LIDDELL

GLENCORE

EPBC Approval 2013/6908 - 2018 Annual Report

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1 Introduction

Liddell Coal Operations (LCO) is an established open-cut mine located at Ravensworth, approximately 25 kilometres north-west of Singleton in the Upper Hunter Valley of New South Wales. LCO is operated and managed by Liddell Coal Operations Pty Limited, a wholly owned subsidiary of Glencore Coal Pty Limited (Glencore), on behalf of a joint venture between Glencore (67.5%) and Mitsui Matsushima Australia (32.5%).

Mining operations at Liddell Coal have been continuous since the 1950s. Operations prior to the 1950s were intermittent, with underground operations commencing in 1923 and open cut operations in 1946. Current open cut operations access the coal reserves previously not mined by the underground operations. The current open cut mining operation has been in operation since 1990. **Figure 1** shows LCO's referral areas under EPBC 2013/6908.

On 24th December 2014, LCO was granted EPBC Approval 2013/6908 for a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* to expand the existing Liddell open cut coal mine operations in the Hunter Valley region in New South Wales, under the following Controlling Provisions:

- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 and 20A)
- Water resources/trigger (sections 24D and 24 E)

Mining activities commenced within the approval area on the 19 May 2015. Condition 19 of EPBC Approval 2013/6908 requires an annual compliance report to be published on the LCO website addressing compliance with each of the conditions of this approval, including implementation of the management plans required by the Approval. This report has been developed to meet the requirements of Condition 19 for the period 19 May 2017 to 18 May 2018.

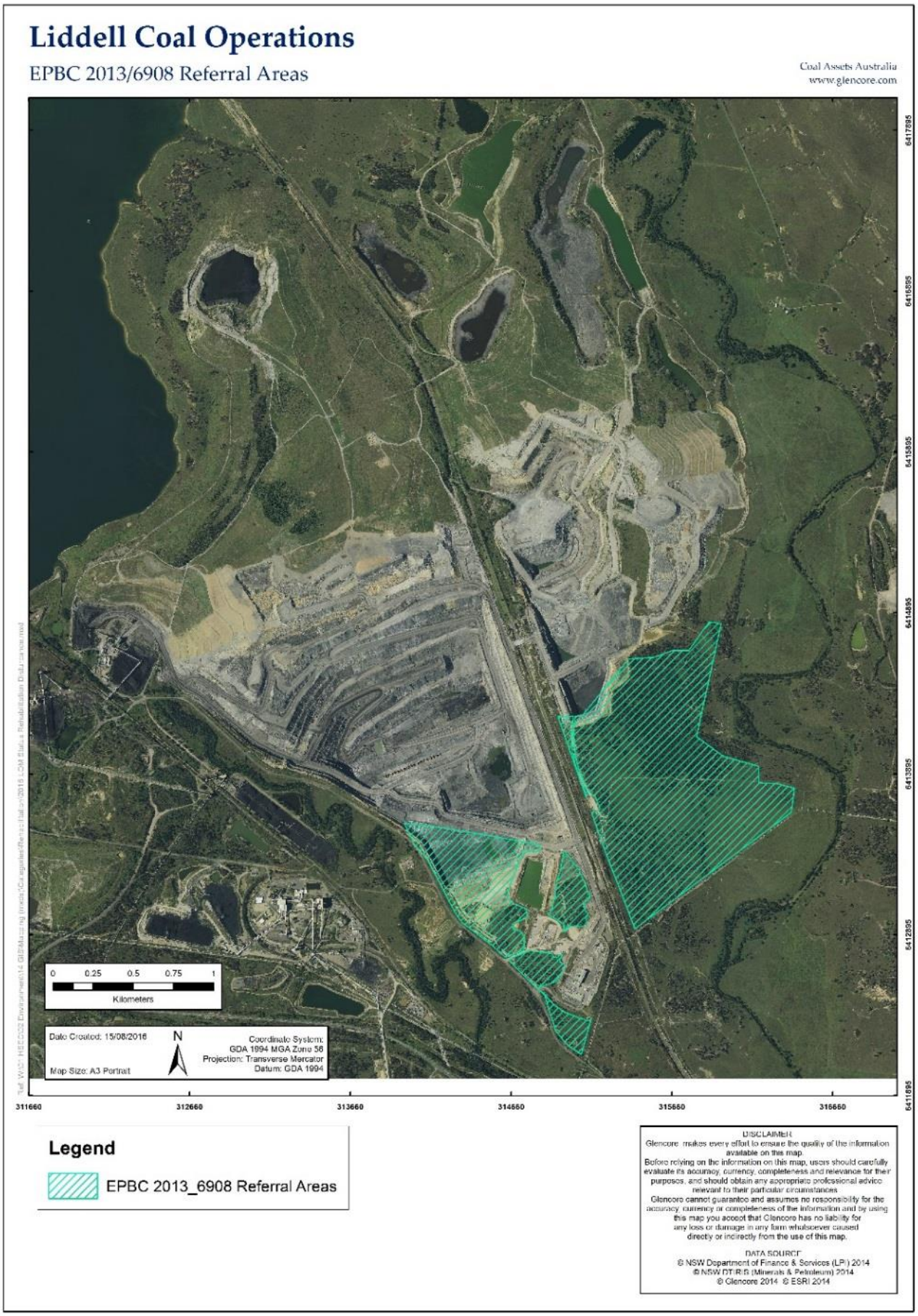

Figure 1 – LCO EPBC 2013/6908 Referral Areas

2 Statement of Compliance

This section being summarised as **Table 2** outlines the conditions of EPBC Approval 2013/6908, a summary of actions completed during the reporting period with a respect to each condition, and the corresponding compliance status with reference to **Table 1**.

Table 1 reproduces the "risk levels" from the Audit Guidelines which were attributed to the non-compliances identified during the audit period.

Where a non-compliance is identified in **Table 2,** it have been ranked in accordance with the *Independent Audit Guideline. Post-approval requirements for State significant developments* (Audit Guidelines) (DP&E, 2015).

Table 1 - Risk Levels for Non Compliances

Risk Level	Colour Code	Description
High		Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium		Non-compliance with: • potential for serious environmental consequences, but is unlikely to occur; or • potential for moderate environmental consequences, but is likely to occur
Low		Non-compliance with: • potential for moderate environmental consequences, but is unlikely to occur; or • potential for low environmental consequences, but is likely to occur
Administrative non-compliance		Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions)

Table 2 - EPBC 2013/6908 Compliance Status

Condition	Actions During Reporting Period	Status
1. The footprint of the action must be no more than 185 ha and must be kept within the areas marked as "Referral Areas" in Figure 1.2 (Annexure C). The approval holder must not clear more than 121 ha of native woodland.	Since commencement of the action LCO has cleared 119.48ha of land within the referral area; of which 81.8ha consisted of native woodland During the reporting period (19 May 2017 to 18 May 2018) LCO has cleared 45.65ha of land within the referral area, which consisted of 30.67ha of native woodland.	Compliant
2. To protect threatened species, the approval holder must prepare and submit a Biodiversity Management Plan to the Minister for approval prior to commencement of the action. This Plan must contain detail of the following mitigation measures: a. Fencing and access control; b. Weed control; c. Feral animal control; d. Bushfire management; e. Habitat enhancement measures; f. Tree feeling procedure; g. Indirect impact mitigation measures; and h. Adaptive management.	The Biodiversity Management Plan (BMP) was submitted to the Department of Environment (DoE) on 26 March 2015. The BMP was deemed to meet the requirements of the condition and was approved on 14 May 2015. Revised BMP submitted on 23 June 2016 in accordance with Condition 22. Operations have continued to be implemented as per the Biodiversity Management Plan detailed in **Section 3.1**.	Compliant
3. The approval holder must not commence the action until the Biodiversity Management required under Condition 2 has been approved by the Minister. The approved Plan must be implemented. Note: if more convenient for the approval holder, the requirements of this plan may be met through revision and submission for approval by the Minister of the existing Landscape Management Plan that provides: a. a copy of the management plan, marked up to show the revisions, in both hard copy and electronic copy; and b. A clear summary of all the revisions that have been made to the management plan, and the reasons for these revisions	The BMP was approved on 14 May 2015. The action was commenced on 19 May 2015. Revised BMP submitted on 23 June 2016 in accordance with Condition 22. Implementation of the BMP commenced after approval and a summary of activities completed to date is provided in **Section 3.1**.	Compliant

Condition	Actions During Reporting Period	Status
4. The Biodiversity Management Plan required under condition 2, must include the following information, which must be specific, measurable, realistic and time-bound in relation to each measure listed in condition 2: a. environmental objectives; b. performance criteria; c. methodology; d. duration and frequency of actions to be implemented; e. monitoring and reporting of the effectiveness of the measures; f. corrective actions; g. criteria for triggering corrective actions, should performance criteria not be met; and h. responsibility for implementation.	The BMP submitted was deemed to meet the requirements of this condition and was approved on 14 May 2015. Revised BMP submitted on 23 June 2016 in accordance with Condition 22.	Compliant
5. To protect threatened species and water resources, the approval holder must progressively rehabilitate the areas marked as "Referral Areas" in Figure 1.2 (Annexure C) to achieve a self-sustaining landform consisting of Central Hunter Grey Box-Ironbark Woodland and two mine voids. The Central Hunter Grey Box-Ironbark Woodland must be established progressively, in accordance with the Rehabilitation and Environmental Management Plan required by Condition 39 of Schedule 3 of the NSW Approval, once the Plan is approved by the NSW Government. The approved Plan must be provided to the Department.	LCO undertook rehabilitation in accordance with the Rehabilitation Environmental Management Plan (RMP/MOP). A revised copy of the RMP/MOP was forwarded to the Department on the 31 December 2017. Further detail is provided in **Section 3.1.3**	Compliant
6. In order to compensate for residual significant impacts on threatened species, the approval holder must protect the offset areas through a legal instrument under relevant conservation legislation prior to 30 June 2019 or another date agreed to in writing by the Minister. The legal instrument must: a. be registered on title of the Offset areas; b. provide for the protection and ongoing conservation management of the Offset areas in perpetuity; c. prevent any future development activities or clearing of native vegetation on the Offset areas; and d. require the approval of a State Planning or Environment Minister to be changed or revoked.	Offsets lands specified under this approval are owned by LCO and are managed in accordance with the Biodiversity Offset Management Plan (BOMP). During the reporting period, LCO has been working closely with representatives from the NSW Biodiversity Conservation Trust (BCT) (a new statutory organisation established in August 2017 charged with the private land conservation functions of the NSW Office of Environment and Heritage and nature Conservation Trust) on multiple reviews of the CA content, plans and survey requirements. An application was submitted to the Minister on 13 June 2018 seeking extension for the implementation of the Conservation	Compliant

Condition	Actions During Reporting Period	Status
	Agreements due to advice from BCT that they would be unable to finalise them before 30 June 2018. An extension till 30 June 2019 was granted by the Minister 20 June 2018. LCO will continue to provide the BCT with our full co-operation to facilitate timely completion of the CA's.	
7. The approval holder must provide the Department with details of the offset areas, including offset attributes, shapefiles, textual descriptions and maps to clearly define the location and boundaries of the offset area, to be submitted to the Department prior to commencement of the action.	The required data was submitted on 4 May 2015. The action commenced on the 19 May 2015. An application to vary the boundary of the Bowmans Creek Riparian Corridor was submitted to the Department on 13 April 2017 along with a revised BOMP. This variation was approved along with the BOMP on 4 December 2017. Implementation of the Conservation Agreements to satisfy Condition 6 has required detailed survey of the offset areas. LCO will forward updated attribute data package for the Department's records.	Compliant
8. To ensure management of the offset areas, the approval holder must submit an Offset Management Plan to the Minister for approval prior to 31 May 2015 to provide for the conservation and management in perpetuity of the offset areas. The Plan must include: a. a detailed methodology, frequency, timing and duration of all Offset area management measures proposed. The management measures must include: i. weed and pest control; ii. fencing; iii. ecological monitoring; and iv. assisted regeneration. b. key milestones, performance indicators, corrective actions and timeframes for the completion of all actions outlined in the Plan; c. a detailed methodology, timing goals and corrective actions for revegetation of: i. the Bowmans Creek Riparian Corridor, in accordance with Figure 8.3 (Annexure D)	The Biodiversity Offset Management Plan (BOMP) was submitted on 29 May 2015. The BOMP was deemed to meet the requirements of the condition and was approved on 5 January 2016. A revised Biodiversity Offset Management Plan (BOMP) was submitted to the Department on 13 April 2017 seeking to adjust the boundaries of the Bowmans Ck Riparian Corridor. The BOMP was deemed to meet the requirements of Condition 8 and approved on 4 December 2017. Operations have continued to be implemented as per the Biodiversity Offset Management Plan detailed in **Section 4.1**.	Compliant

Condition	Actions During Reporting Period	Status
ii. the Mountain Block Offset Site, in accordance with Figure 8.4 (Annexure E); and iii. exotic grassland and derived grassland areas of the Mitchells Hills South Offset Area, as depicted in Figure 3.1 of the letter from David Foster to the Department dated 29 October 2014 (Annexure F), with native woodland or forest communities that occur on the site.		
9. The approved Offset Management Plan required under Condition 8 must be implemented.	Monitoring activities associated with the BOMP commenced in Spring/Summer 2015 while the plan was under assessment. Implementation of the BOMP has continued since this time, including the incorporation of changes made by a revision of this plan approved on 4 December 2017. A summary of activities completed to date is provided in **Section 4.1**.	Compliant
10. To compensate for residual significant impacts on the Spotted-tailed Quoll, the approval holder must provide an Indirect Offset Plan to the Minister for approval, prior to 30 June 2015. This Plan must specify how it will allocate $243 000 over a period of not more than five years for recovery actions for the Spotted-tailed Quoll, as identified in either the Draft National Recovery Plan for the Spotted-tailed Quoll- Dasyurus maculatus (K. Long and J. Nelson 2008) or in the NSW Office of Environment and Heritage's Saving Our Species Project Species Action Statement. The Plan must include: a. a detailed description of the actions funding, including location and timing of activities; b. demonstration of how the funded activities are additional to any offset requirements of any existing approval conditions and additional to existing practise or other requirements; c. an explanation of how the activities described in the Plan will contribute to conservation of the Spotted-tailed Quoll; d. provisions to ensure appropriate management of funds and that auditable financial records are kept and maintained; e. provision for publication of findings: i. of a standard that would be acceptable for publication in an internationally recognised peer-reviewed scientific journal; and	The Indirect Offset Plan (IOP) was originally approved on 5 May 2016. A revised IOP was submitted to the Department on 30 March 2017. The revised IOP details amended projects Task 2 Surveying/Monitoring STQ Populations and Task 3 Assess Habitat Use by Female STQ. This IOP was deemed to meet the requirements of Condition 10 and approved 5 September 2017.	Compliant

Condition	Actions During Reporting Period	Status
ii. together with methodologies and results, on the internet within twelve months of the collection of results and in a form that may be accessed by the public.		
11. The approved Indirect Offset Plan must be implemented.	The IOP was originally approved on 5 May 2016 and revision subsequently approved in September 2017. Implementation of approved projects under the IOP is discussed in further detail in **Section 4.2**.	Compliant
12. To protect water resources and threatened species, the approval holder must submit a Water Management Plan (WMP) for approval by the Minister prior to commencement of the action which provides for the avoidance and mitigation of impacts to water resources and threatened species. The plan must include the following: a. Management action, mitigation measures and practices designed to limit impacts of the proposal on surface and ground water resources. Management actions, mitigation measures and practices prescribed by the plan must be clear, measurable, auditable and time bound; b. Surface and groundwater monitoring program, that must be implemented for the life of the action, to monitor the success of the management actions in the WMP, define measurable targets of management actions and performance indicators, and provide an adaptive management framework for the duration of the action's impact on water resources. This program must include: i. surface water quality, including pH, electrical conductivity, total suspended solids and total dissolved solids, in Bayswater Creek and Bowmans Creek each month, at each of the sites specified in Figure 9.11 of the Preliminary Documentation; ii. groundwater quality at least every two months and groundwater pressures and levels at least monthly at each location depicted in figure 2-13 of the Groundwater Impact Assessment (Annexure A) and; iii. documentation of the reference value against which the 2 meter drawdown trigger for the Bowmans Creek alluvium will be assessed and a justification of this reference value. c. Clear objectives and performance indicators, timeframes for the completion of all actions outlined in the Plan as well as corrective actions for circumstances where	The Water Management Plan (WMP) was submitted to the Department of Environment (DoE) on 26 March 2015. The WMP was deemed to meet the requirements of the condition and was approved on 14 May 2015. The action commenced on 19 May 2015. A revised WMP was approved on 26 July 2017, primarily amending the groundwater monitoring triggers and associated response plan.	Compliant

Condition	Actions During Reporting Period	Status
a management action, mitigation measure or practice fails to meet its prescribed objective or performance indicator.		
13. The approved Water Management Plan must be implemented.	Implementation of the WMP commenced after approval and a summary of activities completed to date is provided in **Section 5**.	Compliant
14. The approval holder must only discharge water into the Hunter River or its tributaries in accordance with the Hunter River Salinity Trading Scheme.	LCO did not conduct any discharge event under the Hunter River Salinity Trading Scheme during the reporting period. Further information is provided in **Section 5**.	Compliant
15. If monitoring of surface water quality identifies an exceedance of the Trigger Values for surface water, the approval holder must: a. keep a written record of the exceedence; b. report the exceedence to the Department within 5 business days of the monitored exceedance if the exceedance has the potential to result in environmental harm; c. unless agreed otherwise by the Department in writing, complete an investigation into the potential for environmental harm for any exceedence described in condition 15b. and provide a written report to the Department within 30 calendar days of receiving the result, including: i. a description of the investigations carried out; ii. a statement of the cause and extent of the exceedance; iii. an assessment of the potential for environmental harm; iv. actions taken to prevent environmental harm, if required; and v. actions taken to prevent exceedance from re-occurring in the future.	The surface water quality monitoring Investigation Trigger Action Response Plan (ITARP) was not instigated during the reporting period. Further information is provided in **Section 5**.	Compliant
16. If groundwater monitoring identifies groundwater drawdown in the alluvium of Bowmans Creek of more than 2 metres, the approval holder must: a. report this to the Department within 5 business days of the monitored exceedance; b. unless agreed otherwise by the Department in writing, complete an investigation into the potential for environmental harm and provide a written report to the Department within 30 calendar days of receiving the result, including: i. a description of the investigations carried out; ii. a statement of the cause and extent of the drawdown;	The Bowmans Creek groundwater drawdown ITARP was not triggered during the reporting period. Further information is provided in **Section 5**.	Compliant

Condition	Actions During Reporting Period	Status
iii. actions taken to prevent environmental harm; and iv. actions taken to prevent exceedance from re-occurring in the future.		
17. Within 21 calendar days after the commencement of the action, the approval holder must advise the Department in writing of the actual date of commencement.	The action was commenced on the 19th May 2015 and correspondence with communication regarding the notification of commencement was sent to the Department Post Approvals (reference LCO 15/039).	Compliant
18. The approval holder must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement the Indirect Offset Plan (described in condition 10), Water Management Plan (described in condition 12) and Biodiversity Management Plan (described in condition 2) required by this approval, and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audits may also be publicised through the general media.	LCO maintains accurate records in accordance with Condition 18.	Compliant
19. Within three months of every 12 month anniversary of the commencement of the action, the approval holder must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans as specified in the conditions. Documentary evidence providing proof of the date of publication must be provided to the Department at the same time as the compliance report is published.	The EPBC Approval 2013/6908 – 2017 Annual Report was published on the LCO public website on 18 August 2017. Notification of this was also provided to the Department on 18 August 2017. This is within three months of the 12 month anniversary of commencing the action on 19 May.	Compliant
20. Potential or actual contraventions of the conditions of the approval must be reported to the Department in writing within 2 business days of the approval holder becoming aware of the actual or potential contravention. All contraventions must be included in the compliance reports.	There were no contraventions of EPBC Approval 2013/6908 identified during the reporting period.	Compliant
21. Upon the direction of the Minister, the approval holder must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.	Not triggered during the reporting period.	Compliant

Condition	Actions During Reporting Period	Status
22. The approval holder may choose to revise a management plan approved by the Minister under conditions 2, 8 and 12 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the revised plan would not be likely to have a new or increased impact. If the approval holder makes this choice they must: i. notify the Department in writing that the approved plan has been revised and provide the Department with an electronic copy of the revised plan; ii. implement the revised plan from the date that plan is submitted to the Department; and iii. for the life of this approval, maintain a record of the reasons the approval holder considers that taking the action in accordance with the revised plan would not be likely to have a new or increased impact.	During the reporting period LCO made revisions to the following management plans in consultation with the department in accordance with Condition 22: • Biodiversity Management Plan; • Water Management Plan; • Indirect Offset Management Plan; and • Biodiversity Offset Management Plan • MOP	Compliant
22A. The approval holder may revoke their choice under condition 22 at any time by notice to the Department. If the approval holder revokes the choice to implement a revised plan, without approval under section 143A of the Act, the plan approved by the Minister must be implemented.	Not triggered during the reporting period.	Compliant
22B. If the Minister gives a notice to the approval holder that the Minister is satisfied that the taking of the action in accordance with the revised plan would be likely to have a new or increased impact, then: i. Condition 22 does not apply, or ceases to apply, in relation to the revised plan; and ii. The approval holder must implement the plan approved by the Minister. To avoid any doubt, this condition does not affect any operation of conditions 22 and 22A in the period before the day the notice is given. At the time of giving the notice the Minister may also notify that for a specified period of time that condition 22 does not apply for one or more specified plans required under this approval.	Not triggered during the reporting period.	Compliant
22C. Conditions 22, 22A and 22B are not intended to limit the operation of section 143A of the EPBC Act which allows the approval holder to submit a revised plan to the Minister for approval.	Not applicable (NA)	NA
23. Revoked.	NA	NA
24. If, at any time after seven years from the date of this approval, the approval holder has not substantially commenced the action, then the approval holder must not substantially commence the action without the written agreement of the Minister.	Not triggered. Action commenced on 19 May 2015	Compliant

Condition	Actions During Reporting Period	Status
Note: The date stated in condition 24 relates to the date of the approval decision (24 December 2014).		
25. Unless otherwise agreed to in writing by the Minister, the approval holder must publish all management plans referred to in these conditions of approval on its website. Each management plan must be published on the website within 1 month of being approved and remain published for the life of the approval.	During the reporting period all management plans referred to in these conditions were published on the Liddell Coal Website within one month of being approved.	Compliant

3 Avoidance and Mitigation of Impacts

3.1 Biodiversity

The objectives of the Biodiversity Management Plan (BMP) are to provide direction for the short to long term management and enhancement of the biodiversity values of the BMP Area, as well as to provide a detailed description of the measures to be implemented to achieve this over the next three years. The BMP area is defined as all land within Mining Lease 1597 boundary excluding any biodiversity offset areas.

Since the BMP was initially approved in August 2015, LCO is reporting compliance with year 3 performance criteria during this reporting period. **Table 3** summarises the performance criteria set for year 3 of operation of the BMP; and actions completed to date.

Table 3 - BMP Implementation Summary

Action/Item	Performance Indicators	Completion Criteria	Performance Comment
Year 2 2017			
Fencing, Signage and Access Control			
Complete inspection of all fencing of BMP Area to map locations, condition and identify need for new fencing or redundant fencing.	Complete inspection of all fencing of BMP Area to map locations, condition and identify need for new fencing or redundant fencing.	All actions identified from inspection in year 1 have been implemented.	Compliant. Fence line condition mapping completed. Actions identified have been completed. Regular monitoring ongoing to identify further works as area management changes.
Fencing of relevant parts of BMP area.	Fencing occurs, based on outcomes of inspection.	All biodiversity offset areas and relevant parts of the BMP area (being retained vegetation, rehabilitation and waterways) will have boundary fencing of appropriate design and condition.	Compliant. Boundary secure.
Any new fencing does not have barbed wire on upper strands and as little barbed wire generally as possible. The bottom strand will be plain wire and elevated to allow faunal passage (while maintaining cattle exclusion).	New fences are installed without barbed wire on upper strands and an elevated plain wire bottom strand.	New fences are constructed with as little barbed wire as possible, with none on upper strands and an elevated plain wire bottom strand.	Compliant. New fencing installed to the appropriate specification.
Removal of redundant fences.	Inspection undertaken to identify redundant fences.	Redundant fences removed.	Compliant. Fence line condition mapping completed.
	Commence removal of redundant fences.		Redundant fence line removal completed. Regular monitoring ongoing to identify further works as area management changes.
Minimum twice yearly inspections of fences to identify condition.	Inspections undertaken nominally in March and September.	All fences in functional condition.	Compliant. Inspections being completed as required.
	Damaged critical fences to be repaired within 1 week (temporary if needed), final		Compliant.

Action/Item	Performance Indicators	Completion Criteria	Performance Comment
	repairs and non-critical repairs to be completed in 1 month.		
Information signage for the spotted-tailed quoll.	Signs will be installed along access tracks in areas of spotted-tailed quoll habitat (such as Bowmans Creek Corridor) to alert drivers to potential activity.	Information signage for the spotted-tailed quoll has been installed and maintained.	Compliant. Signage installed and maintained as required.
Access Track Maintenance			
New access tracks (only constructed where necessary) are subject to due diligence assessments.	Complete due diligence assessments for new access tracks to minimise impact on biodiversity, where possible.	New access tracks are only constructed where necessary, are subject to due diligence inspections	Compliant. New access tracks are installed in accordance with the BMP and subject to preclearance due diligence.
Minimum twice a year BMP Area inspections to identify track conditions.	Inspections undertaken nominally in March and September.	Tracks maintained in good usable condition.	Compliant. Inspections being completed as required.
	Action and repair track damage.		
Rehabilitation of unnecessary access tracks.	Tracks no longer required will be rehabilitated.	Unnecessary access tracks are rehabilitated.	Compliant. No access tracks required to be rehabilitated.
Topsoil Management			
Areas containing weeds that may pose a threat to rehabilitation are sprayed prior to topsoil stripping.	Pre-stripping weed control of topsoil is completed, as needed.	Weed control is completed prior to topsoil stripping (where required) to minimise future potential impact to rehabilitation success.	Compliant. Weeds are managed in line with Weed Action Plan. Preclearance survey identifies any weed infestations requiring further management.
Erosion, Sedimentation and Salinity			
Implement erosion and sediment controls during land clearing.	Actions required by Ground Disturbance Permit are implemented.	Appropriate erosion and sediment control measures required have been identified and implemented. There are no areas of significant erosion, sedimentation within the BMP Area due to land clearing.	Compliant. Erosion and Sediment Controls installed as per standard operating practices.
Creek and Drainage Line Protection			
Fencing/protection of LCO controlled side of riparian corridor (as part of Offset Management Plan).	Riparian corridor will be fenced from human and livestock access.	Riparian areas are adequately fenced/protected against damage from uncontrolled human or livestock access.	Compliant. Fencing maintained appropriately and inspected regularly to prevent damage. Monitoring did not identify any adverse impacts due to LCO operations.
Pathogen Management			
If reasonable potential for pathogens is identified in the BMP Area, appropriate pathogen monitoring and management protocols are	If reasonable potential is identified, pathogens are considered in design and implementation of monitoring works.	Methods to identify potential pathogens are considered in monitoring program design (if reasonable potential of pathogen presence is identified onsite).	Compliant. Monitoring has not identified any requirement for additional pathogen management controls.

Action/Item	Performance Indicators	Completion Criteria	Performance Comment
developed and implemented.	If identified (or potential identified), management actions for specific pathogens are developed and implemented.	Signs of pathogen presence (or potential presence) are immediately reported.	N/A
		If suspected to be onsite, detailed management actions are developed and implemented.	N/A
		There is no onsite infestation of Phytophthora cinnamomi, Myrtle rust or Chytridiomycosis.	N/A
Seed Collection			
Where suitable remnant vegetation is available, implementation of seed collection and handling program for use in revegetation/rehabilitation works.	Pre-clearing surveys identify potential seed sources.	Rehabilitation/revegetation works use seeds collected onsite, thus maintaining as much genetic similarity (local provenance) as possible.	Compliant. Preclearance surveys assess the potential for seed collection opportunities. During the reporting period, no seed resources where identified in preclearance areas. Local provenance seed is used where possible in rehabilitation areas. LCO did conduct seed collection activities across its landholdings during the reporting period.
	Seeds are collected, stored and handled according to appropriate program.		
	Collected seed resources are used in revegetation/rehabilitation works.		
Vegetation Clearing			
Detailed pre-clearing procedure is to be implemented when clearing areas of woody native vegetation (including shrub, groundcover and isolated trees in grasslands).	Pre-clearing process is to be implemented as part of GDP process.	Pre-clearing process has been followed when required.	Compliant. Preclearance process followed and no fauna harmed during clearing activities. Habitat material salvaged and relocated to rehabilitation areas when possible. Appropriate records are maintained.
	Outcomes of pre-clearing process are recorded and recommendations are implemented.	Recommendations from pre-clearing process have been implemented, prior to tree felling if necessary.	
		Outcomes of pre-clearing procedure are recorded and readily accessible.	
Detailed tree felling process is to be implemented when clearing areas of woody native vegetation (including shrub, groundcover and isolated trees in grasslands).	Tree felling process is to be implemented as part of the GDP process.	Tree felling process has been followed when required.	
	Outcomes of tree-felling process are recorded and recommendations are implemented.	Recommendations from tree felling process have been implemented.	
Translocation Works			
Translocation of tiger orchids or other threatened flora species (if encountered during pre-clearing process) to biodiversity offset areas.	Tiger orchids identified during pre-clearing process are salvaged during the tree felling process and are translocated into biodiversity offset areas.	Tiger orchids (or other threatened flora species if encountered) are salvaged from Approved Modification Area and translocated into biodiversity offset areas.	Compliant. A single Tiger Orchid was identified during pre-clearing process and translocated into an approved Biodiversity Offset Area during the reporting period. Appropriate records are maintained and the individual added to ongoing monitoring program.
	Any translocated individuals are subject to regular monitoring and maintenance works, if required.	Detailed records are kept on the process, including regular monitoring and maintenance works as required.	

Action/Item	Performance Indicators	Completion Criteria	Performance Comment
	Reporting of translocation works and monitoring works is maintained.		
Remnant Vegetation and Habitat Management			
Remnant vegetation is to be protected from accidental impact.	Areas to be disturbed will be clearly defined in the field to prevent accidental impact to remnant vegetation.	No areas of remnant vegetation are impacted unnecessarily.	Compliant. No unplanned clearing occurred during the reporting period.
Remnant vegetation is protected from disturbance.	Remnant vegetation will be fenced or sign-posted as necessary to protect from disturbance.	Remnant vegetation is protected from disturbance such as accidental clearing, unauthorised access, erosion, weeds and feral animals.	Compliant. Clearing activities appropriately demarcated and managed to ensure no unplanned clearing occurred during the reporting period.
	Annual inspections are completed to assess condition of fences and signs, areas of erosion concern, weeds or feral animals requiring control.		Compliant. Inspections being completed as required. Ecological monitoring of remnant areas completed and no impact from LCO recorded.
	Management works will be conducted, as necessary.		Compliant. Primarily weed management works are occurring in remnant areas.
Annual inspections undertaken by suitably qualified personnel to assess the extent of natural regeneration occurring.	Annual inspection undertaken by suitably qualified personnel to assess extent of natural regeneration occurring.	Areas where natural recruitment is not occurring have been identified and assisted regeneration is occurring if considered appropriate.	Compliant. Annual inspections completed by external professional. Management recommendations to be actioned on an ongoing basis.
	Appropriate action is undertaken if regeneration is deemed as being inadequate.		
Rehabilitation Works			
Criteria for these works are included within the Mining Operations Plan (SLR 2015). This includes detailed criteria for rehabilitation success (survival, succession, vegetation structure and health).			
Weed Control			
Complete weed inspections of BMP area every two months to document diversity and abundance of noxious weed records. This will then inform ongoing control actions (as needed), including timing, frequency, target species and methods to be used.	Inspections completed every two months, followed by implementation of required control methods, as required.	Weed densities in rehabilitation/regeneration areas are no worse than those in remnant vegetation (analogue) sites. There are no significant weed infestations that are identified as a risk to rehabilitation or regeneration areas.	Compliant. Inspections being completed as required with appropriate weed priorities actioned.
Weed inspections of remnant and rehabilitation areas	Minimum twice yearly monitoring inspections are undertaken of rehabilitation areas to identify areas of weed infestation.	Regular inspections are undertaken for weed inspections and outcomes documented.	Compliant. Inspections being completed as required with appropriate weed priorities actioned. Annual Weed Action Plan completed and implemented. Annual monitoring undertaken and management
	Annual inspections are undertaken of remnant vegetation to identify areas of weed infestation		

Action/Item	Performance Indicators	Completion Criteria	Performance Comment
	Weed management actions of infestations are undertaken in accordance with current or other best practice approaches.		recommendations actioned. Observed as being effective during monitoring and inspections.
Feral Animal Control			
Complete feral animal inspections of BMP area every two months to document sighting and abundance records. This will then inform ongoing control actions (as needed), including timing, frequency, target species and methods to be used.	Inspections completed every two months, followed by implementation of required control methods, as required.	BMP area is inspected for feral animal diversity and abundance every two months.	Compliant. Inspections being completed as required with appropriate feral animal priorities actioned.
		Control measures are implemented in response to outcomes of the inspections.	
		Measures are being taken to control feral animals in the BMP area.	
Develop and implement an effective annual pest animal action plan.	Develop and implement pest animal action plan. Stable or downward trend in population size recorded.	Strategies from action plans are implemented and targets are achieved. Stable or downward trend in population size recorded.	Compliant. Pest Action Plan Developed and implemented. Observed as being effective during monitoring and inspections.
Particular action is paid to managing foxes, feral cats and feral dogs in order to protect the spotted-tailed quoll population in this area.	Implementation of favoured fox, feral cat and feral dog control measures. Monitoring of impacts of fox, feral cat and feral dog control on spotted-tailed quoll population.	Monitoring demonstrates that fox, feral cat and feral dog control methods are being effective in managing target species and not impacting negatively on the spotted-tailed quoll population.	Compliant. Annual dog baiting program completed in conjunction with regional aerial baiting and baiting programs at neighbouring operations. Monitoring and inspection show effective control occurring.
Develop a vertebrate pest control register to document when and where each control method is implemented.	Update and maintain vertebrate pest control register.	Pest animal control register is maintained and up to date.	Compliant. Pest control register in developed and maintained.
Blue-billed Duck Management			
Complete habitat enhancement, maintenance and monitoring works (as required) for the blue-billed duck	Ongoing habitat enhancement and management works within Dam 3 and two Triangle Dams.	Monitoring shows appropriate habitat for the blue-billed duck is maintained is provided in Dam 3 and two Triangle Dams.	Compliant. Monitoring has shown continued drought conditions are impacting on the development of aquatic flora establishment. Management actions identified and will be ongoing.
	Monitoring works as required.		
Habitat Enhancement			
Salvage of habitat features (particularly for the spotted-tailed quoll) such as hollow-bearing trees, logs, stumps, large rocks and boulders.	Suitable habitat features identified during the pre-clearing process are salvaged.	Appropriate habitat features have been salvaged.	Compliant. Habitat features suitable for salvage are stockpiled or directly placed into rehabilitation and offset areas. Ongoing habitat augmentation works will continue as per recommendation from monitoring events.
	Salvaged features are either re-instated into areas with low levels of habitat features or stockpiled appropriately for later use.	Salvaged habitat features are re-instated into areas of remnant vegetation lacking in habitat features or into rehabilitated vegetation.	
	Timber or boulder piles will be constructed in riparian	Appropriate spotted-tailed quoll habitat has been	

Action/Item	Performance Indicators	Completion Criteria	Performance Comment
	areas and areas of regeneration, revegetation and/or rehabilitation (as appropriate) to provide potential quoll denning habitat.	salvaged and placed into onsite rehabilitation areas.	
		Habitat features that have been salvaged and are yet to be re-instated are in appropriate storage.	
		Appropriate documentation is available of any habitat features salvaged.	
Nest boxes are providing habitat value for native fauna.	Continue staged instillation of nest boxes. Established nest boxes are subject to annual inspection and maintenance.	All nest boxes and monitored and maintained.	Compliant. Nest box installation occurring. Ongoing installation program will continue as deemed required by annual monitoring.
Salvaged–reinstated hollows	Salvaged and re-instated hollows are subject to annual monitoring in conjunction with nest boxes.	All salvaged re-instated hollows are monitored and maintained.	Compliant. Habitat features suitable for salvage are stockpiled or directly placed into rehabilitation and offset areas. Ongoing habitat augmentation works will continue as per recommendation from monitoring events.
Timing of nest box installation	Removed hollows will be replaced (with nest boxes) within six months of each discrete clearing event.	Seasonal breeding opportunities are not lost due to delay in nest box installation.	Compliant. 14 hollow bearing or stag trees with sheeting bark cleared during reporting period. Hollows and logs removed during clearing works have been placed in offset and rehabilitation areas. Nest boxes have been installed to replace cleared hollows as part of an ongoing habitat augmentation program.
Salvaging, stockpiling and deployment of habitat features	Suitable habitat features are identified and salvaged as part of the pre-clearing process. These can then be stockpiled until deployment in target areas once rehabilitation/regeneration works are complete.	Suitable habitat features are salvaged, stockpiled and reused to augment habitat complexity (thus value) in rehabilitation/regeneration areas.	Compliant. Salvage and suitable habitat material was stockpiled or directly placed in rehabilitation and offset areas. Ongoing habitat augmentation works will continue.
Foraging specific plant resources	Rehabilitation and revegetation plantings undertaken include bulloak (Allocasuarina luehmannii), swamp oak (Casuarina glauca), broom bitter pea (Daviesia genistifolia), sickle wattle (Acacia falcata), hickory wattle (Acacia implexa) and cooba (Acacia salicina)	Rehabilitation areas include plant species that are specific foraging resources.	Compliant. Species planted in rehabilitation are consistent with the species list present in the BMP and include foraging species.

Action/Item	Performance Indicators	Completion Criteria	Performance Comment
Grazing Management			
Stock rotation	Cattle are grazed within improved pasture areas within mine rehabilitation >3years.	Groundcover percentage is maintained at 70% and greater	Compliant. LCO coordinate a cattle grazing trial and rotate stock between paddocks under supervision of district agronomist to ensure groundcover is >70%.
	Stocked will be managed to allow pasture recovery and maintain pasture availability and sufficient groundcover.		Compliant. Grazing impacts monitored and managed.
Shade trees and shelter belts (in areas suitable for future grazing) are planted with suitable endemic species compatible with adjoining vegetation communities.	Any shade trees and shelter belts are planted with suitable endemic species.	Shade trees and shelter belts comprise suitable endemic species compatible with adjoining vegetation communities.	Compliant. Stock are managed within the areas available and shade/shelter trees are planted however additional works are being completed in 2018.
Bushfire Management			
The current Bushfire Management Plan will be updated according to the approved modification.	The current Bushfire Management Plan will be updated to address the approved modification.	Bushfire risk is managed according to an updated Bushfire Management Plan which allows for appropriate protection of life and property, as well as identified significant ecological features.	Compliant. This plan has been updated and is maintained as required.
Bushfire Management Plan will be implemented.	Implementation of requirements of updated Bushfire Management Plan.		Compliant. Requirements from the plan being implemented.
Ecological Monitoring			
Undertake floristic, fauna, LFA, waterbird, nest box, stygofauna and instream/riparian monitoring program throughout LCO	Monitoring program completed and reported	Monitoring programs completed and results reported.	Compliant. Monitoring program completed by external professionals. Results reported in this report.
Undertake annual inspections of LCO rehabilitation areas	Annual inspections completed	Annual inspections completed	
Native fauna presence in rehabilitation/regeneration areas	Fauna monitoring completed	Fauna monitoring confirms that native fauna species are recorded within rehabilitation/regeneration areas.	
Collate data on actions implemented and results of inspections and monitoring into the AEMR.	AEMR completed as required annually	AEMR completed as required annually	Compliant.

3.1.2 Biodiversity Monitoring

During the reporting period, LCO undertook biodiversity monitoring in accordance with the BMP to assess progress/performance against the BMP criteria and Rehabilitation Management Plan (RMP/MOP) performance criteria. This section details the results from rehabilitation and biodiversity monitoring within the BMP area.

In general remnant vegetation sites have maintained broadly consistent vegetation and fauna diversity and abundance since monitoring commenced in 2012 and 2013 respectively. Both provide a range of habitat features that have remained intact and unaltered by mining and mining-related activities. Although not currently impacting on overall condition, introduced species should continue to be managed for continual suppression (with emphasis on noxious species as well as suppressing introduced grasses) to ensure that these areas remain in a similar if not improved state. Management of introduced species (in particular panic veldtgrass) along with increasing connectivity and riparian width of vegetation in this corridor would assist the habitat availability and complexity of this site. Recent introduced species management works have been undertaken with some success however are not necessarily reflected in plot data as activities have not been directly undertaken within monitoring sites.

Introduced fauna species continue to be identified across these monitoring sites, however occur in low numbers. Predator species the fox (Vulpes vulpes), is of greatest concern as it is most likely to be supressing small terrestrial fauna populations. All other introduced fauna species were identified in low numbers not likely to be interfering with the recovery of other fauna groups.

Other key findings of the 2017 biodiversity monitoring program were as follows:

- There was a decrease in threatened fauna observed at one monitoring location during 2017 compared to previous years. However, this reduction was not a result of any observable habitat changes. Despite no threatened species being observed, overall fauna diversity was higher in 2017 than any previous monitoring event.
- Stygofauna monitoring indicates substantial declines to diversity. The cause of this decline is unknown as no substantial changes over time have been observed to groundwater quality; however these will be subject to additional monitoring during the 2018 reporting period to determine whether these results are cause for concern.
- In-stream and riparian ecological monitoring and macroinvertebrate data have revealed only minor change since commencement of monitoring. These are considered stable and do not require intervention.
- General floristic diversity (both natives and introduced species) were lower during 2017 compared to previous events. This correlates with hotter and drier weather conditions than average, which likely prevented seedling emergence of many small annual species and may have caused plant withering (subsequently making identification of key plant features such as seeds and flowers difficult).
- LCO will continue to implement the BMP commitments and recommendations detailed in the 2017 BMP monitoring report.
- As per the BMP, LCO will prepare an Annual Ecological Monitoring Report (AEMR) which will document the monitoring methods and results from the winter monitoring period through to the autumn monitoring period. The intent of this report will be to provide a comparison of the data collected with previous monitoring event and to provide (where necessary) ongoing management recommendations and ameliorative methods to ensure the biodiversity within the BMP area is subject to a positive feedback loop. The full report summarising the method and results of the 2017 Annual Ecological Monitoring Program is available on the LCO website.

As detailed in the 2017 BMP monitoring report (Umwelt 2018), a number of improvement recommendations are noted which LCO continue to implement during the reporting period and onwards. Improvement activities undertaken during the reporting period included but not limited to:

- Supplementary plantings to assist with in-filling vegetation gaps across multiple strata within select rehabilitation areas;
- Ongoing and targeted weed management as appropriate;
- Installation of significant amount of habitat material in woodland rehabilitation areas whilst aiming at creating improved connectivity to remnant areas; and
- Increased feral fauna management program.

3.1.3 Rehabilitation Program

Rehabilitation activities during the reporting period were completed generally in accordance with the approved Mining Operations Plan (MOP). LCO achieved the 2017 rehabilitation targets as specified in the 2015-2022 MOP during the reporting period.

Overall, LCO achieved 37ha of rehabilitation during 2017 comprising of 19 ha Central Hunter Box Ironbark Woodland. During Q4 2017, LCO received approval for a new MOP 2018-2020 to realign the operational progress and the MOP with regards to disturbance and rehabilitation. LCO will continue to implement the MOP/RMP and BMP to progressively rehabilitate the operation. Rehabilitation monitoring results are included in the BMP **Section 3.1.2**.

4 Offsetting of Residual Impacts

4.1 Biodiversity Offsets

The Biodiversity Offset Management Plan (BOMP) was developed to guide ongoing management of the LCO biodiversity offset areas, to maintain and enhance biodiversity values, particularly those relating to threatened species and threatened ecological communities (TECs) within the LCO biodiversity offset areas.

The objectives of the BOMP are to provide direction for the short to long term management and enhancement of the biodiversity values of the LCO biodiversity offset areas, as well as to provide a description of the measures to be implemented to achieve this over the next three years.

Although this reporting period begins in May 2017, annual objectives detailed in the BOMP for each year are measured from the approved date of the BOMP i.e. year 2 commences 5th January 2017. Therefore, performance against year 2 performance criteria is outlined in this section.

The following **Table 4** summarises the performance criteria set for year 2 of operation of the BOMP, and actions completed to date.

Table 4 - BOMP Implementation Summary

Management Strategy	Action	Year 2 Performance Criteria	Completion Criteria	Performance Comment
Pathogen Management	If reasonable potential for pathogens is identified in the biodiversity offset areas, appropriate pathogen monitoring and management protocols are developed and implemented.	If identified (or potential identified), management actions for specific pathogens are developed and implemented.	Methods to identify potential pathogens are considered in monitoring program design (if reasonable potential of pathogen presence is identified onsite. Signs of pathogen presence (or potential presence) are immediately reported. If suspected to be onsite, detailed management actions are developed and implemented. There is no onsite infestation of Phytophthora cinnamomi, Myrtle rust or Chytridiomycosis.	Compliant. No pathogens were identified as part of the Biodiversity Offset Monitoring Program or during bi-monthly inspections.
Aboriginal Cultural Heritage Management	Detailed rehabilitation planning for the Bowmans Creek Riparian Corridor includes identification of need for cultural heritage assessment. Develop and implement protocols for identification of potential cultural heritage issues, including how to avoid or mitigate impacts across all biodiversity offset areas	Implement plan and protocols as required.	Cultural heritage is appropriately considered within rehabilitation works in Bowmans Creek Riparian Corridor. Protocol developed and implemented.	Compliant. Liddell have considered impacts to Aboriginal Cultural Heritage during planning for rehabilitation. Liddell's Aboriginal Cultural Heritage Management Plan and Unexpected Finds Protocol outline the requirements for disturbing previously undisturbed areas. An Aboriginal Cultural Heritage Training Package has also been developed for those working near sensitive areas. A due diligence assessment has been completed for all offset areas. All cultural heritage sites identified through the assessment are demarcated and communicated to personnel working in the area. The due diligence assessment findings have also been included in the Offset Remediation Strategy for planning/implementation.
Fencing and signage	Complete inspection of all fencing of biodiversity offset areas to map locations, condition and identify need for new fencing or redundant fencing.	Implement actions identified in year 1.	All actions identified from inspection in year 1 have been implemented.	Compliant. Bi-monthly inspections completed with fencing repair as required to ensure

Management Strategy	Action	Year 2 Performance Criteria	Completion Criteria	Performance Comment
	Install or repair boundary fences restricting unauthorised access to property and controlling livestock movements	Fencing occurs based on outcomes of inspection.	All biodiversity offset areas will have boundary fencing of appropriate design and condition.	access is restricted to unauthorised access and controlling livestock movements.
	Any new fencing does not have barbed wire on upper strands and as little barbed wire generally as possible. The bottom strand will be plain wire and elevated to allow faunal passage (while maintaining cattle exclusion).	New fences are installed without barbed wire on upper strands and an elevated plain wire bottom strand.	New fences are constructed with as little barbed wire as possible, with none on upper strands and an elevated plain wire bottom strand.	Compliant. All new fences have been installed without barbed wire on the upper strains and have an elevated plain wire bottom strand for fauna passage.
	Removal of redundant fences.	Continued removal of redundant fences as required.	Redundant fences removed.	Compliant. Redundant fence line removal has been completed for the BOAs. ~13,000m of fencing removed.
	Inspections of fences every two months to identify condition.	Inspections of fence every two months. Damaged critical fences to be repaired within 1 week, final repairs and non-critical repairs to be completed in 1 month.	All fences in functional condition.	Compliant. Bi-monthly inspections completed with actions implemented as required. ~3,600m of fencing repaired and ~9,500m installed.
	Information signage for the spotted-tailed quoll.	Information signage is maintained.	Information signage for the spotted-tailed quoll has been installed and maintained.	Compliant. Signage installed and maintained in good condition.
Grazing Management	All stock to be removed from offset areas.	No stock grazing.	Grazing has not occurred in biodiversity offset areas	Compliant. Stock is removed from offset areas.
	Minimum bi-monthly inspections to determine presence of rogue stock and assess condition of fences. Action removal of rogue stock and repair fences	To be completed bi-monthly.	Completion of Stock Inspection Reports	Compliant. Bi-monthly inspections completed. Once instance of rogue stock access was identified. The stock were removed and fence repairs made as required with no follow up access issues.
	Remove reported rogue stock and repair damaged fences.	Action and remove reported rogue stock and repair damaged fences.	No rogue stock in biodiversity offset areas and fences in functional condition.	
Access Track Maintenance	New access tracks (only where necessary) are subject to due diligence assessments.	Due diligence assessments completed for new access tracks.	New access tracks are only constructed where necessary, and are subject to due diligence inspections	Compliant. Due diligence inspections completed for any Ground Disturbance Permit within the offset areas.

Management Strategy	Action	Year 2 Performance Criteria	Completion Criteria	Performance Comment
	Minimum twice yearly (nominally in March and September) inspections to identify track conditions.	Inspections undertaken nominally in March and September. Action and repair track damage.	Tracks maintained in good usable condition.	Compliant. Bi-monthly inspections identified that tracks utilised for offset area access were all in good condition.
	Rehabilitation of unnecessary access tracks.	Tracks no longer required are rehabilitated.	Unnecessary access tracks are rehabilitated.	None identified.
Pest Management	Complete feral animal inspections of Bowmans Creek Riparian Corridor biodiversity offset areas every two months to document sighting and abundance records. This will then inform ongoing control actions (as needed), including timing, frequency, target species and methods to be used.	Inspections completed every two months, followed by implementation of required control methods, as required.	Biodiversity offset areas are inspected for feral animal diversity and abundance every two months. Control measures are implemented in response to outcomes of the inspections. Measures are being taken to control feral animals in the biodiversity offset areas.	Compliant. Pest Management Inspections occurred as a part of the bi-monthly offset area inspection regime during the reporting period. Monitoring was carried out via site inspections as well as use of camera traps Feral fauna were identified in low numbers across all offsets and do not appear to be increasing in abundance.
	Complete feral animal inspections of Mountain Block and Mitchell Hills South biodiversity offset areas every four months to document sighting and abundance records. This will then inform ongoing control actions (as needed), including timing, frequency, target species and methods to be used.	Inspections completed every four months, followed by implementation of required control methods, as required.	Biodiversity offset areas are inspected for feral animal diversity and abundance every four months. Control measures are implemented in response to outcomes of the inspections. Measures are being taken to control feral animals in the biodiversity offset areas.	

Management Strategy	Action	Year 2 Performance Criteria	Completion Criteria	Performance Comment
	Develop and implement an annual pest animal action plan.	Develop and implement pest animal action plan. Stable or downward trend in population size recorded.	Strategies from action plans are implemented and targets are achieved. Stable or downward trend in population size recorded.	Compliant. During the reporting period Liddell developed and implemented an annual Feral Animal Management and Control Plan and maintained a vertebrate pest register. Liddell undertook control programs for the following vertebrate pests during the reporting period: • Feral pig trapping • Wild dog and fox baiting • Rabbit and Hare culling
	Particular action is paid to managing foxes, feral cats and feral dogs in order to protect the spotted-tailed quoll population in this area.	Implementation of favoured fox, feral cat and feral dog control measures. Monitoring of impacts of fox, feral cat and feral dog control on spotted-tailed quoll population.	Monitoring demonstrates that fox, feral cat and feral dog control methods are being effective in managing target species and not impacting negatively on the spotted-tailed quoll population.	LCO continued the trial use of 1080 ejector baiting in conjunction with traditional 1080 baiting methods with good success. During Liddell's baiting rounds, there was no evidence of spotted-tailed quoll activity near bait stations. Feral animal monitoring has not identified an increase in feral populations.
	Develop a vertebrate pest control register to document when and where each control method is implemented.	Update and maintain vertebrate pest control register.	Pest animal control register is maintained and up to date.	Compliant. Pest control register maintained.
Weed control	Complete weed inspections every two months to document diversity and abundance of noxious weed records.	Inspections completed every two months, followed by implementation of required control methods, as required.	Weed densities in rehabilitation/regeneration areas are no worse than those in remnant vegetation (analogue) sites.	Compliant. Weed Management Inspections occurred as a part of the bi-monthly offset area inspection regime during the reporting period. Weed control works were completed in line with the annual weed action plan targeting priority species and areas of active regeneration.
			There are no significant weed infestations that are identified as a risk to rehabilitation or regeneration areas.	
			Regular inspections are undertaken for weed species inspections and outcomes are documented.	

Management Strategy	Action	Year 2 Performance Criteria	Completion Criteria	Performance Comment
	Complete weed inspections every four months to document diversity and abundance of noxious weed records.	Inspections completed every two months, followed by implementation of required control methods, as required.	Weed densities in rehabilitation/regeneration areas are no worse than those in remnant vegetation (analogue) sites.	
			There are no significant weed infestations that are identified as a risk to rehabilitation or regeneration areas.	
			Regular inspections are undertaken for weed species inspections and outcomes are documented.	
Natural Regeneration of Mountain Block and Mitchell Hills South	Control of weeds and feral animals in regeneration areas.	Weed and feral animal control works are completed, as required.	Natural regeneration is not impeded by weeds or feral animals.	Compliant. Targeted weed control works and targeted feral fauna control programs were undertaken during the reporting period in response to species identified during the 2016 and 2017 monitoring events.
	Confirmation of mapping of areas for regeneration, including appropriateness of target community	Mapping of areas for regeneration including appropriateness of target community. Revised in ongoing monitoring works, as needed.	Revised in ongoing monitoring works, as needed.	Compliant. No change identified from 2016 monitoring event. Target revegetation communities are appropriate. Natural recruitment is occurring in all offsets.
	Management of regeneration progress is responsive to monitoring outcomes.	Management of regeneration progress is responsive to monitoring outcomes.	Accurate mapping of regeneration areas.	Compliant. Regeneration was monitored as part of the annual monitoring program as indicated in **Section 4.1.2** and as part of general site floristic monitoring. Regeneration is occurring in the offsets to varying degrees. Active revegetation is the main source of regeneration in the Bowmans Creek Riparian Corridor.
Assisted Regeneration of Mountain Block and Mitchell Hills South	Review need for assisted regeneration where outcomes of natural regeneration is deemed lacking.	Natural regeneration.	Assisted regeneration is implemented after three years if natural regeneration is deemed lacking.	Compliant. Natural regeneration was identified in Mountain Block and in Mitchell Hills South. High temperatures and low rainfall is likely to have impacted natural regeneration capacity of the existing vegetation.

Management Strategy	Action	Year 2 Performance Criteria	Completion Criteria	Performance Comment
Rehabilitation Works in Offset Areas	Detailed mapping and planning of rehabilitation works required, including earthworks, reshaping, slope stabilisation works, scalping of heavily weeded areas, fencing, erosion control and revegetation.	Detailed planning of all works required.	Rehabilitation works are planned in detail in first year and is being implemented.	Annual monitoring informs the decision on active regeneration works required. An offset area remediation strategy is in place and being implemented to progress the establishment.
	Develop detailed performance criteria for all management zone types.		Criteria developed.	As per the BOMP, detailed completion criteria are developed at the completion of the initial three year BOMP period and hence outside of this reporting period.
	Implement rehabilitation/ revegetation program.	Implementation of plan.	Rehabilitation and revegetation plan implemented.	Compliant. Works summarised in the offset remediation strategy. Log stockpiles to increase habitat value installed in central areas of Bowmans Creek Riparian Corridor. Revegetation works have commenced in northern areas of Bowmans Creek Riparian Corridor as well as in central areas. Supplementary planting in Mountain Block Offset has occurred. Nest boxes have been installed in both of these BOAs. Works to continue in future reporting periods
	Positive feedback loop from monitoring results.	Feedback from monitoring is incorporated into ongoing review and improvement of plan.	Monitoring outcomes considered in continual review and improvement of plan.	Compliant. Feedback from monitoring is being utilised to update the offset remediation strategy and improve the plan.
Habitat Augmentation	Salvage of habitat features (particularly for the spotted-tailed quoll) such as hollow-bearing trees, logs, stumps, large rocks and boulders.	Suitable habitat features identified during the pre-clearing process are salvaged.	Appropriate habitat features have been salvaged.	Compliant. Identified suitable hollows and logs were salvaged during the reporting period and stockpiled near riparian corridor for use in regeneration works (Refer to Offset Management Plan) or placed directly into rehabilitation areas.
		Salvaged features are either re-instated into areas with low levels of habitat features or stockpiled appropriately for later use.	Salvaged habitat features are re-instated into areas of remnant vegetation lacking in habitat features or into rehabilitated vegetation.	

Management Strategy	Action	Year 2 Performance Criteria	Completion Criteria	Performance Comment
		Timber or boulder piles will be constructed in riparian areas and areas of regeneration, revegetation and/or rehabilitation (as appropriate) to provide potential quoll denning habitat.	Appropriate spotted-tailed quoll habitat has been salvaged and placed into onsite rehabilitation areas.	
			Habitat features that have been salvaged and are yet to be re-instated are in appropriate storage.	
			Appropriate documentation is available of any habitat features salvaged.	
	Nest boxes are providing habitat value for native fauna.	Continue staged installation of nest boxes.	All nest boxes and monitored and maintained.	Compliant. Hollows displaced during clearing activities in the BMP areas are relocated or replaced with nest boxes in rehabilitation and offset areas. LCO completed the installation of additional 310 nest boxes to further augment the existing habit.
	Salvaged–reinstated hollows	Established nest boxes are subject to annual inspection and maintenance.	All salvaged re-instated hollows are monitored and maintained.	Compliant. Salvaged and reinstated log piles have been stockpiled and constructed in offset areas. Where appropriate, salvaged habitat is relocated directly into rehabilitation areas. Annual ecological monitoring occurring which includes a monitoring program to inspect and maintain nest boxes..
	Timing of nest box installation	Salvaged and re-instated hollows are subject to annual monitoring in conjunction with nest boxes.	Seasonal breeding opportunities are not lost due to delay in nest box installation.	Complaint. Nest boxes have been installed in all offset areas and a monitoring program developed to monitor over a number of years.
	Salvaging, stockpiling and deployment of habitat features	Removed hollows will be replaced (with nest boxes) within six months of each discrete clearing event.	Suitable habitat features are salvaged, stockpiled and reused to augment habitat complexity (thus value) in rehabilitation/regeneration areas.	Compliant. Salvaged and reinstated log piles have been stockpiled and constructed in offset areas. Where appropriate, salvaged habitat is relocated directly into rehabilitation areas. Further, nest boxes are installed in the time frames required. LCO are currently in the process of undertaking control of established willow (Salix sp) trees in the Bowmans Creek Riparian Corridor. Where appropriate, hollows

Management Strategy	Action	Year 2 Performance Criteria	Completion Criteria	Performance Comment
				will be salvaged and utilised within this offset. As will dead woody debris.
	Habitat augmentation will occur in Mountain Block and Mitchell Hills South offset areas if monitoring identifies a dearth of key habitat features such as hollows, log piles or boulder piles.	Suitable habitat features are identified and salvaged as part of the pre-clearing process. These can then be stockpiled until deployment in target areas once rehabilitation/regeneration works are complete.	All biodiversity offset areas have suitable levels of key habitat features, when compared (through monitoring) to remnant vegetation features.	Compliant. Nest boxes have been installed in all three BOAs. Log pile installation is continuing along Bowmans Creek Riparian Corridor and further works occurring.
Translocation works	Translocation of tiger orchids or other threatened flora species (if encountered during pre-clearing process) to biodiversity offset areas. Methods to be adopted are detailed within the Biodiversity Management Plan.	Tiger orchids are salvaged and translocated according to the process in the BMP as needed. Tiger orchids identified during pre-clearing area salvaged, translocated and ongoing monitoring occurs.	Tiger orchids (or other threatened flora species if encountered) are salvaged and translocated into biodiversity offset areas in accordance with the Biodiversity Management Plan.	One Tiger Orchid was identified during due diligence inspections in March 2018 and translocated into a biodiversity offset area in accordance with the Biodiversity Offset Management Plan.
Creek and drainage line protection on Bowmans Creek Riparian Corridor	Fencing/protection of LCO controlled side of riparian corridor.	Riparian corridor will be fenced from human and livestock access.	Riparian areas are adequately fenced/protected against damage from uncontrolled human or livestock access.	Compliant. Fencing is in place to secure the offset area.
	Rehabilitation works to address stabilisation and erosion issues, as necessary.	Implementation, as needed.	Creek bank is stable and erosion issues are addressed.	Areas targeted for stabilisation and erosion control works have been identified and addressed as part of the detailed remediation strategy. Works are planned to be trialled in 2018.
Seed collection	Where suitable remnant vegetation is available, implementation of seed collection and handling program for use in revegetation/rehabilitation works.	Pre-clearing surveys identify potential seed sources. Seeds are collected, stored and handled according to appropriate program. Collected seed resources are used in revegetation/rehabilitation works.	Rehabilitation/revegetation works use seeds collected onsite, thus maintaining as much genetic similarity (local provenance) as possible.	Preclearance surveys completed as required. No significant seed resources identified in clearing areas completed during reporting period. Seed has been harvested from offset areas during 2018.
Erosion and Sediment Control	Undertake erosion and sediment inspection and map areas requiring remediation.	Complete inspection and mapping (year 1).	Appropriate erosion and sediment control measures required have been identified and implemented.	Erosion and sediment control structures and measures are inspected and monitored regularly in accordance with the LCO WMP.

Management Strategy	Action	Year 2 Performance Criteria	Completion Criteria	Performance Comment
	Develop remediation plan and implement.	Remediation plan developed and commenced where practical.	There are no areas of significant erosion or sedimentation.	Remedial works required for erosion in Mountain Block Offset. Planning has commenced and consultation completed with Liddell Registered Aboriginal Parties due to archaeological objects required to be managed during remediation.
	Monitor completed erosion works and action repairs if required.		Erosion control works are stable and successful.	
Bushfire Management	The current Bushfire Management Plan will be updated according to the approved modification. Bushfire Management Plan will be implemented.	Implementation of requirements of updated Bushfire Management Plan.	Bushfire risk is managed according to an updated Bushfire Management Plan which allows for appropriate protection of life and property, as well as identified significant ecological features.	Compliant. Bushfire Management Plan covering the offset areas is in place and being implemented. No bushfire activity was evident in any of the offset areas during the reporting period.
Ecological Monitoring	Undertake floristic, fauna, LFA and nest box monitoring program	Ecological Monitoring program completed and reported.	Monitoring programs completed and results reported.	Compliant. Ecological monitoring program completed. Results summarised in **Section 4.1.2.**
	Undertake annual inspections of LCO rehabilitation and active regeneration areas	Annual inspections completed	Annual inspections completed	Compliant. Annual Rehabilitation Inspection completed in February 2018.
	Native fauna presence in rehabilitation/regeneration areas	Fauna monitoring completed	Fauna monitoring confirms that native fauna species are recorded within rehabilitation/regeneration areas.	Compliant. Native fauna recorded within rehabilitation and regeneration areas during annual ecological monitoring program.

4.1.2 Biodiversity Offset Monitoring Program

An annual monitoring program to inform the adaptive management process for the ongoing implantation and improvement off LCO offset areas is detailed in the BOMP. This section summarises the results of the monitoring program undertaken during the reporting period.

In general, the remnant vegetation of Mitchell Hills South is considered to have the highest habitat values of the biodiversity offset sites (with high hollow densities, rock on rock habitats, moderate log presence, abundant shrubs, low introduced species, although poor water resource availability), and Bowmans Creek Riparian Corridor is considered to require the greatest amount of intervention (particularly for introduced groundcover species). Although remnant vegetation at all biodiversity offset sites was generally in good condition and general coverage of weed species was low, all had noxious or invasive species present that were considered to require management to prevent interference with ecological value and subsequent potential for recovery.

Although not specifically identified within monitoring plots, LCO has been undertaking extensive management actions within the Mountain Block and Bowmans Creek Riparian Corridor since the 2015 baseline monitoring. Works have been targeted at areas deemed to be in greatest need of management action (not necessarily within monitoring plots) and therefore will not be reflected within quantitative data. Management actions undertaken during the reporting period have included but not limited to:

- Installation of 310 nest boxes across BOAs and rehabilitation areas
- Herbicide application and ring-barking throughout Mountain Block and northern Bowmans Creek Riparian Corridor targeting coolatai grass (Hyparrhenia hirta), willows (Salix spp.), mother-of-millions (Bryophyllum delagoense), golden wreath wattle (Acacia saligna), African olive (Olea europaea subsp. cuspidata) and green cestrum (Cestrum parqui)
- Herbicide application focusing on coolatai grass (Hyparrhenia hirta), blackberry (Rubus fruticosus sp. aggregate) and tree-of-heaven (Ailanthus altissima) and others encountered.
- Supplementary planting and seeding Bowmans Creek Riparian Corridor
- Targeted control of African lovegrass (Eragrostis curvula) in the northern areas of Bowmans Creek Riparian Corridor
- Targeted placement of log piles within central areas of the Bowmans Creek Riparian Corridor
- Feral fauna control (all of which (with the exception of those for the feral cat (Felis catus) have been undertaken with some success):
- Baited trapping for pig (Sus scrofa) in Bowmans Creek Riparian Corridor around both Dam 1 and ALV2
- Baiting and camera trapping in the northern extents of Mitchell Hills South for the pig (Sus scrofa)
- A site wide 1080 baiting program for wild dogs (Canis lupus familiaris) and foxes (Vulpes vulpes) at 47 bait stations
- An aerial 1080 baiting program in Mitchell Hills South and the northern extents of Mountain Block
- Feral cat (Felis catus) trapping around the MIA and Rehabilitation Area-Entrance Pit
- Planting of approximately 22,000 tubestock consistent with Rover Oak Forest and Central Hunter Box-Ironbark Woodland (over approximately 16.5 hectares)
- Ongoing removal of redundant fencelines

A substantial decline in occurrence of African lovegrass (*Eragrostis curvula*) was observed across all BOAs during the reporting period as a result of ongoing targeted weed spraying works. This should allow recovery of small native herbs and grasses that had potential to be out competed by invasive species.

Remnant sites typically showed a greater native species diversity than their regenerating/rehabilitating counterparts. These results were slightly skewed in 2017 by the ready availability of water in a given monitoring area (i.e. fauna diversities were greater along Bowmans Creek despite having lower overall habitat value than most other monitoring locations).

Monitoring also identified that regenerating sites typically had a high introduced species diversity and high introduced species coverage when compared to reference sites. The one exception being riparian

site R02, however this site has a long history of grazing and given its proximity to Bowmans Creek is likely to receive more waterborne introduced seed propagules than the other sites.

In 2017, remote cameras were particularly effective in identifying reduced utilisation of sites by pigs (*Sus scrofa*) and foxes (*Vulpes vulpes*). This may be attributable to management actions of these species or could correlate with a poor breeding season as a result of reduced resources. This may result in an increased detection of spotted-tailed quolls *(Dasyurus maculata maculatus)* during the 2018 monitoring event.

Key findings of the 2017 biodiversity offset monitoring program were as follows:

- Remnant vegetation is generally in good condition; however some potentially problematic weed species are encroaching in these areas (particularly site R02 which has particularly high occurrence of exotic grass panic veldtgrass (*Ehrharta erecta*)).
- Levels of pig (*Sus scrofa*) appear to have reduced since the baseline monitoring event, likely as a result of management actions as part of the BOMP. These actions are likely to be assisting in the local recovery of the spotted-tailed quoll (*Dasyurus maculatus maculatus*) in these areas, which will hopefully increase in abundance during subsequent monitoring events.
- Although unlikely to yet be colonised, substantial nest box installation (200) activities have been undertaken in all three offsets. Ongoing monitoring should see an increasing trend in presence of hollow dependent species.
- Feral fauna species were observed across all offset areas; however no areas were considered to be “infested” by feral fauna. Current management practices seem to be keeping these levels relatively low.
- Vegetation of Bowmans Creek Riparian Corridor is highly disturbed and requires substantial intervention (remnant and regeneration areas). Active revegetation works have commenced (25,550 hiko tubestock planted and 7ha direct seeded) and should start to show progress in subsequent monitoring events.
- Regeneration of canopy species at Mountain Block sites WR03 and WR05 are progressing well and should not require substantial intervention for recovery. However revegetation sites in Bowmans Creek Riparian Corridor and WR10 in Mitchell Hills South were devoid of recruiting canopy species.
- Observed levels of threatened species during the 2017 monitoring event were low across all sites (remnant and regenerating), with the exception of micro-bats which did not discriminate between low and high quality vegetated areas, instead preferring areas in proximity to water resources.

It is anticipated that floristic and fauna value provided by the BOAs will increase with time as more management actions required by the BOMP are initiated and as planted tube stock begins to grow and provide improved habitat value in the form of canopy coverage and foraging resources.

Recommendations for the enhancement of existing ecological values and improved rehabilitation/ regeneration were received as part of the 2017 monitoring program; refer to the full offset monitoring report Umwelt 2018. A key action was the expansion of habitat augmentation works in the form of log piles from the Bowmans Creek Riparian Corridor into all other offset areas to further assist colonisation of these areas by a diverse range of fauna species and create movement corridors between areas of remnant vegetation.

Liddell has actioned on the recommendations of the monitoring report and will continue remediation implementation.

4.2 Indirect Offsets

The State and Commonwealth approvals both require the provision of an indirect offset to augment the agreed land-based biodiversity offsets to address the impacts of the project. This indirect offset was agreed to be a financial contribution towards recovery actions for the spotted-tailed quoll (*Dasyurus maculatus maculatus*) as part of the Final Draft National Recovery Plan for the Spotted-tailed Quoll *Dasyurus maculatus* (Long and Nelson 2008); and/or Management actions identified for the spotted-tailed quoll as part of the Office of Environment and Heritage (OEH) Saving Our Species Project Species Action Statement.

An Indirect Offset Plan (IOP) was developed to satisfy this condition and was approved by the DoE on 2nd March 2016. The objective of this IOP is to specify how the $243,000 indirect offset (by way of financial contribution over not more than five years) will be used to support recovery actions for the quoll. A revised IOP was submitted on the 23th March 2017 and subsequently approved by the Australian Government Department of Environment & Energy (DoEE) on the 5 May 2018. The revised IOP details amended projects Task 2 Surveying/Monitoring STQ Populations and Task 3 Assess Habitat Use by Female STQ.

4.2.1 Management Actions during the reporting period

Task 1 Development of Individual Recognition Software for Quolls

To recap Task 1 involves the development and sharing of computer software that enables the identification of individual quolls from remote camera data. In the 2017 Annual Report we advised that the software development was successful, with the initial build of the Quoll Identification Toolkit (QIT) completed utilising $80,000 funds providing by LCO under research agreement with Invasive Animals Limited (IAL).

As documented in the 2017 the software developer Delves Falzon Pty Limited recommended a number of actions to complete before publicly releasing the QIT. IAL have advised the following summary in **Table 5**.

Table 5 - QIT Development Progress

Action	Status
1. Continue to refine Matlab based version (address issues raised in initial testing).	Complete
2. Conduct user testing with NSW OEH Saving our Species and UNE/NSW Dept. Primary Industries project groups.	Progressing in 2018/19 FY with additional funding from OEH.
3. Undertake refinements to QIT once testing is complete	Awaiting outcome of user-testing
4. Prepare scientific paper for publication	In progress
5. Develop user manual	In progress
6. Release of QIT for use	In progress

As indicated in item 2, IAL subsequently identified that further funding was required to complete the user testing phase and allow further refinements to the QIT. Further funding has been provided by NSW OEH and the user testing program is now progressing utilising images and quoll identification collected by NSW OEH and NSW DPI project groups.

Task 2 Surveying/Monitoring STQ Populations

A research agreement was developed and executed on the 4 April 2018 with the University Of New England (UNE) to undertake the Project. In short, this project focuses on the development of survey and monitoring techniques of Spotted-tailed quoll populations by implementing a draft camera trapping protocol (based on previous research) for testing and refinement. It is proposed to establish camera trapping grids (lured camera trap stations) replicated at three sites over four years within Royal National Park, Wollemi National Park and in the Middle Foy Brook offset areas. These areas are known to contain a population of quolls, and these have been recorded in the area by way of a variety of survey methods including live trapping, camera trapping, spotlighting, scat collection and hair funnels. Further detail can be viewed within Section 6.4 of the IOP.

The details the invoices issued and payments completed by LCO to fund the project to date are shown in **Table 6**. The funding is being utilised to purchase necessary cameras and consumables to establish the project.

Table 6 - Payments Completed 2017-18 FY

Payment	Invoice No.	Milestone	Amount	Date Paid
1	F1011567	Execution of Agreement and establish project	$61,000	4/05/2018

In accordance with the requirements of the IOP, an annual progress report was submitted on the 27 July 2018 and should be read in conjunction with this report.

5 Water Resources

5.1 Surface Water

Surface water monitoring is undertaken along the two creek lines adjacent the operation (Bayswater and Bowmans) as well as at onsite water storages. During the reporting period, LCO undertook the approved Water Management Plan (WMP) surface water monitoring program. This monitoring program utilises specific surface water quality monitoring trigger limits which provide for the identification of potential adverse impacts; results from the reporting period are summarised in this **Section 5.1.**

The WMP sets impact assessment criteria for both Bayswater and Bowmans Creek. The criterion has been determined based on a statistical analysis of data collected over a 5 year period. In accordance with ANZECC (2000) guidelines a 90th percentile concentration is appropriate for maintaining water quality. Due to the disturbed nature of both catchments and ephemeral nature of each creek, this is deemed to be an appropriate statistical criterion to adopt whilst mining operations are ongoing. Additionally, since the creeks are known to cease surface flow naturally at different points due to climatic variances, different trigger levels are adopted to reflect the flow state at each location. This reflects the natural ponding and varying quality of both creeks. The creek trigger levels are presented in **Table 7**.

Table 7 - WMP trigger values for surface water quality

	pH lower limit[4]	pH upper limit		EC 90th %tile[1]	EC Max[2]	TDS 90th %tile[1]	TDS Max[2]	TSS 90th %tile[1]	TSS Max[2]
		90th %tile[1]	Max[2]						
Bayswater	6.5	8.3	8.5	5130	7300	3230	5180	50[3]	302
Bowmans Creek	6.5	8.3	8.8	2020	4570	1210	3460	50[3]	97

[1] whole creek 90th percentile
[2] maximum recorded value for whole creek
[3] ANZECC criteria for TSS
[4] ANZECC criteria for pH lower limit

Trigger Level when creek is flowing
Trigger Level when no flow in creek

Figure 2 below shows the locations of each of the surface water monitoring sites.

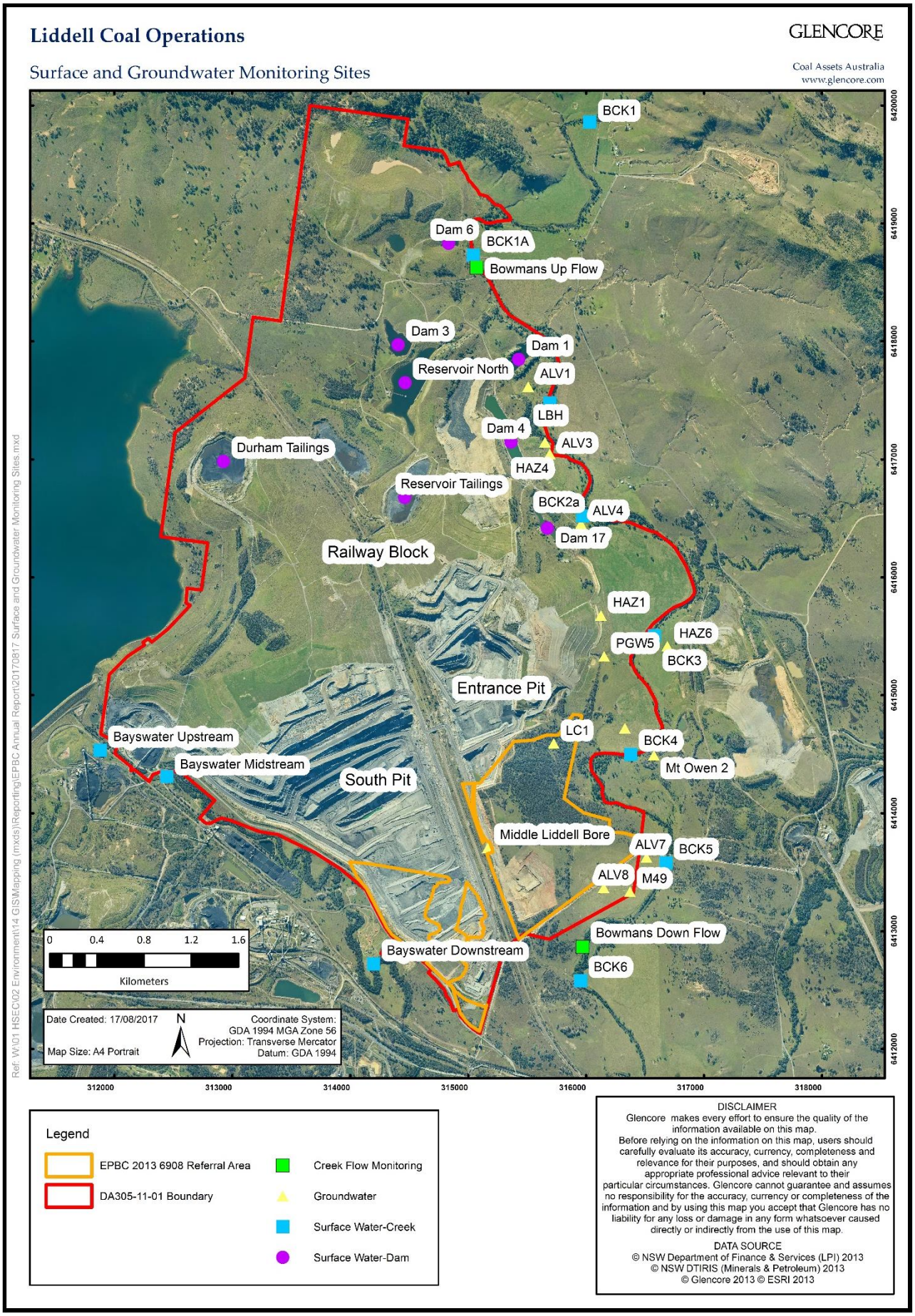

Figure 2 – Location of surface and groundwater monitoring sites

5.1.1 Bayswater Creek

Monitoring of the three sites within the creek (upstream, midstream and downstream) was completed monthly during the reporting period in accordance with the WMP.

It should be noted that Bayswater Creek is a highly modified watercourse and regularly experiences periods of low or no flow. The measured pH, Electrical Conductivity (EC) Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) levels were typical of historical results. There was no exceedance of flow or no flow applicable water management plan trigger levels,

Table 8 below summarises the monitoring program results and identifies that no trigger limits were exceeded in Bayswater Creek during the reporting period.

Table 8 - Bayswater Creek Trigger Limit Summary

Bayswater Creek Water Quality Results														
Month	Bayswater Creek Upstream					Bayswater Creek Midstream					Bayswater Creek Downstream			
	pH	EC (µS/cm	TSS (mg/L)	TDS (mg/L)	Flow	pH	EC (µS/cm	TSS (mg/L)	TDS (mg/L)	Flow	pH	EC (µS/cm	TSS (mg/L)	TDS (mg/L)
Jun-17	7.90	3970	10	2240	Slow	8.27	5060	19	3270	Still	Dry			
Jul-17	8.02	3970	8	2480	Trickle	8.35	5260	5	3280	Still	Dry			
Aug-17	7.78	3530	8	2380	Trickle	8.25	4750	<5	3220	Still	Dry			
Sep-17	7.86	3460	6	2230	Trickle	8.11	4340	<5	2840	Still	Dry			
Oct-17	7.86	3410	7	2350	Trickle	8.17	4560	<5	2990	Still	Dry			
Nov-17	8.01	3340	9	2290	Trickle	8.30	4460	<5	3020	Still	Dry			
Dec-17	7.94	3740	11	2130	Trickle	8.17	5270	6	3340	Still	Dry			
Jan-18	7.93	3740	6	2150	Trickle	8.09	5150	<5	3000	Still	Dry			
Feb-18	7.89	3680	8	2250	Slow	8.07	5430	<5	3520	Still	Dry			
Mar-18	7.93	3480	7	2360	Slow	8.07	4660	<5	3170	Trickle	Dry			
Apr-18	7.95	4190	6	2570	Steady	8.15	5290	<5	3350	Still	Dry			
May-18	7.95	3550	<5	2220	Steady	8.15	4840	<5	2820	Still	Dry			

5.1.2 Bowmans Creek

Monitoring of the eight sites within the creek (upstream BCK1, BCK1A, BCK2, BCK2A, BCK3, BCK4 BCK5 and downstream BCK6) was completed monthly during the reporting period in accordance with the WMP.

It should be noted that historical disturbance (grazing, mining, etc) has modified the catchment of Bowmans Creek significantly; it is ephemeral in nature and often pool or have very low flow leading to potential stagnant conditions which influences water quality. With these considerations (as detailed in the WMP), trigger limits are dependent on the flow conditions at time of monitoring. **Table 9** summarises the monitoring results and identifies any trigger limit exceedances in Bowmans Creek during the reporting period.

Table 9 - Bowmans Creek Trigger Limit Summary

Bowmans Creek Water Quality Results																				
Month	BCK1 (Upstream)					BCK 1A					BCK2					BCK2A				
	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	Flow	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	Flow	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	Flow	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	Flow
Jun-17	8.11	819	<5	438	Slow	8.17	957	6	494	Steady	8.08	927	<5	507	Slow	8.13	964	<5	504	Steady
Jul-17	8.04	844	9	464	Slow	8.05	1140	7	626	Slow	8.03	1080	<5	588	Slow	8.17	1060	<5	572	Slow
Aug-17	7.67	857	<5	467	Slow	7.51	1280	<5	826	Trickle	7.44	1040	13	613	Slow	7.29	1040	<5	594	Trickle
Sep-17	7.74	860	<5	478	Slow	7.83	2270	8	1310	Slow	7.61	1070	<5	619	Slow	7.62	1080	<5	594	Still
Oct-17	7.73	860	<5	538	Slow	7.70	3060	<5	2100	Trickle	7.74	1040	<5	636	Pools	7.69	1090	<5	696	Pools
Nov-17	8.00	886	10	504	Still	7.95	3050	<5	2110	Still	8.07	1100	8	636	Pools	7.89	1120	40	621	Pools
Dec-17	7.93	914	10	522	Still	7.80	4160	11	2990	Still	7.54	1160	8	681	Still					Dry
Jan-18	7.84	906	15	502	Still	7.77	4140	10	2390	Still					Dry	7.62	1120	<5	618	Still
Feb-18	7.91	894	22	478	Still	7.64	3860	<5	2630	Still					Dry					Dry
Mar-18	7.96	1060	14	650	Still	7.89	6720	<5	5100	Trickle					Dry					Dry
Apr-18	7.84	1070	<5	570	Slow	8.12	1980	<5	1200	Steady	7.55	1310	<5	728	Still					Dry
May-18	7.91	1070	<5	656	Slow	7.99	2800	6	1710	Trickle					Dry					Dry

Orange Shading – Denotes an exceedance of the 90$^{\%}$ile or maximum trigger limit as applicable for the flow conditions

Bowmans Creek Water Quality Results																				
Month	BCK3					BCK4					BCK5					BCK6 (Downstream)				
	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	Flow	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	Flow	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	Flow	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	Flow
Jun-17	8.17	1000	6	538	Slow	8.20	1040	10	568	Slow	8.23	1040	5	638	Slow	8.18	1190	6	613	Slow
Jul-17	8.22	1060	9	592	Slow	8.22	1180	7	638	Slow	8.24	1400	<5	766	Slow	8.07	1350	7	763	Slow
Aug-17	8.17	1050	6	636	Slow	8.04	1290	<5	807	Slow	8.13	1730	<5	1030	Slow	7.54	1290	<5	798	Slow
Sep-17	8.07	1090	17	648	Slow	8.06	1420	6	844	Slow	8.14	1820	<5	1070	Slow	7.73	1320	<5	772	Slow
Oct-17	7.99	1080	17	677	Still	8.09	1580	6	981	Slow	8.18	1980	<5	1220	Still	7.63	1380	<5	872	Trickle
Nov-17	8.22	1190	26	696	Still	8.33	1860	18	1110	Still	8.42	1940	<5	1150	Still	7.95	1470	<5	842	Still
Dec-17	8.19	1230	42	728	Still	8.22	2090	33	1320	Still	8.28	1970	27	1090	Still	7.81	1590	11	1010	Still
Jan-18	8.16	1320	12	690	Still	8.25	2090	16	1100	Still	8.19	1920	14	996	Still	7.89	1660	9	885	Still
Feb-18	8.12	1430	22	818	Still	8.26	2110	26	1210	Still	7.96	1880	31	1060	Still	7.92	1800	36	1030	Still
Mar-18	8.07	1360	29	778	Still	8.34	2020	36	1250	Still	8.27	2020	16	1210	Still					Dry
Apr-18	8.07	1450	38	818	Trickle	7.61	2010	33	1230	Still	8.08	2050	12	1230	Still	7.36	2030	6	1270	Still
May-18	8.16	1350	7	837	Slow	8.24	2100	20	1290	Still	8.46	2220	<5	1320	Still	7.91	1960	<5	1190	Still

During the reporting period, there were a number of isolated water exceedances at varying sites, reflecting the ephemeral nature of the creek. These isolated exceedances occurred during periods of low flow and often just prior to periods of no flow.

As per the WMP monitoring program and Trigger Action Response Plan (TARP), exceedances of trigger levels are required to be sustained to initiate an investigation. No trigger investigations were initiated for during the reporting period as isolated exceedances were not recorded above applicable triggers for three consecutive months.

5.1.3 HRSTS Discharge Monitoring

Any discharges from the Liddell Colliery must be undertaken in accordance with the Hunter River Salinity Trading Scheme (HRSTS). There were no discharge events from LCO under the HRSTS during the reporting period.

5.2 Groundwater

LCO is located within an area of the Upper Hunter Valley subject to extensive underground and open cut mining activities since the early 20th century. Current and historical mining operations have extensively altered the physical features and environmental setting of the local area, including the region's surface water and groundwater systems. Mining operations to the west, south and east of LCO, Lake Liddell to the west, and the major geological feature Hunter Thrust to the north, all have major influence on groundwater levels in the region. Due to such operations and features regional groundwater levels largely reflect current and past mining activities, with water levels varying with time and location according to local mining activities.

The LCO Water Management Plan (WMP) documents the processes and responsibilities of all aspects of the site water management system.

The WMP groundwater monitoring program adopts site specific trigger levels for impact investigation and assessment. If monitoring results suggest significant and continuous deviation from historical or background trends in water quality, further investigations into potential impacts are conducted. These are either Investigation Trigger Action Response Plans (ITARP) or Management Triger Action Response Plans (MTARP) as per the WMP. It is highlighted that, due to changes in land-use in the vicinity of LCO through both mining and agriculture, as well as local variability in groundwater conditions, there is limited opportunity for establishment of groundwater reference sites, hence the appropriateness site specific trigger levels based on historical measurements. Currently, investigations into potential impacts are conducted if there are three consecutive exceedances of the nominated triggers.

During the reporting period and as per recommendations from ITARP reports, an application was made to the Department amend the WMP, primarily regarding groundwater monitoring triggers and the Investigation Trigger Action Response Plan (ITARP). A revised WMP was approved on 26 July 2017. **Table 10** presents the adopted site specific trigger levels for water level and groundwater quality applicable during June and July 2017 and the adopted site specific trigger levels relevant to the period August 2017 to May 2018 (post approval of the revised WMP).

In addition to the adoption of revised trigger levels, the PGW5 trigger was removed in the July 2017 revision of the WMP. Following recommendations of post an ITARP report on continued triggers at PGW5, it was determined that this site should not be retained as a trigger level site as this paired site contains one piezometer in the Pikes Gully Seam and one in the Overburden.

Furthermore, ALV9 was installed in December 2017 as per the WMP. This monitoring bore is intended to inform of any actual draw down impacts in Bowmans Creek at the predicted maximum impacted area, noting that drawdown is not predicted to commence until 2019.

The WMP groundwater monitoring program was implemented during the reporting period with the results indicating that no potential mining impacts occurred. Monitoring results observed during the reporting period are summarised in following **Section 5.2.1** with the breakdown of:

- Groundwater quality of alluvial and shallow bedrock aquifers including applicable ITARP summary of ALV8L Investigation – September 2017, ALV2S Investigation – December 2017 and ALV3S Investigation – April 2018
- Groundwater quality of Hard Rock Aquifer (Coal Measures) Review including applicable ITARP summary of PGW5S Investigation and PGW5L Further Investigation – July 2017

- Groundwater levels of Alluvial and Shallow Bedrock Aquifers including applicable ITARP summary of ALV8L Investigation – December 2017, ALV3 Investigation – March 2018, ALV1L and ALV4L Investigation – April 2018 and ALV7 and ALV8S Investigation – May 2018
- Groundwater levels of Hard Rock Aquifer (Coal Measures)

Table 10 - Groundwater Impact Assessment Criteria

Groundwater Quality Impact Assessment Criteria											
		Groundwater Elevation (Depth To Water (m)) – Definition #2				EC (µS/cm)					pH
		January – July 2017		August 2017 – May 2018		January – July 2017		August 2017 – May 2018			
		10th%ile	Ref. Max	10th%ile	Ref. Max	80%ile	Max	20%ile	80%ile	Max	
Alluvial and Shallow Bedrock Aquifers											
ALV1	Alluvial aquifer (L)	5.31	6.31	4.97	6.31	1520	2020	N/A	1370	2020	6.5 – 8.5
	Shallow bed rock (S)	5.03	6.84	4.75	6.84	1580	1770	N/A	1560	1770	
LBH	Alluvial aquifer (L)	5.29	6.24	5.05	6.24	1690	3090	N/A	1550	3090	
ALV3	Alluvial aquifer (L)	6.08	7.08	5.7	7.08	1490	3080	N/A	1390	3080	
	Shallow bed rock (S)	6.32	7.26	5.99	7.26	2630	4510	N/A	2800	4510	
ALV4	Alluvial aquifer (L)	5.88	12.84	5.56	6.73	2200	3080	N/A	1920	3080	
	Shallow bed rock (S)	6.47	7.42	6.28	7.42	5380	6430	N/A	5310	6430	
ALV2	Alluvial aquifer (L)	4.91	6.76	4.8	6.76	2940	4160	N/A	2830	4160	
	Shallow bed rock (S)	4.82	8.53	4.67	8.53	2830	3370	2560	2820	3370	
ALV7	Alluvial aquifer (L)	6.83	7.34	6.75	7.34	1900	2310	N/A	1780	2310	
	Shallow bed rock (S)	10.42	11.38	10.21	11.38	2260	2540	N/A	2230	2540	
ALV8	Alluvial aquifer (L)	7.04	8.36	6.96	8.36	1320	1880	N/A	1310	1880	
	Shallow bed rock (S)	9.84	11.08	9.03	11.08	2090	2400	1540	1990	2400	
Hard Rock Aquifers (Coal Measures)											
PGW5	Overburden (L)	12.52	19.63	N/A	N/A	5050	6060	N/A	N/A	N/A	6.5 – 8.5
	Coal Measure (S)	11.03	11.37	N/A	N/A	5770	6820	N/A	N/A	N/A	
Groundwater Level Trigger Definition #1 – 2m drawdown in Bowmans Creek Alluvium											
ALV9L		Groundwater elevation of monitoring piezometer ALV2L minus 5.0m (AHD).									
ALV8L		Groundwater elevation of monitoring piezometer ALV7L minus 4.5m (AHD).									

5.2.1 Groundwater Quality Monitoring

Groundwater quality of Alluvial and Shallow Bedrock Aquifers

During the reporting period of 19 May 2017 to 18 May 2018, there were no exceedances of the 6.5 to 8.5 pH trigger values for either the alluvial or shallow bedrock aquifers monitored at LCO.

Between June 2017 and March 2018, measured pH at these monitoring locations typically showed an increasing trend before declining trend through April and May 2018. Overall, the bulk of analyses on alluvial and shallow bedrock aquifers showed minimal deviation from long-term trends during the reporting period.

It is considered the changes in pH observed are due to climatic variations and the result of a prolonged period of below average rainfall. The monitoring program will continue to be implemented to observe any change in groundwater pH.

Groundwater quality monitoring results and trigger limits for the alluvial and shallow bedrock aquifers during the reporting period are shown in **Table 11** (pH) and **Table 12** (EC) below. A summary of the hard rock water quality monitoring and results are shown in **Table 13** (pH & EC).

Table 11 - Groundwater pH results for Alluvial and Shallow Bedrock Aquifers

Alluvial and Shallow Bedrock Groundwater Quality - pH													
Site	**ALV1L**	**ALV1S**	**ALV2L**	**ALV2S**	**ALV3L**	**ALV3S**	**ALV4L**	**ALV4S**	**ALV7L**	**ALV7S**	**ALV8L**	**ALV8S**	**LBH**
Trigger	6.50 – 8.50												
Jun-17	7.06	7.72	7.35	7.78	7.29	7.52	7.30	7.42	7.23	7.42	7.39	7.31	7.32
Jul-17	7.18	7.91	7.32	7.92	7.12	7.61	6.97	7.56	7.26	7.37	7.07	7.39	7.44
Aug-17	6.91	7.70	7.20	7.72	7.02	7.41	6.68	7.28	7.04	7.15	6.98	7.26	6.96
Sep-17	6.94	7.68	7.28	7.63	7.21	7.38	6.75	7.37	7.21	7.36	6.98	7.20	6.97
Oct-17	7.15	7.92	7.54	7.91	7.37	7.73	6.97	7.61	7.27	7.45	7.12	7.43	7.17
Nov-17	7.09	7.97	7.54	7.89	7.29	7.73	6.93	7.81	7.29	7.45	7.12	7.41	7.04
Dec-17	7.19	8.23	7.84	8.15	7.25	7.78	6.94	7.79	7.65	7.67	7.12	7.39	7.17
Jan-18	7.64	8.31	7.76	7.98	7.60	7.96	7.44	8.03	7.40	7.46	7.14	7.32	7.44
Feb-18	6.90	7.51	7.36	7.64	7.19	7.66	6.93		7.20	7.37		7.39	6.97
Mar-18	7.08	7.56	7.38	7.62	7.24	7.50	7.01	7.39	7.16	7.24		7.23	6.94
Apr-18	7.25	7.77	7.47	7.57	7.44	7.61	7.28	7.25	7.27	7.52		7.41	6.81
May-18	7.24	8.03	7.80	7.93	7.70	8.44	7.25	7.27	7.20	7.63	7.39	7.77	7.83

Table 12 - Groundwater results for EC in Alluvial and Shallow Rock Aquifers

Alluvial and Shallow Bedrock Groundwater Quality - EC													
Site	ALV1L	ALV1S	LBH	ALV3L	ALV3S	ALV4L	ALV4S	ALV2L	ALV2S	ALV7L	ALV7S	ALV8L	ALV8S
Applicable Impact Assessment Criteria to July 2017													
Trigger	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm
80th %ile	1.52	1.58	1.69	1.49	2.63	2.20	5.38	2.94	2.83	1.90	2.26	1.32	2.09
20th %ile	2.02	1.77	3.09	3.08	4.51	3.08	6.43	4.16	3.37	2.31	2.54	1.88	2.40
Jun-17	1.19	1.33	1.20	1.09	2.23	1.55	5.24	2.78	2.84	1.75	2.31	1.33	2.29
Jul-17	1.16	1.28	1.13	1.03	2.14	1.55	5.05	2.99	2.72	1.72	2.07	1.39	1.68
Applicable Impact Assessment Criteria from August 2017													
80th %ile	1.37	1.56	1.55	1.39	2.80	1.92	5.31	2.83	2.82	1.78	2.23	1.31	1.99
20th %ile	2.02	1.77	3.09	3.08	4.51	3.08	6.43	4.16	3.37	2.31	2.54	1.88	2.40
Aug-17	1.18	1.32	1.14	1.06	2.20	1.54	5.20	2.40	2.76	1.74	2.09	1.46	1.71
Sep-17	1.16	1.31	1.14	1.07	2.18	1.50	4.99	2.21	2.73	1.73	2.14	1.50	1.68
Oct-17	1.28	1.43	1.26	1.21	2.37	1.61	5.21	2.23	2.86	1.78	2.24	1.34	1.76
Nov-17	1.20	1.32	1.19	1.16	2.34	1.55	5.25	1.97	2.84	1.76	2.26	1.22	1.68
Dec-17	1.18	1.32	1.21	1.15	2.46	1.52	5.32	2.01	2.85	1.76	2.20	1.27	1.67
Jan-18	1.16	1.29	1.23	1.14	4.23	1.48	5.28	1.94	2.84	1.75	2.20	1.24	1.64
Feb-18	1.17	1.30	1.24	1.15	2.90	1.50		1.90	2.83	1.74	2.21	Dry	1.64
Mar-18	1.19	1.30	1.25	1.16	2.89	1.47	5.30	1.88	2.78	1.73	2.21	Dry	1.65
Apr-18	1.16	1.42	1.21	1.30	2.23	1.68	5.51	1.82	2.66	1.72	2.09	Dry	1.62
May-18	1.15	1.27	1.36	1.24	1.79	1.57	5.23	1.87	2.72	1.68	2.22	1.46	1.65

Orange Shading – Denotes an exceedance of the 80th%ile trigger limit

Yellow Shading – Denotes an exceedance of the 20th%tile trigger limit

Groundwater monitoring has occurred at LCO as per the approved WMP. **Table 12** summarises the EC measurements of the groundwater with comparison to the trigger levels applicable during the reporting period. During the reporting period, a number of consecutive exceedances of the 80th percentile EC trigger limits have occurred. A number of ITARP investigations occurred and have been deemed to have had no potential or actual environmental harm and not the result of a mining related impact; each ITARP report is summarised herein. LCO undertook all required notifications and investigations during the reporting period as detailed/required by the WMP. Noteworthy, the LCO groundwater impact assessment (SKM, 2014) states there are no known fresh or saline groundwater supported wetlands or recognised aquifer ecosystems present in the area (Umwelt, 2001; Ecological, 2013).

LCO received below average rainfall for the majority of 2017 and 2018 with a total of 380 mm recorded at the LCO meteorological monitoring station for the reporting period. The review of climate data during ITARP investigations also identified high evaporation rates during the equivalent period. It is considered that the observed changes in EC across the affected monitoring locations are a result of these prolonged dry conditions. A summary of these investigations is provided below.

ALV8L Investigation – September 2017

ALV8L showed an exceedance of the 80th percentile EC trigger level value in August 2017, defined as three (3) consecutive exceedances of the adopted 80th percentile trigger value. An investigation was undertaken by an external hydrogeologist.

The investigation is summarised as follows:

- The groundwater EC measured at ALV8L and ALV8S reflected natural variability due to climatic factors and there was not a mining-related impact. The climate data showed high evaporation and below average rainfall for the majority of 2017, which was considered to have resulted in the observed increase in EC.
- The observed groundwater EC remained within the historical range.

The relevant ITARP report is provided in **Appendix A**.

ALV2S Investigation – December 2017

During the reporting period, there was an exceedance of the 80th percentile EC trigger at piezometer ALV2S in December 2017, defined as three (3) consecutive exceedances of the adopted 80th percentile trigger value. An investigation was undertaken by an external hydrogeologist.

The investigation is summarised as follows:

- The groundwater EC measured at ALV2L and ALV2S reflects natural variability due to climatic factors and there is not a mining-related impact. The climate data showed high evaporation and below average rainfall for the majority of 2017, which is considered to have resulted in the observed increase in EC.
- The observed groundwater EC at ALV2S was not outside of the maximum range recorded and was not of sufficient magnitude to lead to a down gradient impact on beneficial use.
- ALV2S was not within the extent of drawdown from mining operations and there was no potential seepage sources.

The relevant ITARP report is provided in **Appendix B**.

ALV3S Investigation – April 2018

During the reporting period, there was an exceedance of the 80th percentile EC trigger at piezometer ALV3S in March 2018, defined as three (3) consecutive exceedances of the adopted 80th percentile trigger value. An investigation was undertaken in consultation with an external hydrogeologist.

The investigation is summarised as follows:

- The groundwater EC measured at ALV3S reflects natural variability due to climatic factors and there is not a mining-related impact. The climate data showed high evaporation and below

average rainfall for the majority of 2017, which is considered to have resulted in the observed increase in EC.

- ALV3S was not within the extent of drawdown from mining operations and there was no potential seepage sources.

The relevant ITARP report is provided in **Appendix C**.

Groundwater Quality of Hard Rock Aquifer

LCO also monitor a number of hard rock aquifers to provide for the ongoing water management onsite. Monitoring of Piezometer PGW5S and PGW5L was used to inform LCO on groundwater pressurisation of the strata between the Bowmans Creek shallow bedrock and lower overburden and underground workings within the Pikes Gully Seam.

For the reporting period, **Table 13** presents the groundwater pH and EC exceedances in the Hard Rock Aquifer (Coal Measures). Monitoring piezometer PGW5L is installed into the overburden and piezometers PGW5S is installed into the Pikes Gully coal seam. From August 2017 PGW5 was not retained as trigger level monitoring site. LCO monitor the quality and levels of several other bores to hard rock aquifers however these are considered mine water storages and have no applicable investigation limits.

Table 13 - Exceedances for EC and pH in Hard Rock Aquifers

Hard Rock Groundwater Quality				
	EC (mS/cm)		**pH**	
Applicable Impact Assessment Criteria to July 2017				
Site	**PGW5L**	**PGW5S**	**PGW5L**	**PGW5S**
80th %tile	5.05	5.77	**6.5 – 8.5**	**6.5 – 8.5**
20th %tile	6.06	6.82	**-**	**-**
Jun-16	5.76	6.01	7.45	7.30
Jul-16	5.61	5.69	7.62	7.31
Applicable Impact Assessment Criteria from August 2017				
80th %tile	N/A	N/A	N/A	N/A
20th %tile	N/A	N/A	N/A	N/A
Aug-16	5.78	5.86	7.28	7.11
Sep-16	5.67	5.8	7.18	7.02
Oct-16	5.87	5.9	7.47	7.21
Nov-16	5.89	6.05	7.56	7.34
Dec-16	6.02	6.25	7.99	7.39
Jan-17	5.82	6.12	7.97	7.62
Feb-17	5.83	6.16	7.54	7.14
Mar-17	5.85	Dry	7.57	Dry
Apr-17	5.51	Dry	7.63	Dry
May-17	5.78	5.86	7.78	7.11

Orange Shading – Denotes an exceedance of the 80th %ile trigger limit

Yellow Shading – Denotes an exceedance of the 20th %ile trigger limit

No exceedance of pH criterion at any bore occurred during the reporting period. The analyses on hard rock aquifers showed a number of exceedances of the 80th percentile EC trigger, minimal deviation from long-term EC trends and historical trends. A summary of ITARP investigations into these exceedances is provided below.

PGW5S Investigation and PGW5L Further Investigation – July 2017

There was an exceedance of the 80th percentile EC trigger value at PGW5S in June 2017. This result followed an exceedance of 80th percentile EC trigger in the two preceding months and therefore resulted in three (3) consecutive exceedances of the adopted 80th percentile trigger value. An investigation was undertaken in July 2017 by an external hydrogeologist.

PGW5L exceeded the 80th percentile EC trigger value in December 2016, which was investigated. The exceedance continued into 2017 and a further investigation was conducted to assess if the continued exceedance posed an environmental risk.

The investigations are summarised as follows:

- Groundwater quality (as salinity) continued to reflect natural variability due to climatic factors and there was not a mining-related impact. The conclusion from the investigation of PGW5 conducted in February 2017, that there is no potential harm to the environment due the currently elevated groundwater salinity, was considered to have remained valid.
- The observed groundwater salinity remained within the historical range (referred to as the baseline dataset, specifically July 2005 to May 2017 inclusive).
- It was recommended that monitoring continues at PGW5 and that these piezometers, which are installed into the Overburden and Pikes Gully Seam respectively and, accordingly, are not water table aquifer piezometers, would not be retained as trigger level sites in the future. Further investigation of PGW5 was not considered necessary.

The relevant ITARP report is provided in **Appendix D**.

Groundwater Quality Summary

Based on the conclusions regarding the various trigger exceedances discussed above, LCO has determined that no environmental harm has occurred as a result of any mining impact during the reporting period. This is further supported by the facts that LCO is still currently not mining in the area where the environmental assessment predicted impacts would occur, and ground water monitoring investigations have indicated that no mining induced drawdown is occurring (further details provided in **Section 5.2.2**).

As per the recommendations made by the groundwater consultant during the 2016 reporting period, a review of the trigger methodology was completed and revised trigger levels determined using the larger dataset available. Consultation was undertaken during the reporting period regarding revision to the WMP triggers and associated justification with DoE approval received on 26 July 2017. LCO will continue to monitor the system as per the WMP.

5.2.2 Groundwater Level Monitoring

Current and historical mining operations have extensively altered the physical features and environmental setting of the local area, including the region's surface water and groundwater systems. Due to such operations and features regional groundwater levels largely reflect current and past mining activities, with water levels varying with time and location according to local mining activities. LCO monitor the groundwater level of the Bowmans Creek Alluvial and Shallow Bedrock Aquifers to identify any potential impacts from mining such as depressurisation.

A review of full historical monitoring results identified that the sympathetic response in water levels observed in the paired bores indicate similar processes are driving the recharge for both the alluvial aquifer and shallow bedrock aquifer. The different absolute levels for the paired bores reflect the different hydraulic connectivity between the alluvium and shallow bedrock. Water level relationships show a shift from slight upward pressures (gaining stream) upstream (ALV1), through to equal pressures adjacent

to LCO (ALV3, ALV4, ALV2) to slight downward pressures (losing stream) to the south (ALV7, ALV8). Rainfall (recharge) appears to be the dominant driver for groundwater level variability for the Bowmans Creek alluvium.

Similarly to the groundwater quality, the WMP groundwater monitoring program adopts site specific trigger levels for impact investigation and assessment. If monitoring results suggest significant and continuous deviation from historical or background trends in groundwater level, further investigations into potential impacts are conducted using the ITARP and MTARP process as described previously. No potential mining impacts were identified during the reporting period.

Revised impact assessment criteria for groundwater levels were approved in consultation with DoE on 26 July 2017 following a review into the site specific trigger values. Consequently, the monitoring results from this reporting period are assessed against two sets of trigger levels during the course of the reporting period. Groundwater level monitoring results and trigger limits for the alluvial, shallow bedrock and hard rock aquifers during the reporting period are shown in **Table 13** below and results triggering the relevant criteria identified. A summary of each ITARP investigation conducted during the reporting period is also provided below.

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Table 14 - Groundwater Level Monitoring Results and Trigger Exceedances

Alluvial, Shallow Bedrock and Hard Rock Groundwater Levels - Depth to Water																
Site	ALV1L	ALV1S	LBH	ALV3L	ALV3S	ALV4L	ALV4S	ALV2L	ALV2S	ALV7L	ALV7S	ALV8L	ALV8S	ALV9L*	PGW5L	PGW5S
10th %ile	5.31	5.03	5.29	6.08	6.32	5.88	6.47	4.91	4.82	6.83	10.42	7.04	9.84	N/A	12.52	11.03
Max	6.31	6.84	6.24	7.08	7.26	12.84	7.42	6.76	8.53	7.34	11.38	8.36	11.08	N/A	19.63	11.37
Jun-17	3.31	2.70	3.61	4.95	5.13	4.91	5.39	4.37	4.14	6.45	8.55	6.21	7.20	N/A	11.39	10.54
Jul-17	3.40	2.77	3.66	5.01	5.18	4.86	5.44	4.39	4.18	6.48	8.63	6.25	7.26	N/A	10.27	9.97
10th %ile	4.97	4.75	5.05	5.7	5.99	5.56	6.28	4.8	4.67	6.75	10.21	6.96	9.03	9.8	N/A	N/A
Max	6.31	6.84	6.24	7.08	7.26	6.73	7.42	6.76	8.53	7.34	11.38	8.36	11.08	11.76	N/A	N/A
Aug-17	3.56	2.98	3.72	5.06	5.24	5.00	5.57	4.44	4.32	6.55	8.81	6.39	7.55	N/A	N/A	N/A
Sep-17	3.90	3.41	3.92	5.12	5.33	5.12	5.68	4.44	4.30	6.59	9.04	6.57	7.87	N/A	N/A	N/A
Oct-17	4.28	3.89	4.14	5.35	5.69	5.34	5.87	4.44	4.34	6.63	9.21	7.00	8.26	N/A	N/A	N/A
Nov-17	4.50	4.10	4.34	5.55	5.79	5.45	6.02	4.50	4.40	6.66	9.47	7.22	8.45	N/A	N/A	N/A
Dec-17	4.76	4.37	4.55	5.73	6.01	5.52	6.14	4.58	4.53	6.70	9.59	7.51	8.71	N/A	N/A	N/A
Jan-18	5.01	4.61	4.76	5.91	6.21	5.62	6.22	4.64	4.63	6.73	9.84	7.91	9.02	3.99	N/A	N/A
Feb-18	5.28	4.97	5.22	6.17	6.50	5.74	6.34	4.74	4.74	6.81	11.50	8.03	12.80	4.02	N/A	N/A
Mar-18	5.46	5.08	5.44	6.33	6.67	5.84	6.43	4.81	4.83	6.97	11.46	8.30	12.35	3.98	N/A	N/A
Apr-18	3.95	3.70	4.07	5.88	6.15	5.38	6.00	4.50	4.48	6.97	10.71		10.73	3.85	N/A	N/A
May-18	4.12	3.91	3.98	5.31	5.57	5.35	6.07	4.57	4.50	6.93	10.84		10.71	3.94	N/A	N/A

Piezometer installed in December 2017. Drawdown criteria limit derived from ALV2L minus 5.0 (AHD).

During the reporting period, consecutive exceedances of the relevant approved trigger levels were observed at monitoring locations ALV1L, ALV3L, ALV3S, ALV4L, ALV7L, ALV7S, ALV8L and ALV8S and are understood to be the result of natural climatic variations and not to be related to mining activities but the result of constrained baseline historical data. LCO undertook all required notifications and investigations during the reporting period as detailed/required by the WMP. No notifications were made to the DoE as environmental harm was not considered to have occurred.

ALV8L Investigation – December 2017

During the reporting period, there was an exceedance of the 80th percentile groundwater level trigger at piezometer ALV8L in December 2017, defined as three (3) consecutive exceedances of the adopted 80th percentile trigger value. An investigation was undertaken by an external hydrogeologist.

The investigation is summarised as follows:

- High evaporation and below average rainfall was observed during the majority of 2017 which led to a decrease in groundwater levels at site ALV8L. This decrease in groundwater elevation caused a depth trigger to occur later in the year.
- A review of the mine water containment systems has yielded no evidence of malfunctions nor significant changes that could result in offsite drainage of saline water or increased connectivity.
- The exceedance was not outside of the maximum range recorded and was not considered to be of sufficient magnitude to lead to a downgradient impact on beneficial use.
- It was concluded that the groundwater depths measured at ALV8L and ALV8S reflect natural variability due to climatic factors and there was not a mining-related impact.
- In accordance with the WMP, if groundwater levels persist below the trigger level for a further 9 months, such that the exceedance has been continuous for 12 months, then a subsequent investigation shall be undertaken to confirm the exceedance remains unrelated to mining activity.

The relevant ITARP report is provided in **Appendix B**.

ALV3S & ALV3L Investigation – March 2018

During the reporting period there was an exceedance of 80th percentile groundwater level trigger at the paired piezometer ALV3L and ALV3S in February 2018, defined as three (3) consecutive exceedances of the adopted 80th percentile trigger value. An investigation was undertaken in consultation with an external hydrogeologist.

The investigation is summarised as follows:

- High evaporation and below average rainfall was observed during the majority of 2017 which led to a decrease in groundwater levels at site ALV3. This decrease in groundwater elevation caused an EC trigger to occur later in the year.
- A review of the mine water containment systems has yielded no evidence of malfunctions nor significant changes that could result in offsite drainage of saline water or increased connectivity.
- ALV3L and ALV3S are not within the extent of drawdown from mining operations. Water levels along the whole system have generally declined similarly to ALV3. Further, the observed decline is consistent for both the shallow bedrock and alluvium along the whole system.
- The exceedance was not outside of the maximum range recorded and was not considered to be of sufficient magnitude to lead to a down gradient impact on beneficial use.
- It was concluded that the groundwater depths measured at ALV3L and ALV3S reflect natural variability due to climatic factors and there was not a mining-related impact.
- In accordance with the WMP, if groundwater levels persist below the trigger level for a further 9 months, such that the exceedance has been continuous for 12 months, then a subsequent investigation shall be undertaken to confirm the exceedance remains unrelated to mining activity.

The relevant ITARP report is provided in **Appendix E**.

ALV1L, ALV4L & ALV3S Investigation – April 2018

During the reporting period there was an exceedance of 80th percentile groundwater level trigger at the paired piezometer ALV1L and ALV4L in March 2018, defined as three (3) consecutive exceedances of the adopted 80th percentile trigger value. Further, piezometer ALV3S measured three consecutive groundwater quality triggers, 80th%ile electrical conductivity; this investigation is summarised previously. An investigation was undertaken in consultation with an external hydrogeologist.

The investigation is summarised as follows:

- High evaporation and below average rainfall was observed during the majority of 2017 which led to a decrease in groundwater levels at sites ALV1L and ALV4L. This decrease in groundwater elevation caused a depth trigger to occur later in the year. This natural variability influences the recharge and interaction of groundwater and surface water hence influences the groundwater quality.
- ALV1L, ALV4L and ALV3S are not within the extent of drawdown impacts from mining operations.
- A review of the mine water containment systems has yielded no evidence of malfunctions nor significant changes that could result in offsite drainage of saline water or increased connectivity.
- The exceedance was not outside of the maximum range recorded.
- Water levels along the whole system have generally declined similarly. Further, the observed decline is consistent for both the shallow bedrock and alluvium along the whole system.
- It was concluded that the groundwater depths measured at ALV1L and ALV4L reflect natural variability due to climatic factors and there was not a mining-related impact.
- In accordance with the WMP, if groundwater levels persist below the trigger level for a further 9 months, such that the exceedance has been continuous for 12 months, then a subsequent investigation shall be undertaken to confirm the exceedance remains unrelated to mining activity.

The relevant ITARP report is provided in **Appendix C**.

ALV7L, ALV7S and ALV8S Investigations – May 2018

During the reporting period there was an exceedance of 80th percentile groundwater level trigger at the paired piezometer ALV7L, ALV7S and ALV8S in April 2018, defined as three (3) consecutive exceedances of the adopted 80th percentile trigger value. An investigation was undertaken by an external hydrogeologist.

The investigation is summarised as follows:

- The large and rapid groundwater level decline at ALV7S and ALV8S is considered to be due to the groundwater storage mechanisms of the shallow bedrock and the dewatering of a fracture horizon and is therefore not considered to be a mining related impact.
- ALV7L and ALV7S are not within the extent of predicted drawdown impacts from mining operations; additionally, ALV7L is used as the reference bore for potential drawdown at ALV8L and there has been no exceedance of drawdown trigger investigation limits.
- The climate data shows high evaporation and below average rainfall with significant variation in residual rainfall mass curve that is the longest downward trend since 2005. Since there is direct relationship between these bores and rainfall; despite reference maximums being exceeded at ALV7S and ALV8S, it is not expected that there is potential for harm to the environment as the system is varying naturally.
- In accordance with the WMP, if groundwater levels persist below the trigger level for a further 9 months, such that the exceedance has been continuous for 12 months, then a subsequent investigation shall be undertaken to confirm the exceedance remains unrelated to mining activity.

The relevant ITARP report is provided in **Appendix F**.

Groundwater Levels of Hard Rock Aquifer (Coal Measures)

LCO monitor a number of hard rock aquifers to provide for the ongoing water management onsite. The groundwater elevations within these aquifers vary significantly between the piezometers monitored, reflecting differences in groundwater levels between different stratigraphic layers and as a consequence of recent and historical mining and dewatering operations. There are no investigation groundwater trigger levels for monitoring of these water bodies.

Noteworthy findings from the ongoing monitoring indicate that there is no significant connectivity between the Hazeldene workings and the actively mined Liddell Seams below. This is supported by the lack in response of groundwater elevations/pressures in the Hazeldene workings when drawn down of the mined Liddell seams occurs

6 Reference Information

Reference information, listed in **Table 14** below, is information that is directly related to the development of this document or referenced from within this document.

Table 15 - Reference Information

Reference	Title
DP&E 2015	*Independent Audit Guideline. Post-approval requirements for State significant developments*
LIDOC-90533967-2881	*Liddell Coal Operations Mining Operations Plan/Rehabilitation Management Plan*
LIDOC-90533967-3755	*Biodiversity Offset Management Plan*
LIDOC-90533967-3687	*Biodiversity Management Plan*
LIDOC-90533967-3776	*Indirect Offset Management Plan*
LIDOC-90533967-3694	*Water Management Plan*
LCO 2018	*Liddell Coal Operations Annual Review 2017*
Umwelt 2015	*Biodiversity Monitoring Report. Prepared for Liddell Coal Operations Pty. Ltd*
Umwelt 2015	*Biodiversity Offset Monitoring Report Prepared for Liddell Coal Operations Pty Ltd*
Umwelt 2015	*Rehabilitation Monitoring Report Prepared for Liddell Coal Operations Pty Ltd*
Umwelt 2018	*Biodiversity Monitoring Report. Prepared for Liddell Coal Operations Pty. Ltd*
Umwelt 2018	*Biodiversity Offset Monitoring Report Prepared for Liddell Coal Operations Pty Ltd*
ARRP 2017	*Liddell Coal Operations Annual Rehabilitation Monitoring Report 2017*
Jacobs 2015	*Liddell Coal Operations Investigation Trigger Action Response Plan October 2015*
Jacobs 2016	*Liddell Coal Operations Investigation Trigger Action Response Plan May 2016*

Appendix A - September 2017 ALV8L ITARP

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26 September 2017

Attention: Ben de Somer
Liddell Coal Operations Pty Ltd
PO Box 7
SINGLETON NSW 2330

Project Name: Liddell Coal Operations
Project Number: IA138100

Subject: ALV8L EC Trigger Investigation

Dear Ben

1. Introduction

1.1 Overview

Jacobs Group (Australia) Pty Ltd (Jacobs) has been commissioned by Liddell Coal Operations Pty Ltd (LCO) to undertake an investigation of a groundwater quality trigger at groundwater monitoring piezometer ALV8L at Liddell Mine, specifically in regard to whether the exceedance presents a potential to harm the environment.

An exceedance of the trigger level with respect to Electrical Conductivity (EC) at monitoring piezometer ALV8L (installed into the Alluvial aquifer) was notified on 13 September 2017, being three consecutive exceedances of the nominated trigger level.

This letter presents an investigation of the exceedance at ALV8L

1.2 Scope of Work

The Scope of Work for this groundwater investigation consists:

- investigation of three consecutive EC exceedances at groundwater monitoring site ALV8L
- assessment of whether there is potential harm to the environment from the exceedance.

2. ALV8L Groundwater Investigation

In accordance with agreed amendments to the current Water Management Plan for Liddell Mine (LCO, 2017), notification of the exceedance was provided to DPI Water, Department of Planning and Environment and Department of Environment on 13 September 2017 via email.

Table 1 presents the recent water quality observations (EC) at monitoring sites ALV8L and ALV8S (shallow bedrock aquifer below alluvial aquifer).

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Table 1 : Groundwater Quality (EC, mS/cm) Observations and Trigger Levels at ALV8L and ALV8S

Well ID	Unit	80th Percentile Trigger Limit EC (mS/cm)	Reference Maximum EC (mS/cm)	May 2017 EC (mS/cm)	Jun 2017 EC (mS/cm)	July 2017 EC (mS/cm)	Aug 2017 EC (mS/cm)
ALV8L	Alluvial aquifer	1.31	1.88	1.16	1.33	1.39	1.46
ALV8S	Shallow bedrock below alluvial aquifer	1.99	2.40	1.51	2.29	1.68	1.71

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Figure 1 presents time-series groundwater elevation at sites ALV8L and ALV8S. **Figure 2** presents time-series groundwater quality (salinity as EC). **Figure 1** and **Figure 2** include a residual mass curve with respect to rainfall and evaporation. The SILO climatic dataset (Department of Science, Information Technology and Innovation of the Queensland Government) was used. The residual mass curves were determined using internally calculated means and applied on a daily basis, in accordance with the approach presented in Jacobs (2017) [Station No. 0610208].

It is noted that the HARTT analysis method, which was noted by DPI Water in response to the Jacobs (2017) investigation as a tool that could be used with trigger level investigations, was reviewed and found to not be suitable for use at Liddell Mine. As Jacobs understands it, the HARTT methodology was developed by the WA Department of Agriculture for use in the Gnangnara Groundwater Mound in WA. Jacobs has concerns that the proximity of monitoring piezometers to Bowmans Creek, which is known to be gaining at the northern end of the mining lease, intermittently gaining/losing at the midpoint and losing at the southern end of the mining lease, renders the analysis method potentially invalid. Correspondence with the WA Department of Agriculture has indicated that a revised model is in the process of being developed and that revised model will be reviewed when it is released.

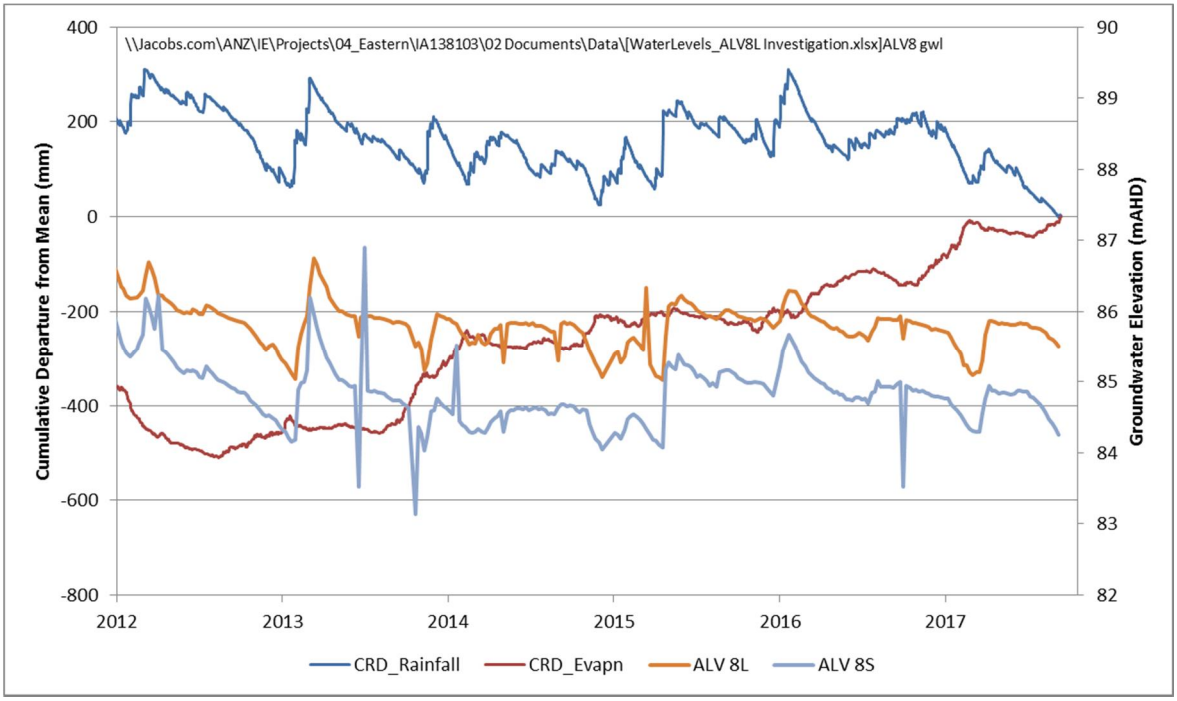

Figure 1 : Groundwater elevation (mAHD) observations at site ALV8L and ALV8S

From **Figure 1**, there is a significant drop in the residual mass curve (rainfall) commencing January 2017, commensurate with an increase in slope in the residual mass curve (evaporation). This implies below average rainfall combined with higher than average evaporation. The decreased rainfall corresponds with a reduction in groundwater levels, which continued until March 2017 when high rainfall was experienced. This rainfall event is shown by

an increase in the residual mass curve (rainfall) and led to a declining trend in evaporation and increased groundwater levels at ALV8L and ALV8S.

The high rainfall did not persist beyond March and the declining trend in the residual mass curve (rainfall) continued throughout the remainder of the data set signifying lower than average rainfall from March to September 2017. This in turn led to a rising trend in evaporation from July 2017 and a declining trend in groundwater levels at both sites.

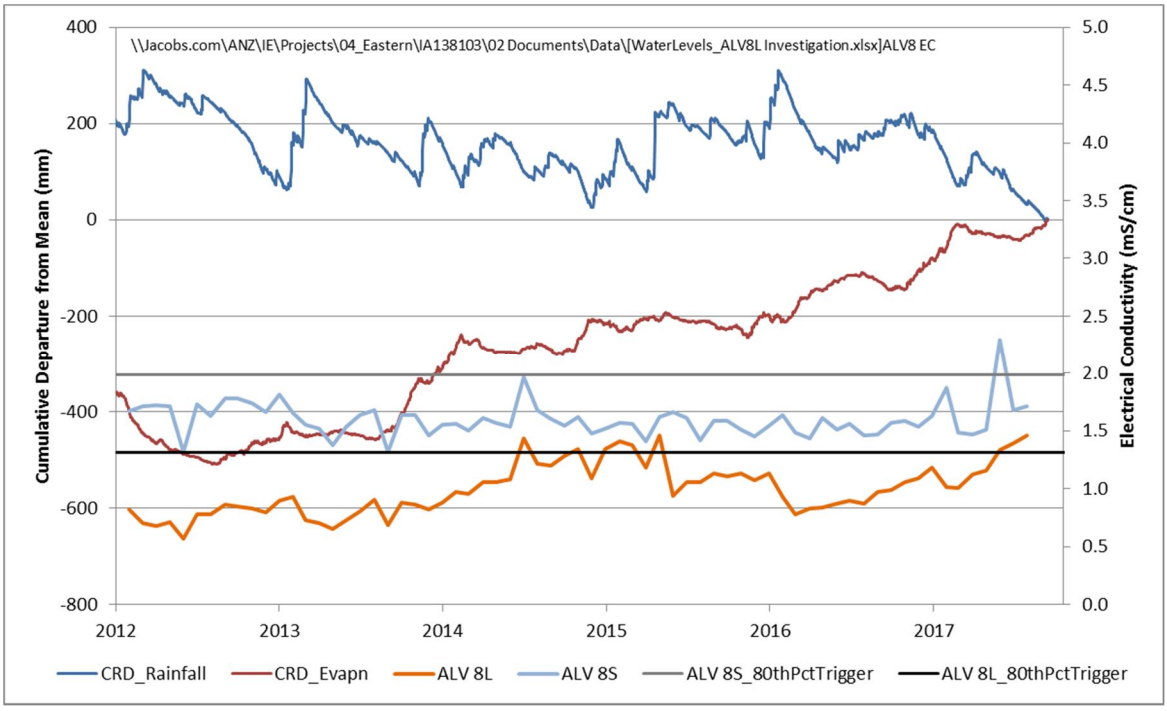

Figure 2 : Groundwater quality (EC, mS/cm) observations at ALV8L and ALV8S and August 2017 Trigger Value

From **Figure 2**, the increase in groundwater salinity (as EC, mS/cm) in both ALV8L and ALV8S correlates reasonably with the increase in slope of the residual mass curve (evaporation) and the declining trend observed in the residual mass curve (rainfall). It is therefore considered that climatic conditions have resulted in evaporative concentration effects within the alluvial groundwater thereby increasing the EC. It is interpreted that there is a delay of several months in the response, which would be expected with evaporative effects on shallow groundwater.

The difference in groundwater levels between ALV8L and ALV8S demonstrates a downward hydraulic gradient between the alluvial and shallow bedrock aquifers so it is not possible that deeper, higher EC, groundwater has migrated into the alluvial aquifer. A strong groundwater level response to rainfall is evident in the both aquifers (Figure 1) and it is therefore considered that the reduced rainfall recharge has led to the rising trend in EC observed at ALV8L and ALV8S. This mechanism reflects natural variability due to climatic factors and it is therefore considered that there is not a mining-related impact.

It should be noted that the same trend has been observed at ALV7L and ALV7S however, the EC at these bores have not exceeded the trigger levels.

The currently observed EC values are consistent with the historical dataset. As such, it is concluded that the on-going exceedance at ALV8L does not present potential harm to the environment and that monitoring at this site should continue.

The trigger values displayed in **Figure 2** are the August 2017 revised values derived from the baseline dataset (July 2005 to May 2017) (LOC, 2017).

3. Conclusion

Jacobs considers that the groundwater EC measured at ALV8L and ALV8S reflects natural variability due to climatic factors and there is not a mining-related impact. The climate data shows high evaporation and below average rainfall for the majority of 2017, which is considered to have resulted in the observed increase in EC.

It is highlighted that the observed groundwater EC currently remains within the historical range. The rising trend is likely to continue whilst rainfall remains below average; further change in EC is expected once rainfall conditions return to normal.

It is recommended that routine monitoring continues at ALV8L and ALV8S and it is suggested that if groundwater EC continues to exceed the trigger level on any three consecutive occasions, then a further review should be conducted to ascertain if the trend continues to be climate driven or potentially impacted by mining activities.

4. References

Jacobs, 2017. *PGW5 Groundwater Investigation – December 2016*. Letter prepared for Liddell Coal Operations Pty Ltd by Jacobs Group (Australia) Pty Ltd. Reference No. IA117100/015b, dated 3 February 2017.

LCO, 2017. *Liddell Glencore | Plan for Water Management*. Management plan prepared by Liddell Coal Operations Pty Ltd. Reference No. LIDOC-90533967-3694, Version 9 (Approved).

5. Closing

Should you require additional information then please do not hesitate to contact our office.

Yours sincerely

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Appendix B - December 2017 ALV2S and ALV8L ITARP

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25 January 2018

Attention: Ben de Somer
Liddell Coal Operations Pty Ltd
PO Box 7
SINGLETON NSW 2330

Project Name: Liddell Coal Operations
Project Number: IA138104

Subject: ALV8L Groundwater Depth Trigger Investigation

Dear Ben

1. Introduction

1.1 Overview

Jacobs Group (Australia) Pty Ltd (Jacobs) has been commissioned by Liddell Coal Operations Pty Ltd (LCO) to undertake an investigation of a groundwater level trigger at groundwater monitoring piezometer ALV8L at Liddell Mine, specifically in regard to whether the exceedance presents a potential to harm the environment and determine whether it is a mining related impact.

An exceedance of the trigger level with respect to Groundwater Level Trigger Definition #2 at monitoring piezometer ALV8L (installed into the Alluvial aquifer) was notified on 12 January 2018, being three consecutive exceedances of the nominated trigger level.

This letter presents an investigation of the exceedance at ALV8L.

1.2 Scope of Work

The Scope of Work for this groundwater investigation consists:

- investigation of three consecutive groundwater depth exceedances at groundwater monitoring site ALV8L.
- assessment of whether there is potential harm to the environment from the exceedance and determine whether it is a mining related impact.

2. ALV8L Groundwater Investigation

In accordance with agreed amendments to the current Water Management Plan for Liddell Mine (LCO, 2017), notification of the exceedance was provided to DPI Water, Department of Planning and Environment and Department of Environment on 12 January 2018 via email.

Table 1 presents the recent water level observations at monitoring sites ALV8L (alluvial aquifer) and ALV8S (shallow bedrock aquifer below alluvial aquifer).

25 January 2018
Subject: ALV8L Groundwater Depth Trigger Investigation

Table 1 : Groundwater Level Observations and Trigger Levels at ALV8L and ALV8S

Well ID	Unit	Trigger Values		Monitoring Results			
		10th Percentile Trigger Limit Depth to Water (m)	Reference Maximum Depth to Water (m)	Sept 2017 Depth to Water (m)	Oct 2017 Depth to Water (m)	Nov 2017 Depth to Water (m)	Dec 2017 Depth to Water (m)
ALV8L	Alluvial aquifer	6.96	8.36	6.57	7.00	7.22	7.51
ALV8S	Shallow bedrock below alluvial aquifer	9.03	11.08	7.87	8.26	8.45	8.71

Figure 1 presents time-series groundwater elevation at sites ALV8L and ALV8S. **Figure 2** presents time-series streamflow monitored at stations 300091 (downstream) and 300090 (upstream). Both Figures include a residual mass curve with respect to rainfall and evaporation. The SILO climatic dataset (Department of Science, Information Technology and Innovation of the Queensland Government) was used. The residual mass curves were determined using internally calculated means and applied on a daily basis, in accordance with the approach presented in the Liddell Coal PGW5 Groundwater Investigation (Jacobs, 2017) [Station No. 061208].

In response to Jacobs (2017), the Hydrograph Analysis and Rainfall Time Trends (HARTT) analysis method was identified by DPI Water as a tool that could be used in trigger level investigations. This method was subsequently reviewed and found to not be suitable for use at Liddell Mine. As Jacobs understands it, the HARTT methodology was developed by the WA Department of Agriculture for use in the Gnangnara Groundwater Mound in WA. Jacobs has concerns that the proximity of monitoring piezometers to Bowmans Creek, which is gaining at the northern end of the mining lease, intermittently gaining/losing at the midpoint and losing at the southern end of the mining lease, renders the analysis method potentially invalid. Correspondence with the WA Department of Agriculture has indicated that a revised model is in the process of being developed and that revised model will be reviewed when it is released.

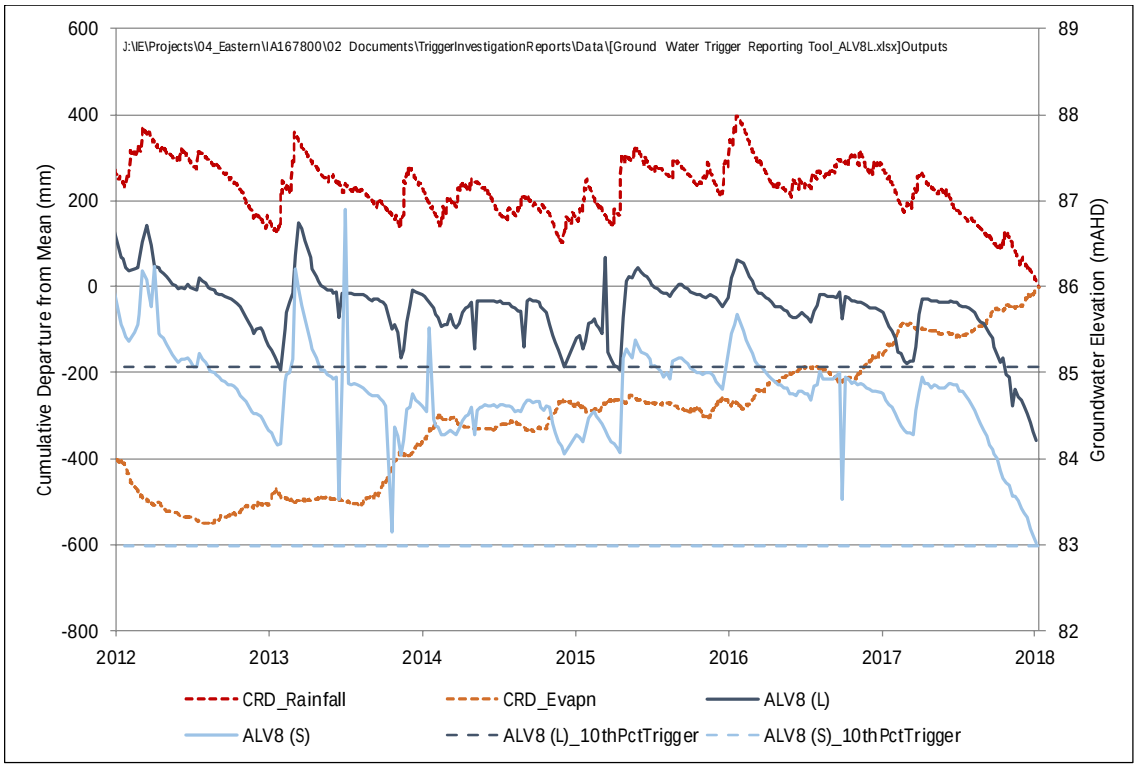

Figure 1 : Groundwater elevation (mAHD) observations at site ALV8L and ALV8S and August 2017 Trigger Values

The trigger values displayed in **Figure 1** are the August 2017 revised values derived from the baseline dataset (July 2005 to May 2017) (LCO, 2017).

From **Figure 1**, there is a significant drop in the residual mass curve (rainfall) commencing January 2017, commensurate with an increase in slope in the residual mass curve (evaporation). This implies below average rainfall combined with higher than average evaporation. The decreased rainfall corresponds with a reduction in groundwater levels, which continued until March 2017 when a short lived period of higher rainfall was experienced. This rainfall event is shown by an increase in the residual mass curve (rainfall) and led to a declining trend in evaporation and increased groundwater levels at ALV8L and ALV8S.

The increased rainfall did not persist beyond March and the declining trend in the residual mass curve (rainfall) continued throughout the remainder of the data set signifying lower than average rainfall from March to December 2017. This in turn led to a rising trend in evaporation from July 2017 and a declining trend in groundwater levels at both sites. Generally, the water levels trends are very similar to the CRD trend. It can be seen that the groundwater levels at ALV8L dropped below the 10th percentile trigger limit in October 2017. The water levels observed at ALV8S remained above the 10th percentile trigger limit, however the levels have decreased at the same rate as the levels for ALV8L and, if current climatic conditions persist, will likely drop below the 10th percentile. This indicates that there are similar rates of decreasing water levels in the alluvial aquifer as the shallow bedrock aquifer.

As shown in **Table 2**, there are decreases in water levels within the Bowmans Creek Alluvium and shallow bedrock aquifer across the site and the decreases observed for ALV8L and ALV8S are not unique to that location implying that the groundwater response is driven by climate and not mining activity. It is therefore considered that the climatic conditions have resulted in reduced recharge and increased evaporation, therefore, decreasing the water levels in the system.

Table 2 : Water Level Observations Within the Bowmans Creek Alluvium and Shallow Bedrock Aquifer

Well ID	Unit	Trigger Values		Monitoring Results				
		10th Percentile Trigger Limit Depth to Water (m)	Reference Maximum Depth to Water (m)	Sept 2017 Depth to Water (m)	Oct 2017 Depth to Water (m)	Nov 2017 Depth to Water (m)	Dec 2017 Depth to Water (m)	Change in WLs (m) Oct 2017 to Dec 2017
ALV1L	Alluvial	4.97	6.31	3.90	4.28	4.50	4.76	-0.48
ALV1L	Bedrock	4.75	6.84	3.41	3.89	4.10	4.37	-0.48
ALV2L	Alluvial	4.80	6.76	4.44	4.44	4.50	4.53	-0.09
ALV2L	Bedrock	6.28	8.53	4.30	4.34	4.40	4.53	-0.19
ALV3L	Alluvial	5.70	7.08	5.12	5.35	5.55	5.73	-0.38
ALV3L	Bedrock	5.99	7.26	5.33	5.69	5.79	6.01	-0.32
ALV4L	Alluvial	5.56	6.73	5.12	5.34	5.45	5.52	-0.18
ALV4L	Bedrock	6.28	7.42	5.68	5.87	6.02	6.14	-0.27
ALV7L	Alluvial	6.75	7.34	6.59	6.63	6.66	6.70	-0.07
ALV7L	Bedrock	10.21	11.38	9.04	9.21	9.47	9.59	-0.38
ALV8L	Alluvial	6.96	8.36	6.57	7.00	7.22	7.51	-0.51

ALV8S	Bedrock	9.03	11.08	7.87	8.26	8.45	8.71	-0.45
LBH	Alluvial	5.05	6.24	3.92	4.14	4.34	4.55	-0.44

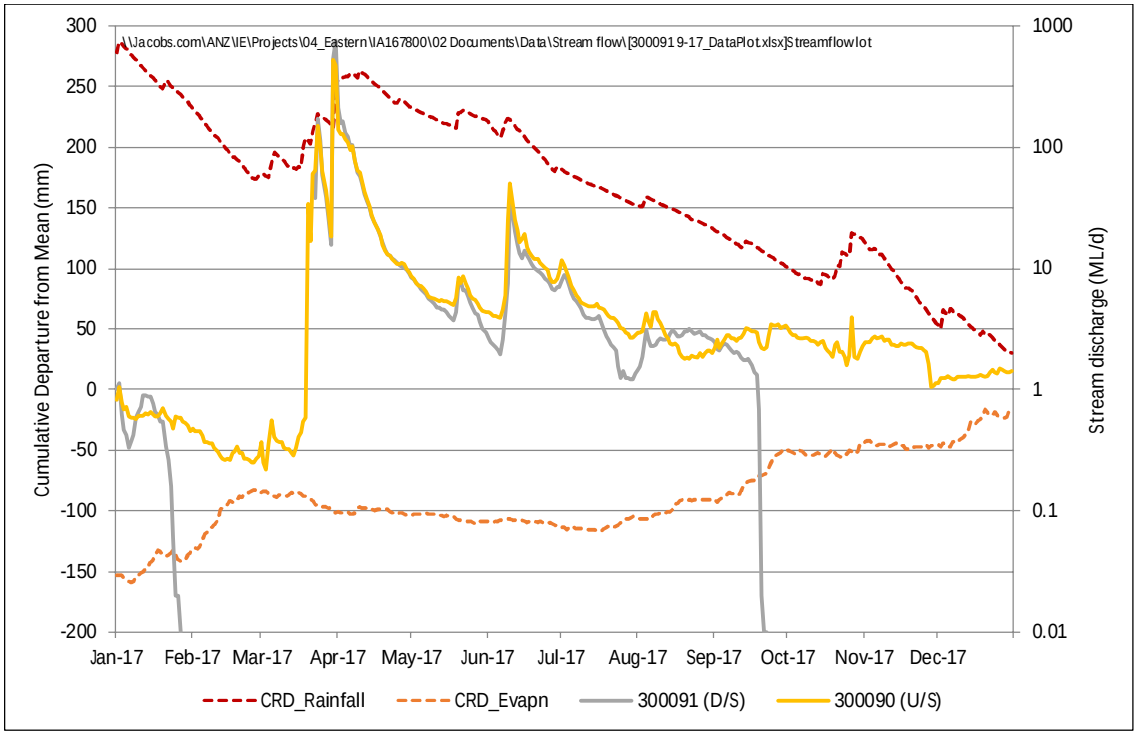

Figure 2 : Streamflow observations (ML/d) at 300090 (U/S) and 300091 (D/S)

From **Figure 2,** the streamflow (ML/d) observed at Bowmans Creek gauging stations 300091 (downstream) and 300090 (upstream) correlates reasonably with the declining trend observed in the residual mass curve (rainfall). This supports the conclusion that climatic conditions have resulted in reduced groundwater levels and surface water flows across the site. In regions where the creek is losing, a decrease in flow is expected to lead a reduction in groundwater levels.

This mechanism reflects natural variability due to climatic factors. Furthermore, ALV8L is not within the extent of drawdown from mining operations and there are no potential seepage sources. It is therefore considered that there is not a mining-related impact.

3. Conclusion

The climate data shows high evaporation and below average rainfall for the majority of 2017, which is considered to have resulted in the observed decease in water levels.

ALV8L is not within the extent of drawdown from mining operations and there are no potential seepage sources.

There are water level decreases within the Bowmans Creek Alluvium and Shallow Bedrock Aquifer as well as a reduction in Bowmans Creek flows due to the dry Spring and Summer months of 2017.

The exceedance is not outside of the maximum range recorded and is not considered to be of sufficient magnitude to lead to a downgradient impact on beneficial use.

On this basis, it is concluded that the groundwater depths measured at ALV8L and ALV8S reflect natural variability due to climatic factors and there is not a mining-related impact.

It is recommended that routine monitoring continues at ALV8L and ALV8S and it is suggested that if groundwater depth continues to exceed the trigger level on any three consecutive occasions commencing from January 2018, then a further review should be conducted to ascertain if the trend continues to be climate driven or potentially impacted by mining activities.

In accordance with the Liddell Coal Water Management Plan (LCO, 2017), if groundwater levels continue to be measured below the trigger level for a further nine months, such that the exceedance has been continuous for 12 months, then a subsequent investigation shall be undertaken to confirm the exceedance remains unrelated to mining activity.

4. References

Jacobs, 2017. *PGW5 Groundwater Investigation – December 2016*. Letter prepared for Liddell Coal Operations Pty Ltd by Jacobs Group (Australia) Pty Ltd. Reference No. IA117100/015b, dated 3 February 2017.

LCO, 2017. *Liddell Glencore | Plan for Water Management*. Management plan prepared by Liddell Coal Operations Pty Ltd. Reference No. LIDOC-90533967-3694, Version 9 (Approved).

5. Closing

Should you require additional information then please do not hesitate to contact our office.

Yours sincerely

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25 January 2018

Attention: Ben de Somer
Liddell Coal Operations Pty Ltd
PO Box 7
SINGLETON NSW 2330

Project Name: Liddell Coal Operations
Project Number: IA138104

Subject: ALV2S EC Trigger Investigation

Dear Ben

1. Introduction

1.1 Overview

Jacobs Group (Australia) Pty Ltd (Jacobs) has been commissioned by Liddell Coal Operations Pty Ltd (LCO) to undertake an investigation of a groundwater quality trigger at groundwater monitoring piezometer ALV2S at Liddell Mine, specifically in regard to whether the exceedance presents a potential to harm the environment and determine whether it is a mining related impact.

An exceedance of the trigger level with respect to Electrical Conductivity (EC) at monitoring piezometer ALV2S (installed into the Shallow bedrock aquifer) was notified on 12 January 2018, being three consecutive exceedances of the nominated trigger level.

This letter presents an investigation of the exceedance at ALV2S.

1.2 Scope of Work

The Scope of Work for this groundwater investigation consists:

- investigation of three consecutive EC exceedances at groundwater monitoring site ALV2S.
- assessment of whether there is potential harm to the environment from the exceedance and determine whether it is a mining related impact.

2. ALV2S Groundwater Investigation

In accordance with agreed amendments to the current Water Management Plan for Liddell Mine (LCO, 2017), notification of the exceedance was provided to DPI Water, Department of Planning and Environment and Department of Environment on 12 January 2018.

Table 1 presents the recent water quality observations (EC) at monitoring sites ALV2L (alluvial aquifer) and ALV2S (shallow bedrock aquifer below alluvial aquifer).

25 January 2018
Subject: ALV2S EC Trigger Investigation

Table 1 : Groundwater Quality (EC, mS/cm) Observations and Trigger Levels at ALV2L and ALV2S

Well ID	Unit	Trigger Values		Monitoring Results			
		80th Percentile Trigger Limit EC (mS/cm)	Reference Maximum EC (mS/cm)	Sep 2017 EC (mS/cm)	Oct 2017 EC (mS/cm)	Nov 2017 EC (mS/cm)	Dec 2017 EC (mS/cm)
ALV2L	Alluvial aquifer	2.83	4.16	2.21	2.23	1.97	2.01
ALV2S	Shallow bedrock below alluvial aquifer	2.82	3.37	2.73	2.86	2.84	2.85

Figure 1 presents time-series groundwater elevation at sites ALV2L and ALV2S. **Figure 2** presents time-series groundwater quality (salinity as EC). Both Figures include a residual mass curve with respect to rainfall and evaporation. The SILO climatic dataset (Department of Science, Information Technology and Innovation of the Queensland Government) was used. The residual mass curves were determined using internally calculated means and applied on a daily basis, in accordance with the approach presented in the Liddell Coal PGW5 Groundwater Investigation (Jacobs, 2017) [Station No. 061208].

In response to Jacobs (2017), the Hydrograph Analysis and Rainfall Time Trends (HARTT) analysis method was identified by DPI Water as a tool that could be used in trigger level investigations. This method was subsequently reviewed and found to not be suitable for use at Liddell Mine. As Jacobs understands it, the HARTT methodology was developed by the WA Department of Agriculture for use in the Gnangnara Groundwater Mound in WA. Jacobs has concerns that the proximity of monitoring piezometers to Bowmans Creek, which is known to be gaining at the northern end of the mining lease, intermittently gaining/losing at the midpoint and losing at the southern end of the mining lease, renders the analysis method potentially invalid. Correspondence with the WA Department of Agriculture has indicated that a revised model is in the process of being developed and that revised model will be reviewed when it is released.

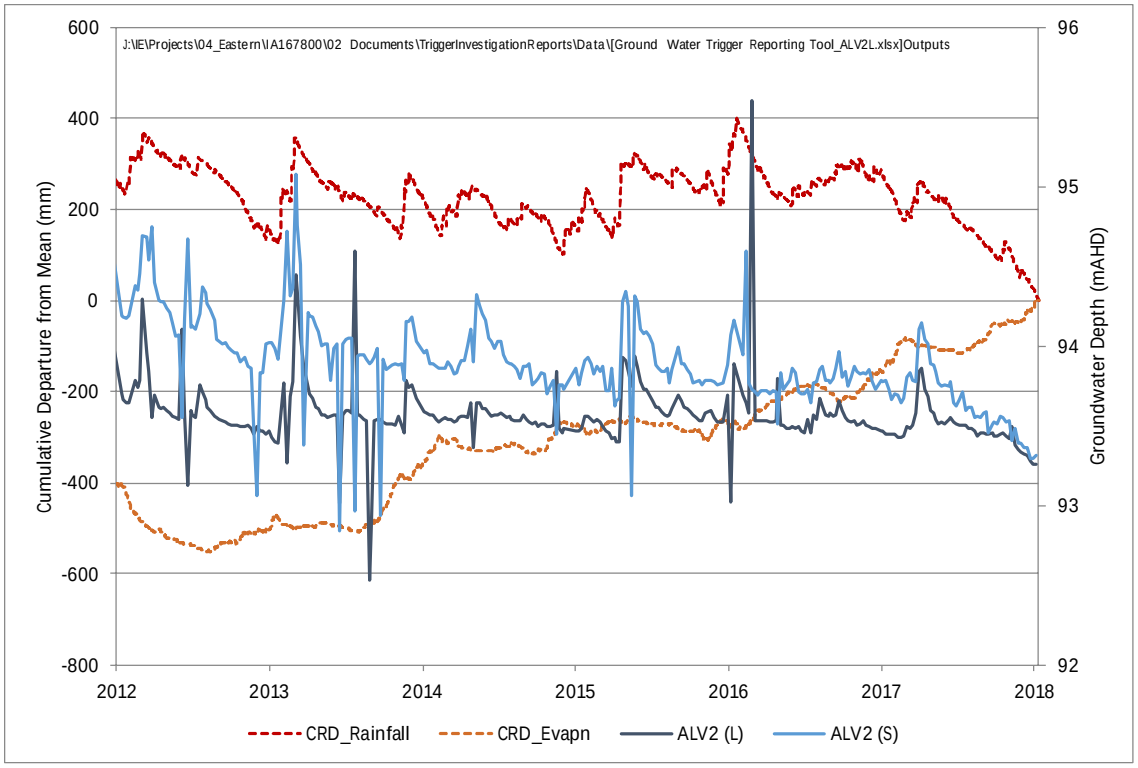

Figure 1 : Groundwater elevation (mAHD) observations at site ALV2L and ALV2S

From **Figure 1**, there is a significant drop in the residual mass curve (rainfall) commencing January 2017, commensurate with an increase in slope in the residual mass curve (evaporation). This implies below average rainfall combined with higher than average evaporation. The decreased rainfall corresponds with a reduction in groundwater levels at both

ALV2 bores, which continued until March 2017 when a short lived period of higher rainfall was experienced. This rainfall event is shown by an increase in the residual mass curve (rainfall) and led to a declining trend in evaporation and slightly increased groundwater levels at ALV2L and ALV2S.

The increased rainfall did not persist beyond March and the declining trend in the residual mass curve (rainfall) continued throughout the remainder of the data set signifying lower than average rainfall since March 2017. This in turn led to a rising trend in evaporation from July 2017 and a declining trend in groundwater levels at both sites.

The difference in groundwater levels between ALV2L and ALV2S demonstrates an upward hydraulic gradient from the shallow bedrock into the alluvial aquifer, which is consistent with the hydraulic mechanism in the mid to upper catchment area of the site. In this area it is considered that the shallow bedrock receives direct rainfall recharge at outcrop which creates sufficient head to drive groundwater into the alluvium. On this basis it is assumed that the reduction in rainfall has led to a reduction in the upwards gradient almost to the point, in recent months, where the shallow bedrock and alluvial groundwater levels are in equilibrium. The reduced recharge to both aquifers is evidenced in the downward groundwater level trend.

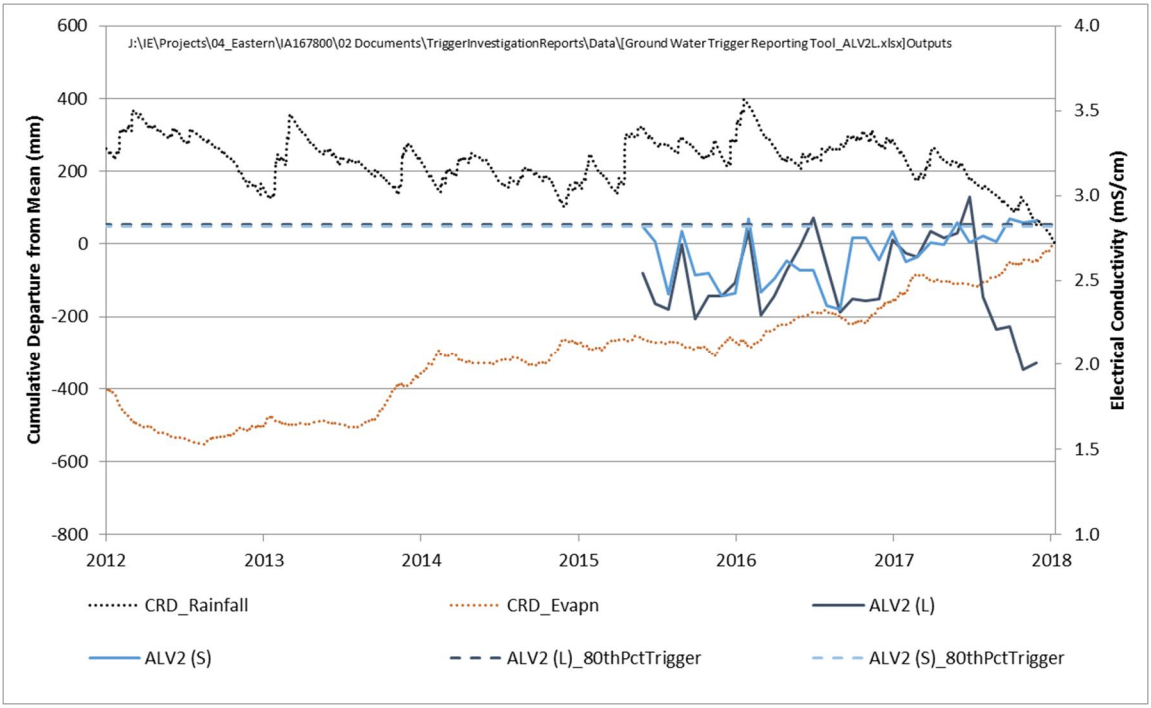

Figure 2 : Groundwater quality (EC, mS/cm) observations at ALV2L and ALV2S and August 2017 Trigger Value

Figure 2 shows the variation in groundwater salinity (as EC, mS/cm). The salinity increase at ALV2S is consistent with the increase in slope of the residual mass curve (evaporation) and the declining trend observed in the residual mass curve (rainfall) and it is therefore considered that the reduced rainfall recharge has led to the rising trend in EC observed at ALV2S. This mechanism reflects natural variability due to climatic factors and it is therefore not considered to be a mining-related impact.

The reduction in EC at ALV2L may be due to the reduction in the upward gradient and hence reduced recharge of higher EC water from the underlying shallow bedrock. During times of lower groundwater levels, the alluvial groundwater may have been further freshened by recharge from Bowmans Creek.

The currently observed EC values at ALV2S are consistent with the historical dataset. As such, it is concluded that the exceedance does not present potential harm to the environment and that monitoring at this site should continue.

The trigger values displayed in **Figure 2** are the August 2017 revised values derived from the baseline dataset (July 2005 to May 2017) (LCO, 2017).

3. Conclusion

Jacobs considers that the groundwater EC measured at ALV2L and ALV2S reflects natural variability due to climatic factors and there is not a mining-related impact. The climate data shows high evaporation and below average rainfall for the majority of 2017, which is considered to have resulted in the observed increase in EC.

It is highlighted that the observed groundwater EC at ALV2S is not outside of the maximum range recorded and is not of sufficient magnitude to lead to a downgradient impact on beneficial use. The rising trend may continue whilst rainfall remains below average and a reduction in EC is expected when rainfall levels increase.

ALV2S is not within the extent of drawdown from mining operations and there are no potential seepage sources.

It is recommended that routine monitoring continues at ALV2L and ALV2S and it is suggested that if groundwater EC continues to exceed the trigger level on any three consecutive occasions commencing from January 2018, then a further review should be conducted to ascertain if the trend continues to be climate driven or potentially impacted by mining activities.

4. References

Jacobs, 2017. *PGW5 Groundwater Investigation – December 2016*. Letter prepared for Liddell Coal Operations Pty Ltd by Jacobs Group (Australia) Pty Ltd. Reference No. IA117100/015b, dated 3 February 2017.

LCO, 2017. *Liddell Glencore | Plan for Water Management*. Management plan prepared by Liddell Coal Operations Pty Ltd. Reference No. LIDOC-90533967-3694, Version 9 (Approved).

5. Closing

Should you require additional information then please do not hesitate to contact our office.

Yours sincerely

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Appendix C - April 2018 ALV1L, ALV3S and ALV4L ITARP

LIDDELL

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ALV1L, ALV4L & ALV3S Groundwater Trigger Investigation April 2018

1. Introduction

1.1 Overview

In accordance with the Liddell Coal Operations (LCO) Water Management Plan (WMP) approved under NSW DA305-11-01 and EPBC Approval 2013/6908, LCO has undertaken an investigation as a result of groundwater triggers at monitoring piezometers ALV1L, ALV4L and ALV3S. Specifically, piezometers ALV1L and ALV4L have both measured three consecutive Definition #2 trigger exceedances from January 2018 to March 2018. Piezometer ALV3S has measured three consecutive groundwater quality triggers, 80th%ile electrical conductivity, from January 2018 to March 2018.

As per the WMP, LCO provided notification of the exceedance on the 13 April 2018 to Department of Crown Lands and Water, Department of Planning & Environment and Department of Environment. This notification noted "it is considered that the observations are not of potential harm to the environment based on our current knowledge, and it is noted that the measured values are below the reference maximum value of the baseline dataset recorded for the site".

This report details the Investigation Trigger Action Response Plan (ITARP) investigation completed by LCO for the each of the three trigger exceedances, specifically to determine if the exceedance presents a potential to harm the environment and determine whether it is a mining related impact requiring further investigation.

1.2 Scope

The scope for this groundwater investigation consists of:

- An investigation of three consecutive groundwater depth exceedances at groundwater monitoring site ALV1L and ALV4L.
- An investigation of three consecutive groundwater quality exceedances at groundwater monitoring site ALV3S.
- An assessment of whether there is potential harm to the environment from the exceedance and determine whether it is a mining related impact.

2. Groundwater Investigation

The monitoring results that triggered this investigation, as well as the applicable trigger levels for the three triggering piezometers are shown in **Table 1** below. Noteworthy, the groundwater level triggers exceeded are Definition #2 groundwater level triggers as per the WMP, neither of these monitoring location have Drawdown Definition #1 triggers applicable.

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Liddell Coal Operations Pty Ltd ABN 40 058 857 882
Manager and Agent of the Liddell & Foybrook Joint Ventures

Table 1: Site specific trigger values for ground water level, electrical conductivity and monthly observations

Groundwater Level - Depth to Water (m)							
Well ID	**Unit**	**Trigger Values – Definition #2**		**Monitoring Results**			
		10th percentile trigger limit	**Reference Maximum**	**Nov 2017**	**Dec 2017**	**Jan 2018**	**Feb 2018**
ALV1L	Alluvial Aquifer	4.97	6.31	4.76	5.01	5.28	5.46
ALV4L	Alluvial Aquifer	5.56	6.73	5.52	5.62	5.74	5.84
Groundwater Quality - Electrical Conductivity (ms/cm)							
Well ID	**Unit**	**Trigger Values**		**Monitoring Results**			
		80th percentile trigger limit	**Reference Maximum**	**Nov 2017**	**Dec 2017**	**Jan 2018**	**Feb 2018**
ALV3S	Shallow bedrock below alluvial aquifer	2.80	4.51	2.46	4.23	2.90	2.89

2.1 Groundwater elevations

Observed groundwater elevations and applicable trigger levels for ALV1L, ALV4L and ALV3S are shown below in **Figure 1**. A residual mass curve with respect to rainfall and evaporation is also plotted for analysis, which was calculated and applied on a daily basis in accordance with the approach presented in the Liddell Coal PGW5 Groundwater Investigation (Jacobs, 2017). As per previous investigation reports and in consultation with Department of Crown Lands and Water, LCO has reviewed the Hydrograph Analysis and Rainfall Time Trends (HARRT) analysis method and found it not suitable for use at LCO. The methodology utilised for this investigation is consistent with previous investigation reports.

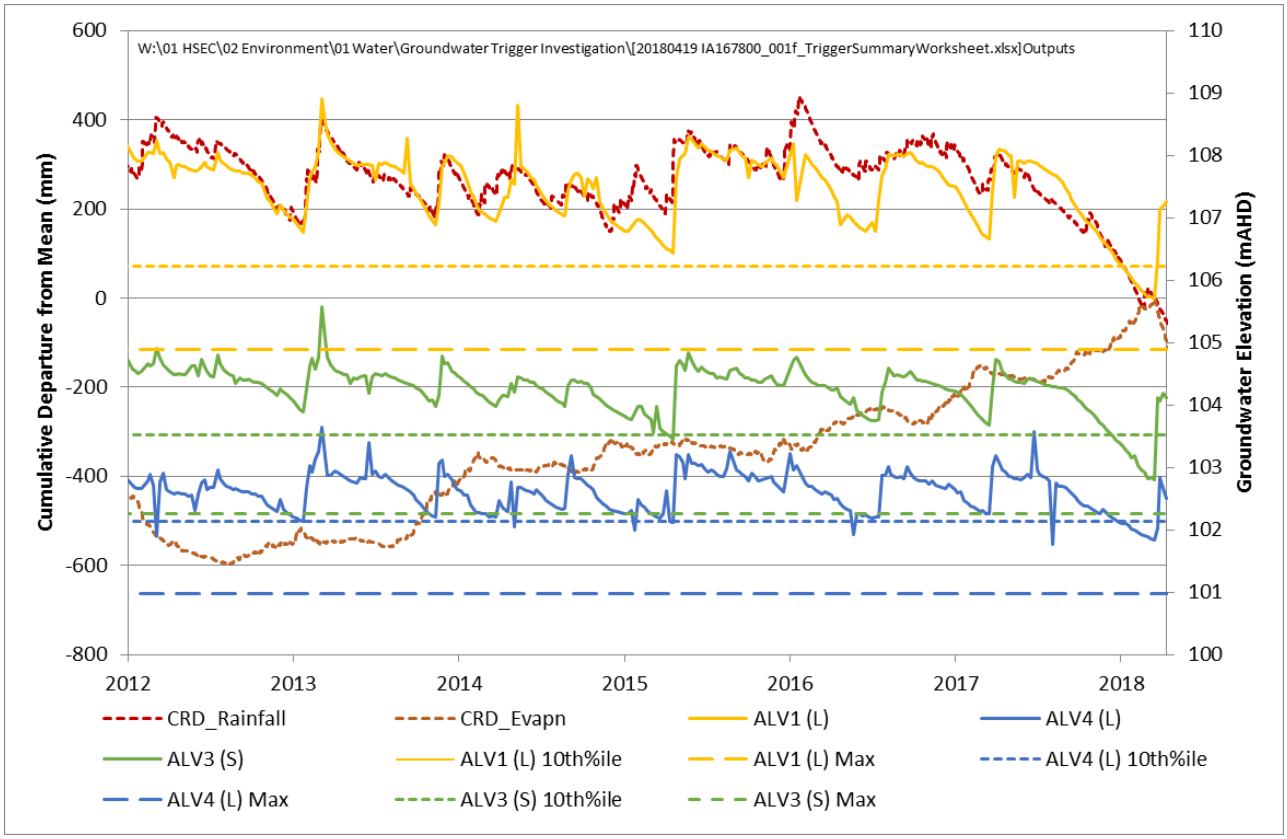

Figure 1 - Groundwater elevation (mAHD) observations at site ALV1L, ALV4L & ALV3S with August 2017 Trigger Values

As per **Figure 1**, there is a significant drop in the residual mass curve (rainfall) commencing January 2017, commensurate with an increase in slope in the residual mass curve (evaporation). This implies below average rainfall combined with higher than average evaporation was experienced. The decreased rainfall corresponds with a reduction in groundwater levels, which continued until March 2017 when a short lived period of higher rainfall was experienced. This rainfall event is shown by an increase in the residual mass curve (rainfall) and led to a declining trend in evaporation and increased groundwater levels at each of the alluvial piezometers ALV1L and ALV4L; as well as the underlying shallow bedrock piezometer ALV3S. The measured levels at all three bores have not exceeded the WMP reference maximum.

The increased rainfall did not persist beyond March 2017 and the declining trend in the residual mass curve (rainfall) recommenced throughout the remainder of the data set signifying lower than average rainfall from March 2017 to March 2018. This in turn led to a rising trend in evaporation from July 2017 and a declining trend in groundwater levels at all sites. Generally, the water level trends at all three sites are very similar to the CRD trend. Previous ITARP investigations have corroborated the understanding that rainfall is the primary driver influencing water level recharge in both the alluvium and underlying shallow bedrock, which outcrops up gradient.

Review of the depth to water measurements of all monitoring locations along Bowman's Creek (**Figure 2**) shows a similar declining trends in groundwater elevation (increasing trend in depth to water) over the entire measured system during 2017 and early 2018. Further, the decreases in water levels within the Bowman's Creek Alluvium and shallow bedrock aquifer demonstrate a similar trend. This supports the

understanding that both systems recharge in the same way. The consistency of these observations implies that the groundwater response is driven by climate and not mining activity. It is therefore considered that the climatic conditions have resulted in reduced recharge and increased evaporation, therefore, decreasing the water levels in the system. Furthermore, neither ALV1L, ALV4L nor ALV3S are within the extent of drawdown from mining operations hence the decrease in levels is considered to not be a mining-related impact.

There appears to be no clear correlation between the levels measured at these three bores with that of the underground workings inferring continued lack of connectivity (i.e. confinement of alluvium).

The currently observed groundwater levels at ALV1L and ALV4L are consistent with the historical dataset. As such, it is concluded that the exceedance does not present potential harm to the environment and that monitoring at this site should continue.

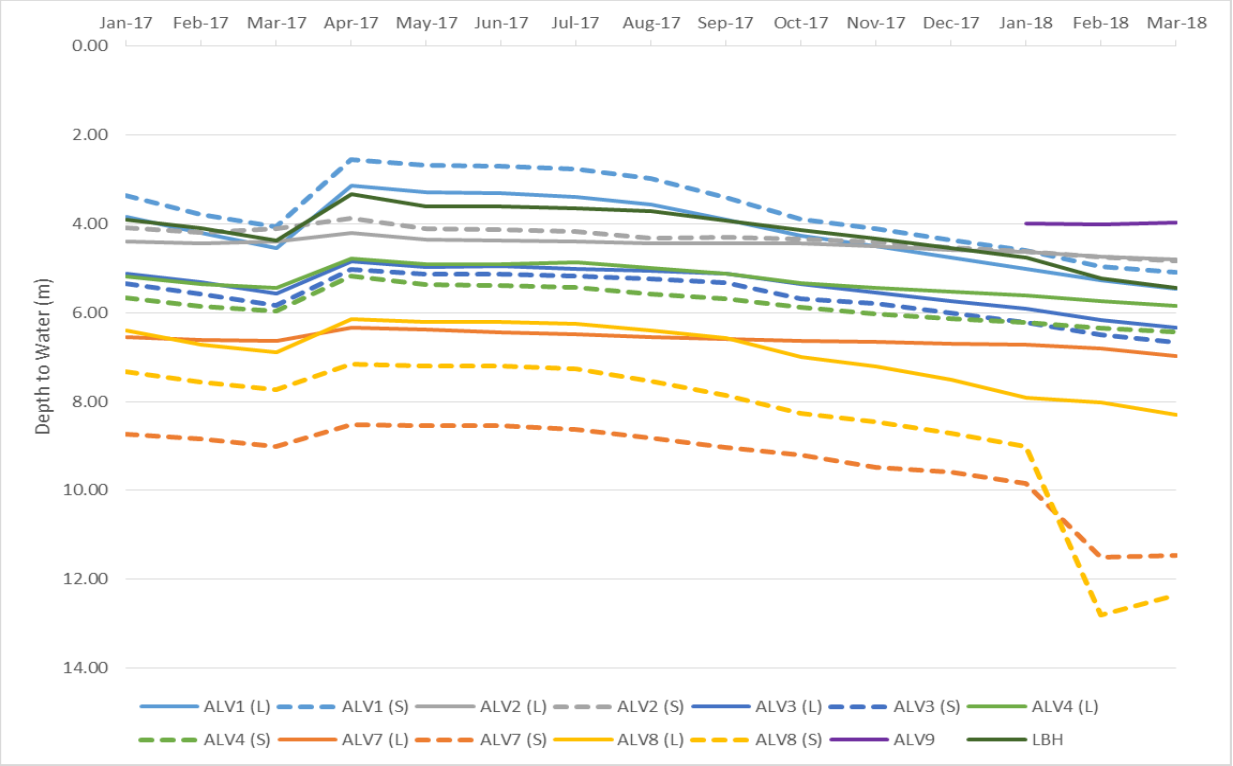

Figure 2 - Bowman's Creek alluvium and shallow bedrock depth to water observations

Whilst outside the scope of this investigation, LCO notes the significant decrease in groundwater levels at ALV7S and ALV8S since January 2018. Despite the monitoring results not yet triggering an ITARP investigation, LCO is continuing to monitor these bores closely and notes that weekly monitoring results have measured substantial recovery with recent rainfall. Additionally, short term loss and recovery was also observed over the same period in 2017, with significant rainfall events occurring in March 2017. At this time, LCO do not believe there to be material harm or potential mining related impacts occurring and will continue to monitor as per the WMP.

2.2 Groundwater Quality – Electrical Conductivity (EC)

To understand the water quality trigger at ALV3S, **Figure 3** shows the groundwater levels and trigger criteria for the paired piezometer ALV3L and ALV3S; with the residual mass curve for rainfall and evaporation. As shown, there is a downward hydraulic gradient from the ALV3L to ALV3S and consistent sympathetic response in both alluvium and shallow bedrock implying that, at this site, similar recharge mechanism occur for both systems. LCO investigated and reported the groundwater levels trending below the ITARP levels in March 2018, as required by the WMP; concluding that the measured levels were the result of climatic variations opposed to mining related impacts.

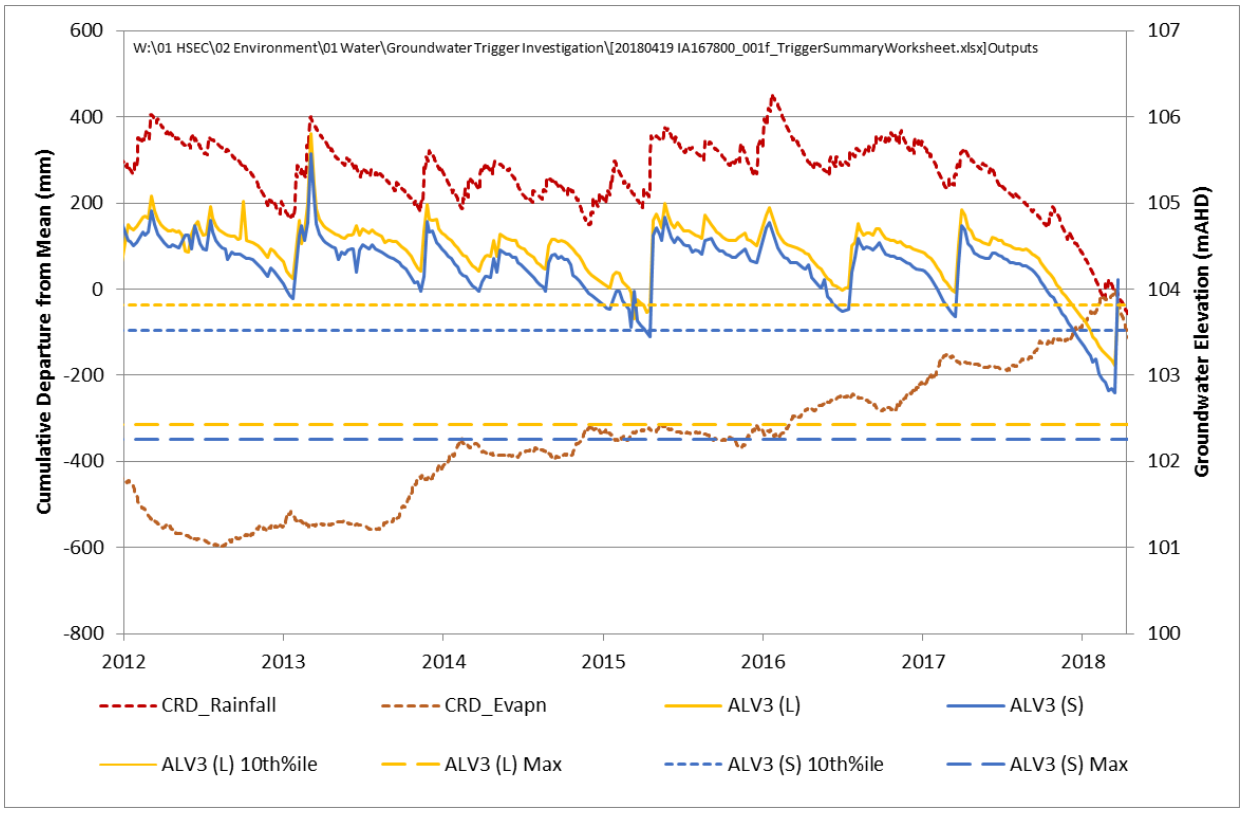

Figure 3 - Groundwater elevation (mAHD) observations at site ALV3L and ALV3S with August 2017 Trigger Values

Electrical conductivity at ALV3 with reference to the residual mass curve for rainfall and evaporation CRD is shown in **Figure 4**. With respect to ALV3S, the salinity increase has an apparent spike in January 2018, less than the reference maximum, before returning to levels just above the 80th percentile trigger level. The general increase in salinity at ALV3S is consistent with the increase in slope of the residual mass curve (evaporation) and the declining trend observed in the residual mass curve (rainfall) since March 2017. This observation has occurred previously in 2016 and 2017 where the EC levels similarly increased in line with the residual mass curves. It is therefore considered that the reduced rainfall recharge has led to the rising trend in EC observed at ALV3S. This mechanism reflects natural variability due to climatic factors and it is therefore not considered to be a mining-related impact.

Figure 5 shows the EC measurements at both the alluvium and shallow bedrock paired piezometer. Similar increasing trends in EC have been observed at ALV2S, ALV4S, ALV7S and ALV8S implying that levels are responding consistently to climatic variations.

The currently observed EC values at ALV3S are consistent with the historical dataset. As such, it is concluded that the exceedance does not present potential harm to the environment.

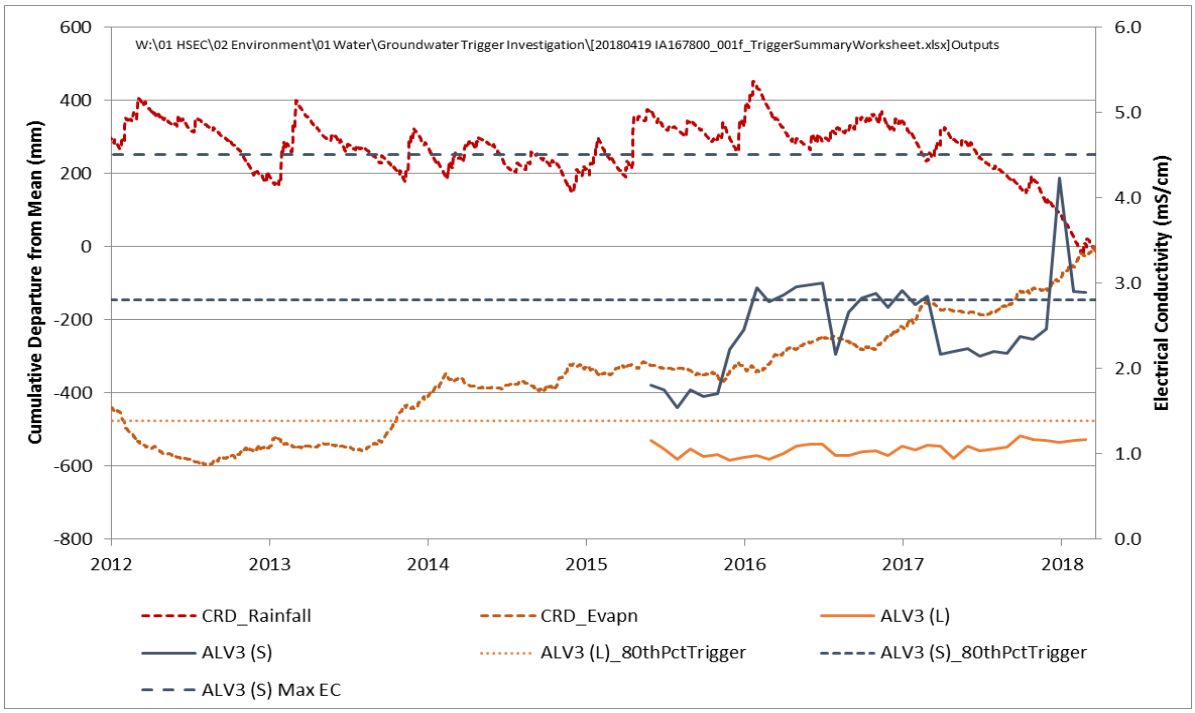

Figure 4 - Groundwater quality electrical conductivity (ms/cm) observations at ALV3L & ALV3S

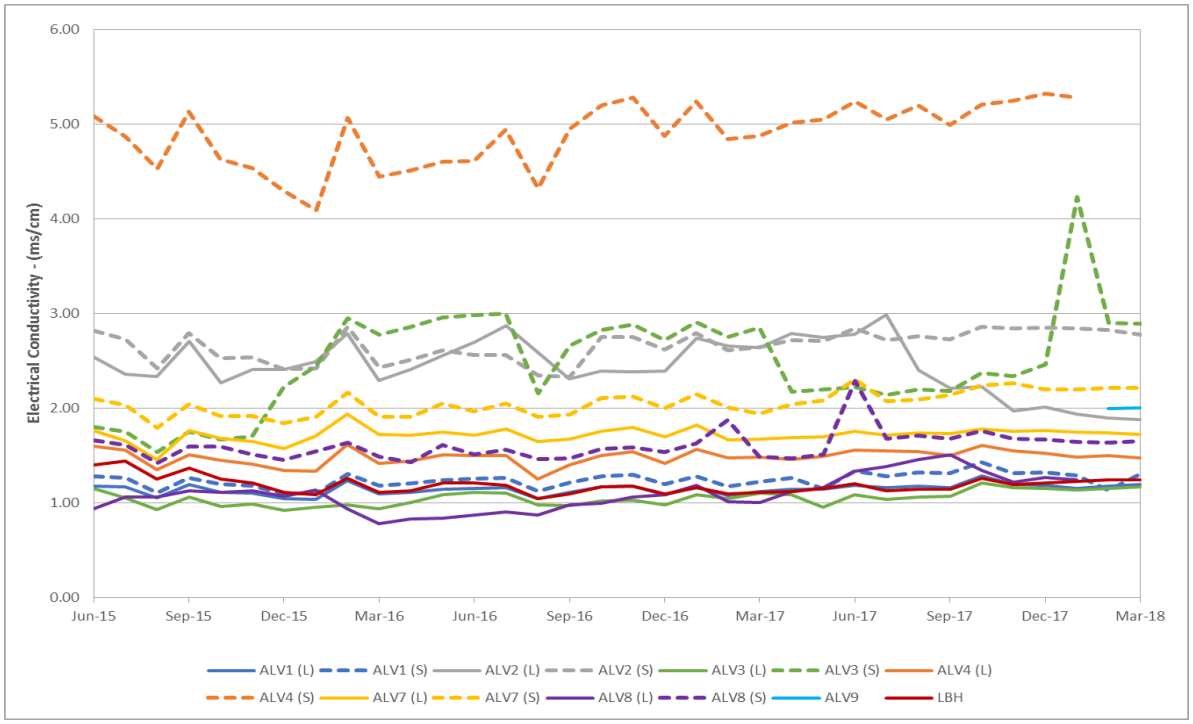

Figure 5 - Groundwater quality electrical conductivity (ms/cm) observations at all sites

A review of the mine water containment systems has yielded no evidence of malfunctions nor significant changes that could result in offsite drainage of saline water or increased connectivity.

2.3 Streamflow monitoring

Observed streamflow gauge monitoring results and residual mass curves for rainfall and evaporation are shown on **Figure 6** below.

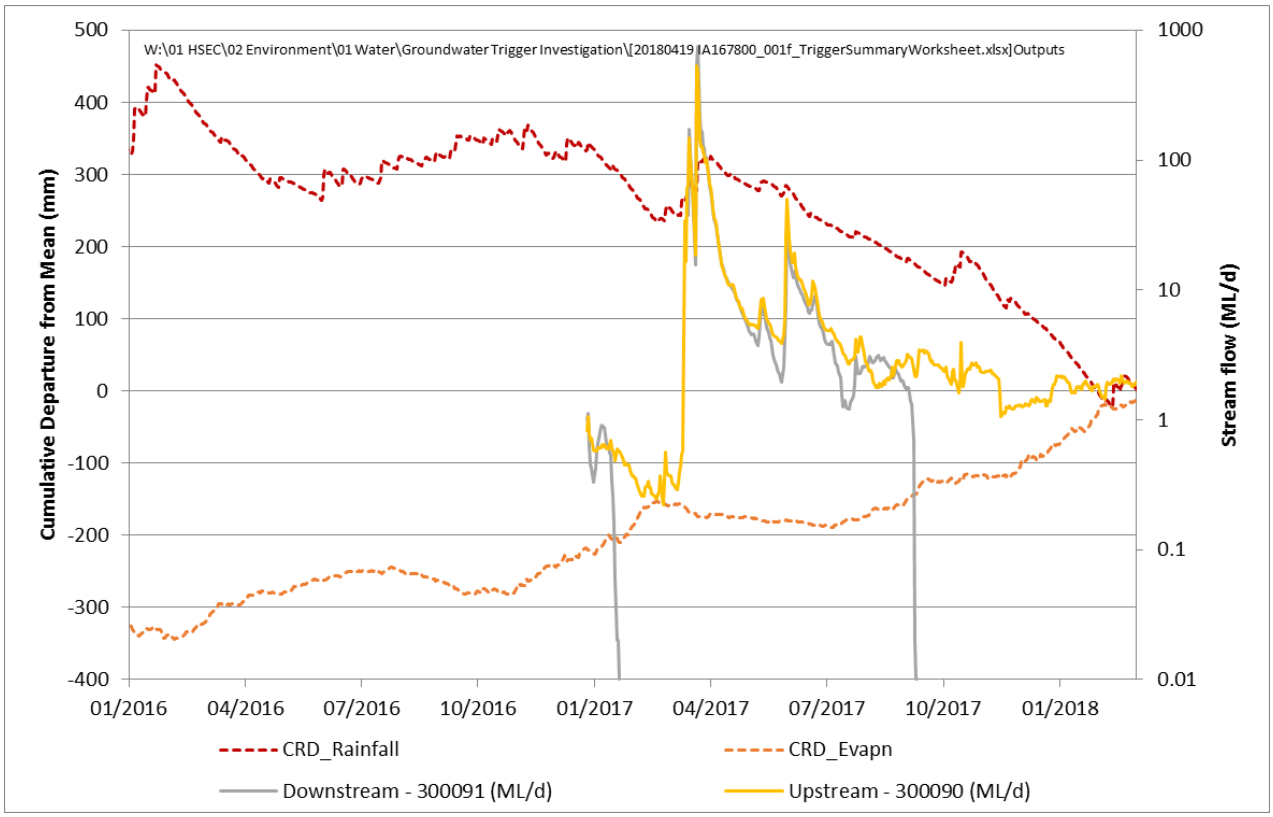

Figure 6 - Bowman's Creek streamflow observations

Bowman's Creek is an ephemeral water course that naturally ceases surface flows. From **Figure 6**, the streamflow (ML/d) observed at Bowmans Creek gauging stations downstream and upstream correlates reasonably with the declining trend observed in the residual mass curve (rainfall). This supports the conclusion that climatic conditions have resulted in reduced groundwater levels and surface water flows across the site. In regions where the creek is losing, a decrease in flow is expected to lead to a reduction in groundwater levels. This mechanism reflects natural variability due to climatic factors.

3. Conclusion

A review of the mine water containment systems has yielded no evidence of malfunctions nor significant changes that could result in offsite drainage of saline water or increased connectivity. There appears to be no clear correlation between the levels measured at these three bores with that of the underground workings, inferring continued lack of connectivity hence no depressurisation at these bores.

ALV1L, ALV4L and ALV3S are not within the extent of drawdown impacts from mining operations.

The climate data shows high evaporation and below average rainfall for the majority of 2017 and early 2018, which is considered to have resulted in the observed decrease in water levels.

Water levels along the whole system have generally declined similarly. Further, the observed decline is consistent for both the shallow bedrock and alluvium along the whole system.

Groundwater EC levels along the shallow bedrock system have generally increased similarly to ALV3S.

The exceedances at ALV1L, ALV4L and ALV3S are not outside of the maximum range recorded for the applicable levels datasets.

From the investigation findings, ALV1L and ALV4L groundwater levels as well as ALV3S groundwater EC levels are likely reflecting natural variability due to climate factors and there is no mining related impact or likely potential of environmental harm.

LCO propose to continue monitoring in accordance with the WMP. Consequently, if groundwater levels at ALV1L and ALV4L continue to be measured below the trigger level for a further nine months, such that the exceedance has been continuous for twelve months, then a subsequent investigation shall be undertaken to confirm the exceedance remains unrelated to mining activity. Additionally, if EC levels at ALV3S remain above the trigger level for a further three months, such that the exceedance has been continuous for six months, then a subsequent investigation shall be undertaken to confirm the exceedance remains unrelated to mining activity.

Appendix D - July 2017 PW5S ITARP

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24 July 2017

Attention: Ben de Somer
Liddell Coal Operations Pty Ltd
PO Box 7
SINGLETON, NSW 2330

Project Name: Liddell Coal Operations
Project Number: IA138100

Subject: PGW5S Groundwater Investigation and PGW5L Further Investigation - July 2017

Dear Ben

1. Introduction

1.1 Overview

Jacobs Group (Australia) Pty Ltd (Jacobs) has been commissioned by Liddell Coal Operations Pty Ltd (LCO) to undertake an investigation of a groundwater quality trigger at groundwater monitoring piezometer PGW5S at Liddell Mine, and complete a review of on-going exceedance at groundwater monitoring piezometer PGW5L at Liddell Mine, specifically in regard to whether the continuing exceedance presents a potential to harm the environment.

An exceedance of the trigger level with respect to Electrical Conductivity (EC) at monitoring piezometer PGW5S (installed into the Overburden[1]) was notified on 13 July 2017, being three consecutive exceedances of the nominated trigger level.

An exceedance of the trigger level with respect to Electrical Conductivity (EC) at monitoring piezometer PGW5L (installed into the Pikes Gully Seam[1]) occurred in December 2016 and was subsequently investigated (Jacobs, 2017). At the time, given that monitoring piezometer PGW5S had also exceeded the 80th percentile value of the historical record in October and November 2016, that piezometer was also included in the Jacobs (2017) investigation.

Jacobs' (2017) investigation concluded that:

"*..the exceedances are due to natural climatic variation and there is no evidence that they are mining related…*" and

"*…It is anticipated that current behaviour of groundwater quality will continue and it is not considered necessary to undertake further investigation if the current exceedance continues.*"

[Jacobs, 2017, page 8]

[1]It is highlighted that it is currently proposed to remove monitoring site PGW5 from the Groundwater Level Trigger Definition and Groundwater Quality Trigger Definition at Liddell Mine, since piezometers PGW5S and PGW5L are not water table aquifer piezometers, instead being installed into the Overburden and Pikes Gully Seam respectively.

This letter presents an investigation of the exceedance at PGW5S and a review of whether the above-mentioned conclusion, with respect to PGW5L, remains valid.

It is also noted that piezometers PGW5S and PGW5L have been incorrectly identified in previous correspondence as being screened in the Pikes Gully Seam and Overburden respectively. Recent field investigation has found that the depth to the bottom of the smaller diameter piezometer (PGW5S) is 11.5m below top of casing, which implies it is installed into the Overburden. The depth to the bottom of the larger diameter piezometer (PGW5L) is 44m below top of casing, implying it is installed into the Pikes Gully Seam. This discrepancy has now been corrected in the current draft of the Water Management Plan.

1.2 Scope of Work

The Scope of Work for this groundwater investigation consists:

- investigation of continuing exceedance at groundwater monitoring site PGW5
- assessment of whether there is potential harm to the environment from the exceedance.

2. PGW5 Further Groundwater Investigation

In accordance with agreed amendments to the current Water Management Plan for Liddell Mine (LCO, 2017), notification of the exceedance was provided to DPI Water, Department of Planning and Environment and Department of Environment on 13 July 2017 via email.

Table 1 presents the recent water quality observations (EC) at monitoring site PGW5. It is noted that the trigger values presented in **Table 1** are those used in the previous investigation, whereas, in the future, there will not be a trigger value defined for monitoring site PGW5.

Figure 1 presents time-series groundwater elevation at site PGW5 and **Figure 2** presents time-series groundwater quality (salinity as EC). **Figure 1** and **Figure 2** include a residual mass curve with respect to rainfall and evaporation. The SILO climatic dataset (Department of Science, Information Technology and Innovation of the Queensland Government) was used. The residual mass curves were determined using internally calculated means and applied on a daily basis, in accordance with the approach presented in Jacobs (2017) [Station No. 0610208].

It is noted that the HARTT analysis method, which was noted by DPI Water in response to the Jacobs (2017) investigation as a tool that could be used with trigger level investigations, was reviewed and found to not be suitable for use at Liddell Mine. As Jacobs understands it, the HARTT methodology was developed by the WA Department of Agriculture for use in the Gnangnara Groundwater Mound in WA. Jacobs has concerns that the proximity of monitoring piezometers to Bowmans Creek, which is known to be gaining at the northern end of the mining lease, intermittently gaining/losing at the midpoint and losing at the southern end of the mining lease, renders the analysis method potentially invalid. Correspondence with the WA Department of Agriculture has indicated that a revised model is in the process of being developed and that revised model will be reviewed when it is released.

From **Figure 1**, there is a significant drop in the residual mass curve (rainfall) commencing January 2017, commensurate with an increase in slope in the residual mass curve (evaporation). This implies below average rainfall combined with higher than average evaporation. It is interpreted that there is a delay of several months before this change is recognised in the groundwater elevation at site PGW5. In any regard, the observed elevations are consistent with the historical range and it is expected that they will they will return to their median value following resumption of median climatic conditions.

Table 1: Groundwater Quality (EC, mS/cm) Observations (Hard Rock Aquifer (Coal Measures))

Site	80th%	Ref. Maxm	2015							2016													2017					
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
PGW 5S	**5.77**[1]	**6.82**[1]	**5.88**	5.41	5.02	5.60	4.91	5.03	4.81	4.81	**5.79**	4.97	5.01	5.14	5.14	5.69	5.09	5.33	**5.84**	**6.01**	5.69	**6.01**	5.57	5.76	**5.85**	**5.86**	**6.01**
PGW 5L	**5.05**[1]	**6.06**[1]	5.04	4.83	4.36	4.92	4.42	4.44	4.30	4.28	**5.06**	4.46	4.43	4.45	4.51	4.83	4.41	4.71	**5.09**	**5.26**	**5.06**	**5.74**	**5.43**	**5.50**	**5.62**	**5.62**	**5.76**

Note. 1. The nominated trigger values refer to those values noted in the previous investigation (Jacobs, 2017). In the current revision of the Water Management Plan, site PGW5 is proposed to be removed from the Groundwater Level Trigger Definition and Groundwater Quality Trigger Definition a Liddell Mine, since piezometers PGW5S and PGW5L are not water table aquifer piezometers, instead being installed into the Overburden and Pikes Gully Seam respectively. Accordingly, in the future, there will not be a trigger value defined for monitoring site PGW5.

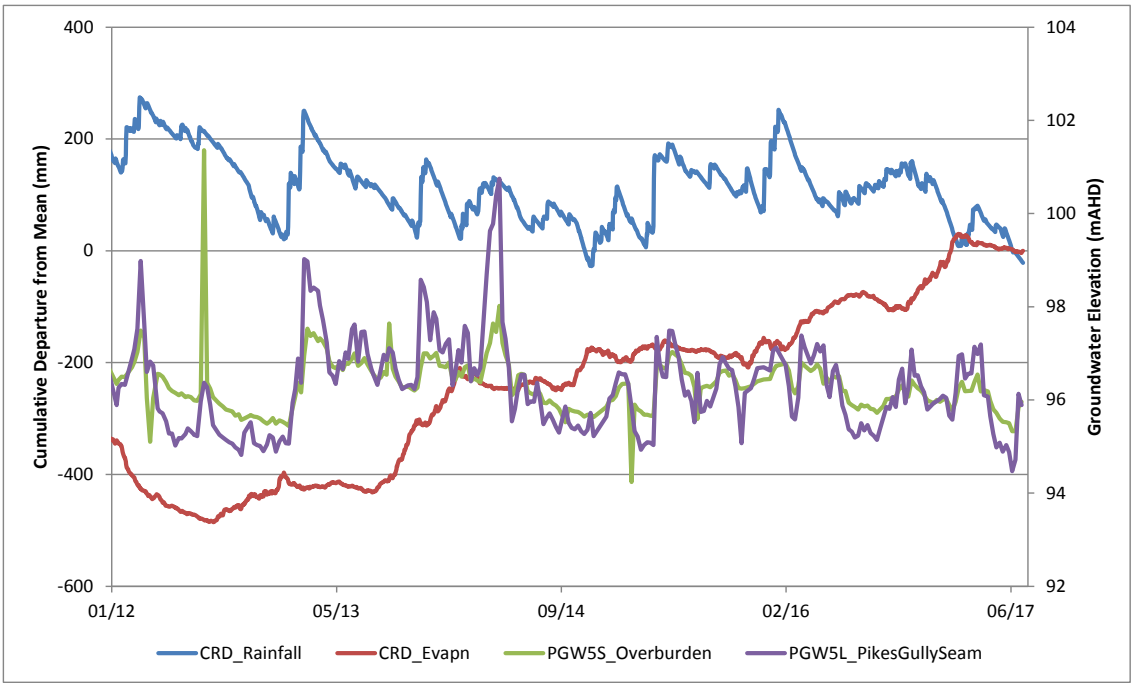

Figure 1 : Groundwater elevation (mAHD) observations at site PGW5

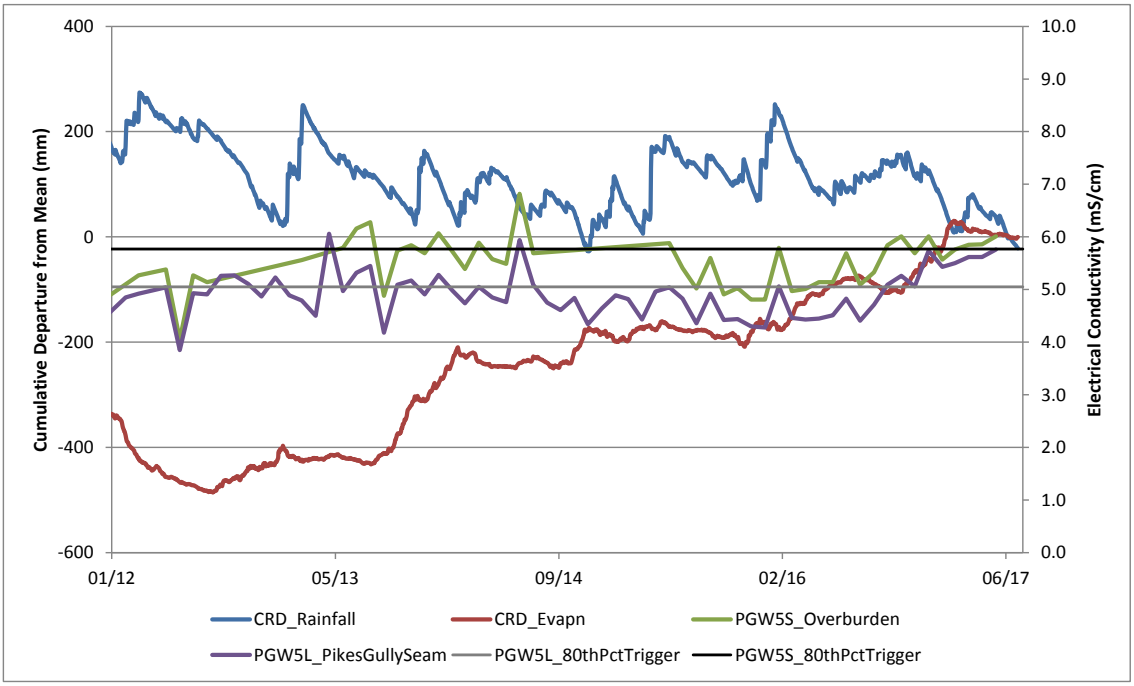

Figure 2 : Groundwater quality (EC, mS/cm) observations at PGW5

From **Figure 2**, the increase in groundwater salinity (as EC, mS/cm) in both PGW5S and PGW5L correlates reasonably with the increase in slope of the residual mass curve (evaporation), if it is interpreted that there is a delay of several months in the response. The currently observed values are not, however, significantly outside the range of the historical record.

It is concluded that the on-going exceedance in groundwater quality (salinity) at PGW5 does not present potential harm to the environment and that monitoring at this site should continue. As noted above, these piezometers are installed into the Overburden and Pikes Gully Seam respectively, and accordingly are not intended to be retained as trigger level sites in the future.

3. Conclusion

Jacobs considers that groundwater quality (as salinity) continues to reflect natural variability due to climatic factors and there is not a mining-related impact. The conclusion from the investigation of PGW5 conducted in February 2017, that there is no potential harm to the environment due the currently elevated groundwater salinity, remains valid. It is highlighted that the observed groundwater salinity currently remains within the historical range (referred to as the baseline dataset, specifically July 2005 to May 2017 inclusive).

It is recommended that monitoring continues at PGW5, however, as noted, it is intended that these piezometers, which are installed into the Overburden and Pikes Gully Seam respectively and, accordingly, are not water table aquifer piezometers, will not be retained as trigger level sites in the future. Further investigation of PGW5 is not considered to be required at this stage.

It is suggested that if groundwater quality significantly exceeds the historical maximum, say 8.0mS/cm at either site on three consecutive occasions, then a further review should be considered.

4. References

Jacobs, 2017. *PGW5 Groundwater Investigation – December 2016*. Letter prepared for Liddell Coal Operations Pty Ltd by Jacobs Group (Australia) Pty Ltd. Reference No. IA117100/015b, dated 3 February 2017.

LCO, 2017. *Draft Liddell Glencore | Plan for Water Management*. Management plan (draft) prepared by Liddell Coal Operations Pty Ltd. Reference No. LCO SD PLN 0041, Revision 7.1 (Draft).

5. Closing

Should you require additional information then please do not hesitate to contact our office.

Yours sincerely

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Appendix E - March 2018 ALV3L and ALV3S ITARP

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ALV3L & ALV3S Groundwater Depth Trigger Investigation March 2018

1. Introduction

1.1 Overview

In accordance with the Liddell Coal Operations (LCO) Water Management Plan (WMP) approved under NSW DA305-11-01 and EPBC Approval 2013/6908, LCO has undertaken an investigation as a result of groundwater level triggers at monitoring piezometers ALV3L and ALV3S. Specifically, both of these piezometers have measured three consecutive Definition #2 trigger exceedances from December 2017 to February 2018.

As per the WMP, LCO provided notification of the exceedance on the 20 March 2018 to DPI Water, Department of Planning & Environment and Department of Environment. This notification noted "it is considered that the observations are not of potential harm to the environment based on our current knowledge, and it is noted that the measured values are below the reference maximum value of the baseline dataset recorded for the site".

This report details the Investigation Trigger Action Response Plan (ITARP) investigation completed by LCO for the paired piezometer ALV3, specifically to determine if the exceedance presents a potential to harm the environment and determine whether it is a mining related impact.

1.2 Scope

The scope for this groundwater investigation consists of:

- An investigation of three consecutive groundwater depth exceedances at groundwater monitoring site ALV3L and ALV3S.
- An assessment of whether there is potential harm to the environment from the exceedance and determine whether it is a mining related impact.

2. Groundwater Investigation

The groundwater level monitoring results that triggered this investigation, as well as the applicable trigger levels for the paired ALV3 piezometer are shown in **Table 1** below. The trigger levels exceeded in this case are Definition #2 groundwater level triggers as per the WMP, this monitoring location does not have Drawdown Definition #1 triggers applicable.

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Manager and Agent of the Liddell & Foybrook Joint Ventures

Table 1: ALV3 site specific trigger values for groundwater level and monthly observations

Well ID	Unit	Trigger Values		Monitoring Results			
		10th percentile trigger limit Depth to Water (m)	Reference Maximum Depth to Water (m)	Nov 2017 Depth to Water (m)	Dec 2017 Depth to Water (m)	Jan 2018 Depth to Water (m)	Feb 2018 Depth to Water (m)
ALV3L	Alluvial aquifer	5.70	7.08	5.55	5.73	5.91	6.17
ALV3S	Underlying Shallow bedrock	5.99	7.26	5.79	6.01	6.21	6.50

2.1 Groundwater elevations

Observed groundwater elevations and applicable the trigger levels for ALV3L and ALV3S are shown below in **Figure 1**. A residual mass curve with respect to rainfall and evaporation is also plotted for analysis, which was calculated and applied on a daily basis in accordance with the approach presented in the Liddell Coal PGW5 Groundwater Investigation (Jacobs, 2017). As per previous investigation reports and in consultation with DPI Water, LCO has reviewed the Hydrograph Analysis and Rainfall Time Trends (HARRT) analysis method and found it not suitable for use at LCO. The methodology utilised for this investigation is consistent with previous investigation reports.

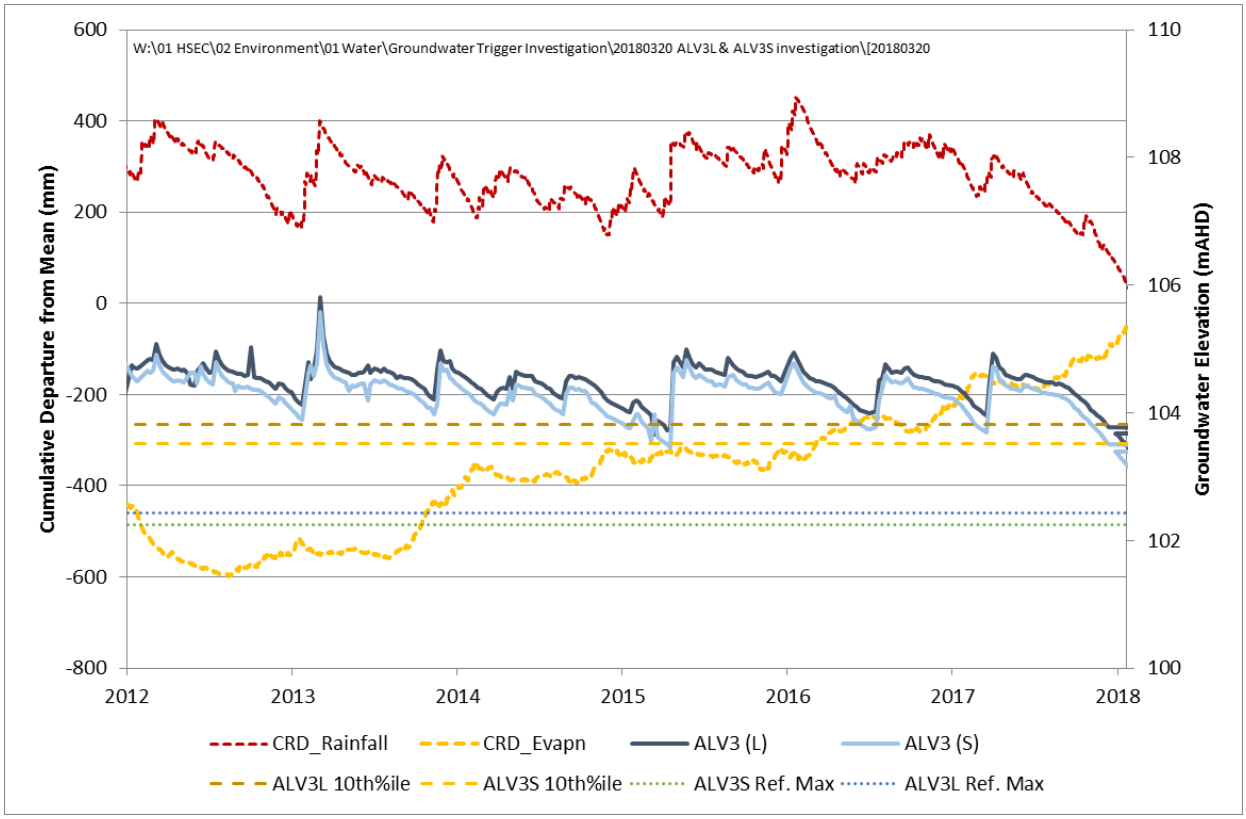

Figure 1 - Groundwater elevation (mAHD) observations at site ALV3S & ALV3L with August 2017 Trigger Values

From **Figure 1**, there is a significant drop in the residual mass curve (rainfall) commencing January 2017, commensurate with an increase in slope in the residual mass curve (evaporation). This implies below average rainfall combined with higher than average evaporation. The decreased rainfall corresponds with a reduction in groundwater levels, which continued until March 2017 when a short lived period of higher rainfall was experienced. This rainfall event is shown by an increase in the residual mass curve (rainfall) and led to a declining trend in evaporation and increased groundwater levels at ALV3L & ALV3S. The measured levels at ALV3L & ALV3S have not exceeded the WMP reference maximum.

The increased rainfall did not persist beyond March 2017 and the declining trend in the residual mass curve (rainfall) continued throughout the remainder of the data set signifying lower than average rainfall from March 2017 to February 2018. This in turn led to a rising trend in evaporation from July 2017 and a declining trend in groundwater levels at both sites. Generally, the water level trends at ALV3L & ALV3S are very similar to the CRD trend; further both bores trend together consistently. This indicates that there are similar rates of decreasing water levels in the alluvial aquifer as the shallow bedrock aquifer.

Review of the depth to water measurements of all monitoring locations along Bowman's Creek (**Figure 2**) shows a similar declining trends in groundwater elevation (increasing trend in depth to water) over the entire measured system during 2017 and early 2018. Further, the decreases in water levels within the Bowman's Creek Alluvium and shallow bedrock aquifer demonstrate a similar trend. The consistency of these observations implies that the groundwater response is driven by climate and not mining activity. It is therefore considered that the climatic conditions have resulted in reduced recharge and increased evaporation, therefore, decreasing the water levels in the system. Furthermore, ALV3 is not within the

extent of drawdown from mining operations hence the decrease in levels is considered to not be a mining-related impact.

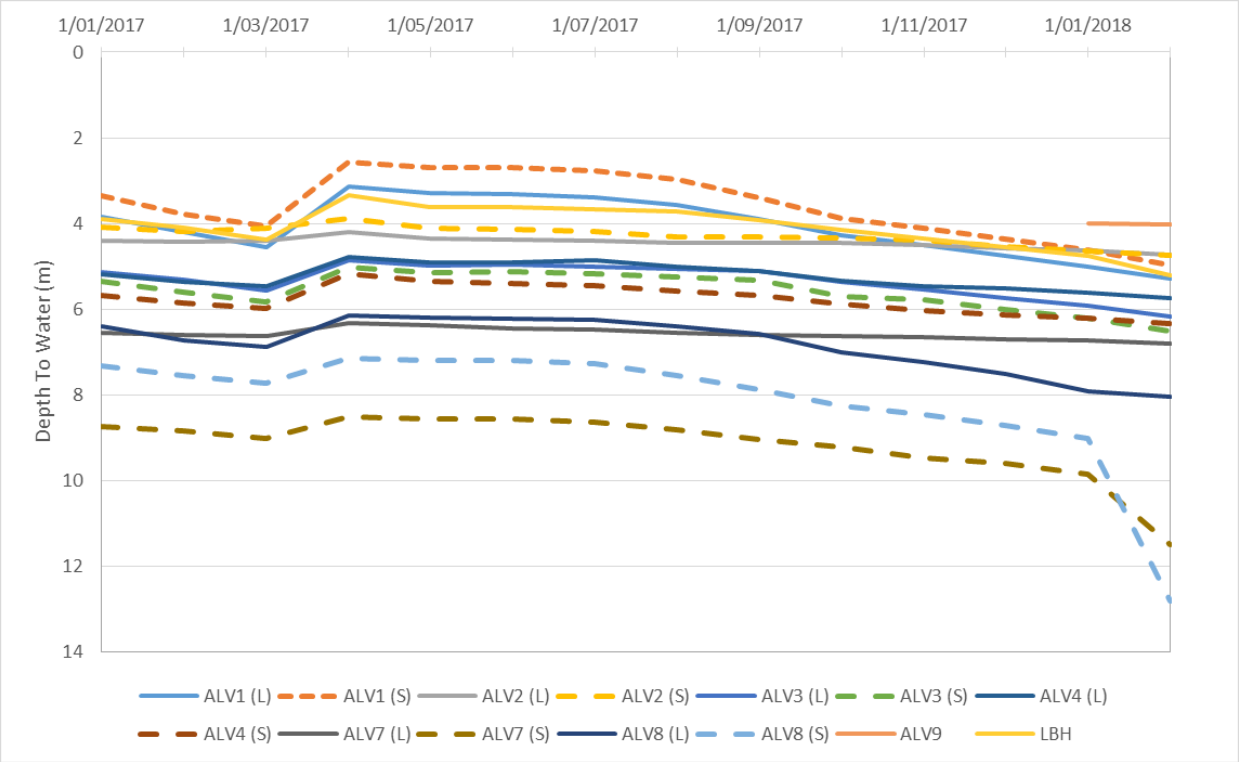

Figure 2 - Bowman's Creek alluvium and shallow bedrock depth to water observations

2.2 Streamflow monitoring

Observed streamflow gauge monitoring results and residual mass curves for rainfall and evaporation are shown on **Figure 3** below.

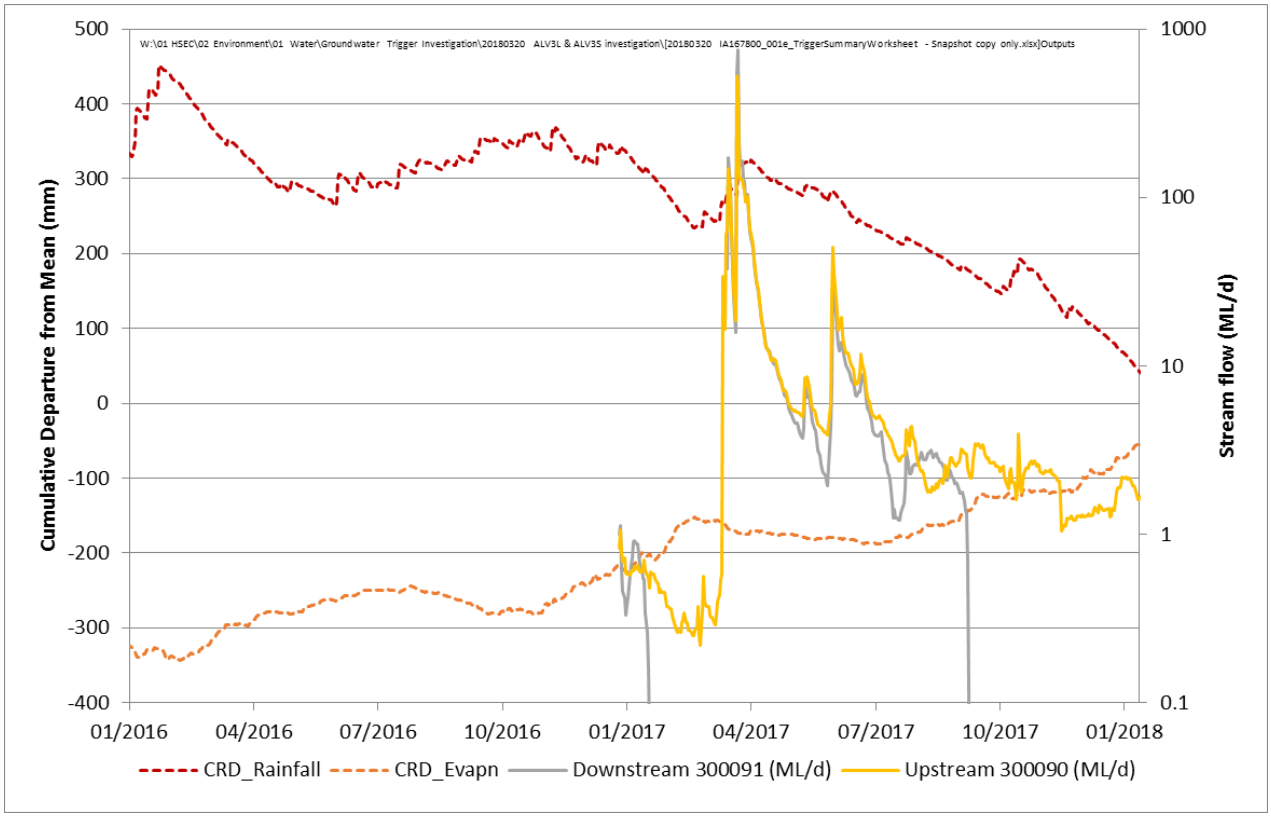

Figure 3 - Bowman's Creek streamflow observations

Bowman's Creek is an ephemeral water course that will naturally cease surface flows. From **Figure 2**, the streamflow (ML/d) observed at Bowmans Creek gauging stations downstream and upstream correlates reasonably with the declining trend observed in the residual mass curve (rainfall). This supports the conclusion that climatic conditions have resulted in reduced groundwater levels and surface water flows across the site. In regions where the creek is losing, a decrease in flow is expected to lead a reduction in groundwater levels. This mechanism reflects natural variability due to climatic factors.

3. Conclusion

The climate data shows high evaporation and below average rainfall for the majority of 2017 and early 2018, which is considered to have resulted in the observed decrease in water levels.

ALV3L and ALV3S are not within the extent of drawdown from mining operations.

Water levels along the whole system have generally declined similarly to ALV3. Further, the observed decline is consistent for both the shallow bedrock and alluvium along the whole system.

The exceedance at ALV3L and ALV3S are not outside of the maximum range recorded.

From the investigation findings, ALV3L and ALV3S groundwater levels are likely reflecting natural variability due to climate factors and there is no mining related impact or likely potential of environmental harm.

LCO propose to continue monitoring in accordance with the WMP. Consequently, if groundwater levels continue to be measured below the trigger level for a further nine months, such that the exceedance has been continuous for 12 months, then a subsequent investigation shall be undertaken to confirm the exceedance remains unrelated to mining activity.

Appendix F - May 2018 ALV7L, ALV7S and ALV8S ITARP

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ALV7L, ALV7S & ALV8S Groundwater Trigger Investigation May 2018

1. Introduction

1.1 Overview

In accordance with the Liddell Coal Operations (LCO) Water Management Plan (WMP) approved under NSW DA305-11-01 and EPBC Approval 2013/6908, LCO has undertaken an investigation as a result of groundwater triggers at monitoring piezometers ALV7L, ALV7S and ALV8S. Specifically, each piezometer has measured three consecutive Definition #2 trigger exceedances from February 2018 to April 2018.

As per the WMP, LCO notified Department of Crown Lands and Water, Department of Planning & Environment and Department of Environment of the exceedance on the 11 May 2018. This notification noted "It is considered that the observations are not of potential harm to the environment based on our current knowledge and; it is noted for ALV7S and ALV8S that whilst the measured values exceeded the reference maximum of the baseline dataset recorded for the site in February and March, levels have recovered to within the baseline reference range in April." Further, it was noted that "there has not been an exceedance of the drawdown trigger limits in the alluvium (as per the WMP, groundwater level Definition #1 trigger)."

This report details the Investigation Trigger Action Response Plan (ITARP) investigation completed by LCO for the each of the three trigger exceedances, specifically to determine if the exceedance presents a potential to harm the environment and determine whether it is a mining related impact requiring further investigation.

1.2 Scope

The scope for this groundwater investigation consists of:

- An investigation of three consecutive groundwater depth exceedances at groundwater monitoring sites ALV7L, ALV7S and ALV8S.
- An assessment of whether there is potential harm to the environment from the exceedance and determine whether it is a mining related impact.

2. Groundwater Investigation

The monitoring results that triggered this investigation, as well as the applicable trigger levels for the three triggering piezometers are shown in **Table 1** below. Noteworthy, the groundwater level triggers

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exceeded are Definition #2 groundwater level triggers as per the WMP, neither of these monitoring locations have Drawdown Definition #1 triggers applicable.

Table 1: Site specific trigger values for ground water level and monthly observations

Groundwater Level - Depth to Water (m)							
Well ID	Unit	Trigger Values – Definition #2		Monitoring Results			
		10th percentile trigger limit	Reference Maximum	January 2018	February 2018	March 2018	April 2018
ALV7L	Alluvial Aquifer	6.75	7.34	6.73	6.81	6.97	6.97
ALV7S	Shallow Bedrock Below Alluvial Aquifer	10.21	11.38	9.84	11.50	11.46	10.71
ALV8S	Shallow Bedrock Below Alluvial Aquifer	9.03	11.08	9.02	12.80	12.35	10.73

2.1 Groundwater elevations

Paired piezometers are installed at each monitoring location, ALV7 and ALV8, targeting the alluvial aquifer (ALV7L, ALV8L) and the underlying shallow bedrock (ALV7S, ALV8S). Observed groundwater elevations and applicable trigger levels for paired piezometers ALV7 and ALV8 are shown below in **Figure 1**. A residual mass curve with respect to rainfall and evaporation is also plotted for analysis, which was calculated and applied on a daily basis in accordance with the approach presented in the Liddell Coal PGW5 Groundwater Investigation (Jacobs, 2017). As per previous investigation reports and in consultation with Department of Crown Lands and Water, LCO has reviewed the Hydrograph Analysis and Rainfall Time Trends (HARRT) analysis method and found it not suitable for use at LCO. The methodology utilised for this investigation is consistent with previous investigation reports.

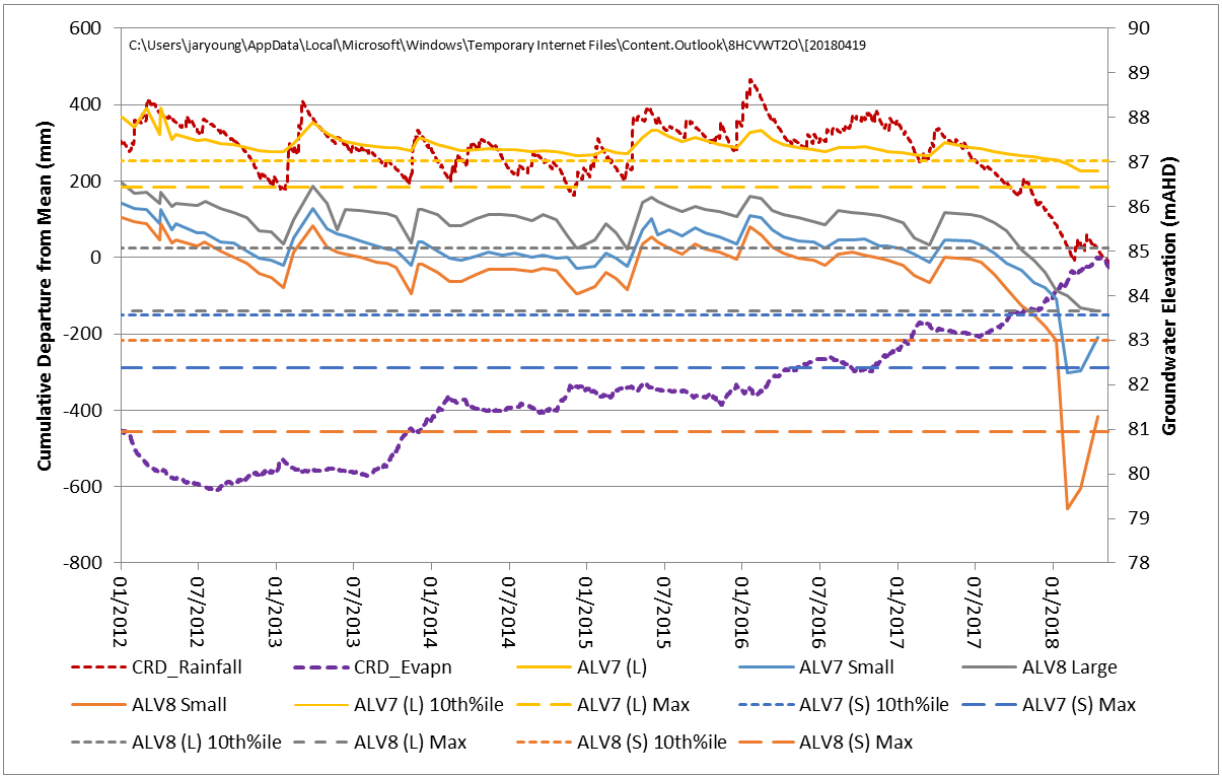

Figure 1 - Groundwater elevation (mAHD) observations at paired piezometers ALV7 and ALV8 with August 2017 Trigger Values

As per **Figure 1**, there is a significant drop in the residual mass curve (rainfall) commencing January 2017, commensurate with an increase in slope in the residual mass curve (evaporation). This implies below average rainfall combined with higher than average evaporation was experienced. Further the evaporation mass curve has seen prolonged steady increase since July 2017 to present indicating that the above average evaporation has been sustained without break. The decreased rainfall corresponds with a reduction in groundwater levels, which continued until March 2017 when a short lived period of higher rainfall was experienced. This rainfall event is shown by an increase in the residual mass curve (rainfall) and led to a declining trend in evaporation and increased groundwater levels at each of the alluvial piezometers ALV7L and ALV8L; as well as the underlying shallow bedrock piezometers ALV7S and ALV8S.

The increased rainfall did not persist beyond March 2017 and the declining trend in the residual mass curve (rainfall) recommenced throughout the remainder of the data set signifying lower than average rainfall from March 2017 to March 2018. This in turn led to a rising trend in evaporation from July 2017 and a declining trend in groundwater levels at all sites.

Similarly to March 2017, observed rainfall during March 2018 was 89mm at LCO. Rainfall during March 2018 essentially equalled the rainfall recorded at LCO in the previous three months with a total of 93mm. This short rain event corresponded with a temporary stabilisation in the rainfall residual mass curve however negligible stabilisation of the evaporation residual mass curve. This rainfall also corresponded with the measured levels at the two shallow bedrock bores that have shown significant movement during 2018.

The large and rapid decreases in water level in the shallow bedrock bores (ALV7S and ALV8S) is inferred to be due to the dewatering of a fracture horizon. Groundwater storage in fractured rock systems is almost entirely within the fracture network as opposed to unconsolidated formations, such as alluvium, where groundwater storage is within the intergranular pore space. In ALV7S and ALV8S in is considered that as groundwater levels have gradually declined under dry climatic conditions, the groundwater level dropped below a fracture horizon that was transmitting water to these bores causing the water level to drop to the next fracture horizon. The rainfall events towards the end of February and throughout March 2018 have been sufficient to partially recover shallow bedrock groundwater levels. Groundwater storage within the alluvium is more evenly distributed throughout the formation and therefore shows more gradual variations compared to the shallow bedrock.

Generally, the water level trends at all four bores sites are very similar to the CRD trend and whilst the reference maximums for ALV7S and ALV8S have been exceeded, the residual mass curve rainfall has the longest declining trend since 2005 at the commencement of the reference time frame. This implies that LCO is measuring groundwater levels in climate conditions at maximums measured in the reference period and therefore observations within reference maximums are likely to occur in a system driven by rainfall.

Previous ITARP investigations have corroborated the understanding that rainfall is the primary driver influencing water level recharge in both the alluvium and underlying shallow bedrock, which outcrops up gradient.

Review of the depth to water measurements of all monitoring locations along Bowman's Creek (**Figure 2**) shows a similar declining trend in groundwater elevation (increasing trend in depth to water) over the entire measured system during 2017 and early 2018. Further, the decreases in water levels within the Bowman's Creek Alluvium and shallow bedrock aquifer demonstrate a similar trend. This supports the understanding that both systems recharge in the same way. The consistency of these observations along the whole system implies that the groundwater response is driven by climate and not mining activity. It is therefore considered that the climatic conditions have resulted in reduced recharge and increased evaporation, therefore, decreasing the water levels in the system.

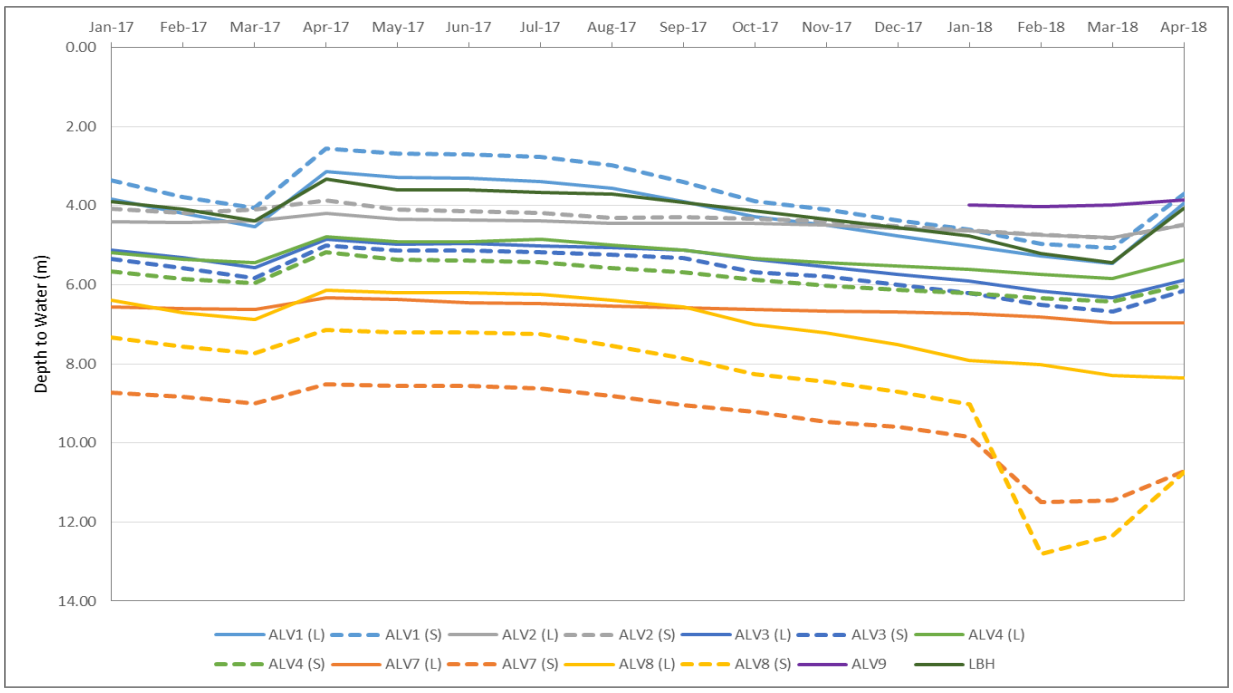

Figure 2 - Bowman's Creek alluvium and shallow bedrock depth to water observations

Measurements of the underlying shallow bedrock piezometer at each location show significant change which is not corroborated to the same degree as the above alluvial; despite similar level trends. This is considered to be due to the groundwater storage mechanisms of the shallow bedrock and the dewatering of a fracture horizon and is therefore not considered to be a mining related impact.

As per EIS modelling, LCO has potential to have drawdown impacts occur along Bowman's Creek as a result of the operation and approved under DA205-11-01 and EPBC 2013/6098. As per the WMP, Definition 1 triggers are in place to detect and monitor potential drawdown impacts; these observations do not corroborate drawdown impacts or exceed the Definition 1 trigger levels. Noteworthy, ALV7 is not within the predicted potential drawdown area and is used as the reference bore for detection of drawdown at ALV8; both bores have exhibited similar changes in groundwater levels supporting the conclusion that the observations are climate driven and not a mining-related impact.

As per **Figure 3,** there appears to be no clear correlation between the levels measured at these three bores with that of the underground workings (measured at M49, MLB & Mount Owen), which have shown a general rising trend throughout 2018, inferring continued lack of connectivity with the overlying alluvium.

A review of the mine water containment systems has yielded no evidence of malfunctions nor significant changes that could result in offsite drainage of saline water or increased connectivity.

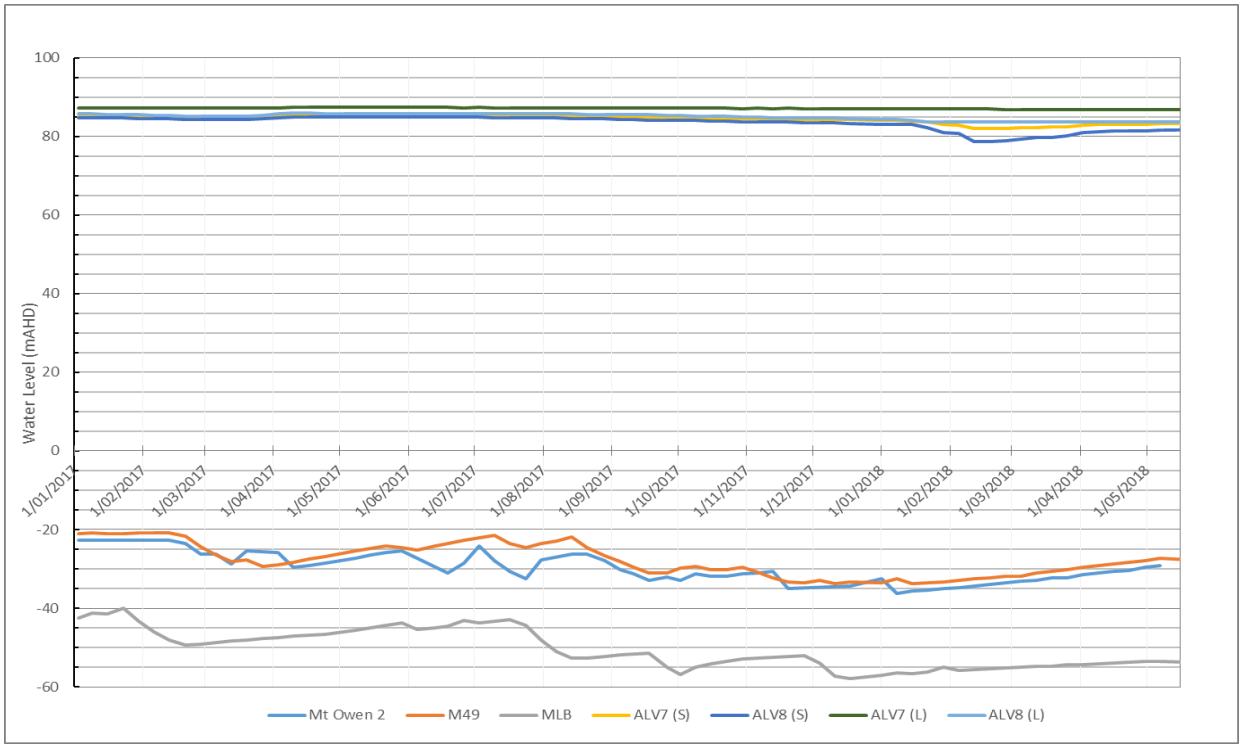

Figure 3 – Hard rock aquifers and paired piezometer ALV7 and ALV8

2.2 Streamflow monitoring

Observed streamflow gauge monitoring results and residual mass curves for rainfall and evaporation are shown in **Figure 4** below.

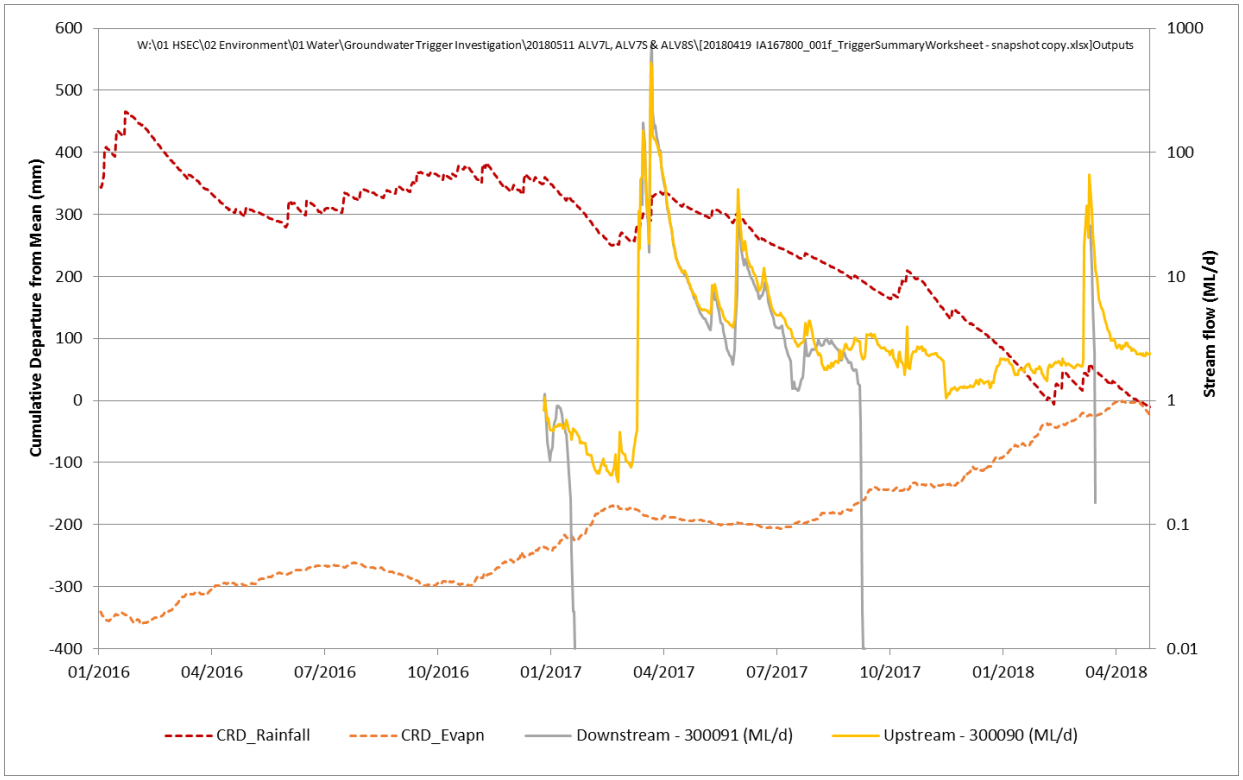

Figure 4 - Bowman's Creek streamflow observations

Bowman's Creek is an ephemeral water course that naturally ceases surface flows. From **Figure 4**, the streamflow (ML/d) observed at Bowman's Creek gauging stations downstream and upstream correlates reasonably with the declining trend observed in the residual mass curve (rainfall). For instance, the short rainfall events of March 2018 resulted in high flows along the whole system for a short period of time. This supports the conclusion that overall dry climatic conditions have resulted in low surface water flows across the site and reduced groundwater levels. In regions where the creek is losing, a decrease in flow is expected to lead to a reduction in groundwater levels. This mechanism reflects natural variability due to climatic factors.

3. Conclusion

ALV7S and ALV8S are located within the shallow bedrock underlying the alluvial aquifer with monitoring at these bores used to inform of the connectivity between alluvium and potentially mining affected bedrock below. The alluvial aquifer did not exhibit groundwater level changes to the same degree as that measured in the shallow bedrock indicating poor connectivity. Further, there appears to be no clear correlation between the levels measured at these three bores with that of the underground workings, inferring continued lack of connectivity hence no depressurisation at these bores.

The large and rapid groundwater level decline at ALV7S and ALV8S is considered to be due to the groundwater storage mechanisms of the shallow bedrock and the dewatering of a fracture horizon and is therefore not considered to be a mining related impact.

ALV7L and ALV7S are not within the extent of predicted drawdown impacts from mining operations; additionally, ALV7L is used as the reference bore for potential drawdown at ALV8L and there has been no exceedance of drawdown trigger investigation limits.

Water levels along the whole system have generally declined similarly. Further, the observed decline is consistent for both the shallow bedrock and alluvium along the whole system.

The climate data shows high evaporation and below average rainfall with significant variation in residual rainfall mass curve that is the longest downward trend since 2005. Since there is direct relationship between these bores and rainfall; despite reference maximums being exceeded at ALV7S and ALV8S, it is not expected that there is potential for harm to the environment as the system is varying naturally.

LCO propose to continue monitoring in accordance with the WMP. Consequently, if groundwater levels at ALV7S, ALV7L and ALV8S continue to be measured below the trigger level for a further nine months, such that the exceedance has been continuous for twelve months, then a subsequent investigation shall be undertaken to confirm the exceedance remains unrelated to mining activity.