LIDDELL

GLENCORE

EPBC Approval 2013/6908 – 2016 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.

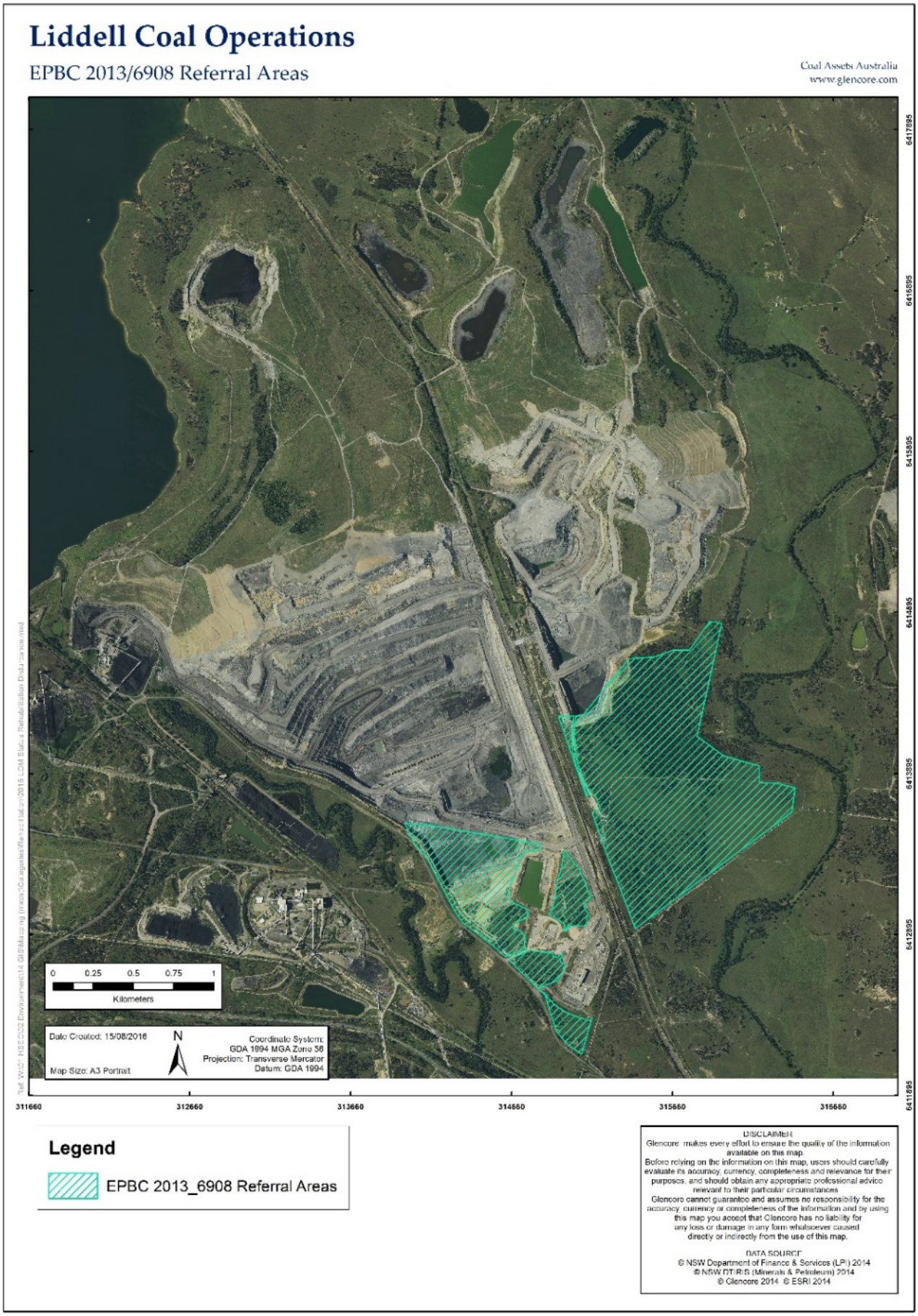

Figure 1 – LCO EPBC 2013/1608 Referral Areas

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 2015 till 18 May 2016.

2 Statement of Compliance

Table 1 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. During the reporting period on the 22 December 2015, a Post Approval Variation to the conditions of approval was issued to LCO. The variation is:

- Revoke Condition 23 and delete the definition of 'Departments Offsets Policy';
- Delete Conditions 6, 22 and 23 and substitute with revised conditions specified below;
- Replace 'person taking the action' with approval holder throughout;
- Add condition 22A, 22B and 22C and the definition of 'New or increased impact'.

Table 2 Reflects this variation to approval. **Table 2** Non Compliances have been ranked in accordance with the *Independent Audit Guideline. Post-approval requirements for State significant developments* (Audit Guidelines) (DP&E, 2015).

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

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 2103/6908 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 37.42Ha of land within the referral area as follows: • 18.85Ha of clearing (including 5.27Ha of native woodland) was undertaken during the pre-commencement stage. • During the reporting period (19 May 2015 to 18 May 2016) LCO has cleared 18.56Ha of land within the referral area, which consisted of 16.53Ha 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.	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 the 14th May 2015. The action was commenced on the 19 May 2015. 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.	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.	Liddell undertook rehabilitation in accordance with the Rehabilitation Environmental Management Plan (RMP/MOP) however, did not achieve the target rehabilitation hectares as specified in the MOP. This is further discussed in **Section 4.1.3**. Liddell did not provide a copy of the approved MOP to the DoE in the specified timeframe, however the document was available on the Liddell Coal Website for public accessibility.	Non Complaint
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 2017 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.	Requirement has not yet been triggered. Offsets lands specified under this approval are owned by LCO and are being managed in accordance with the Biodiversity Offset Management Plan (BOMP). Negotiations are being held with NSW Office of Environment & Heritage regarding the appropriate mechanism for securing these offsets.	Compliant
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.	Compliant

Condition	Actions During Reporting Period	Status
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) 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.	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.	Compliant
9. The approved Offset Management Plan required under Condition 8 must be implemented.	The BOMP was approved on the 5 January 2015. Implementation monitoring activities commenced in Spring/Summer whilst the plan was under assessment. 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	The Indirect Offset Management Plan (IOMP) was submitted on 29 June 2015. The IOMP was deemed to meet the requirements of the condition and was approved on 5 May 2016.	Compliant

Condition	Actions During Reporting Period	Status
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 QuoII; 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 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 IOMP was approved on 5 May 2016. Implementation of Project 1 under the IOMP 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	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.	Compliant

Condition	Actions During Reporting Period	Status
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 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.	During the reporting period, LCO conducted one minor discharge under the Hunter River Salinity Trading Scheme on the 26 August 2015. 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.	No surface water quality results triggering an exceedance were recorded during the reporting period.	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; iii. actions taken to prevent environmental harm; and	Not triggered during the reporting period.	Compliant

Condition	Actions During Reporting Period	Status
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.	Liddell maintained accurate records in accordance with Condition 18. Liddell published a copy of audit reports on its website during the reporting period.	Compliant
21. Upon the direction of the Minister, the person taking the action 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
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 accordance with Condition 20: - Biodiversity Management Plan	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

Condition	Actions During Reporting Period	Status
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 person taking the action has not substantially commenced the action, then the person taking the action must not substantially commence the action without the written agreement of the Minister.	Not triggered. Action commenced on 19 May 2015	Compliant
25. Unless otherwise agreed to in writing by the Minister, the person taking the action 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 publicised 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.

The following **Table 3** summarises the performance criteria set for year 1 of operation of the BMP, and actions completed to date.

Table 3 - BMP Implementation Summary

Management Strategy	Year 1 Performance Criteria	Action Completion
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.	All fence lines mapped, condition recorded, and new/redundant fence lines needs identified.
	Fencing occurs based on outcomes based on outcomes of inspection. New fences meet design criteria (refer to BMP), redundant fences removed.	Fencing of Archaeological Sensitive Landscape area completed to design criteria. Removal of redundant fences ongoing in 2016.
	Fence line inspections completed at least twice a year.	2 monthly inspections completed.
	Information signage for Spotted-tailed quoll	Signage installed in February 2016.
Access Track Maintenance	Due diligence assessments completed for new access tracks.	Due diligence inspections completed via Ground Disturbance Permit for water pipeline inspection road between Liddell & Mt Owen Complex water management pipelines.
	Track inspections completed at least twice per year.	2 monthly inspections completed.
	Tracks no longer required are rehabilitated.	None identified.
Topsoil management	Pre-strip weed control completed as identified.	Pre-strip weed control completed in South Cut Strip 22 & 23 clearing areas prior to topsoil salvage.
Erosion and Sediment Control	Implement erosion and sediment control as required by Ground Disturbance Permit.	Erosion and sediment controls implemented for South Cut Strip 22 & 23 clearing areas.

Creek line protection	Riparian corridor fenced from human/livestock access	Fence line inspection identified fencing in place, improvements ongoing in 2016.
Pathogen Management	If identified (or potential identified), management actions for specific pathogens are developed and implemented.	None identified during pre-clearing inspections or monitoring processes.
Seed collection	Pre-clearing inspection identify seed resource for collection and collection completed.	None identified in clearing areas completed during reporting period.
Vegetation clearing	Detailed pre-clearing inspections are completed and recommendations implemented. Tree felling processes implemented.	Detailed pre-clearing inspections completed for South Pit Strip 22 & 23 and recommendations included in Ground Disturbance Permit. Tree felling processes implemented for identified habitat and non-habitat trees. All information recorded within GDP for each area.
Translocation works	Tiger orchids identified during pre-clearing area salvaged, translocated and ongoing monitoring occurs.	None identified during reporting period.
Remnant Vegetation & Habitat Management	Remnant vegetation is: Clearly demarcated during clearing activities; Fenced or sign-posted; Inspected annually to identify weed/pest/erosion concerns	Clearing boundaries for Strip 22/23 clearly demarcated by survey and installation of barrier tape. Annual inspection of remnant vegetation completed via biodiversity monitoring program in December 2015. Summary contained in Section 3.1.2.
Weed control	Weed inspections completed within BMP area every two months, including remnant vegetation. Control works completed.	Weed Management Inspections occurred as a part of the bi-monthly BMP area inspection regime during the reporting period. The BMP area was mapped for weeds during the development of Liddell's annual Weed Action Plan (WAP). Weed control in BMP areas was undertaken during the reporting period and focussed on weed species including galenia (*Galenia pubescens*) and fireweed (*Senecio madagascariensis*).
Pest control	Pest inspections completed within BMP area, including remnant vegetation. Control works completed. Develop and implement pest animal action plan. Update and maintain vertebrate pest register.	Pest Management Inspections occurred as a part of the bi-monthly BMP area inspection regime during the reporting period. Monitoring was carried out via site inspections as well as use of cameras. During the reporting period Liddell developed and implemented a 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 in the BMP area: - Feral pig trapping - Wild dog and fox baiting - Kangaroo culling
	Investigation and trials (if appropriate) into fox, feral cat and feral dog control methods posing minimal impact to spotted-tailed quoll population in this area.	Liddell investigated and trialled the use of ejector style 1080 bait stations for the dog baiting rounds during the reporting period. The ejector baiting system is made up of a spring activated device that propels the contents of the 1080 capsule into the mouth of a wild dog or fox as it pulls upwards with sufficient force on a baited lure head. The benefits of these ejector stations are that only large animals with sufficient strength can activate the device and they cannot be moved – resulting in less risk to non-target animals. During Liddell's baiting rounds, there was no evidence of spotted-tailed quoll activity near bait stations.
Blue-billled duck management	Ongoing habitat and management works within Dam 3. Monitoring completed.	Liddell undertook weed control works around Dam 3 in accordance with the Weed Action Plan. Liddell also managed water levels in Dam 3 via pumping in order to maintain an appropriate level. Fence maintenance around the dam was also undertaken. Liddell installed stock watering systems in the trial cattle grazing areas around Dam 3 and Triangle Dams to allow for the complete exclusion of stock from dam edges and encouraging vegetation regeneration. Waterbird monitoring completed in 2015 did not identify any blue-billed ducks present.
Habitat Enhancement	Suitable habitat features are salvaged during pre-clearing, and either re-instated or stockpiled. Timber and boulder piles are constructed in rehabilitation of regeneration areas.	Identified suitable hollows and logs were salvaged during South Pit Strip 22/23 clearing process and stockpiled near riparian corridor for use in regeneration works (Refer offset Management Plan) Boulder piles were constructed in mine rehabilitation areas throughout the reporting year.
	Nest boxes are established in suitable remnant vegetation including offsets, and established mine rehabilitation areas. New nest boxes will be installed to replace removed hollows within 6-months.	All hollows and salvageable material was removed cleared areas from the South Cut and Entrance pits were relocated to the Bowmans Creek Biodiversity Offset Area for use as habitat features along the corridor.
	Rehabilitation and revegetation plantings undertaken include bulloak	Seed mixes used are determined by soil testing results prior to sewing. Seed mixes

	(*Allocasuarina luehmannii*), swamp oak (*Casuarina glauca*), broom bitter pea (*Daviesia genistifolia*), sickle wattle (*Acacia falcata*), hickory wattle (*Acacia implexa*) and cooba (*Acacia salicina*).	used in woodland rehabilitation areas included the species as listed in the BMP.
Grazing management	Stock grazed in pasture rehabilitation areas >3yrs old. Stock is rotated to allow pasture recovery. Shade trees or shelter belts are planted with endemic species.	During the reporting period, two separate paddocks (49ha total) were grazed by 20 head of cattle as part of an ongoing grazing trial to investigate grazing sustainability of rehabilitated areas. The grazing areas range from 3-10yrs old. Grazing areas are monitored for pasture health during the trial. Some shelter trees have been planted and are in the establishment phase and once developed, Liddell will continue grazing trials in these areas.
Bushfire Management	The current Bushfire Management Plan will be updated to address the approved modification.	Bushfire Management Plan was updated during the reporting period and includes management measures for approved BMP areas.
Ecological Monitoring	Ecological Monitoring program completed and reported. Annual mine rehabilitation inspections completed. Annual reporting completed.	The Biodiversity Monitoring Program was completed. Results summarised in Section 3.1.2

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. These monitoring results will be used as baseline monitoring for the BMP area and are summarised below.

Overall the quality of rehabilitation at LCO is in moderate condition (with the exception of northern sections of Mountain Block which will require substantial intervention). Most areas have a good ground coverage which is preventing substantial erosion. However in most cases, ground coverage is provided by non-target species (particularly Rhodes grass (Chloris gayana) and vegetation has not been established for lengths of time in which substantial soil organic matter (leaf litter) has had the time to accrue.

To mitigate this, it has been identified that supplementary plantings/seedings should be used to increase pasture diversity. Further planting of shade trees in pasture areas for cattle is to be completed to provide for post mine land use.

Rehabilitation monitoring has also identified that canopy species on South Cut rehabilitation areas including lemon-scented gum (*Corymbia citriodora*), (*Eucalyptus populnea*) and sugar gum (*Eucalyptus cladocalyx*) have been very successful and should be thinned to encourage other locally endemic species to come through. Also, weed species galenia (*Galenia pubescens*) and noxious fireweed (*Senecio madagascariensis*) were typically encountered in most rehabilitation areas and will be subject to control as part of routine weed control works.

Other key findings of the 2015 biodiversity monitoring program were as follows:

- remnant vegetation is generally in a good condition, however some potentially problematic weed species are encroaching on these areas
- threatened fauna levels observed during 2015 were generally lower than previous years across most monitoring sites. These reductions are largely not considered to relate to changes to habitat value (as no changes were readily identifiable); and were considered more likely to be a result of hot, dry and windy weather conditions occurring during the time of surveys which would have influenced fauna activity (particularly flying species). Microbat species account for the majority of the threatened fauna species count;
- a monitoring site along Bowmans Creek (but outside of the offset area) indicate a gradual decrease in threatened fauna species diversity since monitoring commencement and this is likely to be a consequence of reductions to habitat value following flooding events combined with hot, dry and windy weather conditions at the time of survey limiting movement of small species;
- of the ten nest boxes surveyed, 8 were unoccupied, one was occupied and one had nesting material present;
- there has not been a notable increase in the extent of feral species presence;
- rehabilitated vegetation is considered to be in a moderate condition, works such as supplementary planting will be still required to continue to develop areas towards rehabilitation commitments;
- weed levels are inconsistent with reference sites, works to are being undertaken continually;
- low diversity of native flora species in the groundcover;
- low levels of habitat features such as logs, hollows and rock-plies as well as leaf-litter and woody debris; and
- poor development of a soil profile capable of sustaining native vegetation.

LCO will continue to implement the BMP commitments and recommendations detailed in the 2015 BMP monitoring report.

4 Offsetting of Residual Impacts

4.1 Biodiversity Offsets

Although this reporting period begins in May 2015, annual objectives detailed in the BOMP for each year are measured from the approved date i.e. Year 1 commences 5th January 2016. Therefore Liddell is currently sitting in the 8th month of Year 1 and not all objectives have been completed as a result.

The 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.

The following **Table 4** summarises the performance criteria set for year 1 of operation of the BOMP, and actions completed to date.

Table 4 - BOMP Implementation Summary

Management Strategy	Year 1 Performance Criteria	Action Completion
Pathogen Management	If identified (or potential identified), management actions for specific pathogens are developed and implemented.	No pathogens were identified as part of the Biodiversity Offset Monitoring Program or during bi-monthly inspections.
Aboriginal Cultural Heritage Management	Include cultural heritage considerations into detailed rehabilitation planning. Develop and implement protocols for identification of potential cultural heritage issues, including how to avoid or mitigate impacts.	Liddell have considered cultural heritage impacts during planning for rehabilitation. Liddell's Aboriginal Cultural Heritage Management Plan and Unexpected Finds Protocol outlines the requirements for disturbing previously undisturbed areas. An Aboriginal Cultural Heritage Training Package has also been developed for those working near sensitive areas.
Fencing and signage	Complete inspection of all fencing of biodiversity offset areas to map locations, condition and identify need for new fencing or removal of redundant fencing.	All fence lines mapped, condition recorded, and new/redundant fence lines needs identified.
	Fence line inspections completed at least twice a year.	2 monthly inspections completed.
	Information signage for Spotted-tailed quoll	Signage installed in February 2016.
Grazing Management	All stock to be removed from offset areas	Stock was removed from parts of the Mt Block BOA and the Bowmans Creek BOA.
	Minimum bi-monthly inspections to determine presence of rogue stock and assess condition of fences. Action removal of rogue stock and repair fences	2 monthly inspections completed and no rogue stock was identified in BOMP areas.
Access Track Maintenance	Due diligence assessments completed for new access tracks.	Due diligence inspections completed via Ground Disturbance Permit for water pipeline inspection road between Liddell & Mt Owen Complex water management pipelines.
	Track inspections completed at least twice per year.	2 monthly inspections completed.
	Tracks no longer required are rehabilitated.	None identified.

Pest Management	Pest inspections completed within BOAs. Control works completed. Develop and implement pest animal action plan. Update and maintain vertebrate pest register.	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 cameras. During the reporting period Liddell developed and implemented a 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
	Investigation and trials (if appropriate) into fox, feral cat and feral dog control methods posing minimal impact to spotted-tailed quoll population in this area.	Liddell investigated and trialled the use of ejector style 1080 bait stations for the dog baiting rounds during the reporting period. The ejector baiting system is made up of a spring activated device that propels the contents of the 1080 capsule into the mouth of a wild dog or fox as it pulls upwards with sufficient force on a baited lure head. The benefits of these ejector stations are that only large animals with sufficient strength can activate the device and they cannot be moved – resulting in less risk to non-target animals. During Liddell's baiting rounds, there was no evidence of spotted-tailed quoll activity near bait stations.
Weed control	Weed inspections completed within BOAs every two months, including remnant vegetation. Control works completed.	Weed Management Inspections occurred as a part of the bi-monthly offset area inspection regime during the reporting period. In Offset areas, weed control predominantly focussed on weeds such as African Love Grass (*Eragrostis Curvula*), Blackberry *(Rubus fruticosus)* and Willows *(Salix species)* present in the Bowmans Creek Corridor and Mountain Block Offset Areas.

Natural Regeneration	The existing mapping of the current extent of grassland and disturbed areas targeted for regeneration will be refined in the first monitoring event to assist in tracking the progress of the regeneration. Confirmation of mapping of areas for regeneration, including appropriateness of target community Monitoring of regeneration areas completed in Yr 1.	Since approval of the BOMP, Liddell has not yet undertaken the first monitoring event. These works will be completed within Year 1 of the BOMP and results will be provided in the next Annual Report.
Assisted Regeneration	Detailed mapping and planning of rehabilitation works required in Bowmans Creek Riparian Corridor and Mt Block Offset Area, including earthworks, reshaping, slope stabilisation works, scalping of heavily weeded areas, fencing, erosion control and revegetation.	A Rehabilitation Strategy document is currently being finalised which details the planned rehabilitation works.
Habitat Augmentation	Suitable habitat features are salvaged during pre-clearing, and either re-instated or stockpiled. Timber and boulder piles are constructed in rehabilitation of regeneration areas.	Identified suitable hollows and logs were salvaged during South Pit Strip 22/23 clearing process and stockpiled near riparian corridor for use in regeneration works (Refer offset Management Plan) Boulder piles were constructed in mine rehabilitation areas throughout the reporting year.
	Nest boxes are established in suitable remnant vegetation including offsets, and established mine rehabilitation areas. New nest boxes will be installed to replace removed hollows within 6-months.	All hollows and salvageable material was removed cleared areas from the South Cut and Entrance pits were relocated to the Bowmans Creek Biodiversity Offset Area for use as habitat features along the corridor. Nest boxes have been ordered and installation is progressing as planned in accordance with Year 1 objectives.
Translocation works	Tiger orchids identified during pre-clearing area salvaged, translocated and ongoing monitoring occurs.	None identified during reporting period.
Creek line protection	Riparian corridor fenced from human/livestock access	Fence line inspection identified fencing in place, improvements ongoing in 2016.
	Need for stabilisation and erosion control works is assessed as part of detailed rehabilitation planning. Implementation, as needed.	Areas targeted for stabilisation and erosion control works have been identified and addressed as part of the detailed Rehabilitation Strategy which is currently being finalised.

Seed collection	Pre-clearing inspection identify seed resource for collection and collection completed.	None identified in clearing areas completed during reporting period.
Erosion and Sediment Control	Undertake erosion and sediment inspection and map areas requiring remediation.	BOMP areas have been mapped and areas requiring erosion control works have been identified and addressed as part of the detailed Rehabilitation Strategy which is currently being finalised.
Bushfire Management	The current Bushfire Management Plan will be updated to address the approved modification.	Bushfire Management Plan was updated during the reporting period and includes management measures for approved BMP areas.
Ecological Monitoring	Ecological Monitoring program completed and reported. Annual mine rehabilitation inspections completed Annual reporting completed.	Ecological monitoring program completed. Results summarised in **Section 4.1.2**

4.1.2 Biodiversity Offset Monitoring Program

It should be noted that with the recent approval of Mod 5 and the development of a BOMP; LCO has significantly different specifications of rehabilitation requirements compared to previous Mod 4. With this and considering that LCO during 2015 is in Year 1 of the Mod 5 approval; monitoring results are representative of baseline conditions against which subsequent changes can be compared.

Key findings of the 2015 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 sections of Bowmans Creek Riparian Corridor)
- Vegetation of Bowmans Creek Riparian Corridor is highly disturbed and requires substantial intervention to improve to Mod 5 target community;
- Regenerating Mountain Block sites WR03 and WR04 and Mitchell Hills South site WR10 and WR11 are progressing well and should not require substantial intervention for recovery.
- Observed levels of threatened species during the 2015 monitoring event were low across all sites (remnant and regenerating). This was not considered a reflection of poor quality habitat, and instead more likely a reflection of the very hot, dry and windy conditions experienced during the surveys undertaken which likely interfered with activity levels.
- 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.

4.1.3 Rehabilitation Program

Rehabilitation activities during the reporting period were completed as detailed in the MOP. Liddell’s rehabilitation performance does not align with the 2015-2022 MOP for the reporting period (shortfall of 6Ha). The variation is due to a reduction in our production profile during the reporting period as a result of declining market conditions. The decrease in production output resulted in less land being available for rehabilitation as originally planned due to overburden emplacements not having reached design capacity, particularly the RL195 Dump within the South Cut mining area. It is important to note that all areas available to be rehabilitated during the reporting period have been completed.

LCO expect that the rehabilitation areas that have were planned for 2015 MOP period will be available and completed during the next MOP reporting period. Current planned rehabilitation for 2016 has been increased by to make up the shortfall from 2015.

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 Management Plan (IOMP) 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. From the Glencore perspective, additional objectives for this IOP include:

- collection and interpretation of data that is relevant locally (in the Middle Foy Brook area), while also contributing to knowledge of this species from a regional perspective;
- collection and interpretation of data which is transferrable and able to inform management actions on other Glencore sites; and sharing of project outputs to relevant agencies to allow incorporation into existing management actions for the quoll.

Following approval of the IOMP, LCO commenced implementation of Project 1: Development of software to allow identification of individual Quolls from remote camera images. This project is being completed in partnership with Invasive Animals Limited (IAL), and at the conclusion of the reporting period, LCO and IAL were finalising a Research Agreement to complete the project. Execution of the Research Agreement is expected to be completed in June 2016 and payment of an initial payment of $50,000 in July 2016.

5 Water Resources

5.1 Surface Water

The approved Water Management Plan (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 this is deemed to be an appropriate statistical criterion to adopt whilst mining operations are ongoing. The creek trigger levels are presented in **Table 5**.

Table 5 - Post 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.

Monitoring during the reporting period was completed as per the applicable approved WMP.

5.1.1 Bayswater Creek

Bayswater Creek is a highly modified watercourse and regularly experiences periods of low or no flow. There were no issues identified during the reporting period.

Table 6 below summarises the trigger limit exceeded in Bayswater Creek during the reporting period.

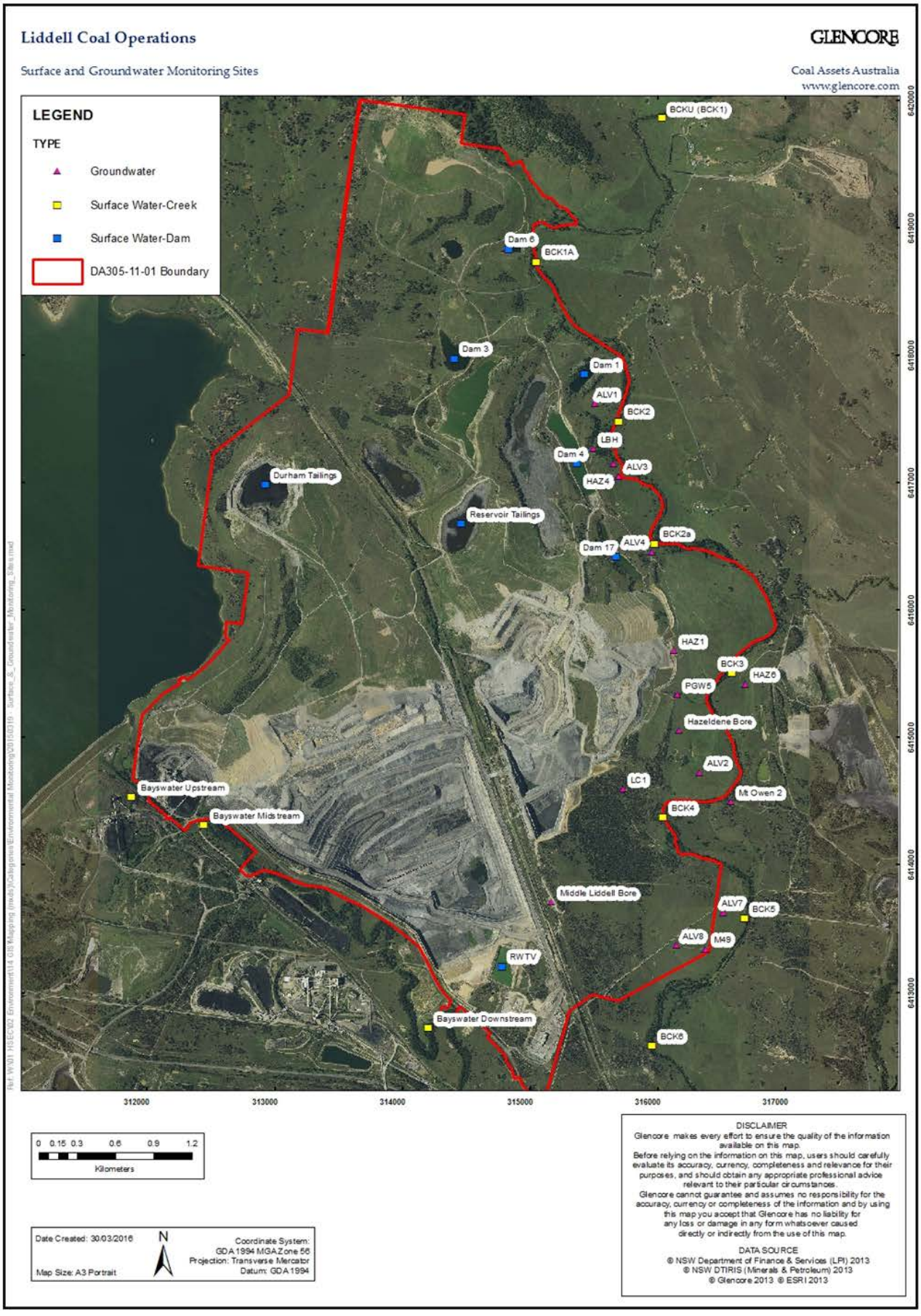

Figure 2 – Location of surface and groundwater monitoring sites

Table 6 Bayswater Creek Trigger Limit Summary

Bayswater Creek – Values Exceeding Trigger Limits												
Month	**Bayswater Creek Upstream**				**Bayswater Creek Midstream**				**Bayswater Creek Downstream**			
	pH	**EC (µS/cm**	**TSS (mg/L)**	**TDS (mg/L)**	**pH**	**EC (µS/cm**	**TSS (mg/L)**	**TDS (mg/L)**	**pH**	**EC (µS/cm)**	**TSS (mg/L)**	**TDS (mg/L)**
Jun 15	7.83	4410	<5	2700	8.27	5120	<5	3120	Dry			
Jul 15	7.86	4260	<5	2740	8.15	**5160**	<5	3390	Dry			
Aug 15	7.98	4070	<5	2810	8.23	4840	<5	3400	Dry			
Sep 15	7.80	3950	142	2540	8.18	4640	<5	2310	Dry			
Oct 15	7.75	4430	11	2900	8.05	**5170**	<5	**3420**	Dry			
Nov 15	8.05	3940	<5	2020	**8.44**	4800	<5	2600	Dry			
Dec 15	8.11	4230	11	2660	**8.40**	5070	<5	3280	Dry			
Jan 16	7.72	1440	10	850	7.99	2620	<5	1680	Dry			
Feb 16	8.00	4420	5	2850	8.23	**5250**	<5	**3420**	Dry			
Mar 16	8.17	4250	<5	2760	**8.38**	5110	5	**3390**	Dry			
Apr 16	7.98	3830	<5	2500	8.24	4640	**40**	3030	Dry			
May 16	7.80	3830	10	2440	8.11	4560	**91**	2960	Dry			

Orange Shading – Denotes an exceedance of the 90$^{\%}$ile trigger limit

Orange text – Denotes elevated results not above a trigger due to no flow conditions

The measured pH, Electrical Conductivity (EC) and Total Dissolved Solids (TDS) levels were typical of historical results. There was no exceedance of flow applicable post WMP trigger levels, however there where a number of elevated results during no flow conditions. These results did not exceed the “no flow” maximum criterion.

The measured Total Suspended Solids (TSS) levels identified one elevated result of 142mg/L in September. Levels returned back to normal in following monitoring events and this result coincides with similar elevated levels in Bayswater Creek hence a likely function of previous rainfall.

5.1.2 Bowmans Creek

Bowmans Creek is ephemeral in nature and often pools leading to potential stagnant conditions which influences water quality.

Table 7 below summarises the trigger limit exceeded in Bowmans Creek during the reporting period.

Table 7 Bowmans Creek Trigger Limit Summary

Bowmans Creek – Values Exceeding Trigger Limits																
Month	BCK1 (Upstream)				BCK 1A				BCK2				BCK2A			
	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)
Jun 15	8.23	633	<5	370	8.16	709	<5	400	8.07	750	<5	418	8.03	767	<5	434
Ju15	8.05	631	<5	354	8.00	701	<5	415	7.91	728	<5	434	7.91	743	<5	414
Aug 15	8.04	745	<5	398	8.05	835	<5	501	8.04	918	<5	510	8.03	878	<5	520
Sep 15	8.02	596	<5	345	8.06	638	<5	446	8.01	698	<5	393	8.05	720	155	520
Oct 15	7.62	741	5	388	7.95	1070	<5	596	7.62	1010	5	520	7.79	1010	6	576
Nov 15	8.20	937	<5	528	8.28	1050	<5	617	8.15	1030	<5	502	8.20	1020	7	519
Dec 15	7.86	866	8	441	8.07	1900	<5	1090	7.82	1210	<5	651	7.82	1160	<5	634
Jan 16	7.88	440	6	306	7.90	446	10	308	7.93	453	6	306	7.95	456	10	299
Feb 16	7.82	697	6	370	8.08	1020	6	615	8.03	927	<5	550	8.08	949	14	540
Mar 16	8.11	778	6	436	8.20	1850	<5	1100	7.95	1130	<5	632	7.90	1070	<5	617
Apr 16	7.82	785	<5	462	8.00	2040	<5	1330	7.68	1090	<5	604	7.71	1303	<5	567
May 16	7.66	796	12	460	7.68	**2590**	6	1600	7.63	1080	11	584	7.95	1010	12	593
Month	BCK3				BCK4				BCK5				BCK6 (Downstream)			
	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)
Jun 15	8.05	806	<5	467	8.07	860	<5	498	8.08	920	<5	498	8.12	928	<5	520
Ju15	7.93	779	<5	452	7.99	808	<5	450	8.06	853	<5	468	8.05	855	<5	506
Aug 15	8.18	923	<5	582	8.19	1060	<5	616	8.20	1180	<5	678	8.19	1110	<5	638
Sep 15	8.03	755	<5	475	8.06	784	<5	482	8.16	846	<5	529	8.19	812	6	573
Oct 15	7.91	989	8	550	7.87	1160	5	661	7.95	1380	10	780	7.81	1180	<5	704
Nov 15	8.15	1080	19	639	8.24	1240	10	633	8.28	1390	<5	792	8.17	1390	<5	792
Dec 15	8.25	1170	20	626	8.26	1650	10	896	8.21	1810	<5	994	8.03	1320	<5	722
Jan 16	7.8	464	35	317	7.83	463	<5	334	7.96	491	11	332	7.97	493	10	333

Month	BCK3				BCK4				BCK5				BCK6 (Downstream)			
	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)
Feb 16	8.07	955	24	520	8.05	1190	49	694	8.14	1320	13	780	7.96	1220	5	722
Mar 16	8.29	1060	43	590	8.32	1580	40	956	8.36	1800	10	1080	8.07	1190	<5	698
Apr 16	8.03	1090	15	635	8.11	1660	<5	990	8.18	1860	8	1130	7.80	1260	<5	730
May 16	8.02	1090	16	620	8.09	1930	11	1190	8.17	1990	10	1220	7.73	1430	10	902

Orange Shading – Denotes an exceedance of the 90%ile trigger limit

Orange text – Denotes elevated results not above a trigger due to no flow conditions

During the reporting period, there were only two isolated pH exceedances at sites BCK4 and BCK5 that during March 2016 that did not persist into consecutive events. Similarly for EC, only site BCK1A recorded elevated EC results during April 2016 as flow slowed from a trickly to still in May 2016 (hence no exceedance). Finally, one isolated TSS exceedance was recorded at site BCK2A during September 2015 and returned to normal levels the month afterwards. Slow flow conditions were recorded in the field notes with no obvious source noted.

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). During the reporting period, there was one discharge event from the site under the HRSTS occurring in August 2015. There was no exceedance of any compliance limits applicable to the discharge event. **Table 8** below summarises the HRSTS discharge events and monitoring results.

Table 8** - **Pre HRSTS Monitoring Results

HRSTS Discharge Monitoring					
Event		Volume Discharged (ML)	Mean EC (µs/cm)	Salt Load (Tonnes)	Total Allowable discharge (Tonnes)
Start	Finish				
19:30 25/08/2015	19:30 26/08/2015	0.74	5971	2.64	1216

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.

Groundwater quality monitoring occurs at a number of paired bores pairing the Bowmans Creek Alluvium (ALV "L") and underlying shallow bedrock (ALV "S").

The WMP groundwater monitoring program had minor changes compared to the historical monitoring system with the most significant change being the introduction of monitoring site specific trigger limits for impact investigation and assessment. The trigger values adopted for the groundwater monitoring program are intended to provide an indication of potential impacts to groundwater resources as a result of mining operations. Further investigations into such potential impacts are to be conducted if monitoring results suggest significant and continuous deviation from historical or background trends in water quality.

5.2.2 Groundwater Quality Monitoring

pH trigger values are derived from default ANZECC guideline values. For Electrical Conductivity (EC), LCO adopted the 80th percentile and 20th percentile trigger values based on the 24 months data between January 2013 to January 2015. It is important to note that these values are associated with a period of very stable observations of EC compared to the historical record. Groundwater level triggers were calculated as the 10th percentile data for the same period.

Groundwater quality monitoring results and trigger limits for the alluvial and shallow bedrock aquifers during the reporting period are shown in **Table 9**, **Table 10** and **Table 11** below.

Groundwater quality results are discussed in detail in **Section 5.2.2.**

Table 8 below summarises the pH measurements of the groundwater with comparison to the applicable trigger levels.

Table 9 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 15	6.92	7.66	7.33	7.73	7.14	7.50	6.86	7.46	7.20	7.30	7.18	7.26	6.79
Ju15	6.92	7.55	7.29	7.62	7.17	7.40	6.79	7.35	7.16	7.24	7.03	7.11	6.84
Aug 15	6.91	7.61	7.20	7.72	7.10	7.36	6.89	7.25	7.14	7.24	6.81	7.09	6.83
Sep 15	6.89	7.61	7.18	7.66	7.04	7.31	6.70	7.25	7.02	7.24	7.06	7.10	6.78
Oct 15	7.18	7.75	7.40	7.85	7.26	7.52	6.99	7.48	7.29	7.50	7.29	7.43	7.09
Nov 15	7.15	7.71	7.49	7.84	7.47	7.54	6.98	7.37	7.18	7.44	7.27	7.38	7.11
Dec 15	7.04	7.59	7.39	7.90	7.22	7.52	6.94	7.48	7.35	7.60	7.27	7.36	7.09
Jan 16	6.77	7.34	6.87	7.13	6.91	7.16	6.68	7.23	7.11	7.28	7.34	7.26	6.81
Feb 16	7.17	7.56	7.38	7.72	7.71	7.53	7.17	7.33	7.24	7.32	7.28	7.22	7.51
Mar 16	7.11	7.52	7.35	7.92	7.57	7.45	7.11	7.39	7.31	7.42	7.43	7.30	7.34
Apr 16	7.11	7.59	7.36	7.69	7.56	7.48	7.05	7.29	7.19	7.34	7.31	7.22	7.49
May 16	6.94	7.24	7.20	7.56	7.42	7.38	6.93	7.11	7.24	7.28	7.45	7.19	7.21

There were no exceedances of the pH trigger limits at the Alluvial and Shallow Bedrock during the reporting period.

Table 10 below summarises the EC measurements of the groundwater with comparison to the applicable trigger levels.

Table 10 Groundwater exceedances for EC in Alluvial and Shallow Rock Aquifers

Alluvial and Shallow Bedrock Groundwater Quality - EC													
Site	**ALV1L**	**ALV1S**	**ALV2L**	**ALV2S**	**ALV3L**	**ALV3S**	**ALV4L**	**ALV4S**	**ALV7L**	**ALV7S**	**ALV8L**	**ALV8S**	**LBH**
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 %tile	**1.14**	**1.37**	**3.43**	**2.90**	**1.31**	**2.73**	**2.21**	**5.29**	**1.57**	**2.25**	**1.21**	**1.65**	**1.24**
20th %tile	**1.04**	**1.19**	**2.27**	**2.65**	**0.94**	**2.03**	**1.59**	**4.57**	**1.39**	**2.01**	**0.75**	**1.50**	**1.02**
Jun 15	1.18	1.28	2.54	2.82	1.15	1.80	1.60	5.08	1.76	2.10	0.94	1.66	1.40
Ju15	1.17	1.26	2.36	2.73	1.05	1.75	1.56	4.87	1.66	2.03	1.06	1.61	1.44
Aug 15	1.05	1.11	2.33	2.42	0.93	1.54	1.35	4.53	1.46	1.79	1.06	1.42	1.25
Sep 15	1.19	1.26	2.71	2.79	1.06	1.75	1.51	5.13	1.76	2.04	1.13	1.59	1.37
Oct 15	1.11	1.20	2.27	2.53	0.97	1.67	1.45	4.63	1.68	1.92	1.11	1.60	1.25
Nov 15	1.10	1.18	2.41	2.54	0.99	1.70	1.41	4.54	1.65	1.92	1.13	1.51	1.21
Dec 15	1.04	1.10	2.41	2.41	0.92	2.22	1.34	4.30	1.57	1.84	1.07	1.45	1.11
Jan 16	1.03	1.10	2.49	2.42	0.95	2.45	1.34	4.09	1.71	1.91	1.13	1.54	1.08
Feb 16	1.23	1.31	2.79	2.86	0.98	2.95	1.61	5.07	1.94	2.16	0.93	1.63	1.26
Mar 16	1.09	1.18	2.30	2.43	0.93	2.78	1.42	4.45	1.72	1.91	0.78	1.49	1.11
Apr 16	1.11	1.20	2.41	2.51	1.00	2.86	1.44	4.51	1.71	1.91	0.83	1.43	1.13
May 16	1.14	1.24	2.56	2.61	1.09	2.96	1.51	4.60	1.75	2.05	0.84	1.61	1.21

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

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

LCO also monitor a number of hard rock aquifers to provide for the ongoing water management onsite. Monitoring of Piezometer PGW5S and PGW5L is 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 11** identifies exceedances of the groundwater quality criteria applicable to PGW5 bores. 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 11 - Exceedances for EC and pH in Hard Rock Aquifers

Hard Rock Groundwater Quality - EC				
Site	**PGW5L**	**PGW5S**	**PGW5L**	**PGW5S**
	EC (mS/cm)		**pH**	
80th %tile	**5.27**	**6.12**	**6.5 – 8.5**	**6.5 – 8.5**
20th %tile	**4.57**	**5.52**	**-**	**-**
Jun 15	5.04	5.88	7.62	7.26
Ju15	4.83	5.41	7.59	7.21
Aug 15	4.36	5.02	7.56	7.02
Sep 15	4.92	5.60	7.52	7.16
Oct 15	4.42	4.91	7.72	7.25
Nov 15	4.44	5.03	7.65	7.31
Dec 15	4.30	4.81	7.78	7.29
Jan 16	4.28	4.81	7.31	6.82
Feb 16	5.06	5.79	7.73	7.18
Mar 16	4.46	4.97	7.76	7.22
Apr 16	4.43	5.01	7.67	7.20
May 16	4.45	5.14	7.61	7.04

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. The analyses on hard rock aquifers showed a number of exceedances of the 20th percentile trigger, minimal deviation from long-term EC trends and the historical investigation monitoring limits applied. PGW5-L and PGW5-S show similar EC levels and trends, suggesting connectivity between the overburden and the Pikes Gully coal seam. The EC data collected for the hard rock aquifer during the monitoring period is consistent with historical monitoring data recorded for these locations.

5.2.3 Groundwater Level Monitoring

LCO monitor the groundwater level of the Bowmans Creek Alluvial and Shallow Bedrock Aquifers to identify any potential impacts from mining such as depressurisation. Groundwater elevations decrease with distance downstream. The sympathetic response in water levels observed in the paired bores indicate similar processes are driving the recharge for both systems. 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.

Groundwater levels generally decreased from 2001 to 2006 (during drought conditions) before rebounding to 2001 levels following the 2007 floods. Since then groundwater levels have remained relatively stable. A very slight downward trend are observed in the water levels towards the end of the 2015 monitoring period, which correlates to the downward trend in the cumulative deviation mean monthly rainfall.

Prior to the 2015 WMP approval, groundwater levels were not compared against specific trigger limits. However once approved in August, site specific investigation limits were introduced on the bores located within the Bowmans Creek Alluvium. The specific investigation limits and response plan is detailed in the 2015 WMP.

During the reporting period consecutive exceedances of trigger levels were observed at monitoring locations ALV2S and LBH.

Groundwater level monitoring results and trigger limits for the alluvial and shallow bedrock aquifers during the reporting period are shown in **Table 12** below.

Table 12 Groundwater level trigger exceedances

Alluvial and Shallow Bedrock Groundwater Levels															
Site	**ALV1L**	**ALV1S**	**ALV2L**	**ALV2S**	**ALV3L**	**ALV3S**	**ALV4L**	**ALV4S**	**ALV7L**	**ALV7S**	**ALV8L**	**ALV8S**	**LBH**	**PGW5L**	**PGW5S**
	Depth to Water (m)														
10th %ile	4.33	3.84	4.39	4.04	5.34	5.59	5.50	5.88	6.59	9.10	6.85	7.89	3.84	10.72	9.91
Jun 15	2.96	2.35	4.04	3.60	4.69	4.84	4.67	4.87	6.06	8.04	5.81	6.71	3.44	8.37	8.89
Jul 15	3.14	2.48	4.25	3.89	4.83	5.02	4.75	5.12	6.19	8.30	6.03	6.95	3.50	9.86	9.34
Aug 15	3.26	2.56	4.32	4.03	4.91	5.09	4.89	5.26	6.31	8.44	6.13	7.09	3.62	9.96	9.61
Sep 15	3.14	2.46	4.83	3.91	4.82	4.99	4.83	5.11	6.21	8.24	6.01	6.86	3.55	9.12	9.33
Oct 15	3.26	2.58	4.30	4.04	4.91	5.09	4.93	5.25	6.29	8.36	6.09	6.98	3.62	9.13	9.31
Nov 15	3.29	2.65	4.30	4.10	4.90	5.09	4.91	5.34	6.37	8.46	6.13	7.05	3.62	9.77	9.60
Dec 15	3.54	3.04	4.36	4.11	5.01	5.21	5.09	5.39	6.44	8.62	6.25	7.21	3.76	9.15	9.41
Jan 16	2.97	2.34	4.00	3.73	4.65	4.80	4.77	4.88	6.11	7.97	5.80	6.48	3.37	8.80	9.09
Feb 16	3.28	2.64	4.24	3.99	4.93	5.10	5.01	5.07	6.07	8.01	5.84	6.66	3.69	9.72	9.33
Mar 16	3.56	3.03	4.37	4.11	5.03	5.21	5.13	5.41	6.26	8.30	6.10	6.94	3.73	8.48	9.07
Apr 16	3.84	3.36	4.36	4.13	5.09	5.29	5.22	5.54	6.38	8.45	6.19	7.07	3.88	8.88	9.18
May 16	4.19	3.70	4.38	4.05	5.28	5.50	5.38	5.74	6.46	8.54	6.28	7.19	4.09	9.74	9.48

Yellow Shading – Denotes an exceedance of the 10%tile trigger limit

5.2.4 Discussion of results

The data presented above shows that a number of 20th percentile triggers for EC have occurred for almost all sites since monitoring under the approved Water Management Plan commenced in June 2015. These triggers have been deemed to have had no potential or actual environmental harm as 'low' groundwater EC observation (i.e. a relatively fresh groundwater) may only be detrimental to the environment if, for example, a saline ecosystem is present that relies on access to groundwater of a particular salinity. 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).

Various exceedances of the 80th percentile EC trigger values have also occurred and these prompted an Incident Trigger Action Response Plan during October 2015, attached as Appendix A. Of note, there has been relatively consistent trending above the 80th percentile trigger at site ALV7L since the ITARP was completed. Site LBH triggered on five consecutive occasions, and site ALV1L almost activated a trigger for the same period as site LBH. The investigation trigger action response plan (ITARP Jacobs, 2015) examined these three alluvial aquifer monitoring wells and concluded that:

- There have been no mining operations undertaken within the immediate vicinity of the LBH during the investigation period.
- The groundwater assessment conducted for Mod 5 (SKM, 2014) noted that groundwater is expected not to be affected based on modelled mining scenarios.
- The local and regional climate within the LCO area during the investigation period was relatively similar to that during the January 2013 to January 2015 period for which the trigger values were derived. However, there is a suggestion that the LCO local climate was wetter than average at the beginning of 2015 compared to 2014 (particularly in January and April 2015).
- Mine water storage dams do not appear to indicate leakage to groundwater within the investigation period. This consideration is based on measured water levels and water quality.
- Bowmans Creek surface water quality data indicates no irregularity within the investigation period against historical trends.
- Groundwater level and pH data recorded during the investigation period present seasonal fluctuations within the expected range of trigger value and historical data.
- Groundwater EC data recorded during the investigation period are within the ranges observed historically for ALV 1 L and ALV 7 L.
- Groundwater data appear to be influenced by rainfall events, causing a decrease in depth to water levels, and an increase in EC and pH. The wetter that average conditions recorded in 2015 may be a reason for increasing trends in EC observed at the investigation sites.
- While groundwater EC data recorded during the investigation period for LBH presents an increasing trend that has been occurring since 2012, salinities are within expected ranges based on historical data recorded at the monitoring location.
- It is unlikely there is potential for environmental harm (as defined in the WMP LCO, 2015) to occur from EC recorded during the investigation period. This is considered based on a review of the historical data recorded at the sites, for example, data recorded during the 2005/06 drought.

In summary, the investigation report (Jacobs, 2015) concluded the 80th percentile transient exceedance observed between June and September 2015 at monitoring location LBH was not due to any mining related impact, nor had any environmental harm had occurred, and is likely caused by trigger values being calculated during a relatively stable period of groundwater observations between January 2013 and January 2015. The method used to calculate the trigger values, ANZECC (2000), does not consider groundwater data outside the previous two year period. Groundwater observations prior to January 2013 present larger seasonal variations in response to climate conditions. It was considered that by constraining trigger values to the stable groundwater conditions between January 2013 and January 2015, there is a risk of activating unnecessary ITARPs for groundwater monitoring wells if the climate within the Project area returns to larger seasonal variations observed in earlier data. Jacobs recommended that monitoring triggers be reviewed and updates to the WMP be made accordingly.

A second ITARP (Jacobs, 2016) was also initiated to investigate ALV3S in May 2015 as per the requirements of the Water Management Plan. In summary the investigation, attached as Appendix B concluded that these triggers have had no potential or actual environmental harm and the exceedances are due to climatic variation not mining induced impact. Jacobs recommended that LCO continue to monitor the water levels and water quality to verify that the EC levels are trending back to within the trigger limits as groundwater levels decline. This should continue during the 2016 monitoring period and be assessed in conjunction with the annual reporting in 2017. If there are any departures from this trend at this time, further investigation should be completed to establish what is causing the anomaly.

Three consecutive exceedances of the 10th percentile water level trigger have also occurred at monitoring location ALV2S during the period March to May 2016. The water level data collected for the shallow hard rock aquifer at this location during the monitoring period is consistent with historical monitoring data recorded, and LCO is also not actively mining in the vicinity of ALV3. The exceedance is likely attributable to the calculation of the trigger value being constrained by the stable groundwater monitoring conditions between January 2013 and January 2015.

Based on the conclusions discussed above regarding the various trigger exceedances noted above, and the recommendation to review the EC and water level monitoring triggers levels for the groundwater monitoring program, LCO has determined that no environmental harm has occurred as a result of any mining impact during the reporting. 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 levels have remained relatively stable, indicating no mining induced drawdown occurring. As per the recommendations made by the groundwater consultant, a review of the trigger methodology has been completed and revised trigger levels determined using the larger dataset available. A revised WMP containing the updated triggers and associated justification is currently under review by the Department of Environment.

6 Reference Information

Reference information, listed in ***Table 13*** below, is information that is directly related to the development of this document or referenced from within this document.

Table 13 – Reference information

Reference	Title
DP&E 2015	*Independent Audit Guideline. Post-approval requirements for State significant developments*
LCO TS EXT 0001	*Liddell Coal Operations Mining Operations Plan/Rehabilitation Management Plan*
LCO SD PLN 0046	*Biodiversity Offset Management Plan*
LCO SD PLN 0040	*Biodiversity Management Plan*
LCO SD PLN 0048	*Indirect Offset Management Plan*
LCO SD PLN 0041	*Water Management Plan*
LCO 2016	*Liddell Coal Operations Annual Review 2015*
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*
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 - October 2015 ITARP

Memorandum

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Date	12 November 2015
To	Ben de Somer (LCO)
From	Garry Straughton (Jacobs); Dr Justin Bell (Jacobs)
Subject	**Liddell Coal Operations | Investigation Trigger Action Response Plan October 2015**

Dear Ben,

1. Introduction

1.1 Overview

Jacobs Group (Australia) Pty Ltd (Jacobs) has been commissioned by Liddell Coal Operations (LCO) to undertake an Investigation Trigger Action Response Plan (ITARP) for the LCO open-cut coal mining operation.

The *Liddell Coal Operations Plan for Water Management* (LCO, 2015) states an ITARP is undertaken after the transient exceedance (i.e. three or more consecutive breaches) of water level or water quality trigger values. The transient approach is a check to determine whether the exceedance is repeated, ongoing and not due to erroneous sampling methods.

> ***Investigation Trigger***
>
> *Trigger values are conservative assessment levels, and not 'pass/fail' compliance criteria. (ANZECC, 2006)*
>
> *An investigation trigger applies when a nominated trigger value is exceeded three or more times consecutively, and the potential for environmental harm to occur as a consequence is deemed unlikely. Action is taken in the form of re-sampling, a review of all data or checks against model predictions. (LCO, 2015)*

A transient exceedance of water quality (electrical conductivity; EC) data has been observed at the LBH Bowmans Creek alluvial aquifer groundwater monitoring well between June and September 2015. This has prompted the requirement for an ITARP to be undertaken.

As part of this commission, LCO has requested Jacobs to undertake a precautionary ITARP for ALV 1 L and ALV 7 L Bowmans Creek alluvial aquifer groundwater wells. This is due to the water quality data observations at these sampling sites being in close proximity of breaching their trigger values over the same transient time period.

Table 1-1 presents the site specific trigger values, and monthly observations, at the three investigation sites since June 2015.

Table 1-1 : Site specific trigger values for electrical conductivity, and monthly observations

Well ID	Unit	Electrical conductivity (mS/cm)				
		Upper limit 80th percentile	June 2015	July 2015	August 2015	September 2015
LBH	Alluvial aquifer	1.24	1.40	1.44	1.25	1.37
ALV 1 L	Alluvial aquifer	1.14	1.18	1.17	1.05	1.19
ALV 7 L	Alluvial aquifer	1.57	1.76	1.66	1.46	1.76

1.2 Scope of work

The scope of work for this ITARP includes:

- A review of LCO specific environmental conditions (DA 305-11-01).
- A review of LCO mining operations within the LBH area that may result in a change in groundwater EC.
- A review of historical environmental data to identify long-term natural variations within the system.
- A review of LCO environmental data recorded since June 2015 (groundwater level and quality, surface water flows and quality, and climate observations).
- Discussion regarding the potential for environmental harm to occur.
- A review of the site specific triggers values derived in the LCO WMP.

1.3 Data sources

Environmental data and mining operation data were sourced from the following:

- Bureau of Meteorology online climate data (2015)
- LCO environmental monitoring systems (2015)
- SILO rainfall data (DSITI, 2015)

2. Background

2.1 Specific Environmental Conditions (Schedule 3 DA 305-11-01)

ALV 1 L, ALV 7 L and LBH are groundwater monitoring wells installed within the Bowmans Creek alluvium aquifer. In accordance with condition 23 (c)(iv) of DA 305-11-01, measures to mitigate any direct hydraulic connection between backfilled open cuts and Bowmans Creek alluvium will be investigated if the potential for adverse effects is detected as part of the monitoring undertaken onsite.

2.2 Liddell Coal Operations Mining Extension plans (Modification 5)

The groundwater assessment conducted for Mod 5 (SKM, 2014) noted that peak predicted losses from the alluvium (corresponding to a drawdown of less than 2 meters) are not predicted to occur until the progression of the Entrance Pit to the south-eastern side of the dyke and Davis Creek Fault, and into the M49 underground workings in approximately 2021 and 2022. Therefore, it is considered unlikely that impacts from LCO mining operations will occur before this time period.

2.3 Recent Mining Operations

The following details recent mining operations at LCO and within the vicinity of the LBH groundwater monitoring well:

- The Reservoir North void area (approximately 800 m northwest on the opposite side of the old Antiene Tailings Emplacement Area) was completed in 2009.
- No mining activities have occurred within the vicinity of LBH since before 2011.
- Rehabilitation of overburden emplacements has occurred on the western side of the old Antiene Tailings Emplacement Area, while maintenance was undertaken on the adjacent water storage feature (Dam 4).

3. Environmental Data Analysis

3.1 Meteorological

3.1.1 Overview

Bredenkamp *et. al.* (1995) proposed that a relationship exists between rainfall and groundwater levels, and that it can be explained based on groundwater mass balance present in their research. Butterworth *et. al.* (1999) present a review of this method and note that, with some limitations, water levels in a specific aquifer will fluctuate according to Cumulative Rainfall Departure (CRD) from the mean, given a proportionality of a/S, where a is fraction of rainfall that recharges the groundwater system and S is storativity.

Application of the method is presented in Butterworth *et. al.* (1999) and Baalousha (2005). Further discussion of the CRD method is presented in Xu and van Tonder (2001).

A critique of the CRD method is presented by Weber and Stewart (2004). Weber and Stewart (2004) note there are several limitations to the method that require consideration. However, it has valid hydrologic meaning in the short term. Weber and Stewart (2004) criticisms of the method include:

- The choice of beginning and end points of the data can affect the results.
- A lack of consideration that above average rainfall can reset the hydrological system without mathematically eliminating the accumulated deficit.
- The lack of support for the necessary inference that rainfall events and observed groundwater level response, that are widely separate in time, are related.

3.1.2 Rainfall observations

Overview

Rainfall recorded at the LCO weather station (approximate elevation 130 mAHD) has been analysed against three Bureau of Meteorology (BOM) weather stations within the Liddell regional area. These are:

- Bowmans Creek (Grenell) station 61270 (elevation 255 mAHD);
- Muswellbrook (St. Helliers) station 61374 (elevation 190 mAHD); and
- Singleton STP station 61397 (elevation 145 mAHD).

SILO rainfall data interpreted at Ravensworth Electricity Commis BOM station 61208 (elevation 76 mAHD) (DSITI, 2015) was also used for analysis to LCO data. While the station was closed on 31st

December 1969, it is the only weather station in the SILO dataset that contains interpreted rainfall data within the immediate area around the LCO site from 1889.

Cumulative rainfall totals

Rainfall data have been collected at LCO since 2006. Analysis of daily cumulative rainfall totals suggests rainfall at the LCO site is similar to that recorded at Muswellbrook (St. Helliers) 61374, Singleton STP 61397 and SILO Ravensworth Electricity Commis 61208 interpreted data (see Figure 3-1). These stations are located approximately 22 km northwest, 25.5 km southeast and 0.4 km southeast of LCO respectively.

Rainfall recorded at Bowmans Creek (Grenell) 61270 presents a localised, higher rainfall conditions compared to the LCO (see Figure 3-1). This difference is most likely due its positioning at a higher elevation compared relative to LCO. Bowmans Creek (Grenell) weather station is located approximately 18.4 km northeast of LCO.

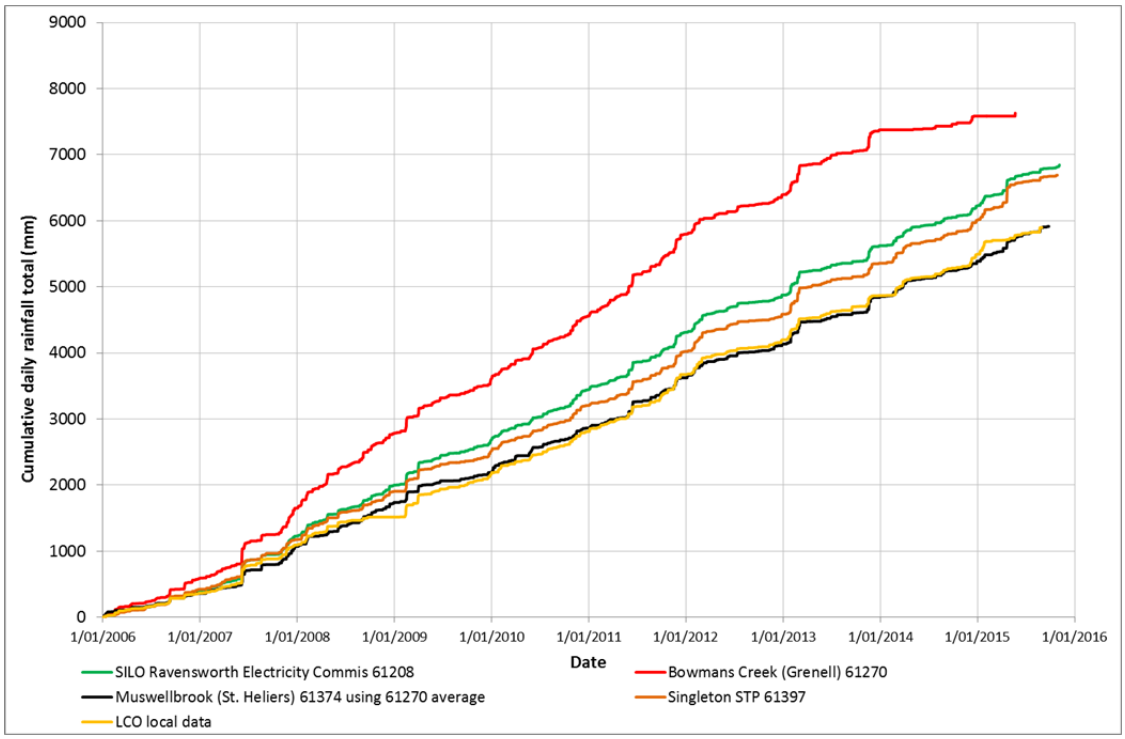

Figure 3-1 Cumulative daily rainfall totals (mm) 2006 to 2015

3.1.3 Cumulative Rainfall Departure

The following considerations were made when calculating the CRD for the LCO site:

- A start date of 1st January 2006 was chosen due to the climate system being in a drought phase (under climate stress), and correlates to the beginning of the LCO data.
- An 'external' average daily rainfall (i.e. an average taken from a nearby weather station that is external to the investigation site) was calculated from SILO Ravensworth Electricity Commis 61208 for use in the LCO CRD analysis. This was due to the SILO data containing interpreted rainfall records from 1889 to present, allowing use of a larger data set for a long term average daily rainfall to be calculated for each month.

Figure 3-2 presents the CRD analysis results between 2006 and 2015.

Interpretation of CRD should only be undertaken at a qualitative level. Slope gradient provides an indication of whether rainfall conditions are wetter (a positive gradient), drier (a negative gradient) or stable (horizontal gradient) in comparison to the average daily rainfall total. The CRD results suggest:

- Regional rainfall conditions were in a period of drought from approximately January 2006 to mid-June 2007.
- The regional area became wetter relative to average daily rainfall from mid-2007, and presented stabilised rainfall conditions, showing seasonal fluctuations, to mid-2011. SILO Ravensworth Electricity Commis 61208). However, presents increasingly wetter conditions to mid-2011 when compared to LCO data.
- Data for both locations follow a very similar trend, with a very wet period between mid-2011 and the start of 2012.
- The stable rainfall period between 2012 and the start of 2015 is presented in both data sets. However, the LCO data suggests a slight drier trend compared to the SILO Ravensworth data.
- Both data sets present wet conditions from 2015 onwards, with a very wet period in April 2015.

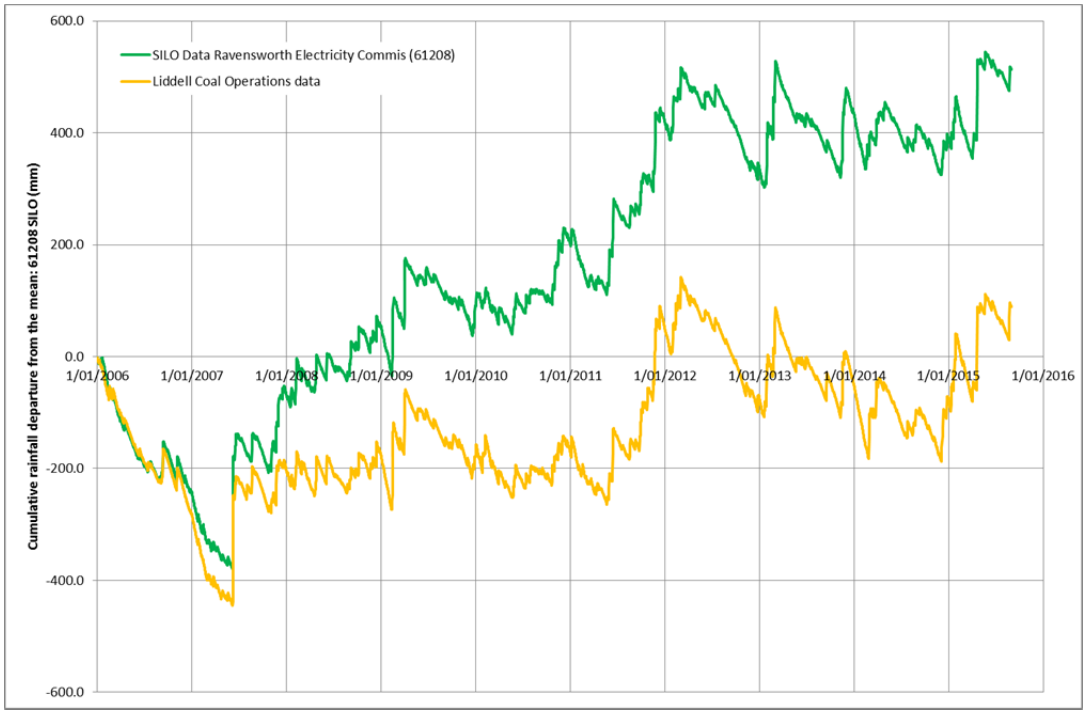

Figure 3-2 Cumulative Rainfall Departure Liddell Regional Area (2006 to 2015)

The review indicates that since 2015, weather conditions at the LCO site, and regional area, have been wetter than average. Considerably higher than average rainfall conditions are observed in the January and April 2015 data at LCO, presenting steep positive trends in the CRD analysis (Figure 3-2).

3.2 Surface Water

3.2.1 Dam water storage

Water quality and water level data are collected from monitoring locations within onsite mine water storages (dams). The purpose of the monitoring is to use results to inform decisions in relation to mine water management and in particular discharges off site.

A review of the data was undertaken to potentially identify if leakage had occurred from these storage areas. Dam 1 and Dam 4 are of particular interest in relation to ALV 1 L and LBH due to their proximity to the groundwater wells. There are no water storages near ALV 7 L. The data suggests:

- Water storage levels are relatively stable during the investigation period (Figure 3-3).
- pH observations remain within the expected range of between 7.5 and 9 pH units (Figure 3-4).
- EC is typically greater than 4 mS/cm for all dams, except for Dam 1, which fluctuates between 0.5 to 2 mS/cm (Figure 3-5).

It is considered that there are no irregular trends within the water storage data during the investigation period that may be contributing to EC trigger value exceedance at LBH and potential exceedance at ALV 1 L and ALV 7 L.

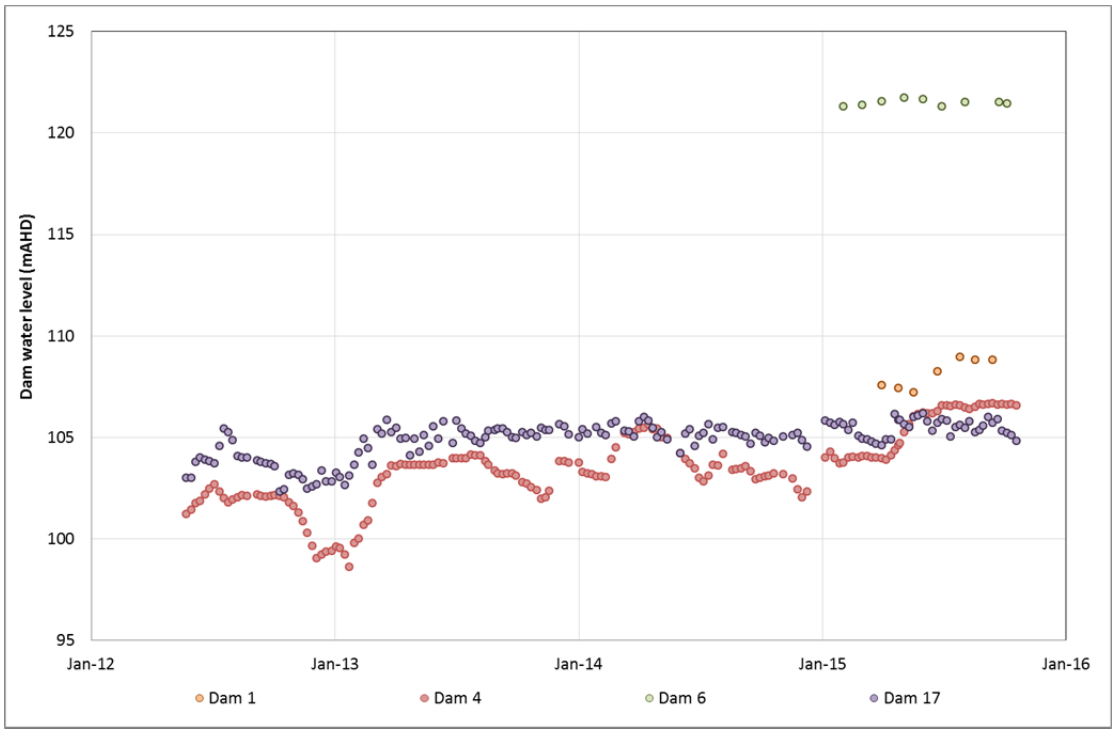

Figure 3-3 Dam water storage levels

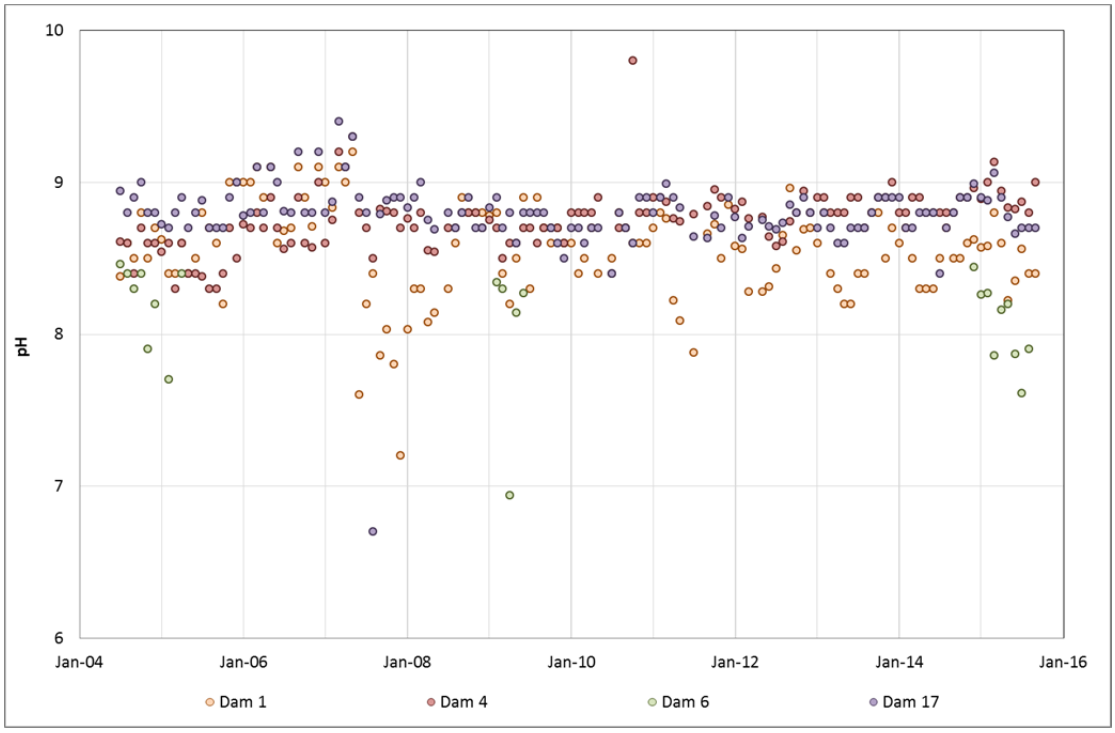

Figure 3-4 Dam water storage pH

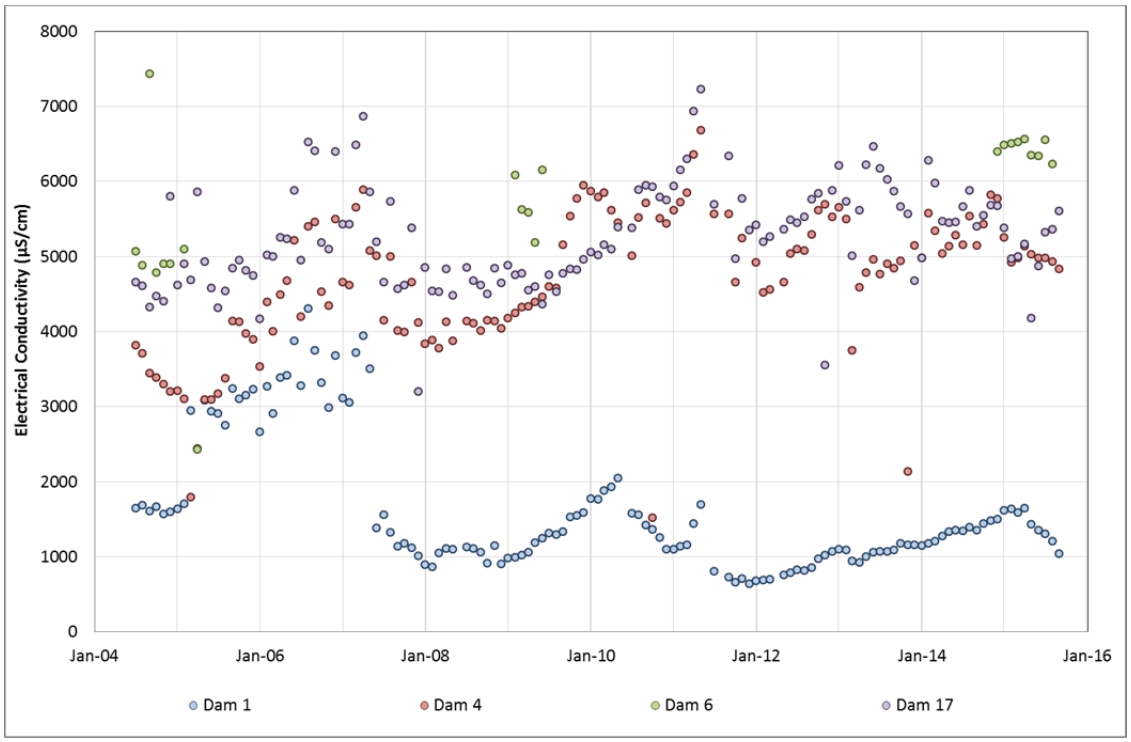

Figure 3-5 Dam water storage EC

3.2.2 Bowmans Creek

Surface water quality (pH and EC) data were reviewed to identify any potentially significant observations within the investigation period. The review targeted monitoring locations along Bowmans Creek due to its proximity to the three investigation sites. Bayswater Creek data was therefore not reviewed.

The review of Bowmans Creek surface water quality data during the investigation period found:

- pH observations at all Bowmans Creek monitoring locations ranged between 7 and 9 which is consistent with historical trends (Figure 3-6 and Figure 3-7)
- EC observations range around 1 mS/cm, which is relatively less saline than the previous month's observations (May 2015; Figure 3-8 and Figure 3-9). However, these salinities are not unexpected within the surface water system when considered against previous years (e.g. 2008, 2009 and 2011). It appears EC may be influenced by rainfall events (refer to Figure 3-2 for interpretation of wetter than average conditions in the LCO region, where similar observations are made for the lower salinity records during 2008, 2009 and 2011 seasonal positive CRD gradients).

It is considered that there are no irregular trends within the Bowmans Creek surface water quality data during the investigation period that may be contributing to EC trigger value exceedance at LBH and potential exceedance at ALV 1 L and ALV 7 L.

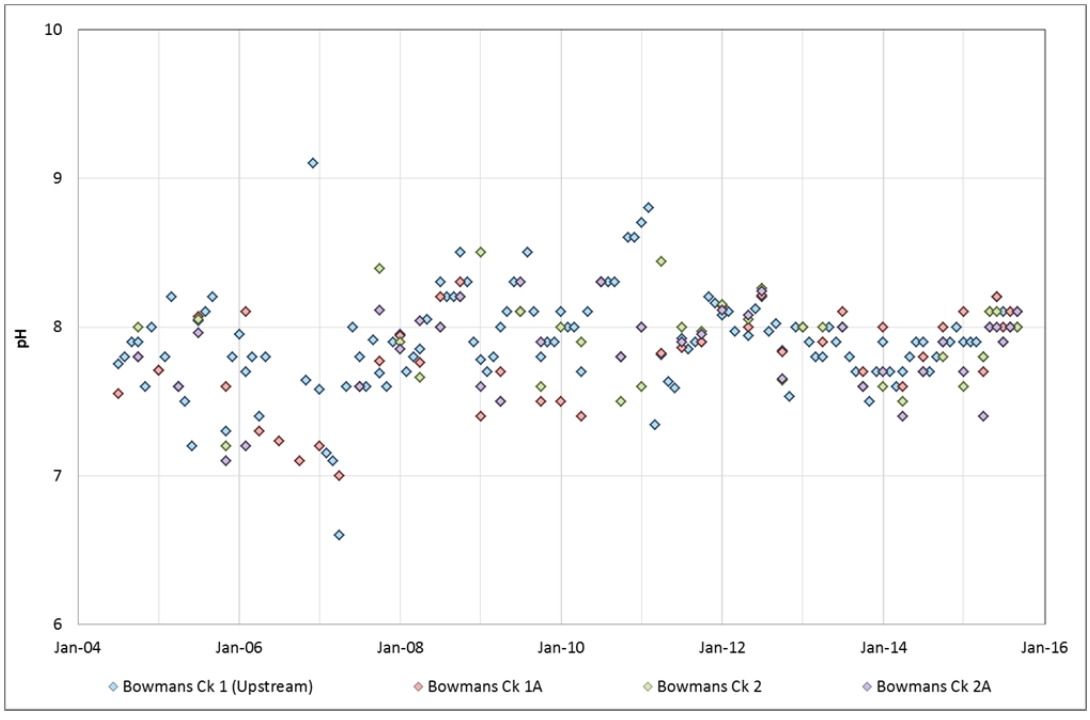

Figure 3-6 Bowmans Creek Surface Water pH: Bowmans Creek 1, 1A, 2 and 2A

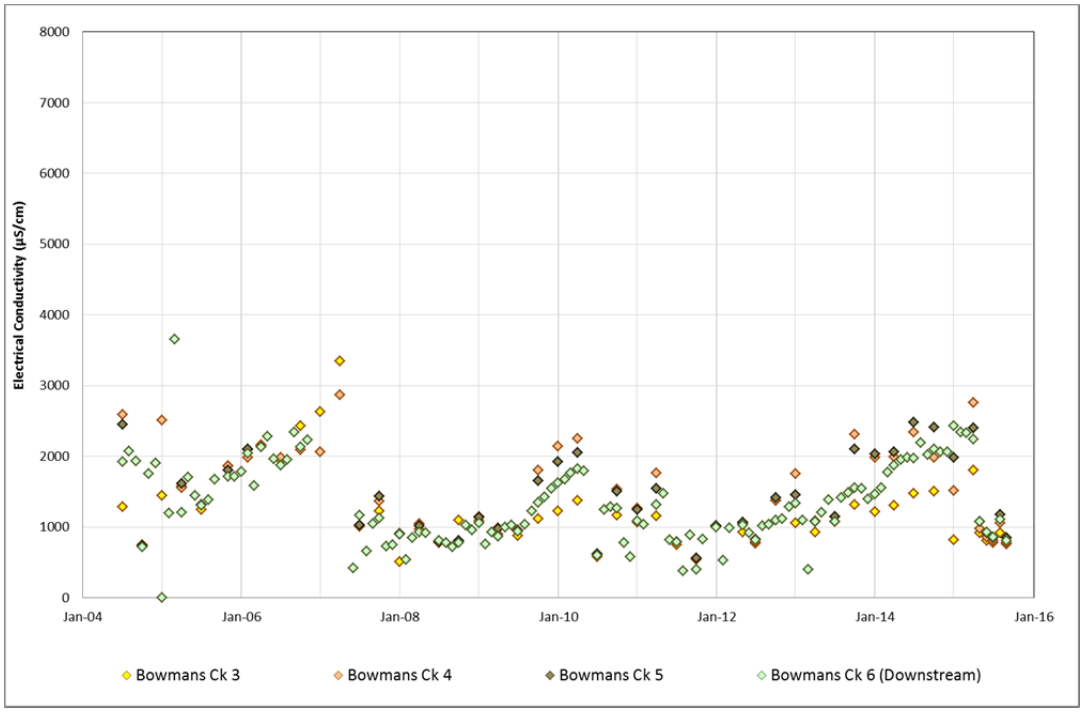

Figure 3-7 Bowmans Creek Surface Water pH: Bowmans Creek 3, 4, 5, 6

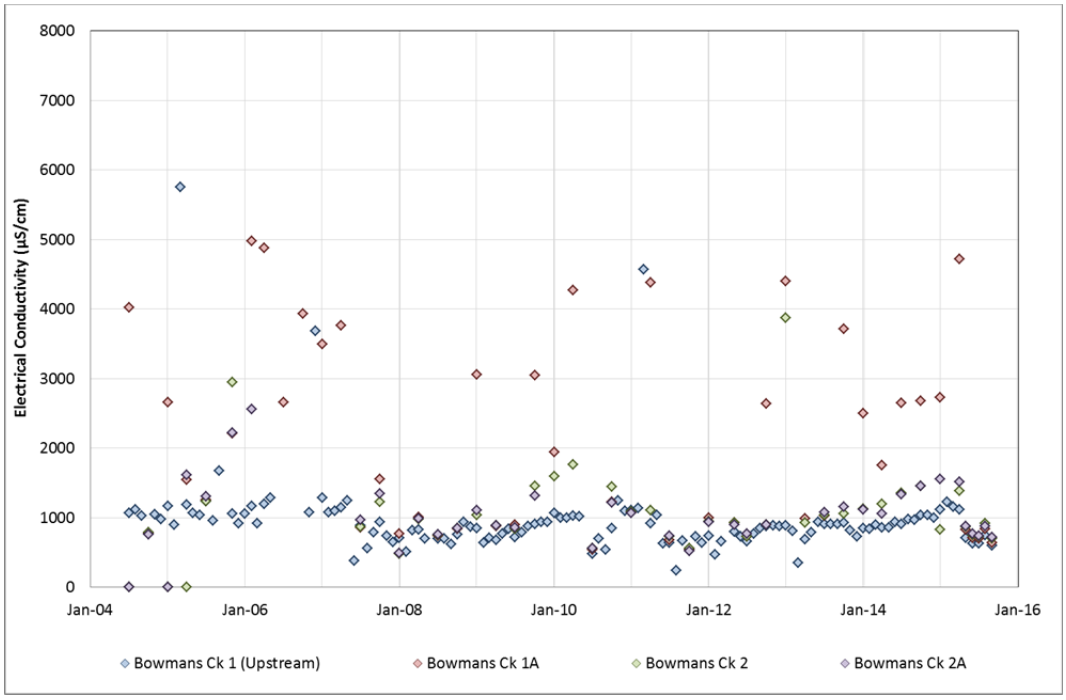

Figure 3-8 Bowmans Creek Surface Water EC: Bowmans Creek 1, 1A, 2 and 2A

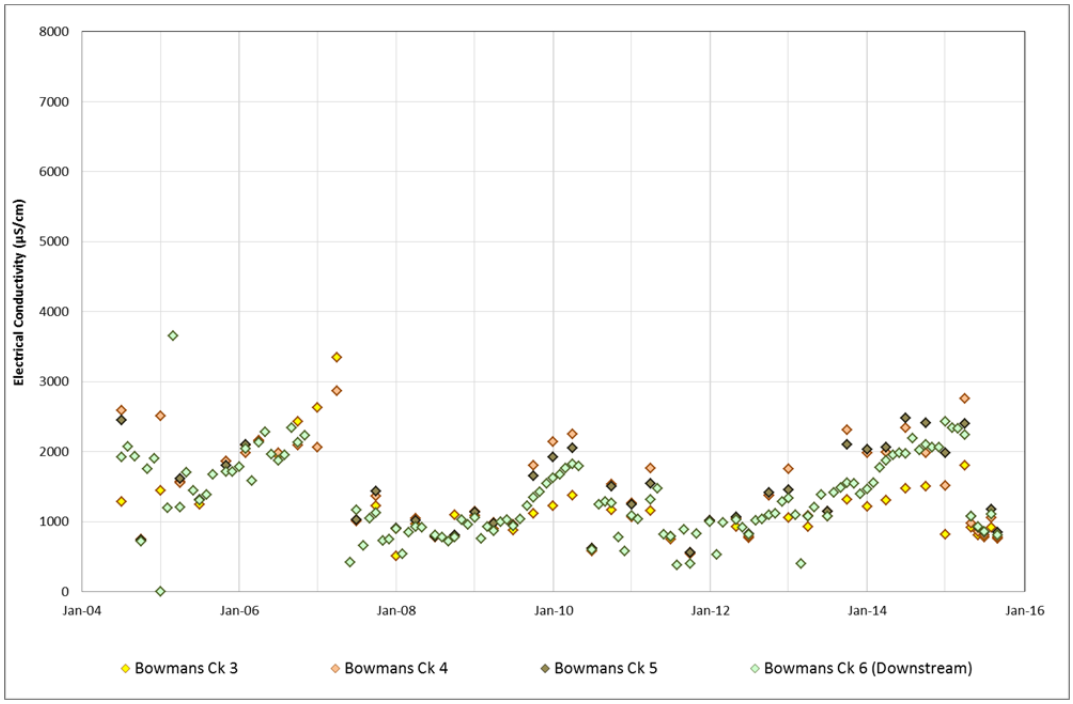

Figure 3-9 Bowmans Creek Surface Water EC: Bowmans Creek 3, 4, 5 and 6

3.3 Groundwater

Groundwater data (depth to water, EC and pH) are collected from Bowmans Creek alluvial aquifers on a monthly basis. Figure 3-10 to Figure 3-12 present groundwater data for ALV 1 L, ALV 7 L and LBH between 2005 and 2015. A review of groundwater data for the investigation period found that:

- Groundwater levels fluctuate seasonally within historical observation ranges taken from 2005 to 2015.
- Groundwater pH observations are stable, and within the WMP trigger values of between 6.5 and 8.5 pH units (LCO, 2015) which are derived from the ANZECC (2000) methodology.
- Groundwater EC observations at ALV 1 L and ALV 7 L fluctuate around 1 and 1.5 mS/cm respectively.
- Groundwater EC observations at LBH appear to be trending to higher salinities from 2012. However, these are within the historical salinity data range recorded at the monitoring well.

It is considered that while LBH salinities are trending to higher salinities, there are no irregular trends within the ALV 1 L, ALV 7 L and LBH groundwater data during the investigation period when compared to historical data. This supports that there are no irregular trends in groundwater data during the investigation period that may be contributing to EC trigger value exceedance at LBH and potential exceedance at ALV 1 L and ALV 7 L.

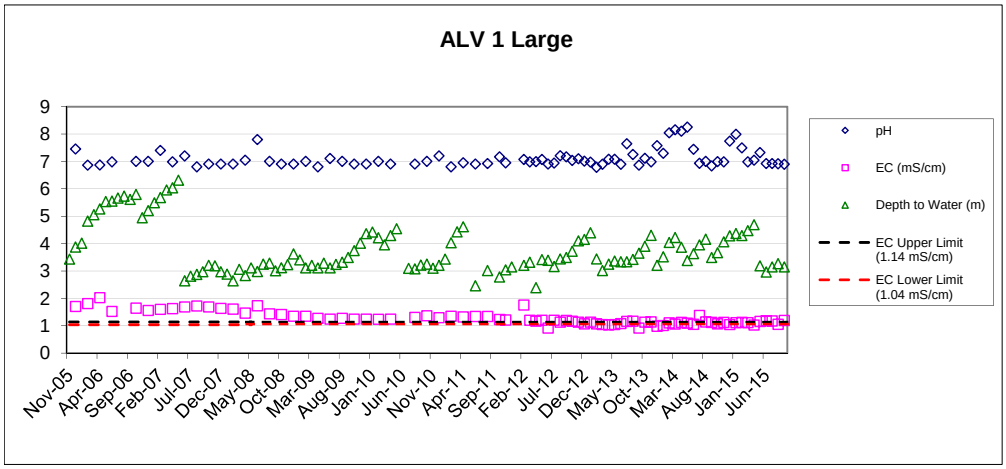

Figure 3-10 ALV 1 L Groundwater Data 2005 to 2015

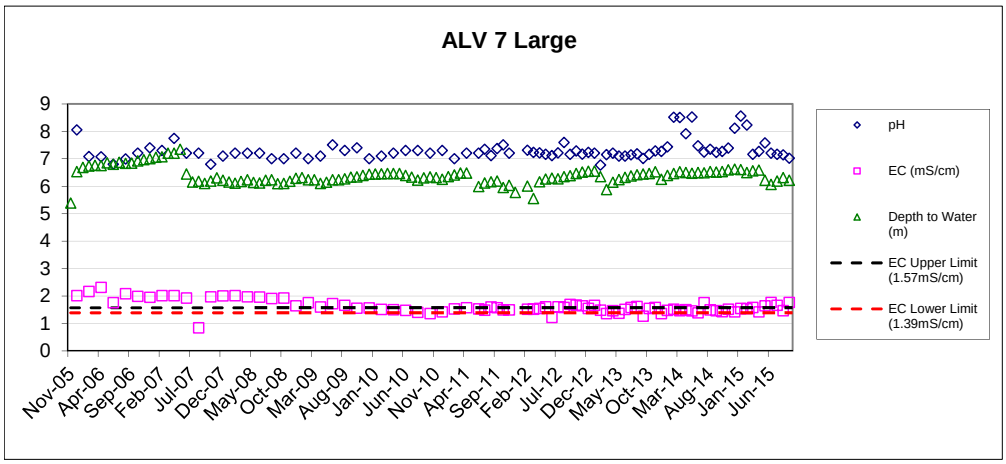

Figure 3-11 ALV 7 L Groundwater Data 2005 to 2015

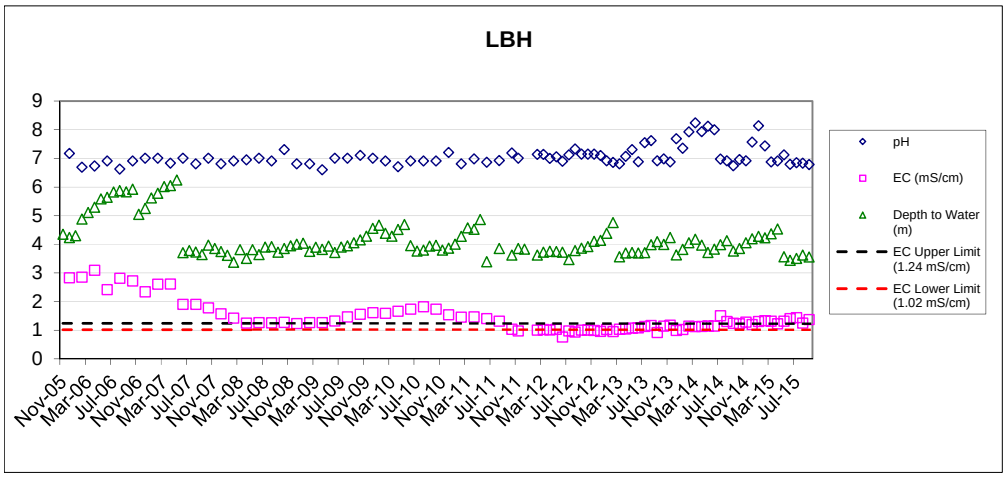

Figure 3-12 LBH Groundwater Data 2005 to 2015

4. Discussion

4.1 Potential for environmental harm

It is considered that groundwater EC data observed at ALV 1 L, ALV 7 L and LBH between the investigation period does not have the potential for environmental harm (as defined in the WMP LCO, 2015). This consideration is based on the following:

- EC observations of groundwater sampled from ALV 1 L are within historical ranges at this monitoring location. For example, during the drought in 2005/06, EC reached 2.0 mS/cm due to climatic conditions
- EC observations of groundwater sampled from ALV 7 L are within historical ranges at this monitoring location. For example, during 2014, EC reached 2.5 mS/cm due to climatic conditions.
- EC observations of groundwater sampled from LBH are within historical ranges at this monitoring location. For example, during the drought in 2005/06, EC reached 3.5 mS/cm due to climatic conditions.
- It is understood environmental harm was not recorded when natural climate conditions resulted in the elevated EC readings, specifically during the 2005/06 drought.

4.2 Rainfall and groundwater relationship

Observed data suggests there is a relationship between rainfall and groundwater parameters such as depth to water, electrical conductivity and pH. Figure 4-1 to Figure 4-3 present groundwater data plotted against monthly rainfall totals. The data suggests:

- Groundwater levels typically rise during months that experience high amounts of rainfall. This observation is most prominent in ALV 1 L and LBH data.
- All monitoring sites suggest a rise in EC and pH are correlated to months with high rainfall events.

There is a risk when comparing monthly rainfall data with monthly groundwater observations that smoothing of climate data can occur. Infrequent, intense storms can be masked by more moderate, prolonged rainfall events within monthly totals. However, the data recorded at the LCO site identifies that rainfall events can cause a rise in EC and pH in the observed groundwater data.

It is most likely that the wetter than average conditions during the beginning of 2015 may be contributing to increased EC and pH results, observed at ALV 1 L, ALV 7 L and LBH.

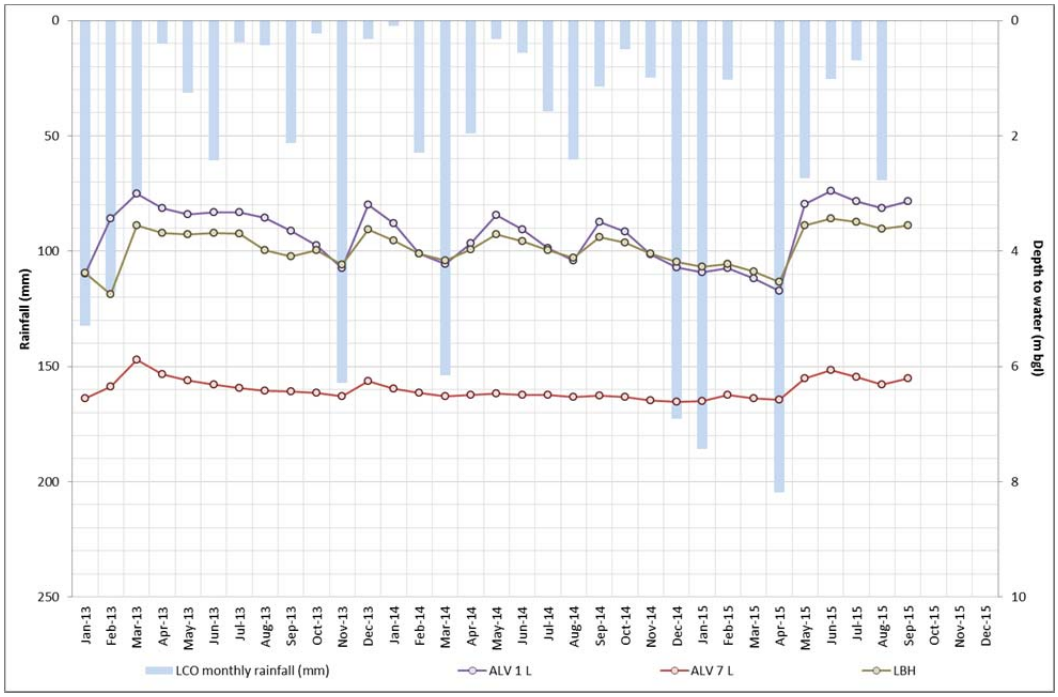

Figure 4-1 Depth to groundwater (m bgl) against monthly rainfall totals (mm) 2013 to 2015

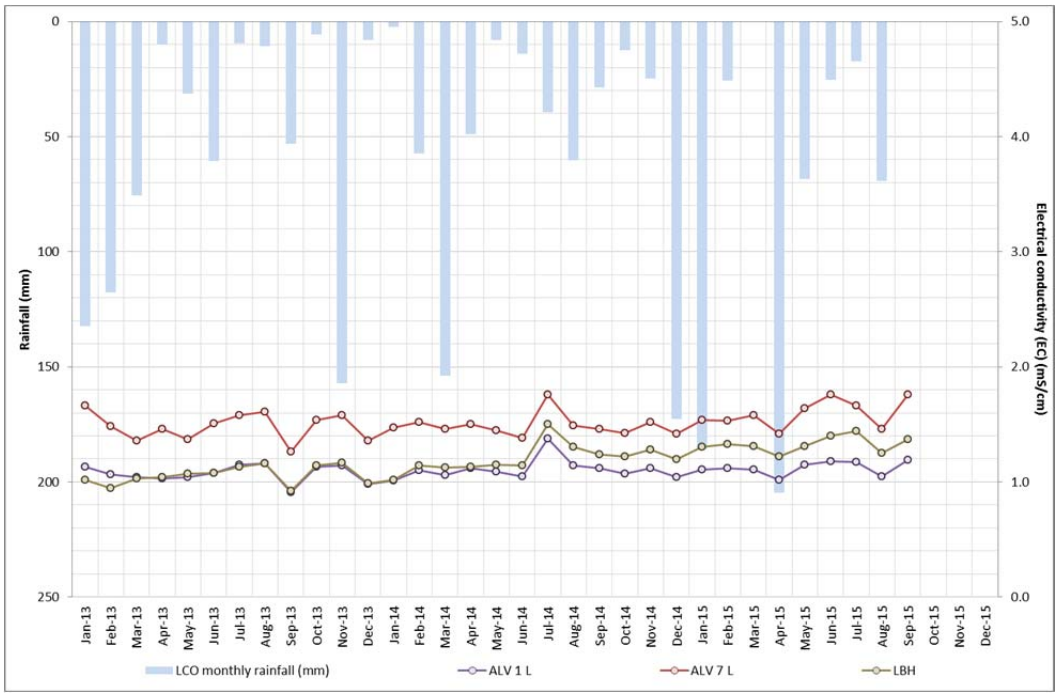

Figure 4-2 Groundwater electrical conductivity (mS/cm) against monthly rainfall totals (mm) 2013 to 2015

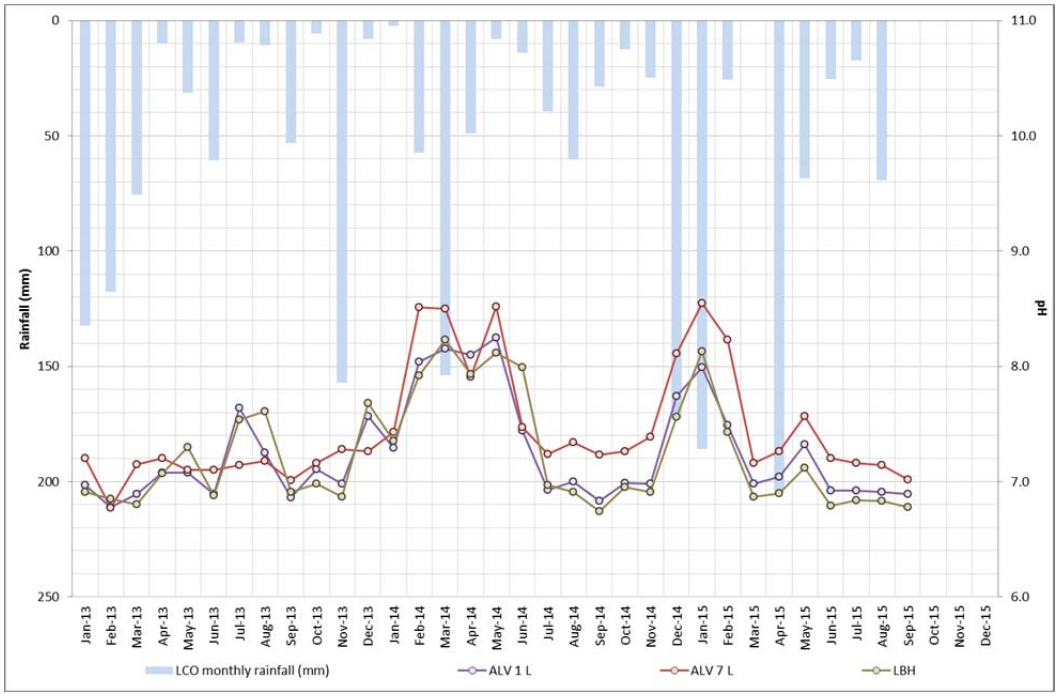

Figure 4-3 Groundwater pH against monthly rainfall totals (mm) 2013 to 2015

4.3 Trigger Value Assessment

Trigger values derived in the LCO WMP were based on the 80th and 20th percentiles of site specific data (i.e. individual monitoring well data) over a 24 month period between January 2013 and January 2015. This approach is modified from the approach discussed in ANZECC (2000), which details:

> *A trigger for further investigation will be deemed to have occurred when the median concentration of n independent samples taken at a test site exceeds the 80th percentile of the same indicator at a suitably chosen reference site. Where suitable reference site data do not exist, the comparison should be with the relevant guideline value published in this document.*

The use of site specific trigger values was considered due to the absence of a reference site, the geological environment in which the site is located (Permian coal measures that have the potential to elevate groundwater salinities above ANZECC (2000) published values), and the wide range of salinities recorded throughout the LCO site.

The site specific trigger value method has short falls when compared to the reference site method:

- Trigger values are constrained to the previous two year period. If natural environmental conditions change for the proceeding years (for example, wetter or drier climate conditions) exceedances may occur.
- If the 24 month dataset coincides with a period of stable observation, the 80th and 20th percentile values may be highly constrained.

The 24 months between January 2013 and January 2015 are associated with a period of very stable observations of EC compared to the historical record for ALV 1 L, ALV 7 L and LBH. The ranges of EC for these monitoring sites are 0.10, 0.18 and 0.22 mS/cm respectively. These are the smallest EC ranges for groundwater wells monitoring the alluvial aquifer, and therefore the potential to exceed these trigger values are higher than other alluvial aquifer monitoring wells. Table 4-1 presents the site specific EC trigger values for alluvial aquifer monitoring wells, and their range.

Table 4-1 Trigger values for alluvial aquifer electrical conductivity (mS/cm)

Well ID	Unit	Upper limit 80th percentile	Lower limit: 20th percentile	Range
ALV 1 L	Alluvial aquifer	1.14	1.04	0.10
ALV 2 L	Alluvial aquifer	3.43	2.27	1.16
ALV 3 L	Alluvial aquifer	1.31	0.94	0.37
ALV 4 L	Alluvial aquifer	2.21	1.59	0.62
ALV 7 L	Alluvial aquifer	1.57	1.39	0.18
ALV 8 L	Alluvial aquifer	1.21	0.75	0.46
LBH	Alluvial aquifer	1.24	1.02	0.22
PGW5 L	Alluvial aquifer	5.27	4.57	0.70

5. Conclusion

An investigation trigger action response plan was undertaken in accordance with condition 23 (c)(iv) of DA 305-11-01 and LCO's Water Management Plan (LCO, 2015) due to an exceedance of the EC trigger value for LBH between June and September 2015. ALV 1 L and ALV 7 L were included in the assessment due to their proximity of exceedance during the same period.

The investigation trigger action response plan (ITARP) undertaken for Bowmans Creek alluvial aquifer monitoring wells ALV 1 L, ALV 7 L and LBH considers that:

- There have been no mining operations undertaken within the immediate vicinity of the LBH during the investigation period.
- The groundwater assessment conducted for Mod 5 (SKM, 2014) noted that groundwater is expected not to be affected based on modelled mining scenarios.
- The local and regional climate within the LCO area during the investigation period is relatively similar to that during the January 2013 to January 2015 period for which the trigger values were derived. However, there is a suggestion that the LCO local climate was wetter than average at the beginning of 2015 compared to 2014 (particularly in January and April 2015).
- Mine water storage dams do not appear to indicate leakage to groundwater within the investigation period. This consideration is based on measured water levels and water quality.
- Bowmans Creek surface water quality data indicates no irregularity within the investigation period against historical trends.
- Groundwater level and pH data recorded during the investigation period present seasonal fluctuations within the expected range of trigger value and historical data.
- Groundwater EC data recorded during the investigation period are within the ranges observed historically for ALV 1 L and ALV 7 L.

- Groundwater data appear to be influenced by rainfall events, causing a decrease in depth to water levels, and an increase in EC and pH. The wetter that average conditions recorded in 2015 may be a reason for increasing trends in EC observed at the investigation sites.
- While groundwater EC data recorded during the investigation period for LBH presents an increasing trend that has been occurring since 2012, salinities are within expected ranges based on historical data recorded at the monitoring location.
- It is unlikely there is potential for environmental harm (as defined in the WMP LCO, 2015) to occur from EC recorded during the investigation period. This is considered based on a review of the historical data recorded at the sites, for example, data recorded during the 2005/06 drought.

It is considered that the ALV 1 L, ALV 7 L and LBH wells may be exceeding trigger values due to their constrained limits (no more than 0.10, 0.18 and 0.22 mS/cm change respectively), and that the site is experiencing higher than average rainfall for the investigation, which did not occur to the same magnitude during the period at which trigger values were set. These trigger values were derived during a relatively stable period of groundwater observations between January 2013 and January 2015.

The occurrence of a prolonged stable period in data can be a short fall in the use of the site specific trigger value method against the ANZECC (2000) reference site or published trigger value method. However, due to the absence of a reference site, geological setting (Permian coal measures) and the wide range of salinities recorded throughout the LCO site, it is considered this was an appropriate approach to undertake.

It is considered that installation of a reference site at the site, at this time, would not necessarily have been a worthwhile investment due to the large range in water quality (specifically EC) observations within the LCO site.

6. Recommendations

There is a potential risk LCO may continue to activate ITARPs for the ALV 1 L, ALV 7 L and LBH monitoring wells based on the site specific trigger value method. It is advised that to mitigate the risk of commissioning ITARPs when observations remain within historical trends recorded at these monitoring locations, and other potential monitoring locations, LCO should consider the following measures:

- Undertaking a review of water quality and water level trigger values assigned to groundwater monitoring wells within the LCO WMP. This review will allow assessment of the appropriateness of newly defined water quality and water level trigger values against observed data since August 2015. The review should be undertaken when adequate seasonal data is captured within the observed dataset. It is therefore suggested the review should be undertaken in August 2016.
- Application of ‘maximum’ site specific trigger value against groundwater monitoring wells within the LCO WMP. This will allow consideration within the natural, long-term threshold to be applied immediately to observation against the monitoring well’s historic data if a trigger value exceedance is identified, before undertaking an ITARP. In cases where observations exceed maximum trigger value, or present an irregular trend not consistent to historical data, an ITARP can then be commissioned to understand the likelihood for potential environmental harm to occur.
- A groundwater well census to identify the presence of a potentially suitable reference monitoring well offsite from the LCO operations. This could lead to application of the ANZECC (2000) reference site method for the nominated groundwater wells if the method is deemed suitable for the LCO site.

7. References

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Appendix B - May 2016 ITARP

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3 June 2016

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

Project Name: Liddell Coal Operations
Project Number: 16-06271

Subject: ALV3S Groundwater Investigation - May 2016

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 a review of the recent groundwater quality trigger at ALV3S.

There has been an exceedance of the trigger level with respect to Electrical Conductivity (EC) at monitoring piezometer ALV3S. In accordance with the current revision of the Water Management Plan (LCO, 2016), this report presents an investigation of the exceedance and an assessment of the potential of harm to the environment resulting from the exceedance.

1.2 Background

The WMP (LCO, 2016) update was recommended based on the findings of the October 2015 Investigation Trigger Action Response Plan (ITARP) (Jacobs, 2015), which investigated the transient exceedance of Electrical Conductivity (EC) 80th percentile trigger values at alluvial groundwater monitoring bore LBH (as well as ALV1L and ALV7L).

The October 2015 ITARP (Jacobs, 2015) concluded the 80th percentile transient exceedance observed between June and September 2015 was likely caused by groundwater response to a rainfall recharge event, however, also noted that the trigger values, at the time, were calculated based on an uncommonly stable period of water quality between January 2013 and January 2015 and consideration should be given to update of the triggers to incorporate natural variability at the site.

Accordingly, the trigger values nominated in the WMP were updated to incorporate all available data, with respect to a calculated 80th%ile (which, by definition, will be exceeded in 20% of all sampling events) as well as a reference maximum.

1.3 Scope of Work

The Scope of Work for this groundwater investigation includes:

- Investigation of the exceedance at ALV3S and other piezometers, namely ALV7L
- Assessment of potential impact to the environment.

2. Groundwater Monitoring Program

2.1 Groundwater Monitoring Network

Two distinct groundwater systems are monitored and reported across the region:

- The shallow, unconfined, water table aquifer (alluvium and shallow bedrock)
- The deep, confined, aquifers. These monitoring records provide an indication of the regional groundwater pressures and quality.

In accordance with Condition 23 (c) (iv) of DA 305-11-01, relevant ongoing groundwater monitoring activates conducted at LCO aim to monitor:

- Background changes in groundwater yield/quality against mine-induced changes
- Impacts of the development on regional and local (including alluvial) aquifers
- Impacts on the Bowmans Creek alluvial aquifer.

Monitoring is undertaken each month for groundwater levels / pressures and at least bimonthly with respect to quality, in accordance with the requirements of EPBC 2013/6908 (Condition 12 (b) (ii)).

LCO's groundwater monitoring program comprises a network of piezometers that monitor the alluvial (L), shallow bed rock (S), and hardrock aquifers. The majority of the water table aquifer piezometers have been installed as nested pairs. The groundwater monitoring network is shown in **Figure 1**.

2.2 Site Specific Trigger Values

Groundwater monitoring has been on-going at LCO since 2002 and provides long term and seasonal observation of groundwater levels and water quality with respect to the water table aquifer. Data indicates that both groundwater level and water quality have remained relatively consistent since monitoring began in 2002, with minor to moderate seasonal variability.

Table 1 presents the site specific trigger values for water quality (EC) (Bowmans Creek Alluvium), after Table 9-14 of the WMP (LCO, 2016).

Table 2 presents the site specific trigger values for water level (Bowmans Creek Alluvium), after Table 9-13 of LCO (2016). It is noted that the Depth to Water level trigger are two-fold, as presented in Section 9.2.3.2 of the WMP (LCO, 2016), insofar there is also a 2m decline in water level compared with the previous equivalent (seasonal) groundwater level.

2.3 Groundwater Trigger Action Response Plan

Figure 2 presents the schematic of the Trigger Action Response Plan (TARP), after Figure 10.2 of the WMP (LCO, 2016).

In accordance with the TARP, an investigation is initiated if the nominated site specific trigger values (water quality) are exceeded on three consecutive occasions.

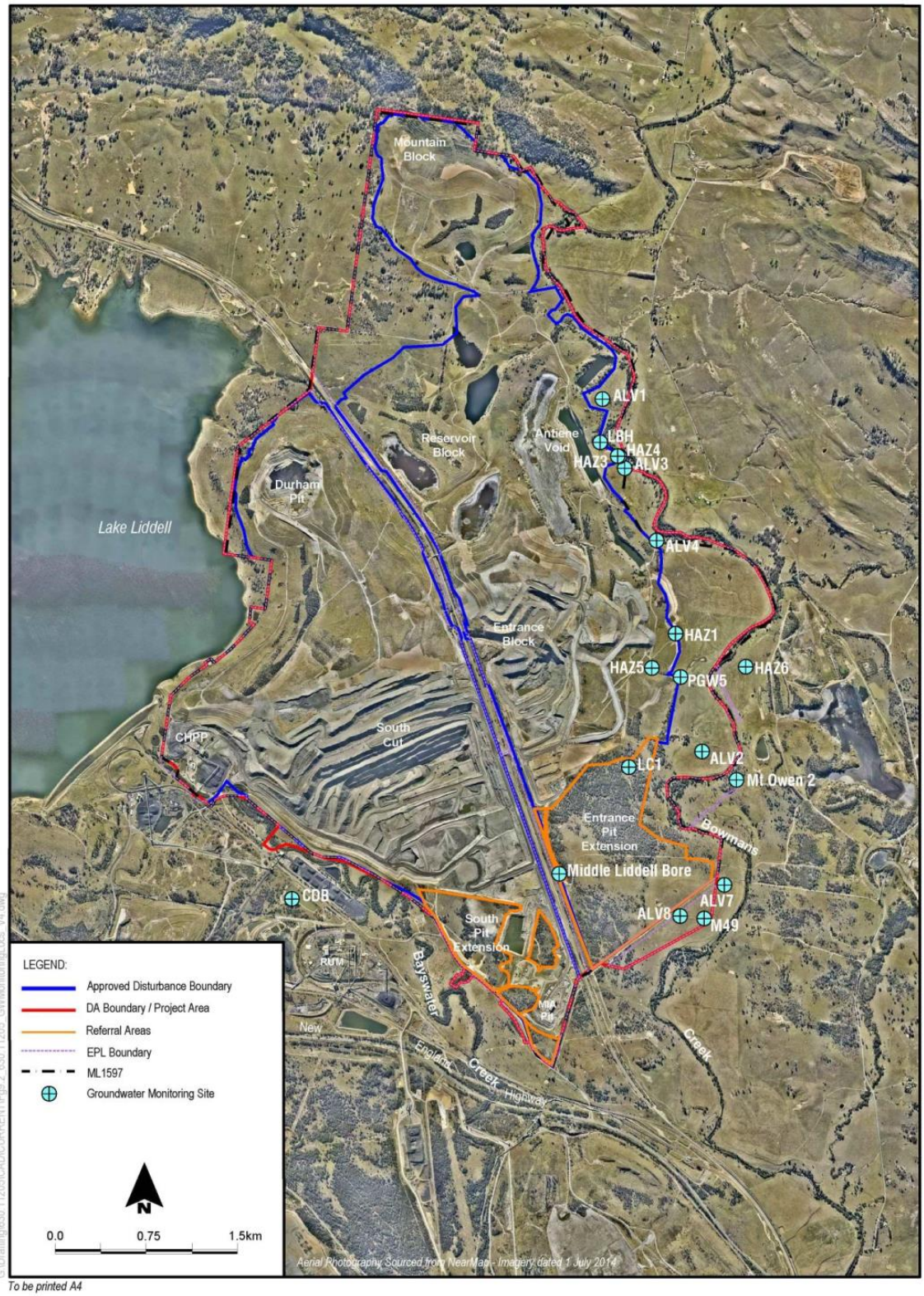


Figure 1: Groundwater Monitoring Locations

Table 1 : Site Specific Trigger Values (EC) (after Table 9.14 of LCO (2016))

Monitoring Location	Unit	Upper Limit (80th%ile) (mS/cm)	Reference Maximum (mS/cm)
ALV1	Alluvial aquifer (L)	1.52	2.02
	Shallow bedrock (S)	1.58	1.77
ALV2	Alluvial aquifer (L)	2.94	4.16
	Shallow bedrock (S)	2.83	3.37
ALV3	Alluvial aquifer (L)	1.49	3.08
	Shallow bedrock (S)	2.63	4.51
ALV4	Alluvial aquifer (L)	2.20	3.08
	Shallow bedrock (S)	5.38	6.43
PGW5	Alluvial aquifer (L)	5.05	6.06
	Shallow bedrock (S)	5.77	6.82
ALV7	Alluvial aquifer (L)	1.90	2.31
	Shallow bedrock (S)	2.26	2.54
ALV8	Alluvial aquifer (L)	1.32	1.88
	Shallow bedrock (S)	2.09	2.40
LBH	Alluvial aquifer (L)	1.69	3.09

Table 2 : Site Specific Trigger Values (Water Level) (after Table 9.13 of LCO (2016))

Monitoring Location	Unit	Lower Limit (10th%ile)		Reference Minimum	
		DTW (mBTOC)[1]	Elevation (mAHD)	DTW (mBTOC)[1]	Elevation (mAHD)
ALV1	Alluvial aquifer (L)	5.50	105.69	6.31	104.88
	Shallow bedrock (S)	5.22	105.97	6.84	104.35
ALV2	Alluvial aquifer (L)	4.91	92.97	6.76	91.12
	Shallow bedrock (S)	4.92	92.96	8.53	89.35
ALV3	Alluvial aquifer (L)	6.32	103.19	7.08	102.43
	Shallow bedrock (S)	6.63	102.88	7.26	102.25
ALV4	Alluvial aquifer (L)	5.94	101.76	12.84	94.86
	Shallow bedrock (S)	6.67	101.03	7.42	100.28
PGW5	Alluvial aquifer (L)	12.61	93.24	19.63	86.22
	Shallow bedrock (S)	11.09	94.76	11.37	94.48
ALV7	Alluvial aquifer (L)	6.84	86.93	7.34	86.43
	Shallow bedrock (S)	10.51	83.26	11.38	82.39
ALV8	Alluvial aquifer (L)	7.04	83.66	8.36	83.66
	Shallow bedrock (S)	9.84	82.18	11.08	80.94
LBH	Alluvial aquifer (L)	5.58	105.21	6.24	104.55

Notes. 1. DTW (mBTOC) is Depth to Water (metres below Top of Casing).

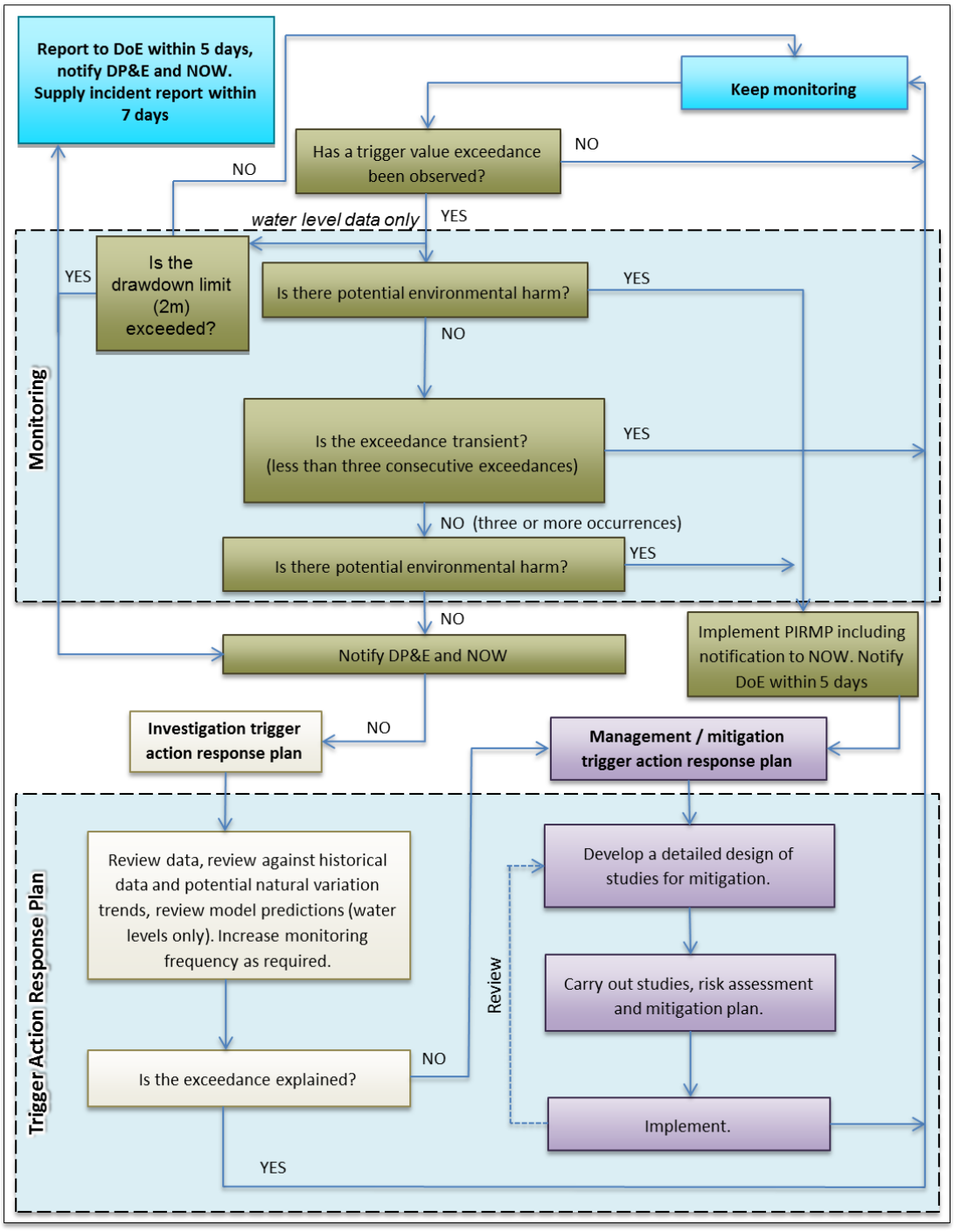


Figure 2: Exceedance of groundwater trigger values action response plan (TARP)

3. Recent Observations

Table 3 presents recent water quality and water level observation data from the Bowmans Creek Alluvium, together with the site specific trigger values.

Figure 3 presents the time-series groundwater elevation for alluvial and shallow bedrock piezometers, together with the calculated cumulative departure from mean (rainfall) or CRD curve. It is noted that the CRD (monthly) was calculated commencing from 2005.

Figure 4 presents the time-series water quality (EC) for alluvial and shallow bedrock piezometers. The trigger value (80th%ile) of ALV3S is also displayed in **Figure 4**. The CRD is again presented in **Figure 4**. It is highlighted that the horizontal axis of **Figure 4** is 2012 to present, rather than 2005 to present as adopted in **Figure 3**.

4. ALV3S Trigger Investigation

The groundwater quality observations at ALV3S exceeded the EC trigger level of 2.63mS/cm during three consecutive monitoring rounds in February, March and April 2016. As per the TARP, this investigation comprised the following tasks:

- Review of historical data
- Identification of potential for natural variation due to climate or otherwise
- Assessment of potential impact to the environment.

4.1 Groundwater Assessment

The groundwater level and EC have been plotted in red in **Figure 3** and **Figure 4** to allow easy identification of ALV3 piezometers. The monthly CRD is plotted in **Figure** 3 and **Figure 4** as a thin black line, to enable identification of rainfall trends. CRD is a commonly used method for considering rainfall trends in groundwater systems.

From **Figure 3**, groundwater elevation generally follows fluctuations in the CRD. i.e. periods of greater than average rainfall (increasing trend in the CRD) lead to increase in groundwater elevation. For example, there was a distinct increase in groundwater elevation in January to April 2015 associated with a period of greater than average rainfall. This was interpreted in Jacobs (2015) as a groundwater recharge event, which led to changes in groundwater quality as the recharge pulse transmitted through the water table aquifer.

From **Figure 3**, there is a period of greater than average rainfall commencing in November 2015 and culminating in January 2016. This is again interpreted as having led to a groundwater recharge event, indicated by the increase in groundwater elevation (both in alluvial and shallow bedrock piezometers) in January 2016. Numerical data is presented in **Table 3**.

The groundwater recharge event is seen in **Figure 4**, to lead to an increase in EC in most alluvial piezometers and in all shallow bedrock piezometers. As per the conclusion presented in Jacobs (2015), groundwater recharge leads to increased water-rock interaction / mobilisation of salt within the shallow bedrock. Minor transient exceedance of EC will not have an adverse impact on the environment and it is considered there is no potential harm due to the exceedance.

It is expected that the water quality of ALV3S will return to below the 80th%ile trigger shortly, as has been observed to occur in the past. It is highlighted that groundwater quality at ALV3S

Table 3a: Bowmans Creek Alluvium Water Quality (EC, mS/cm) Observations

Site	80th%ile	Ref. Maxm	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16
ALV 1L	1.52	2.02	1.18	1.17	1.05	1.19	1.11	1.10	1.04	1.03	1.23	1.09	1.11	
ALV 1S	1.58	1.77	1.28	1.26	1.11	1.26	1.20	1.18	1.10	1.10	1.31	1.18	1.20	
ALV 2L	2.94	4.16	2.54	2.36	2.33	2.71	2.27	2.41	2.41	2.49	2.79	2.30	2.41	
ALV 2S	2.83	3.37	2.82	2.73	2.42	2.79	2.53	2.54	2.41	2.42	**2.86**	2.43	2.51	
ALV 3L	1.49	3.08	1.15	1.05	0.93	1.06	0.97	0.99	0.92	0.95	0.98	0.93	1.00	
ALV 3S	2.63	4.51	1.80	1.75	1.54	1.75	1.67	1.70	2.22	2.45	**2.95**	**2.78**	**2.86**	
ALV 4L	2.20	3.08	1.60	1.56	1.35	1.51	1.45	1.41	1.34	1.34	1.61	1.42	1.44	
ALV 4S	5.38	6.43	5.08	4.87	4.53	5.13	4.63	4.54	4.30	4.09	5.07	4.45	4.51	
PGW 5L	5.05	6.06	5.04	4.83	4.36	4.92	4.42	4.44	4.30	4.28	**5.06**	4.46	4.43	
PGW 5S	5.77	6.82	**5.88**	5.41	5.02	5.60	4.91	5.03	4.81	4.81	**5.79**	4.97	5.01	
ALV 7L	1.90	2.31	1.76	1.66	1.46	1.76	1.68	1.65	1.57	1.71	**1.94**	1.72	1.71	
ALV 7S	2.26	2.54	2.10	2.03	1.79	2.04	1.92	1.92	1.84	1.91	2.16	1.91	1.91	
ALV 8L	1.32	1.88	0.94	1.06	1.06	1.13	1.11	1.13	1.07	1.13	0.93	0.78	0.83	
ALV 8S	2.09	2.40	1.66	1.61	1.42	1.59	1.60	1.51	1.45	1.54	1.63	1.49	1.43	
LBH	1.69	3.09	1.40	1.44	1.25	1.37	1.25	1.21	1.11	1.08	1.26	1.11	1.13	

Table 3b: Bowmans Creek Alluvium Groundwater Level (Depth to Water, m) Observations

Site	10th%ile	Ref. Minm	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16
ALV 1L	5.50	6.31	2.96	3.14	3.26	3.14	3.26	3.29	3.54	2.97	3.28	3.56	3.84	
ALV 1S	5.22	6.84	2.35	2.48	2.56	2.46	2.58	2.65	3.04	2.34	2.64	3.03	3.36	
ALV 2L	4.91	6.76	4.04	4.25	4.32	4.83	4.30	4.30	4.36	4.00	4.24	4.37	4.36	
ALV 2S	4.92	8.53	3.60	3.89	4.03	3.91	4.04	4.10	4.11	3.73	3.99	4.11	4.13	
ALV 3L	6.32	7.08	4.69	4.83	4.91	4.82	4.91	4.90	5.01	4.65	4.93	5.03	5.09	
ALV 3S	6.63	7.26	4.84	5.02	5.09	4.99	5.09	5.09	5.21	4.80	5.10	5.21	5.29	
ALV 4L	5.94	12.84	4.67	4.75	4.89	4.83	4.93	4.91	5.09	4.77	5.01	5.13	5.22	
ALV 4S	6.67	7.42	4.87	5.12	5.26	5.11	5.25	5.34	5.39	4.88	5.07	5.41	5.54	
PGW 5L	12.61	19.63	8.37	9.86	9.96	9.12	9.13	9.77	9.15	8.80	9.72	8.48	8.88	
PGW 5S	11.09	11.37	8.89	9.34	9.61	9.33	9.31	9.60	9.41	9.09	9.33	9.07	9.18	
ALV 7L	6.84	7.34	6.06	6.19	6.31	6.21	6.29	6.37	6.44	6.11	6.07	6.26	6.38	
ALV 7S	10.51	11.38	8.04	8.30	8.44	8.24	8.36	8.46	8.62	7.97	8.01	8.30	8.45	
ALV 8L	7.04	8.36	5.81	6.03	6.13	6.01	6.09	6.13	6.25	5.80	5.84	6.10	6.19	
ALV 8S	9.84	11.08	6.71	6.95	7.09	6.86	6.98	7.05	7.21	6.48	6.66	6.94	7.07	
LBH	5.58	6.24	3.44	3.50	3.62	3.55	3.62	3.62	3.76	3.37	3.69	3.73	3.88	

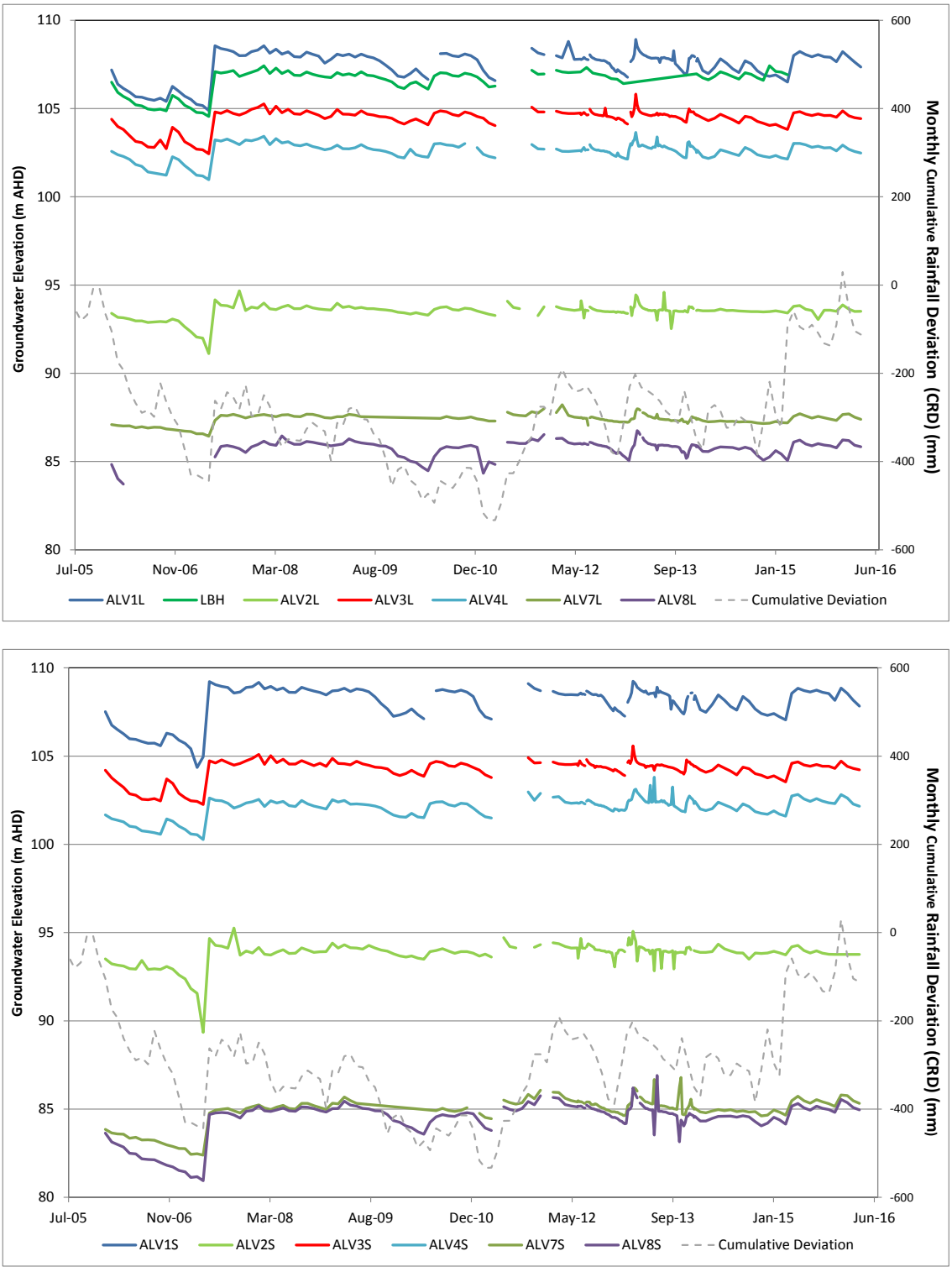
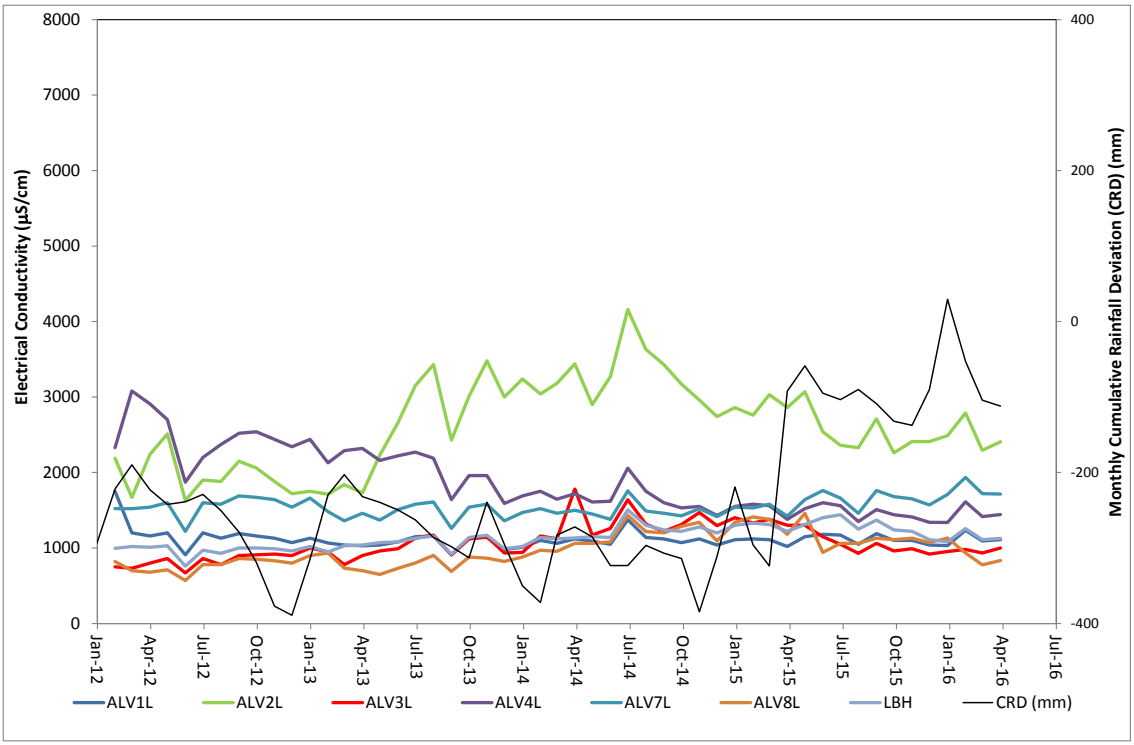


Figure 3: Bowmans Creek Alluvium Groundwater Elevations vs. CRD



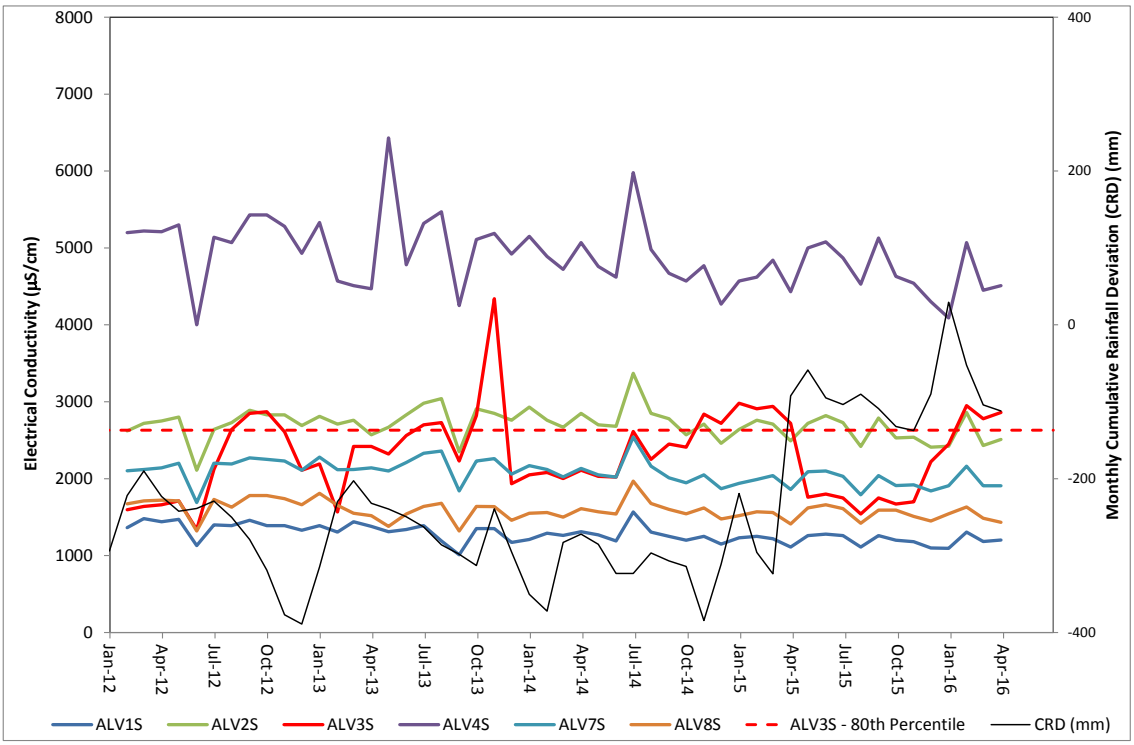


Figure 4: Bowmans Creek Alluvium Groundwater Water Quality (EC) vs. CRD

exhibits more variability than other shallow bedrock piezometers; however, its behaviour is not considered particularly remarkable.

Along similar lines, piezometer ALV7L exceeded its 80th%ile trigger value with respect to EC in February 2016 in response to the groundwater recharge event culminating in January 2016. It is again considered that this is a naturally occurring process and there is no potential harm due to the exceedance.

Review of water level data (not presented in this report) from dam storages, such as Dam 4, does not indicate any adverse trend with respect to ALV3S or other monitoring location.

5. Conclusion

A review of the three, consecutive, trigger level exceedances observed at ALV3S has been completed. It is has been determined that the exceedances are likely due to natural climatic variations. Above average rainfall was received between November 2015 and January 2016. This led to a temporary increase in groundwater elevation in both ALV3S and ALV3L, as with all other piezometers on site. It is interpreted that this constituted a groundwater recharge event which led to enhanced water-rock interaction / mobilisation of salts within the shallow bedrock. Depending on the magnitude of rainfall received over a discrete period, a groundwater recharge event may lead to a decrease in groundwater salinity (due to dilution) or an increase in groundwater salinity (due to enhanced water-rock interaction and / or re-saturation and mobilisation of salt within intermittently saturated portions of the aquifer).

Minor transient exceedance of EC at ALV3S and elsewhere will not have an adverse impact on the environment and it is considered there is no potential harm due to the exceedance, as it is a naturally occurring response of the aquifer. It is expected that groundwater quality at ALV3S will return to below its 80th%ile trigger value shortly, as has been observed to occur in the past.

It is recommended that LCO continue to monitor the water levels and water quality to verify that the EC levels are trending back to within the trigger limits as groundwater levels decline. This should continue during the 2016 monitoring period and be assessed in conjunction with the annual reporting. If there are any departures from this trend at this time, further investigation should be completed to establish what is causing the anomaly.

6. References

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