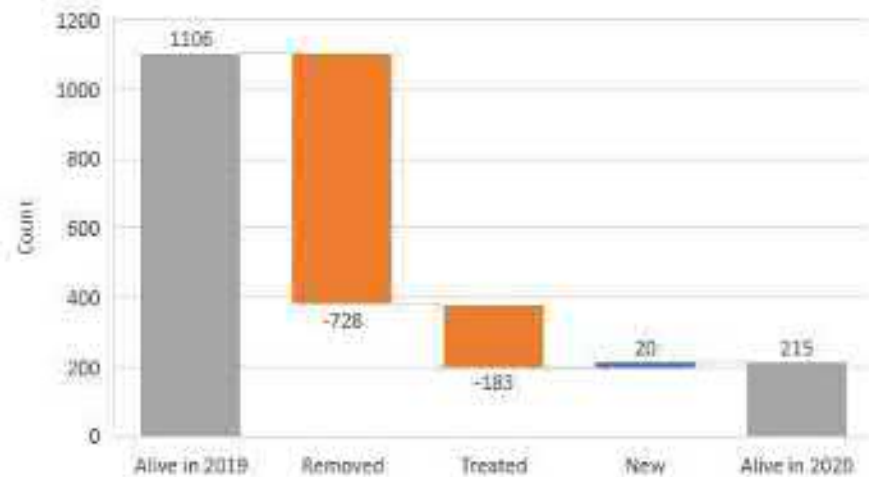


Transect 2: 29% Prickly Pear Load Reduction

Note: 10 Ha analysed and compared per transect

Prickly Pear Transect 3 Change

■ Increase ■ Decrease ■ Total



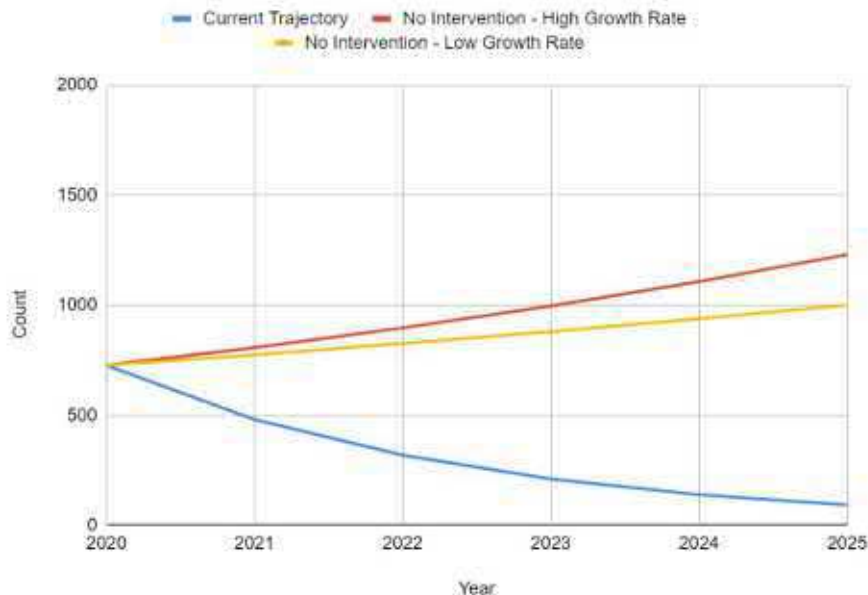
Transect 3: 81% Prickly Pear Load Reduction



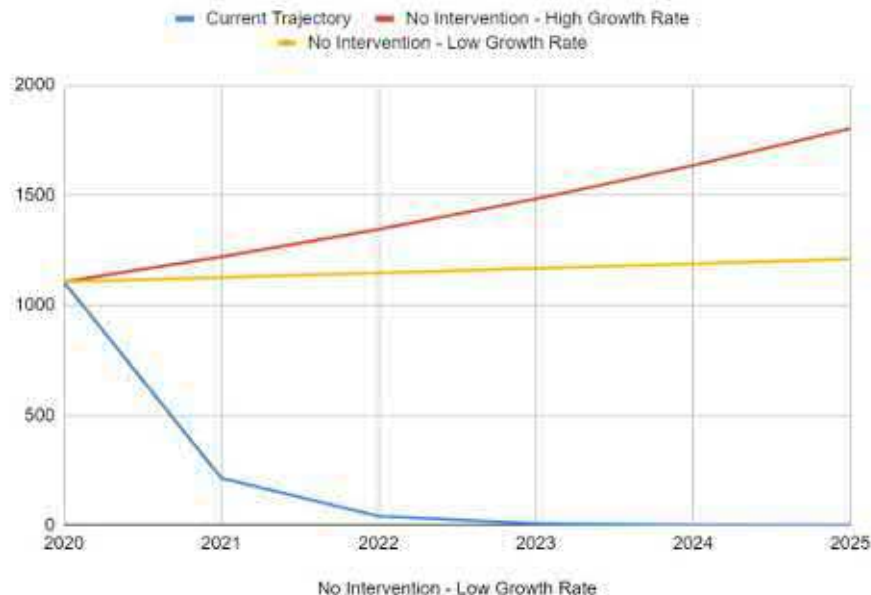
Weed Forecast: Prickly Pear (*Opuntia stricta*)

7

Prickly Pear Transect 2 Forecast: Count vs Year



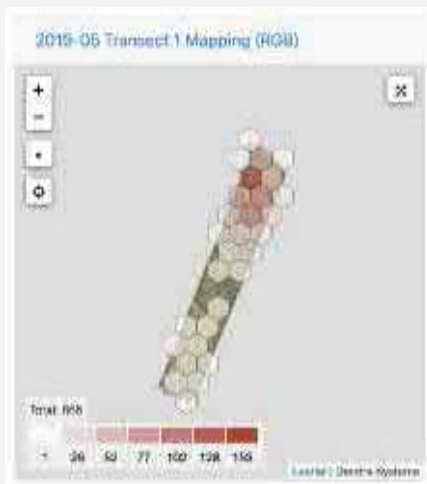
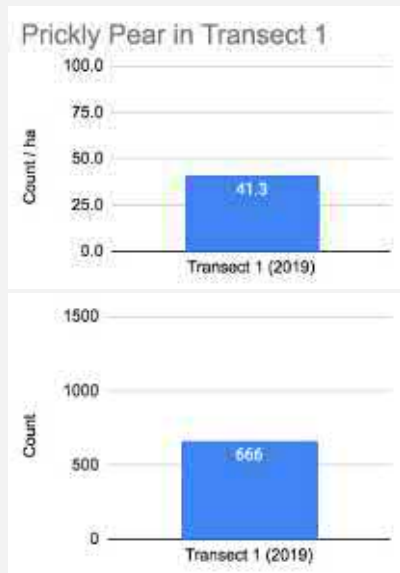
Prickly Pear Transect 3 Forecast: Count vs Year



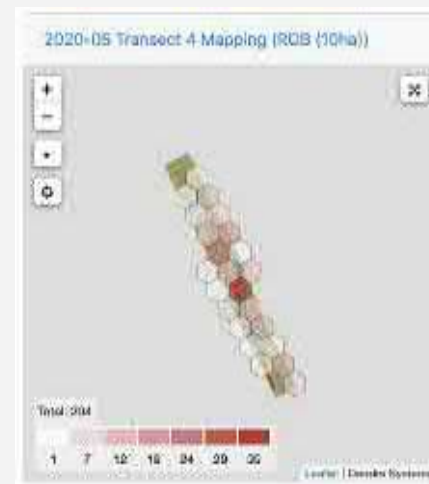
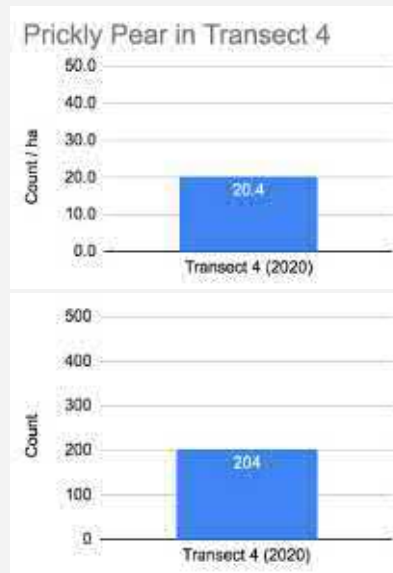
Weed management: Prickly Pear (*Opuntia stricta*)

Additional transects analysed

8



Note: 16.13 Ha analysed in Transect 1, 2019



Note: 10 Ha analysed in Transect 4, 2020



Weed management: African Boxthorn (*Lycium ferocissimum*)

9



2019



African boxthorn (transect 3)



2020



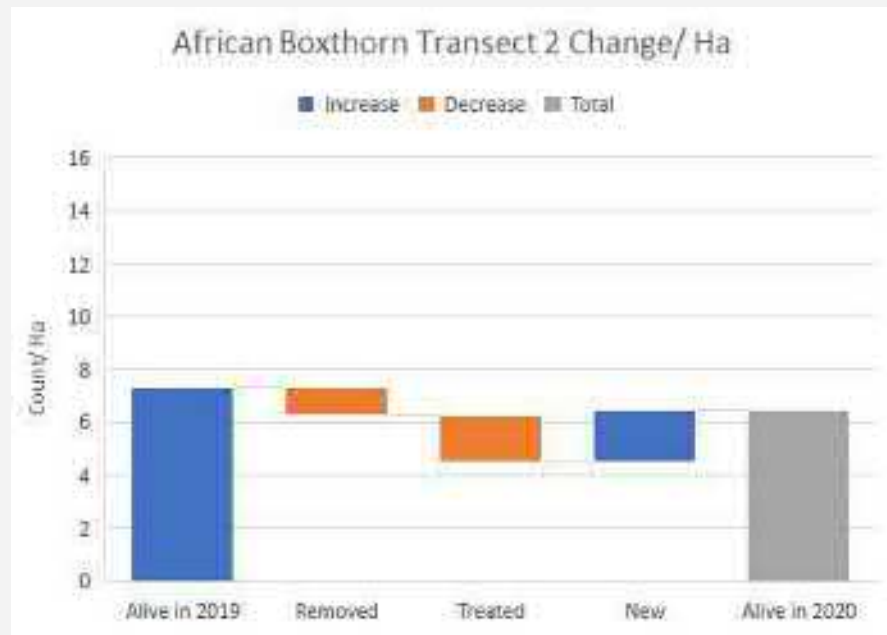
Treated African boxthorn (transect 3)

Note: Full area shown here for 2019, however only the 10 Ha transect was used in the data comparison



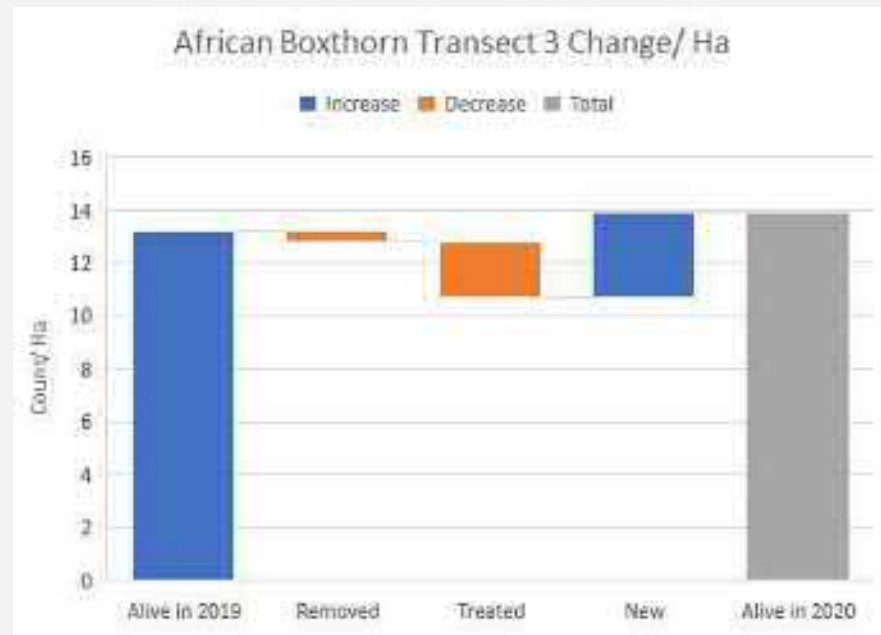
Weed management: African Boxthorn

(*Lycium ferocissimum*)



Transect 2: 11% African Boxthorn Load Reduction

Note: 10 Ha analysed and compared per transect



Transect 3: +5% African Boxthorn Load Growth



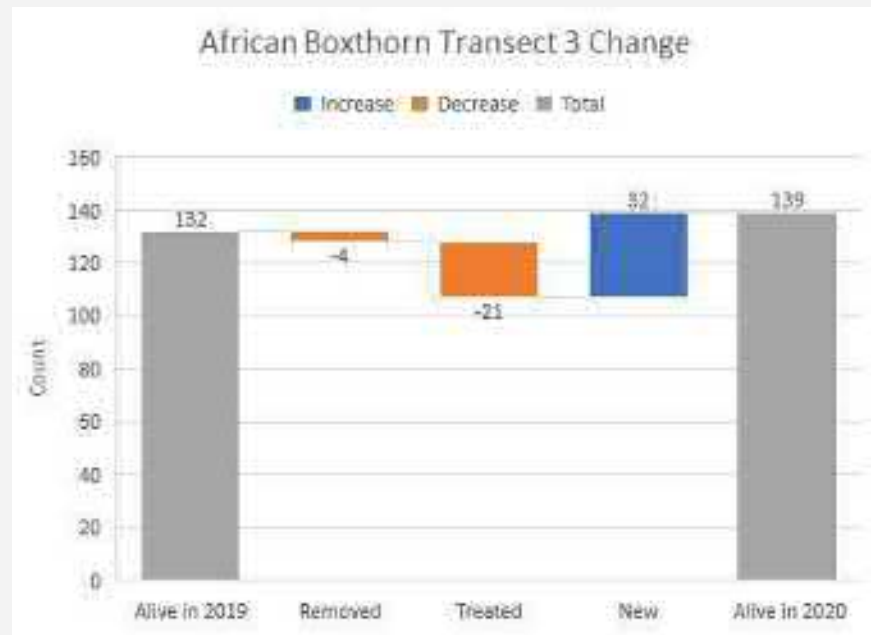
Weed management: African Boxthorn

(*Lycium ferocissimum*)



Transect 2: 11% African Boxthorn Load Reduction

Note: 10 Ha analysed and compared per transect



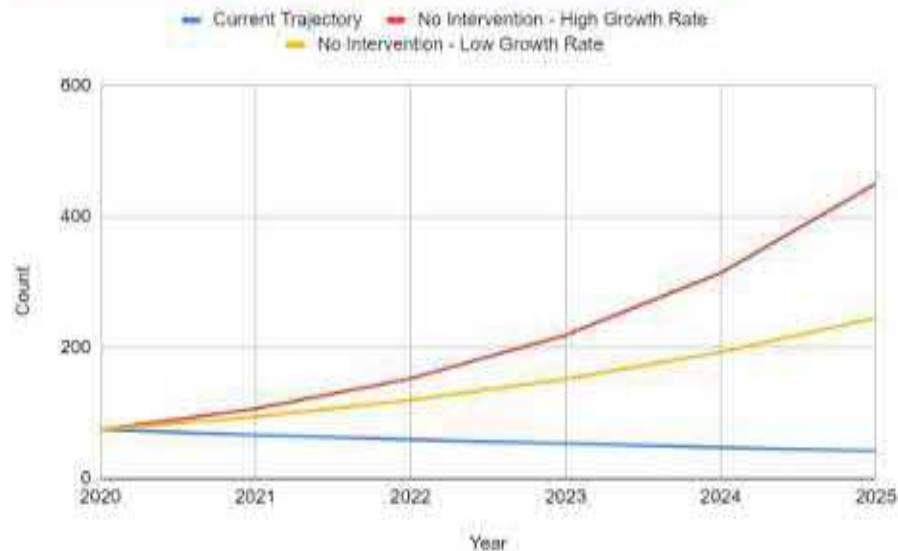
Transect 3: +5% African Boxthorn Load Growth



Weed Forecast: African Boxthorn (*Lycium ferocissimum*)

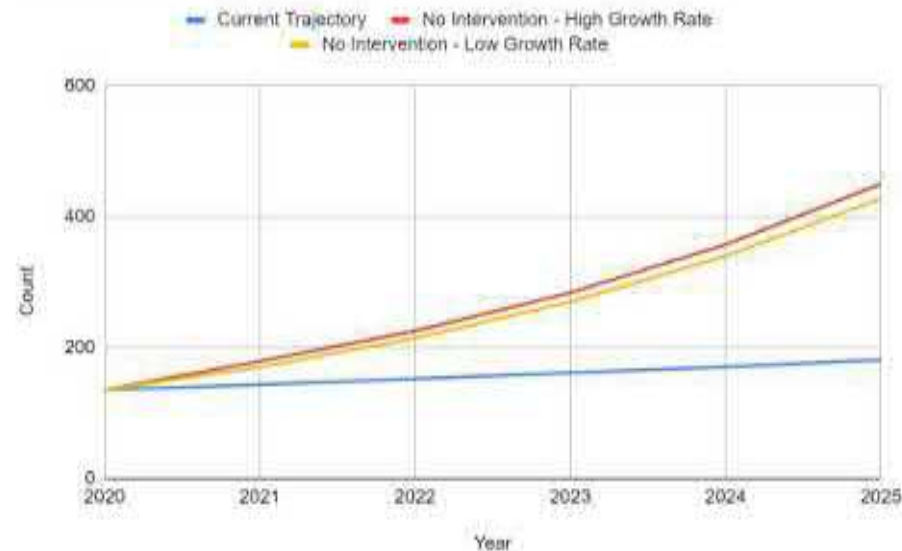
12

African Boxthorn Transect 2 Forecast: Count vs Year



Transect 2: 11% African Boxthorn Load Reduction

African Boxthorn Transect 3 Forecast Count vs Year



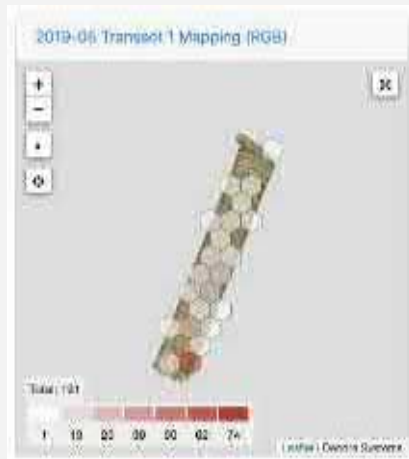
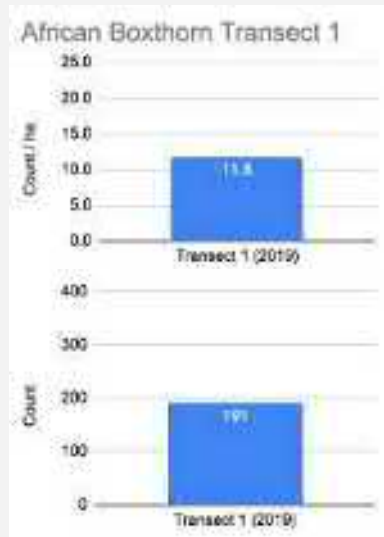
Transect 3: +5% African Boxthorn Load Growth



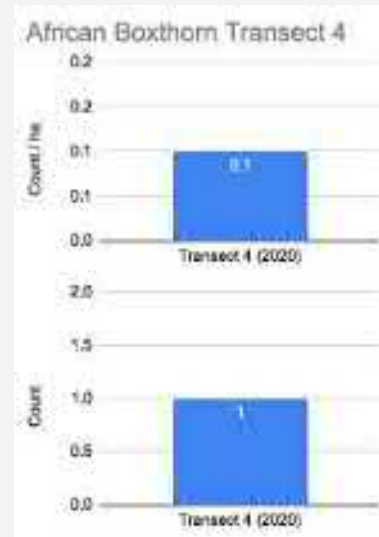
Weed management: African Boxthorn

(*Lycium ferocissimum*) Additional transects analysed

13



Note: 16.13 Ha analysed in Transect 1, 2019



Note: 10 Ha analysed in Transect 4, 2020



Weed management: Galenia (*Galenia pubescens*)

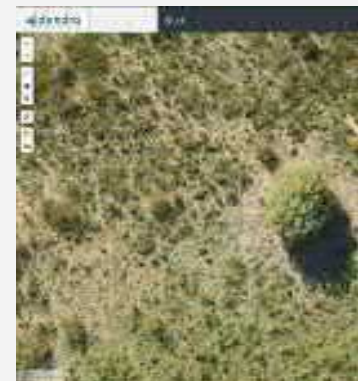
14



2019



Galenia in view (transect 2)



No Galenia in view (transect 3)



2020

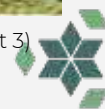


No Galenia in view (transect 2)



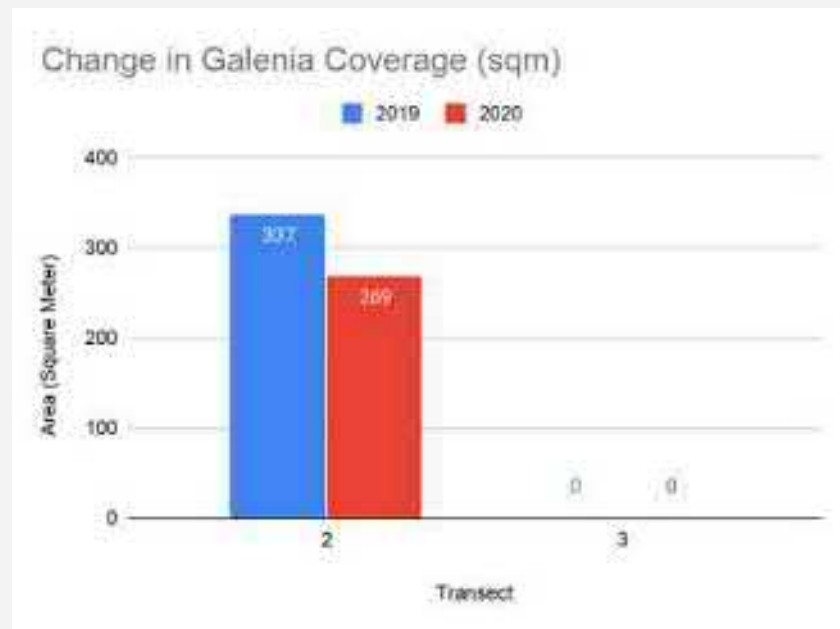
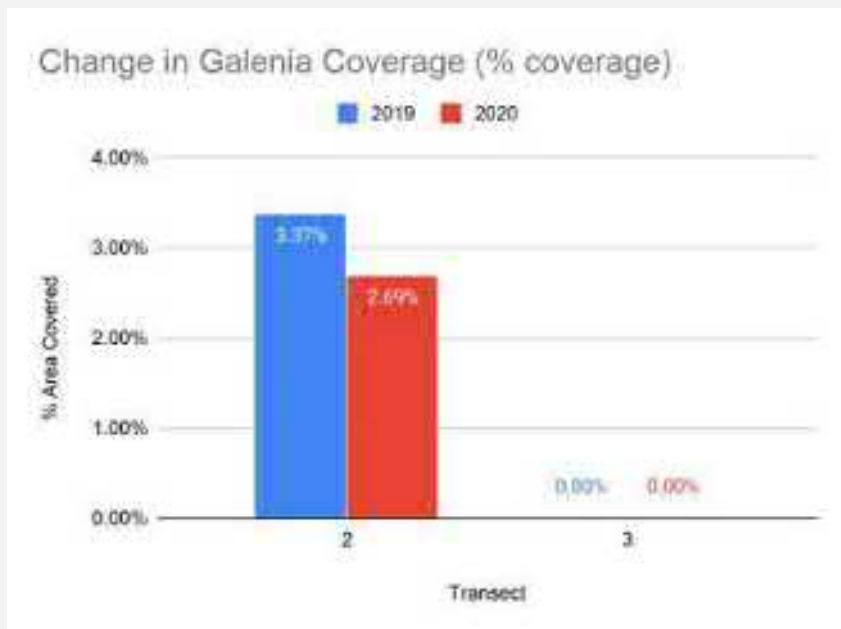
No Galenia in view (transect 3)

Note: Full area shown here for 2019, however only the 10 Ha transect was used in the data comparison



Weed management: Galenia (*Galenia pubescens*)

15



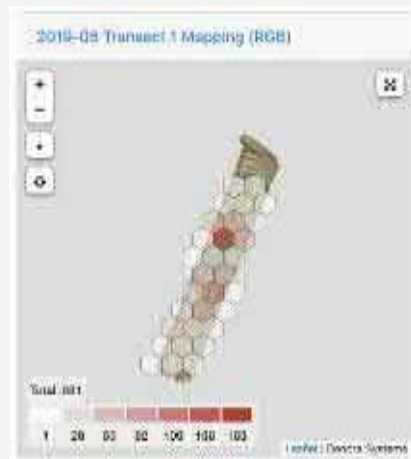
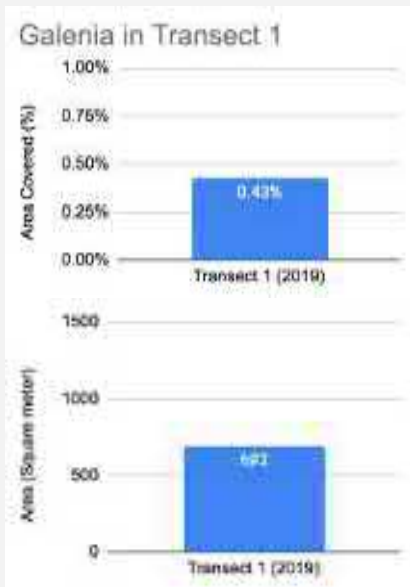
Note: 10 Ha analysed and compared per transect



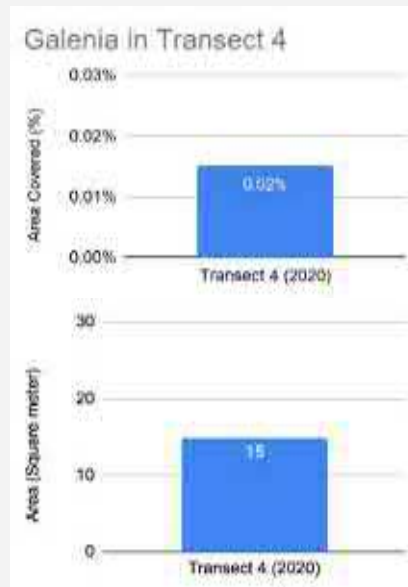
Weed management: Galenia (*Galenia pubescens*)

Additional transects analysed

16



Note: 16.13 Ha analysed in Transect 1, 2019



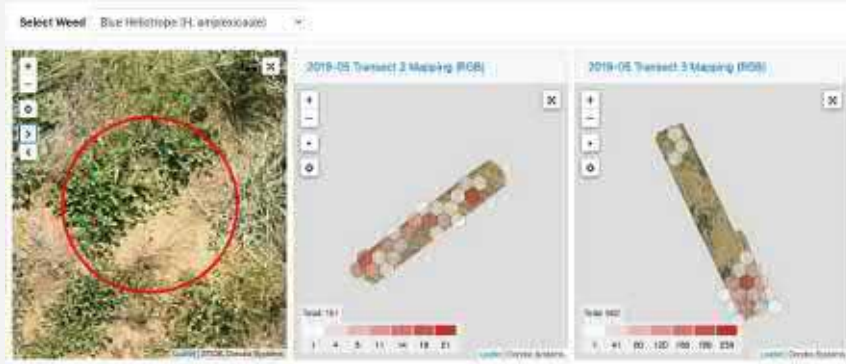
Note: 10 Ha analysed in Transect 4, 2020



Weed Management: Blue heliotrope

(*Heliotropium amplexicaule*)

17



2019



Blue Heliotrope in view (transect 2)



No Blue Heliotrope in view (transect 3)



2020



Blue Heliotrope expansion (transect 2)



Blue Heliotrope in view (transect 3)

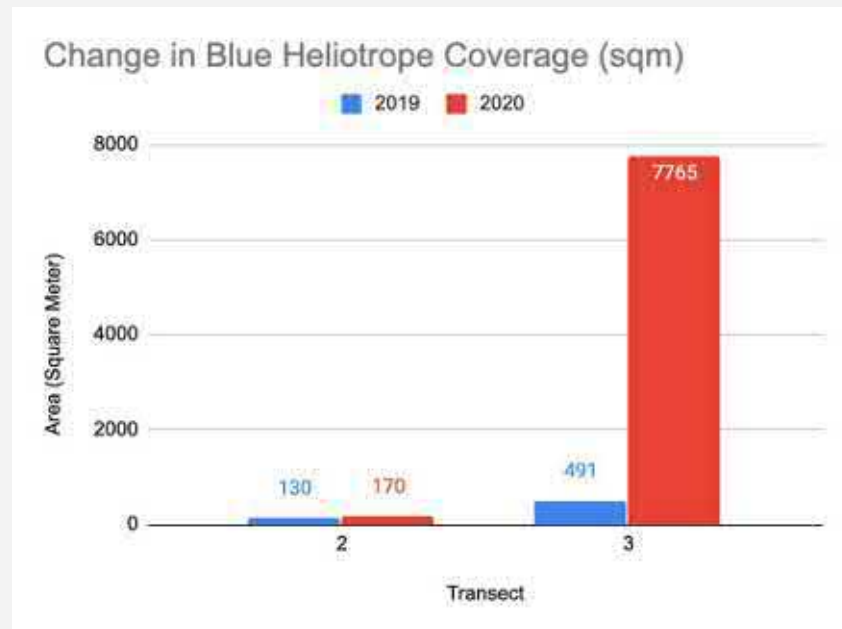
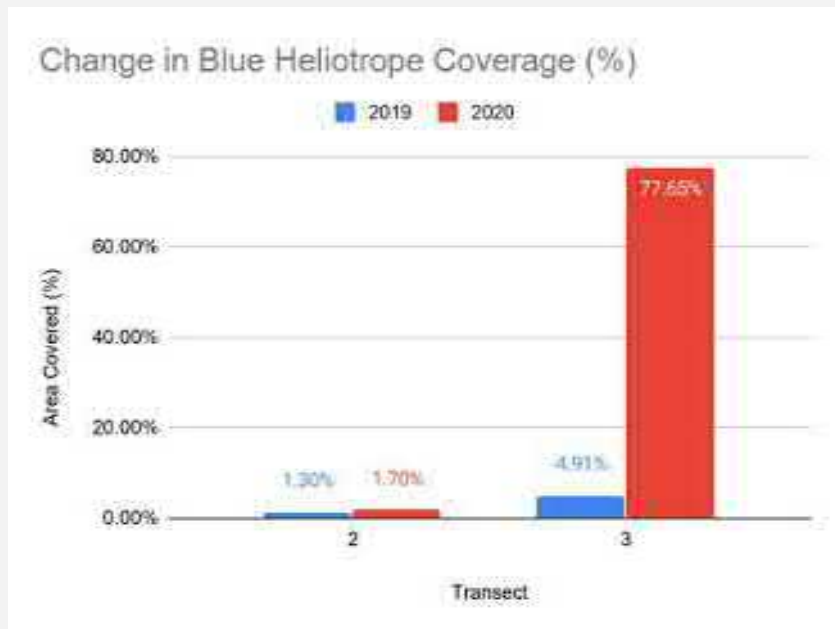
Note: Full area shown here for 2019, however only the 10 Ha transect was used in the data comparison

Dendra Systems Ltd. ABN: 31616659039



Weed Management: Blue heliotrope (*Heliotropium amplexicaule*)

18

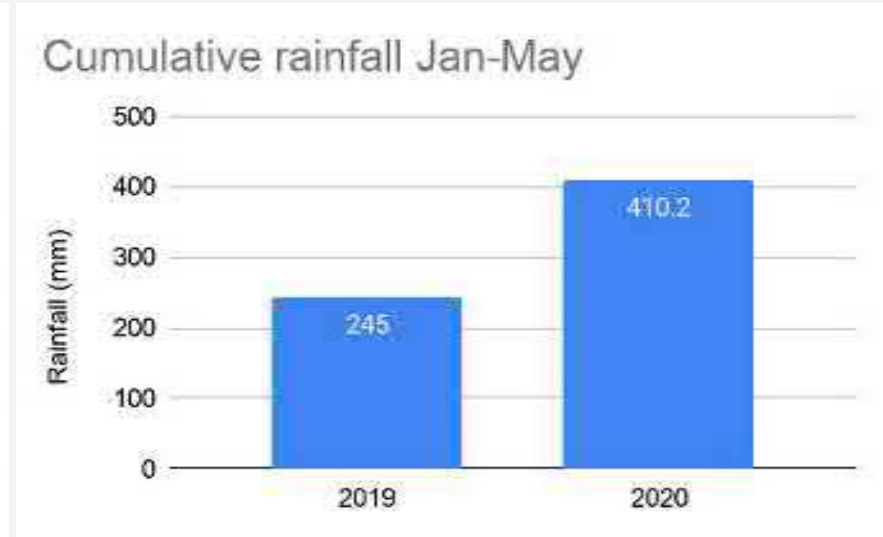
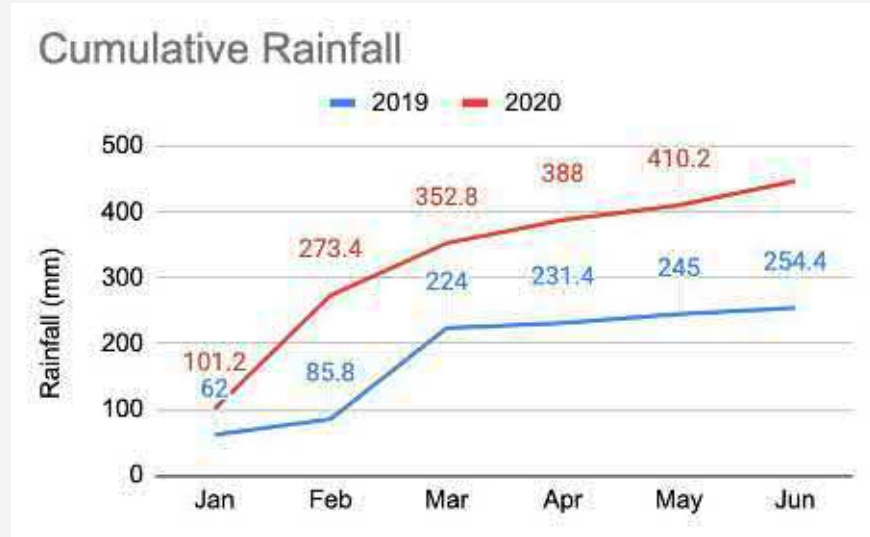


Note: 10 Ha analysed and compared per transect



Weed Conditions: Response to rainfall

Blue heliotrope (*Heliotropium amplexicaule*)



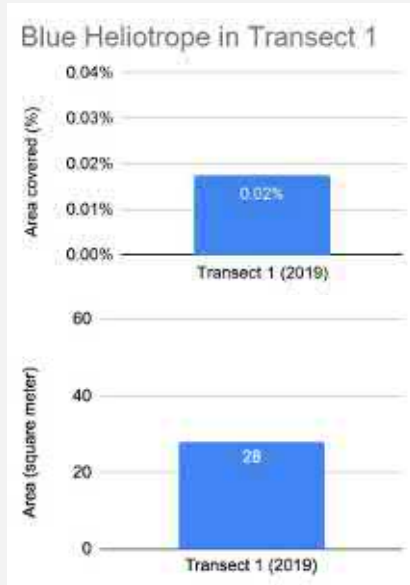
Monthly rainfall Singleton Defence AWS

Source: Bureau of Meteorology, Australian Government

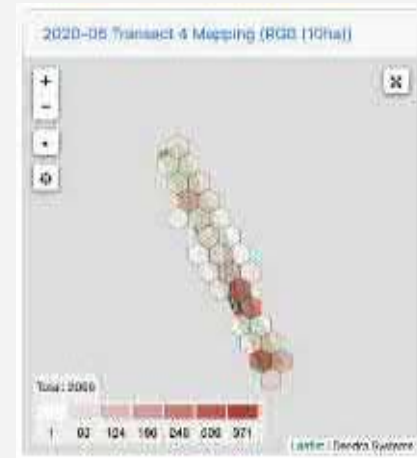
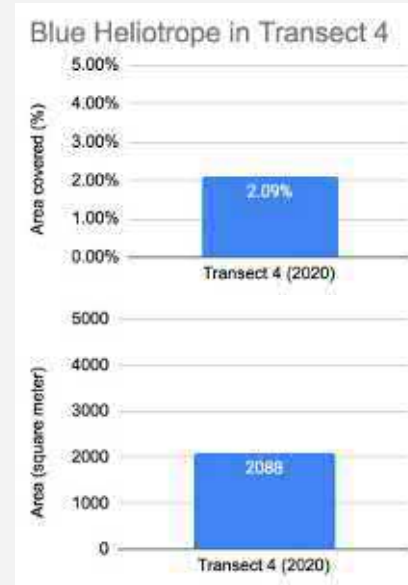


Weed Management: Blue heliotrope (*Heliotropium amplexicaule*) Additional transects analysed

20



Note: 16.13 Ha analysed in Transect 1, 2019



Note: 10 Ha analysed in Transect 4, 2020



Weed management: African Turnip Weed

(*Sisymbrium thellungii*)



2019



No African Turnip Weed in view (transect 3)



2020



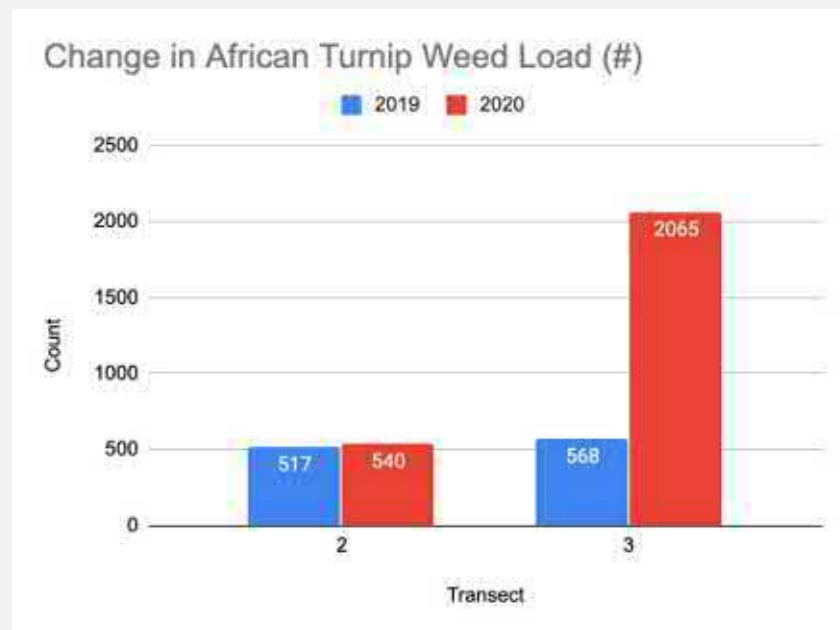
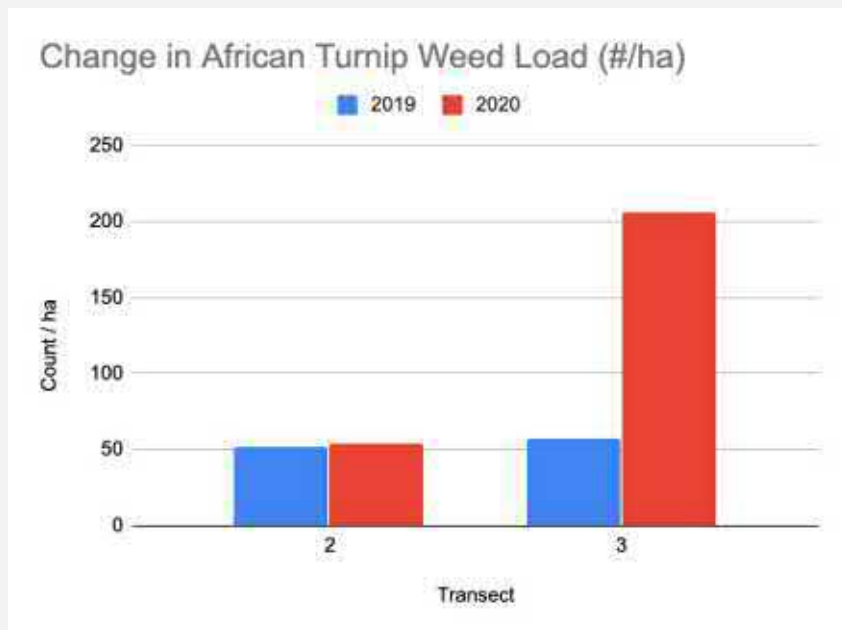
African Turnip Weed, flowering, in view (transect 3)

Note: Full area shown here for 2019, however only the 10 Ha transect was used in the data comparison



Weed Forecast: African Turnip Weed (*Sisymbrium thellungii*)

22

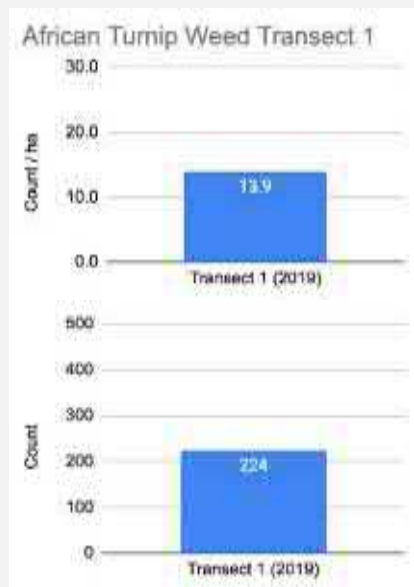


Note: 10 Ha analysed and compared per transect

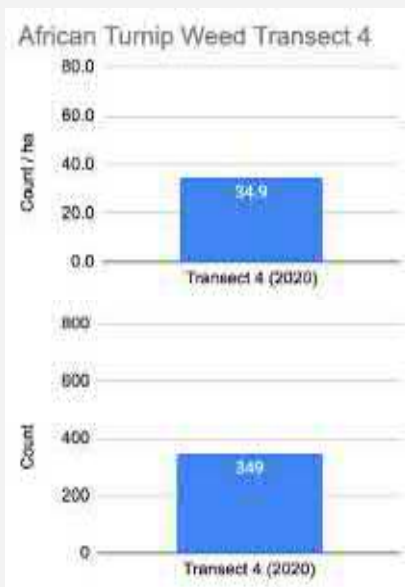


Weed management: African Turnip Weed

(*Sisymbrium thellungii*) Additional transects analysed



Note: 16.13 Ha analysed in Transect 1, 2019



Note: 10 Ha analysed in Transect 4, 2020



Weed management: Cotton Bush (*Gomphocarpus* sp.)

24



2019



Cotton Bush in view (transect 2)



No Cotton Bush in view (transect 3)



2020



Cotton Bush in view (transect 2)



Cotton Bush in view (transect 3)

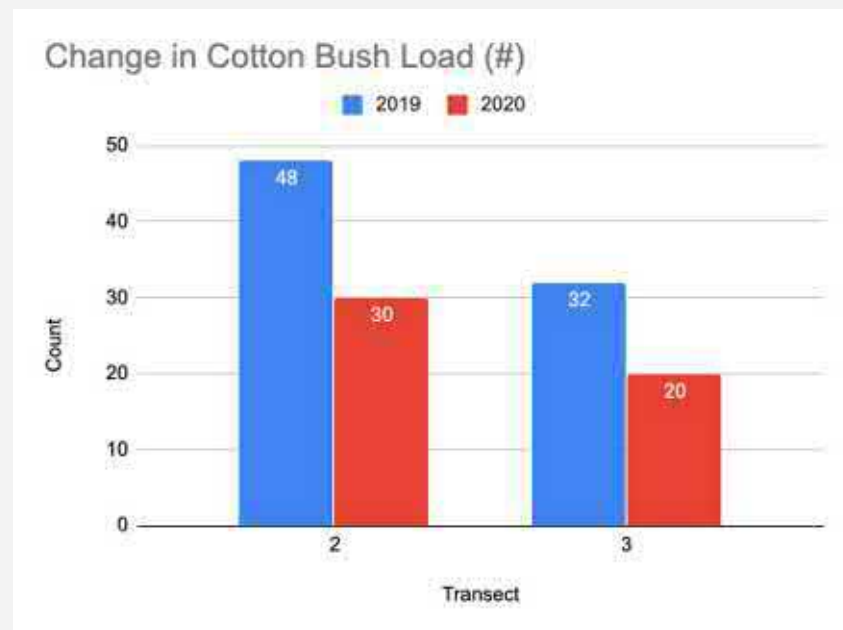
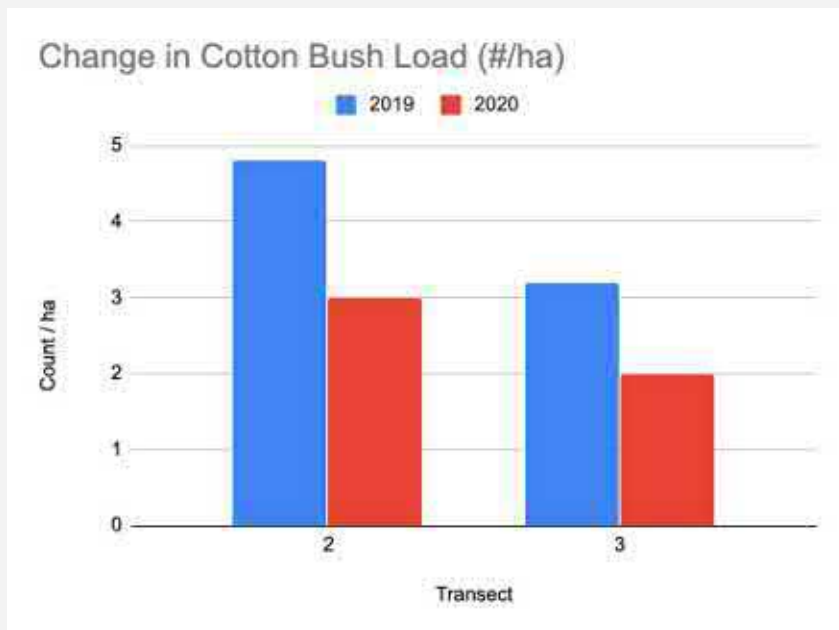
Note: Full area shown here for 2019, however only the 10 Ha transect was used in the data comparison



Weed Management: Cotton Bush

(*Gomphocarpus* sp.)

25

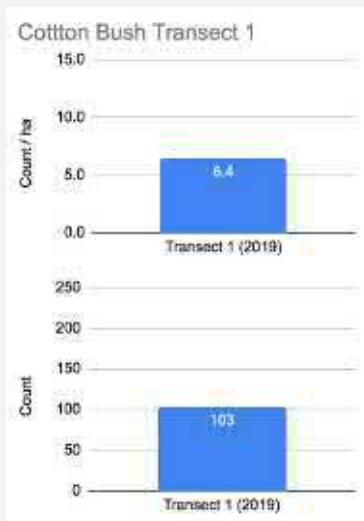


Note: 10 Ha analysed and compared per transect

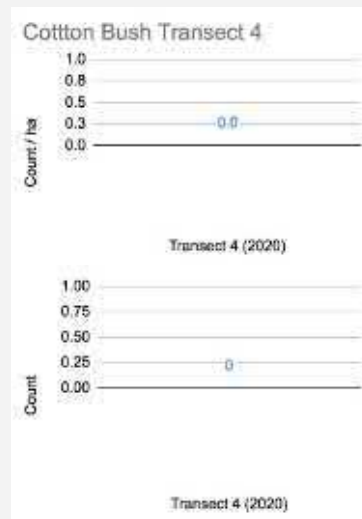


Weed management: Cotton Bush (*Gomphocarpus* sp.) ²⁶

Additional transects analysed



Note: 16.13 Ha analysed in Transect 1, 2019



Note: 10 Ha analysed in Transect 4, 2020



Ground Truth Photographs



Prickly pear
Field ground truth
Photo May 2020



African boxthorn
Field ground truth
Photo May 2020



Galenia
Field ground truth
Photo May 2020



African Turnip Weed
Field ground truth
Photo May 2020



Blue Heliotrope
Field ground truth.
Photo May 2020



Cotton Bush
Field ground truth.
Photo May 2020

Weed Metrics: Data driven decision making

Budget and forecast

- Budget development and justification to match actual and required on-the-ground conditions

Weed load

- Measures number of weeds in the area and gives an indication of the size of the weed load that needs to be managed.
- Uses: Budget setting

Weed removal and treatment

- Measures the number of weeds which were present in the previous year which no longer exist (removal) or are treated or presumed dead (treatment)
- Uses: Contractor coverage assessment; Spray efficacy; calculate ROI

Weed spread

- Measures new weeds which were not present previously
- Uses: Understanding weed load forecast and can be used to project time required to reach completion criteria , resource allocation and budget setting

Weed persistence

- Indicates possible resistance to herbicide or insufficient dosing, or non-treated areas.
- Uses: herbicide selection, weed spraying contractor management.

Planning and Management

- Driving a targeted intervention to realise improved on-the-ground outcomes and cost savings
- Integrating into site-wide weed management



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Contact us

mining@dendra.io

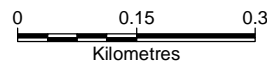
Unit 2, 5 John Street
Singleton, NSW, 2330

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Mapping Services, Brisbane

1:9,560



Projection: GDA94 MGA Zone 56




MT ARTHUR MINE

Aerial Weed Assessment Transects

Drawn: DEACJ	Date: 28/08/2020	Revision: 0	Figure: 1
Checked:	Filename: MAC_BIODIVERSITY		



Legend

-  Transect 2 (VD1)
-  Transect 3 (Operational Area)
-  Transect 4 (Thomas Mitchel Drive Onsite Offset)