



Ashton Coal  
2017 Annual Review



**Table 1 Title Block**

Name of Operation	Ashton Coal
Name of Operator	Ashton Coal Operations Limited
Development consent number	DA No. 309-11-2001-i
Name of holder of development consent	Ashton Coal Operations Pty Limited
Mining Lease number	ML 1529 ML 1533 ML 1623
Name of holder of mining lease	ML 1529 -Ashton Coal Mines Limited,  ML 1533 - White Mining Limited (ACN 009713893), White Mining (NSW) Limited (ABN 19 089 414 595), ICRA Ashton Pty Ltd ACN 097 499 780,  ML 1623 - White Mining (NSW) Limited (ACN 089 414 595) Austral-Asia Coal Holdings Pty Ltd (ACN 110 038 663) and ICRA Ashton Pty Ltd (ACN 097 499 780) *
Water Licence Number	See Section 7
Name of holder of water licence	Ashton Coal Mines Limited
MOP / RMP start date	28 March 2013
MOP / RMP end date	30 June 2018
Annual Review Start date	1 January 2017
Annual review end date	31 December 2017
<p>I, Aaron McGuigan, certify that this Annual Review is a true and accurate record of the compliance status of Ashton Coal for the period 1 January 2017 to 31 December 2017 and that I am authorised to make this statement on behalf of Ashton Coal Operations Limited.</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	Aaron McGuigan
Title of authorised reporting officer	Operations Manager
Signature of authorised reporting officer	
Date	28-03-18

\*As of 31 December 2017, the Leaseholder names are correct. During 2014 Ashton Coal underwent some ownership changes. Applications have been submitted to DRE for title changes but have not been processed.

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## 1 Statement of Compliance

The Annual Review is required to incorporate a statement of compliance which includes a summary table that highlights the compliance status of the operation with its relevant approval conditions, as at the end of the reporting period (Table 2).

**Table 2 Statement of Compliance as at 31 December 2017**

Were all conditions of the relevant approvals complied with?	
Development Consent 309-11-2001-i	No
ML 1529	yes
ML 1533	yes
ML 1623	yes

**Table 3 Non Compliances**

Relevant Approval	Condition Number	Condition Summary	Compliance Status	Comment	Where addressed in Annual Review
DA 309-1-2001-i	Schedule 5 13(a)	Maintain a register of complaints on the website, updated monthly	Non-compliant (administrative)	The complaints register was not available on the internet. There had been no complaints. This was rectified on the 13 February.	Section 10.3
DA 309-1-2001-i	Schedule 5 1(f)	Maintenance of the Community Response Line required by the Environmental Management Strategy	Non-compliant (administrative)	The community response line was found inoperable by a member of the community. This was rectified within 24 hours of notification.	Section 10.3

## 2 Introduction

The Ashton Coal Project (ACP) is located approximately 14 kilometres north-west of Singleton in the Upper Hunter Valley, New South Wales (NSW). The ACP is adjacent to the Open-Cut mines of Glendell (Glencore), Rixs Creek and Rixs Creek North (Bloomfield Group), Hunter Valley Operations (Rio Tinto) and Ravensworth Operations (Glencore). Adjacent Underground mines include Glennies Creek and Ravensworth Underground Mine (Glencore).

The ACP is operated by Ashton Coal Operations Limited (ACOL), and includes a decommissioned open cut coal mine, an underground coal mine, a Coal Handling and Preparation Plant and a rail siding. The Ashton Underground Coal Mine is approved to produce 5.45 Mtpa of coal. In 2017 2.8 million tonnes of run of mine coal was produced. This coal was processed and exported through the Port of Newcastle, New South Wales.

ACOL hold the South East Open Cut Project (SEOC), to the south east of current surface operations. This project was approved by the Planning Assessment Commission (PAC) on the 4 October 2012, however was subsequently appealed. In 2014 the Land and Environment Court upheld the approval, subject to further conditions. The revised Development Consent was issued to Ashton Coal in April 2015. The SEOC approval has not been taken up and is not within the scope of this AR.

This AR details the ACP's environmental and community performance for the reporting period 1 January 2017 to 31 December 2017. The operational area is shown in Figure 1.

This AR is a statutory approval requirement and has been prepared in accordance with the Ashton Coal Mine Project Approval (DA No. 309-11-2001-i; as modified, Schedule 5, condition 10), annual reporting requirements of Mining Leases 1529, 1533, 1623 and 1696 and the commitments outlined in the Mining Operations Plan (MOP). The AR is written in accordance with the NSW Government Annual Review Guideline as published in October 2015.

The AR is distributed to a range of stakeholders and is available on the Ashton Coal website at <http://www.ashtoncoal.com.au>.

## 2.1 Mine Contacts

Relevant mine contacts are listed in Table 4.

**Table 4 Mine contact details**

Name	Role	Phone contact details
Aaron McGuigan	Operations Manager	(02) 6570 9104
Phillip Brown	Environment and Community Relations Superintendent	(02) 6570 9219 Mobile: 0439 909 952
Environment and Community Response Line	n/a	1800 657 639 Email: Ashton.environment&community@yancoal.com.au



Figure 1 Overview of operations

### 3 Approvals

Details of ACP's existing statutory approvals as at 31 December 2017 are provided below in Table 5. Water licences held by the ACP are discussed in Section 7.

**Table 5 ACOL's primary statutory approvals as at 31 December 2017**

Approval	Description	Issue date	Expiry date
Development consents or project approvals issued by the DPE			
DA 309-11-2001-i	Development Consent for the ACP (as modified from time to time)	11/10/2002 Last modified 20/6/16	26/2/2024 or 12 years from recommencement of open cut operations, whichever is later.
Mining leases and exploration licences issued by the DRE			
ML 1533	Mining Lease	26/02/2003	26/02/2024
ML 1529	Mining Lease	10/09/2003	11/11/2021
ML 1623	Mining Lease	30/10/2008	30/10/2029
EL 5860	Exploration Licence (EL)	23/10/2017	21/05/2020
EL 4918*	Exploration Licence	17/12/2010	17/12/2015
EPL issued by the EPA			
EPL 11879	Environment Protection Licence (EPL)	01/01 (anniversary date)	Not specified

\* Renewal for exploration licence 4918 was lodged with DRE on 17 December 2015. No further correspondence has been issued from DRE on this matter since.

**Table 6 ACOL's other statutory approvals as at 31 December 2017**

Approval	Description	Expiry date
Radiation Management Licence		
RML5061098	Radiation Management Licence	06/04/18
Aboriginal heritage		
Section 90 Consent Permits AHIP 1131017 AHIMS Permit ID 3436	Longwalls 1-4: Salvage excavations. Community collection. Harm to certain Aboriginal objects through proposed works. Certain Aboriginal objects must not be harmed	23/12/21
Section 90 Consent Permits AHIP 1130976	Longwalls 5-8: Movement only of certain Aboriginal objects. Test excavations. Salvage excavations. Community collection. Harm to certain Aboriginal objects through proposed works. Certain Aboriginal objects must not be harmed	26/08/31
Voluntary Conservation Agreement		
Conservation Agreement	Conservation agreement over the southern conservation area. Agreement between The Minister administering the NPW Act 1974 and Ashton Coal Mines Limited for Ashton Coal Mine.	Perpetuity
Tailings Emplacement approval		
S126 Approval	Emplacement of carbonaceous materials Ashton North East Open Cut (NEOC) Issued 08/04/04	Perpetuity
S126 Approvals	Emplacement of carbonaceous materials Ravensworth Void 4 Issued 17/01/07	Perpetuity
S100 Approval	Emplacement of coarse rejects materials in the NEOC void Issued 01/03/12	Perpetuity

Approval	Description	Expiry date
S100 Approval	Emplacement of fine rejects in the Ravensworth Void No 4 Issued 2/01/2007	Perpetuity

### 3.1 Changes to approval documents

During the reporting period there were no changes to the development consent. In July a modification to EPL 11879 was lodged to streamline groundwater monitoring requirements, remove outdated conditions relating to open cut operations (e.g. Hours of operation and blasting activities) and align the EPL boundary with the development consent. The EPL variation is still being processed.

An administrative modification for the South East Open Cut SEOC Project was lodged with the Department of Planning and Environment. The modification seeks to amend those conditions which impose obligations or require compliance at a time prior to the physical commencement of the project. At the end of this reporting period, Yancoal is reviewing submissions and preparing a response to the DPE.

The Extraction Plan for Longwalls 201 to 204 was approved in May 2017, facilitating the commencement of mining in LW 201 in May 2017.

### 3.2 Mining Operations Plan

ACP has an approved MOP for a five and a half year period from 28 March 2013 to 1 July 2018. During the reporting period the mining operations plan was revised to cover changes to the mine plan and extended to 1 July 2018 to allow for further mine and landform planning.

The MOP satisfies the requirements of ESG3 Mining Operations Plan (MOP) Guidelines as published September 2013. The revised MOP was approved in April 2017 and the extension was granted in October 2017.

### 3.3 Environmental Management Plans

ACOL has developed a range of environmental management plans to meet the requirements of DA 309-11-2001-i. Management plans are reviewed and maintained in accordance with Schedule 5 Condition 6. A summary of the status of the management plans is provided in Table 7. Management plans required by the consent are published on <http://www.ashtoncoal.com.au>.

**Table 7 Status of management plans as at 31 December 2017**

Environmental management plan	Condition	Approval date
Environmental Management Strategy	Schedule 5 condition 1	13/04/2017
Noise	Schedule 3 Condition 9	13/04/2017
Air Quality	Schedule 3 Condition 17	13/04/2017
Heritage	Schedule 3 condition 34	13/04/2017
Biodiversity	Schedule 3 condition 28	13/04/2017
Water*	Schedule 3 Condition 26	11/05/2016

\* The Water Management Plan was reviewed and lodged for approval in the last half of 2017. Approval is pending.

Schedule 5 condition 3 allows management plans to be updated under the conditions of the consent that applied prior to the approval of Modification 5, or otherwise with the approval of the Secretary.

## 4 Operations summary

During the reporting period there were no material changes to operations at the Ashton Coal Project. Open cut mining ceased in September 2011, with remaining open cut rehabilitation works completed between 2011 and 2012. There has been no topsoil works or overburden movement since this time. A summary of 2017 underground operations is provided below in Section 4.4. Mine Progression is shown in Figure 13 and Figure 14.

### 4.1 Exploration

There was one eight inch large diameter exploration hole drilled during 2017 in the central western section of ML1533. The hole was drilled to gain a better understanding of the coal quality of the Lemington 11-12 Seam (LEM11-12), Lemington 15A-B Seam (LEM 15A-B), Upper Liddell Seam (ULD), Upper Lower Liddell Seam (ULLD) and Lower Barrett Seam (LB). The results gained from this hole, in particular washability and yield, were included in the mine model to allow more accurate prediction and scheduling of ROM-product tonnes and quality.

### 4.2 Construction

During the reporting period there was one gas well constructed to the Pikes Gully Seam goaf in the central eastern part of ML1533, one goaf water level monitoring hole drilled to the ULD Seam LW101 goaf and one dewatering hole was drilled from the surface to the ULLD Seam. A back road fan shaft was also constructed from the ULLD Seam to the surface by the raise bore method.

The back road fan surface infrastructure was moved from the ULD shaft to the ULLD shaft and the ULD fan site was decommissioned and is being rehabilitated.

Rehabilitation of all drilling sites and completed boreholes, involving sealing or capping with gate valves was undertaken, with rehabilitated sites monitored in accordance with ACP procedures. Boreholes that are yet to be grouted or that require additional testing have been secured with borehole caps.

During the reporting period there were no material variations from the MOP related to construction activities.

### 4.3 Hours of operation

Under Schedule 2, condition 8 of the Development consent DA 309-11-2001-i, underground mining may be undertaken 24 hours a day 7 days a week. Surface construction works on the site is limited to day periods only in the case of construction of gas wells, and day and evening periods only in the case of all other construction activities.

### 4.4 Mining

The underground mine is approved to extract coal from the Pikes Gully (PG), Upper Liddell (ULD), Upper Lower Liddell (ULLD) and Lower Barrett (LB) coal seams. The underground mine utilises the longwall method of coal extraction, following continuous miner development of main headings and

twin heading gate-roads. Seam thickness varies from about 1.8m to 2.8m high. All underground roadways are driven at approximately 2.6 m mined height. The longwall has been designed to allow extraction of the full seam thickness. The expected underground mine life is until approximately 2027.

During the reporting period, coal was mined from the Upper Liddell coal seam (LW 106A) and the Upper Lower Liddell Seam (ULLD) (LW201). As planned in the Mining Operations Plan (MOP), approximately 2.8 million tonnes of run-of-mine (ROM) coal was mined from the underground operations, resulting in approximately 1.5mt of product Coal, 1.24mt of which was transported by rail during the reporting period. Table 8 provides a summary of the mine's performance figures for the reporting period.

**Table 8 Mine Performance Data, 2017**

Material	Approved Limit (DA309-11-2001i)	2016 (previous reporting period)	2017 (current reporting period)	2018 (MOP Forecast)
Topsoil stripped	-	0	0	0
Topsoil Spread	-	0	0	0
Overburden	-	0	0	0
ROM Coal (t)	5,450,000	2,378, 739	2,790,532	2,870,527
Coarse Reject (t)	-	1,097,224	1,342,842	
Tailings (t)	-	255,655	291,740	
Product Coal (t)	-	1,555,989	1,536,598	1,338,768

#### 4.4.1 Gas management

During the reporting period, the ACP conducted gas drainage borehole drilling activities within the underground area, specifically designed to provide longwall panel goaf gas drainage. One longwall large diameter goaf gas drainage hole was completed during this period.

#### 4.5 Next Reporting Period

In accordance with the approved Extraction Plan for Longwalls 201-204 in the Upper Lower Liddell Seam, during 2018 mining operations will continue to mine in LW 201 before moving to LW 202 and LW 203.

### 5 Actions required from previous review

There are a number of actions resulting from the 2016 AR, and the annual review inspection undertaken by the DPE Division of Resources and Geoscience (DRG), as discussed in Table 9.

**Table 9 Actions required from previous review**

Action required from previous annual review	Source of Action	Action undertaken	Where discussed in annual review
Continue to work through the action plan developed from the Independent environmental audit conducted in 2016.	2016 AEMR	Ongoing. There is one action to be addressed, and that will continue to be addressed during this reporting period.	11
Develop a new MOP, due at the beginning of 2018	2016 AEMR	The current MOP has been extended to the 1 July 2018 to allow for landform planning. A new MOP will be lodged in the first half of 2018.	3.2
Amend the Environmental Protection Licence 11879	2016 AEMR	An EPL amendment was lodged in the third quarter of 2017. Ashton Coal is in consultation with the EPA to progress the amendment. Consultation will continue during 2018.	3.1
Continue to enact changes to environmental management as a result of the approval of modification 5 including the review and update of management plans;	2016 AEMR	Management plans required under Modification 5 were updated and approved during 2017, with the exception of the water management plan, which was lodged but not yet approved. Approval is anticipated in the first quarter of 2018.	3.3
Progress the diversion of runoff from the North East Open Cut rehabilitated area	2016 AEMR	Ongoing. During late 2017 and early 2018 there will be a peer review completed along with finalization of options analysis for NEOC runoff management.	9.5
Progress the approval of LW 201 – 204 Extraction Plan	2016 AEMR	Complete. The LW 201 – 204 Extraction Plan was approved in May 2017	3.1
Install the backroad ventilation fan to service the ULLD seam	2016 AEMR	Complete. The backroad fan construction was completed in the third quarter of 2018.	4.2
Non-Compliances – please include a table of non-compliances following Table 2 in the Annual Review in accordance with the guideline ‘Post approval requirements for State significant mining developments – Annual Review’ Department of Planning and Environment October 2015.	DPE Letter - Annual Review 2016, 19/6/17	Complete.	Table 3
Community Engagement Activities – please include details of specific community engagement activities undertaken during the reporting period	DPE Letter - Annual Review 2016, 19/6/17	Community support and engagement undertaken in 2017 is detailed in this AR.	10.1

Action required from previous annual review	Source of Action	Action undertaken	Where discussed in annual review
Biodiversity – please include specific details of management activities undertaken within the Southern Woodland Conservation Area in accordance with the Biodiversity Management Plan.	DPE Letter - Annual Review 2016, 19/6/17	Management Activities including weed spraying, dog/fox baiting and vegetation monitoring were undertaken during the reporting period.	6.4.3
Environmental Performance Improvement (Section 13) – in accordance with the guideline ‘Post approval requirements for State significant mining developments – Annual Review’ Department of Planning and Environment October 2015 please provide timelines for the implementation of proposed environmental performance improvements in accordance with Schedule 5, Condition 10(f).	DPE Letter - Annual Review 2016, 19/6/17	Actions for next reporting period have been tabulated to include due dates and a summary of tasks, including whether management plans will need to be updated.	13
In accordance with Schedule 5, condition 13 of the approval, please ensure a summary of all monitoring results, including model performance results which have been reported in accordance with the various plans and programs are approved under the conditions of this consent are made publicly available on the projects website.	DPE Letter - Annual Review 2016, 19/6/17	A summary of monitoring results is available on Ashton Coal’s website at <a href="http://www.ashtoncoal.com.au/page/sustainability/environment/air-quality-monitoring/">http://www.ashtoncoal.com.au/page/sustainability/environment/air-quality-monitoring/</a> . Model performance results are discussed in each relevant section of the annual review. Annual monitoring data is compared to predicted modelled data in the air quality, noise and groundwater monitoring sections. Background data is provided in other monitoring sections such as Biodiversity and rehabilitation.	n/a
The department notes that Section 7.4.2 indicates that two bores are subject to further investigation (T3A and WML 173) as groundwater triggers were exceeded. Please provide further information in relation to this exceedance event and a commitment for a corrective action/s by 20 July 2017.	DPE Letter - Annual Review 2016, 19/6/17	A letter was provided outlining the further investigations by the due date.	n/a
Ongoing rehabilitation maintenance of gas drainage pipeline rehabilitation should be undertaken and reported in the 2017 Annual Review	DRG Letter – Annual Review 2016	Gas drainage line rehabilitation continued during 2017	9.6

## 6 Environmental Performance

Table 10 outlines the key performance or management issues and how they have been addressed, as well as the implementation of any management measures from the reporting period and proposed improvements for following years.

The environmental aspects covered require management plans under the current development consent, or are major environmental aspects covered by various procedures, plans and programmes.

Where practical, environmental management of the main environmental aspects managed at the ACP have been discussed in Table 10. Where tabulating the information is not practical, further detail is included in the following sections of the report.

**Table 10 Environmental Performance Summary**

Aspect	Approval criteria/ EIS prediction	Performance during the reporting period	Trend / key management implications	Implemented / proposed management actions.
Noise (Section 6.2)	See Table 12	Compliant with EPL and Development Consent conditions. For more detail, see Table 12. During the reporting period there were two noise complaints, investigation indicated that they were not due to Ashton Coal's operations. Noise results this reporting period were below the predictions made in the EIS.	Noise monitoring results during the reporting period follow the trends of past years: Ashton Coal's operations are largely inaudible in the surrounding community and minimal noise complaints have occurred.	The Noise Management Plan will be reviewed and updated if necessary to ensure best practice noise management techniques appropriate to the current operational status of the ACP and current policies and guidelines.
Air Quality (Section 6.3)	See section 6.3.2 for detail on approval criteria and background levels.	Compliant with Development consent.	There was 100 per cent data capture for depositional dust gauges and 98 per cent data capture for TEOMs. There were no events where Ashton Coal's operations contributed to 50ug/m <sup>3</sup> daily average. There were no air quality complaints or reportable incidents related to air quality in the reporting period.	Air Quality will continue to be managed in accordance with the Air Quality Management Plan.

Aspect	Approval criteria/ EIS prediction	Performance during the reporting period	Trend / key management implications	Implemented / proposed management actions.
Visual Amenity and Lighting	Implement reasonable and feasible measures to mitigate visual and offsite impacts of lighting, Ensure no unshielded light shines above the horizontal, and All external lighting must comply with Australian Standard AS4282 (INT) 1997.	Visual amenity and lighting management at ACOL are managed in accordance with the internal Lighting Management Plan. Fixed lighting is utilised to illuminate the areas around the underground surface facilities, CHPP and open cut workshop. Earthen bunds are constructed and tree screens planted as a visual screen for infrastructure screening where possible. During the reporting period, earthen bunds and tree screens were inspected and maintained as required. Dead trees removed from screen along New England Highway, livestock exclusion fences installed.	There have been no lighting or visual amenity related incidents or complaints during the reporting period. ACOL will continue to effectively manage lighting and visual amenity according to the Lighting Management Plan and the Mining Operations Plan.	Lighting will continue to be managed to minimize impacts on the local community and highway traffic while maintaining lighting levels necessary for operational and safety needs. Contractors were engaged and tubestock trees ordered during the reporting period, but put on hold until Autumn 2019 due to extended dry weather.
Waste management (section 6.6)	The applicant must: Minimise and monitor the waste generated by the development, Ensure appropriate storage, handling and disposal of waste, Manage onsite sewage treatment and disposal, Report on waste management and minimisation in the AEMR.	Waste management will continue to be managed in accordance with Ashton Coal's waste management plan and the conditions of consent. Waste Management followed similar trends to previous years, with no significant changes to waste volumes or management throughout the year.	Ashton Coal's waste management contractor continues to do weekly inspections of operational areas and these are provided in monthly reports. Any issues are rectified immediately or area supervisors notified if necessary. There were no reportable incidents or community complaints relating to waste, chemical or hydrocarbon	Waste management will continue to be managed in accordance with the waste management plan and the conditions of consent.
Spontaneous Combustion	16 (a) Ashton Coal must implement reasonable and feasible measures to minimise offsite odour, fume and dust emissions including those generated from spontaneous combustion.	During the reporting period there was no spontaneous combustion in the rehabilitation or the CHPP stockpile areas. Spontaneous combustion surrounding the Void 4 tailings storage facility was monitored and managed where possible, although during winter 2017 impacts were low. These areas will continue to be monitored to measure effectiveness, and	The nature of the loosely compacted overburden containing high levels of carbonaceous material indicates that ongoing management and maintenance of spontaneous combustion at the Void 4 tailings facility is required. New outbreaks are relatively common, and some areas	Ashton Coal will continue to monitor and manage spontaneous combustion.

Aspect	Approval criteria/ EIS prediction	Performance during the reporting period	Trend / key management implications	Implemented / proposed management actions.
		ongoing management of spontaneous combustion will be undertaken.	may extinguish without any management works undertaken.	
Aboriginal Cultural Heritage	There are stringent requirements for the management of Aboriginal Cultural Heritage at Ashton Coal. Requirements of the development consent and AHIP 1131017 (Longwalls 1-4) and AHIP 1130976 (Longwalls 5-8) are detailed in the Aboriginal Cultural Heritage Management Plan (ACHMP)	During the reporting period, salvage works were completed in the LW 201 subsidence crack zone, gas pipeline area and the LW202 subsidence crack zone, with predominantly low artefact densities throughout all areas salvaged. Artefact analysis works were undertaken onsite by archaeologists and Aboriginal community representatives for a total of four weeks throughout 2017	Over 20,000 artefacts have now been salvaged and analysed. Ongoing works are minor in nature and will cover areas of potential subsidence cracking associated with Longwalls in the ULLD seam.	<p>During the next reporting period, ACP plans to:</p> <p>Continue artefact analysis with archaeologists and the aboriginal community;</p> <ul style="list-style-type: none"> <li>• Continue effective consultation with the Aboriginal community through the ACCF; and</li> <li>• Commence artefact salvage and analysis of LW203 subsidence crack zones and other minor areas as required to meet operational requirements.</li> <li>• Continue to monitor and manage lands within the Conservation Area to preserve Aboriginal sites and flora and fauna of the area;</li> <li>• Conduct minor salvage works as required to meet operational requirements.</li> </ul>

Aspect	Approval criteria/ EIS prediction	Performance during the reporting period	Trend / key management implications	Implemented / proposed management actions.
Bushfire	Bushfire at ACOL is managed in accordance with the Bushfire Management Plan which documents fire prevention and control measures to reduce the risk of and protect the operations and surrounding neighbours from bushfire.	During the reporting period, firebreaks were slashed around fence lines, pipelines and other infrastructure. There was one bushfire recorded on ACOL owned land along the New England Highway near St Clements Church. The rural fire service attended and was assisted by Ashton Coal equipment and personnel. There was minor damage to Ashton Coal owned pipelines, fences and a shed. Pipelines were used by residents of Camberwell and were repaired as a priority.	Firebreaks are maintained at Ashton Coal on a schedule to mitigate impacts of bushfire. An investigation was undertaken and it is probable that the fire started as a result of an electrical fault on power lines near the church.	The prevention of bushfire on ACOL owned lands will continue to be actively managed in accordance with the Bushfire Management Plan.
Biodiversity (Flora and Fauna)(Section 6.4)	See Section 6.4	All required biodiversity monitoring was undertaken during the reporting period. Further information is included in Section 6.4	Consistent with previous years, the Bowmans Creek Diversion rehabilitation is progressing well. Consistent with previous years, the key management issue relating to biodiversity onsite is weed management. Ashton continues to have annual weed management plans to address this issue.	During the next reporting period Biodiversity will continue to be managed through the Flora and Fauna Management Plan.
Bowmans Creek Diversion (Section 9.1 to 9.3)	See Section 9	Bowmans Creek Diversion is a major environmental aspect for ACOL. Performance during the reporting period is discussed in sections: <ul style="list-style-type: none"> <li>• 6.4.2 Aquatic ecology – Bowmans and Glennies Creek,</li> <li>• 6.5 Pest Management,</li> <li>• 9.3Bowmans Creek Diversion Management,</li> <li>• 9.2 Bowmans Creek Diversion Rehabilitation Monitoring Program, and</li> </ul>	See the following sections: <ul style="list-style-type: none"> <li>• 6.4.2 Aquatic ecology – Bowmans and Glennies Creek,</li> <li>• 6.5 Pest Management,</li> <li>• 9.3Bowmans Creek Diversion Management,</li> <li>• 9.2 Bowmans Creek Diversion Rehabilitation Monitoring Program, and</li> <li>• 9.6 Rehabilitation status.</li> </ul>	A focus on weed control will continue to facilitate the ongoing success of the diversion rehabilitation.

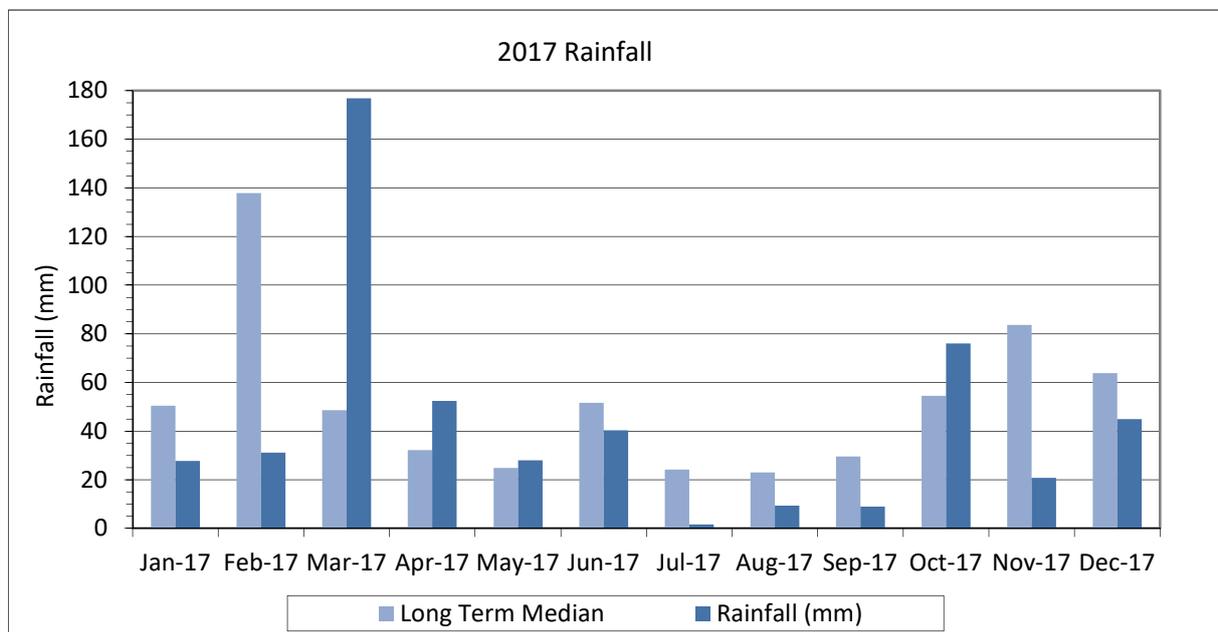
Aspect	Approval criteria/ EIS prediction	Performance during the reporting period	Trend / key management implications	Implemented / proposed management actions.
		<ul style="list-style-type: none"> <li>9.6 Rehabilitation status.</li> </ul>		
Water – Surface water (Section 7.3)	See Section 7	Surface water quality trends indicate no adverse mining impacts on the water quality of the local waterways. The site water management plan was updated and lodged for approval during the reporting period.	There have been no reportable incidents or community complaints in relation to water quality during the reporting period. No TARPs under the Water Management Plan were triggered.	During the next reporting period, ACOL will continue to undertake monitoring and remedial works where required to commence the diversion of clean water off established rehabilitated areas, reducing the clean water diverted to in-pit storage.
Water – Groundwater (Section 7.4)	See Section 7	During the reporting period, no unpredicted impacts to groundwater systems were identified. A response investigation was triggered during the year for site T3A. Investigation results indicated that the trigger was unrelated to mining impacts. An annual Groundwater Management Report is included as Appendix 2.	There have been no reportable incidents or community complaints in relation to groundwater during the reporting period.	Groundwater will continue to be managed in accordance with the Water Management Plan.

## 6.1 Meteorological Data

Meteorological data is used at Ashton to interpret environmental impacts and to understand rehabilitation and land management outcomes. Ashton has two meteorological monitoring stations: Monitoring Site 1 (predominantly used to monitor for noise and air quality impacts in adverse weather conditions) and the Repeater Station (the main monitoring site). A summary of meteorological data recorded at the Repeater monitoring station during the reporting period is provided in Table 11. Rainfall is included as Figure 2 and seasonal wind roses as Figure 3.

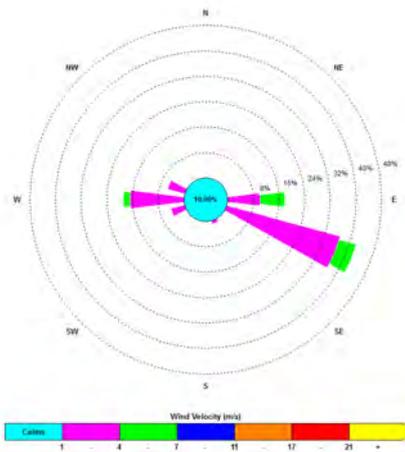
**Table 11 Summary of meteorological results from the Repeater Monitoring Station**

Parameter	Units	2017	2016	2015
Total rainfall	mm	518	754	902
Maximum monthly rainfall	mm	147 (recorded in March)	138 (recorded in February)	270 (recorded in April)
Minimum monthly rainfall	mm	1.6 (recorded in July)	23 (recorded in August)	15 (recorded in September)
Maximum temperature	°C	46 (recorded in February)	40.9 (recorded in December)	39.3 (recorded in November)
Minimum temperature	°C	1.0 (recorded in July)	2.2 (recorded in July)	2.7 (recorded in July)

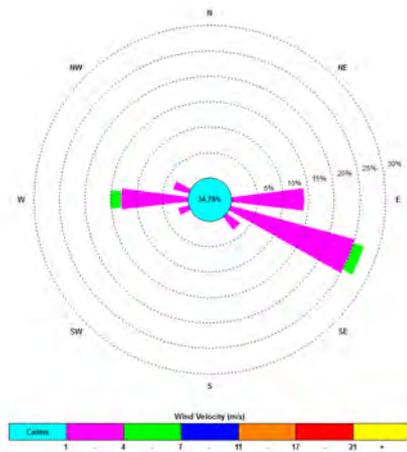


**Figure 2 2017 Rainfall**

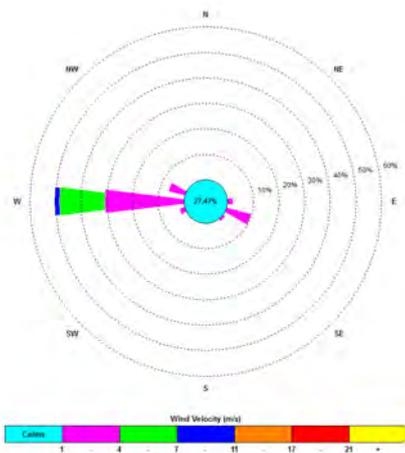
Summer 2017



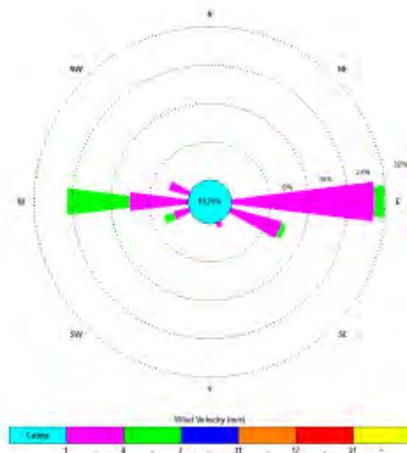
Autumn 2017



Winter 2017



Spring 2017



Annual Wind Rose, 2017

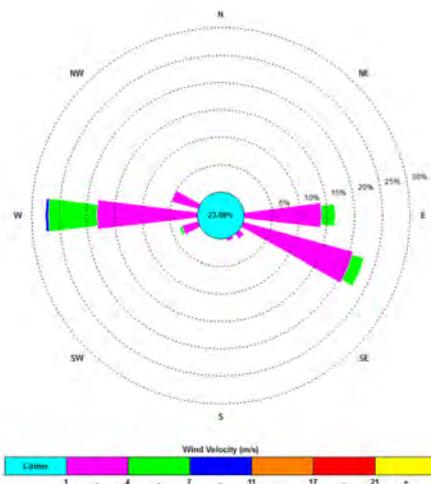


Figure 3 Seasonal and annual wind roses, 2017

## 6.2 Noise

### 6.2.1 Environmental Management

The operation's noise management plan details the relevant noise impact assessment criteria, compliance procedures and controls relating to mining activities.

Received levels from various noise sources are noted during attended monitoring and particular attention is paid to the extent of potential mine contribution. During 2017, potential noise generating activities from the ACP included underground mine related activities, construction of a new back road fan for the ULLD seam, maintenance of equipment, operation of the CHPP, train loading and land management activities. Noise mitigation measures include properly maintaining mobile plant, CHPP and ventilation fans, limiting hours of mobile noise generation (such as drilling activities), permanent noise mitigating engineering controls at the CHPP, and pit top facilities located below natural surface level.

### 6.2.2 Environmental Performance

Noise generated by the ACP must not exceed limits as specified in Appendix 6 of DA 309-11-2001-i and condition L2.1 of EPL 11879.

At each of the three monitoring locations, the mine's average noise energy over a 15 minute period ( $LA_{eq(15min)}$ ), and the highest noise level generated for 0.6 seconds during one minute ( $LA1_{(1min)}$ ) (in the absence of any other noise), is measured on a monthly basis. When the mine was measurable and where meteorological conditions resulted in criteria applying (in accordance with the project approval), a low frequency noise assessment was conducted in accordance with the *NSW Industrial Noise Policy* for January to October and *Noise Policy for Industry* for November and December.

An analysis of periodic attended noise monitoring results indicate operations were not audible at any monitoring location during monitoring, with the exception of Site N3 in April 2017, where monitored results were in compliance with relevant criteria. No secondary monitoring was required during the reporting period.

Noise did not exceed the relevant  $L A_{eq(15 min)}$  or  $L A_{eq(1min)}$  criterion at any location at any time, indicating nuisance and sleep disturbance noise generation was well within specified noise limits.

Analysis of all noise emissions from ACP showed that they complied with tonal, impulsive and low frequency modifying factor levels as per definitions in the *NSW Industrial Noise Policy*.

There were two community noise complaints received during the reporting period, in January and June. In both instances investigations into noise levels and operations being undertaken at the time concluded that the noise was not likely to have been generated by Ashton Coal's operations.

A summary of results from the ACP's attended noise monitoring is provided in Table 12.

### 6.2.3 Trends and management measures

Noise monitoring results during the reporting period follow the trends of the past few years, where

Ashton Coal's operations are largely inaudible in the surrounding community and minimal noise complaints have occurred. Noise generated by ACOL operations during the next reporting period are expected to remain consistent with the past three years.

**Table 12 Attended Noise Monitoring Results**

LAeq (15min)	N2	N3	N4
Noise impact criteria (Intrusive criteria) (LAeq (15min)) Night	36	36	36
Noise Impact criteria (LAeq (1min) ) Night	46	46	46
Predicted noise level for 2014 for each monitoring location (2002 EIS)*	37	N/A	N/A
January	IA	IA	IA
February	IA	IA	IA
March	IA	IA	IA
April	NM	36	IA
May	IA	IA	IA
June	IA	IA	IA
July	IA	IA	NM
August	NM	IA	IA
September	IA	IA	IA
October	IA	IA	IA
November	IA	IA	IA
December	IA	IA	IA

\* 2014 is the year that best represents current mining operations as modelled in the 2002 EIS.

IA – no site noise was audible at the monitoring site.

NM – some site noise was audible but could not be quantified



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Figure 4 Meteorological and Noise Monitoring Locations

## 6.3 Air Quality

### 6.3.1 Environmental Management

The air quality monitoring network consists of depositional dust gauges, fine particle monitors that operate on a set schedule and real-time fine particulate monitors that operate continuously. The coupling of operational procedures and monitoring allows the ACP to take a proactive approach to dust management where necessary.

Depositional dust monitoring is carried out in accordance with *Australian Standard 3580.10.1:2003 Determination of particulates – Deposited matter – Gravimetric method* and analysed for insoluble solids and ash residue. Depositional dust samples are collected on a 30 day (plus or minus two days) basis from one approved depositional dust gauge monitoring site in accordance with the approved Air Quality Management Plan (AQMP)

Two statutory real-time tapered element oscillating microbalance sampler (TEOM) are used to record fine dust particles (i.e. particulate matter 10 microns and less (PM<sub>10</sub>)) on a continuous basis. These monitors are based upstream and downstream of Ashton Coal's operations and are used to calculate Ashton Coal's contribution to air quality, particularly close to Camberwell village. There is also one TEOM used for operational management purposes, which is not reflective of impacts on sensitive receptors.

During 2017 a TEOM was established at Site 10 adjacent to Camberwell church to comply with the requirements of the revised EPL and the Air Quality Management plan was revised and approved twice, firstly to align with changes to the monitoring network and to align with the EPL changes and secondly to comply with the requirements of DA 309-1-2001-i Modification 5.

Controls have been put in place in accordance with the approved management plan to reduce the potential for the generation and movement of dust from Ashton Coal's operation area. These controls are considered to have been adequate for the reporting period, and will continue to be applied during the next reporting period. The controls include:

- Large earth berms and tree plantations between the operations and the village have been constructed and trees established;
- At the closure of the mining operations in the NEOC, all available overburden dumps were bulk shaped and then rehabilitated during autumn 2012;
- Roads are clearly delineated and maintained and water carts utilised around the site to keep trafficked areas in a damp condition;
- All stockpiles are kept damp by the use of fixed or mobile water sprays under dry and windy conditions; and
- All diesel equipment used on site is maintained properly and fitted with appropriate pollution control devices.

The cumulative reduction protocol outlined in the AQMP includes maintaining an open dialogue with neighbouring mining operations, sharing data and participating in the Upper Hunter Mining Dialogue Emissions and Air Quality working group.

The locations of air quality monitoring sites at Ashton Coal are shown in Figure 5.



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Figure 5 Location of air quality monitoring sites

## 6.3.2 Environmental Performance

### 6.3.2.1 Depositional Dust Gauges

Depositional dust gauge data capture rates for the reporting period were 100 per cent at all statutory sites.

In accordance with DA 309-11-2001-i, the criterion for the maximum total deposited dust level is 4 grams per square metre per month ( $\text{g}/\text{m}^2/\text{month}$ ) over an annual averaging period. The criterion for the maximum increase in deposited dust levels due to ACP's operations over an annual averaging period at any one dust gauge is  $2 \text{ g}/\text{m}^2/\text{month}$ .

Table 13 shows the annual average insoluble solids over the 2015 to 2017 reporting periods and the background levels from the 2002 EIS. There was no exceedance of the  $4\text{g}/\text{m}^2/\text{month}$  at Site D6 during the reporting period.

**Table 13 Comparison of annual average deposited dust results, 2015 - 2017**

Site reference	Location	2017 annual average $\text{g}/\text{m}^2/\text{month}$	2016 annual average $\text{g}/\text{m}^2/\text{month}$	2015 annual average $\text{g}/\text{m}^2/\text{month}$	Annual Average EIA Background Values $\text{g}/\text{m}^2/\text{month}$
D6	St Clements Church	3.45	3.0	3	1.5

Contamination by bird droppings, insects and vegetation is a common issue for depositional dust monitoring systems. During this reporting period there was one contaminated result, recorded in September 2017. A depositional dust gauge is deemed contaminated by an independent monitoring contractor or a National Association of Testing Authority (NATA) accredited laboratory. Results found to be contaminated are excluded from the annual average calculation.

### 6.3.2.2 Tapered Element Oscillating Microbalance Samplers (TEOM)

Under the approved AQMP there are two  $\text{PM}_{10}$  TEOM monitoring stations in operation, as well as one operational TEOM and the local Upper Hunter Air Quality Monitoring Network (UHAQMN) TEOM based in Camberwell village (Table 14).

**Table 14 Purpose, location and performance of TEOM sites.**

Monitoring Station No	Particulates measured	Monitor Purpose	Location	Data capture (%)
7	$\text{PM}_{10}$	Management tool for assessment of upstream air quality	West of Ashton Coal	97.8
9	$\text{PM}_{10}$	Upstream monitoring point. May be used as a downstream monitoring point depending on prevailing wind direction.	Centre rail	99.2
10	$\text{PM}_{10}$	Downstream monitoring point. May be used as an upstream monitoring point depending on prevailing wind direction. Also used to calculate TSP compliance.	St Clements Church	95.2
UHAQMN	$\text{PM}_{10}$ and $\text{PM}_{2.5}$	Reference site only (not compliance related data).	Camberwell Village	98.0 96.4

A summary of the results from the real-time  $\text{PM}_{10}$  TEOM monitoring sites for the reporting period is

provided in Table 15. During the reporting period the short term 24-hour impact assessment criteria of 50 µg/m<sup>3</sup> was exceeded a number of times at each site, including air emissions from all sources. An investigation into each event was undertaken, including using wind direction data and upstream/ downstream monitoring points, as well as assessing regional air quality trends and localised influences or events at the time.

On the 25<sup>th</sup> September 2017, Site 9 returned a 24 hour average reading on 122µg/m<sup>3</sup>. Following the initial review of data, it was determined that Ashton Coals estimated contribution was 53.75µg/m<sup>3</sup> and the DPE were notified. Further investigations were carried out, based on the most accurate daily meteorological and air quality monitoring data, as well as the activities being undertaken at Ashton Coal and the inferred contribution from Ashton Coal operations was calculated as 49.94µg/m<sup>3</sup>.

**Table 15 Summary of TEOM PM<sub>10</sub> results**

Monitoring station number	Minimum 24- hour result µg/m <sup>3</sup>	Maximum 24- hour result µg/m <sup>3</sup>	Short term criteria (µg/m <sup>3</sup> )	Reporting period annual average µg/m <sup>3</sup>	Long term Criteria annual average µg/m <sup>3</sup>
Site 7	7.7	69.3	50	23.8	30
Site 9	7.6	127.6		32.8 <sup>^</sup>	
Site10	5.9	68.1		23.3	
UHAQMN PM <sub>10</sub>	7.1	101.5		27.4	
UHAQMN PM <sub>2.5</sub>	2.2	24.7	25	7.4	8*

<sup>^</sup> Site 9 is a boundary site that is not located near any privately owned residence and does not create a non-compliance with consent conditions. \* Advisory reporting only

### 6.3.3 Trends and key management implications

Monitoring results indicate that the ACP continues to meet air quality in accordance with DA 309-11-2001-i, indicating that current air quality management practices are effective.

There were no reportable incidents or community complaints relating to air quality during the reporting period.

#### 6.3.3.1 Greenhouse gas reporting

Yancoal Australia Ltd reported greenhouse gas emissions results under the National Greenhouse and Energy Reporting Scheme (NGER) for the 2016-2017 reporting period. Overall ACP emitted 382,519 tonnes CO<sub>2</sub>, equivalent to a 5 per cent increase from the 2015-2016 reporting period. The variation in results from previous years can be attributed to an increase in production (approximately 17 per cent) in a less gassy seam than previous years.

## 6.4 Biodiversity (Flora and Fauna)

Each year the ACP undertakes extensive terrestrial and aquatic flora and fauna monitoring to track progress against management plan and closure objectives. The monitoring program is aimed at tracking the condition of habitat areas over time and ensuring that the management plan’s established performance indicators and project approval requirements are being met. The

monitoring program includes terrestrial and aquatic monitoring, weed and vertebrate pest monitoring and associated management measures where required. This monitoring program complements the rehabilitation monitoring of Bowmans Creek, North East Open Cut and the farmland over the underground mine which is discussed in Section 9. Monitoring includes areas within the Southern Conservation Area. A monitoring form as requested by the NSW Office of Environment and Heritage (OEH) is included as Appendix 1.

#### 6.4.1 Fauna Monitoring

Fauna surveys were undertaken in accordance with the Biodiversity Management Plan in June and November/December 2017.

In total, eight survey sites were re-established in 2017 consisting of four sites that have been undermined in the past (impact) and four in remnant vegetation that have had no mining activities (control). Among these control and impact sites, two consisted of riparian habitat, whereas the remaining six sites were woodland. Each site was systematically sampled using a variety of fauna survey methodologies including small and medium mammal trapping, mammal hair sampling, funnel trapping for reptiles, echolocation recording for microchiropteran bat species, remote camera detection, call playback surveys for nocturnal birds/mammals and active searches (diurnal and nocturnal) for amphibians, reptiles, mammals and birds.

Seven threatened species were recorded within the Ashton Coal Project (ACP) site, being the grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*), speckled warbler (*Pyrrholaemus sagittatus*), scarlet robin (*Petroica boodang*), brush-tailed phascogale (*Phascogale tapoatafa*) large-eared pied bat (*Chalinolobus dwyeri*), eastern bentwing bat (*Miniopterus schreibersii oceanensis*) and yellow-bellied sheath-tail-bat (*Saccolaimus flaviventris*). Each of these species has been recorded in previous surveys within the ACP. Each of the species is listed as vulnerable under the BC Act.

As documented in 2016, the grey-crowned babbler is utilising each of the woodland remnants in the ACP site with 24 observations of this species and 4 nests attributed to this species recorded during the 2017 survey period.

In 2017, the brush-tailed phascogale was recorded on 60 occasions from trapping, hair funnels, remote camera and spotlighting methods. This species was caught 16 times, detected in 37 hair funnel traps and spotlighted and recorded on remote camera at two and three of the transects, respectively. Although we cannot be certain on the size of the population within the ACP site, mark-recapture data identified nine different individuals were captured, with one individual that was recaptured during the survey period. This species is notoriously hard to capture and apart from the 2015 and 2016 bi-annual fauna monitoring surveys, there have previously been very few records of this species in the local area. A review of the Atlas of NSW Wildlife (BioNet 2017) revealed only 15 previous documented sightings of this species within 10 kilometres of the ACP site. As such, the results from the 2017 monitoring surveys complement those of the 2015 and 2016 surveys in continuing to be of regional significance; highlighting the importance of the remnant woodland patches across the ACP site.

Analysis of pooled species data demonstrated similar species diversity between the control (130) and impact (131) areas. Based on this similarity, there is little indication from fauna results that mining is

having an adverse impact in the ACP site. Similarly, comparison among faunal groups indicates that species diversity was consistent.

When compared to previous years, the species diversity among faunal groups remained generally consistent. The results of the fauna monitoring surveys within the ACP site indicate that threatened fauna species and their habitats have not been adversely impacted by mining. The threatened species diversity recorded in 2017 is slightly higher than the 2016 monitoring results however such variation is expected when monitoring a dynamic biological system.

#### 6.4.2 Aquatic ecology – Bowmans and Glennies Creek

Aquatic ecology monitoring was undertaken during spring and autumn of 2017 in accordance with the monitoring program outlined in the Flora and Fauna Monitoring (Biodiversity) Management Plan (FFMP). Results of stream health monitoring were lower than in previous years due to the natural environmental responses to prevailing climatic conditions.

The main influencing events for the stream health monitoring of Bowmans and Glennies Creeks in 2017 were the scouring floods in April 2017 (prior to monitoring in May) followed by drought flow conditions in Bowmans Creek until monitoring was undertaken in November. Releases of water from Glennies Creek Dam mitigated drought effects in Glennies Creek, however low flows were the main environmental influence on Bowmans Creek results in the November monitoring period.

For both Bowmans and Glennies Creeks, the pre-autumn 2017 flood volumes were sufficient to scour out or mobilise aquatic biota to the effect that, following cessation of floods, the recolonisation of aquatic habitats would most likely have been initiated by opportunistic short-lived taxa. This results in larger fluctuations in both diversity and macroinvertebrate stream health indices as they reflect the rapid changes in the makeup of the aquatic assemblages post-flood.

Similarly, conditions leading up to the spring sampling period were characterised by other opportunistic short-lived taxa, suited to drought conditions. The spring monitoring showed swings in both diversity and macroinvertebrate stream health indices as the stream ecosystem experienced rapid changes in the makeup of the drought specialist assemblages.

The compounding post-flood and drought effects experienced throughout 2017 are the main basis for a number of low performance index results over the two sampling seasons this year.

The condition of the BCD riparian habitats has continued to advance in 2017 with increased complexity and density of the riparian vegetation. Whilst there has been some increase in complexity of emergent and submerged vegetation, there has also been an increase in density and cover of some emergent vegetation over the low flow period to the extent that overall in-stream aquatic habitat value has decreased. The low flow and drought pool conditions have resulted in dense accumulations of green filamentous algae in both the natural creek pools, the excised creek pools and pools within the diversion. Similar conditions are noted in Glennies Creek. This is primarily due to the lack of water release from Glennies Creek Dam following the April storm (through to the autumn sampling period) and also immediately before the spring sampling.

Comparisons of the macroinvertebrate biota data for the natural creek and BCD channel pools over autumn and spring 2017 indicate that the diversion channel sites are supporting a macroinvertebrate biodiversity and complexity consistent with that encountered in the range of monitoring sites

located up and downstream in the retained Bowmans Creek sections (the in-line sections). Whilst the diversity of fish recorded from the diversions channels in 2017 was lower than the diversity of fish in the creek sites this year, this is considered a drought impact with fish concentrated in the deeper creek pools. The fact that native fish were found in the diversion channels demonstrate that Bowmans Creek provides regularly spaced refuge habitat during periods of low flow.

In accordance with the FFMP, the number of monitoring points along Glennies Creek was reduced during 2017 from four to two. Glennies Creek is a regulated system and results over the monitoring program have been very consistent since the inception of stream health monitoring.

### 6.4.3 Southern Voluntary Conservation Area

A Voluntary Conservation Agreement was made between ACOL and the Minister for the Environment under the NP&W Act on the 16 September 2010. The VCA contains remnant Hunter Valley vegetation, threatened fauna species and archaeological sites of high significance, including the Glennies Creek Site containing a number of Grinding Grooves. The Agreement covers 65.66 hectares of land above the existing ACOL underground mine (Figure 1). Section G – I of the VCA agreement acknowledges that Development Consent DA309-11-2001-i issued by the Department of Planning on the 11 October 2002, permits the mining of coal by longwall methods in four seams beneath the VCA and any impacts to the surface conservation area as a direct result of mining operations.

The VCA is managed through the Plan of Management, as well as the Flora and Fauna Management Plan and the Biodiversity Offsets Management Plan.

During the reporting period and according to the plan of management, the back road ventilation fan was relocated to service the ULLD seam. This work was essential to maintain the safety of underground workers. Previously disturbed ground was used where possible along with approximately 1000 square metres of clearing small shrubs and native pasture. The ULD seam vent fan site was decommissioned and was in the process of being rehabilitated at the end of the reporting period.

Flora monitoring within the conservation area during 2017 identified the biggest threat as weeds – in particular African Boxthorn and African Olive, along with Balloon Vine. These weeds were addressed within the reporting period and are included in the 2018 weed action plan for ongoing management.

Weeds are a major threat to the conservation area and, consistent with previous years, weed spraying was undertaken in the conservation area. Areas sprayed are shown in Figure 7. Roads through the conservation area have been maintained and are graded as required to maintain access and minimise erosion and sedimentation issues.

## 6.5 Pest Management

Weed and pest management are undertaken at ACP in accordance with the MOP, FFMP and good land management principles.

### 6.5.1 Weed Management

Weed control programs at ACP target weeds that are locally declared under the Weed Control

Order 2014 (NSW *Biosecurity Act 2015*), including African boxthorn, Mother-of-millions, various ground cactus species, St John’s Wort and other environmental weeds. Weed control on site has been consistent over the last few years, targeting the larger populations of weeds, the more invasive species and the riparian zones.

Priority areas for treatment included the mine site boundary, Bowmans and Glennies Creeks, rehabilitation areas and selected offset and conservation areas. Green Cestrum has been included as a priority species for control in 2018. Areas of weed control activities and the species treated during 2017 are shown in Figure 7.

### 6.5.2 Vertebrate pest management

During the reporting period, Ashton Coal continued an integrated control program to combat the presence of feral animals on ACP properties. Programs were carried out in spring and winter and were run simultaneously with other baiting programs in the Singleton/ Muswellbrook region. Methods utilised during 2017 included site monitoring by means of Trail Cameras and Site Inspections, a 1080 Baiting including buried and ejector baits, and pig trapping. Over the two trapping programs, six pigs were trapped and shot, and 22 wild dogs and 98 foxes took baits.

## 6.6 Waste Management

Waste management will continue to be managed in accordance with the Waste Management Plan and conditions of consent. There were no significant changes to waste volumes or management throughout the year. ACP’s waste management contractor continues to do weekly inspections of operational areas and these are provided in monthly reports. Any issues are rectified immediately or area supervisors notified if necessary. There were no reportable incidents or community complaints relating to waste, chemical or hydrocarbon management.



**Figure 6 Waste Management 2017**

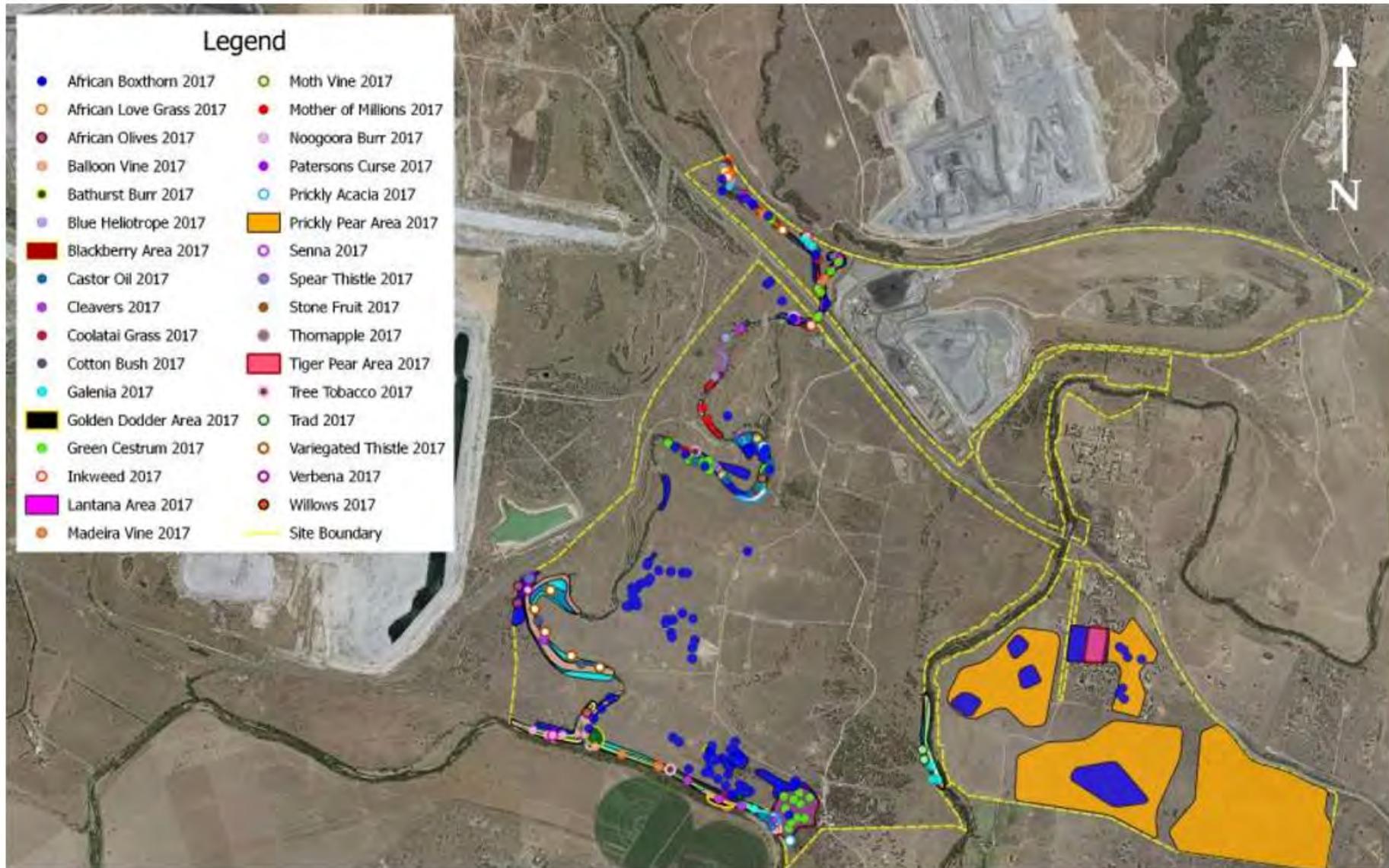


Figure 7 Weed control works, 2017

## 6.7 Heritage

There are stringent requirements for the management of Aboriginal Cultural Heritage at Ashton Coal.

Requirements under DA 309-11-2001-i, AHIP 1131017 (LW 1-4) and AHIP 1130976 (LW 5-8) are detailed in the Aboriginal Cultural Heritage Management Plan (ACHMP). Condition 34 (c) calls for regular consultation with the Aboriginal community in the conservation and management of Aboriginal cultural heritage.

During the reporting period, salvage works were completed in the LW 201 subsidence crack zone, gas pipeline area and the LW202 subsidence crack zone, with predominantly low artefact densities throughout all areas salvaged.

Artefacts that have been salvaged onsite are analysed by specialist archaeologists and the aboriginal community. Artefact analysis works were undertaken onsite by archaeologists and Aboriginal community representatives for a total of four weeks throughout 2017. Skills developed with participants included artefact identification and recording techniques such as data entry, use of digital callipers and digital camera. To date, over 20,000 artefacts have been analysed by the archaeologists and the Aboriginal community representatives.

There were three Aboriginal Community Consultation Forum (ACCF) meetings held during the reporting period. ACCF meetings discuss current mine operations, upcoming cultural heritage fieldwork, management of cultural heritage, and provide the Aboriginal community an opportunity to contribute to cultural heritage matters. There was an additional meeting held during the reporting period to consider how to replace artefacts on country following artefact salvage and analysis at the cessation of mining.

During the next reporting period, ACP plans to:

- Continue artefact analysis with archaeologists and the aboriginal community;
- Continue effective consultation with the Aboriginal community through the ACCF; and
- Commence artefact salvage and analysis of LW203 subsidence crack zones and other minor areas as required to meet operational requirements.
- Continue to monitor and manage lands within the Conservation Area to preserve Aboriginal sites and flora and fauna of the area;
- Conduct minor salvage works as required to meet operational requirements

## 7 Water Management

Ashton Coal manages water through its approved site Water Management Plan (WMP) and associated surface and groundwater monitoring programs, last approved on 11 May 2016. The ACP is situated between Bettys Creek in the north, the Hunter River in the south, Glennies Creek in the east and Bowmans Creek and its associated floodplain in the west. Bowmans Creek and Glennies Creek are tributaries of the Hunter River, while Bettys Creek is a tributary of Bowmans Creek. Monitoring of surface and ground water sites is conducted in accordance with the approved monitoring programs.

Ashton Coal is a zero discharge site. No water was discharged offsite during the reporting period. No compensatory water has been required or provided to private landholders in the reporting period.

## 7.1 Water Balance

ACP regularly monitors the water balance for the operation to assist in forecasting and modelling for different climatic and site scenarios. A series of flow meters and surveyed volumes are utilised to monitor the use and transfer of water between key water storages on-site. Water storages are surveyed on a regular basis to ensure the accuracy of water volume data. A schematic overview of the site's water management system can be found in Figure 8.

The water balance is reported annually in accordance with the Mineral Council of Australia's Water Accounting Framework for the Minerals Industry (2012) (MCA WAF) on a calendar year basis:

[http://www.minerals.org.au/file\\_upload/files/resources/water\\_accounting/WAF\\_UserGuide\\_v1.2.pdf](http://www.minerals.org.au/file_upload/files/resources/water_accounting/WAF_UserGuide_v1.2.pdf).

The MCA WAF allows sites to account for, report on and compare site water management practices in a rigorous, consistent and unambiguous manner that can easily be understood by non-experts. The MCA WAF focusses on the flows between the environment and the boundary of the operation i.e. the inputs, outputs and diversions.

### 7.1.1 Water Demands

The ACP has three main water demands:

- The supply for the Coal Handling and Preparation Plant (CHPP);
- The supply for underground operations; and
- The supply for above ground dust suppression.

A total of 2.8 million tonnes (Mt) of ROM coal was processed over the 2017 calendar year resulting in a CHPP total demand of approximately 740 ML, or 263 litres per feed tonne. Metered underground supply was 195 ML, while dust suppression use over the 2017 calendar year was measured to be 35 ML.

### 7.1.2 Inputs and Outputs

Rainfall/runoff and aquifer interception are the principal water resources for the ACP with approximately 253 hectares (ha) captured by the surface water management infrastructure on site during the reporting period. Over the 2017 calendar year, modelling indicates rainfall/runoff accounted for 34.9 per cent of the total water inputs to the water management system while groundwater interception and extraction accounted for approximately 42.7 per cent. Water sourced from the Hunter River and Glennies Creek accounted for 15.5 per cent while water entrained in the feed coal accounted for 7.2 per cent of the total water inputs. Major outflows from the ACP over the 2017 calendar year included evaporation (19.3 per cent), entrainment in product coal and rejects (38 per cent), loss from the underground (25.2 per cent) and seepage (17.6 per cent).

## 7.2 Water take and licencing

Department of Industry - Water (DoI-Water) requires water take to be reported over a financial year period (i.e. 1 July 2016 to 30 June 2017). Consequently, this water take section is reported in a manner consistent with this requirement.

ACP measures its water take in accordance with the approved WMP. Measured water take is partitioned in accordance with the protocol detailed within the WMP which incorporates a combination of site observations, measurements and predictions of the site Groundwater Model.

Water take occurs via two separate methods: incidental (or passive) take, and pumped surface water take. Incidental take occurs through mining induced fracturing of aquifers which report to the underground workings. This water is removed from the mine by a network of dewatering pumps. Pumped surface water take involves active pumping from Glennies Creek and the Hunter River to provide higher quality water for a variety of uses including potable water and irrigation of rehabilitation, use in equipment and as fire-fighting water at the mine.

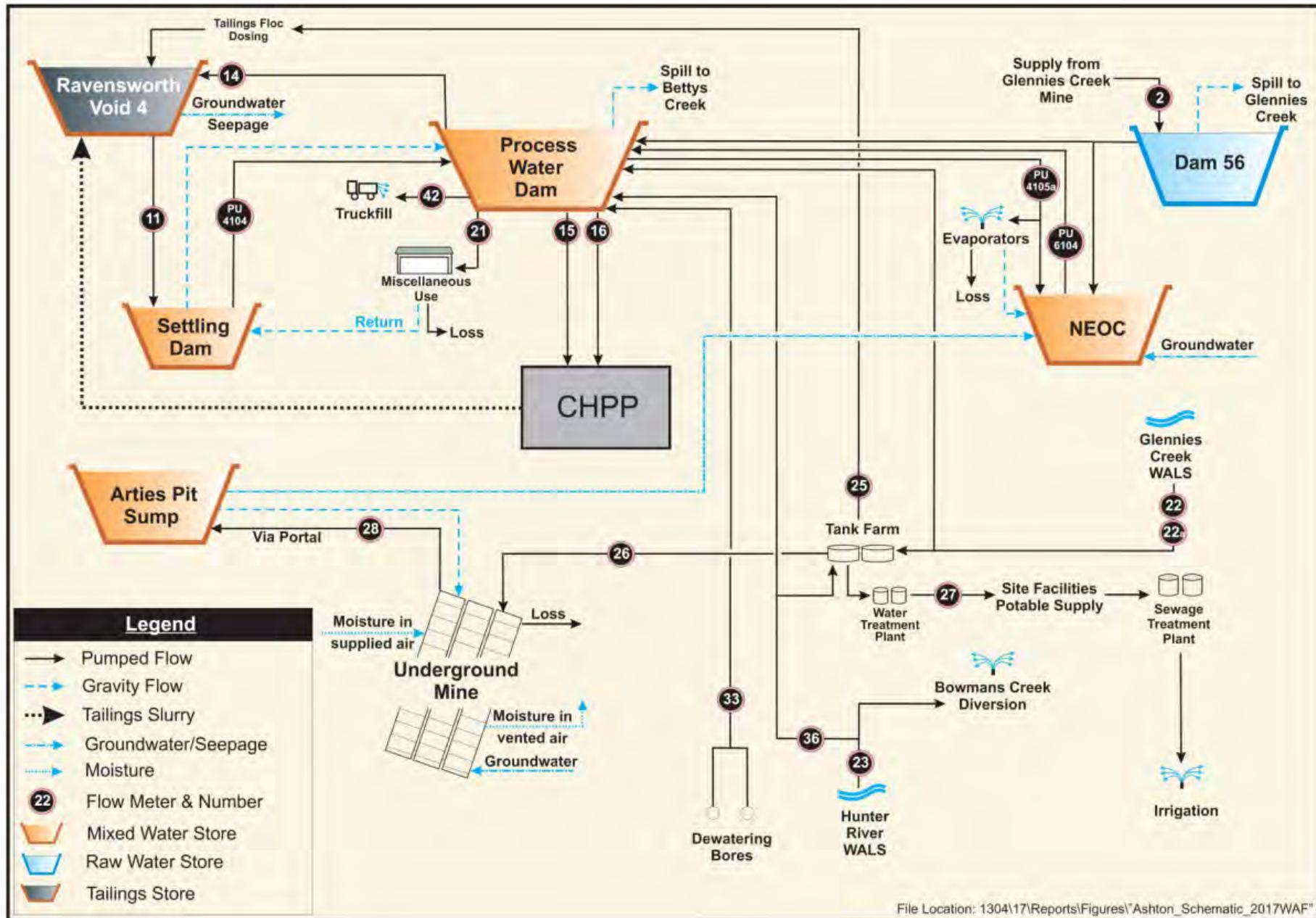
**Table 16 Water Management Act 2000 Licences and associated water take for FY17.**

Water Licence Number	DoI - Water Reference	Water sharing Plan, source and management zone	Entitlement (ML)	Passive take / inflows(ML)	Active pumping (ML)	Total (ML)
984	20AL201282	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	9			
997	20AL201311	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	11			
1120	20AL201624	Whole Water Source (Hunter Regulated River Water Source)	3			
1121	20AL201625	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Ck Junction)	335	4.52	4.94	9.46
1358	20AL203056	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	4			
6346	20AL203106	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Creek Junction)	15.5	1.35	0	1.35
8404	20AL200491	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	80	11.13	0	11.13
15583	20AL204249	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	354	28.07	239.34	267.41
19510	20AL211015	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Creek Junction)	130			
23912	20AL211423	Hunter Unregulated and Alluvial Water Sources 2009, surface water, Whole Water Source (Jerrys Water Source) (Bowmans Creek)	14			
29566	20AL212287	Hunter Unregulated and Alluvial Water Sources 2009, Aquifer,	358	16	0	16

Water Licence Number	DoI - Water Reference	Water sharing Plan, source and management zone	Entitlement (ML)	Passive take / inflows(ML)	Active pumping (ML)	Total (ML)
		Jerrys Management Zone (Jerrys Water Source)				
36702	20AL212975	Hunter Unregulated and Alluvial Water Sources 2009, Surface water, Jerrys Management Zone (Jerrys Water Source) (Bowmans Creek)	116			
36703	20AL212976	Hunter Unregulated and Alluvial Water Sources 2009, Surface water, Jerrys Management Zone (Jerrys Water Source) (Bowmans Creek)	150	13.23	0	13.23
TOTAL			1579.5	74.3	244.28	318.58

**Table 17 Water Act 1912 Licences and associated water take, FY17**

Water Licence Number	Water sharing Plan, source and management zone	Entitlement (ML)	Passive take / inflows (ML)	Active pumping (ML)	Total (ML)
20BL169508	Water Act 1912 Groundwater Licence	100	0	0	0
20BL173716	Water Act 1912 Groundwater Licence	511	223.7	0	223.7
20BL173735	Water Act 1912 Groundwater Licence	Nil - Monitoring Only	-	-	-



**Figure 8 Ashton Coal Water Schematic** \* All dams must have spillways constructed to ensure dam wall stability. Dams at the ACP are managed to prevent spills occurring.

### 7.3 Surface Water

#### 7.3.1 Environmental Management

Surface water at the ACP is managed in accordance with the approved WMP. Appropriate controls have been put in place to mitigate potential causes of water pollution. These controls are considered to have been adequate for the reporting period. Water quality for the creeks and rivers surrounding ACP operations is monitored by an independent consultant at 14 approved monitoring sites. The location of the surface water monitoring sites is shown in Figure 9 and described in Table 18. Analysis of all water samples collected is undertaken by a NATA accredited laboratory. Monthly water samples were collected and analysed during the reporting period for pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Total Suspended Solids (TSS).

The ACP WMP aims to minimise any adverse impacts on receiving waters downstream of operations; including Glennies Creek, Bettys Creek and Bowmans Creek, all of which drain into the Hunter River. The WMP also outlines measures for managing water on site. The approved surface water monitoring program has established impact assessment criteria, described as trigger values which, if activated, would lead to a response in terms of more intensive monitoring, investigation and if required, remedial action.

#### 7.3.2 Environmental Performance

The location of surface water monitoring sites and data capture rates are provided in Figure 9. SM1 and SM2 in Bettys Creek were dry, which is typical for this watercourse. A summary of the surface water quality data for statutory sites during the reporting period is provided in Table 19 and graphically in Figure 10 and Figure 11.

**Table 18 Surface water monitoring locations and data capture rates**

Site	Stream	Location	Data capture rate %
SM 1	Bettys Creek	Glendell land upstream of Ashton	25
SM 2	Bettys Creek	Just upstream of confluence with Bowmans Creek	25
SM 3	Bowmans Creek	Water pool at north west corner of mine lease	100
SM 4	Bowmans Creek	Water pool immediately downstream of New England Highway	100
SM 4a	Bowmans Creek	Former channel	100
SM 5	Bowmans Creek	Halfway down Ashton property	75
SM 6	Bowmans Creek	Just upstream of confluence with Hunter River	100
SM 7	Glennies Creek	Upstream of Ashton Mine	100
SM 8	Glennies Creek	Halfway down Ashton property	100
SM 9	Hunter River	Upstream of confluence with Bowmans Creek	100
SM10	Hunter River	Downstream of confluence with Bowmans Creek	100
SM 11	Glennies Creek	Upstream of confluence with Hunter River	100

Site	Stream	Location	Data capture rate %
SM 12	Hunter River	Downstream of confluence with Glennies Creek	100
SM 13	Hunter River	Upstream of confluence with Glennies Creek between Bowmans Creek and Glennies Creek	100
SM 14	Hunter River	Directly upstream of confluence with Glennies Creek	100

\*SM1 and SM2 in Betty's Creek were dry for most of the reporting period

pH results were generally consistent with the past two year's results.

Surface water pH measured in Bowmans Creek (SM3, SM4, SM4a, SM5 and SM6) were neutral and did not trigger response levels as detailed in the SWMP.

Glennies Creek (SM7, SM8 and SM11) pH levels were neutral to slightly alkaline throughout the year. The pH levels remained within the acceptable pH range and no trigger responses were required during the reporting period.

pH levels in the Hunter River (SM9, SM10, SM12, SM13 and SM14) were neutral to slightly alkaline with minimal variation between sites, and remained within the acceptable recommended pH range.

Surface water Electrical Conductivity (EC) results were generally consistent with results from 2015 and 2016.

Typical of previous years, Bowmans Creek sites (SM3, SM4, SM5 and SM6) generally experienced higher EC results compared to other monitoring sites. This is due to a natural inflow of saline ground water which forms most of the flow during dry months and low surface flow periods, resulting in increased EC levels.

Bowmans Creek EC levels fluctuated between 534 - 2430 $\mu$ S/cm. Elevated levels of EC at SM4 have been observed previously and result from natural saline groundwater inflows to the pool. During periods of low flow in Bowmans Creek, the saline groundwater discharge becomes the dominant supply of water to the pool resulting in increasingly elevated EC levels. EC levels greater than 10,000  $\mu$ S/cm have been historically observed at the site. Glennies Creek (SM7, SM8 and SM11) EC levels remained very consistent (most likely due to the consistency of flow from Glennies Creek Dam) and remain stable between monitoring sites.

Hunter River (SM9, SM10, SM12, SM13 and SM14) EC levels were generally low throughout the year, fluctuating between 283 and 1262  $\mu$ S/cm, as shown in Figure 10 and Figure 11.

An investigation was triggered by total dissolved solids (TDS) levels at monitoring site SM13 (Hunter River mid) in the latter part of 2017. An assessment was undertaken by an independent consultant to determine whether these elevated levels may be influenced by ACP activities. The investigation indicated the elevated salinity in the Hunter River was related to a reduction in the release of lower seasonal river flow, rather than any local effects from ACP.

The monitoring data collected during the reporting period continued to indicate that there are no adverse impacts from mining on surface water quality around the mine site.

**Table 19 Water Quality Summary, 2017**

Creek System		pH	EC μS/cm	TDS mg/L	TSS mg/L
Bettys Creek	Minimum	7.1	399	286	2
	Maximum	7.8	1154	697	70
	Average	7.5	721	468	25
Bowmans Creek	Minimum	6.7	534	285	1
	Maximum	8.3	2430	1450	174
	Average	7.7	1215	736	22
Glennies Creek	Minimum	7.6	209	125	2
	Maximum	8.3	364	434	27
	Average	7.8	710	226	8
Hunter River	Minimum	7.5	283	159	2
	Maximum	8.4	1262	714	74
	Average	8.2	797	485	24

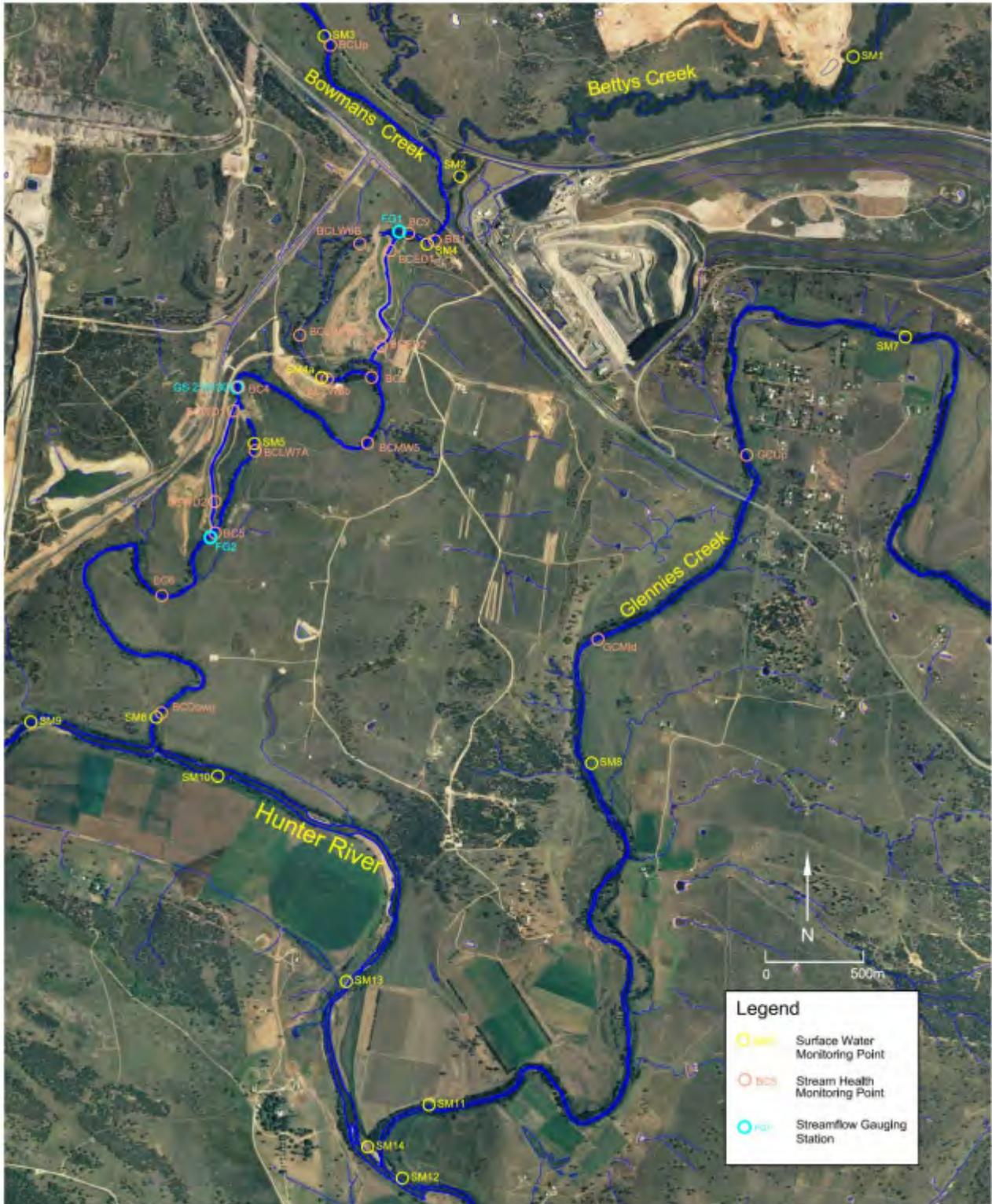


Figure 9 Ashton Coal surface water monitoring locations

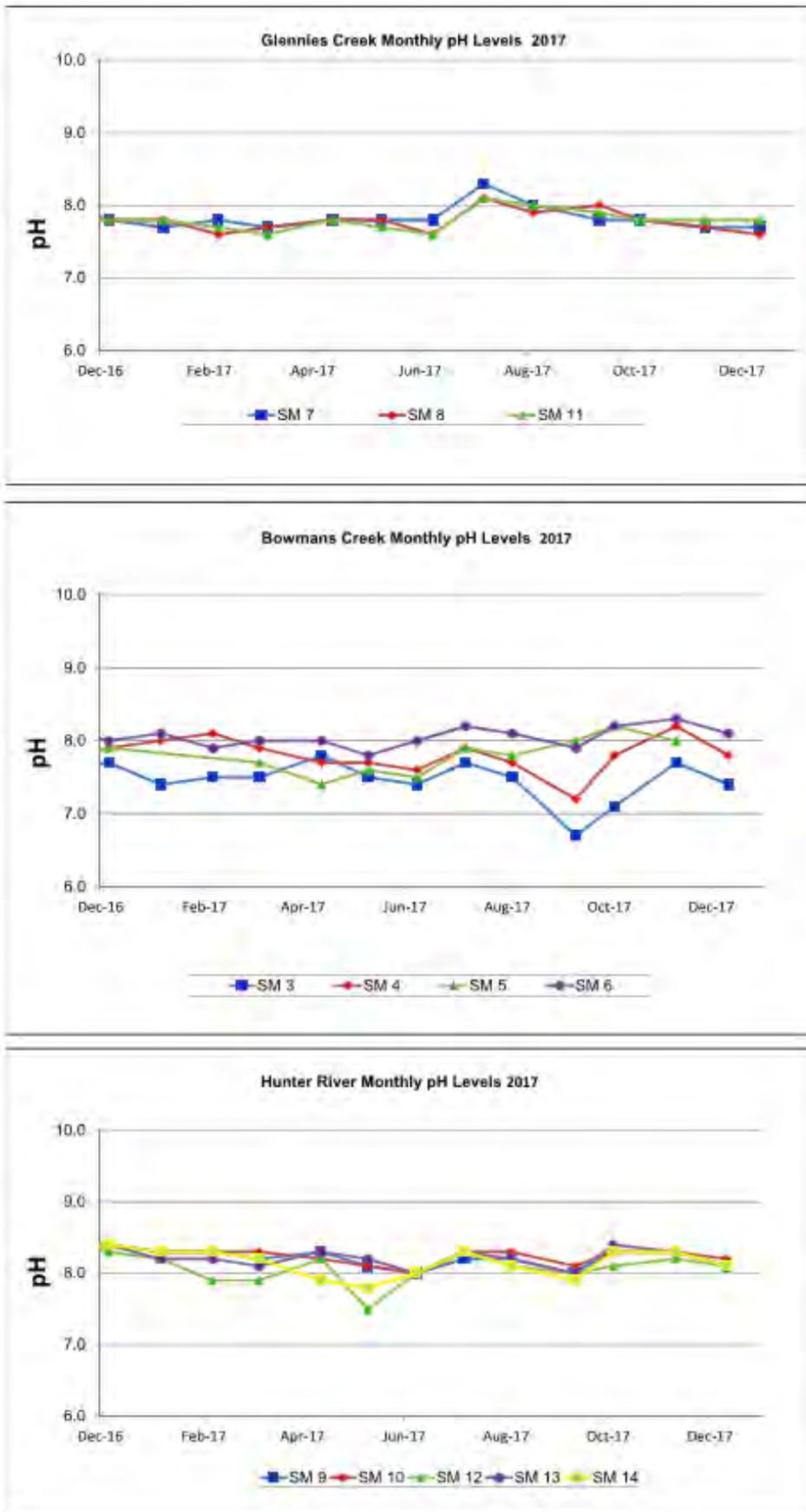


Figure 10 pH, Bowmans and Glennies Creeks and Hunter River

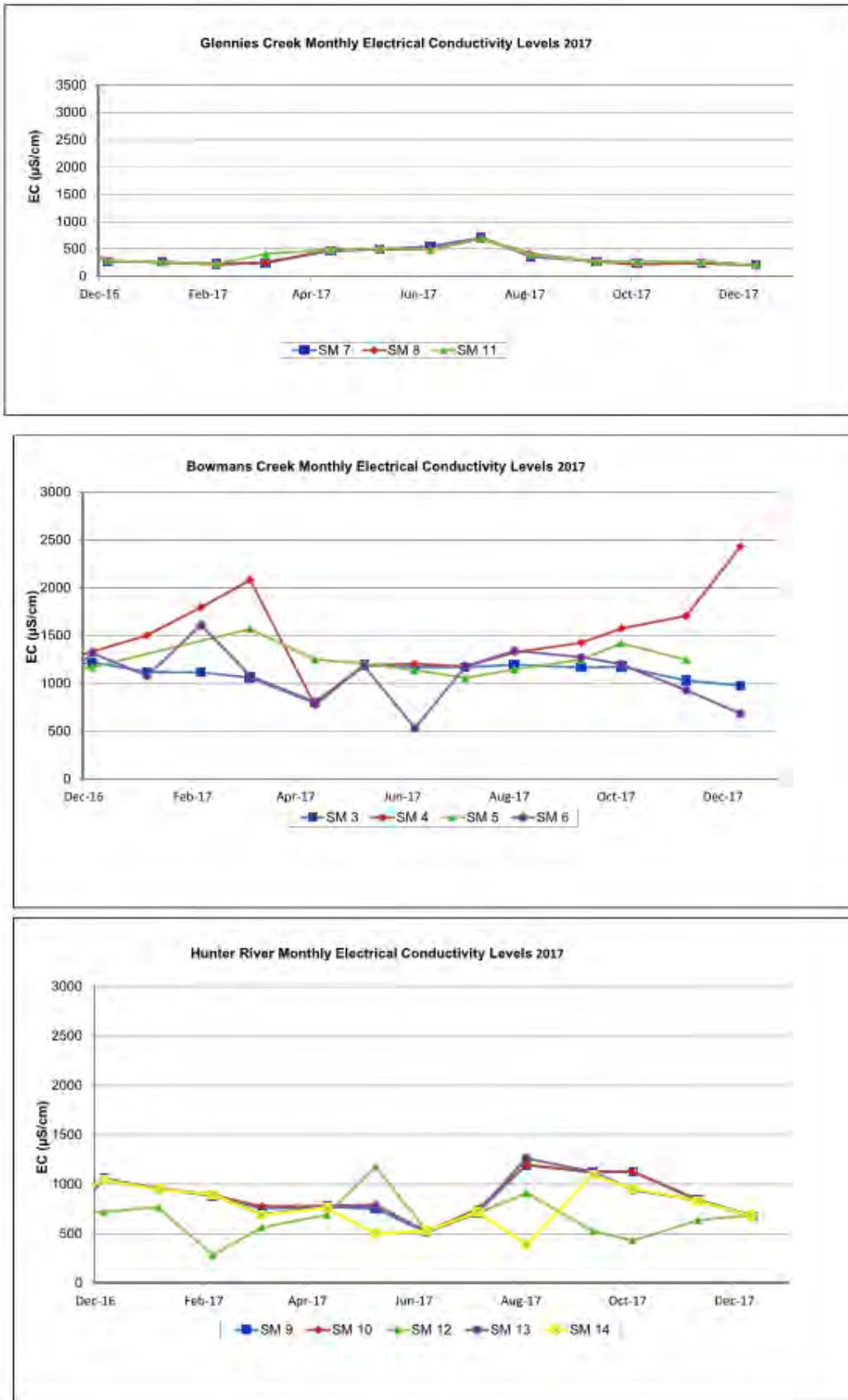


Figure 11 Electrical Conductivity, Bowmans and Glennies Creeks and Hunter River

## 7.4 Groundwater

### 7.4.1 Environmental Management

The location of the groundwater monitoring sites is shown in Figure 12. The monitoring network is spatially distributed across the underground mining area. Monitoring coverage is focussed in areas within and adjacent to the mining associated subsidence footprint, notably:

- Saturated quaternary sediments (alluvium) including Bowmans Creek Alluvium (BCA), Glennies Creek Alluvium (GCA) and Hunter River Alluvium (HRA).
- Shallow Permian sandstone and minor coal seams referred to in this report as coal measures overburden (CMOB).
- Permian coal measures of varying thickness targeted by mining.

The ACP WMP aims to minimise adverse impacts (other than those approved under the development consent) on aquifers in proximity to the operation, including the hard rock coal measures and the shallow alluvial deposits associated with the Hunter River, Glennies Creek and Bowmans Creek. The groundwater monitoring program includes groundwater level, piezometric pressure and field water quality parameters and has been carried out in accordance with the WMP approved in May 2016 and the requirements detailed under the conditions of Development Consent DA No. 309-11-2001-i and EPL 11879.

A groundwater model is utilised to predict impacts and changes to the hydrogeological regime of the site. During 2016 the groundwater model was updated and recalibrated using up to date monitoring data and mine plans. The model has worked well throughout the 2017 with no exceedances of impacts from those modelled and approved.

ACOL's approved groundwater monitoring program has established impact assessment criteria. Impact assessment criteria can be described as trigger values that, if exceeded, would lead to a response in terms of more intensive monitoring, investigation and ultimately if required remedial action.

Monitoring of water levels and water quality parameters is undertaken on a monthly basis at selected monitoring bores. Physical parameters – pH, EC and temperature are monitored quarterly and chemical speciation is undertaken on relevant bores annually.

Further information on groundwater management during 2017 can be found in Appendix 2.

During 2017, the Extraction Plan for Longwalls 201 – 204 was approved. This included a condition for Ashton Coal to undertake a technical review of historical groundwater impacts. This review will be completed and lodged with DPE in the first quarter of 2018.

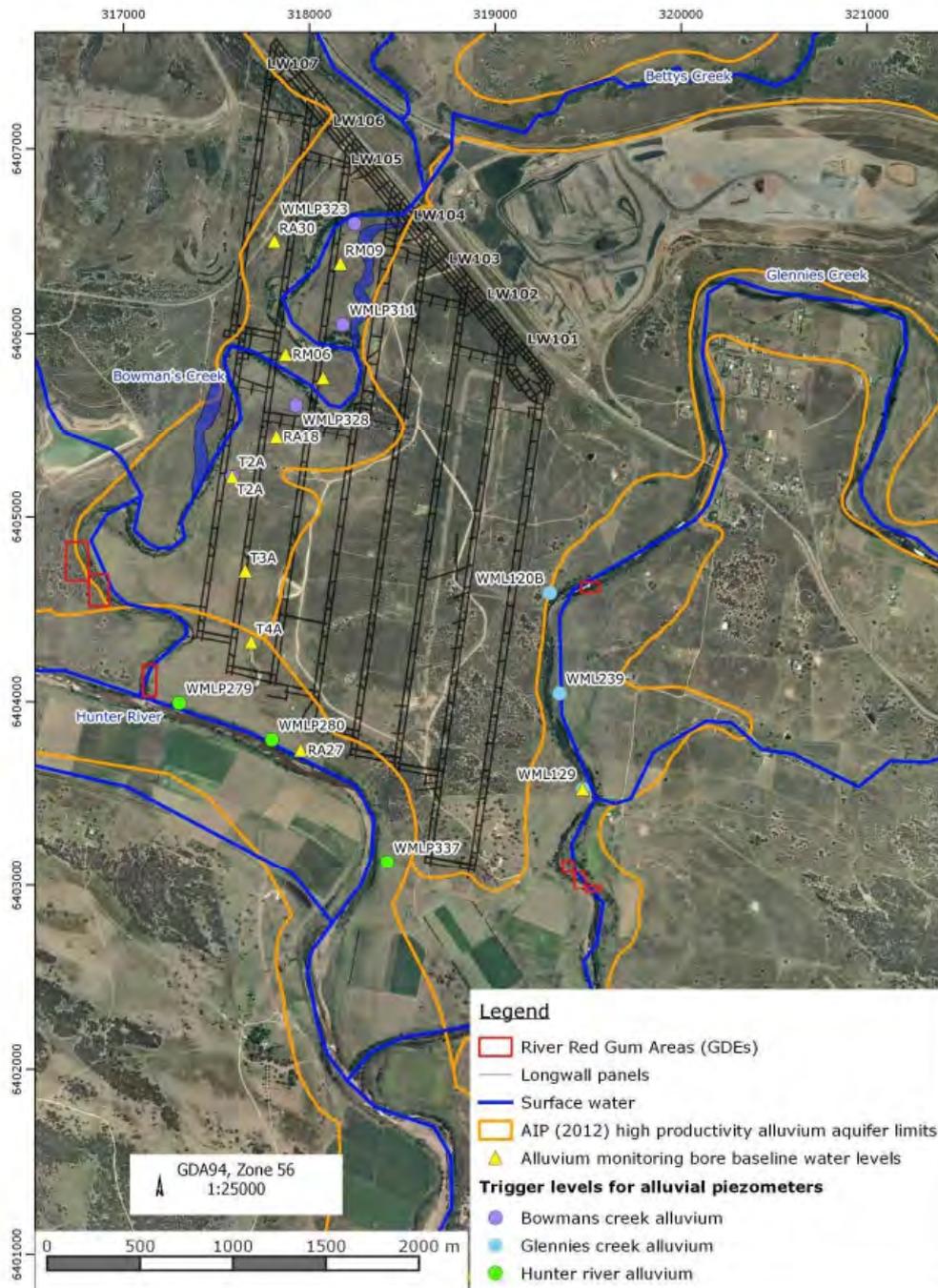


Figure 12 ACOL's groundwater trigger action response plan monitoring locations

## 7.4.2 Environmental Performance Summary

Groundwater monitoring over the 2017 reporting period was consistent with the requirements outlined in the WMP. A summary of the findings of the monitoring report are included below, with the full report contained as Appendix 2:

- Comparison of the data with the requirements of the WMP shows that there were no water quality (EC or pH) exceedances of the WMP criteria that triggered the TARP within the WMP, with the exception of the EC level in T3A. This is further discussed in Appendix 2.
- Groundwater levels in Bowman's Creek have declined throughout the year. The decline is generally in line with the Cumulative Rainfall Departure (CRD). Groundwater levels in the Hunter River and Glennies Creek have been stable.
- Alluvial groundwater levels showed a response to rainfall after several days of rain in April 2017, suggesting some groundwater recharge did occur.
- Groundwater levels in the coal seams and coal seam overburden above LW201 (ULLD) have generally remained stable and have not been impacted by longwall mining. There is minor decline of groundwater levels in WML183 (PG) of about 3.5 m and WML262 (ULD) of about 3 m, which is within the modelled predictions and approved limits.
- Groundwater levels in the alluvium and coal seam overburden above LW106A (ULD) show a response to rainfall recharge in April 2017. The trend analysis indicates that groundwater levels have not been impacted by longwall mining.
- All mining related groundwater level and quality impacts are within model predictions and approved limits.

## 8 Mine Subsidence

Underground longwall mining operations commenced in February 2007. Mining of the PG seam (LWs 1-8) and ULD seams LW 101 to LW 106A are completed. As at the end of the reporting period, operations are mining in LW 201 (in the ULLD Seam).

During the reporting period, mining operations occurred in LW 106A in the ULD seam and LW201 in the ULLD seam. Extraction of LW106A was completed in May 2017 and commenced in LW201 in July 2017 until the end of the reporting period. LW201 is forecast to be completed in approximately March 2018. Subsidence monitoring was undertaken in accordance with the relevant extraction plans- *Ashton Coal Project Upper Liddell Seam Extraction Plan, Longwalls 105-107* and the *Ashton Coal Mine Longwalls 201-204 Extraction Plan November 2016*. Monitoring included both regular survey monitoring and visual inspection of environmental, land and infrastructure features.

During the reporting period:

- LW106A completed extraction on 31 May 2017,
- LW201 commenced extraction on 7 July 2017 and continued for the remainder of the reporting period.

A small portion of Property 130 that was previously mined under in the ULD seam has been mined

under in the ULLD seam during the reporting period. A small farm dam is the only additional infrastructure that hasn't been previously undermined. There are no stacked edges under property 130 so tilts and strains are expected to be general background levels.

Prior to mining in LW201, some 132kv power poles were upgraded to better manage subsidence impacts in accordance with the Built Features Management Plan (BFMP).

There were no unexpected impacts to the environment or infrastructure during this reporting period.

The progress of ULD and ULLD LW extraction is shown in Figure 13 and Figure 14.

## 8.1 Subsidence Monitoring and Remediation

Monitoring of subsidence is conducted on the surface during the extraction of all Longwalls using longitudinal subsidence lines. Subsidence monitoring sections are located over the start and finish of each panel, a main cross line extending over all seven southern panels and a dedicated cross line extending over LW 6B, 7B and 8. All panels have monitoring data from each start and end line, and various cross lines relevant to panel, surface or strata features.

Table 20 outlines the maximum subsidence parameters predicted and recorded during regular survey of subsidence lines as the longwalls pass each location.

**Table 20 Incremental Subsidence Monitoring of LW106A and LW201, 2017**

	Incremental Subsidence (m)	Incremental Tilt (mm/m) (Stacked edge/general background)	Incremental Strain (mm/m) (Stacked edge/general background)
<b>Longwall 106A</b>			
Predicted SMP/EP	2.10	96/48	48/12
LW6CL1	0.76	19/10	17/6
LW106CL1*	1.50	41/5	25/6
LW6CL2	1.21	16/6	19/2
LW106CL2*	2.10	41/14	30/3
XL5	2.10	19/23	8/9
<b>Longwall 201</b>			
Predicted SMP/EP	2.50	150/76	76/43
LW1 CL1	2.86 <sup>^</sup>	17/11	9/5
LW101 CL1*	2.69 <sup>^</sup>	16/10	8/8
XL1	2.27	37/26	10/18
XL2	20mm	/2	/10
XL3	264mm	45/1	15/4
XL4*	2.50	37/33	20/18
XL5	2.40	69/30	48/11

**Table 21 Cumulative Subsidence Monitoring of LW106A and LW201, 2017**

	Cumulative Subsidence (m)	Cumulative Tilt (mm/m) (Stacked edge/general background)	Cumulative Strain (mm/m) (Stacked edge/general background)
<b>Longwall 106A</b>			
Predicted SMP/EP	3.80	174/87	87/22
LW6CL1	2.26	40/26	24/9
LW106CL1*	1.50	41/5	25/6
LW6CL2	2.53	44/8	30/7
LW106CL2*	2.20	42/14	31/3
XL5	3.10	25/23	5/10
<b>Longwall 201</b>			
Predicted SMP/EP	5.70	350/120	170/74
LWCL1	5.46	43/23	17/11
LW101 CL1*	4.91	31/21	22/28
XL1	4.92	66/55	16/45
XL2	35mm	/4	/9
XL3	490mm	79/2	25/7
XL4*	3.99	42/61	20/23
XL5	5.42	142/70	58/28

\* Double goaf centre-lines installed or Cross-line extended after extraction of Pikes Gully seam, therefore final measured data excludes previous subsidence due to the extraction of PG seam longwalls.

^Measured over the edge (double) goaf zone of Pikes Gully LW1

The latest subsidence monitoring survey of LW 106A indicate a maximum of 3.1m of subsidence has been measured, which is less than predictions. The maximum measured values of tilt and strain are lower than the predicted maxima at the completion of mining LW 106A.

To manage subsidence impacts the 132kV power poles were reassessed and replaced with concrete poles prior to longwall extraction. The power lines have been fitted with rollers prior to longwall extraction. Visual and survey monitoring of the 132kV transmission line power poles was undertaken regularly whilst mining LW 201. Consistent with the 2016 AR, maximum subsidence of power poles were within stated predictions. There has been no adverse impacts on the power poles and the transmission line remains serviceable.

During the reporting period the Right of Way (ROW) access to Property 130 and Property 130 was undermined by LW 201, along with some fences and gates and a small farm dam. This infrastructure was predicted to suffer perceptible subsidence impacts (e.g. surface cracking). The section of access road was closed off prior to undermining and an alternate access was adopted, with a suitable detour being activated. Remediation works were completed and the ROW reopened. Fences within Property 130 were retensioned following subsidence, and gates re-hung where required. The farm Dam was repaired following the cracking experienced as a result of the subsidence.

Rehabilitation of the surface cracks has been occurring as extraction continues with a small excavator smoothing cracks. Affected surface roads have been repaired to smooth compression humps and minor cracks.

Ponding has become evident in some subsided areas after rainfall events, typically in those areas which were flat pre-mining. Remediation is planned in consideration of the currently approved multi seam mining which will see the same area undermined for up to four times. Presently, the ponding does not present a significant risk and serves as a water source for stock which graze over the lease. Some areas of ponding were rehabilitated or redirected during the reporting period to allow for continued safe road access around the property.

In general, the maximum subsidence movements detected were less than those predicted. There is no indication of any significant lateral movement of the steep slope adjacent to Glennies Creek or of the New England Highway road cutting (to date).

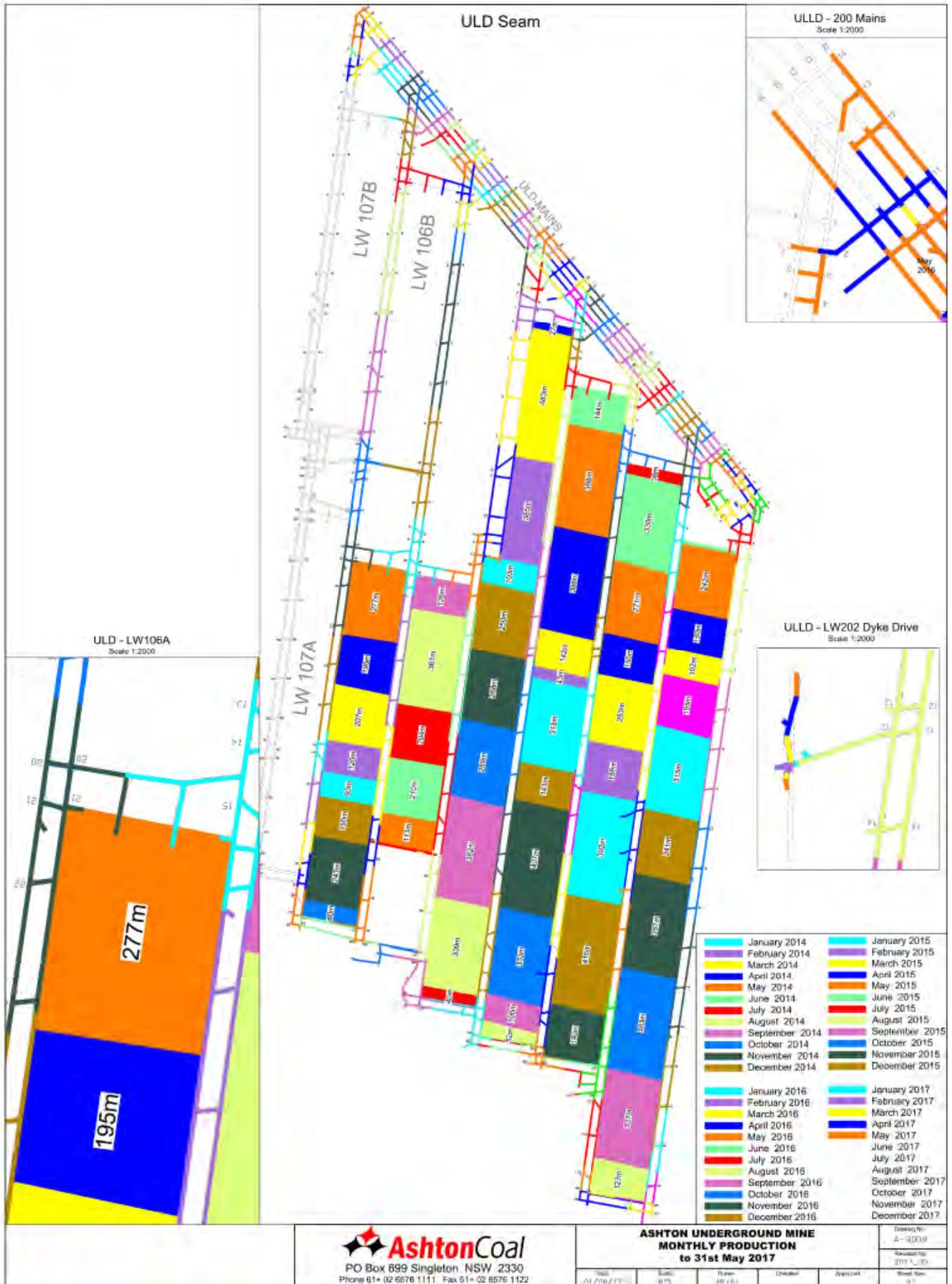


Figure 13 Production in ULD seam to May 2017

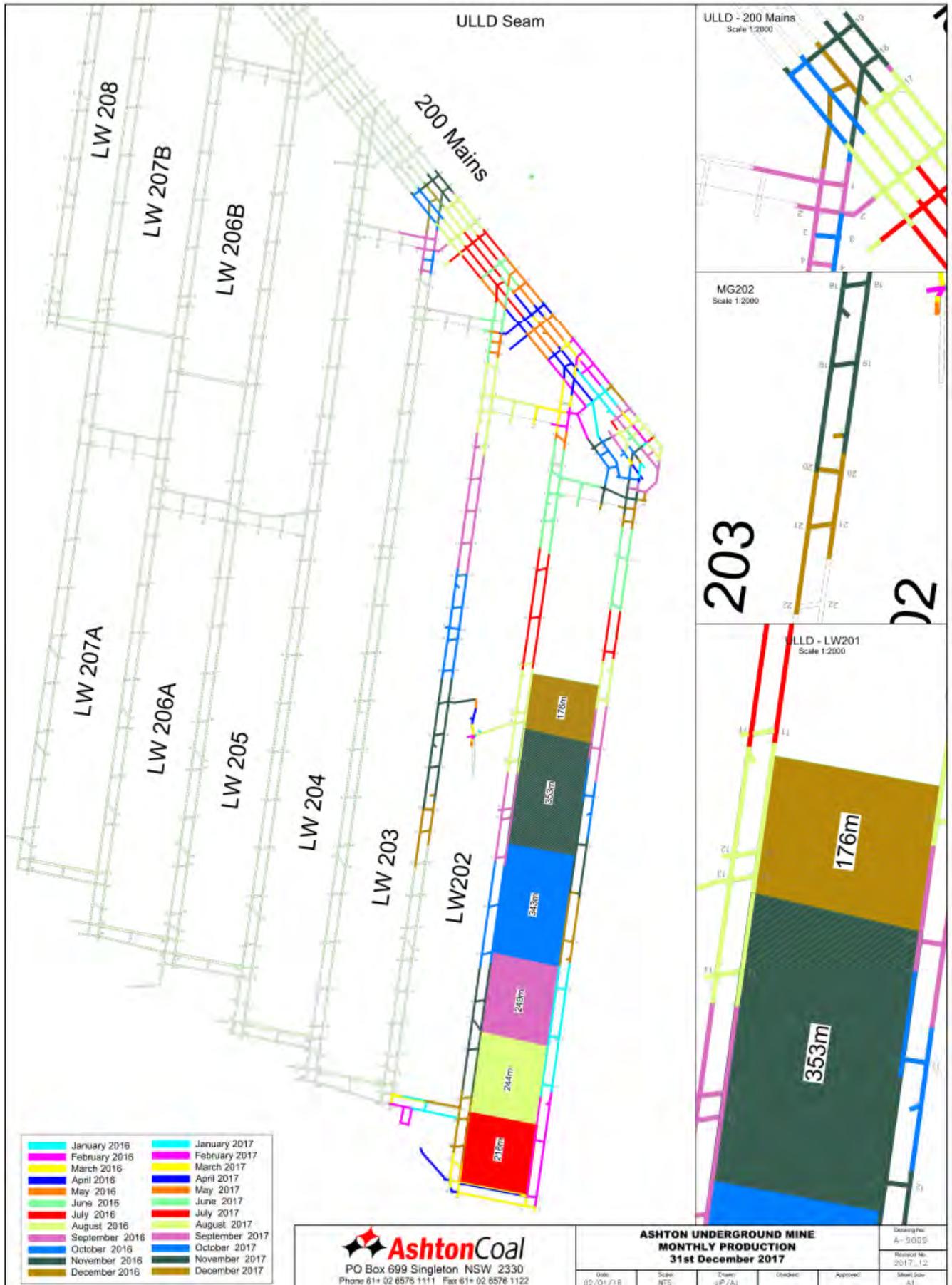


Figure 14 Production in ULLD Seam to December 2017

## 9 Rehabilitation and Land Management

Rehabilitation and land management activities undertaken are outlined in the MOP amendment C, issued in March 2017. There were no notable variations in activities when compared with the MOP.

Consistent with the MOP, there were no areas of rehabilitation relinquished or signed off by DRE during the reporting period.

During the next reporting period, rehabilitation will be monitored and maintenance conducted as required.

There are four main primary domains (or land management units) under active rehabilitation, monitoring and maintenance:

- Bowmans Creek Riparian Zone – which includes the excised sections of Bowmans Creek and the River Red Gum population south of the diversions.
- Bowmans Creek Diversion – rehabilitation monitoring of the diverted creek sections is continuing in accordance with the commitments made in the Bowmans Creek Diversion Environmental Assessment, water management plan and MOP.
- Farmland above the underground mine – effective land management to ensure the land remains viable farmland is the focus over this area, which is managed in accordance with the MOP and the Flora and Fauna Management Plan (FFMP).
- North East Open Cut – rehabilitation has been completed in this area, monitoring and maintenance activities are ongoing in accordance with the MOP and the FFMP.

The MOP defines rehabilitation phases for each domain, and the completion criteria for each phase. For each domain, specific performance indicators have been established to allow the progress of rehabilitation to be measured. Consistent with MOP requirements, the performance indicators and current condition (measured during the 2017 rehabilitation monitoring) are described tables under each subheading.

### 9.1 Bowmans Creek Riparian Zone

Results from the Bowmans Creek Riparian Zone (BCRZ) monitoring events recorded 100 flora species, 30 native and 70 exotic. *Casuarina cunninghamiana* (River Oak) was the dominant canopy species for the majority of the surveyed areas. Trees were up to 10m in height with many saplings and seedlings observed in the survey. Midstorey and shrub strata were poorly developed throughout the survey areas with a small number of species identified. Natural recruitment of native species in these strata including *Acacia salicina* (Cooba) and *Melia azedarach* (White Cedar) were observed at a few locations where conditions were suitable while *Brachychiton populneus* (Kurrajong) was observed all along the BCRZ. The ground cover and forb strata were predominantly exotic species, which is not unexpected given the previous land use of the area.

Environmental and listed weed species were prevalent throughout the BCRZ and were identified as the single biggest threat to natural recruitment and regeneration of native species. Weeds of particular note included *Populus nigra* (Lombardy Poplar), *Morus alba* (White Mulberry) and *Salix*

*spp.* (Willow) in the canopy strata, with *Lyceum ferocissimum* (African Boxthorn) and *Ricinus communis* (Castor Oil Plant) dominate the shrub layer despite obvious ongoing weed control efforts. The three vine species *Anredera cordifolia* (Madeira Vine), *Araujia sericifera* (Moth Vine) and *Cardiospermum grandiflorum* (Balloon Vine) were recorded at multiple locations and pose a significant threat to both existing vegetation and regeneration. These weeds have been targeted in the Weed action plan during 2017 and also planned for control during 2018.

Erosion was observed in a few isolated ephemeral tributaries where notching and undercutting is occurring. Feral animal activity in the form of pig ruts were widespread and one feral pig was observed. Nest boxes were not observed at any point during the surveys, although there are a small number of hollows in some old growth River Oak trees.

The *Eucalyptus camaldulensis* (River Red Gum) population dominates the canopy along a relatively short (approximately 350m) section of Bowmans Creek on the southern reaches. Scattered individuals were recorded between this section and the junction with the Hunter River. The population is judged to be in good health with ten old growth trees (diameter >200cm), 12 mature individuals or groups of trees (diameter >100cm and <200cm) and 28 individual or groups of saplings and seedlings (>100cm diameter). This last category ranged in height from 0.5m to 7m in height and represents several different ages of saplings (age for height) suggesting a number of recruitment episodes. The planting of River Red Gums have maintained approximately the same numbers between surveys.

Overall the health of the BCRZ and River Red Gum population was considered to be good with natural recruitment evident throughout Bowmans Creek. Weeds and the disruptive effect of feral pigs are the two biggest threats to the continuing improvement of Bowmans Creek. The BCRZ is in Phase 4 - Ecosystem and Landuse Establishment and is judged to have achieved the control of stock and vehicular access criteria, not achieved the invasive species criteria and habitat enhancement criteria (i.e. nest box installation) and partially achieved, or on the trajectory to achieving, the vegetation establishment criteria. (See Table 22)

Recommendations made were for increased weed and feral animal control measures with the possibility of coordination with adjoining property owners, installation of nest boxes as per the FFMP and investigation of the identified erosion to determine if any remedial action is required.

**Table 22 Bowmans Creek Riparian Zone Performance Criteria (Ecosystem and Landuse Establishment)**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Limit soil compaction and the spread of weeds by minimising site access by vehicles and stock	Fencing	Adequate fencing is installed and maintained.	Vehicle access is restricted to nominated site access roads as far as practical. Stock is excluded.	ACOL Weed Management Plan Noxious Weeds Act 1993	Achieved – Fencing is satisfactory and stock access restricted
Invasive species, weeds and feral animals are effectively controlled or eliminated	Distribution and density of weeds.	Annual Weed Inspection and findings reported in AEMR.	Weeds and pest animal species, and abundance are comparable to analogue sites.	FFMP	Not Achieved – Weeds control activity apparent but requires further works and control of key invasive species
	Distribution and number of feral animals.	Annual vertebrate pest survey and findings reported in AEMR.			
	Damage caused by feral animals.				
The rehabilitated landscape is enhanced using best available practices and materials.	Provision of nest boxes.	Installation of nest boxes reported in AEMR.	Nest boxes established at a ratio of 1:3 in accordance with the FFMP.	FFMP	No nest boxes observed
		Nest boxes monitored annually and results reported in AEMR.	Nest boxes established are monitored and maintained.		
Safety risks are eliminated as far as reasonably practicable.	Bushfire hazard.	Bushfire hazard reduction activities reported in AEMR.	Fire breaks and perimeter trails are maintained. The bushfire hazard is managed in accordance with the ACOL EMS.	Rural Fires Act 1997	Not the focus of this report
Establish vegetation profile consistent with the planned final landuse.	Revegetation species mix applied in accordance with Table 21 of the MOP.	Reporting and monitoring protocol as per the Bowmans Creek Diversion Rehabilitation Strategy (ACOL, e) employing a modified vegetation complexity assessment method (Newsome & Catling 1979).	Species mix used aligns to the intended final land use.	Bowmans Creek Diversion Rehabilitation Strategy (ACOL, e)	Partially Achieved – Natural regeneration is occurring, some midstorey and shrub species observed. Planted River Red Gums surviving River Oak Forest areas are regenerating
			Groundcover includes tussock grass clumps, areas of open ground and fallen timber.		
	Mid-stratum is very open to sparse, > 2 metres in height.				
	Over-storey structure ranges from forest (i.e. riparian corridor) to woodland (i.e. floodplain areas), with a diverse yet clumped species composition consistent with reference sites.				
	Structural complexity scores.				

## 9.2 Bowmans Creek Diversion Rehabilitation Monitoring Program

Construction of the Bowmans Creek Diversion (BCD) was completed in November 2012, with revegetation plantings commencing that year to establish two vegetation communities (River Oak Forest and Red Gum Woodland) within the BCD rehabilitation area.

Rehabilitation monitoring is conducted annually by independent ecological consultants to provide details of the current condition of planted trees and shrubs, total vegetation and weed coverage and extent of any erosion issues or concerns that may affect the success of the revegetation.

A combination of permanent monitoring quadrats and photographic points to track vegetation growth and coverage, erosion transects and Landscape Functional Analysis (LFA) is used to determine the progress of revegetation and ecosystem function. Eleven monitoring quadrats have been established. Monitoring was performed in May through June and again in October.

The 2017 monitoring recorded 67 species, of which 29 were native and 38 were exotic. A large proportion of the native species identified were the planted canopy, midstorey and shrub species. When compared to results of previous years, this shows a gradual influx of species into the rehabilitated area, as expected. No listed or environmental weeds were observed with the BCD planting areas, although numerous weedy herbs and forbs were observed.

**Table 23 Number of species recorded in the BCD, 2015 to 2017**

	2015	2016	2017
Total species recorded	50	43	67
Native	16	14	29
Exotic	34	29	38

The canopy plantings have stabilised in terms in survival and continue to exhibit good growth, with individual River Oak trees estimated to be up to 8m in height. The Forest Red Gum Woodland plantings have also stabilised, with numbers consistent for the last three surveys. Midstorey and shrub species are very sparse with only a few individuals surviving, although *Acacia falcata* (Hickory Wattle) has flowered and seeded in the past. Density of the planted areas is well above forest and woodland densities indicating that no further planting of canopy is required.

Towards the end of 2017, some of the River Oaks along the BCD have been observed to be browning off due to drought. This is a natural occurrence visible up and downstream of the diversion and is not expected to cause any issues with the regeneration of the diversion.

In terms of the physicochemical processes associated with the rehabilitation as measured using Landscape Functional Analysis and compared to Woodland Analogue values, the River Oak Forest Community has achieved all benchmarks, while the Forest Red Gum Community requires more time to mature and develop the necessary litter layer and nutrient cycling to achieve the benchmarks. The one area of concern for the BCD is the Western Diversion, east bank where the shallow topsoil and aspect has limited the establishment of both groundcovers and canopy.

The BCD revegetation program has largely been successful and now moves into its second phase where species diversity is increased. In terms of the Performance Criteria outlined in the MOP, the BCD is in *Phase 4 - Ecosystem and Landuse Establishment*. There are 10 criteria measured as part of this survey. The BCD revegetation has achieved six of the 10 criteria and partially achieved two. The

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two that have been assessed as not achieved include weed densities with the caveat that weed control will always be ongoing and the final criteria requiring several more years for the vegetation community to mature.

**Table 24 Bowmans Creek Diversion Performance Criteria (Ecosystem and Landuse Establishment)**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Limit soil compaction and the spread of weeds by minimising site access by vehicles and stock.	Fencing	Adequate fencing is installed and maintained.	Vehicle access is restricted to nominated site access roads as far as practical.	ACOL Weed Management Plan Noxious Weeds Act 1993 Australian and NSW Weed Strategies	Achieved Fencing is intact and in good condition restricting access to designated tracks. Tracks are well delineated and maintained.
			Stock is excluded.		Achieved Stock have been successfully excluded.
Invasive species, weeds and feral animals are effectively controlled or eliminated from site.	Distribution and density of weeds	Annual Weed Inspection and findings reported in AEMR.	Weeds and pest animal species, and abundance are comparable to analogue sites.	Rural Lands Protection Act 1998 FFMP	Partially Achieved - Ongoing Control efforts are being undertaken – weed control is and will be an on-going task.
	Distribution and number of feral animals	Annual vertebrate pest survey and findings reported in AEMR.			Comment to be supplied by ACOL
	Damage caused by feral animals				Achieved No evidence of feral animal damage in the planted areas
Safety risks are eliminated as far as reasonably practicable.	Bushfire hazard	Bushfire hazard reduction activities reported in AEMR.	Fire breaks and perimeter trails are maintained.  The bushfire hazard is managed in accordance with the ACOL EMS.	Rural Fires Act 1997	Not the focus of this survey
Establish vegetation profile consistent with the planned final land use.	Revegetation species mix applied in accordance with MOP Table 22	Rehabilitation/planting activities reported in AEMR including date of seeding and species mix used.	Species mix used aligns to the intended final land use.	Florabank Guidelines (1999)	Achieved Species that have been planted to date are in accordance with Table 22 of the MOP.

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
					Numbers and dates of plantings to be supplied by ACOL.
	Structural complexity scores	Reporting and monitoring protocol as per the Bowmans Creek Diversion Rehabilitation Strategy (ACOL, e) employing a modified vegetation complexity assessment method (Newsome & Catling 1979).	Groundcover includes tussock grass clumps, areas of open ground and fallen timber.	Bowmans Creek Diversion Rehabilitation Strategy (ACOL, e)	Not Achieved As per Bowmans Creek Diversion Rehabilitation Strategy (ACOL, e) Groundcover still predominantly composed of exotic grasses and herbs
			Mid-stratum is very open to sparse, > 2 metres in height.		Partially Achieved Established mid-storey species are very sparse. Many are now > 2 m tall at this stage, and are mature. Requires more diversity.
			Over-storey structure ranges from forest (i.e. riparian corridor) to woodland (i.e. floodplain areas), with a diverse yet clumped species composition that is consistent with reference sites.		Achieved Overstorey establishment has been largely successful. River Oak Forest overstorey successful, Red Gum Woodland successful. But this community is still young and requires time to mature.
			Structural complexity scores are broadly comparable to reference sites.		Not Achieved - Yet Revegetation is in Phase 2 (3 - 6 years) of a long term rehabilitation project. Vegetation is still too young to be compared to mature reference sites.

### 9.3 Bowmans Creek Diversion Management

The two reaches of the BCD (Eastern and Western), have been constructed in the underground mining area as shown in Figure 9. Construction commenced on the Eastern diversion in March 2011 and on the Western diversion in February 2012. Both were commissioned with flow through each diversion in November 2012. Temporary low level block banks have been constructed across the original channel of Bowmans Creek, directing low flows into the diversion reaches. High (flood) flows are designed to overtop the temporary block banks in order that such flows not pass through the diversion until full vegetation establishment. The construction program has been completed (engineering sign off obtained) with the exception of permanent block banks which will be constructed one year prior to mining LW 106B (in the ULD Seam).

The vision for the diversions, outlined in the Bowmans Creek Rehabilitation Strategy, is to establish an ecologically healthy riparian corridor between the New England Highway and the Hunter River, on land owned by ACOL. Fulfilment of this requirement includes the construction, landscaping and ongoing monitoring and management which, compared to the characteristics and conditions of the pre-diverted creek, will provide:

- flow channels that mimic the hydraulic and geomorphic characteristics and provide similar resilience;
- for fish passage and a diversity of aquatic habitat;
- an enlarged area of ecologically diverse, naturally vegetated, riparian corridor; and
- a free draining floodplain that is vegetated to a standard consistent with the final intended land use.

In addition to general land management and environmental monitoring, there are a number of rehabilitation and monitoring commitments specific to the BCD that are reported in this AR, as shown in Table 25.

**Table 25 Bowmans Creek Diversion Commitments**

Commitment	Status	Further detail
Survey of bed and banks including bed samples at six months, one year, two years and at five yearly intervals, or after a flood with a peak flow of greater than 150m <sup>3</sup> /s. (Development consent, Appendix 3, Mod 6, commitments 7.1 and 7.2)	The last survey was carried out in 2014, and is next due in late 2017.	The report will be finalised in early 2018.
Fish passage and aquatic ecology in stream diversions are monitored and remain within acceptable levels, or appropriate remedial measures considered.	Fish results detailed in section 6.4.2 demonstrate that the diversion channels have continued to provide fish passage during periods of extended flow and provide refuge habitat during periods of low flow.	See section 6.4.2
Community structure in the diversion channels are monitored bi-annually to record growth rates, species abundance as well as percentage cover to determine a final structural complexity index.	Annual monitoring was undertaken in 2017.	See section 6.4.2 and 9.2

#### 9.4 Farmland rehabilitation monitoring (pastures above underground mining)

The Pasture – Underground Mining area monitoring is designed to determine if mining subsidence is having an effect on pasture productivity. This year's survey demonstrates that the effect is limited and localised to a few small areas of subsidence. *Allocasuarina luehmannii* (Bulloak) regeneration, the presence of other canopy species, weed infestations and anthropogenic disturbance such as infrastructure construction are having a larger effect. On the higher country the mainly native grass pastures are being colonised by *Hyparrhenia hirta* (Coolatai Grass) and by Bulloak which is facilitating the spread of African Boxthorn and reducing the pasture areas. On the lower alluvial flat country adjacent to Bowmans Creek it is the spread of weeds such as *Silybum mauritianum* (Variegated Thistle) that is affecting pasture productivity. The weed action plan for 2017 continued to address the most important weed management areas and species, and will continue through 2018.

LFA indices recorded from three transects show that physicochemical processes are equivalent to the analogue areas and are unaffected by mining. Land capability has also been assessed as not affected by underground mining.

The performance criteria places the Pasture – Underground areas in *Phase 5 - Ecosystem and Landuse Sustainability*, which has six associated performance criteria. Five of these criteria have been assessed as being achieved, with one – weed control, as partially achieved.

The Trees over Grass (ToG) domain encompasses areas of remnant canopy, natural regrowth and wholly planted corridors linking the Southern Voluntary Conservation Area (SVCA) to the south with Bowmans Creek to the north, and Glennies Creek to the east. As such the largest impediment to developing functional habitat is cattle grazing of young canopy trees, a lack of structural diversity in most areas of the domain, and competition from weeds (i.e. African Boxthorn and African Olive in particular). Some minor subsidence was observed, but was not having an adverse effect upon vegetation.

Recommendations for the management of this domain include the erection of stock exclusion fencing to facilitate natural revegetation, an increase in weed control efforts, a modest planting/seeding program to increase diversity, and investigation of the installation of nest boxes to facilitate fauna colonisation.

Vegetation in this domain currently represents two phases of rehabilitation. Where remnant, advanced regrowth or advanced revegetation was observed, (i.e. Eastern Corridor) the domain is deemed to be in *Phase 5 - Ecosystem and Landuse Sustainability*. Other less developed vegetation is considered *Phase 4 - Ecosystem and Landuse Establishment*.

Phase 4 requires four relevant criteria to be met. The ToG domain has been assessed as achieving the *vegetation profile* criterion in the Eastern Corridor, but only partially this requirement in the Western and Central Corridors, and not achieving the requirement for *distribution and density of weeds* across all three corridors. .

The ToG community in Phase 5 rehabilitation has partially achieved the five performance criteria relating to foliage cover, diversity, density, vegetation health and evidence of reproduction.

**Table 26 Pasture over Underground performance criteria (Ecosystem and Landuse Sustainability)**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Restored and maintained to the same or higher land capability and agricultural suitability than prior to mining	LFA Organisation Index	Annual Rehabilitation Monitoring Report	Performance indicator is broadly comparable to that of analogue sites.	CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004) DA Schedule 2, Condition 3.55	Achieved
	LFA Stability Index				Achieved
	LFA Infiltration Index				Achieved
	Land Capability Class		Field data results are used to define land capability and include: Climate Soil texture Position Slope Erosion pH Drainage Rock	DA Schedule 2, Condition 3.55	Achieved
Final Landform is sustainable and resilient to environmental pressures	Weed species abundance and diversity		Performance indicator is broadly comparable to that of analogue sites		Partially achieved - African Boxthorn, African Olive and other weed species are common on both analogue and pasture areas
	Groundcover				Achieved

**Table 27 Trees over Grass performance criteria, Underground mining area (Ecosystem and Landuse Establishment)**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Invasive species, weeds and feral animals are effectively controlled or eliminated from site	Distribution and density of weeds	Annual Weed inspection and findings reported in AEMR	Weeds and pest animal species and abundance are comparable to analogue sites	<i>ACOL Weed Management Plan</i> <i>Noxious Weeds Act 1993</i> Australian and NSW Weed Strategies TSC Act – Key Threatening Processes <i>Rural Lands Protection Act 1998</i> FFMP	Not Achieved – African Boxthorn and Olive are widespread, weed control measures are evident but require continual effort as a matter of urgency
	Distribution and number of feral animals	Annual vertebrate pest survey and findings reported in AEMR			None Observed
	Damage caused by feral animals				
Safety risks are eliminated as far as reasonably practicable	Bushfire hazard reduction works	Bushfire hazard reduction activities reported in AEMR	Bushfire management activities undertaken in accordance with the consent agreement	<i>Rural Fires Act 1997</i>	Achieved – firebreaks were maintained throughout the reporting period.
Establish a vegetation profile consistent with the planned final land use	Revegetation species mix applied in accordance with MOP Table 22	Rehabilitation/planting activities reported in AEMR including date of seeding and species mix used.	Species mix used aligns to the intended final land use.	DA Schedule 2, Condition 3.49	Partially achieved – West and Central Corridor natural regeneration of some of the common canopy species is occurring, but shrub species are largely absent East Corridor - Achieved

**Table 28 Trees over Grass performance criteria, Underground Mining area (Ecosystem and Landuse Sustainability)**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Ecological Diversity will be maintained or enhanced	Foliage Cover	Annual Farm Land Report	Vegetation structure & complexity is broadly comparable to that of analogue sites	CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004) DA Schedule 2, Condition 3.55  DA Schedule 2, Condition 3.55	Partially achieved – Eastern corridor - Achieved West and Central corridors – Partial – shrub layer is largely absent due to grazing
	Tree Diversity		Diversity of maturing tree and shrub species is broadly comparable to that of analogue sites		Partially achieved – Eastern corridor - Achieved West and Central corridors – Partial – shrub layer is largely absent due to grazing, or Bulloak monocultures hinder diversity
	Tree Density		Density of maturing tree and shrub species is broadly comparable to that of analogue sites		Partially achieved – All areas East corridor – denser due to young age West & Central – too sparse in places or denser due to Bulloak monocultures
	Tree Health/condition		Vegetation condition is broadly comparable to that of analogue sites		Partially achieved – Eastern corridor - Achieved West and Central corridors – Partial due to grazing and compaction
	Flowers, fruit, new growth				
	LFA Organisation Index				
LFA Stability Index					
LFA Infiltration Index					
Ecosystem function is restored					

## 9.5 North East Open Cut rehabilitation monitoring program

Open cut mining operations in the NEOC ceased in late 2011, with landform shaping and planting aspects of the rehabilitation completed in July 2012, excluding the NEOC void that remains in use. Maintenance of rehabilitation is on-going. The NEOC rehabilitation program has been in place since 2007. Monitoring is conducted annually. Fieldwork was conducted from May to July 2017.

Over the past few years, there has been a number of studies completed to improve management of runoff from the NEOC rehabilitation. This work will continue in 2018 with a peer review of option studies in order to find the best option to adequately manage runoff from some areas of the NEOC. This will be reported on in the next AR.

The approved MOP (2013 – 2017), requires that monitoring occur within domains defined by land use and function and geophysical characteristics. The MOP defines two domains on the NEOC; *Pasture - NEOC* (Pasture) and *Trees over Grass - NEOC* (ToG). The objectives of the two domains are set out within the MOP and include:

### *Pasture*

- Restored and maintained to the same or higher land capability and agricultural suitability than prior to mining.
- Final landform is sustainable and resilient to environmental pressures.

### *ToG*

- Ecological diversity will be maintained or enhanced.
- Ecosystem function is restored.

The Pasture domain recorded flora diversity approximately half that of the analogue quadrats, with cover and LFA indices at or near achieving benchmark levels. The floral diversity is not a KPI in itself but does point to a potential lack of resilience in response to ecological disturbance such as drought, especially as the vegetative cover on the NEOC is dominated by only four grass species.

The ToG domain had an overall lower floral diversity compared to the analogue areas with the largest differences in the groundcover and forb strata and the grasses. Canopy species diversity was slightly higher in the rehabilitation areas. Physicochemical processes were largely equivalent to analogue values with the Landscape Organisational Index (LOI) scores indicating that nutrient accumulation (i.e. litter and groundcover) has not yet achieved benchmark. This was assessed to be due to the over seeding of canopy and midstorey Acacias acting to shade out the groundcovers.

Erosion was not observed to be an issue, even in areas of low groundcover due to the short draw between drains and the dense grasses above the ToG domain restricting runoff velocity.

Two weed species were identified as potential problems. African Boxthorn was observed to be spreading through the ToG areas and sparsely colonising the Pasture areas. *Galenia secundus* (Galenia) has been recorded as widespread throughout the NEOC. This has been addressed over the past five years with spraying and slashing works to reduce Galenia infestation.

Land capability was assessed as remaining unchanged and consistent with consent requirements.

Recommendations included increased weed control efforts especially against African Boxthorn and the largest infestations of Galenia. To improve the resilience of the Pasture areas it was suggested that a broadcast seeding of a wider variety of drought tolerant grasses and rhizobia-inoculated legumes would improve productivity when stocking occurred.

In terms of performance criteria, both domains are in Phase 5 - Ecosystem and Landuse Sustainability. The Pasture domain achieved four of the six criteria and partially achieved the remaining two. The ToG domain has achieved six of the eight criteria and partially achieved the remaining two while the vegetation structure is still developing.

**Table 29 Pasture – NEOC Performance Criteria - Ecosystem and Landuse Sustainability**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Restored and maintained to the same or higher land capability and agricultural suitability than prior to mining.	LFA Organisation Index	Annual Rehabilitation Monitoring Report	Performance indicator is broadly comparable to that of analogue sites.	CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004) DA Schedule 2, Condition 3.55  DA Schedule 2, Condition 3.55	Achieved
	LFA Stability Index				Achieved
	LFA Infiltration Index				Achieved
	Land Capability Class		Field data results are used to define land capability and include: Climate Soil texture Position Slope Erosion pH Drainage Rock		Partially Achieved. pH is assumed to still be high Establishment of grazing trials would determine if successful
Final Landform is sustainable and resilient to environmental pressures	Weed species abundance and diversity		Performance indicator is broadly comparable to that of analogue sites.		Achieved Abundances and diversity comparable to analogue plots.
	Groundcover				Partially Achieved Still some areas of patchy groundcover.

**Table 30 Trees over Grass – NEOC Performance Criteria Ecosystem and Landuse Sustainability**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Ecological diversity will be maintained or enhanced	Foliage Cover	Annual Rehabilitation Monitoring Report	Vegetation structure and complexity is broadly comparable to that of analogue sites.	DA Schedule 2, Condition 3.55	Partially Achieved – some areas have been over seeded with midstorey and shrub species.
	Tree Diversity		Diversity of maturing tree and shrub species is broadly comparable to that of analogue sites.		Achieved.
	Tree Density		Density of maturing tree and shrub species is broadly comparable to that of analogue sites.	CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004)	Partially Achieved – midstorey and shrubs in higher density in parts of the ToG areas.
	Tree health/condition		Vegetation condition is broadly comparable to that of analogue sites.		Achieved.
	Flowers, fruit, new growth		Index is broadly comparable to that of local remnant vegetation.		Achieved – saplings observed.
Ecosystem function is restored	LFA Organisation Index			Achieved	
	LFA Stability Index			Achieved	
	LFA Infiltration Index			Achieved	

**Table 31 Pasture - Underground Mining Area performance criteria - ecosystem landuse and sustainability**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Restored and maintained to the same or higher land capability and agricultural suitability than prior to mining	LFA Organisation Index	Annual Rehabilitation Monitoring Report	Performance indicator is broadly comparable to that of analogue sites.	CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004) DA Schedule 2, Condition 3.55  DA Schedule 2, Condition 3.55	Achieved
	LFA Stability Index				Achieved
	LFA Infiltration Index				Achieved
	Land Capability Class		Field data results are used to define land capability and include: Climate Soil texture Position Slope Erosion pH Drainage Rock		Achieved
Final Landform is sustainable and resilient to environmental pressures	Weed species abundance and diversity		Performance indicator is broadly comparable to that of analogue sites		Partially achieved - African Boxthorn, African Olive and other weed species are common on both analogue and pasture areas
	Groundcover				Achieved

**Table 32 Pasture - Underground Mining Area performance criteria - ecosystem landuse and sustainability**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Restored and maintained to the same or higher land capability and agricultural suitability than prior to mining	LFA Organisation Index	Annual Rehabilitation Monitoring Report	Performance indicator is broadly comparable to that of analogue sites.	CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004) DA Schedule 2, Condition 3.55  DA Schedule 2, Condition 3.55	Achieved
	LFA Stability Index				Achieved
	LFA Infiltration Index				Achieved
	Land Capability Class		Field data results are used to define land capability and include: Climate Soil texture Position Slope Erosion pH Drainage Rock		Achieved
Final Landform is sustainable and resilient to environmental pressures	Weed species abundance and diversity		Performance indicator is broadly comparable to that of analogue sites		Partially achieved - African Boxthorn, African Olive and other weed species are common on both analogue and pasture areas
	Groundcover				Achieved

## 9.6 Rehabilitation status

Open cut rehabilitation was completed in 2013. Rehabilitation maintenance is carried out on the NEOC rehabilitation on an as needs basis to enhance species diversity. Maintenance activities generally include slashing to promote species diversity as well as maintenance of some contour banks through re-topsoiling and seeding where required. During the reporting period no rehabilitation maintenance on NEOC was required. Rehabilitation status is outlined in Table 33.

During the reporting period land maintenance activities were carried out above the underground operations, including weed management, repair of subsidence cracking, rehabilitation of the ULD ventilation fan site and gas drainage lines and water diversion works to prevent flooding of roadways. Approximately 800 metres of gas drainage pipeline was rehabilitated during the reporting period. These pipelines will be checked periodically and treated for weeds or re-seeded as required.

During 2018 weed works will continue, predominantly along creek lines and subsidence repairs will continue to be undertaken where required.

**Table 33 Rehabilitation Status**

Mine area type	Previous Reporting Period (Actual) (ha)	This reporting period (Actual) (ha)	Next reporting period (Forecast) (ha)
	2016	2017	2018
Total mine footprint <sup>1</sup>	909.6	909.6	909.6
Total Active disturbance area <sup>2</sup>	177.3	177.3	177.3
Land being prepared for rehabilitation <sup>3</sup>	0	0	0
Land under active rehabilitation <sup>4</sup>	732.2	732.2	732.2
Completed rehabilitation <sup>5</sup>	0	0	0

<sup>1</sup> 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. As such it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands (as defined in the DRE MOP/RMP guidelines). Subsidence remediation areas are excluded.

<sup>2</sup> Total Active Disturbance includes all areas ultimately requiring rehabilitation such as: on-lease exploration areas, stripped areas ahead of mining, infrastructure areas, water management infrastructure, sewage treatment facilities, topsoil stockpile areas, access tracks and haul roads, active mining areas, waste emplacements (active/unshaped/ in or out of pit), and tailings dams (active/unshaped/uncapped).

<sup>3</sup> Land being prepared for rehabilitation – includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development (as defined in the DRE MOP/ RMP guidelines)

<sup>4</sup> Land under active rehabilitation – includes areas under rehabilitation and being managed to achieve relinquishment – includes the following rehabilitation phases as described in the DRE MOP/RMP guidelines – ‘ecosystem and land use establishment’ (area seeded or surface developed in accordance with final use) and ‘ecosystem and land use sustainability’ (revegetation assessed as showing signs of trending towards relinquishment or infrastructure development).

<sup>5</sup> Completed rehabilitation – requires formal sign-off by DRE that the area has successfully met the rehabilitation land use objectives and completion criteria.

## 9.7 Research

No research was undertaken during the reporting period. ACOL is participating in an ACARP research project: *C25031 Closure Criteria for River Diversions: An Alternative to Reference Sites*. Fieldwork and sampling along the Bowmans Creek Diversion was undertaken by researchers during 2016.

The broad aim of this research is to move from the use of reference sites in environmental assessment to a more pragmatic and robust methodology through designing realistic closure criteria based around the use of microbial communities as indicators of environmental condition.

## 10 Community

ACP is committed to minimising the impacts of its operations and is an active participant and contributor to community projects that benefit local people.

### 10.1 Community Support and Engagement

Ashton Coal is committed to making a positive contribution in the region in which it operates. To help facilitate this commitment, a Community Support Program has been established to provide assistance to local initiatives within the Singleton Local Government Area (LGA) and surrounding communities. The aim of the Community Support Program is to help benefit a wide range of community needs such as education, environment, health, infrastructure projects, arts, leisure and research. Further information on the Community Support Program can be found at <http://www.ashtoncoal.com.au/page/sustainability/community/community-support-program/>

Further to this, Ashton Coal supports local initiatives such as the Singleton Mayoral scholarships, through financial support as well as participation in the interview process and awards presentation ceremonies.

Through Yancoal Australia, the Clontarf foundation at Singleton High School is also supported. A number of visits to the foundation's facilities were undertaken during 2017 to meet the boys benefiting from Clontarf's involvement in Singleton.

Two of the key engagement processes at Ashton Coal are the Community Consultative Committee (CCC) and the Aboriginal Community Consultation Forum (ACCF).

The CCC meets every four months as agreed by the committee. During 2017 changes to the CCC were made to align with the conditions of development consent 309-1-2001-i (mod 5). This included the appointment of Margaret McDonald-Hill as the Independent Chairperson of the Committee by the Department of Planning and Environment, and the payment of sitting fees for the community members.

The ACCF is a community engagement process in place to ensure ongoing dialogue between the Aboriginal Community and Ashton Coal. ACCF meetings regularly discuss planned mining operations, potential impacts to Country, upcoming projects and salvage works. The ACCF also plays an important role in assisting Ashton Coal to conduct some necessary activities in a culturally sensitive

manner. Ashton Coal engaged with the ACCF during the reporting period to decide how to replace salvaged artefacts on country in a culturally sensitive manner. The members of this group were also contacted when an injured Wedge Tail Eagle was found in an operational area of the mine to ensure the mines response was culturally appropriate. There were three meetings held during 2017 and regular meetings will continue during the next reporting period.

## 10.2 Local neighbours

Neighbours, particularly those that have the potential to be directly impacted by operations are kept up to date with operations and key projects through phone calls, regular emails and face to face meetings as required.

During the reporting period, interactions with neighbours included the provision of water filters, cleaning out water tanks, liaison regarding wild dog baiting (to ensure the safety of neighbours dogs during the program), and the trapping of feral cats within the Camberwell community upon request of residents.

Tenants of Ashton Coal owned properties were sent information required under the conditions of the consent (modification 5) in relation to potential environmental impacts. There were no instances of exceedances of particulate matter criteria or noise at any properties during the reporting period.

## 10.3 Website and community hotline

The broader community has access to information about the operation through its website, [www.ashtoncoal.com.au](http://www.ashtoncoal.com.au). Included on the site are project approval documents, CCC meeting minutes, community complaint records, environmental monitoring information, environmental audits, environmental management plans and annual environmental management reports. On 1 February 2017 Ashton Coal were notified by DPE that there was no complaints register on the website as required by the development consent. This was rectified on the 13 February 2017 and is updated monthly.

Ashton Coal also operates a free-call 24-hour Community Response Line (1800 657 639) to allow the community to contact the operation directly to ask questions or raise concerns about mining activities. The operation of the community response line is required by Ashton Coal's development consent and environmental protection licence.

During the reporting period, there was a problem with the community response line's operation. A resident of Camberwell attempted to call the line on the 28 January, and after a number of unsuccessful attempts called the Department of Planning to lodge a complaint. The DPE contacted Ashton on the 1 February to alert them to the failure of the community response line, the complaint and the absence of the community complaints register on the website. Ashton investigated the issue and the community response line was operational again on the 2 February.

Investigation identified that while the 1800 657 639 number was operational, the routing to the third party call centre used to answer the community response line 24 hours a day had failed.

Ashton Coal was issued a \$15,000 Penalty Infringement Notice by the Department of Planning and Environment for failing to publish a complaints register on a monthly basis and for failing to maintain a 24-hour complaints telephone line as required by conditions of approval. Ashton Coal has

implemented a more rigorous program of testing the community response line, has removed the routing process to minimise the risk of future failures of the line, and has established a monthly process of updating the complaints register on the website. There have been no further identified issues with the Community response line to date.

### 10.4 Complaints

There were two complaints received during 2017, both in relation to noise. In both instances investigations were undertaken and it was found to be unlikely the noise was generated from Ashton Coal’s operations.

A comparison of complaints received during previous years is shown in Figure 15.

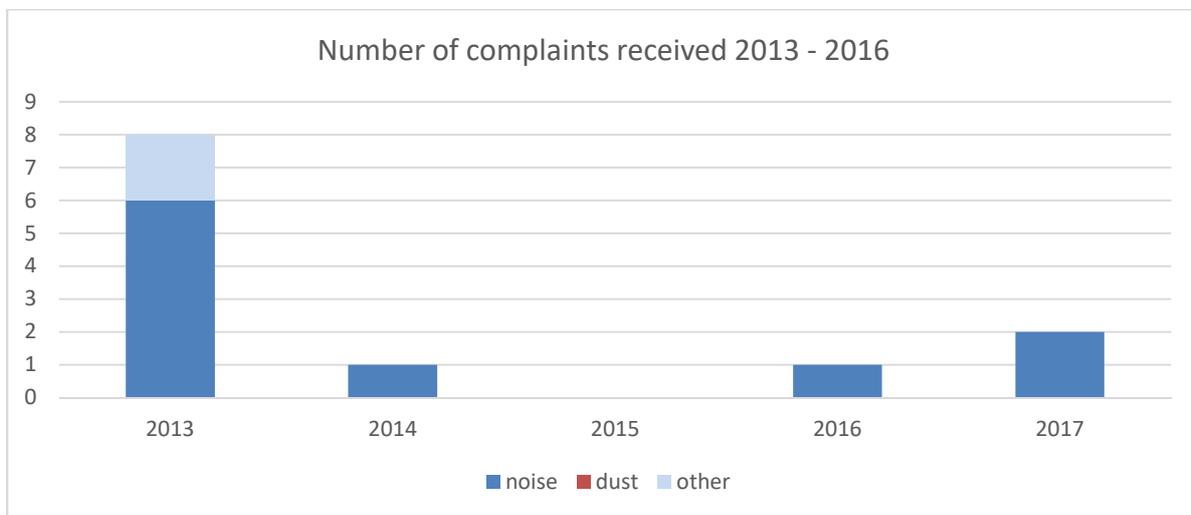


Figure 15 Complaints, 2013 -2017

## 11 Independent audit

During 2016 an Independent Audit of operations was undertaken against the conditions of modification 10, DA 309-11-2001-i. A total of 1550 conditions and commitments were assessed resulting in 27 non-compliances, 16 of which were administrative. No High risks were identified in the audit.

All actions have been completed except for one relating to stormwater runoff on the NEOC. An options analysis was completed during 2017. This will be peer reviewed in early 2018 and consultation with the EPA will continue.

The Audit can be found on Ashton Coal’s website at:

<http://www.ashtoncoal.com.au/page/publications/environmental/environmental-audits/>.

## 12 Incidents and non-compliances during the reporting period

There were no reportable incidents at Ashton Coal during 2017.

There was one non-compliance as discussed in Section 10.3. Ashton Coal was issued a \$15,000 Penalty Infringement Notice by the Department of Planning and Environment for failing to publish a

complaints register on a monthly basis and for failing to maintain a 24-hour complaints telephone line as required by the approved Environmental Management Strategy. Ashton Coal has implemented a more rigorous program of testing the community response line, has removed the telephone routing process to minimise the risk of future failures of the line, and has established a monthly process of updating the complaints register on the website. There have been no further identified issues with the Community response line to date.

During 2016, DA 309-11-2001-i was modified with approval of modification 5. As a result, during 2017:

- All management plans were reviewed to comply with new conditions;
- The Ashton Coal website was revised and updated; and
- An Independent Chair was assigned to the Community Consultative Committee

ACP will continue to work towards compliance to all conditions during 2018.

### 13 Activities to be completed in the next reporting period

Activities to be addressed and completed during the next reporting period are detailed below in Table 34.

**Table 34 Actions to be completed next reporting period**

Action	Due for completion by	Action summary
Mine Operations Plan	1 July 2018	Develop a new MOP according to the new Mine Operation Plan guideline and lodge for approval by the end of June 2018.
NEOC runoff	31 December 2018	Finalise best option for surface water runoff from the NEOC. Budget for future earthworks that may be required. Lodge a variation to the EPL if required. Update water management plan as required.
Baseline fauna survey, NEOC	31 December 2018	Conduct a baseline fauna survey on the NEOC to further understand colonisation of NEOC rehabilitation. This information will be fed into future baseline data and completion criteria for parts of the NEOC rehabilitation.

## 14 References

Global Acoustics (2017) *Noise Monitoring results, Jan – Dec 2017.*

Umwelt (2018) *2017 Fauna Monitoring Program, Ashton Coal.*

Marine Pollution Research (2018) *Ashton Coal AEMR 2017 Aquatic Ecology monitoring, Bowmans and Glennies Creeks.*

Australasian Groundwater and Environmental Consultants (2018) *2017 annual groundwater monitoring and compliance report.*

Enright Land Management (2017) *Ashton Coal Operations 2017 Wild Dog and Fox Baiting Reports (Spring and Autumn).*

Enright land management (2018) *Ashton Coal Operations Weed Action Plan.*

J R Richards (2017) *Ashton Coal Mine Waste Statistics December 2017.*

HEC (2018) *Ashton Coal Mine MCA 2017 Water Accounting Framework Report.*

Kleinfelder (2017) *2017 ACOL Annual Flora Monitoring*

Horn, Peter (2016) *Independent Environmental Audit, Ashton Coal Operations*

Ashton Coal Operations Limited (December 2015) *Ashton Coal Project, Upper Liddell Seam Extraction Plan LW 105-107.*

Ashton Coal Operations Limited (November 2016) *Ashton Coal Project, Longwalls 201- 204 Extraction Plan.*

Ashton Coal Operations Limited, Environmental Management Strategy and Management plans,  
<http://www.ashtoncoal.com.au/page/publications/environmental/environmental-management-plans/>

Department of Planning and Environment (2016) Development consent for the Ashton Coal Project (DA 309-11-2001-i)

## 15 Appendix 1. OEH Conservation Area Monitoring Form

## MONITORING REPORT FORM

- This form is being completed for the following reason:
- Annual Report by landholder (self reporting)**
  - Routine visit by OEH with landholder
  - Compliance visit by OEH with landholder
  - Change of ownership visit by OEH with landholder
  - Conservation Agreement
  - Wildlife Refuge
  - Property Agreement

Please make three copies of the completed form and any additional information. One to be retained by the landowner, one for the local Area office of NPWS and the third to go to Conservation Partnerships Delivery Unit, OEH, PO Box A290, Sydney South NSW 1232.

### A LANDOWNER AND PROPERTY DETAILS

Property Owner	Ashton Coal Operations Pty Ltd
Property Name	Southern Woodland Conservation Area
Property Address	New England Hwy, Camberwell
CA number	
Area (ha)	65 ha
CMA Region	Hunter
Agreement signed	
Date of last monitoring visit	8 June 2016
Date of visit	29 May 2017
Officer undertaking visit	Dr Nigel Fisher (Kleinfelder)

### B LANDHOLDER OVERVIEW SINCE LAST VISIT

#### 1 LANDHOLDER EXPERIENCES RELATING TO THE IMPLEMENTATION OF THE CONSERVATION AGREEMENT /WILDLIFE REFUGE

<i>Points to note</i>	<i>Comments</i>

Please place an X in this box if new issue(s)/problem(s) require management help

#### 2 WORKS UNDERTAKEN SINCE LAST VISIT

<i>Description of work undertaken</i>	<i>Source of funding and amount</i>	<i>Date completed</i>
Weed management works – as part of larger property weed management program	Self funded	ongoing

### 3 FIRE HISTORY MONITORING

<i>Date of fire</i>	<i>Area burnt (% of c.a./approx ha)</i>	<i>Reason (hazard red./wild)</i>	<i>Intensity (low/medium/high)</i>

### 4 VISITATION

<i>Average No. of Visitors per year</i>	<i>Purpose of Visitation</i>	<i>Visitation effects</i>	<i>Strategies to overcome effects</i>
Approximately 100	Coal mining activities, land management, cultural heritage monitoring		Stick to designated vehicle tracks, inductions, disturbance permit procedure

### 5 COMMUNITY CONSULTATION AND INPUT INTO DECISION MAKING

<i>Type of Involvement</i>	<i>Numbers involved</i>	<i>Outcomes</i>

## C CONSERVATION VALUES

	<i>Conservation Values noted in Agreement and its significance</i>	<i>Current condition ** (I = improving M= maintain D= declining)  Anecdotal evidence only available at present</i>	<i>Current and emerging threats</i>	<i>Level (severe, high, moderate or low) and extent (throughout, widespread, scattered or localised) of threats</i>	<i>New findings; any other relevant information.</i>
Landscape/ Catchment  - World/national heritage listings  - Landscape &					

	Conservation Values noted in Agreement and its significance	Current condition ** (I = improving M= maintain D= declining) <i>Anecdotal evidence only available at present</i>	Current and emerging threats	Level ( <i>severe, high, moderate or low</i> ) and extent ( <i>throughout, widespread, scattered or localised</i> ) of threats	New findings; any other relevant information.
scenic values					
Biological - Vegetation Communities - Flora - Fauna & habitat - Water bodies	EEC Vegetation Community	Maintaining	Weeds such as African Boxthorn, Olive, Cactus, Galena, Green Cestrum, Balloon Vine, Madeira Vine, Willow	High, Throughout the VCA – manageable but requires ongoing works to control	
Geological	Erosion  Subsidence	Declining  Maintaining	Rills, some gullyng  Cracks visible	Low, localised – but requires control works  Low - Scattered in VCA, requires assessment	
Cultural Heritage - Aboriginal - Historic					
Research/ education					
Other					

**\*\* Current Condition: determine change by comparison with previous Condition Assessments (Pages 5 to 8). Carry out new assessment if not done previously. Biometric can also be used.**

## **D MANAGEMENT ISSUES**

	<b>Describe the Issue</b> (short description of current extent of impacts, new sightings and any other relevant information)	<b>Description of planning and implementation of control measures being and to be undertaken, and duration</b>
<p>Weeds</p> <p>(where applicable, infestation can be given as a % of total vegetation)</p>	<p>African Boxthorn – forming infestations at base of large canopy trees throughout and widespread in the SVCA</p> <p>Olive – forming infestations at base of large canopy trees and excluding other species</p> <p>Balloon and Madeira Vines – encroaching from water courses, where presently is smothering other vegetation</p> <p>Galena – scattered throughout VCA, but localised areas where forms dense mats or carpets excluding other species</p> <p>Green Cestrum – scattered throughout VCA</p>	
<p>Pest Animals</p> <ul style="list-style-type: none"> <li>- Feral</li> <li>- Domestic</li> <li>- Native</li> </ul>	<p>Feral Pigs – rutting sites and carcass observed</p>	
<p>Fire Management</p>		<p>Firebreaks around site maintained prior to fire season</p>
<p>Threatened species; endangered ecological communities etc</p>	<p>Grey Crowned Babbler, phascogales</p>	
<p>Cultural Heritage Management</p>	<p>Salvage of aboriginal artefacts if there is a risk of damage caused by subsidence</p>	
<p>Visitor Impact Management</p>	<p>Mine workers required to visit sites within VCA.</p>	<p>Induction process</p>

	<b>Describe the Issue</b> (short description of current extent of impacts, new sightings and any other relevant information)	<b>Description of planning and implementation of control measures being and to be undertaken, and duration</b>
Community Consultation and input into decision making.		
Research/ Education programs		
Other permitted uses -vehicle access - use of timber -seed collection - etc	Mining Infrastructure	Limit disturbance wherever possible.

## E WORKPLAN TO ADDRESS MANAGEMENT ISSUES (in priority order)

<i>Action to be completed or ongoing action (discuss on site and where necessary confirm details later)</i>	<i>Cost and possible funding sources</i>	<i>Completion Date</i>	<i>Responsibility (landholder, OEH, other)</i>

## F ATTACHMENTS

- Map showing location of activities referred to above eg weed infestations; fire; location of past and future management actions.

List further attachments if relevant:

- Photos from previously/new identified photopoints
- Rapid Assessment Sheets for previous/new sites.
- Other Monitoring results.

I/we confirm a field inspection has been undertaken and this form is a summary of the conservation values and management issues discussed.

Signature: \_\_\_\_\_

Landowner

\_\_\_\_\_

Visiting OEH/NPWS Officer, if applicable

Date report completed: \_\_\_\_\_

### Level of threat definition

**Table 4 Description of the level of impact categories (adapted from State of the Parks 2007 Guidelines)**

Impact of the threat	Description of category
Severe	The threat will lead to loss of property value(s) in the foreseeable future if it continues to operate at current levels
High	The threat will lead to a significant reduction of property e values(s) if it continues to operate at current levels.
Moderate	The threat is having a detectable impact on reserve values(s) but damage is not considered significant.
Mild	The threat is having minor or barely detectable impact on property value(s).

### Extent of threat definition

For cultural heritage places, sites and objects, classify the extent the impact is having on the place/site/object itself.

**Table 5: Description of the extent categories (adapted from State of the Parks 2007 Guidelines)**

Extent of the threat	Description of category
Throughout	The impact is occurring in 50% or more of property area/cultural place/site/object.
Widespread	The impact is occurring in more than 15% but less than 50% of reserve area/cultural place/site/object.
Scattered	The impact is occurring in between 5 and 15% of reserve area/cultural place/site/object.
Localised	The impact is occurring is less than 5% of reserve area/cultural place/site/object.

## CONDITION ASSESSMENT NATIVE VEGETATION

For native bushland and grassland sites and paddocks containing scattered shade trees

Site number or name: MFarm06		Monitoring date: 29 May 2017
Assessment questions		Answer Yes, No or N/A
1.	Is the area fenced to manage stock access and grazing? <i>Healthy bush should be rested for long periods to allow regeneration. To achieve this, it should be fenced off.</i>	Yes
2.	Is there regeneration of native trees and shrubs, or if in grassland, regular germination of native herbs eg perennials such as lilies or orchids and annuals such as daisies? <i>Regeneration of trees and shrubs is necessary for the bush to maintain health, diversity and a range of habitats. An understorey of shrubs encourages small insect eating birds and other native animals.</i>	Yes
3.	Is there a diverse range of tree and shrub species present, e.g. more than 20 (coast), 15 (tablelands), 10 (western slopes and plains)? (Note: healthy river red gum forest may have only one tree and 5-10 shrub species present). <i>Diversity encourages a range of native animals and helps the bush withstand attacks of insects and other adverse conditions.</i>	No
4.	If grassland, is there a diverse range of grasses and broad leaf herbs present?	NA
5.	Is there adequate ground cover, e.g. leaves, bark and twigs, or litter (dead grasses)? <i>Ground cover indicates whether the area is being disturbed by stock and is a measure of tree canopy density and the domination of exotic grasses and weeds.</i>	Yes
6.	Are mosses or lichens on rocks, fallen branches and the ground surface, or are these species, along with liverworts, forming a crust on bare soil?	Yes
7.	Are weeds uncommon, sparsely scattered, absent, or mainly around edges of the area? <i>The understorey may have exotic weeds present. Too many are undesirable and you may need a management plan for their control. Weeds compete with native plants for light, space, water and nutrients.</i>	No
8.	Is there a very low incidence of pest animals, e.g. foxes and rabbits? <i>Remnant bush can be a refuge for pest animals as well as natives. The feral animals should be controlled.</i>	Yes
9.	Is the patch shape a block or part of a corridor more than 30 metres wide rather than a thin strip? <i>Blocks of native vegetation have less edge area than strips, so they are less influenced by changes in levels of weeds, predators, noise and climatic effects.</i>	Yes
10.	Is the area greater than 1 ha (coast), 5 ha (tablelands), 10 ha (western slopes), 20 ha (plains), 50 ha (Western Division)?	Yes
11.	Is the remnant linked to other remnants by corridors, e.g. roadside vegetation, or scattered trees no more than 50 m apart?	Yes

<p><i>Corridors provide shelter and pathways for native organisms (other than birds) to move over the landscape for feeding, breeding, roosting and expanding territory.</i></p>	
<p>12. Is there a mix of tree ages present, i.e. saplings through to old growth with hollows? <i>A range of ages and conditions means the bush is regenerating itself and each stage of growth is suitable habitat for native organisms.</i></p>	<p><b>Yes</b></p>
<p>13. If trees are present is an understorey also present? <i>An understorey of shrubs encourages small insect eating birds and other native animals.</i></p>	<p><b>Yes</b></p>
<p>14. Is the understorey mostly comprised of native shrubs and / or grasses and broad leaf herbs?</p>	<p><b>Yes</b></p>
<p>15. Are there standing trees (alive or dead) with hollows, present in the remnant or paddock? <i>Dead trees with hollows are essential for roosting and nesting of a large range of native birds such as parrots and of bats.</i></p>	<p><b>Yes</b></p>
<p>16. Are the trees mainly healthy, with little or no dieback? <i>Dieback is apparent if there are bare twigs at the outer part of the tree canopy. It is usually a sign of severe insect attack.</i></p>	<p><b>Yes</b></p>
<p>17. Are there less than 20 % of trees affected by mistletoe? <i>Mistletoe is a parasite that invades trees and causes them to lose vigour. Where many trees in an area are affected it is likely to indicate that the area of vegetation is under severe stress.</i></p>	<p><b>No</b></p>
<p>18. Are there logs and fallen timber on the ground? <i>Logs and dead material are essential habitat for smaller native organisms. But they can also be a harbour for pest animals.</i></p>	<p><b>Yes</b></p>
<p>19. If scattered paddock trees are unfenced, are stock camps absent? <i>Bare ground, bare tree roots or the movement of soil all can indicate erosion which needs to be managed and controlled.</i></p>	<p><b>NA</b></p>
<p>20. If scattered paddock trees are unfenced, is evidence of stock ringbarking or rubbing absent?</p>	<p><b>NA</b></p>
<p>21. Is the area free of herbicide, insecticide or fertiliser overspray from adjoining areas? <i>Herbicides and insecticides can kill native plants and small organisms. Fertiliser encourages exotic species by raising nutrient levels.</i></p>	<p><b>Yes</b></p>
<p>22. Is the area free from the threat of salinity and / or high water tables?</p>	<p><b>Yes</b></p>
<p>23. Are patches of vegetation left unburnt as wildlife breeding habitat?</p>	<p><b>Yes</b></p>
<p><b>Total number of 'yes' answers</b></p>	<p><b>17</b></p>

## Condition rating - native vegetation

Number of 'yes' answers			Vegetation condition rating	Need for management attention
Remnant bushland	Remnant grassland	Scattered paddock trees		
15 +	10 +	13 +	<b>Healthy</b>	Maintain current management
9 - 14	6 - 9	8 - 12	Good	Needs some management attention
5 - 8	3 - 5	5 - 7	Fair	Needs a significant level of management attention
0 - 4	0 - 2	0 - 4	Poor	Urgent management necessary if you wish to retain area as stock shelter

**CONDITION ASSESSMENT NATIVE VEGETATION**

For native bushland and grassland sites and paddocks containing scattered shade trees

Site number or name: RWood03		Monitoring date: 29 May 2017	
Assessment questions			Answer Yes, No or N/A
1.	Is the area fenced to manage stock access and grazing? <i>Healthy bush should be rested for long periods to allow regeneration. To achieve this, it should be fenced off.</i>	<i>Healthy</i>	Yes
2.	Is there regeneration of native trees and shrubs, or if in grassland, regular germination of native herbs e.g. perennials such as lilies or orchids and annuals such as daisies? <i>Regeneration of trees and shrubs is necessary for the bush to maintain health, diversity and a range of habitats. An understorey of shrubs encourages small insect eating birds and other native animals.</i>		Yes
3.	Is there a diverse range of tree and shrub species present, e.g. more than 20 (coast), 15 (tablelands), 10 (western slopes and plains)? (Note: healthy river red gum forest may have only one tree and 5-10 shrub species present). <i>Diversity encourages a range of native animals and helps the bush withstand attacks of insects and other adverse conditions.</i>	<i>Diversity</i>	Yes
4.	If grassland, is there a diverse range of grasses and broad leaf herbs present?		NA
5.	Is there adequate ground cover, e.g. leaves, bark and twigs, or litter (dead grasses)? <i>Ground cover indicates whether the area is being disturbed by stock and is a measure of tree canopy density and the domination of exotic grasses and weeds.</i>		Yes
6.	Are mosses or lichens on rocks, fallen branches and the ground surface, or are these species, along with liverworts, forming a crust on bare soil?		Yes
7.	Are weeds uncommon, sparsely scattered, absent, or mainly around edges of the area? <i>The understorey may have exotic weeds present. Too many are undesirable and you may need a management plan for their control. Weeds compete with native plants for light, space, water and nutrients.</i>		Yes
8.	Is there a very low incidence of pest animals, e.g. foxes and rabbits? <i>Remnant bush can be a refuge for pest animals as well as natives. The feral animals should be controlled.</i>		Yes
9.	Is the patch shape a block or part of a corridor more than 30 metres wide rather than a thin strip? <i>Blocks of native vegetation have less edge area than strips, so they are less influenced by changes in levels of weeds, predators, noise and climatic effects.</i>		Yes

10. Is the area greater than 1 ha (coast), 5 ha (tablelands), 10 ha (western slopes), 20 ha (plains), 50 ha (Western Division)?	<b>Yes</b>
11. Is the remnant linked to other remnants by corridors, e.g. roadside vegetation, or scattered trees no more than 50 m apart?  <i>Corridors provide shelter and pathways for native organisms (other than birds) to move over the landscape for feeding, breeding, roosting and expanding territory.</i>	<b>Yes</b>
12. Is there a mix of tree ages present, i.e. saplings through to old growth with hollows? <i>A range of ages and conditions means the bush is regenerating itself and each stage of growth is suitable habitat for native organisms.</i>	<b>Yes</b>
13. If trees are present is an understorey also present?  <i>An understorey of shrubs encourages small insect eating birds and other native animals.</i>	<b>Yes</b>
14. Is the understorey mostly comprised of native shrubs and / or grasses and broad leaf herbs?	<b>Yes</b>
15. Area there standing trees (alive or dead) with hollows, present in the remnant or paddock? <i>Dead trees with hollows are essential for roosting and nesting of a large range of native birds such as parrots and of bats.</i>	<b>Yes</b>
16. Are the trees mainly healthy, with little or no dieback?  <i>Dieback is apparent if there are bare twigs at the outer part of the tree canopy. It is usually a sign of severe insect attack.</i>	<b>Yes</b>
17. Are there less than 20 % of trees affected by mistletoe?  <i>Mistletoe is a parasite that invades trees and causes them to lose vigour. Where many trees in an area are affected it is likely to indicate that the area of vegetation is under severe stress.</i>	<b>Yes</b>
18. Are there logs and fallen timber on the ground?  <i>Logs and dead material are essential habitat for smaller native organisms. But they can also be a harbour for pest animals.</i>	<b>Yes</b>
19. If scattered paddock trees are unfenced, are stock camps absent?  <i>Bare ground, bare tree roots or the movement of soil all can indicate erosion which needs to be managed and controlled.</i>	<b>NA</b>
20. If scattered paddock trees are unfenced, is evidence of stock ringbarking or rubbing absent?	<b>NA</b>
21. Is the area free of herbicide, insecticide or fertiliser overspray from adjoining areas? <i>Herbicides and insecticides can kill native plants and small organisms. Fertiliser encourages exotic species by raising nutrient levels.</i>	<b>Yes</b>

22. Is the area free from the threat of salinity and / or high water tables?	<b>Yes</b>
23. Are patches of vegetation left unburnt as wildlife breeding habitat?	<b>Yes</b>
<b>Total number of 'yes' answers</b>	<b>20</b>

<b>Condition rating - native vegetation</b>				
<b>Number of 'yes' answers</b>			<b>Vegetation condition rating</b>	<b>Need for management attention</b>
<b>Remnant bushland</b>	<b>Remnant grassland</b>	<b>Scattered paddock trees</b>		
15 +	10 +	13 +	<b>Healthy</b>	Maintain current management
9 - 14	6 - 9	8 - 12	Good	Needs some management attention
5 - 8	3 - 5	5 - 7	Fair	Needs a significant level of management attention
0 - 4	0 - 2	0 - 4	Poor	Urgent management necessary if you wish to retain area as stock shelter

## CONDITION ASSESSMENT NATIVE VEGETATION

For native bushland and grassland sites and paddocks containing scattered shade trees

Site number or name: RGrass04		Monitoring date: 29 May 2017	
Assessment questions			Answer Yes, No or N/A
1.	Is the area fenced to manage stock access and grazing? <i>Healthy bush should be rested for long periods to allow regeneration. To achieve this, it should be fenced off.</i>	<i>Healthy</i>	Yes
2.	Is there regeneration of native trees and shrubs, or if in grassland, regular germination of native herbs e.g. perennials such as lilies or orchids and annuals such as daisies? <i>Regeneration of trees and shrubs is necessary for the bush to maintain health, diversity and a range of habitats. An understorey of shrubs encourages small insect eating birds and other native animals.</i>		Yes
3.	Is there a diverse range of tree and shrub species present, e.g. more than 20 (coast), 15 (tablelands), 10 (western slopes and plains)? (Note: healthy river red gum forest may have only one tree and 5-10 shrub species present). <i>Diversity encourages a range of native animals and helps the bush withstand attacks of insects and other adverse conditions.</i>		NA
4.	If grassland, is there a diverse range of grasses and broad leaf herbs present?		No
5.	Is there adequate ground cover, e.g. leaves, bark and twigs, or litter (dead grasses)? <i>Ground cover indicates whether the area is being disturbed by stock and is a measure of tree canopy density and the domination of exotic grasses and weeds.</i>		Yes
6.	Are mosses or lichens on rocks, fallen branches and the ground surface, or are these species, along with liverworts, forming a crust on bare soil?		NA
7.	Are weeds uncommon, sparsely scattered, absent, or mainly around edges of the area? <i>The understorey may have exotic weeds present. Too many are undesirable and you may need a management plan for their control. Weeds compete with native plants for light, space, water and nutrients.</i>		No
8.	Is there a very low incidence of pest animals, e.g. foxes and rabbits? <i>Remnant bush can be a refuge for pest animals as well as natives. The feral animals should be controlled.</i>		Yes
9.	Is the patch shape a block or part of a corridor more than 30 metres wide rather than a thin strip? <i>Blocks of native vegetation have less edge area than strips, so they are less influenced by changes in levels of weeds, predators, noise and climatic effects.</i>		Yes

10. Is the area greater than 1 ha (coast), 5 ha (tablelands), 10 ha (western slopes), 20 ha (plains), 50 ha (Western Division)?	<b>Yes</b>
11. Is the remnant linked to other remnants by corridors, e.g. roadside vegetation, or scattered trees no more than 50 m apart?  <i>Corridors provide shelter and pathways for native organisms (other than birds) to move over the landscape for feeding, breeding, roosting and expanding territory.</i>	<b>Yes</b>
12. Is there a mix of tree ages present, i.e. saplings through to old growth with hollows? <i>A range of ages and conditions means the bush is regenerating itself and each stage of growth is suitable habitat for native organisms.</i>	<b>NA</b>
13. If trees are present is an understorey also present?  <i>An understorey of shrubs encourages small insect eating birds and other native animals.</i>	<b>NA</b>
14. Is the understorey mostly comprised of native shrubs and / or grasses and broad leaf herbs?	<b>No</b>
15. Area there standing trees (alive or dead) with hollows, present in the remnant or paddock? <i>Dead trees with hollows are essential for roosting and nesting of a large range of native birds such as parrots and of bats.</i>	<b>No</b>
16. Are the trees mainly healthy, with little or no dieback?  <i>Dieback is apparent if there are bare twigs at the outer part of the tree canopy. It is usually a sign of severe insect attack.</i>	<b>NA</b>
17. Are there less than 20 % of trees affected by mistletoe?  <i>Mistletoe is a parasite that invades trees and causes them to lose vigour. Where many trees in an area are affected it is likely to indicate that the area of vegetation is under severe stress.</i>	<b>NA</b>
18. Are there logs and fallen timber on the ground?  <i>Logs and dead material are essential habitat for smaller native organisms. But they can also be a harbour for pest animals.</i>	<b>No</b>
19. If scattered paddock trees are unfenced, are stock camps absent?  <i>Bare ground, bare tree roots or the movement of soil all can indicate erosion which needs to be managed and controlled.</i>	<b>NA</b>
20. If scattered paddock trees are unfenced, is evidence of stock ringbarking or rubbing absent?	<b>NA</b>
21. Is the area free of herbicide, insecticide or fertiliser overspray from adjoining areas? <i>Herbicides and insecticides can kill native plants and small organisms. Fertiliser encourages exotic species by raising nutrient levels.</i>	<b>Yes</b>

22. Is the area free from the threat of salinity and / or high water tables?	<b>Yes</b>
23. Are patches of vegetation left unburnt as wildlife breeding habitat?	<b>Yes</b>
<b>Total number of 'yes' answers</b>	<b>10</b>

<b>Condition rating - native vegetation</b>				
<b>Number of 'yes' answers</b>			<b>Vegetation condition rating</b>	<b>Need for management attention</b>
<b>Remnant bushland</b>	<b>Remnant grassland</b>	<b>Scattered paddock trees</b>		
15 +	10 +	13 +	Healthy	Maintain current management
9 - 14	6 - 9	8 - 12	Good	Needs some management attention
5 - 8	3 - 5	5 - 7	Fair	Needs a significant level of management attention
0 - 4	0 - 2	0 - 4	Poor	Urgent management necessary if you wish to retain area as stock shelter

## CONDITION ASSESSMENT - WATER BODIES

For creeks, rivers, farm dams and natural or artificial wetlands

Site number or name:	Monitoring date:	
Assessment questions		Answer Yes, No or N/A
1.	Is all or part of the site fenced to control stock access?	
2.	Is there a diverse range of native tree and shrub species present upslope of the dam or wetland, or along the creek?	
3.	Are there any standing trees (dead or alive), with hollows near to, or within the dam or wetland, or along the creek?	
4.	Is the site linked to remnant vegetation by corridors, eg. roadside or scattered trees no more than 50m apart?	
5.	Is the site free of herbicide, insecticide or fertiliser overspray or run off?	
6.	Are weeds uncommon, sparsely scattered or absent from the site?	
7.	Is there an earthen or floating island within the dam?	
8.	Does the dam have an irregular margin?	
9.	Does 50% of the dam edge have a gentle slope?	
10.	Is 50% of the dam less than 800mm deep when the dam's full?	
11.	Are there any native fish species present in the dam or creek?	
12.	Are introduced fish species (eg. carp) absent from the dam or creek?	
13.	Are there hollow logs, rocks and litter around the dam or along the creek?	
14.	Is more than 50% of the creek corridor vegetated with native species?	
15.	Are the creek banks stabilised by vegetation?	
16.	Are there wider patches of native vegetation along the creek corridor eg 20-30m wide?	
17.	Is the area immediately adjacent to the creek free from cultivation?	
18.	Are aquatic insects present under small to medium rocks or logs within the creek?	
19.	Is the creek's water free from regular algal blooms?	
20.	Does foliage of trees or shrubs hang over the creek, dam or wetland?	
21.	Is there any regeneration of reeds and rushes upslope of the dam or wetland?	
22.	Is there a buffer zone of ungrazed vegetation around the wetland?	

23. Is the area free of irrigation tailwater or polluted stormwater?	
24. Is the area free of fire during bird breeding seasons?	
25. Are patches of vegetation left unburnt as wildlife breeding habitat?	
26. If the area has original vegetation, has the water regime remained largely unmodified?	
27. Does the water level fluctuate regularly (seasonally)?	
<b>Totals number of 'yes' answers</b>	

<b>Condition rating - water bodies</b>				
<b>Number of 'yes' answers</b>			<b>Water resource condition rating</b>	<b>Need for management attention</b>
<b>Dam</b>	<b>Creek</b>	<b>Wetland</b>		
11 +	13 +	10 +	Healthy	Maintain current management
7 – 10	9 - 12	7 - 9	Good	Needs some management attention
4 – 6	5 - 8	4 - 6	Fair	Needs a significant level of management attention
0 – 3	0 - 4	0 - 3	Poor	Urgent management required to improve the resource condition

## MONITORING POINT LOCATIONS AND CORRESPONDING VEGETATION COMMUNITIES REPRESENTED AS AT 8 JUNE 2016

Photo Point	Quadrat No.	Easting/Northing GDA 94 MGA 56	Photo bearing degrees	Vegetation Community Represented
RWood03	RWood03	318430E 6403727N	225	Narrow-leaved Ironbark – Bullock – Grey Box shrub – grass open forest of the Central and Lower Hunter (PCT ID 1603; BVTID HU817)
MFarm06	MFarm06	318969E 6404047N	135	
RGrass04	RGrass04	319228E 6403712N	040	

## BIOMETRIC VEGETATION TYPE BENCHMARKS AND BASELINE QUADRAT SCORES AS AT 29 MAY 2017

Photo Point	Quadrat No.	Native species richness	Overstorey cover %pfc	Mid-storey cover %pfc	Ground cover – grasses %pfc	Ground cover – shrubs %pfc	Ground cover – other %pfc	Proportion overstorey regen.	Exotic cover
<b>Narrow-leaved Ironbark – Bullock – Grey Box shrub – grass open forest of the Central and Lower Hunter (PCT ID 1603)</b>									
Insert Benchmark values		41	15-40	5-20	30-50	5-10	20-40	x	x
01	<b>RWood03</b>	31	17.5	0	68	2	32	10	-
02	<b>MFarm06</b>	21	15	12	46	4	18	10	-
03	<b>RGrass04</b>	9	0	0	44	0	44	-	-

Monitoring Data Sheet			
<b>Monitoring Point Number</b>	RWood03	<b>Date</b>	29 May 2017
<b>Vegetation Community</b>	<b>Narrow-leaved Ironbark – Bulloak – Grey Box shrub – grass open forest of the Central and Lower Hunter (PCT ID 1603; BVTID HU817)</b>		
<b>1. Site Photo(s) Taken</b>	<b>Plate 1 and Plate 2</b>		
<b>2. Floristic BioMetric attributes</b>			
<b>Native cover</b>			
Overstorey:	17.5		
Midstorey:	0		
Groundcover(grass):	68		
Groundcover (shrub):	2		
Groundcover (other):	32		
Native species richness:	31		
Proportion of canopy species regenerating	10		
<b>Exotic cover</b>		0	
<b>3. Observations</b>	<b>GPS coordinates</b>	<b>Photo number</b>	<b>Observations</b>
<b>Natural regeneration of disturbed areas</b>			Advanced regrowth – some large trees but no hollows
<b>Threatened species sightings</b>			Nil
<b>Fire event/fuel</b>			Nil
<b>Weeds</b>			<i>Opuntia stricta</i> (Prickly Pear) <i>Opuntia aurantiaca</i> (Tiger Pear)
<b>Pest animals</b>			Nil
<b>Visitor impact/vehicles</b>			Nil
<b>Rubbish dumping</b>			Nil

Monitoring Data Sheet			
<b>Monitoring Point Number</b>	MFarm06	<b>Date</b>	29 May 2017
<b>Vegetation Community</b>	<b>Narrow-leaved Ironbark – Bulloak – Grey Box shrub – grass open forest of the Central and Lower Hunter (PCT ID 1603; BVTID HU817)</b>		
<b>1. Site Photo(s) Taken</b>	<b>Plate 3 and Plate 4</b>		
<b>2. Floristic BioMetric attributes</b>			
<b>Native cover</b>			
Overstorey:			15
Midstorey:			12
Groundcover(grass):			46
Groundcover (shrub):			4
Groundcover (other):			18
Native species richness:			21
Proportion of canopy species regenerating			10
<b>Exotic cover</b>		4	
<b>3. Observations</b>	<b>GPS coordinates</b>	<b>Photo number</b>	<b>Observations</b>
<b>Natural regeneration of disturbed areas</b>			Advanced regrowth
<b>Threatened species sightings</b>			Nil
<b>Fire event/fuel</b>			Lots of litter on ground
<b>Weeds</b>			<i>Lyceum ferocissimum</i> (African Boxthorn), <i>Opuntia aurantiaca</i> (Tiger Pear), <i>Galena pubescens</i> (Galena)
<b>Pest animals</b>			Nil
<b>Visitor impact/vehicles</b>			Nil
<b>Rubbish dumping</b>			Nil

Monitoring Data Sheet			
<b>Monitoring Point Number</b>	RGrass04	<b>Date</b>	29 May 2017
<b>Vegetation Community</b>	<b>Narrow-leaved Ironbark – Bulloak – Grey Box shrub – grass open forest of the Central and Lower Hunter (PCT ID 1603; BVTID HU817)</b>		
<b>1. Site Photo(s) Taken</b>	<b>Plate 5 and Plate 6</b>		
<b>2. Floristic BioMetric attributes</b>			
<b>Native cover</b>			
Overstorey:		0	
Midstorey:		0	
Groundcover(grass):		44	
Groundcover (shrub):		0	
Groundcover (other):		44	
Native species richness:		0	
Proportion of canopy species regenerating		0	
<b>Exotic cover</b>		78	
<b>3. Observations</b>	<b>GPS coordinates</b>	<b>Photo number</b>	<b>Observations</b>
<b>Natural regeneration of disturbed areas</b>			Nil
<b>Threatened species sightings</b>			Nil
<b>Fire event/fuel</b>			Lots of grass litter fuel
<b>Weeds</b>			<i>Galenia pubescens</i> (Galenia)
<b>Pest animals</b>			Nil
<b>Visitor impact/vehicles</b>			Near vehicle access tracks, and powerline easement
<b>Rubbish dumping</b>			Nil



**Plate 1: SVCA Monitoring photograph of RWood03 - corner of quadrat**



**Plate 2: SVCA Monitoring photograph of RWood03 - from start of 50m transect**



**Plate 3: SVCA Monitoring photograph - MFarm06 taken from corner of quadrat**



**Plate 4: SVCA Monitoring photograph - taken from start of 50m transect**



**Plate 5: SVCA Monitoring photograph - RGrass04 taken from corner of quadrat**



**Plate 6: SVCA Monitoring photograph - RGrass04 - taken from start of 50m transect**

## 16 Appendix 2 – Annual Groundwater Report



## Document details and history

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# **Yancoal – Ashton Coal**

## **February 2017 Groundwater Monitoring Report**

---

### **1 Introduction**

The Ashton Coal Project (ACP) is located 14 km west of Singleton in the Hunter Valley region of New South Wales (NSW) (Figure 1.1). The ACP consists of decommissioned open cut and active underground mining to access a series of coal seams within the Permian Foybrook Formation. Ashton Coal Operations Ltd (ACOL) is wholly owned and operated by Yancoal Australia Limited (Yancoal).

Between 2003 and 2011, coal was recovered from eleven seams of varying thickness, down to and including the Lower Barrett Seam (LB), from an open cut mine known as the North-East Open Cut (NEOC). Between 2007 and 2016, underground longwall mining extracted coal from the Pike's Gully (PG) Seam, the Upper Liddell (ULD) and the Upper Lower Liddell Seams (ULLD). As of July 2017, Longwall Panel LW201 is being mined within the ULLD.

The underground mine is located south of the New England Highway and includes a diversion of Bowmans Creek via two excavated and lined channels. The channels have re-routed Bowmans Creek to areas located above abandoned PG longwall panels.

#### **1.1 Objective**

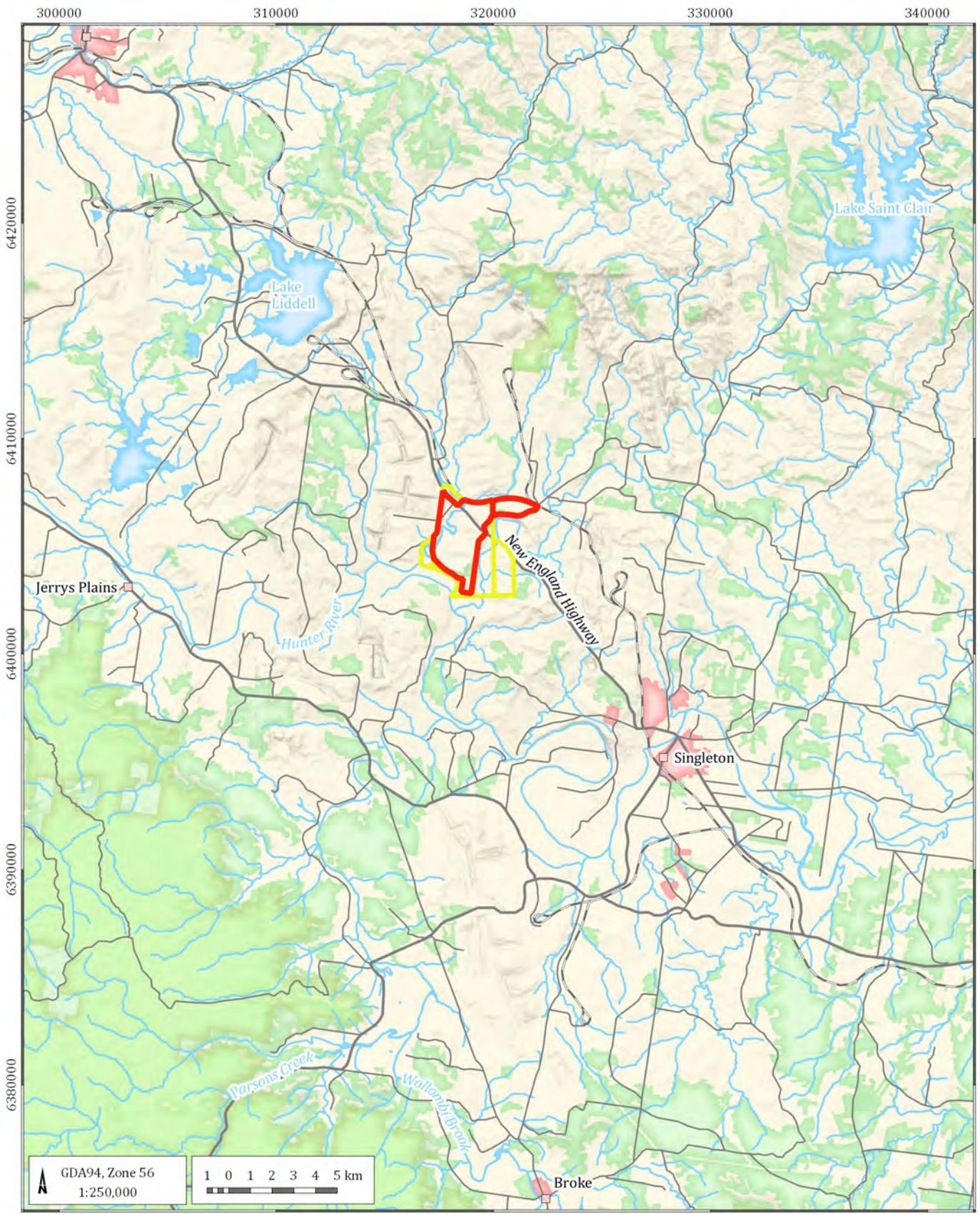
The ACOL development consent (DA 309-11-2001-i – 11 February 2002) last modified June 2016, requires that groundwater be monitored for potential impacts from mining. In 2015, the Department of Planning and Environment (DPE) approved the current Water Management Plan (WMP) version 8; Ashton document – HSEC Management System– Plan – Doc. No. 3.4.1.8 – dated 11 May 2016. The WMP outlines the groundwater monitoring program and trigger values for groundwater levels and quality in the various groundwater systems located within the ACP site.

This report summarises the data collected by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) from January 2017 to December 2017. This report reviews all groundwater monitoring data for the past year.

#### **1.2 Scope**

The scope undertaken to achieve the objectives includes:

- review and assess rainfall, groundwater levels, pH and electrical conductivity (EC) and water chemistry results from groundwater monitoring;
- comparison of groundwater monitoring results against WMP triggers;
- notify ACOL of exceedances which require the enactment of the WMP groundwater response plan; and
- make recommendations regarding the groundwater monitoring network and program, where necessary, to ensure on-going quality control / assurance of the groundwater monitoring.



LEGEND

- |                          |             |
|--------------------------|-------------|
| Ashton mining lease      | Minor road  |
| Ashton exploration lease | Rail        |
| Study area location      | Watercourse |
| Populated place          | Water area  |
| Built up area            | Reserve     |
| Major road               | Vegetation  |
|                          | Land        |

Yancoal Ashton - AEMR 2017 (G1922)

Study area location



DATE  
28/02/2018

FIGURE No:  
**1.1**

## 2 Physical setting

The Ashton underground mine is located south of the New England Highway, bounded by the Hunter River to the south and two Hunter River tributaries - Glennies Creek and Bowmans Creek to the east and west, respectively (Figure 1.1). Underground operations intend extracting four coal seams, PG, ULD, ULLD and LB, via a longwall arrangement.

The underground workings (LW1 to LW8) extracted coal from the PG seam and underlying ULD seam (LW101 to LW108). Noteworthy, LW notation increases from east westward 1 to 8. Currently; longwall mining is taking place within LW201 of the ULLD seam (LW201 to LW208). LW201 is located in the east of the mining lease (ML) close to Glennies Creek and the Glennies Creek alluvium. The final LW panels within ULLD seams are located down dip of LW201, in the western portion of the ML.

### 2.1 Climate and rainfall

Climate monitoring data collected by Ashton Weather Station and the Bureau of Meteorology (BOM) was obtained from Bowmans Creek (BOM station 61270 - Grenell), located about 15 km north of Ashton. The Ashton Weather station has 12 years of rainfall data for the period 1 July 2005 present, while the Bowmans Creek (Grenell) station has 49 years of rainfall data dating from 1969 to present. A summary of average monthly rainfall from Bowmans Creek (BOM station 61270 - Grenell) and the annual 2017 rainfall from the Ashton Weather station is presented in Table 2.1. Precipitation is predominant in November to March; whereas, the winter months are generally drier. The data presented in Table 2.1 shows that rainfall in 2017 was mostly below average, except March and June.

**Table 2.1 Average Monthly Rainfall (mm)**

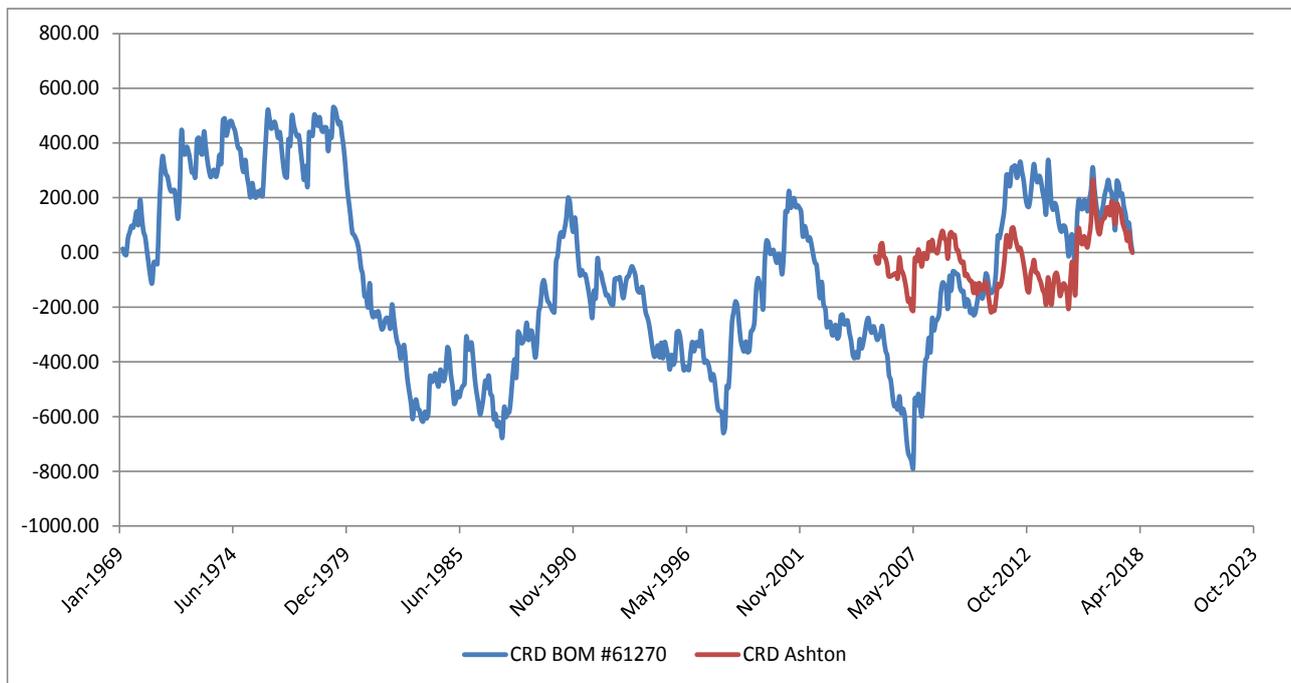
Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ashton	66	76	74	65	36	78	26	31	41	44	78	62	<b>679</b>
Bowmans Ck (Grenell)*	106	92	96	60	59	69	47	47	55	66	85	84	<b>864</b>
% of long term average	62%	83%	77%	108%	61%	113%	55%	66%	75%	67%	92%	74%	<b>79%</b>

*Note: \* is average annual rainfall*

An evapotranspiration (EVT) rate of 765 mm/year was sourced from the Bureau of Meteorology (BOM) database for the Ashton area.

Long-term rainfall trends can be characterised using the Cumulative Rainfall Departure (CRD) method (Bredenkamp et al., 1995). CRD shows trends in rainfall relative to the long-term monthly average and provides a historical record of wetter and drier periods. A rising trend in slope in the CRD plot indicates periods of above average rainfall, while a declining slope indicates periods of below average rainfall. CRD has been used in this study to give context to variations in groundwater levels and chemistry.

The CRD for Ashton weather station and Bowmans Creek station (#61270) are shown on Figure 2.1. CRD trends for both stations showed below average rainfall for 2017 represented by a declining CRD slope.



**Figure 2.1 Cumulative Rainfall Departure**

## 2.2 Surface water

The Ashton mine lease is bounded by Bowmans Creek on the west, Bettys Creek (tributary of Bowmans creek) on the north, Glennies Creek on the east side and Hunter River on the south. Both Bowmans and Glennies Creeks are an affluent of the Hunter River. The three main water courses are described below:

- Hunter River is the main surface water body with a catchment area at Bowmans Creek of 13,590 km<sup>2</sup>. The flow is regulated by Glenbawn dam and by other licensed extractions and releases.
- Glennies Creek and its associated alluvium are located to the east of the underground workings and the Pike's Gully sub-crop area. The catchment area is approximately 600 km<sup>2</sup> and up to half of the Glennies Creek catchment feeds into Lake St. Clair, located within the far north eastern section of the catchment. Water from Lake St. Clair discharges into Glennies Creek under controlled release.
- Bowmans Creek natural channel is above the longwall panel LW6B/LW106B and its associated alluvium are over LW5 to LW8. It is the main water course over the underground workings area. Bowmans creek was diverted in two locations to minimise the impact of mining on both the creek and the potential inflows to the underground workings. The construction of the eastern diversion commenced in March 2011 and the western diversion commenced in February 2012. Both diversions were commissioned in November 2012 and are located within the Bowmans Creek Alluvium (BCA). The diversions were designed to replicate the natural creek setting in terms of channel cross sectional variability in bed level and ecological features (i.e. resting pools). The diversions were lined with a geosynthetic clay liner to minimise leakage from the creek.
- Bowmans Creek flow is not regulated and is monitored according to the WMP. The stream flow gauging station no. 210130, from the NSW Office of Water, was installed in October 1993 and is used as a flow baseline for Bowmans creek with a catchment area of 240 km<sup>2</sup>. This station is located in the middle section of the creek on the mining lease, upstream to the western diversion.

## 2.3 Mining

The longwall panels accessing the ULLD (LW201) are generally offset 24m to the east and 10m south from the overlying ULD longwall panels (LW106a). This offset is designed to reduce the resulting subsidence and associated impacts to the surrounding environment. That said, the northern extent of PG, ULD, ULLD longwalls and the main gate road are aligned results in a “stacked edge” where subsidence impacts are slightly more noticeable at the surface than elsewhere.

Timing of longwall panel coal extraction during 2017 are summarised in Table 2.2.

**Table 2.2 Longwall panel schedule**

Panel	Start	End	Seam
LW106A	18/10/2016	31/05/2017	ULD
LW201	7/7/2017	In progress	ULLD

## 2.4 Conceptual hydrogeology

### 2.4.1 Hydrostratigraphy

Ashton is located in the central Hunter Valley of NSW where the lower sequences of the Whittingham Coal Measures (Singleton Supergroup) subcrop (Figure 2.2). Within the Ashton mining lease, the Hebden seam to the Bayswater seam (inclusive) subcrop. The underground operation targets the PG, ULD, ULLD and the LB seams.

The Whittingham Coal Measures dip west south-west in the Ashton area, an orientation locally controlled by the Camberwell Anticline to the east of the mine and the Bayswater Syncline to the west. The top target coal seam at Ashton, the PG seam, subcrops under the Glennies Creek alluvium (GCA) approximately 150 m east of the mine, while the lowest target coal seam, the LB seam, subcrops under regolith approximately 2 km to the east of the mine. In the western portion of the mining area, the overburden above the PG seam ranges in thickness between 100 m (north end of LW7) and 190 m (south end of LW7).

The stratigraphic sequence in the region comprises two distinct units: Quaternary alluvium and Permian strata. The Permian strata comprise coal seams (typically 2 m to 2.5 m thick) with overburden and interburden (typically 30 m thick between successive seams) consisting of sandstone, siltstone, tuffaceous mudstone, and conglomerate. The Quaternary alluvium consists of unconsolidated silt, sand and gravel in the alluvial floodplains of the Hunter River (HR), Bowmans Creek (BC) and Glennies Creek (GC). The alluvium unconformably overlies the Permian within the floodplains of the HR, BC and GC. Elsewhere, the Permian is overlain by a regolith comprising colluvium, eluvium and completely weathered rock, which interfaces with the floodplain alluvium at the flanks of the valleys.

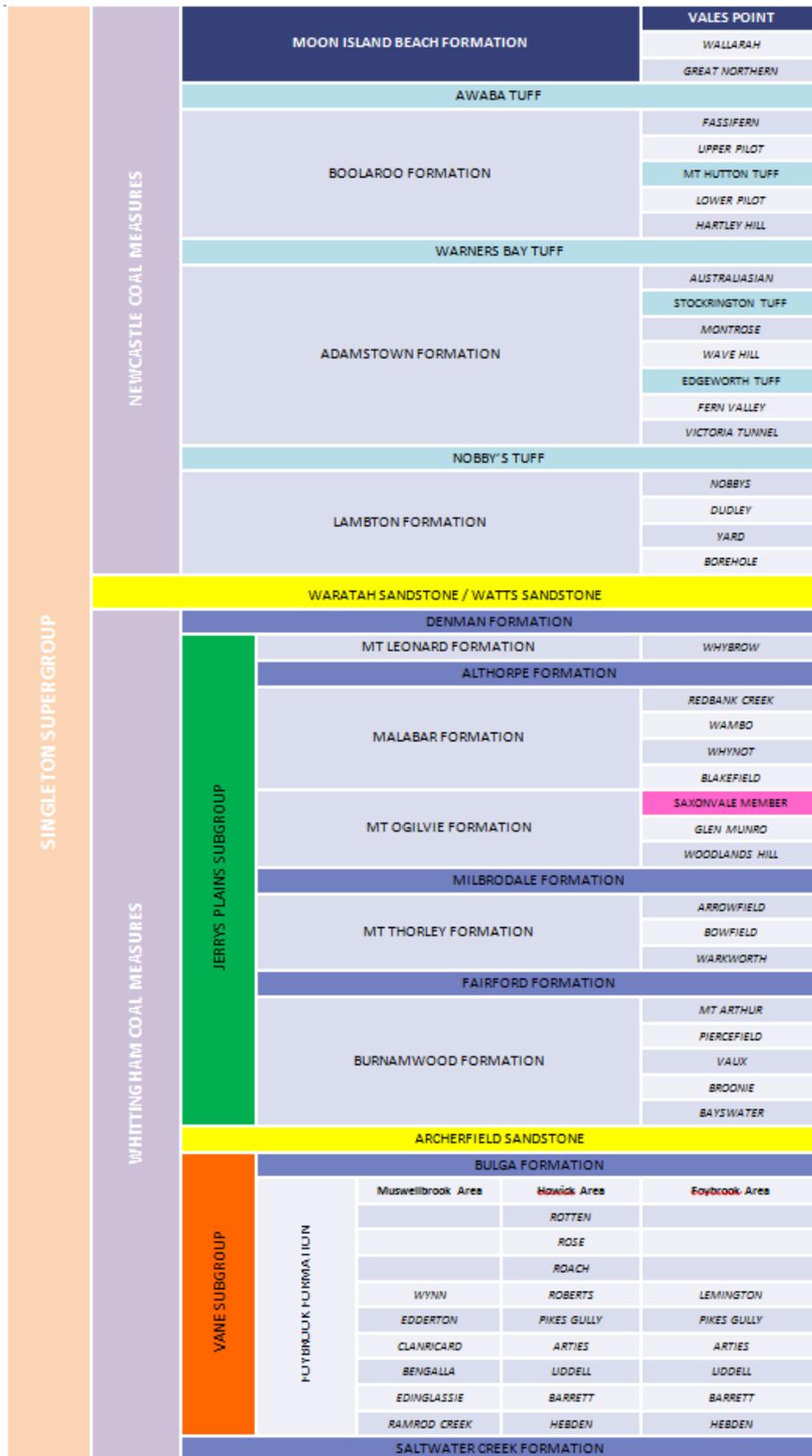


Figure 2.2 Singleton Super Group sequence stratigraphy (after AGE, 2016d)

### 2.4.1.1 Quaternary alluvium / Regolith

Ashton is overlain by Quaternary alluvium associated with the HR, BC and GC. The Bowmans Creek alluvium (BCA) and GCA are in direct connection to the Hunter River alluvium (HRA). The Quaternary/recent aged alluvium/colluvium along the HR, GC and BC flood plains comprises two distinct depositional units, a surficial fine grained sediment and coarser basal material. The surficial alluvium comprises shallow sequences of clay, silty sand and sands. Along the minor drainage lines, the surficial alluvium is typically constrained within 500 m of the creeks and is between 7 m to 15 m thick.

Away from the floodplain areas, the Permian coal measures sequence is overlain by a layer of regolith, comprising colluvium/eluvium, and completely weathered rock that collectively have soil rather than rock properties and interface with the alluvium at the flanks of the floodplain areas. The regolith layer varies in thickness, but is typically 15-20m thick above rock.

### 2.4.1.2 Permian strata

The Whittingham Coal Measures comprise Permian aged coal seams interbedded with siltstone, sandstone, shales and conglomerates. The Whittingham Coal Measures are up to 400 m thick at Ashton, but regionally they range from approximately 250 m to 600 m thickness. At Ashton, the lower portion of the Whittingham Coal Measures is present on site. The profile extends from above the Bayswater seam to the Hebden seam (Figure 2.2).

Locally, the Whittingham Coal Measures are further divided to (AGE, 2016):

- four main target coal seams – PG, ULD, ULLD and the LB;
- a large number of coal seams and plies of varying thickness, including the Bayswater seam, up to 20 Lemington seam plies, the Arties seam, and a number of Liddell seam and Barrett seam plies that are not proposed to be mined in the Ashton underground mine; and
- interburden sediments comprising siltstone, sandstone, conglomerate and claystone.

Over 20 plies of the Lemington seam profile and the overlying Bayswater seam are present within the PG seam overburden. The largest Lemington seam plies are of similar thickness as the four target seams, and may have similar hydraulic properties.

### 2.4.2 Recharge

Recharge is interpreted to occur from direct rainfall to the ground surface, infiltrating into the formations through the thin soil cover and regolith. The coal measures also occur at subcrop in localised zones beneath the HRA, GCA and the BCA. In these areas, the Permian coal measures are interpreted to be recharged by downward seepage and then downdip flow along the most permeable strata in the sequence, primarily the coal seams (Aquaterra, 2009 and AGE 2016).

The combined surface water catchment area potentially providing recharge to the Ashton area is significantly greater in size than the mine area itself. Ashton is located immediately adjacent the confluences of the Hunter River with Bowmans and Glennies Creeks. The Ashton surface and underground infrastructure is located entirely within the Bowman's and Glennies Creek catchments, which extend approximately 30 km and 45 km to the north of Ashton, respectively.

Bowmans and Glennies Creek have up to fourth order tributaries up-stream of the site and rainfall falling within the respective catchments flow through the Ashton area. The Bowmans and Glennies Creeks catchments span approximately 300 km<sup>2</sup> and 600 km<sup>2</sup>, respectively.

### 2.4.3 Groundwater flow

The Quaternary alluvium and regolith combined is interpreted (AGE, 2016) to be an unconfined groundwater system that is recharged by rainfall infiltration, streamflow and upward leakage from the underlying stratigraphy, particularly along GC and BC.

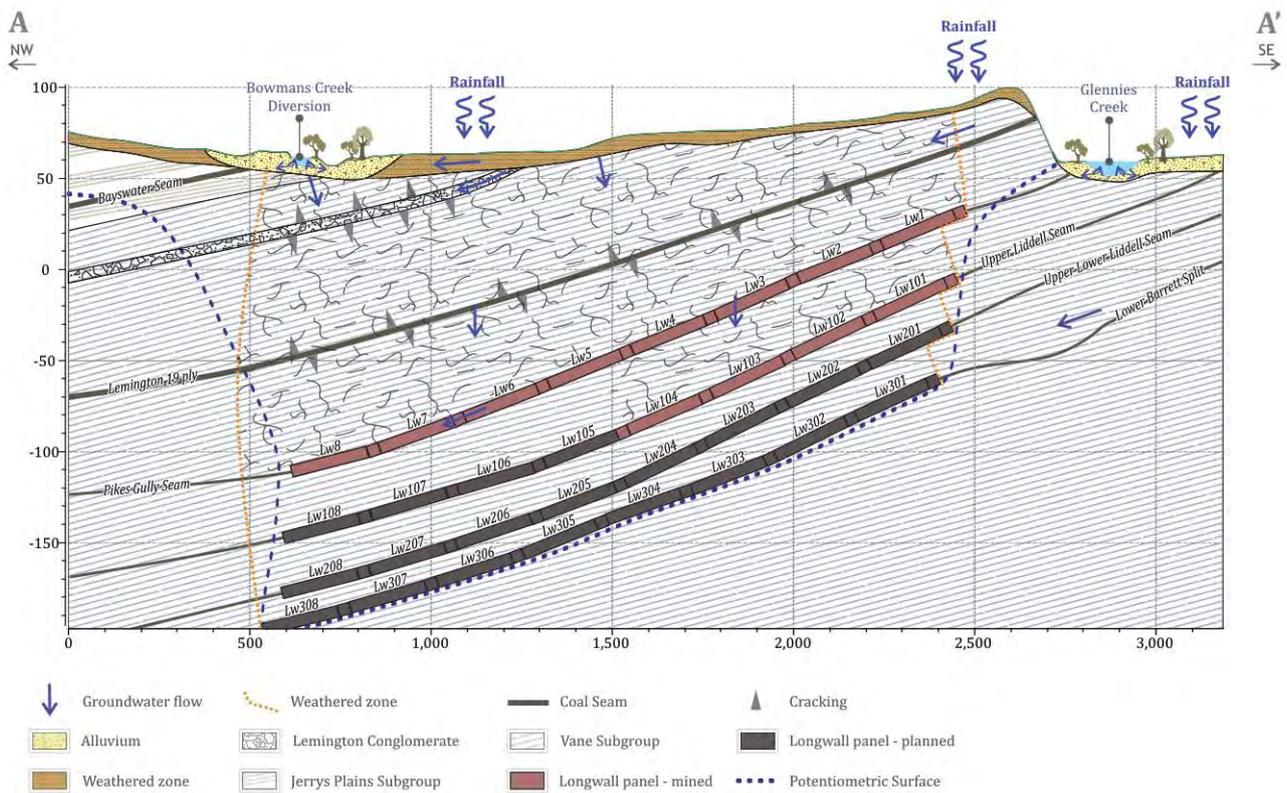
The water table in the alluvium/regolith is a subdued reflection of topography. Groundwater within the HRA flows generally in an easterly direction, while groundwater within GCA and the BCA flows generally in a southerly direction towards the HR, with local flow towards the respective river/creeks.

The direction of groundwater flow for the coal seams is influenced by the local geomorphology and structural geology as well as the long history of mining within the region. Groundwater flow within the Permian coal measures is understood to be to the south-west consistent with the dip direction of the coal seams.

The mining of the PG seam and ULD seam has impacted the groundwater regime at Ashton. Mining has induced subsidence cracking that extends to the ground surface above parts of Ashton, and to a lesser height above the goaf in other areas where the cover depth above the PG seam is greater (ie near the western side of the mine area). It is likely that in areas of shallower cover depth, this cracking has penetrated both the overburden of the PG, along with the BCA. Surface cracking is also visible along and across the longwall panels areas immediately following subsidence. This surface cracking is expected to extend for only a limited depth below surface and may or may not intersect with the subsidence cracking emanating up from the goaf, depending on cover depth and subsidence magnitude.

There is also potential for recharge from the GCA through connectivity with the PG seam (AGE, 2016), which hydraulic testing showed was significantly more permeable close to outcrop than at depth (Peter Dundon and Associates, 2006). Inflows into the workings during mining of LW1 were not significantly greater than during mining of LW1 tailgate (TG1A). This would indicate that mining of LW1 did not increase the connectivity or flow from the PG seam in subcrop beneath the GCA. Although inflows were higher during mining of TG1A than subsequent inflows from subsided strata during extraction of LW1, the total inflows to the end of LW1 were below predicted inflows, and the observed impacts on GCA were less than predicted, confirming that the proximity to Glennies Creek has not resulted in an unexpected level of connectivity and inflows from the Glennies Creek floodplain.

The presence of subsidence cracking over parts of the underground mine increases the potential connectivity of the mine with the water within the creeks and associated alluvium. Planned LW panels within the underlying ULD, ULLD and LB seams may allow for reactivation of subsidence and subsidence related fracturing within these areas (AGE, 2016). Figure 2.3 shows the conceptual hydrogeology after AGE (2016c).



**Figure 2.3 Conceptual hydrogeology - north-west to south-east - not to scale (AGE 2016)**

### 3 Groundwater management plan

#### 3.1 Groundwater monitoring network

The ACOL groundwater monitoring network consists of more than 100 monitoring bores, of which up to 49 are monitored as part of the WMP, in either monthly, quarterly or annual campaigns. The WMP outlines the monitoring plan and key monitoring locations in areas potentially sensitive to mining impacts.

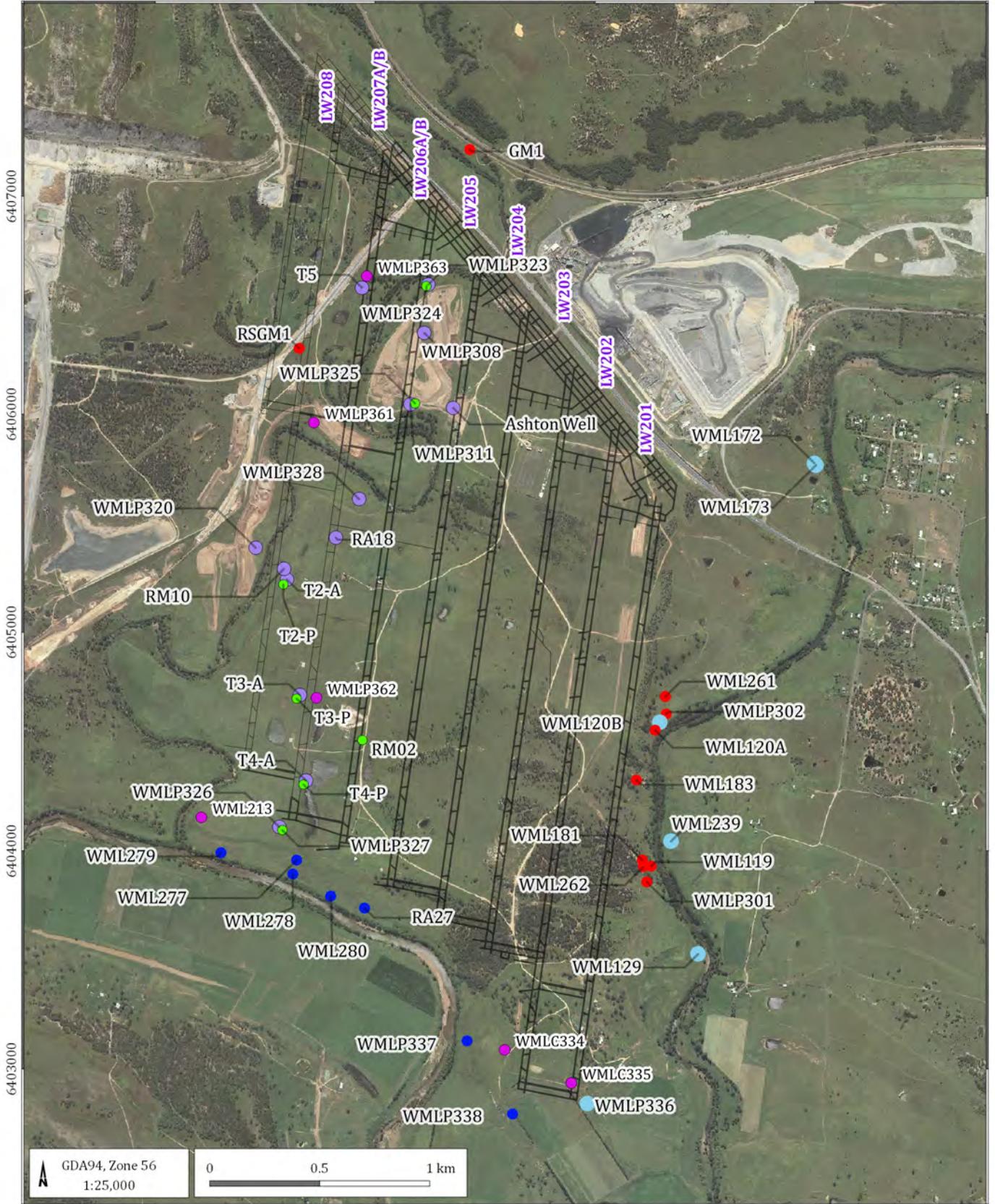
The WMP monitoring locations are presented in Figure 3.1. The groundwater monitoring program includes the monitoring of:

- groundwater levels;
- groundwater (piezometric) pressures;
- field water quality parameters – pH and EC;
- groundwater sampling for comprehensive chemical analysis (including ph, electrical conductivity (EC), field temperature, total dissolved solids (TDS), turbidity, cations / anions / alkalinity, nitrate, nitrite, total nitrogen, total phosphorous, copper, lead, zinc, nickel, iron, manganese, arsenic, selenium, cadmium, chromium); and
- monitoring of groundwater level and EC as required by EPL 11879.

Monitoring frequency is as follows:

- monthly monitoring of groundwater level and field water quality at selected alluvial piezometers;
- monthly monitoring of groundwater level and piezometric pressure in longwall-specific piezometers during active extraction at relevant longwalls;
- quarterly monitoring of groundwater level, piezometric pressure and field water quality at selected piezometers;
- biannual monitoring for monitoring bores specified by EPL 11879; and
- annual sampling at selected piezometers for comprehensive chemical analysis.

The WMP was updated and submitted for DPI Water for approval in June 2017. The updated WMP includes a slightly modified monitoring regime that includes alluvium and coal measure bores east of Glennies Creek. The updated WMP also has a broader array of monitoring bores in the network and targeted water quality triggers. The WMP had not received approval by the end of the 2017 reporting year.



LEGEND

— Longwall panels (ULLD)

VWPs

- WML213 (Bay, Lem, PG, LD, Bar)
- WMLC334 (Lem, Art, LD, Bar)
- WMLC335 (Lem, PG, Art, LD, Bar)
- WMLP361 (Lem, Art, ULD)
- WMLP362 (PG\*)
- WMLP363 (Lem, ULD)

Monitoring bores

- BCA - Bowman's Creek alluvium
- CMOB (Regolith) - Coal measure overburden
- Coal measures
- GCA - Glennies Creek alluvium
- HRA - Hunter River alluvium

Yancoal Ashton - AEMR 2017 (G1922)

WMP Groundwater Monitoring Network



DATE  
28/02/2018

FIGURE No:  
3.1

## 3.2 Trigger values

Trigger values for groundwater level and quality apply to specific piezometers in the Bowmans Creek Alluvium (BCA), Glennies Creek Alluvium (GCA) and the Hunter River Alluvium (HRA) are listed in Table 3.1. A recorded groundwater level below the defined trigger level at a piezometer any time between May 2015 and the end of mining in the ULD (Ashton 2016), that is sustained for three consecutive months, triggers a response under the WMP. Groundwater quality trigger levels are summarised in Table 3.2. Similar to groundwater elevation, three consecutive measurements outside of these values trigger a response under the WMP.

**Table 3.1 Groundwater elevation trigger levels for alluvial monitoring bores**

Aquifer	Trigger monitoring bore	Interpolated base of alluvium (mAHD)	Assigned trigger value end of mining ULD Seam (mAHD)
BCA	WMLP323	57.7	58.4
	WMLP311	54.9	56.2
	T2A	51.8	52.5
	WMLP328	54.7	55.2
GCA	WML120B	50	51.7
	WML129	45	50.4
	WML239	45.4	50.8
HRA	WMLP279	37.4	49
	WMLP280	43.3	48.8
	WMLP337	45.6	47.8

**Table 3.2 Groundwater quality trigger levels for alluvial monitoring bores**

Aquifer	pH trigger	EC trigger
BCA	< 6.5 or > 8.0	> 2,000 $\mu$ S/cm
GCA	< 6.2 or > 8.0	> 2,000 $\mu$ S/cm
HRA	< 6.2 or > 8.0	> 3,100 $\mu$ S/cm

## 4 Groundwater monitoring results

Groundwater monitoring and sampling was completed at the frequency specified in the WMP version 8 (Section 3). Groundwater levels and quality trends for trigger bores are presented in Figure 4.1 through Figure 4.15. Hydrographs and groundwater quality trends for monitoring bores across the whole network are presented in Appendix A.

### 4.1 Alluvium monitoring

#### 4.1.1 WMP compliance groundwater levels

The groundwater level trends and trigger levels for the BCA, GCA and HRA compliance monitoring bores are presented in Figure 4.1, Figure 4.2 and Figure 4.3, respectively. Daily rainfall measurements and Cumulative Rainfall Departure (CRD) have also been plotted and used to compare water level trends. The river and creek water levels (sourced from NSW Office of Water on-line database<sup>1</sup>) are presented graphically in Figure 4.4.

The following observations are noted:

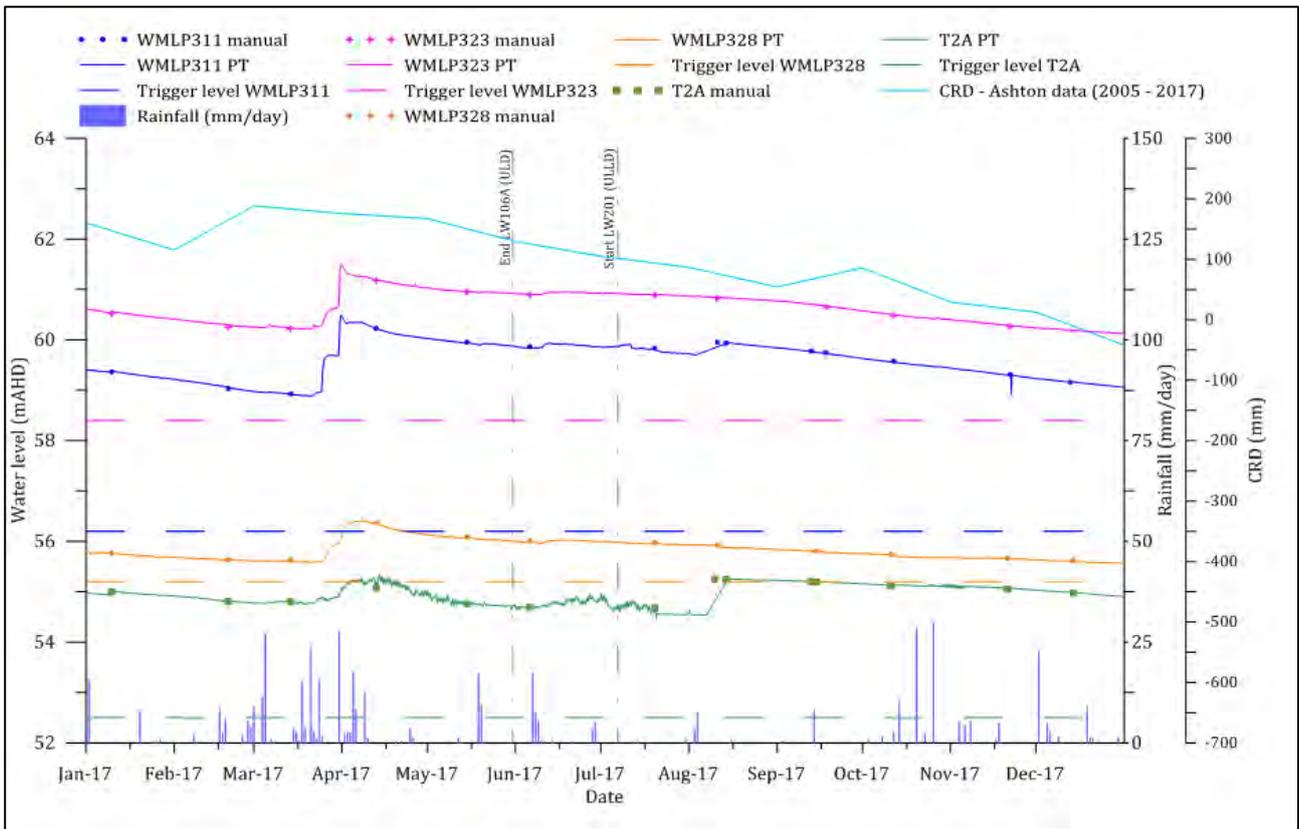
- No exceedances have been noted that require the groundwater management protocol to be enacted.
- BCA groundwater levels (Figure 4.1) have a general decline throughout the year, which corresponds to the declining CRD. There was a rise in the groundwater levels in April following several days of rain.
- GCA groundwater levels (Figure 4.2) were stable throughout the year, varying by less than one metre. This is likely due to the Glennies Creek being a regulated stream.
- HRA groundwater levels (Figure 4.3) were stable throughout the year. A very slight rise in April following several days of rainfall.

Other monitoring bores (refer Appendix A for hydrographs) across the wider site monitoring network have also been reviewed and groundwater levels across the network follow similar trends as the nominated trigger monitoring bore sites in the BCA, GCA and HRA. Groundwater elevations are higher in the north (BCA and GCA) and generally flow southward towards the HRA. Groundwater levels in the BCA rose following several days of rain in April 2017 followed by declining levels for the remainder of the year, which corresponds to a declining CRD. GCA and HRA groundwater was relatively stable throughout the year with minimal response to rainfall recharge.

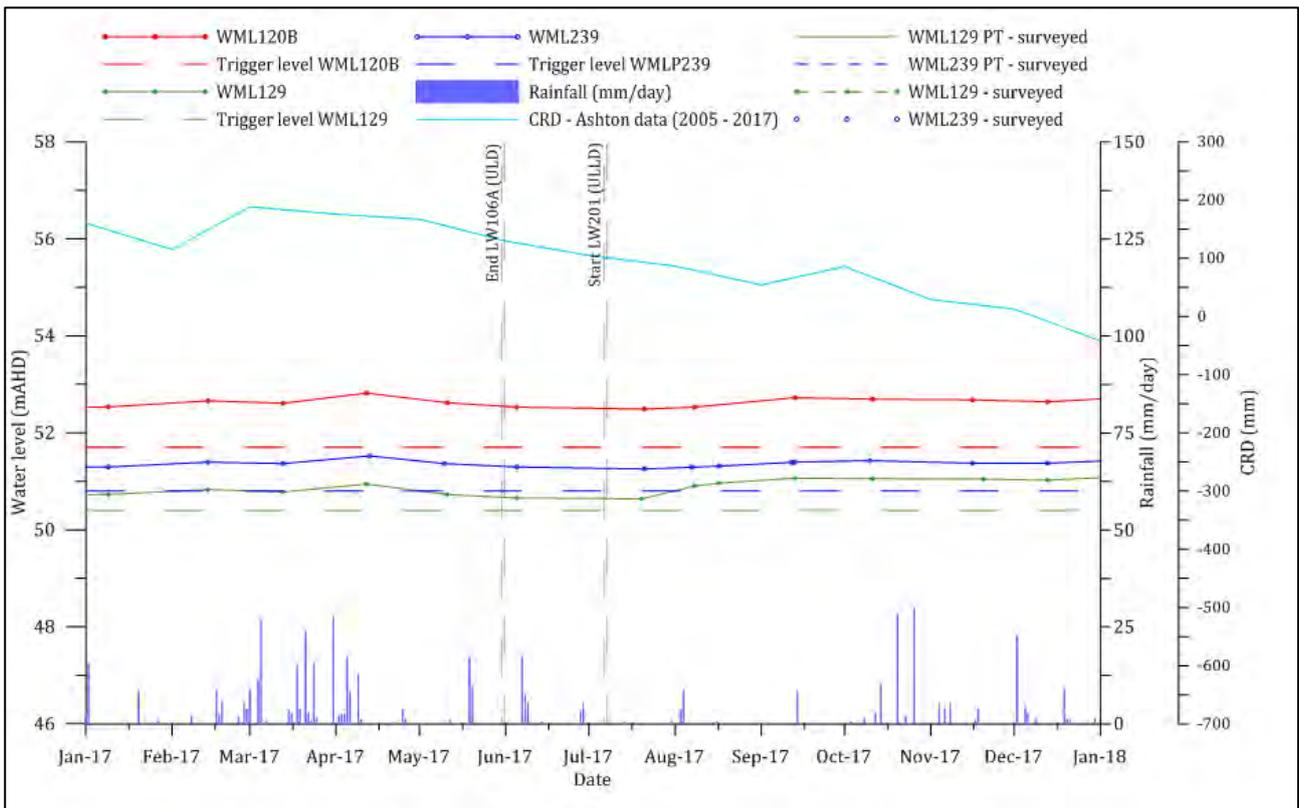
No mining related impacts to alluvium groundwater levels were measured. As such, the measured levels were within the approved ranges.

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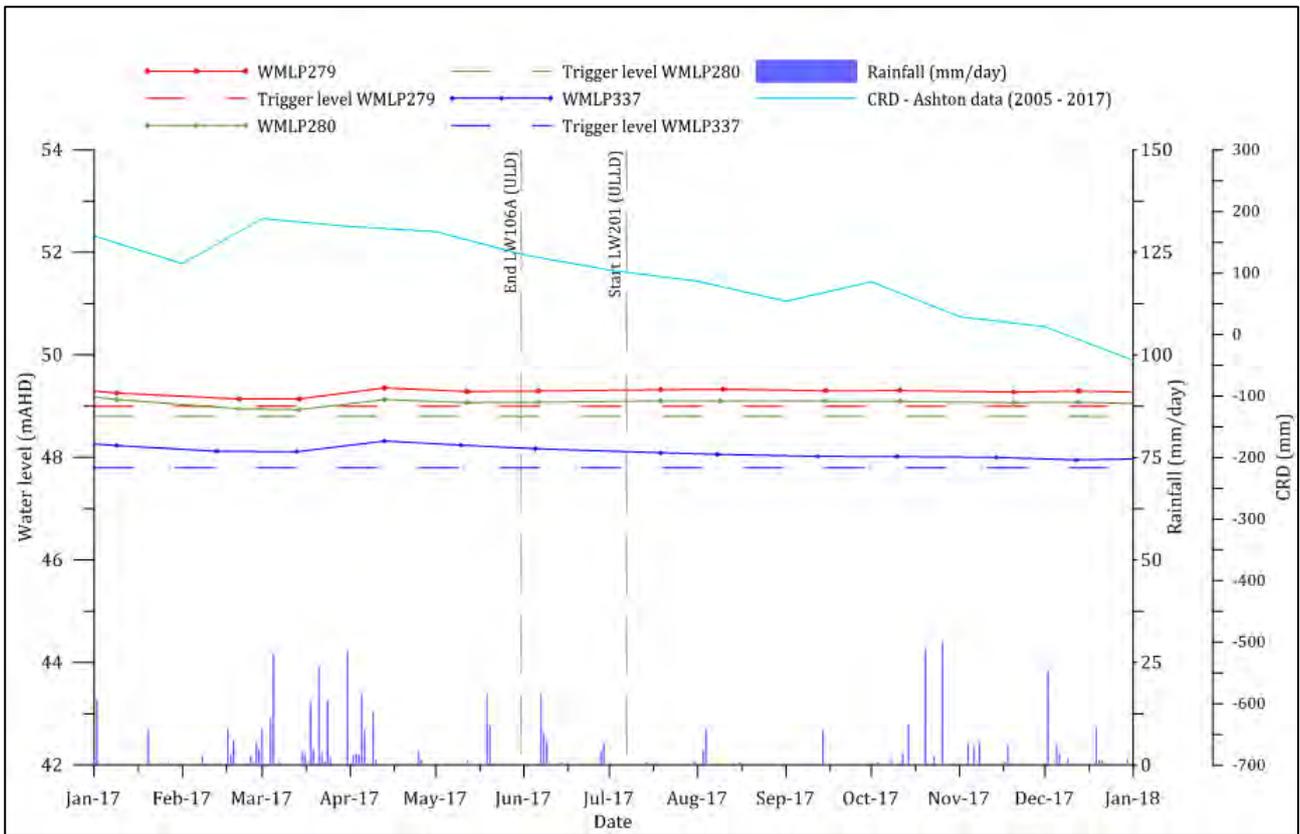
<sup>1</sup> <http://realtimedata.water.nsw.gov.au/water>



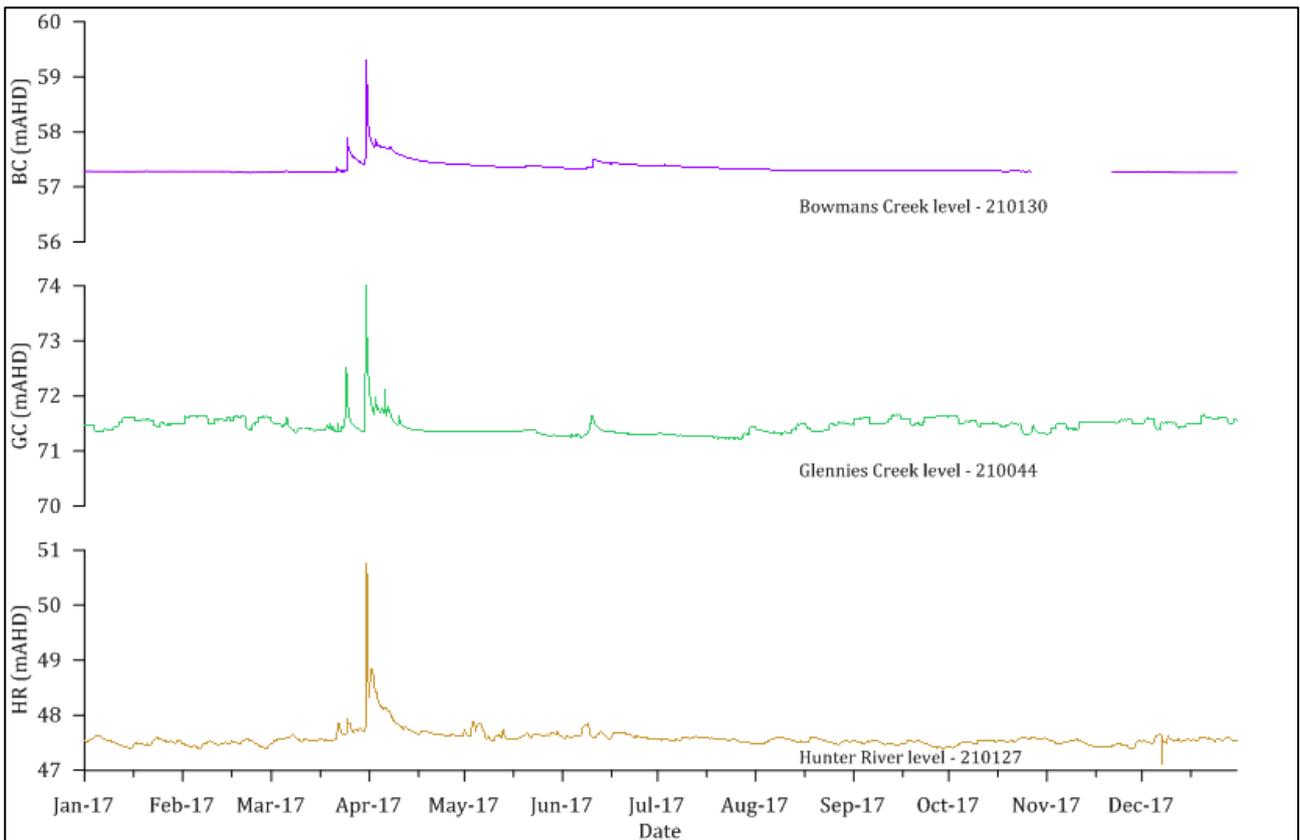
**Figure 4.1 Bowmans Creek alluvium trigger bores hydrograph**



**Figure 4.2 Glennies Creek alluvium trigger bores hydrograph**



**Figure 4.3 Hunter River alluvium trigger bores hydrograph**



**Figure 4.4 River / creek water level trends**

#### 4.1.2 pH, electrical conductivity, major ions

All monitoring bores across the wider site monitoring network have also been reviewed and are presented graphically in Figure 4.5 to Figure 4.16. A full list of sample results for major ions and dissolved metals from the annual sampling, completed in August 2018, is presented in Appendix B. In general, Groundwater pH and EC across the network follow similar trends as the trigger monitoring bore sites in the BCA, GCA and HRA.

Generally, groundwater **pH** is slightly acidic to neutral in the alluvial aquifer and there were no pH exceedances in any of the monitoring bores across the site. The following observations are noted from the data:

- Groundwater pH values within the BCA, GCA and HRA were stable and follow the similar general trends throughout 2017, with minor localised variations. There were no exceedances of the trigger values, with the exception of WML172, as the bore did not exceed the trigger for three consecutive readings the WMP response protocol was not enacted. WML 172 has been investigated previously and found not to be screened in the GCA. Generally, the values are slightly acidic to neutral and range from:
  - BCA - 6.65 (T5) – 7.6 (Ashton Well);
  - GCA – 6.36 (WML120B) – 8.91 (WML172); and
  - HRA – 6.62 (WMLP279) – 7.22 (WMLP337).

Groundwater **EC** is fresh to slightly brackish across the BCA, GCA and HRA monitoring network. There was one EC trigger exceedance during 2017 measured in T3A, located in BCA. The river and creek EC levels (sourced from NSW Office of Water on-line database<sup>2</sup>) are presented in the same figures for each water source. Generally, values were fresh to slightly brackish and range from:

- BCA - 678 (Ashton Well) – 2,252 (T3-A);
- GCA – 379 (WML129) – 2,582 (WML173); and
- HRA – 950 (WMLP279) – 2,911 (WMLP337).

The trend analysis indicates:

- **BCA** groundwater EC (Figure 4.11 and Figure 4.12) closely follows the surface water EC measured at Bowman's Creek (station #210130). Groundwater EC decreases after several days of rainfall in April (as does the surface water) indicating some rainfall recharge occurring. EC has remained stable throughout the year and comparable to historical results. There was a return to background levels, around 1,200  $\mu\text{S}/\text{cm}$ , following the rainfall event in April. All values were below the trigger level of 2000  $\mu\text{S}/\text{cm}$ .

Slightly elevated EC above the trigger level of 2,000  $\mu\text{S}/\text{cm}$  has been continuously measured in T3A throughout the year. An initial investigation was completed in March 2017 to address the exceedance. A second investigation was completed in November 2017 following the second exceedance (third consecutive reading above 2000  $\mu\text{S}/\text{cm}$ ). A historical analysis indicates that EC in T3A has not changed significantly since 2007, with a minimum value of 1,978  $\mu\text{S}/\text{cm}$  recorded in 2012. EC in T4A and WMLP326 are also slightly elevated, compared to the others and do not show as well correlation to the Bowmans Creek EC. It was concluded that although T3A was representative of the BCA in that location, T3A was/is not representative of the BCA generally.

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<sup>2</sup> <http://realtimedata.water.nsw.gov.au/water>

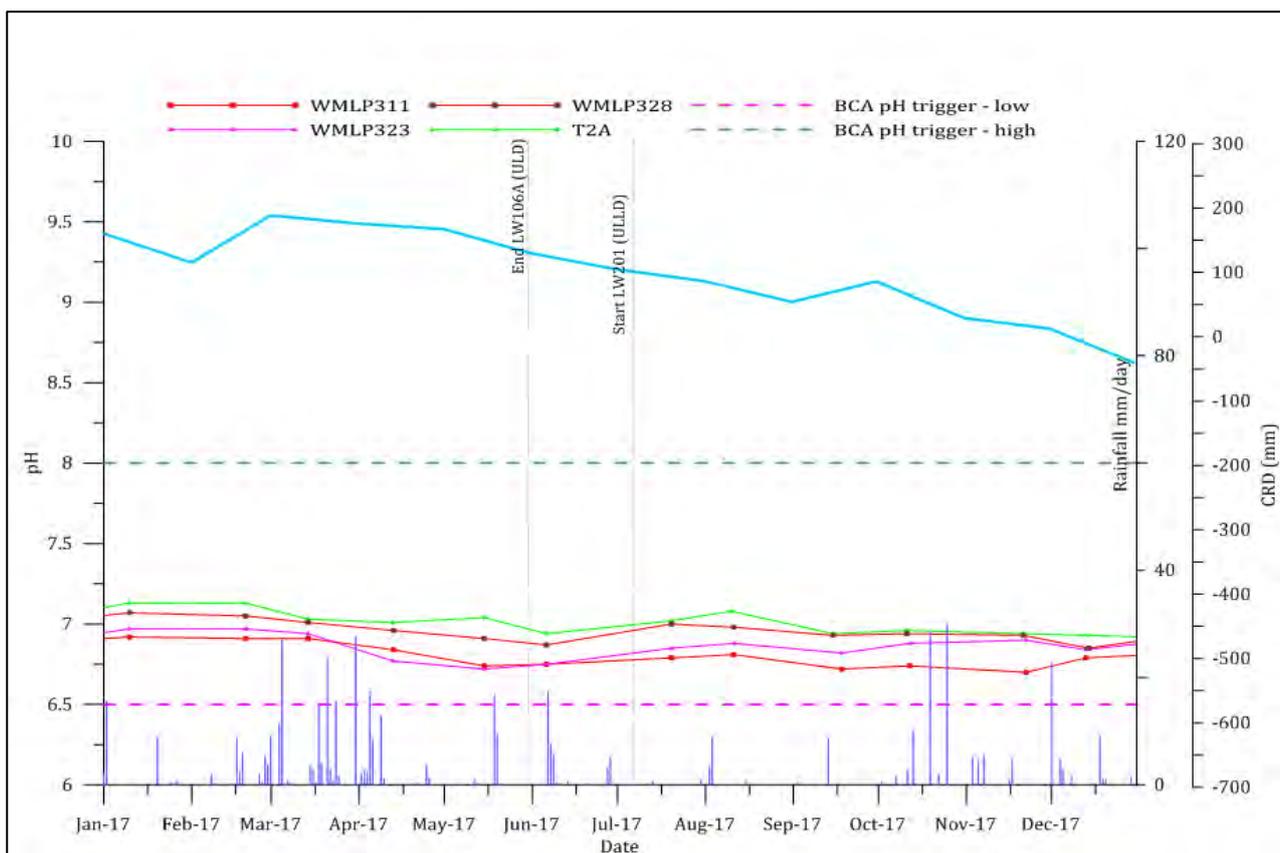
- **GCA** groundwater EC levels have been stable throughout the year with very little variation. The values in the three monitoring bores, WML120B, WML239 and WML129 do not follow the EC of the surface water measured at Glennies Creek (station #210044), which does fluctuate throughout the year. All values were below the trigger level of 2,000  $\mu\text{S}/\text{cm}$ .

GCA monitoring bore WML172 and WML173 have slightly higher EC values than the trigger bores. Monitoring at both bores ceased in June 2017. WML173 has EC values around 2,500  $\mu\text{S}/\text{cm}$ , which is above the trigger value, however, three consecutive measurements were not made. As stated previously, an investigation has been carried out on WML172 and WML173 and WML173 was found to not be screened in the GCA and WML173 was screened in a heat affected coals; hence, neither is representative of either units regionally.

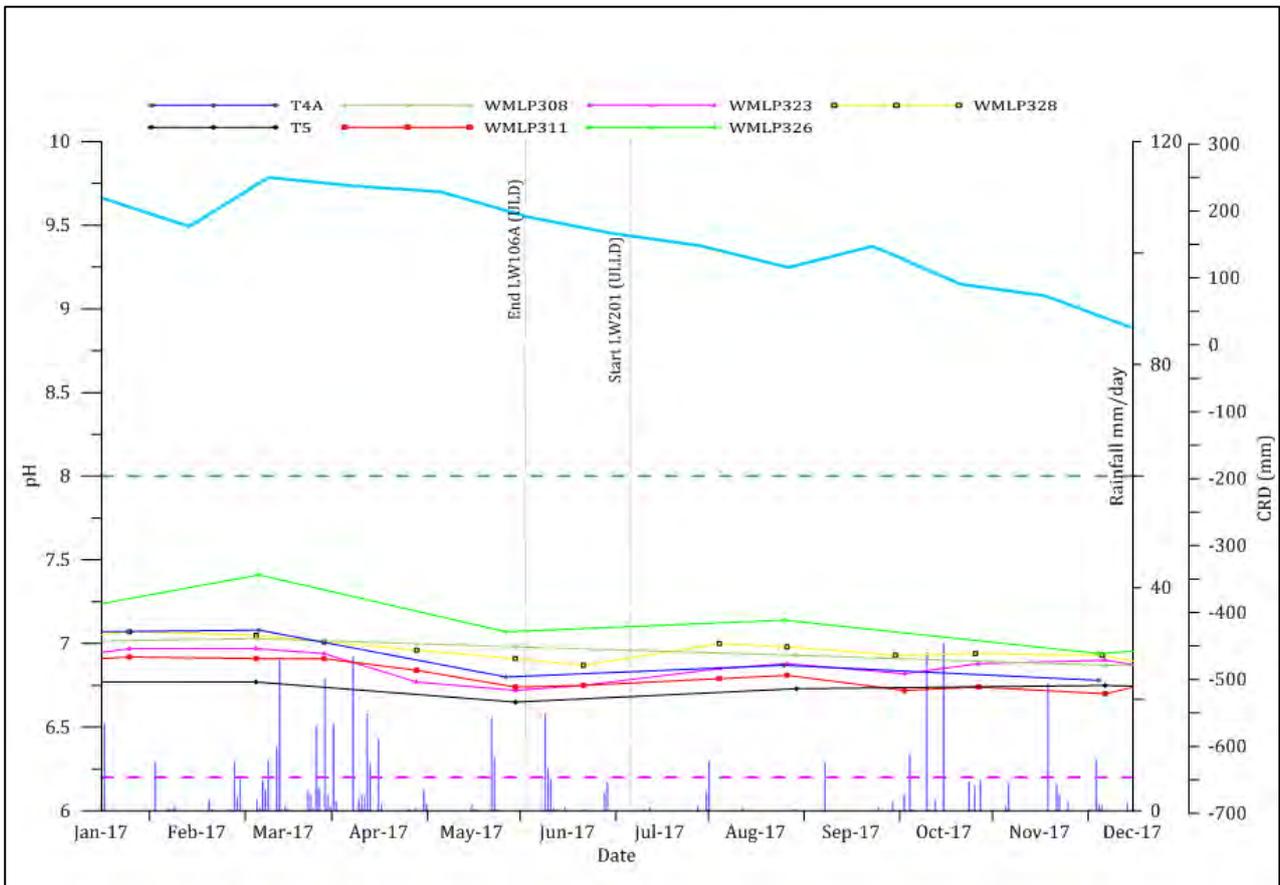
- **HRA** groundwater EC levels have a larger range than BCA and GCA. The levels throughout the year were stable and showed little fluctuation. They do not follow the surface water EC measured in the Hunter River (station #210127) which fluctuates throughout the year. All values were below the trigger level of 3,100  $\mu\text{S}/\text{cm}$ .

The cation water type at all monitoring bores is dominated by Na. With respect to anions, Cl clearly dominates over the  $\text{SO}_4$  ions in the alluvial monitoring bores. A piper diagram of water types is presented in Appendix C.

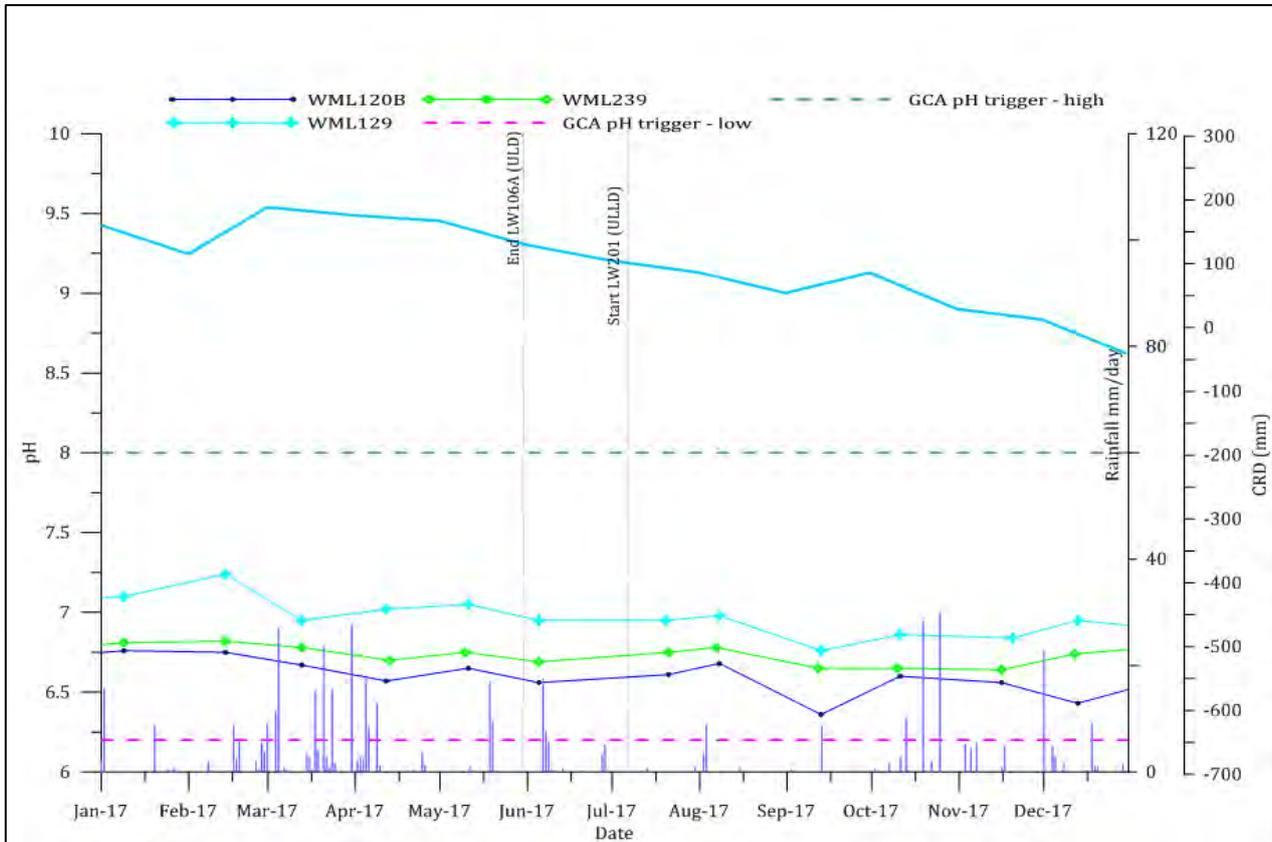
No mining related impacts to alluvium groundwater quality were measured. As such, the measured quality was within the approved ranges.



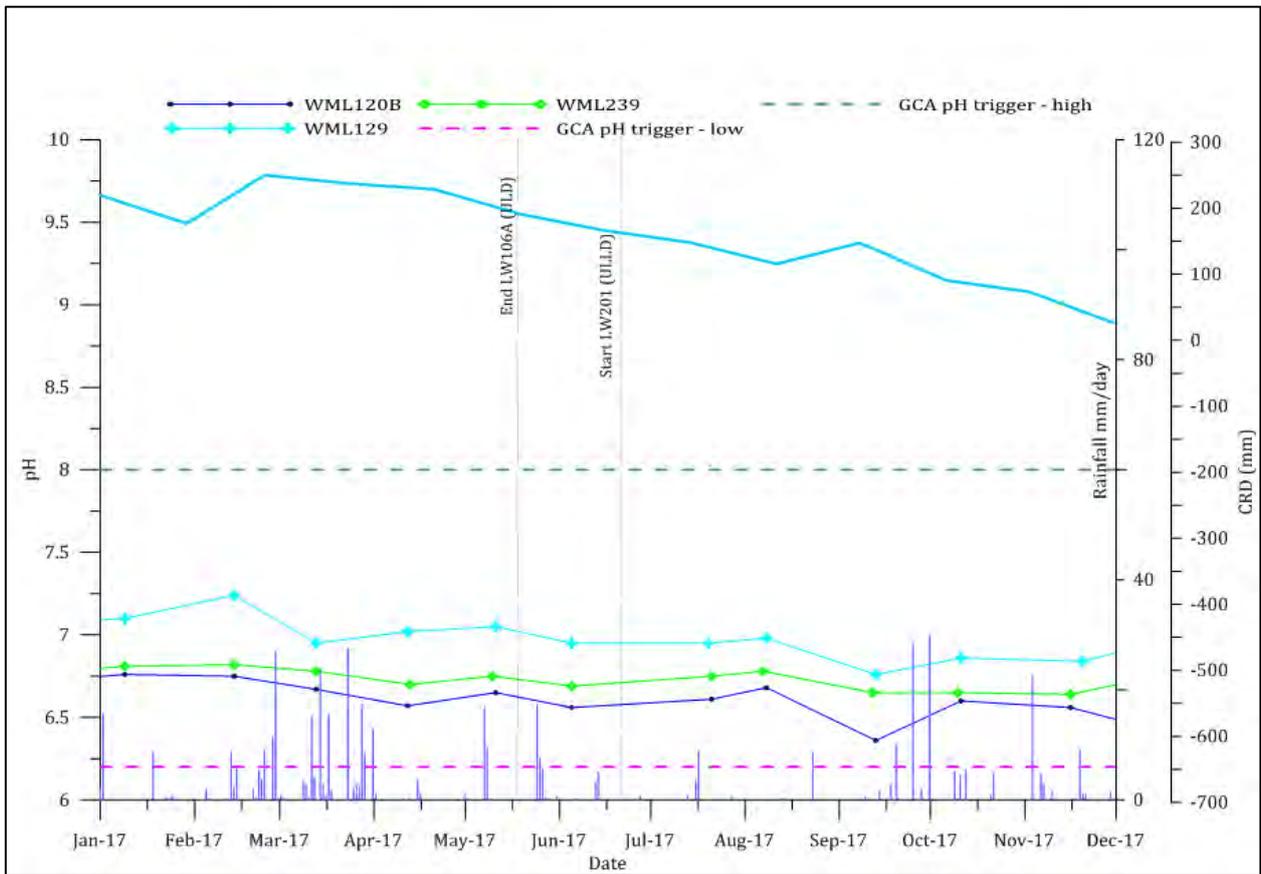
**Figure 4.5 Bowmans Creek alluvium pH trends (water level compliance bores)**



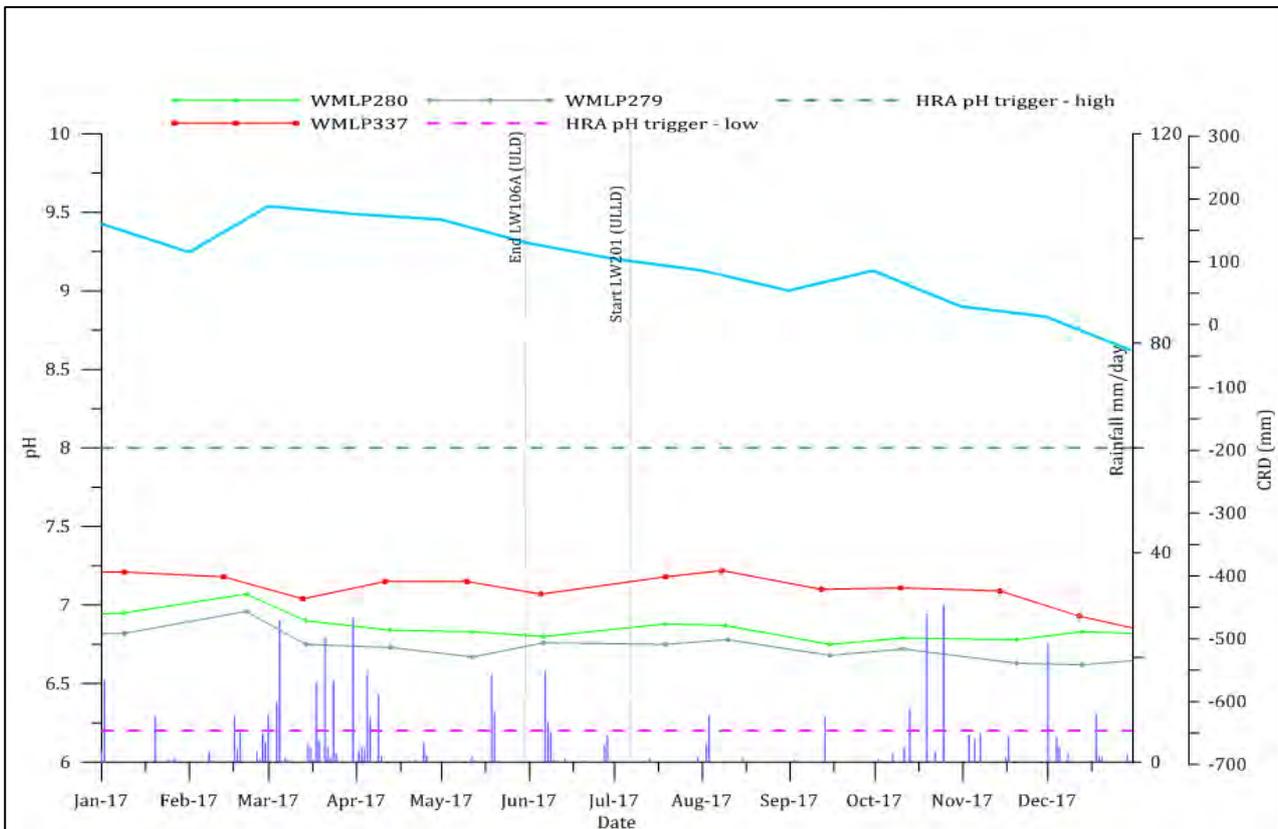
**Figure 4.6 Bowmans Creek alluvium pH trends (other bores)**



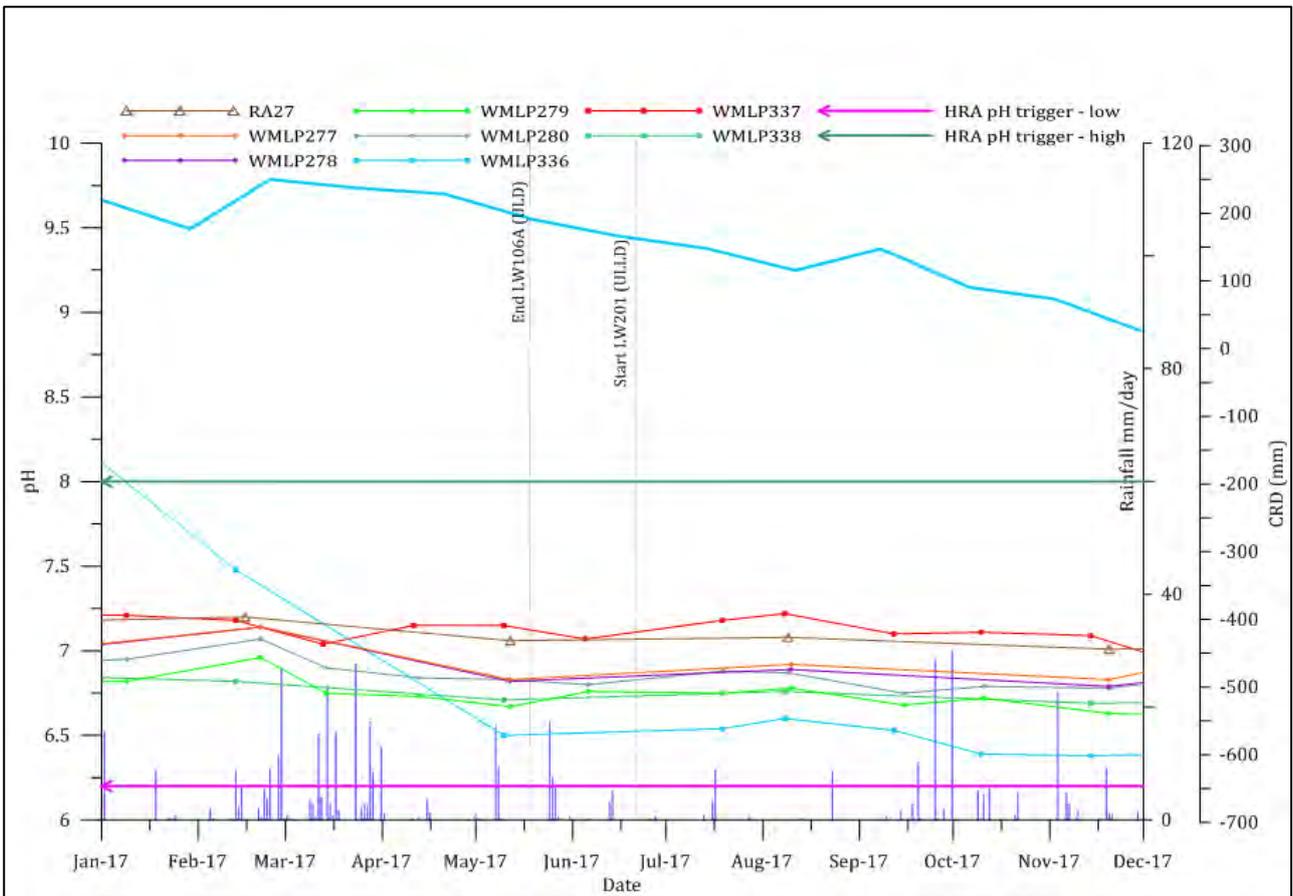
**Figure 4.7 Glennies Creek pH trends (water level compliance bores)**



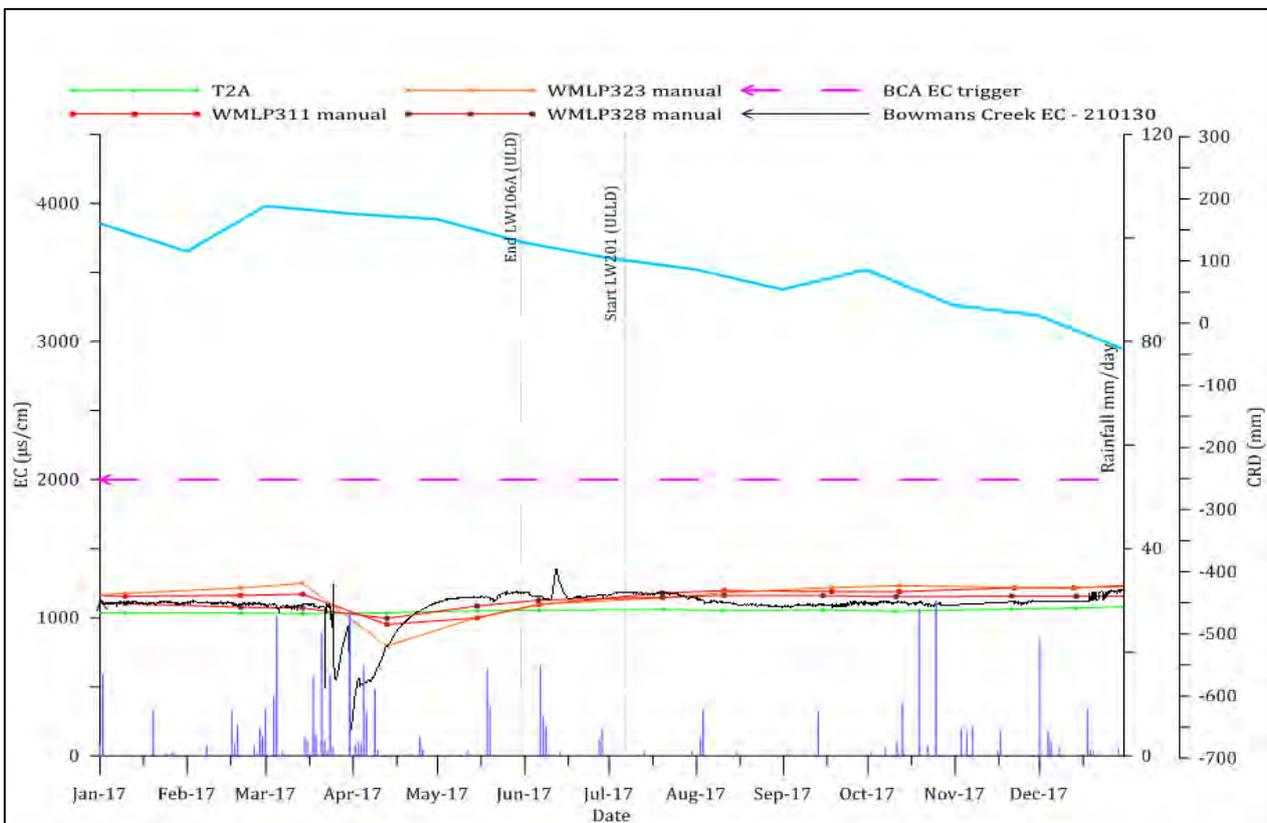
**Figure 4.8** Glenties Creek alluvium pH trends (other bores)



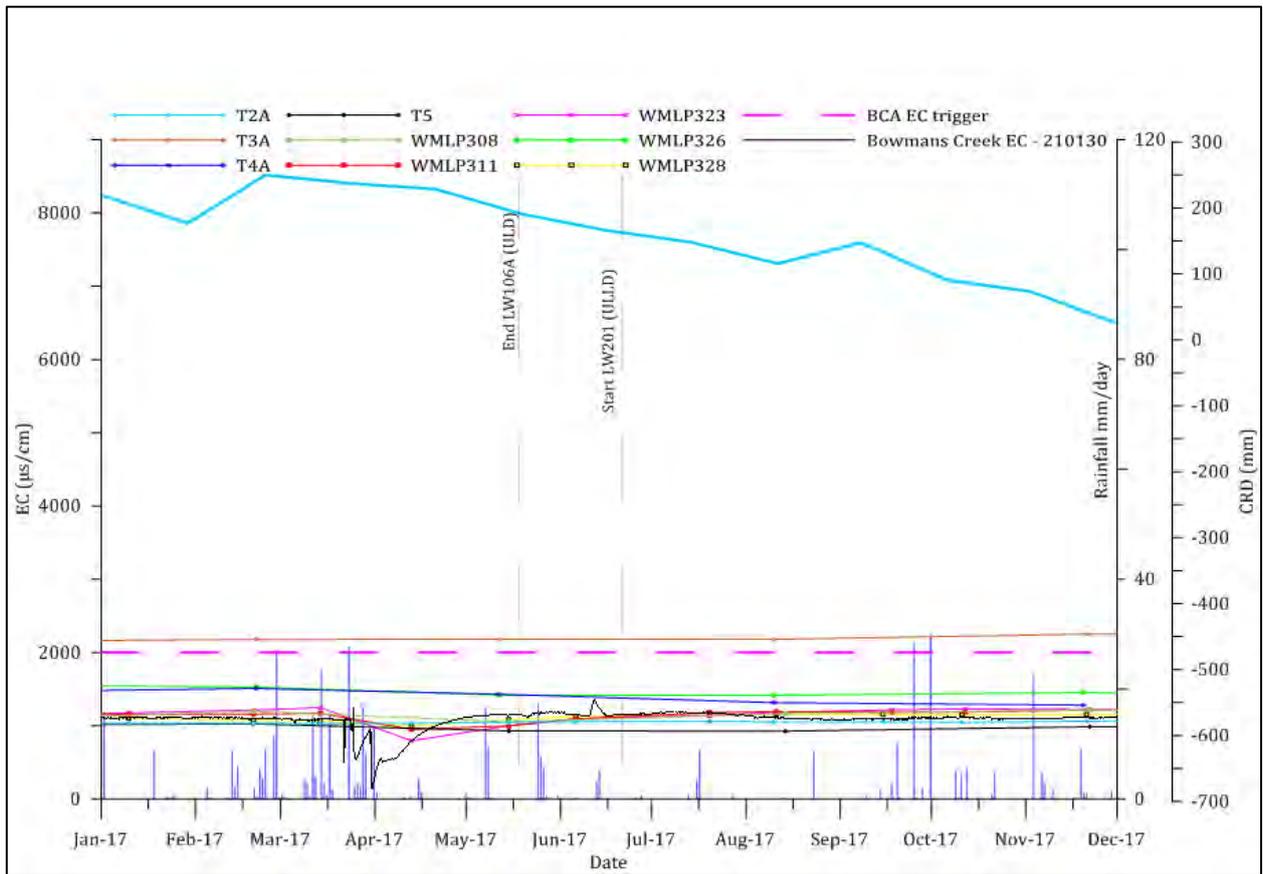
**Figure 4.9** Hunter River alluvium pH trends (water level compliance bores)



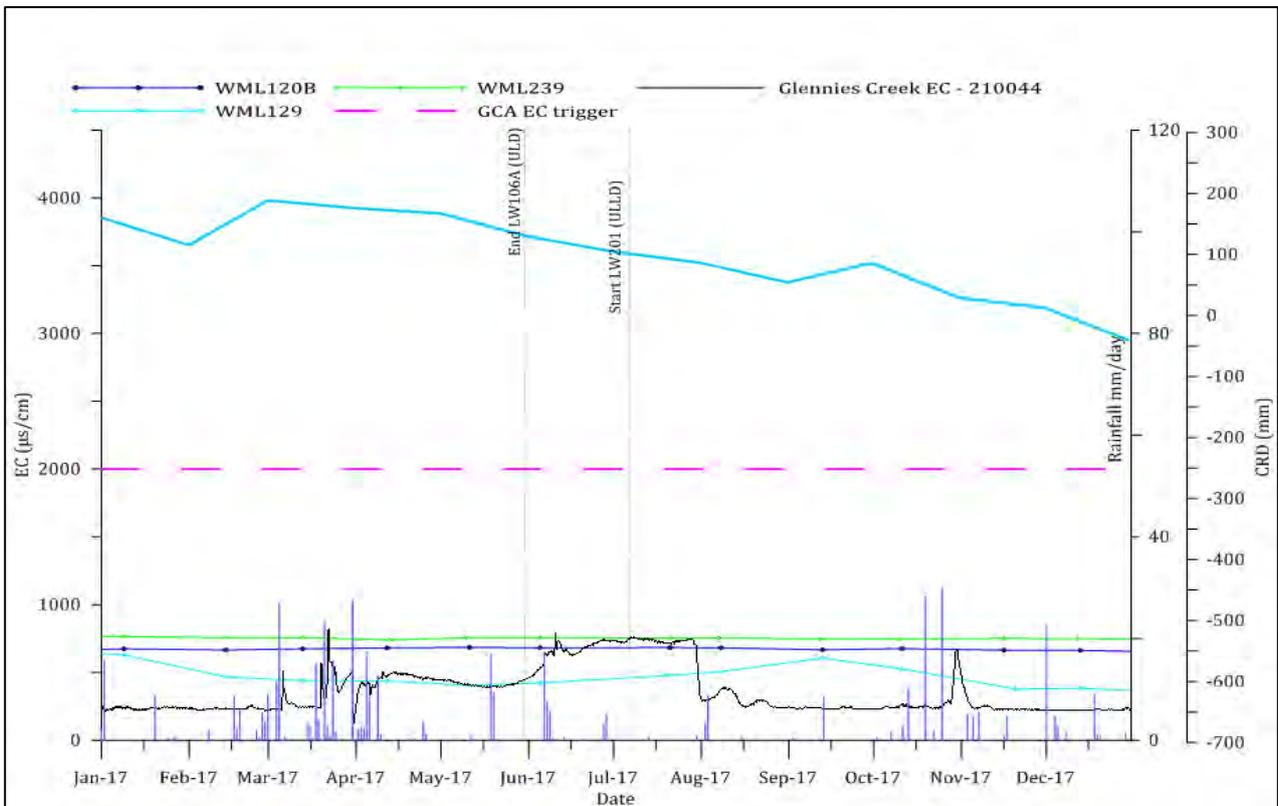
**Figure 4.10 Hunter River alluvium pH trends (other bores)**



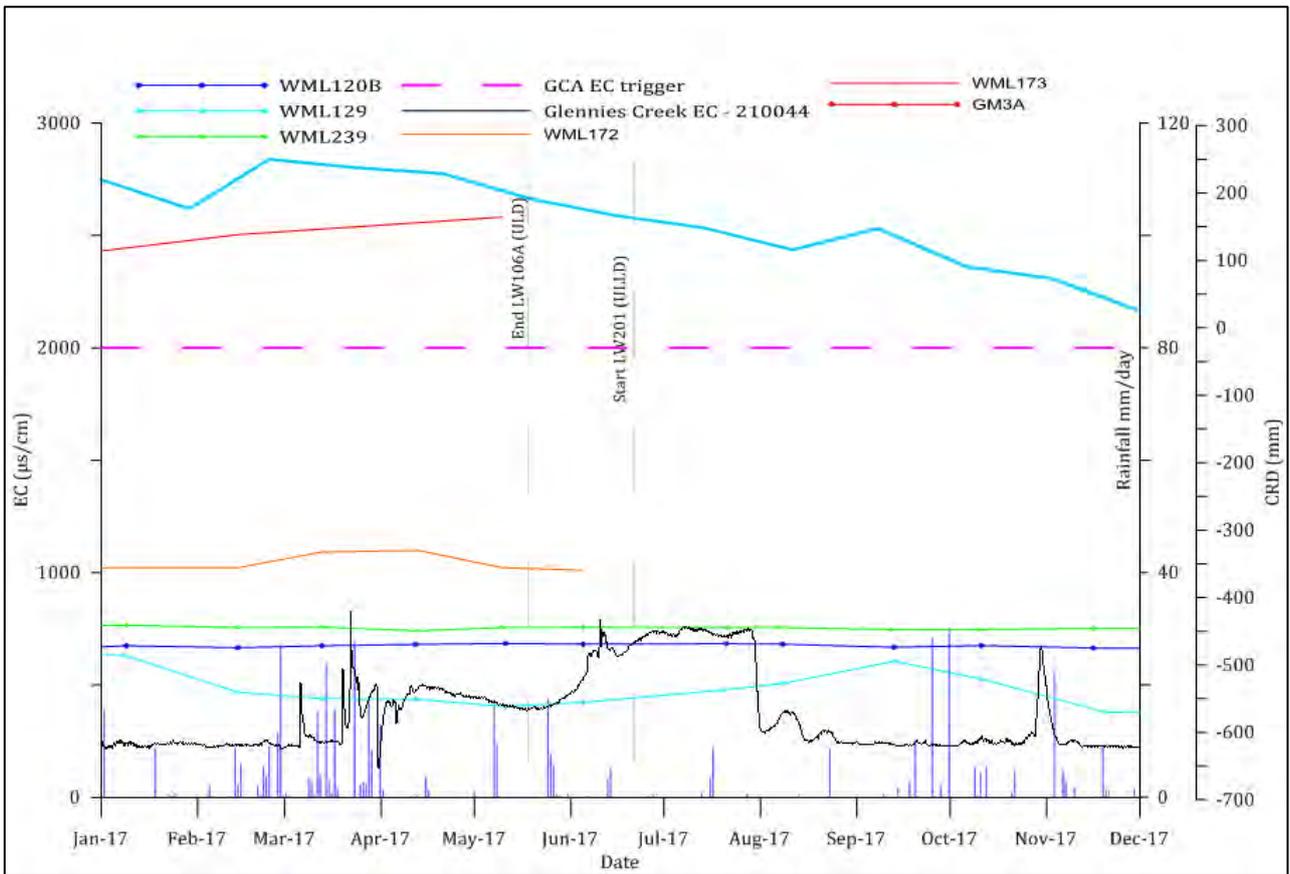
**Figure 4.11 Bowmans Creek alluvium EC trends (water level compliance bores)**



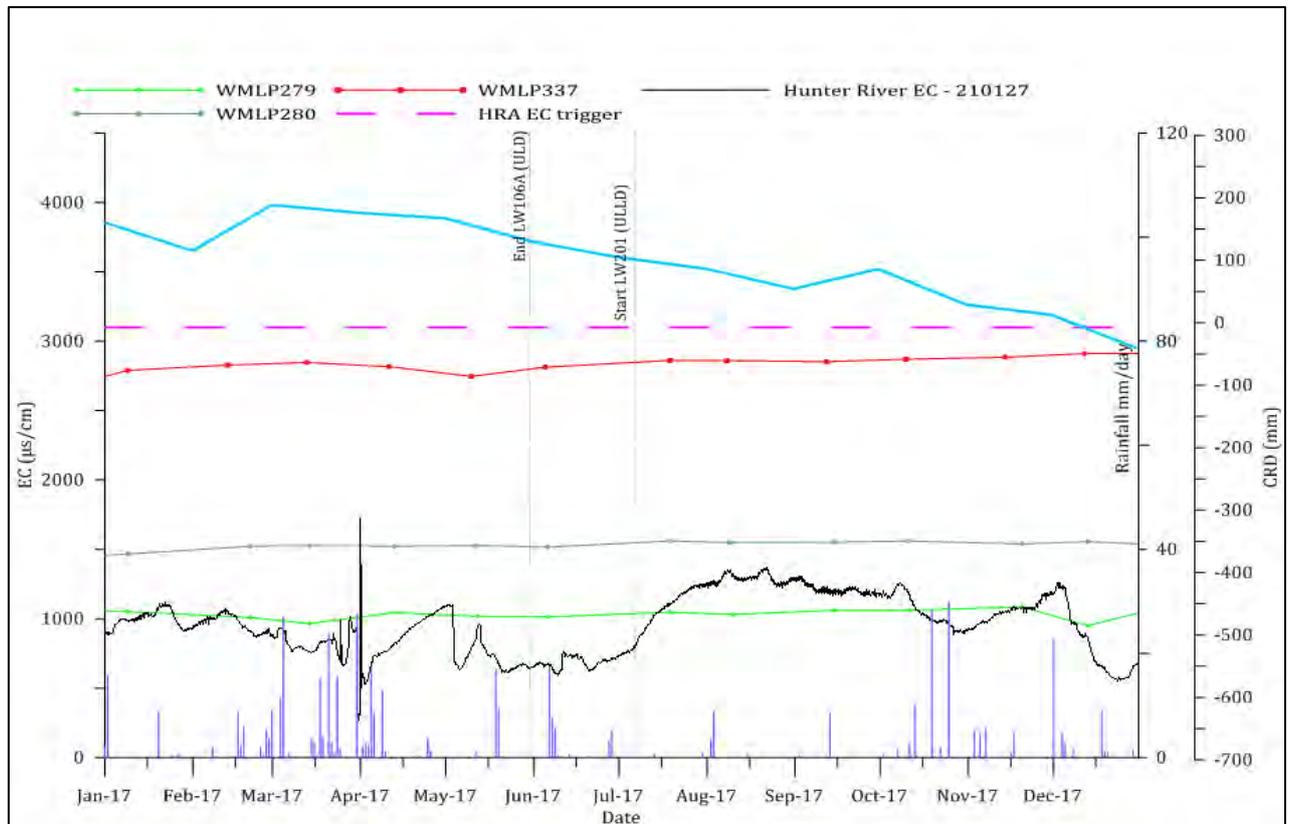
**Figure 4.12 Bowmans Creek alluvium EC trends (other bores)**



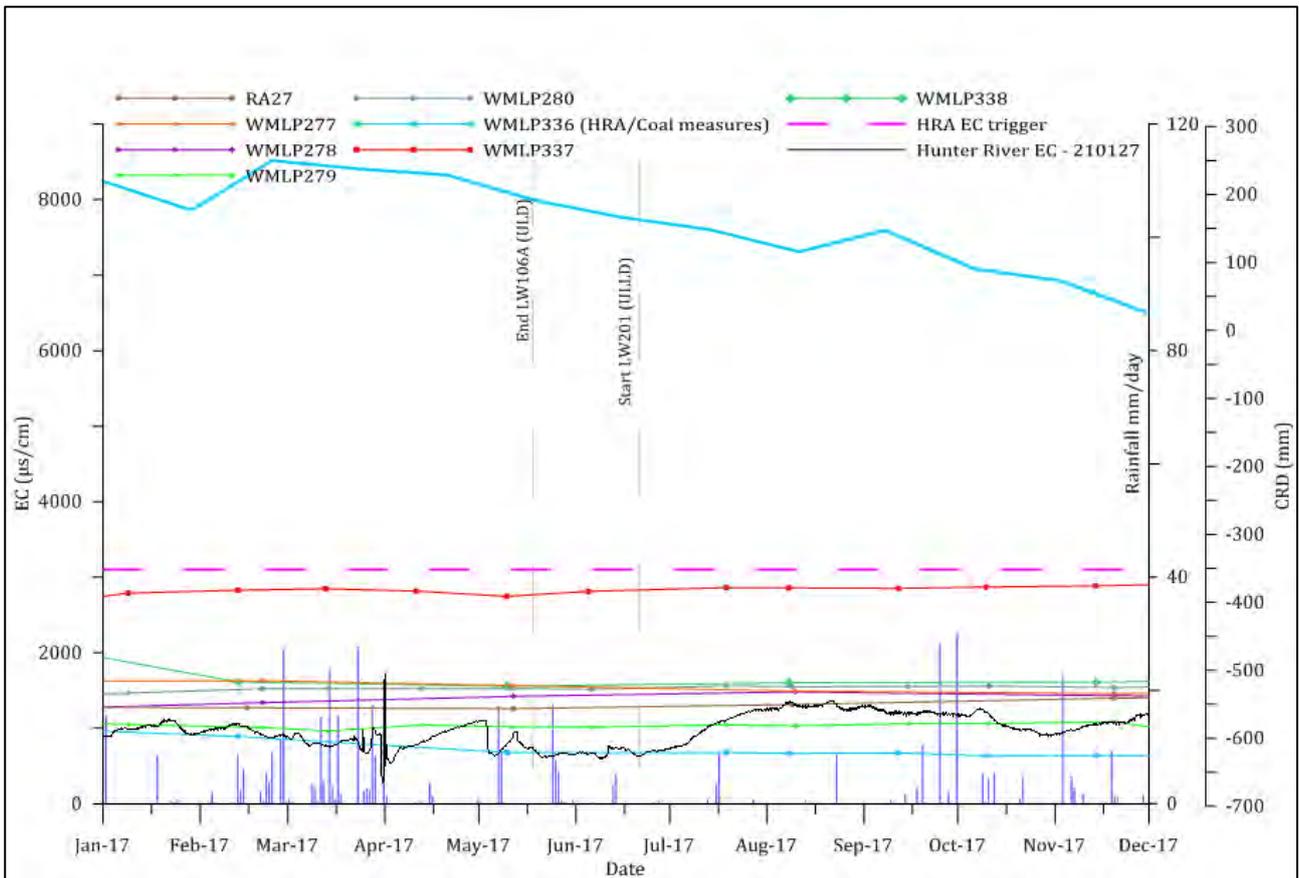
**Figure 4.13 Glennies Creek alluvium EC trends (water level compliance bores)**



**Figure 4.14 Glennies Creek alluvium EC trends (other bores)**



**Figure 4.15 Hunter River alluvium EC trends (water level compliance bores)**



**Figure 4.16 Hunter River alluvium EC trends (other bores)**

#### 4.1.3 Dissolved metals, nitrates and total phosphorous

Dissolved metals results indicate a majority of the results are below the laboratory limit of detection. Manganese and iron were detected at very low concentrations. Neither manganese nor iron are sufficiently toxic and no trigger value is listed in the livestock drinking water guidelines (ANZECC 2000). Low concentrations of Nitrate as N, Total Kjeldahl Nitrogen as N, and total phosphorous were detected, however all concentrations were well below the livestock drinking water guidelines (ANZECC 2000) of 400 mg/L.

A summary of groundwater analysis results is presented in Appendix B.

## 4.2 Coal measure aquifer monitoring

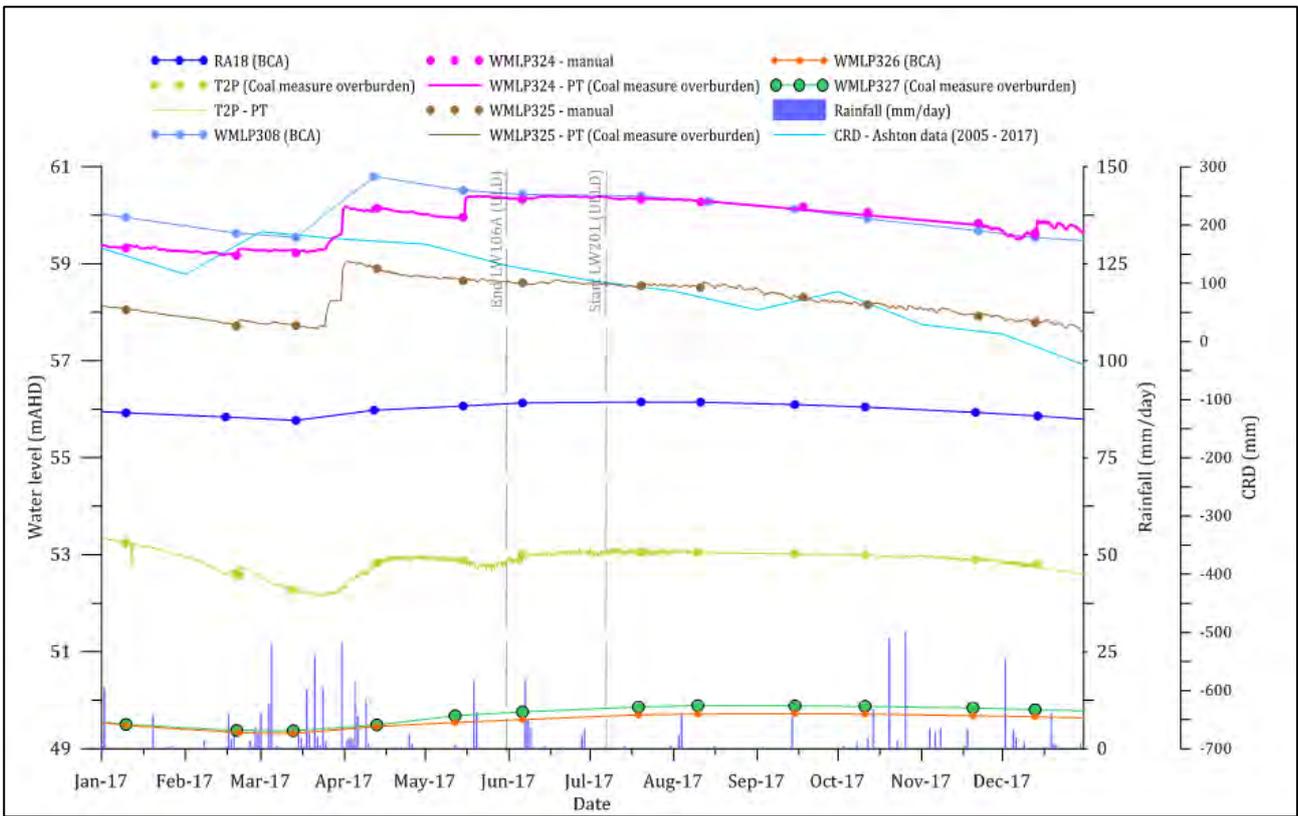
Groundwater monitoring and sampling for coal measures and coal measure interburden monitoring bores was completed at the frequency specified in the WMP version 8 (Section 3). Groundwater levels and quality trends for monitoring points relevant to LW106A and LW201 are presented in the following sections. Hydrographs and groundwater quality trends for all other coal measure monitoring bores across the whole network are presented in Appendix A.

### 4.2.1 Groundwater levels

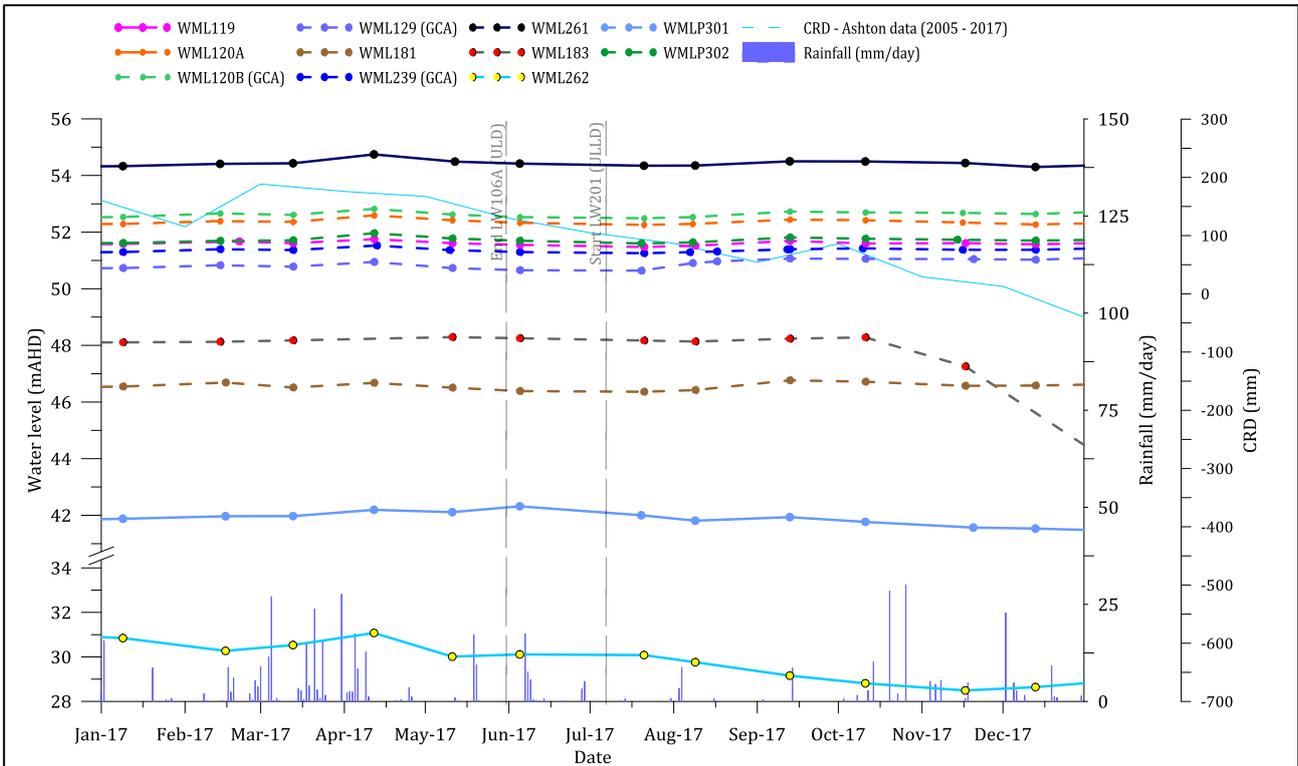
Groundwater level measurements for longwall specific (LW106A and LW201) monitoring bores are presented in Figure 4.17 and Figure 4.18 and vibrating wire piezometer (VWP) heads are presented in Figure 4.19, Figure 4.20 and Figure 4.21, respectively. The following observations are noted:

- Groundwater levels in the LW106A longwall monitoring bores (RA18, T2P, WMLP308, WMLP324, WMLP325, WMLP326 and WMLP327) were generally stable throughout the year. The overburden and Bowmans Creek piezometers showed a response to several days of rainfall in April with piezometers WMLP324 and WMLP325, adjacent Bowmans Creek, showing a rapid groundwater level rise. The rapid rise may be due to surface cracking allowing rapid infiltration of surface water and the low storage within the aquifer. Following the rise, there was a gradual decline throughout the year, which corresponds to the declining CRD.
- Groundwater levels in WML183 (adjacent LW201), screened in the PG seam, shows a decline beginning mid-October. Groundwater level in WML262 (adjacent LW201), screened in the PG seam, showed a gradual decline throughout 2017. Both the PG and ULD seams overlie the currently mined ULLD seam and the decline is likely a response to mining.
- Longwall specific VWP are relatively stable, with the following trends noted:
  - VWP WML213 (Figure 4.19), located south-west of LW106A, pressure heads showed little variation throughout the year. There was a slight decline in pressure head in the Pikes Gully VWP (205.5 mbgl) and also in the ULD VWP (275 mbgl). Pressure heads in the ULD VWP were stable post May, which corresponds to the completing of mining of the LW106A panel, located to the north east of the VWP site.
  - All VWP sensors in WMLP363 (Figure 4.20), located at the northern end of LW106, remained stable throughout the year with the exception of 170mbgl MLD roof. This sensor showed a sudden step up in head pressure in mid-May that may be related to the completion of mining in LW106A.
  - All VWP's in WMLP245 and WML248 (Figure 4.21), located at the northern end of LW106, remained stable throughout the year.

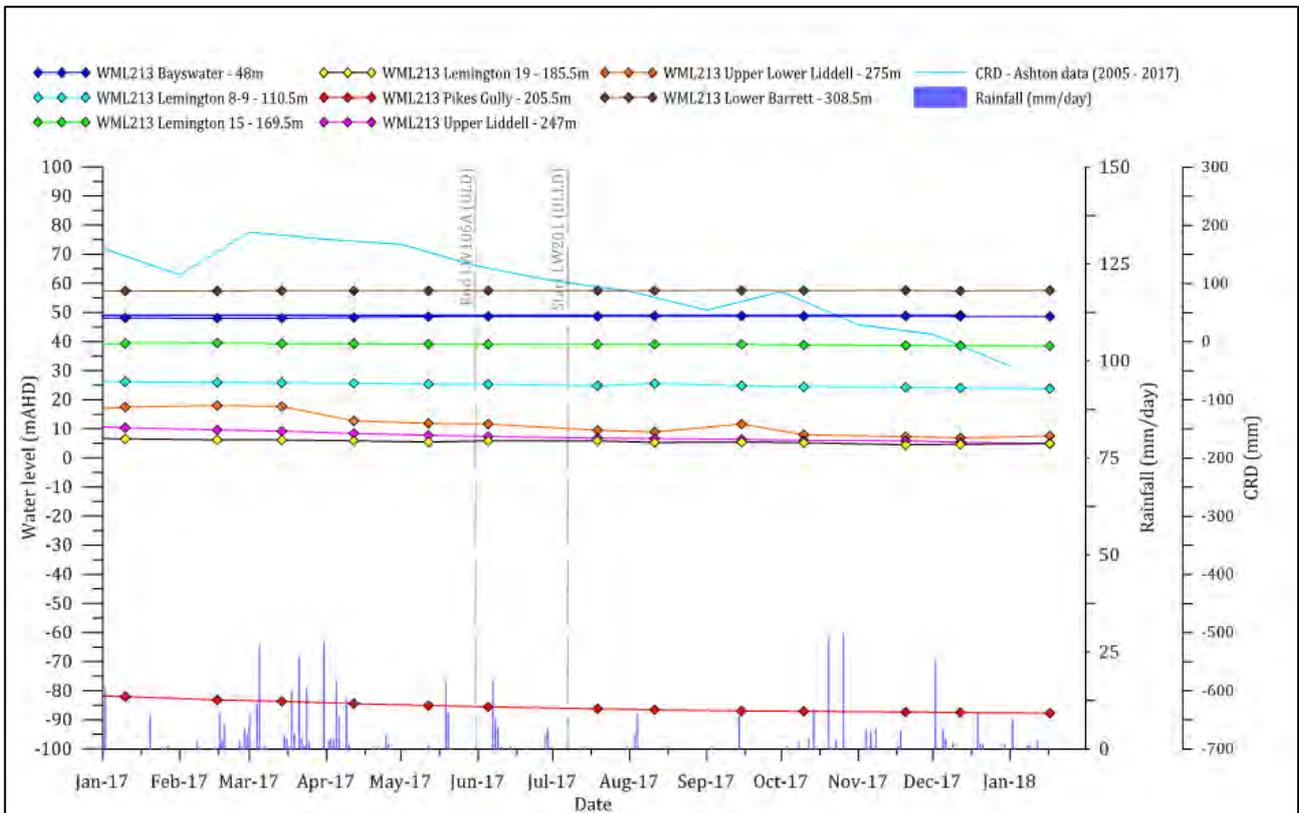
All mining related impacts to coal measure water levels/heads were within the approved ranges.



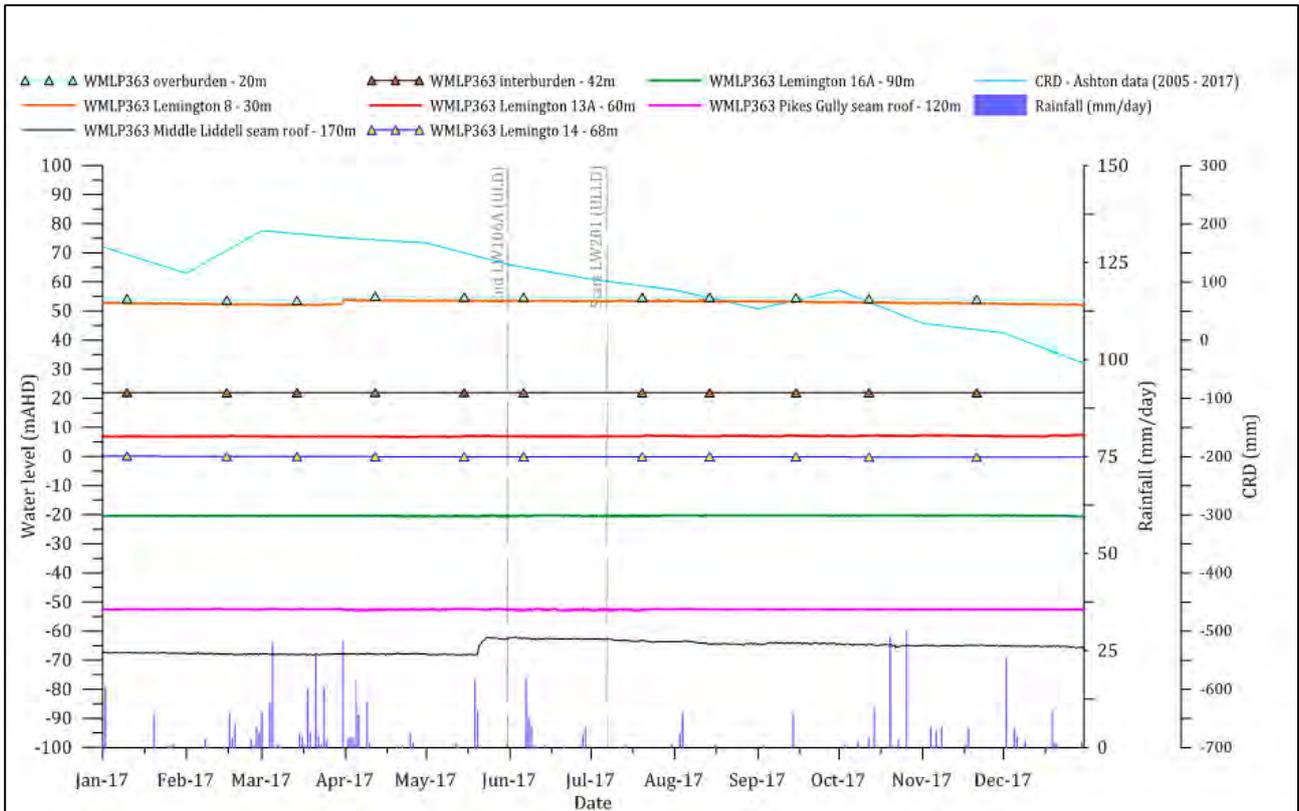
**Figure 4.17 Longwall LW106A specific monitoring bore hydrographs**



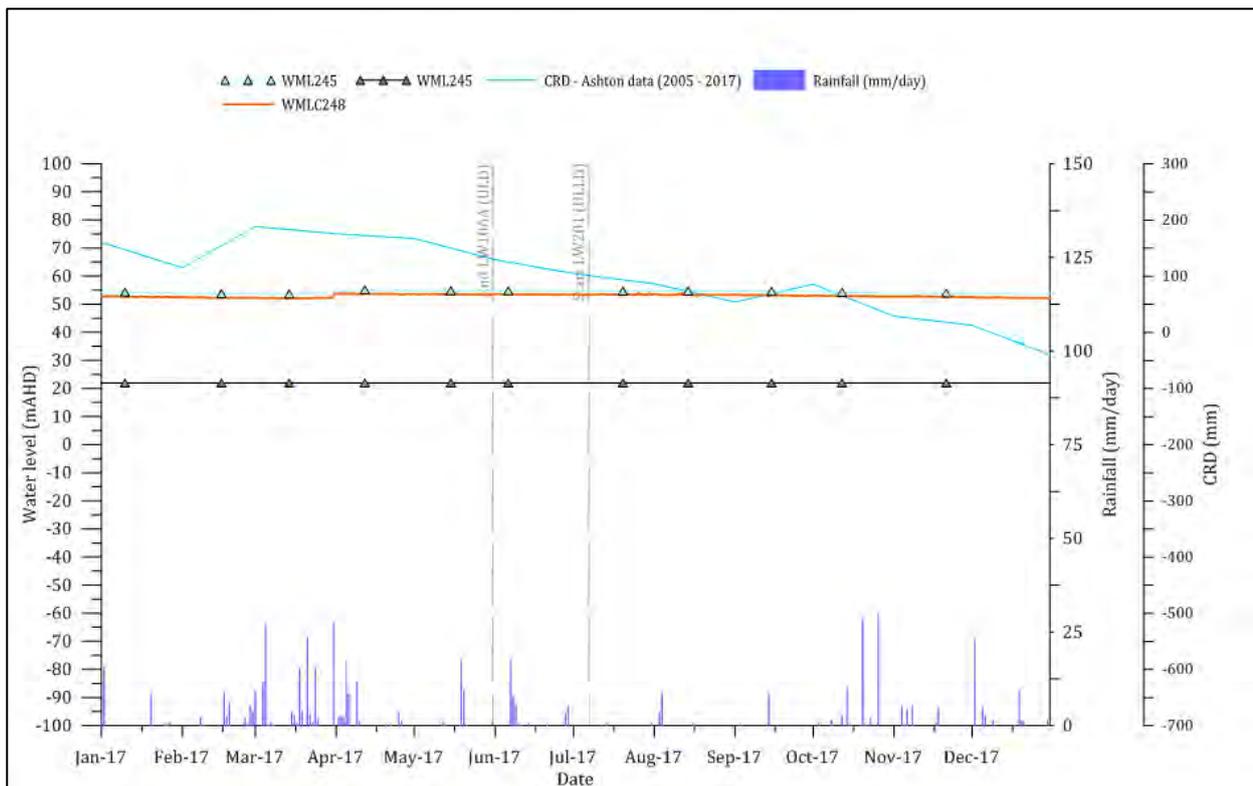
**Figure 4.18 Longwall LW201 specific monitoring bore hydrograph**



**Figure 4.19 Longwall LW106A VWP WML213**



**Figure 4.20 Longwall LW106A VWP WML363**



**Figure 4.21 Longwall LW201 VWP WML245 and 248**

#### 4.2.2 pH, electrical conductivity, major ions

All monitoring bores across the wider site monitoring network have also been reviewed. Temporal charts of pH and EC for all other monitoring bores are presented in Section 4.2.1 are presented in Figure 4.22 and Figure 4.23. A full list of sample results for major ions and dissolved metals from the annual sampling which was completed in August, is presented in Appendix B.

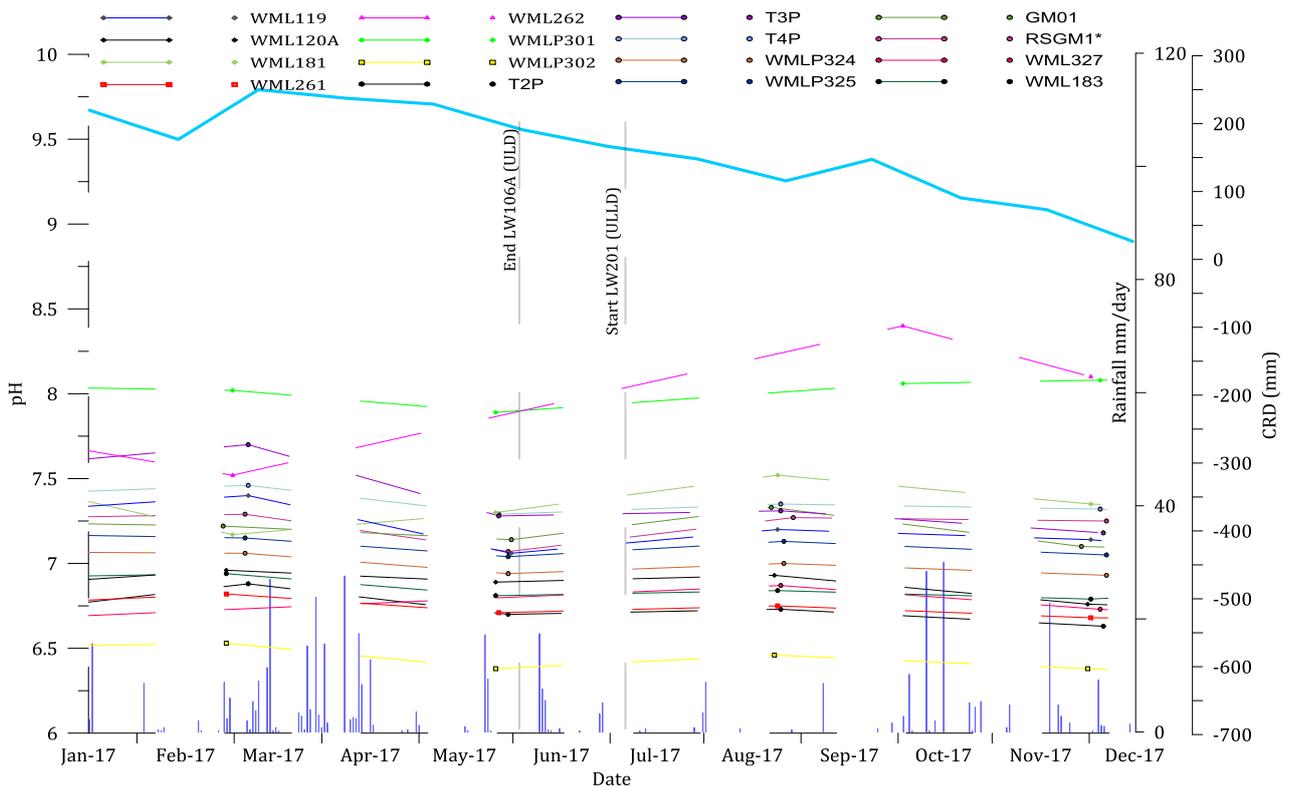
Monitoring results and a trend analysis indicates that pH is stable throughout the year, although as noted in the BCA and GCA monitoring bores, there is a very slight decrease in pH values. Results are within range of historic results. Water quality is slightly acidic to neutral with pH values ranged from 6.38 (WMLP302) to 8.4 (WML262).

EC across the coal measure monitoring network is generally brackish to saline with EC values ranging from 951  $\mu\text{S}/\text{cm}$  (WML120A) to 4478  $\mu\text{S}/\text{cm}$  (WML183). Most EC values were stable throughout the year, with only minor fluctuations.

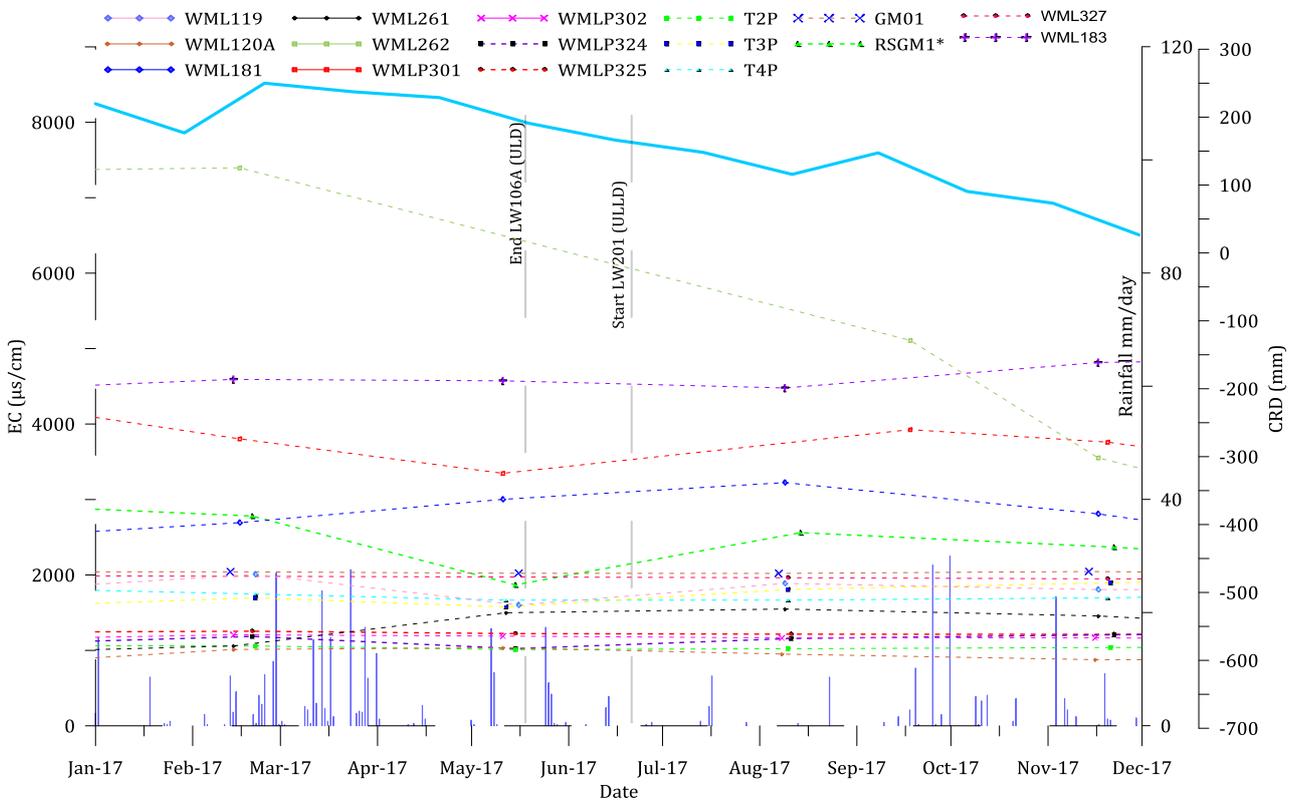
Groundwater quality in WML262, screened in the ULD seam, was found to fluctuate in a slightly different manner to the other coal measure bores in the area. The pH trend in WML262 has increased slightly and the EC has declined from 7,396  $\mu\text{S}/\text{cm}$  (February) to 3,552  $\mu\text{S}/\text{cm}$  (November). These changes occurred during the same period of groundwater level decline. These changes are likely related to the mining of LW201 in the ULD seam and associated subsidence of overlying seams, including the ULD seam. WML183, screened in the PG seam, also experienced a similar groundwater level change; however, the water quality has not varied in the manner of WML262.

The cation water type at all monitoring bores is dominated by Na, except T2P which is calcium dominant. With respect to anions, Cl clearly dominates over the  $\text{SO}_4$  ions, with  $\text{HCO}_3$  dominate in WML119 and WML181, both in the PG seam. A piper diagram of water types is presented in Appendix C.

All mining related impacts to coal measure water quality were within the approved ranges.



**Figure 4.22 Coal measure pH trends (Graph 1)**



**Figure 4.23 Coal measure EC trends (Graph 2)**

### 4.2.3 Dissolved metals, nitrates and total phosphorous

Dissolved metals results indicate a majority of the results are below the laboratory limit of detection. Manganese and iron were detected at very low concentrations. Neither manganese nor iron are sufficiently toxic and no trigger value is listed in the livestock drinking water guidelines (ANZECC 2000). Low concentrations of Nitrate as N, Total Kjeldahl Nitrogen as N, and total phosphorous were detected, however all concentrations were well below the livestock drinking water guidelines (ANZECC 2000) of 400 mg/L.

A summary of groundwater analysis results is presented in Appendix B.

## 5 EPL11879 monitoring bores

Results for 2017 monitoring of EPL11879 monitoring bores are summarised in Table 5.1 (levels) and Table 5.2 (EC). Several of the monitoring bores listed in EPL11879 are not listed in the WMP (GM03, GM03A RA02 and RM02), have been destroyed (RM4, RM5, RM6, RM7 and RM9) or have been sealed (RM01) and can no longer be monitored.

**Table 5.1 Groundwater Levels**

Monitoring bore	Feb 2017	Aug 2017
	Groundwater levels (mBGL)	
GM1	8.32	8.01
GM03	not in WMP	not in WMP
GM3A	dry	11.98
PB1	5.88	6.22
RA02	Destroyed	Destroyed
RM01	Sealed	Sealed
RM2	12.24	11.41
RM03	Dry	Dry
RM4	Destroyed	Destroyed
RM5	Destroyed	Destroyed
RM6	Destroyed	Destroyed
RM7	Destroyed	Destroyed
RM9	Destroyed	Destroyed
RM10	6.49	6.86
RSGM1	6.95	6.72

**Table 5.2 Groundwater EC**

Monitoring bore	Feb 2017	Aug 2017
	Groundwater EC(μS/cm)	
GM1	2042	2020
GM03	not in WMP	not in WMP
GM3A	dry	no data
PB1	1062	1146
RA02	Destroyed	Destroyed
RM01	Sealed	Sealed
RM2	no data	no data
RM03	Dry	Dry
RM4	Destroyed	Destroyed
RM5	Destroyed	Destroyed
RM6	Destroyed	Destroyed
RM7	Destroyed	Destroyed
RM9	Destroyed	Destroyed
RM10	1045	1093
RSGM1	2780	2560

## 6 Mine inflow

Ashton underground mine inflows are calculated through a review of dewatering abstraction volumes and a water balance assessment. The water balance assessment is the most appropriate tool to assess mine inflows as the volume of abstracted water comprises water from a number of sources, including but not limited to groundwater, surface water, incidental take and groundwater transitioning from the point of entry to the abstraction point. The transition time of this “stored” water is assumed to be in the order of years and is normally not considered inflow that has occurred in the past year. It is considered that the stored water is largely from the groundwater sources (predominantly hardrock) rather than surface water. A proportion of abstracted water is understood to have in-flowed prior to 2017 and was stored temporarily in the goaf. For the purposes of the water balance, the stored water volume has not been deducted from the incidental take, as with previous years, and is included in the 2017 take.

Data utilised in the assessment includes:

- metered water volumes pumped to the mine from the various sources;
- metered water abstracted from the mine;
- partitioned water takes from the surface water sources and the separate groundwater sources; and
- estimate of stored water pumped from the mine.

These volumes are summarised in Table 6.1. In 2016, Ashton pumped a total of 441 ML of incidental water take that is considered to have entered the mine from the groundwater source. A small proportion of this water is likely to have been stored in the goaf since prior to 2017.

The groundwater model (AGE 2016) predicted that the underground inflow rate into the mine for the period of 2017 would have been 13 L/sec. The inflow rate of the incidental take is 13.98 L/s, which is slightly above the modelled inflow of 13 L/sec.

**Table 6.1 Breakdown of abstracted water volumes**

Water source		Volume (ML)	
Total water abstracted from mine	Mine water input	194	635
	Abstracted groundwater (Total Incidental Water Take)	441	

## 7 Review of monitoring network - 2017

The ACOL groundwater monitoring network consists of more than 100 monitoring bores, of which up to 49 are monitored as part of the WMP, in either monthly, quarterly or annual campaigns. The WMP outlines the monitoring plan and key monitoring locations in areas potentially sensitive to mining impacts.

Monitoring of groundwater levels, VWP pressure heads and water quality parameters at these bores sufficiently captures the lateral groundwater system behaviour of the alluvial aquifers, the interburden and the coal seam aquifers at the site. The current groundwater monitoring network is considered suitable to detect and changes to groundwater across the site.

The WMP was updated and submitted for DPI Water for approval in June 2017. The updated WMP includes a slightly modified monitoring regime that includes alluvium and coal measure bores east of Glennies Creek. The updated WMP also has a broader array of monitoring bores in the network and targeted water quality triggers. The updated WMP had not received approval by the end of the 2017 reporting year.

## 8 Summary

Groundwater monitoring over the 2017 reporting period was consistent with the requirements outlined in the WMP. A summary of the findings of this report is as follows:

- Comparison of the data with the requirements of the WMP shows that there were no water quality (EC or pH) exceedances of the WMP criteria that required the enactment of the WMP response protocol, with the exception of the EC level in T3A. An initial investigation was completed in March and a second in November 2017 following the second exceedance (third consecutive reading above 2000  $\mu\text{S}/\text{cm}$ ). A historical analysis indicates that EC in T3A has not changed significantly since 2007, with a minimum value of 1,978  $\mu\text{S}/\text{cm}$  recorded in 2012.
- Groundwater levels in Bowman's Creek have declined throughout the year. The decline is generally in line with the CRD. Groundwater levels in the Hunter River and Glennie's Creek have been stable.
- Alluvial groundwater levels showed a response to rainfall after several days of rain in April 2017, suggesting some groundwater recharge did occur.

- Groundwater levels in the coal seams and coal seam overburden above LW201 (ULLD) have generally remained stable and have not been impacted by longwall mining. There is minor decline of groundwater levels in WML183 (PG) of about 3.5 m and WML262 (ULD) of about 3 m, which is within the approved limits.
- Groundwater levels in the alluvium and coal seam overburden above LW106a (ULD) show a response to rainfall recharge in April 2017. The trend analysis indicates that groundwater levels have not been impacted by longwall mining.
- Dissolved metals were typically below the laboratory detection limit, except for manganese and iron which had low concentrations. The measured concentrations were well below the ANZECC (2000) guideline values of 400 mg/L.
- Pressure heads measured in VWP's WML213, WML363 and WML245 did not show any decline or any response to longwall mining.
- All mining related groundwater level and quality impacts are within approved limits.

## 9 Recommendations

The following recommendations from the quarterly analysis are as follows:

- WMP version 9, submitted to DPI Water for approval in June 2017, should be approved. Once approved the sampling regime should be implemented.
- T3A EC trigger should be updated to be in line with historical range

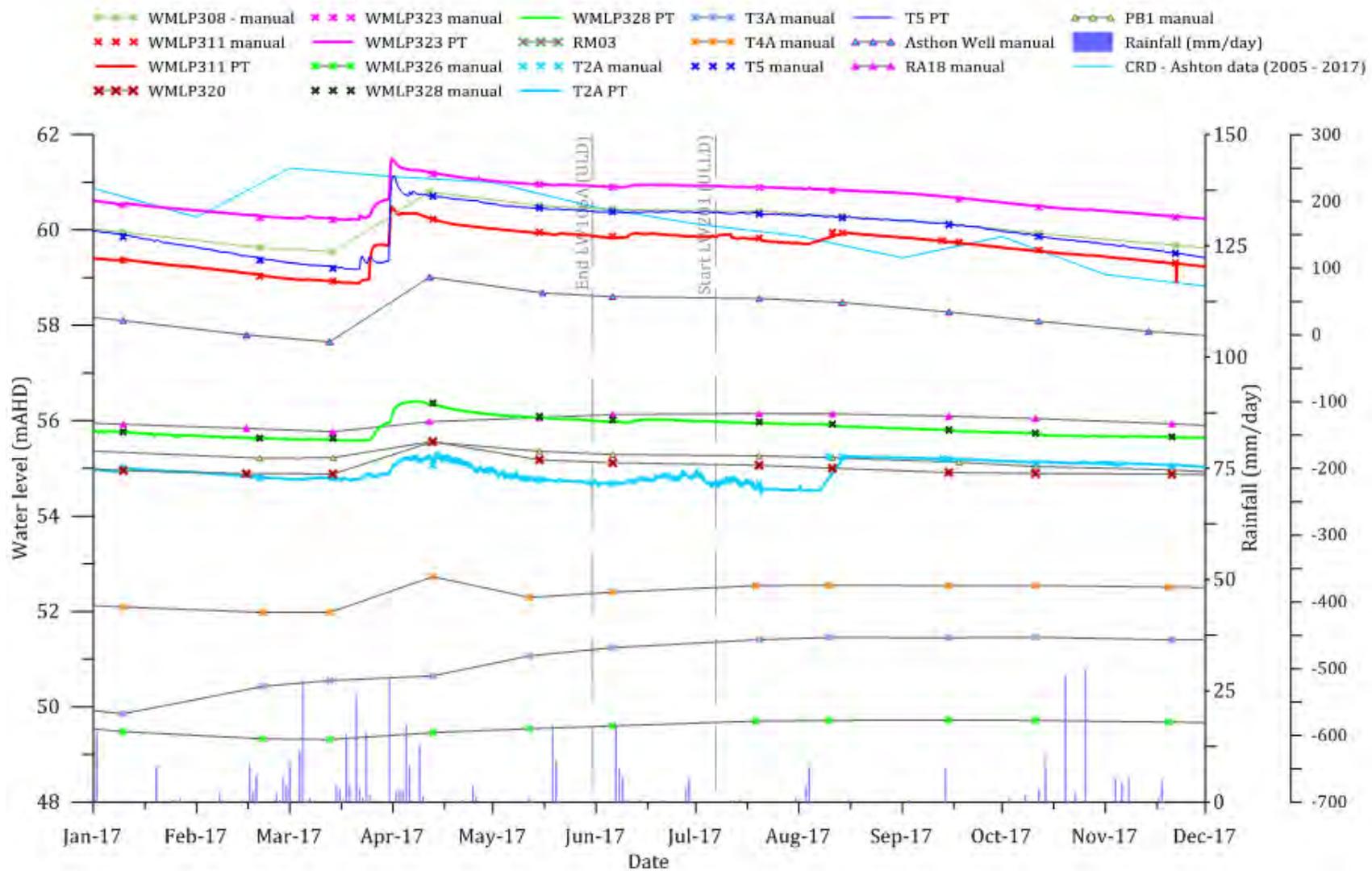
## 10 References

Department of Primary Industries Office of Water (2016), Rivers and Streams Digital Data, <http://realtimedata.water.nsw.gov.au/water>, Sydney NSW.

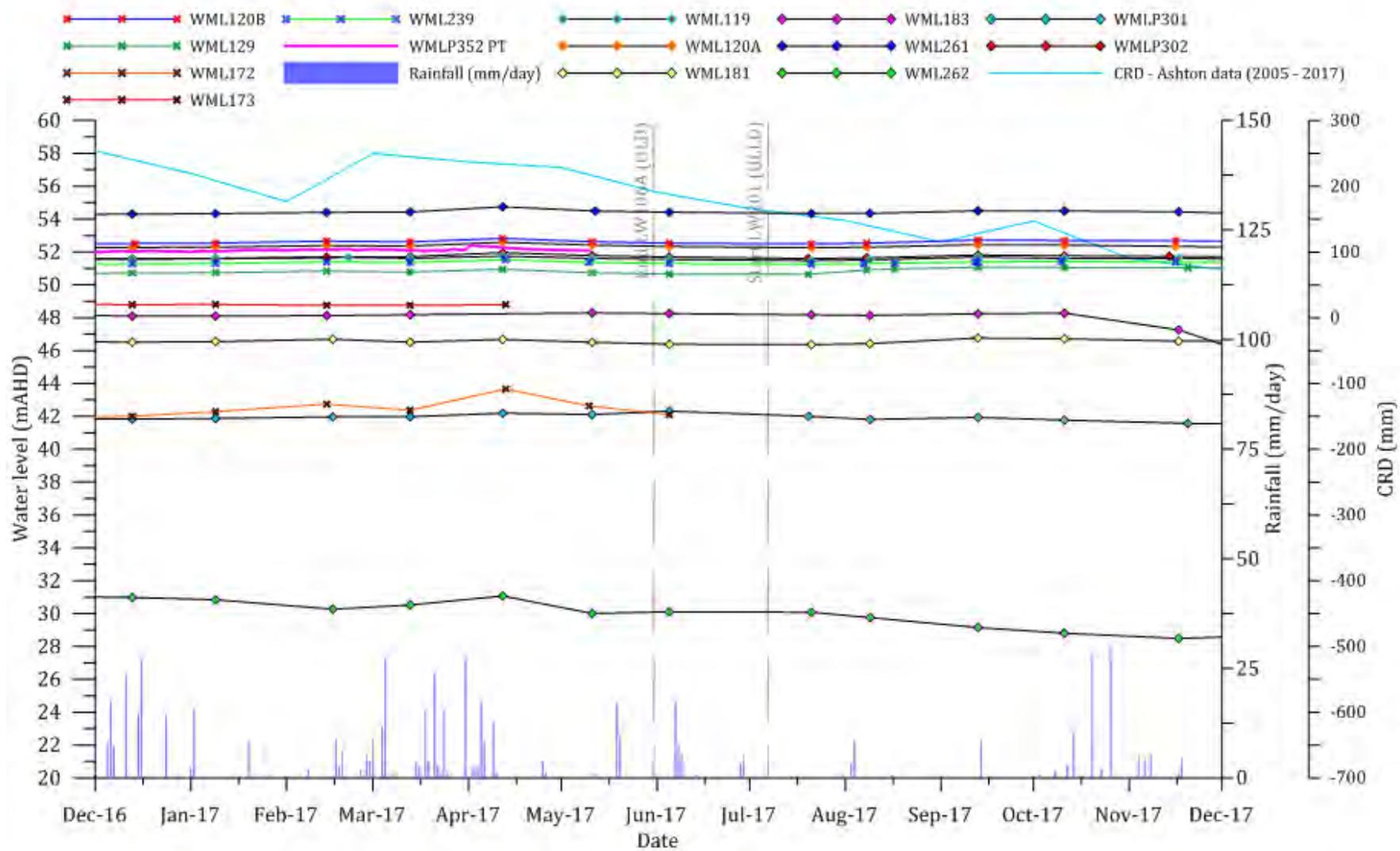
Ashton Coal (2016), *Water Management Plan version 8, HSEC Management System– Plan, Doc No. 3.4.1.8*. Yancoal.

## *Appendix A* **Other monitoring location graphs**

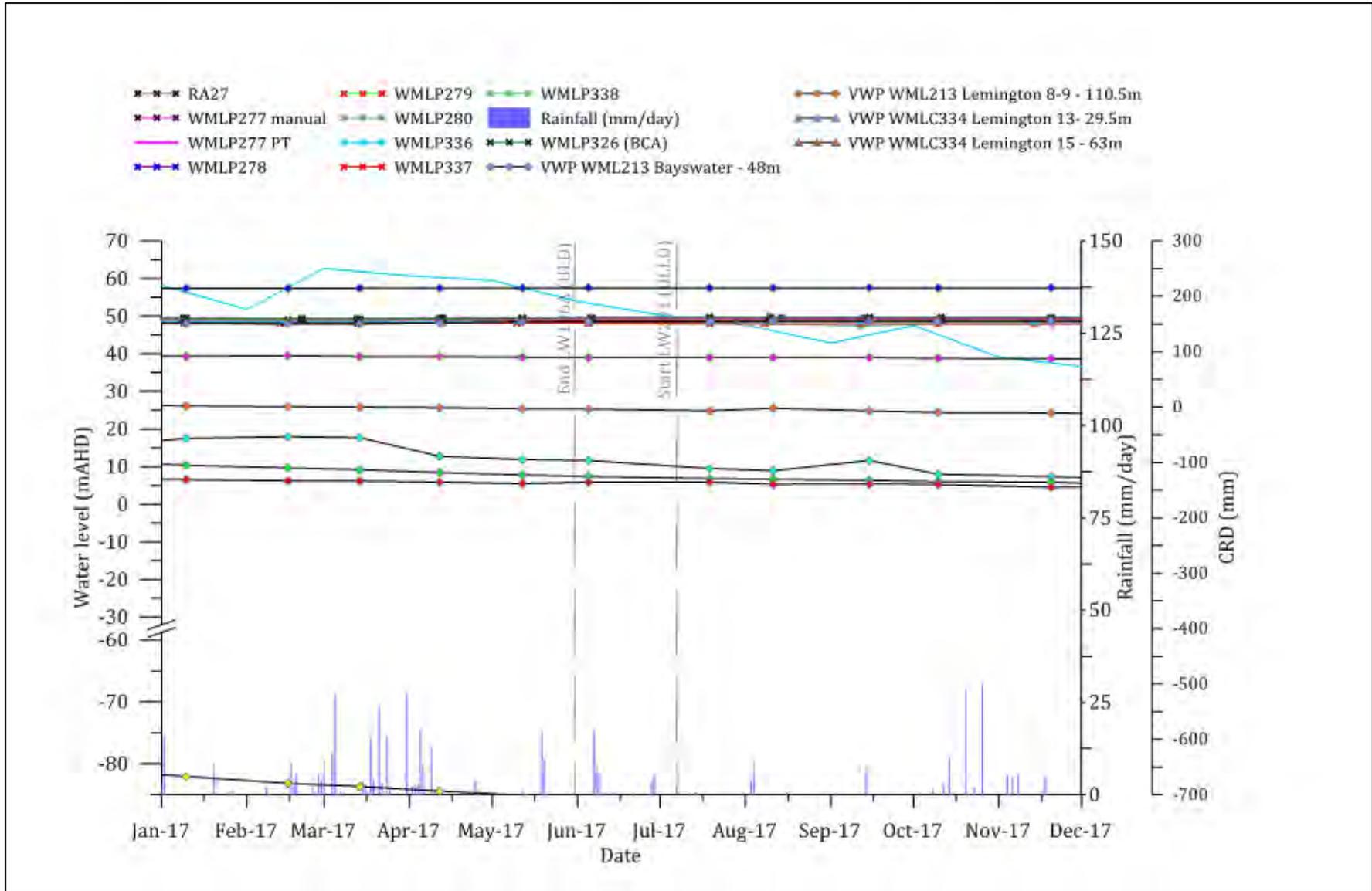
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**Figure 10.1 Bowmans Creek alluvium and adjacent coal measure groundwater levels**



**Figure 10.2** Glennies Creek alluvium and adjacent coal measure groundwater levels



**Figure 10.3 Hunter River alluvium and adjacent coal measure groundwater levels**

## *Appendix B* **Annual groundwater quality laboratory results**

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**Appendix A 1 - Annual groundwater quality laboratory results**

Sample ID	Laboratory ID	Date	pH Value (field)	pH Value (Lab)	pH RPD	EC (field) uS/cm	EC (Lab) uS/cm	EC RPD	Total Dissolved Solids (TDS)	Turbidity (NTU)	Calcium	Magnesium	Sodium	Potassium	Chloride
ANZECC livestock (mg/L)							<b>5970*</b>		<b>4000</b>		<b>1000</b>				
GM1	ES1719516001	7/08/2017	7.33	7.47	-1.9%	2020	2140	-5.8%	1220	1450	62	44	284	3	382
WML239	ES1719516003	7/08/2017	6.78	6.96	-2.6%	756	788	-4.1%	425	117	41	19	73	1	120
WMLP343	ES1719516007	7/08/2017	6.92	7.00	-1.1%	1005	1060	-5.3%	620	9680	60	31	82	0	197
WMLP346	ES1719516006	7/08/2017	6.73	7.01	-4.1%	761	794	-4.2%	468	1820	39	24	75	0	120
WMLP349	ES1719516004	7/08/2017	6.55	6.75	-3.0%	954	983	-3.0%	530	4	34	20	124	0	155
WMLP358	ES1719516005	7/08/2017	6.61	6.74	-1.9%	274	281	-2.5%	325	1470	20	11	22	0	17
YAP016	ES1719516002	7/08/2017	7.06	7.21	-2.1%	1300	1370	-5.2%	732	31	29	22	199	2	202
WML120A	ES1719627006	8/08/2017	6.93	6.91	0.3%	951	967	-1.7%	498	21	38	32	107	2	158
WML120B	ES1719627005	8/08/2017	6.68	6.97	-4.2%	682	705	-3.3%	392	5	32	21	66	0	101
WML129	ES1719627004	8/08/2017	6.98	7.08	-1.4%	507	520	-2.5%	268	25	20	12	59	2	69
WMLP302	ES1719627007	8/08/2017	6.46	6.76	-4.5%	1165	1210	-3.8%	606	3	30	35	159	2	208
WMLP336	ES1719627001	8/08/2017	6.60	6.85	-3.7%	667	726	-8.5%	403	143	40	20	63	1	78
WMLP337	ES1719627002	8/08/2017	7.22	7.07	2.1%	2860	3000	-4.8%	1670	2360	97	105	315	4	649
WMLP338	ES1719627003	8/08/2017	6.76	6.86	-1.5%	1602	1680	-4.8%	890	626	67	47	174	1	316
RA27	ES1719773005	9/08/2017	7.08	7.24	-2.2%	1314	1380	-4.9%	865	1590	34	25	213	0	232
WML119	ES1719773004	9/08/2017	7.20	7.28	-1.1%	1888	1410	<b>29.0%</b>	808	377	26	21	206	5	210
WML181	ES1719773003	9/08/2017	7.52	7.70	-2.4%	3224	3310	-2.6%	1750	92	14	20	666	3	553
WML183	ES1719773002	9/08/2017	6.84	6.94	-1.5%	4478	4620	-3.1%	2510	9	97	175	650	8	770
WML261	ES1719773001	9/08/2017	6.75	6.84	-1.3%	1548	1620	-4.5%	810	2	35	39	221	2	309
WMLP280	ES1719773006	9/08/2017	6.87	7.01	-2.0%	1550	1620	-4.4%	814	15	50	32	209	0	296
T2A	ES1719824010	10/08/2017	7.08	7.12	-0.6%	1053	1110	-5.3%	1500	16200	39	19	132	2	156
T2P	ES1719824011	10/08/2017	6.73	6.86	-1.9%	1022	1070	-4.6%	573	9	61	30	68	2	178
T3A	ES1719824009	10/08/2017	6.75	6.88	-1.9%	2181	2330	-6.6%	1690	2960	46	40	292	0	543
T3P	ES1719824008	10/08/2017	7.31	7.46	-2.0%	1807	1910	-5.5%	814	6	38	36	265	3	320
T4A	ES1719824007	10/08/2017	6.87	7.03	-2.3%	1317	1390	-5.4%	748	44	44	26	154	0	231
T4P	ES1719824006	10/08/2017	7.35	7.48	-1.8%	1666	1760	-5.5%	948	1060	41	29	233	3	267
WMLP277	ES1719824001	10/08/2017	6.92	7.09	-2.4%	1493	1570	-5.0%	749	14	43	29	230	0	264
WMLP278	ES1719824002	10/08/2017	6.89	6.99	-1.4%	1482	1560	-5.1%	710	10	58	32	181	0	283
WMLP279	ES1719824003	10/08/2017	6.78	6.90	-1.8%	1032	1090	-5.5%	605	20	46	22	104	1	178
WMLP326	ES1719824004	10/08/2017	7.14	7.17	-0.4%	1419	1490	-4.9%	1005		55	27	197	0	241
WMLP327	ES1719824005	10/08/2017	6.87	6.97	-1.4%	1963	2050	-4.3%	1416		76	38	261	3	396
PB1	ES1720035004	11/08/2017	6.98	7.06	-1.1%	1146	1210	-5.4%	801		50	28	155	2	176
RA18	ES1720035003	11/08/2017	7.21	7.16	0.7%	1063	1140	-7.0%	742		39	24	174	2	168
RM10	ES1720035005	11/08/2017	7.03	7.08	-0.7%	1088	1150	-5.5%	764		45	27	155	2	164
WML113C	ES1720035001	11/08/2017	6.93	7.02	-1.3%	967	1040	-7.3%	1280	9410	72	36	108	11	156
WMLP311	ES1720035010	11/08/2017	6.81	6.95	-2.0%	1196	1270	-6.0%	673	35	48	33	155	2	183
WMLP320	ES1720035006	11/08/2017	6.93	7.01	-1.1%	1238	1300	-4.9%	868		56	31	158	2	197

Sample ID	Laboratory ID	Date	pH Value (field)	pH Value (Lab)	pH RPD	EC (field) uS/cm	EC (Lab) uS/cm	EC RPD	Total Dissolved Solids (TDS)	Turbidity (NTU)	Calcium	Magnesium	Sodium	Potassium	Chloride
WMLP323	ES1720035008	11/08/2017	6.88	6.97	-1.3%	1182	1250	-5.6%	635	13	53	33	141	2	185
WMLP324	ES1720035007	11/08/2017	7.00	7.06	-0.9%	1157	1220	-5.3%	693	268	52	27	129	2	178
WMLP325	ES1720035009	11/08/2017	7.13	7.18	-0.7%	1215	1290	-6.0%	692	5	48	27	167	2	207
WMLP328	ES1720035002	11/08/2017	6.98	7.03	-0.7%	1162	1230	-5.7%	698	6	49	27	130	2	183
ASHTON WELL	ES1720136001	14/08/2017	7.60	7.63	-0.4%	678	734	-7.9%	468		41	16	65	3	65
RSGM1	ES1720136004	14/08/2017	7.27	7.36	-1.2%	2560	2820	-9.7%	1450	60	19	23	484	0	454
T5	ES1720136003	14/08/2017	6.73	6.82	-1.3%	928	1010	-8.5%	530	127	39	19	115	2	124
WML115B	ES1720136006	14/08/2017	6.73	6.80	-1.0%	3188	3530	-10.2%	2370		90	47	542	1	545
WML115C	ES1720136005	14/08/2017	7.25	7.30	-0.7%	878	941	-6.9%	608		11	6	175	0	56
WMLP308	ES1720136002	14/08/2017	6.93	7.05	-1.7%	1166	1280	-9.3%	644	107	43	30	139	2	176

*All samples mg/L unless specified*

**Appendix A 2 - Annual groundwater quality laboratory results (continued)**

Sample ID	Laboratory ID	Date	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity	Sulfate as SO4	Fluoride	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel
ANZECC livestock (mg/L)							<b>1000</b>	<b>2</b>	<b>0.5</b>	<b>0.01</b>	<b>1</b>	<b>1</b>	<b>0.1</b>		<b>1</b>
GM1	ES1719516001	7/08/2017	0.05	0.05	308	308	166	0.3	0.0005	0.0001	0.0005	0.0005	0.0005	0.3470	0.0005
WML239	ES1719516003	7/08/2017	0.05	0.05	161	161	12	0.2	0.0005	0.0001	0.0005	0.0005	0.0005	0.0210	0.0020
WMLP343	ES1719516007	7/08/2017	0.05	0.05	185	185	26	0.2	0.0005	0.0001	0.0005	0.0005	0.0005	0.2180	0.0030
WMLP346	ES1719516006	7/08/2017	0.05	0.05	190	190	12	0.2	0.0005	0.0001	0.0005	0.0005	0.0005	0.2210	0.0040
WMLP349	ES1719516004	7/08/2017	0.05	0.05	199	199	29	0.3	0.0010	0.0001	0.0005	0.0005	0.0005	0.1970	0.0010
WMLP358	ES1719516005	7/08/2017	0.05	0.05	109	109	4	0.1	0.0005	0.0001	0.0005	0.0005	0.0005	0.1380	0.0020
YAP016	ES1719516002	7/08/2017	0.05	0.05	224	224	111	0.3	0.0005	0.0001	0.0005	0.0005	0.0005	0.0130	0.0005
WML120A	ES1719627006	8/08/2017	0.05	0.05	206	206	19	0.4	0.0005	0.0001	0.0005	0.0005	0.0005	0.1870	0.0005
WML120B	ES1719627005	8/08/2017	0.05	0.05	156	156	17	0.2	0.0005	0.0001	0.0005	0.0005	0.0005	0.0070	0.0005
WML129	ES1719627004	8/08/2017	0.05	0.05	108	108	18	0.2	0.0010	0.0001	0.0005	0.0005	0.0005	0.1960	0.0010
WMLP302	ES1719627007	8/08/2017	0.05	0.05	228	228	30	0.3	0.0005	0.0001	0.0005	0.0005	0.0005	0.0250	0.0005
WMLP336	ES1719627001	8/08/2017	0.05	0.05	182	182	26	0.2	0.0005	0.0001	0.0005	0.0005	0.0005	0.0020	0.0005
WMLP337	ES1719627002	8/08/2017	0.05	0.05	446	446	110	0.4	0.0005	0.0001	0.0005	0.0005	0.0005	0.1590	0.0020
WMLP338	ES1719627003	8/08/2017	0.05	0.05	274	274	61	0.5	0.0005	0.0001	0.0005	0.0005	0.0005	0.4160	0.0020
RA27	ES1719773005	9/08/2017	0.05	0.05	233	233	73	0.3	0.0005	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005
WML119	ES1719773004	9/08/2017	0.05	0.05	371	371	10	0.3	0.0005	0.0001	0.0020	0.0005	0.0005	0.2610	0.0060
WML181	ES1719773003	9/08/2017	0.05	0.05	894	894	17	0.8	0.0005	0.0001	0.0005	0.0005	0.0005	0.0160	0.0005
WML183	ES1719773002	9/08/2017	0.05	0.05	855	855	354	0.3	0.0005	0.0001	0.0005	0.0005	0.0005	0.1730	0.0005
WML261	ES1719773001	9/08/2017	0.05	0.05	276	276	42	0.4	0.0005	0.0001	0.0005	0.0005	0.0005	0.0380	0.0005
WMLP280	ES1719773006	9/08/2017	0.05	0.05	224	224	101	0.4	0.0005	0.0001	0.0005	0.0005	0.0005	0.1570	0.0020
T2A	ES1719824010	10/08/2017	0.05	0.05	181	181	82	0.3	0.0005	0.0001	0.0005	0.0005	0.0005	0.0640	0.0005
T2P	ES1719824011	10/08/2017	0.05	0.05	142	142	76	0.1	0.0030	0.0001	0.0005	0.0005	0.0005	0.2810	0.0005
T3A	ES1719824009	10/08/2017	0.05	0.05	144	144	100	0.3	0.0005	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005
T3P	ES1719824008	10/08/2017	0.05	0.05	350	350	81	0.4	0.0005	0.0001	0.0005	0.0005	0.0005	0.0240	0.0005
T4A	ES1719824007	10/08/2017	0.05	0.05	192	192	105	0.3	0.0005	0.0001	0.0005	0.0005	0.0005	0.0320	0.0005
T4P	ES1719824006	10/08/2017	0.05	0.05	356	356	78	0.4	0.0005	0.0001	0.0005	0.0005	0.0005	0.0340	0.0005
WMLP277	ES1719824001	10/08/2017	0.05	0.05	247	247	96	0.4	0.0005	0.0002	0.0005	0.0005	0.0005	0.0640	0.0030
WMLP278	ES1719824002	10/08/2017	0.05	0.05	211	211	100	0.2	0.0020	0.0001	0.0005	0.0005	0.0005	0.1100	0.0010
WMLP279	ES1719824003	10/08/2017	0.05	0.05	162	162	61	0.2	0.0005	0.0001	0.0010	0.0005	0.0005	0.0760	0.0020
WMLP326	ES1719824004	10/08/2017	0.05	0.05	257	257	79								
WMLP327	ES1719824005	10/08/2017	0.05	0.05	314	314	68								
PB1	ES1720035004	11/08/2017	0.05	0.05	217	217	70								
RA18	ES1720035003	11/08/2017	0.05	0.05	183	183	74								
RM10	ES1720035005	11/08/2017	0.05	0.05	194	194	74								
WML113C	ES1720035001	11/08/2017	0.05	0.05	153	153	77	0.3	0.0005	0.0007	0.0005	0.0005	0.0030	2.3100	0.3220
WMLP311	ES1720035010	11/08/2017	0.05	0.05	217	217	99	0.2	0.0005	0.0001	0.0005	0.0005	0.0005	0.0030	0.0005
WMLP320	ES1720035006	11/08/2017	0.05	0.05	226	226	88								

Sample ID	Laboratory ID	Date	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity	Sulfate as SO4	Fluoride	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel
WMLP323	ES1720035008	11/08/2017	0.05	0.05	203	203	104	0.3	0.0005	0.0001	0.0005	0.0005	0.0005	0.0120	0.0005
WMLP324	ES1720035007	11/08/2017	0.05	0.05	206	206	100	0.3	0.0010	0.0001	0.0005	0.0005	0.0005	0.1420	0.0005
WMLP325	ES1720035009	11/08/2017	0.05	0.05	211	211	75	0.4	0.0005	0.0001	0.0005	0.0005	0.0005	0.3090	0.0005
WMLP328	ES1720035002	11/08/2017	0.05	0.05	200	200	101	0.2	0.0005	0.0001	0.0005	0.0005	0.0005	0.0040	0.0005
ASHTON WELL	ES1720136001	14/08/2017	0.05	0.05	185	185	33								
RSGM1	ES1720136004	14/08/2017	0.05	0.05	400	400	154	1.1	0.0040	0.0001	0.0005	0.0040	0.0005	0.0020	0.0020
T5	ES1720136003	14/08/2017	0.05	0.05	154	154	90	0.2	0.0005	0.0001	0.0005	0.0005	0.0005	0.0050	0.0030
WML115B	ES1720136006	14/08/2017	0.05	0.05	531	531	243								
WML115C	ES1720136005	14/08/2017	0.05	0.05	276	276	48								
WMLP308	ES1720136002	14/08/2017	0.05	0.05	205	205	87	0.2	0.0020	0.0001	0.0005	0.0005	0.0005	0.0510	0.0005
<i>All samples mg/L unless specified</i>															

**Appendix A 3 - Annual groundwater quality laboratory results (continued)**

Sample ID	Laboratory ID	Date	Selenium	Zinc	Iron	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Total Phosphorus	Total Cyanide	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Total Kjeldahl Nitrogen as N	Total Nitrogen as N
ANZECC livestock (mg/L)			<b>0.02</b>	<b>20</b>		<b>30</b>	<b>1500</b>								
GM1	ES1719516001	7/08/2017	0.0050	0.0025	0.7900	0.005	0.030	0.030	0.130	0.002	20	19	3	0.4	0.4
WML239	ES1719516003	7/08/2017	0.0050	0.0060	0.0900	0.005	0.040	0.040	0.080	0.002	7	7	0	0.1	0.1
WMLP343	ES1719516007	7/08/2017	0.0050	0.0100	0.0250	0.005	0.100	0.100	1.700	0.002	10	9	4	3.8	3.9
WMLP346	ES1719516006	7/08/2017	0.0050	0.0180	0.0800	0.005	0.110	0.110	0.680	0.002	7	7	2	1.8	1.9
WMLP349	ES1719516004	7/08/2017	0.0050	0.0140	2.0900	0.005	0.040	0.040	0.060	0.002	9	9	1	0.1	0.1
WMLP358	ES1719516005	7/08/2017	0.0050	0.0110	0.0250	0.005	0.200	0.200	0.730	0.002	3	3		2.6	2.8
YAP016	ES1719516002	7/08/2017	0.0050	0.0100	0.0250	0.005	0.250	0.250	0.020	0.002	13	12	2	0.2	0.4
WML120A	ES1719627006	8/08/2017	0.0050	0.0050	1.1800	0.005	0.030	0.030	0.040	0.002	9	9	1	0.3	0.3
WML120B	ES1719627005	8/08/2017	0.0050	0.0140	0.0250	0.005	0.060	0.060	0.030	0.002	6	6	1	0.1	0.1
WML129	ES1719627004	8/08/2017	0.0050	0.0120	0.3600	0.005	0.020	0.020	0.110	0.002	4	5	1	0.2	0.2
WMLP302	ES1719627007	8/08/2017	0.0050	0.0150	1.6600	0.005	0.020	0.020	0.050	0.002	11	11	1	0.4	0.4
WMLP336	ES1719627001	8/08/2017	0.0050	0.0025	0.0250	0.010	1.930	1.940	0.260	0.002	6	6	0	0.6	2.5
WMLP337	ES1719627002	8/08/2017	0.0050	0.0180	0.0250	0.005	0.090	0.090	0.150	0.002	30	27	4	0.5	0.6
WMLP338	ES1719627003	8/08/2017	0.0050	0.0060	0.0900	0.005	1.670	1.670	0.170	0.002	16	15	3	0.4	2.1
RA27	ES1719773005	9/08/2017	0.0050	0.0025	0.0250	0.005	0.760	0.760	2.460	0.002	13	13	1	1.2	2.0
WML119	ES1719773004	9/08/2017	0.0050	0.0025	0.1300	0.005	0.010	0.010	0.740	0.002	14	12	6	6.1	6.1
WML181	ES1719773003	9/08/2017	0.0050	0.0025	0.0250	0.005	0.005	0.005	0.060	0.002	34	31	4	1.3	1.3
WML183	ES1719773002	9/08/2017	0.0050	0.0060	0.4000	0.005	0.005	0.005	0.005	0.002	46	48	2	1.1	1.1
WML261	ES1719773001	9/08/2017	0.0050	0.0050	1.0100	0.005	0.005	0.005	0.030	0.002	15	15	2	0.3	0.3
WMLP280	ES1719773006	9/08/2017	0.0050	0.0080	0.4200	0.005	0.420	0.420	0.180	0.002	15	14	2	0.2	0.6
T2A	ES1719824010	10/08/2017	0.0050	0.0025	0.0250	0.005	0.300	0.300	5.700	0.002	10	9	2	5.9	6.2
T2P	ES1719824011	10/08/2017	0.0050	0.0080	2.9200	0.005	0.020	0.020	0.005	0.002	9	9	5	0.1	0.1
T3A	ES1719824009	10/08/2017	0.0050	0.0025	0.0250	0.005	0.310	0.310	2.060	0.002	20	18	5	1.9	2.2
T3P	ES1719824008	10/08/2017	0.0050	0.0025	0.2200	0.005	1.560	1.560	0.005	0.002	18	17	4	0.5	2.1
T4A	ES1719824007	10/08/2017	0.0050	0.0060	0.0250	0.005	0.020	0.020	0.170	0.002	13	11	6	0.1	0.1
T4P	ES1719824006	10/08/2017	0.0050	0.0025	0.1900	0.005	0.820	0.820	0.220	0.002	16	15	5	1.3	2.1
WMLP277	ES1719824001	10/08/2017	0.0050	0.0400	0.1800	0.005	0.510	0.510	0.110	0.002	14	15	1	0.2	0.7
WMLP278	ES1719824002	10/08/2017	0.0050	0.0150	0.7500	0.005	0.500	0.500	0.060	0.002	14	13	3	0.4	0.9
WMLP279	ES1719824003	10/08/2017	0.0050	0.0110	0.4100	0.005	0.020	0.020	0.040	0.002	10	9	5	0.1	0.1
WMLP326	ES1719824004	10/08/2017									14	14	0		
WMLP327	ES1719824005	10/08/2017									19	18	1		
PB1	ES1720035004	11/08/2017									11	12	4		
RA18	ES1720035003	11/08/2017									10	12	7		
RM10	ES1720035005	11/08/2017									10	11	6		
WML113C	ES1720035001	11/08/2017	0.0050	0.5370	3.2200	0.005	0.270	0.270	8.400	0.002	9	12	12	6.0	6.3
WMLP311	ES1720035010	11/08/2017	0.0050	0.0025	0.0250	0.005	0.170	0.170	0.020	0.002	12	12	1	0.2	0.4

Sample ID	Laboratory ID	Date	Selenium	Zinc	Iron	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Total Phosphorus	Total Cyanide	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Total Kjeldahl Nitrogen as N	Total Nitrogen as N
WMLP320	ES1720035006	11/08/2017									12	12	2		
WMLP323	ES1720035008	11/08/2017	0.0050	0.0050	0.0250	0.005	0.110	0.110	0.005	0.002	11	12	0	0.2	0.3
WMLP324	ES1720035007	11/08/2017	0.0050	0.0025	0.0250	0.005	0.050	0.050	0.140	0.002	11	11	3	0.3	0.4
WMLP325	ES1720035009	11/08/2017	0.0050	0.0025	0.8300	0.005	0.005	0.005	0.040	0.002	12	12	1	0.2	0.2
WMLP328	ES1720035002	11/08/2017	0.0050	0.0120	0.0250	0.005	0.070	0.070	0.005	0.002	11	10	4	0.1	0.2
ASHTON WELL	ES1720136001	14/08/2017									6	6	0		
RSGM1	ES1720136004	14/08/2017	0.0100	0.0150	0.0250	0.005	0.590	0.590	0.520	0.002	24	24	0	0.4	1.0
T5	ES1720136003	14/08/2017	0.0050	0.0150	0.0250	0.005	1.660	1.660	0.060	0.002	8	9	1	0.5	2.2
WML115B	ES1720136006	14/08/2017									31	32	1		
WML115C	ES1720136005	14/08/2017									8	9	3		
WMLP308	ES1720136002	14/08/2017	0.0050	0.0025	0.2400	0.010	0.090	0.1000	0.130	0.002	11	11	1	0.7	0.8

All samples mg/L unless specified

## *Appendix C* **Groundwater chemistry –Piper plot**

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