ASHTON COAL PROJECT

UPPER LIDDELL SEAM EXTRACTION PLAN

Version 01/08/2012

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Ashton Coal Operations Pty Limited

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Version History

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Abbreviations

ACHMP	Archaeology and Cultural Heritage Management Plan
ACOL	Ashton Coal Operations Pty. Limited
ACP	Ashton Coal Project
AEMR	Annual Environmental Management Report
AXYS	AXYS Consulting Pty Ltd
CRRP	Coal Resource Recovery Plan
DP&I	Department of Planning & Infrastructure (formerly the Department of Planning DoP)
DPI	Department of Primary Industries (part of DTIRIS)
DRE	Division of Resources & Energy (a division of DTIRIS)
DTIRIS	Department of Trade and Investment, Regional Infrastructure and Services (formerly the Department of Industry & Investment – I&I)
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMS	Environmental Management Strategy
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPL	Environmental Protection Licence
ERM	Environmental Resources Management (Australia) Pty Ltd
km	kilometres
LB	Lower Barrett Seam
LMP	Land Management Plan
LW	Longwall (e.g. LW4)
m	metres
MG	maingate (i.e. MG1 = maingate 1)
mm	millimetres
MOP	Mining Operations Plan
MPR	Marine Pollution Research Pty Ltd
Mtpa	million tonnes per annum
NoW	NSW Office of Water (a division of DTIRIS)
OEH	Office of Environment and Heritage (formerly Department of Environment, Climate Change and Water - DECCW)
PG	Pikes Gully Seam
PSE	Principle Subsidence Engineer
RMS	Roads and Maritime Services (formerly the Roads and Traffic Authority)
ROM	Run of mine
SCT	SCT Operations Pty Ltd
SHECM	Safety Health Environment and Community Management System
SMP	Subsidence Management Plan
TARP	Trigger Action Response Plan
TG	tailgate (i.e. TG1 = tailgate 1)
ULD	Upper Liddell Seam
ULLD	Upper Lower Liddell Seam

Glossary

Note: Terms in bold are defined in the development consent, the majority of the remaining definitions are adopted from the SMP Guidelines.

Angle of Draw	The angle between the vertical and the line joining the edge of the mining void with the limit of vertical subsidence, usually taken as 20 mm.
Cover depth	The depth of coal seam from the ground surface (metres).
Cumulative subsidence	The total subsidence effects resulting from all seams mined (within this Extraction plan: up to and including the Upper Liddell Seam).
Environmental consequences	Environmental consequences of Subsidence Impacts, including: damage to infrastructure, buildings and residential dwellings; loss of surface flows to the subsurface; loss of standing pools; adverse water quality impacts; development of iron bacterial mats; cliff falls; rock falls, damage to Aboriginal heritage sites; impacts on aquatic ecology; ponding; etc.
Far-field subsidence	Mining-induced movements of the ground surface in areas where vertical subsidence is less than 20 mm.
First workings	Workings which establish access to the coal resource area and which do not result in surface subsidence. First workings do not include longwall extraction of coal.
Goaf	The mined-out area into which the immediate roof strata break.
Incremental subsidence	The subsidence effects resulting from mining in the Upper Liddell Seam only (i.e. not including for any subsidence already completed as a result of mining in the Pikes Gully Seam).
Development Consent	Development consent (DA 309-11-2001-i) issued on 11 October 2002 under Section 80 of the *Environmental Planning and Assessment Act 1979* by the Minister for Planning (and as modified)
Mitigation Measures	Subsidence management measures which aim to reduce subsidence impacts, usually implemented prior to or during mining.
Remediation Measures	Subsidence management measures which aim to repair any adverse effects of subsidence, usually implemented after mining
Second Workings	Extraction of coal by longwall mining or pillar extraction that may result in surface subsidence.
Subsidence or subsidence effects	Deformation of the ground mass due to mining, including all mining-induced ground movements, including both vertical and horizontal displacement, tilt, strain and curvature.
Subsidence impacts	Physical changes to the ground and its surface caused by subsidence effects, including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs.
Upsidence	Relative vertical upward movements of the ground surface associated with subsidence.
Vertical subsidence	Vertical downward movements of the ground surface caused by underground coal mining.

1 INTRODUCTION

1.1 OVERVIEW

This Extraction Plan details the monitoring, management and reporting activities to be undertaken in connection with secondary extraction of Longwalls (LW) 1-8 in the Upper Liddell (ULD) Seam. These longwall panels are located within the approved Ashton Coal Operations Pty Ltd (ACOL) underground mining area and are bound by the New England Highway to the north, the Hunter River to the south, Glennies Creek to the east and Ravensworth Operations to the west.

Revised subsidence predictions have been prepared and revised technical assessments undertaken in support of this Extraction Plan. These assessments are based on comprehensive technical and environmental monitoring that has been ongoing since the commencement of ACOL operations. Potential environmental consequences, as identified by risk assessment and relevant technical specialists (refer to **Volume 2**), show that predicted consequences are manageable and consistent with those previously identified and approved for the Ashton Coal Project (ACP).

Development of this Extraction Plan has been based on a risk-based approach with a Risk Assessment Workshop conducted in August 2011, attended by relevant ACOL personnel and technical specialists. A summary of the key potential consequences/hazards associated with ULD LW1-8, as identified in the risk workshop and technical assessments is provided in **Table 1**. The table also provides an overview of the associated management measures that have been developed to address each consequence. Proposed monitoring and management is then detailed further in **Section 6.2** and **Section 6.3** respectively, as well as within the respective management plan.

Subsidence effects and potential environmental consequences will be monitored and managed in accordance with the performance measures specified under the development consent, and the individual management plans that form part of this document (refer to **Section 1.5**).

Table 1 Potential Consequences and Associated Management Measures

Impacted Natural and Built Features *	Key Potential Consequence(s)	Management Actions	Comment / Reference
Bowmans Creek	Negligible subsidence movement of diversions – no subsidence consequences predicted.	Subsidence monitoring, environmental and geomorphic monitoring of diversion.	Bowmans Creek Diversion Management Plan (see Appendix G: Water Management Plan)
	Surface cracking of excised creek banks or creek bed.	Visual inspection of the area immediately behind the longwall face. Mapping of cracking to be monitored and recorded using GPS. Remediation of cracking post-subsidence.	Bowmans Creek Diversion Completion Criteria (see BCD Construction MOP, Feb 2011) Mine Design complies with Condition 1.18 of DA309-11-2001-MOD-7 LW ".. voids .. not ..closer than 40 metres from any point vertically beneath the high bank…" Appendix G: Water Management
	Potential for degradation of surface water quality (through erosion and cracking).	Monthly monitoring - field screening - Electrical Conductivity EC, pH, total dissolved solids TDS, total suspended solids TSS.	
	Potential for localised bank instability of excised channel (due to local ground movements tilts and strains).	Weekly visual inspection of affected reach, noting any areas of recent bank collapse, erosion or instability.	
Bowmans Creek floodplain & Overland/Floodplain Areas	Surface ponding	Monitoring and remediation of ponding (to provide free-draining landform).	Appendix I: Extraction Land Management Plan
	Surface cracking	Permanent cracking repaired at completion of longwall subsidence by filling or ripping, and revegetated to prevent erosion and reduce potential safety risks to people and livestock.	
	Erosion – drainage lines	Monitor affected areas and where identified, install temporary sediment controls (i.e. install sediment fence immediately downslope) until stabilisation or reshaping works to prevent ongoing erosion until remediation can be completed.	
Groundwater – alluvium	Drawdown of alluvial aquifer with minor baseflow impacts to Bowmans Creek.	Water level monitoring in relevant piezometers - fortnightly during extraction beneath excised creek and alluvium.	Appendix G: Water Management Development Consent DA 309-11-2001-MOD7
	Changes in ground water quality.	Water quality sampling of groundwater bores on a quarterly basis.	

Impacted Natural and Built Features *	Key Potential Consequence(s)	Management Actions	Comment / Reference
	Increased mine inflows	Routing monitoring of inflows reporting to the underground workings as an indicator of changed geological conditions and possible interaction with overlying alluvial aquifers.	
Ecology	No significant impacts predicted	Biannual targeted searches for threatened species. Riparian monitoring and monitoring of groundwater dependent ecosystems.	Appendix H: Biodiversity Management Plan
	No significant impacts predicted	Sampling as per AusRivAS protocols with site SIGNAL indices calculated. Fish sampling using overnight bait traps.	
Electricity transmission lines	The southern major interconnector, a 132kV transmission line, will require modification to remain serviceable. Other lines are expected to experience manageable levels of subsidence.	Modifications will be based on a advice and works will be undertaken in consultation with Ausgrid. All other lines managed using measures previously utilised during extraction of the PG Seam.	Appendix D: Built Features Management Plan (Ausgrid Asset Management Plan (AMP) and RavOps AMP)
New England Highway	No significant impacts are expected.	Subsidence monitoring in accordance with the RMS Asset Management Plan and Subsidence Monitoring Program.	Appendix D: Built Features Management Plan (RMS AMP) Subsidence Monitoring Program
Fibre optic cable	No significant subsidence impacts are expected.	Monitoring to identify any subsidence-induced damage to cables after completion of active subsidence.	Appendix D: Built Features Management Plan (AAPT AMP)
Local telecommunication lines	Potential for strains to exceed cable tolerance causing service disruption.	Suitable alternate services provided to a single potentially affected residential property. Assessment of line condition prior to subsidence .Consult with NOW regarding short spur servicing gauging station. Investigate decommissioning of lines where appropriate in consultation with Telstra.	Appendix D: Built Features Management Plan (Telstra AMP, NoW AMP, Property 130 AMP)

Impacted Natural and Built Features *	Key Potential Consequence(s)	Management Actions	Comment / Reference
Private access roads	Cracking, potential for roads to become partially waterlogged. Potential safety risk for road users.	Daily inspection during active subsidence and remedial work as per Road Management Response Table (refer BFMP). Alternative access route maintained and available during most phases of subsidence impact to Property 130 access road.	Appendix D: Built Features Management Plan (Property 130 AMP, MacGen AMP, ACOL AMP). Appendix D: Public Safety Management Plan
Brunkers Lane / Lemington Road	Surface cracking / changes in vertical alignment etc. Potential safety risk for road users.	To be reviewed in accordance with the consent and management plan developed in consultation with Ravensworth Operations, Singleton Shire Council prior to application for approval for ULD LW5-8.	Appendix D: Built Features Management Plan Appendix D: Public Safety Management Plan
Prescribed Dams	No significant subsidence impacts are expected.	Subsidence monitoring to be undertaken by ACOL in accordance with any future Dam Safety Committee approval recommendations.	Appendix D: Built Features Management Plan (RavOps AMP)
Mine infrastructure	No significant impacts are expected.	Appropriate mitigation measures are provided in relevant Asset Management Plans with some minor works (e.g. exposing of pipelines) required.	Appendix D: Built Features Management Plan (ACOL AMP)
Farm land and facilities, residential establishments	No impacts to residential establishments are expected. Some farm infrastructure (dams, sheds) may experience minor impacts.	Pre and post subsidence inspections and repair / remediate as required.	Appendix D: Built Features Management Plan (Property 130 AMP, ACOL AMP)
Archaeology	Approaching cracking or proximity of erosion may potentially threaten the integrity of a site, or be located in an area in which remediation of cracking via ripping is required.	Salvage / manage in accordance with protocols approved under current AHIPs for the ACP. Documented visual inspection of all in-situ sites prior to subsidence, on a monthly basis during undermining, and following completion of the longwall.	Appendix J: Archaeology and Cultural Heritage Management Plan

1.2 BACKGROUND

The Ashton Coal Project (ACP) is located approximately 14 km northwest of Singleton in the Hunter Valley region of New South Wales (refer to **Figure 1**). The project includes an open cut mine, an underground mine, a Coal Handling and Preparation Plant and associated rail siding and infrastructure.

The ACP was granted consent on 11 October 2002 by the Minister of Planning pursuant to the provisions of the *Environmental Planning and Assessment Act 1979* (DA 309-11-2001-i). The mine is approved to produce up to 5.45 million tonnes per annum (Mtpa) of run of mine (ROM) coal and operate until 2023.

The underground mine is approved for multiseam longwall extraction, targeting four coal seams in descending order (Pikes Gully (PG), Upper Liddell (ULD), Upper Lower Liddell (ULLD) and Lower Barrett (LB)). Development of the underground mine commenced in December 2005 and is accessed through the southern wall of the Arties Pit under the New England Highway.

Subsidence effects from longwall extraction of the PG Seam at the ACP have been managed in accordance with two approved Subsidence Management Plans – one governing subsidence monitoring and management for longwalls 1 to 4 (LW 1-4) and the other for longwalls 5 to 8 (LW 5-8).

The modification of DA 309-11-2001 in December 2010 replaced the requirement (under the development consent) for the preparation, approval and implementation of a Subsidence Management Plan(s) with that of an Extraction Plan. Under this new subsidence management regime the development consent becomes the principle approval authorising first workings, while an approved extraction plan governs the monitoring and management of subsidence effects from second workings.

Ashton Coal Operations Pty Ltd (ACOL) has prepared this Extraction Plan (including component management plans and supporting technical assessments) to coincide with the scheduled progression of longwall mining from the PG Seam to the ULD Seam. The ULD is the next deepest seam to be mined using the longwall extraction method at the ACP. Pending approval of this Extraction Plan longwall extraction of ULD LW1 is scheduled to commence early in the second quarter of 2012.

ACOL has adopted a strategic approach in preparing this ULD Extraction Plan to include wherever practicable the monitoring and management of subsidence effects associated with mining all eight ULD longwall panels (LW1-8). The key benefits to this approach include:

- The assessment of impacts and development of management strategies consider the site as a whole;
- Management and monitoring of subsidence effects across all eight longwall panels is developed and applied consistently, where appropriate; and
- A simplified set of management plans and document structure, providing greater clarity for site personnel and regulators; enabling more effective implementation of management strategies.

While the scope of this plan addresses all longwall panels in the ULD Seam, ACOL is currently only seeking second workings approval for LW 1-4. This being due to delays in gaining subordinate approvals for diverting Bowmans Creek and the subsequent restrictions

this imposes on ACOL to fully extract LW 6B, 7A and 7B in accordance with the approved mine plan and development consent conditions 1.18, 4.5 and 4.6 (to Schedule 2). As such, some management plans and programs under this Extraction Plan have been prepared in a staged manner, as allowed for by condition 1.22 to Schedule 2 of DA 309-11-2001-i.

This Extraction Plan will be reviewed and updated following completion of the creek diversions and prior to seeking approval for second workings in ULD LW 5-8. This review process is documented in Section 7.4.

1.3 PURPOSE & SCOPE

This Extraction Plan sets out the proposed monitoring, management, and reporting activities developed to address the predicted subsidence impacts from the secondary extraction of LW 1-8 in the ULD Seam at the Ashton Underground Mine and has been prepared in accordance with condition 3.12 and 3.13 to Schedule 2 of DA 309-11-2001-i.

This Extraction Plan forms part of ACOL's Environmental Management Strategy (EMS) for the ACP. The ACP EMS includes a suite of environmental management plans required under condition 3.6 to Schedule 2 of DA 309-11-2001-i, as well as the Mining Operations Plan (MOP) required as a condition to Mining Leases (ML) 1533, 1623, and 1529. The relationship of this Extraction Plan to the ACP EMS is shown on **Figure 2**.

1.4 OBJECTIVES

The objective of this Extraction Plan is to provide for the adequate protection of natural and built features from direct and indirect subsidence impacts of LW 1-8 in the ULD Seam.

This objective will be achieved by:

- Identifying, and implementing as appropriate, a monitoring and management regime to reduce the identified subsidence risks; and
- Implementing a review and auditing process to provide feedback on the implemented monitoring and management regime and to ensure continual improvement.

1.5 DOCUMENT STRUCTURE

This Extraction Plan provides a brief overview of the approved mine plan, associated subsidence and resulting environmental consequences. It also briefly outlines the monitoring and management regime proposed to be implemented for the underground mine, which is detailed further in the component management plans appended to this Extraction Plan. In summary, this plan includes the following information:

- **Section 2** – Summarises the relevant statutory requirements for the preparation of this document and the management of subsidence impacts, providing cross-referencing to the appropriate section or appendices where each requirement is addressed;
- **Section 3** – Provides a description of the proposed mine plan and summary of the existing environment affected under the scope of this plan;

- **Section 4** – Provides information of the results of subsidence monitoring completed (PG Seam LW 1-5) and comparison to former subsidence predictions, to confirm the accuracy of modelling conducted to-date;
- **Section 5** – Summarises the results of recent subsidence modelling and estimation for the approved mine plan for the ULD Seam and outlines the predicted environmental consequences;
- **Section 6** – Outlines the performance measures, management and monitoring activities that are proposed to mitigate predicted subsidence impacts and confirm that subsidence and its consequences are within predicted ranges. The section also sets out the proposed contingency response in the event that subsidence impacts exceed (or are considered likely to exceed) the adopted performance indicator;
- **Section 7** – Details the responsibilities of ACOL personnel under this Extraction Plan and sets out the reporting, auditing and review requirements.

The following reports and management sub-plans have been prepared in accordance with condition 3.12 to Schedule 2 of DA 309-11-2001-i:

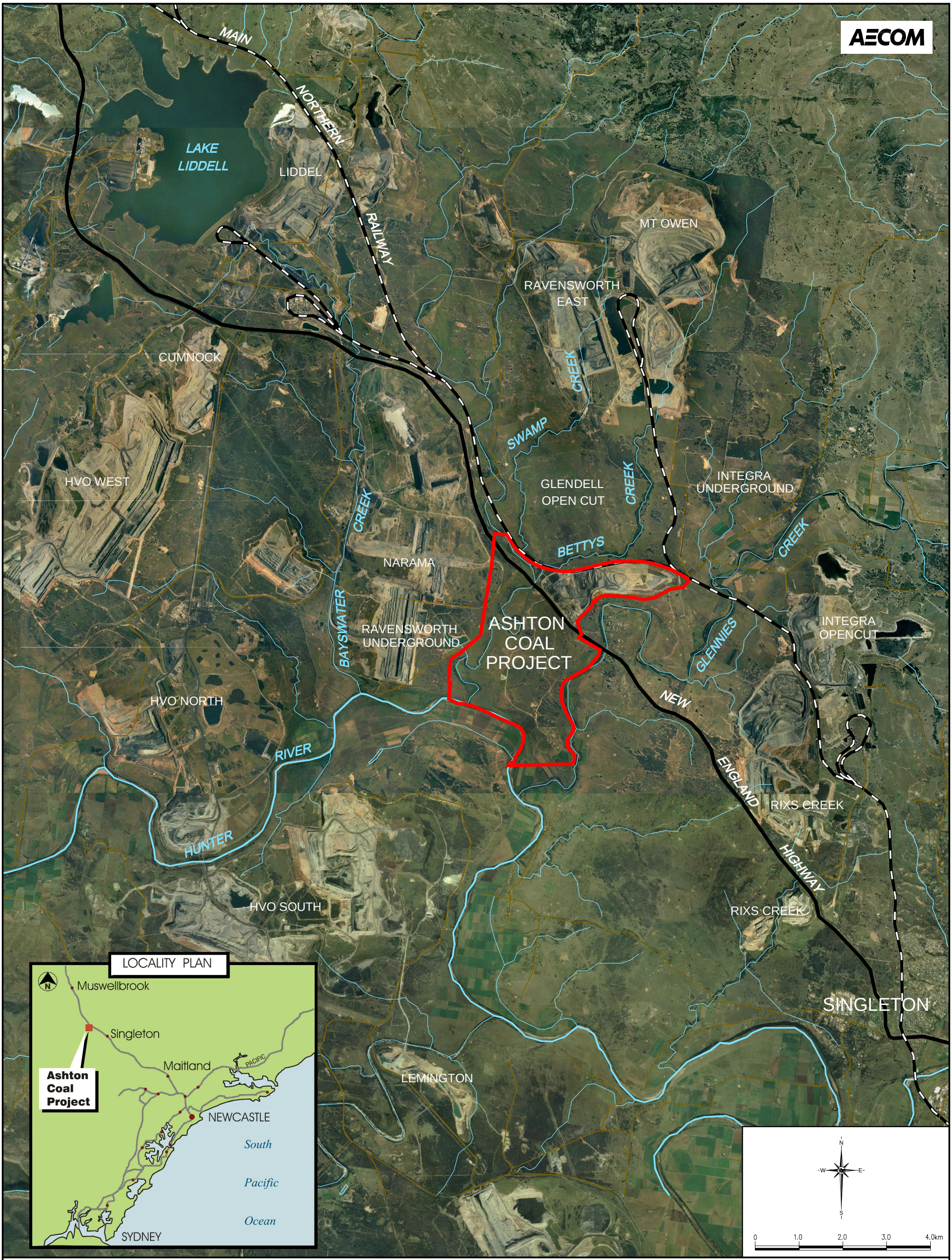
- **Appendix A** – Revised subsidence predictions (by SCT Operations Pty Ltd);
- **Appendix B** – Coal Resource Recovery Plan, providing detail on the mine plan and schedule, geology and overburden, resource recovery and justification for the proposal;
- **Appendix C** – Subsidence Monitoring Program, detailing the proposed survey monitoring that will be conducted to confirm subsidence behaviour, and summarising the monitoring of impacts to built and natural features (contained in other sub-plans);
- **Appendix D** – Built Features Management Plan, structured to include Asset Management Plans (AMPs) for each individual asset / landowner, detailing the consultation, monitoring, mitigation and remediation measures for affected surface infrastructure;
- **Appendix E** – Public Safety Management Plan, listing potential risks associated with subsidence of the surface, and avoidance measures that will be implemented to prevent personal injuries;
- **Appendix F** – Rehabilitation Management Plan, providing a discussion of the current Rehabilitation Strategy which was approved as part of the Bowmans Creek Diversion (BCD) Environmental Assessment (EA). A Rehabilitation Management Plan is currently under preparation in accordance with the amended development consent;
- **Appendix G** – Water Management Plan including monitoring and management practices relevant to extraction of the ULD Seam at the ACP;
- **Appendix H** – Flora and Fauna (Biodiversity) Management Plan, for the monitoring and management of threatened species, terrestrial and aquatic ecosystems;
- **Appendix I** – Extraction Land Management Plan, addressing monitoring and remediation of subsidence impacts, not specifically addressed by the site-wide Land Management Plan;

- **Appendix J** – Archaeology and Cultural Heritage Management Plan identifies potential impacts to Aboriginal cultural heritage and details their management and mitigation; and
- **Appendix K** – Legislative Requirements – provides a reference list of where requirements under the SMP Guidelines (DMR 2003) have been met for ULD LW 1-8.

This Extraction Plan is supported by a series of technical reports, prepared by relevant specialists, which contain a review of *environmental consequences* associated with the revised predictions of subsidence by SCT as presented as **Appendix A**. A facilitated risk assessment workshop, incorporating the relevant technical specialists, was also conducted in accordance with the procedures contained with *Guideline for Applications for Subsidence Management Approvals* (DMR, 2003).

These technical reports are contained within Volume 2, and include the following assessments:

- Technical Report No.1 – Multi-Seam Subsidence - 3D Extrapolation, SCT
- Technical Report No.2 – Subsidence Peer Review, MSEC
- Technical Report No.3 – Groundwater Impact Assessment, RPS Aquaterra
- Technical Report No.4 – Terrestrial Ecology, PEA Consulting
- Technical Report No.5 – Aquatic Ecology, Marine Pollution Research
- Technical Report No.6 – Geomorphology, Fluvial Systems
- Technical Report No.7 – Steep Slopes Stability Assessment, Geotech Solutions
- Technical Report No.8 – Risk Assessment Workshop, Axys Consulting



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Extraction Plan
Upper Lidell Seam LW 1-8

Figure 1
Location of the Ashton Coal Project

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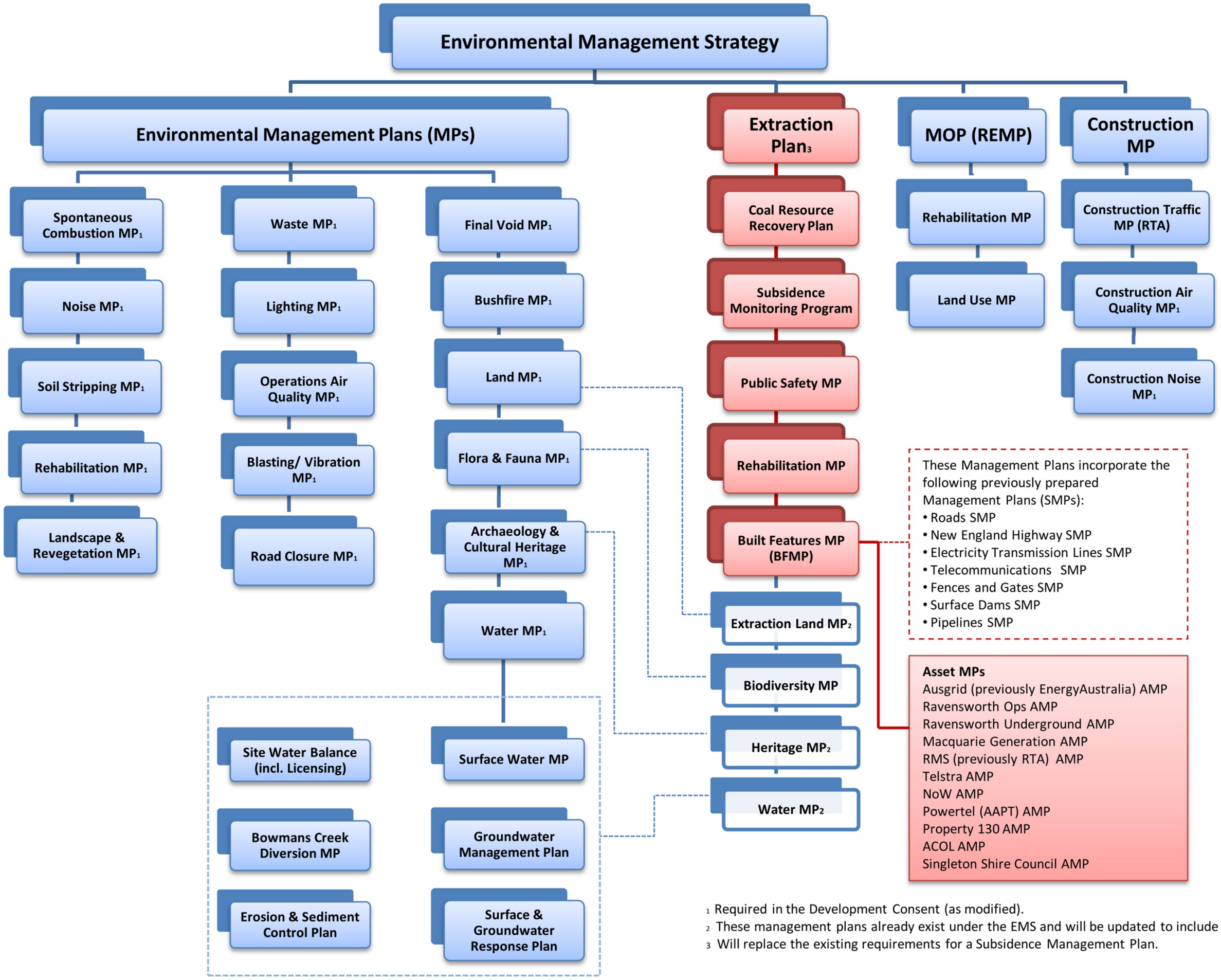

Figure 2 Ashton Coal Environmental Management Strategy

1 Required in the Development Consent (as modified).
2 These management plans already exist under the EMS and will be updated to include the BCD.
3 Will replace the existing requirements for a Subsidence Management Plan.

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2 STATUTORY REQUIREMENTS

2.1 DEVELOPMENT CONSENT

This document has been prepared in accordance with conditions 3.12 and 3.13 to Schedule 2 of DA 309-11-2001-i. The development consent requirements and relevant reference within the Extraction Plan is provided in **Table 2**.

Table 2 Development Consent – Extraction Plan Document Reference

Cdn	Condition	Extraction Plan Reference
3.12	The Applicant shall prepare and implement an Extraction Plan for the second workings within each seam to be mined to the satisfaction of the Director-General.	Extraction Plan and Appendices
3.12(a)	Be prepared by a team of suitably qualified and experienced persons whose appointment has been endorsed by the Director-General.	Endorsement provided on 3 June 2011
3.12(b)	Be approved by the Director-General before the Applicant carries out any of the second workings covered by the plan.	This Application
3.12(c)	Detailed plans of existing and proposed first and second workings and any associated surface development.	Extraction Plan and Appendices
3.12(d)	Detailed performance indicators for each of the performance measures in Tables 1 and 2 [DA 309-11-2001-i MOD 7 Conditions 3.9 and 3.10].	Appendix D (Sect. 4) and G-J
3.12(e)	Provide revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, incorporating any relevant information obtained since this approval.	Appendix A and Vol.2 Technical Reports
3.12(f)	Describe measures that would be implemented to ensure compliance with the performance measures in Tables 1 and 2 and remediate any predicted impacts and/or environmental consequences.	Appendices D, E and G-I
3.12(g)	Include the following to the satisfaction of DRE:	
	A Coal Resource Recovery Plan	Appendix B
	A Subsidence Monitoring Program	Appendix C
	A Built Features Management Plan	Appendix D
	A Public Safety Management Plan	Appendix E
	Appropriate revisions to the Rehabilitation Management Plan required under Condition 3.51	Appendix F
3.12(h)	Water Management Plan	Appendix G
	Biodiversity Management Plan	Appendix H
	Land Management Plan	Appendix I
	Heritage Management Plan	Appendix J
3.12(i)	Program to collect sufficient baseline data for future Extraction Plans.	Appendix C
3.13(a)	Assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval.	Volume 2
3.13(b)	Detailed description of the measures that would be implemented to remediate predicted impacts.	Appendices D and F-J
3.13(c)	Contingency plan that expressly provides for adaptive management.	Section 6.4 and 7.1

In addition to the requirements for the preparation of this Extraction Plan discussed above, **Appendix K** sets out other relevant development consent conditions and statements of commitments relating to the management of subsidence impacts at the ACP. A document reference providing further detail of how each condition is being met is also provided.

This Extraction Plan and supporting documents have been prepared with assistance from a suitably experienced project team as listed in **Table 3**. In accordance with condition 3.12(a) to Schedule 2 of DA 309-11-2001-i, the appointment of the below team of suitably qualified and experienced experts was endorsed by a delegate of the Director-General for DP&I on 3 June 2011.

Table 3 Summary of Project Team

Name	Company	Area of Expertise
Amanda Kerr	AECOM	Environmental/Subsidence Management
Ken Mills	SCT	Subsidence Modelling
Don Kay	MSEC	Subsidence - Independent Peer Review
Craig Schultz	RPS Aquaterra	Ground and Surface Water
Shane Chiddy	AXYS	Risk Assessment
Chris Gippel	Fluvial Systems	Geomorphology
Mervyn Lindsay	Lindsay & Dynan	Electrical Infrastructure - Design
Paul Lambert	Geotech Solutions	Slope Stability Assessment
Angela Bessant	Insite Heritage	Archaeology
Paul Anink	Marine Pollution Research	Aquatic Ecology
John Paul King	PEA Consulting	Terrestrial Ecology

2.1.1 Mining Lease

Submission and approval of Subsidence Management Plans is a requirement of the Mining Lease. Preparation of Subsidence Management Plans is guided by the Division of Resources and Energy (DRE) document "*Guidelines for Applications for Subsidence Management Plan Approvals*" (DMR, 2003).

Where not addressed by the existing relevant planning approval documents, this Extraction Plan has also been prepared to enable ACOL to comply with the Subsidence Management Plan guidelines. A reference table outlining the SMP Guidelines requirements with the content of this Extraction Plan is provided as **Appendix K**.

The Mining Lease includes a number of specific requirements of relevance to the management of impacts to roads, transmission lines, communications and pipelines. These are also discussed in **Appendix K**.

3 MINE PLAN

3.1 MINE PLAN

With increased understanding of the groundwater and surface water systems and their response to mining (gained since the ACP was first approved), ACOL has developed an underground mine plan for the extraction of the ULD Seam that will result in acceptable environmental impacts whilst providing resource optimisation together with business and employment security.

The vertical alignment of LW 1- 8 in the ULD Seam is horizontally offset from the overlying PG Seam mine workings by approximately 60m to the west. The ULD mine plan has been based on detailed analysis of the predicted subsidence behaviour and groundwater impacts to Glennies Creek and Bowmans Creek alluvium. The proposed ULD mine plan is consistent with the ACP approval as included in the approval documents.

The proposed layout includes areas that have been previously undermined (i.e. where PG Seam has already been extracted – "multi-seam") and will also include areas not previously disturbed by subsidence ("single seam"). These latter areas include:

- The southern ends of LW 1- 4 (which were shortened in the PG Seam due to the presence of a geological structure); and
- Sections of LW 7A and 7B (which were shortened in the PG Seam due to delays in obtaining subordinate approvals for the construction of the Bowmans Creek diversions).

The Extraction Plan area and proposed mine plan is shown in **Figure 3** and key dimensions summarised in **Table 4**.

Table 4 Proposed ULD Longwall Panel Dimensions

Panel	Gate Roads (nominal) (m)	Maingate Pillar Width Rib to Rib (m)	LW Void Width (m) (ribline of goaf edge)	LW Length (m)
LW 1*	5.4	25	216	2471
LW 2	5.4	25	216	2245
LW 3	5.4	25	216	2464
LW 4A	5.4	25	216	1680
LW 4B	5.4	85	156	896
LW 5	5.4	25	216	1381
LW 6A	5.4	25	216	1352
LW 6B	5.4	25	216	1065
LW 7A	5.4	25	161	1353
LW 7B	5.4	25	161	1146
LW 8	5.4	20	124	1203

* See paragraph below.

During the preparation of this EP, ACOL were investigating the geotechnical and geological conditions of the proposed LW1 start line position. Based on the outcomes of this investigation, the start line position changed from that assessed the accompanying technical reports. This investigation resulted in the shortening of the longwall block by about 200m and will further minimise the potential for impacts on the overlying private agricultural land and activities to those identified in the accompanying reports.

A full description of the site conditions, depth of cover, mining and resource recovery methods are provided in the Coal Resource Recovery Plan (**Appendix B**).

3.2 MINE SCHEDULE

ACOL's underground mine operates five to seven days a week, 24 hours a day on a rotating shift basis. At the date of this report, extraction of PG Seam LW 1- 6A (inclusive), 7A and 7B (short) is complete with extraction of LW 8 and 6B yet to be completed.

The proposed sequence of mining under this Extraction Plan and anticipated start and completion dates are summarised in **Table 5**, dependent on relevant mining constraints.

Table 5 Proposed Mining Schedule (Secondary Extraction)

Panel	Start Date*	Duration	Completion Date*
ULD LW 1	July 2012	6 months	January 2012
PG LW6B*	March 2013	4 months	June 2013
ULD LW 2	July 2013	6 months	February 2013
ULD LW 3	March 2014	7 months	September 2014
ULD LW 4A	October 2014	4 months	February 2014
ULD LW 4B	March 2015	2 months	May 2015
ULD LW 5	June 20115	3 months	September 2015
ULD LW 6A	October 2015	4 months	February 2015
ULD LW 6B	March 2016	4 months	July 2016
ULD LW 7A	July 2016	4 months	October 2016
ULD LW 7B	October 2016	4 months	February 2016
ULD LW 8	March 2016	4 months	July 2017

* Extraction of PG LW6B is subject to completion of the Bowmans Creek eastern diversion. If construction is completed in time, PG LW 6B may be mined out of sequence (subject to EP/SMP approvals).

Legend

Ashton Mining Leases

ACOL First Workings

ACOL Second Workings

Proposed Bowmans Creek Diversion

0 150 300

1 : 15000 (A3)

AECOM

SITE ACCESS RD

NEW ENGLAND HIGHWAY

BOWMANS CREEK

CREEK

BRUNKERS LANE

ULD LW8

ULD LW7B

ULD LW6B

PROPOSED EASTERN DIVERSION

BOWMANS CREEK

ULD LW4B

NARAMA DAM

PROPOSED WESTERN DIVERSION

ULD LW7A

ULD LW6A

ULD LW5

ULD LW4A

ULD LW3

ULD LW2

ULD LW1

BOWMANS CREEK

HUNTER RIVER

GLENNIES CREEK

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Extraction Plan
Upper Liddell Seam LW 1 - 8

Figure 3
Extraction Plan Area and
Updated Mine Plan

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4 SUMMARY OF PREVIOUS SUBSIDENCE MONITORING

Subsidence monitoring has been undertaken at the ACP since the commencement of longwall operations in early 2007. Observed subsidence behaviour is consistent with predicted subsidence behaviour (SCT, 2011).

A comparison of the predicted and maximum observed subsidence parameters are summarised in **Table 6**. The location of the subsidence monitoring lines is provided in the Subsidence Monitoring Program (**Appendix C**).

As described by SCT (2011), the maximum vertical subsidence observed was less than the 1.6 to 1.8m predicted to occur as a result of the extraction of LW 1- 5 in the PG Seam. Measured tilt and strain values are generally within the range predicted for those panels, although there are several locations where locally higher strains and tilts have been observed. These anomalies are a consequence of ground movements, particularly horizontal ground movements that are not possible to predict by conventional subsidence estimation techniques. Whilst there is significant variability associated with maximum strain values, maximum strain and tilt levels have shown a trend of general decrease as overburden depths increase.

Angle of draw has been shown to increase with overburden depth at the ACP with 0° recorded at 60 m and a maximum of 29° over the maingate goaf edge of LW 5 where overburden depth is approximately 145 m. This general trend continued in recent monitoring where the angle of draw recorded at 155m overburden depth was 24°over LW6A and 27° at 176m overburden depth over LW7A (SCT 2012). As described by SCT (2011), whilst the angle of draw in the ULD Seam is expected to increase with the increased overburden depth, in a multi-seam mining environment the angle of draw is likely to be affected by the extent of the goaf in the overlying seam.

Table 6 Subsidence Monitoring Results (LW 1 – 7A)

Panel	Predicted Subsidence (EIS)	Predicted Subsidence (EA)	Maximum Measured			
North End of LW 1				**CL2**	**XL8**	
Subsidence (mm)	1430	1800	-	1528	1500	-
Tilt (mm/m)	122	244	-	100	103	-
Horizontal movement (mm)	-	-	-	476	500	-
Tensile strain (mm/m)	16	73	-	40	15	-
Compressive strain (mm/m)	25	98	-	28	27	-
Remainder of LW 1			**CL1**		**XL5**	
Subsidence (mm)	1690	1700	1318	-	1436	-
Tilt (mm/m)	60	141	60	-	75	-
Horizontal movement (mm)	-	-	480	-	503	-
Tensile strain (mm/m)	8	42	19	-	17	-
Compressive strain (mm/m)	12	56	23	-	24	-
LW 2			**CL1**	**CL2**	**XL5**	
Subsidence (mm)	1690	1600	1296	1513	1266	-
Tilt (mm/m)	91	102	40	82	78	-
Horizontal movement (mm)	-	-	440	298	390	-
Tensile strain (mm/m)	12	30	17	16	11	-
Compressive strain (mm/m)	18	41	16	32	28	-
LW 3			**CL1**	**CL2**	**XL5**	
Subsidence (mm)	1500	1600	1420	1354	1429	-
Tilt (mm/m)	65	78	41	48	97	-
Horizontal movement (mm)	-	-	463	345	394	-
Tensile strain (mm/m)	9	23	10	17	22	-
Compressive strain (mm/m)	13	31	7	18	24	-
LW 4			**CL1**	**CL2**	**XL5**	**XL10[1]**
Subsidence (mm)	1430	1600	1397	1194	1546	1263
Tilt (mm/m)	46	78	36	40	53	33
Horizontal movement (mm)	-	-	230	560	360	258[1]
Tensile strain (mm/m)	6	23	10	18	9	6
Compressive strain (mm/m)	9	31	9	67	9	10
LW 5			**CL1**	**CL2**	**XL5**	
Subsidence (mm)	1430	1600	1266	1326	1376	-
Tilt (mm/m)	29	78	23	29	35	-
Horizontal movement (mm)	-	300-500	399	339[2]	360	-
Tensile strain (mm/m)	4	23	21	6	5	-
Compressive strain (mm/m)	5	31	-9	-8	-17	-
Longwall 6A			**CL1**	**CL2**	**XL5**	
Subsidence (mm)	1430	1600	1400	1280	1360	
Tilt (mm/m)	29	57	18	25	39	
Horizontal movement (mm)	-	300-500	280	250	320	
Tensile strain (mm/m)	4	17	7	4	8	
Compressive strain (mm/m)	5	23	7	9	9	

Panel	Predicted Subsidence (EIS)	Predicted Subsidence (EA)	Maximum Measured			
Longwall 7A			CL1	CL2	XL5	
Subsidence (mm)	1430	1600	1415	>860	1391	
Tilt (mm/m)	29	57	24	13	23	
Horizontal movement (mm)	-	300-500	338	118	365	
Tensile strain (mm/m)	4	17	7.6	2.4	10	
Compressive strain (mm/m)	5	23	9.6	>3.8	12.1	

[1] *XL10 was installed after some of the horizontal movement associated with the previous longwall may already have occurred so not all horizontal movements may have been measured.*
[2] *Maximum measured at end of line so actual maximum expected to be greater.*

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5 SUBSIDENCE ASSESSMENT

Subsidence or subsidence effects, subsidence impacts, and environmental consequences are defined under the ACP development consent as follows:

Subsidence or subsidence effects	Deformation of the ground mass due to mining, including all mining-induced ground movements, including both vertical and horizontal displacement, tilt, strain and curvature.
Subsidence impacts	Physical changes to the ground and its surface caused by subsidence effects, including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs.
Environmental consequences	The environmental consequences of subsidence impacts, including: damage to infrastructure, buildings and residential dwellings; loss of surface flows to the subsurface; loss of standing pools; adverse water quality impacts; development of iron bacterial mats; cliff falls; rock falls; damage to Aboriginal heritage sites; impacts on aquatic ecology; ponding; etc.

Predicted subsidence effects and impacts associated with secondary extraction in the ULD Seam are described in **Section 5.1**, whilst associated environmental consequences are summarised in **Section 5.2**.

5.1 REVISED SUBSIDENCE PREDICTIONS

Subsidence impacts were considered in detail during the current longwall panel design process to minimise potential impacts to surface infrastructure and in particular, impacts to Bowmans Creek and its associated alluvial aquifer.

Subsidence resulting from multi-seam extraction at the ACP was first considered by GE Holt & Associates (2001) as part of the Environmental Impact Statement (EIS) for the ACP. Multi-seam subsidence impacts were more recently considered within the context of the BCD EA by SCT (2009). This assessment assumed a stacked panel arrangement for LW 5 to 8 and miniwalls beneath retained sections of Bowmans Creek.

However, revised subsidence estimates for LW 1-8 have been prepared to incorporate:

- Current mine design, allowing for the offset longwall panel arrangement and removal of miniwalls;
- Relevant site-specific information regarding subsidence behaviour and overburden characteristics obtained during secondary extraction in the PG Seam; and
- Current data and methods for the estimation of subsidence in multi-seam mining environments (which differ considerably to those used for the EIS) as described by Li et al (2010).

The results of the updated Subsidence Impact Assessment (SCT, 2011) are summarised below. The full report is included as **Appendix A**. Additional work by SCT has also been conducted to develop three-dimensional subsidence extrapolations based on two-

dimensional subsidence profiles developed in numerical caving models. An independent peer review of both these reports was conducted by MSEC and copies of these are provided in Volume 2.

The approach used by SCT for estimating maximum subsidence where longwall panels overlap in two seams was based on empirical experience reported by Li *et* al (2010). This experience indicates maximum subsidence is unlikely to exceed 85% of the combined thickness of the two seams mined. Maximum tilts and strains were estimated on the basis of the maximum subsidence using empirical experience for single seam mining (Holla, 1991).

Numerical modelling was also conducted to estimate subsidence based on the mechanical properties of the overburden strata and the interaction between chain pillars in the two seams mined. Results obtained using this method indicated maximum subsidence of 55-60% of combined seam thickness. However for the purpose of identifying and managing subsidence impacts, the conservative maximum predicted subsidence values obtained using the empirical approach have been adopted and are provided in **Table 7** below. The empirical subsidence predictions are conservative and account for the variability associated with multi-seam operations and are considered a 'potential worst case' for subsidence predictions at the ACP.

Figure 4 presents the cumulative subsidence associated with mining in the ULD Seam, inclusive of any subsidence associated with extraction of the overlying PG Seam. Cumulative subsidence values provide an overview of total subsidence effects associated with mining in both the PG and ULD Seams. Cumulative values include the subsidence effects already experienced as a result of secondary extraction in the PG Seam.

Figure 5 shows the incremental subsidence – namely the quantity of subsidence that is attributable only to extraction in the ULD Seam. Incremental subsidence values for areas of multi-seam mining (i.e. where PG Seam has already been extracted) have been adopted for the purpose of identifying and managing subsidence impacts associated with mining of the ULD Seam. These values account for an incremental subsidence range of 2.4 - 3.4m across the extraction area as detailed in **Table 7**.

As described by SCT (2011), maximum vertical subsidence is naturally variable by about 15% in single seam operations for any given panel geometry and overburden depth. Variability is increased significantly in multi-seam operations and the subsidence contours presented in **Figure 4** and **Figure 5** are indicative of the general level of subsidence rather than providing a high level of precision at a given point.

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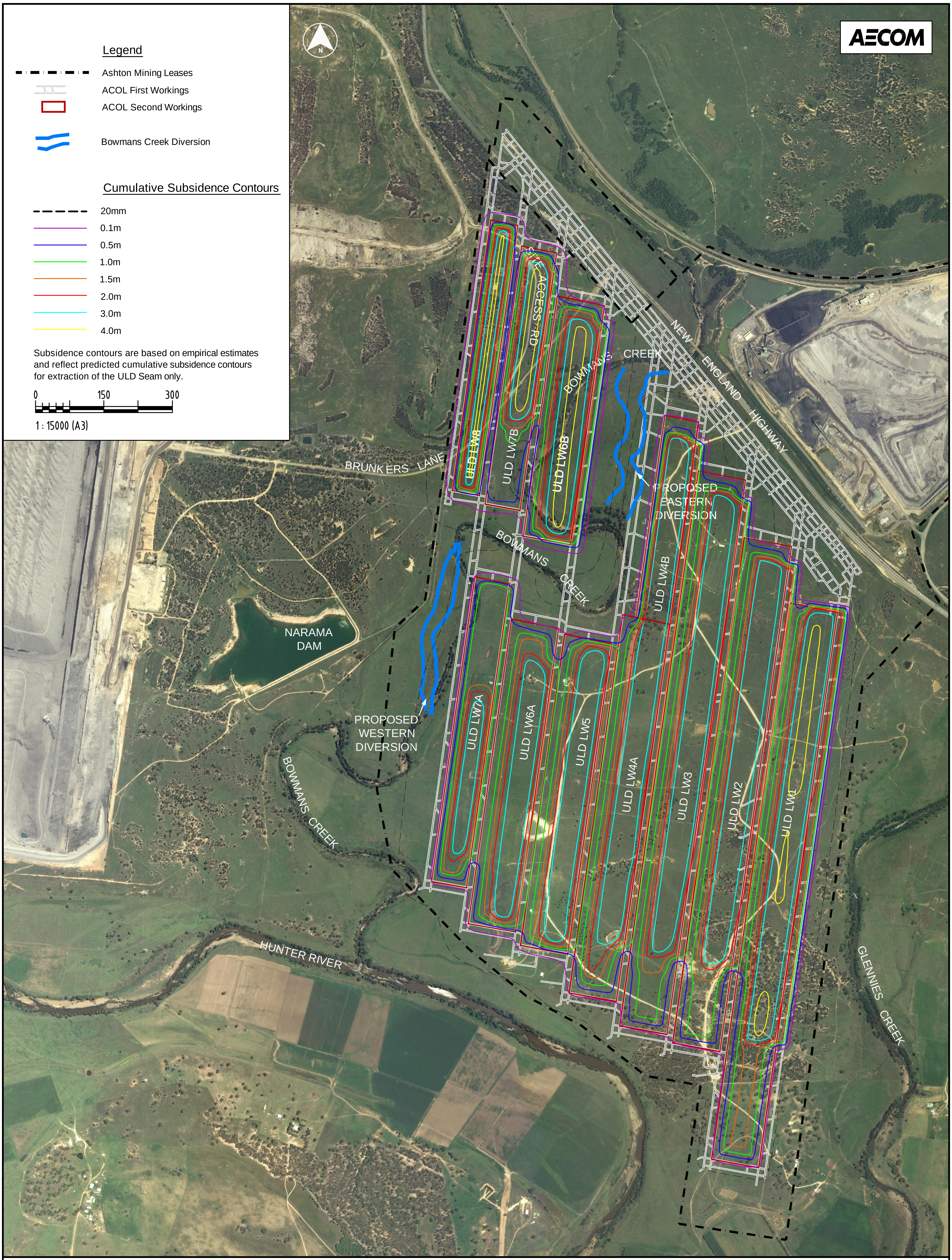

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Extraction Plan
Upper Liddell Seam LW 1 - 8

Figure 4
Predicted Cumulative Subsidence Contours

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Legend

- Ashton Mining Leases
- ACOL First Workings
- ACOL Second Workings
- Bowmans Creek Diversion

Incremental Subsidence Contours

- 20mm
- 0.1m
- 0.5m
- 1.0m
- 1.5m
- 2.0m
- 3.0m

Subsidence contours are based on empirical estimates and reflect predicted incremental subsidence contours for extraction of the ULD Seam only.

0 150 300

1 : 15000 (A3)

AECOM

N

SITE ACCESS RD

BOWMANS CREEK

NEW ENGLAND HIGHWAY

ULD LW8

ULD LW7B

ULD LW6B

PROPOSED EASTERN DIVERSION

BRUNKERS LANE

BOWMANS CREEK

ULD LW4B

NARAMA DAM

PROPOSED WESTERN DIVERSION

ULD LW7A

ULD LW6A

ULD LW5

ULD LW4A

ULD LW3

ULD LW2

ULD LW1

BOWMANS CREEK

HUNTER RIVER

GLENNIES CREEK

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Extraction Plan
Upper Liddell Seam LW 1 - 8

Figure 5
Predicted Incremental Subsidence Contours

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Table 7 Summary of Revised Empirical Subsidence Predictions (ULD Seam)

Panel	Incremental Subsidence from Mining ULD Seam (m)	Incremental[2] Max Tilt (mm/m)	Incremental[2] Max Strain (mm/m)	Maximum Subsidence (85% Combined Seam Thickness) (m)	Max Tilt (mm/m)	Max Strain (mm/m)
LW 1	2.9	183	73	4.4	235	94
LW 2	2.5	139	55	4.0	189	76
LW 3	2.5	119	48	4.0	162	65
LW 4A	2.4	93	37	3.9	128	51
LW 4B	2.4	110	44	3.9	151	60
LW 5	2.5	76	30	4.0	103	41
LW 6A	2.5	73	29	4.0	100	40
LW 6B	2.8	101	41	4.3	132	53
LW 7A	2.5	66	26	4.0	89	36
LW 7B	3.0	91	36	4.5	116	47
LW 8	3.4	98	39	4.4	107	43

Numerical modelling indicates that, whereas in a single seam operation subsidence is generally limited to the extent of the panel, in a multi-seam environment the extent of subsidence may extend into overlying panels. The extent of subsidence in a multi-seam environment is therefore influenced by the geometry of the overlying panel and may extend to the limits of the overlying panel(s).

Conversely in areas of single seam mining (where secondary extraction has not been undertaken in the overlying PG Seam above e.g. southern extents of LW 1-4) subsidence will occur consistent with single seam mining. In these areas maximum subsidence is expected to be less than 1.6m and will be greatest over the central part of the panels.

Overall, subsidence effects will also extend further than those experienced during extraction of the PG Seam, due to the increased depth of cover, and due to increased levels of subsidence associated with multi-seam mining activity through reactivation of the goaf and destabilisation of the chain pillars in the PG Seam.

The revised subsidence estimates for the longwall panels in the ULD Seam are considered by SCT (2011) to be reliable and are based on the previous experience of monitoring the PG Seam at the ACP. However values provided in **Table 7** are not the final subsidence values of the site and future subsidence predictions will be made with greater certainty based on continued subsidence monitoring on site.

The above estimates are higher than previous estimates of subsidence associated with mining in the PG and ULD Seams presented in the EIS (HLA, 2001) and BCD EA (SCT 2009 in Evans & Peck, 2009). This increase is partly attributable to differences in geometry and the adoption of a greater seam thickness to be mined, but primarily because a more conservative approach has been adopted in this current assessment for estimating the maximum subsidence, as per Li et al (2010). The revised subsidence modelling for this Extraction Plan is based on currently accepted best practice and industry knowledge, in

particular research by Li *et al* (2010) which advocates a highly conservative approach to multi-seam subsidence estimation in the absence of any site-specific data. ACOL has aimed to address potential differences in the current and approved estimates by:

- Applying for approval for only LW1 – 4 initially, allowing subsidence monitoring data to be collected and reviewed before approval for ULD LW5-8 is sought;
- Complementing the conservative empirical assessment with analytical assessments (which indicate that cumulative subsidence following the ULD seam and all four seams is consistent or less than the approved envelope). Numerical modelling for multi-seam environments is as yet untested, and data collected from the ULD will be used to refine and calibrate this predictive technique;
- Having both the empirical and numerical studies peer reviewed by MSEC (refer to **Volume 2 – Technical Report No. 2**); and
- Adoption of an offset mine plan which are considered current best practice for managing subsidence impacts.

It is noted that the ACP is an approved multi-seam mine, and as the ULD is only the second seam to be extracted, this still allows for total cumulative subsidence at the completion of mining to remain within the total envelop approved for the mine. Each seam is subject to Extraction Plan approval under the development consent, and the offset mine plan design retains some flexibility with respect to future panel dimensions (start and end points, and panel widths) so as to assist with impact management for future seams.

5.2 SUBSIDENCE IMPACTS

The SCT report (Appendix A) includes a revised assessment of potential impacts to built features. A series of technical reports have also been prepared to review the predictions of environmental consequences. These reports are provided as Volume 2, and are based upon the information presented by SCT, monitoring data obtained at the ACP since prior to the commencement of mining and also based on the issues identified as part of a multi-disciplinary risk assessment workshop conducted as part of the Extraction Plan preparation process (refer to Volume 2).

A summary of each of the environmental consequences, as identified in the accompanying technical reports (Volume 2) is provided below.

5.2.1 Groundwater

An assessment of the impact of the underground mine on local and regional groundwater sources was undertaken by RPS Aquaterra using a calibrated MOD-FLOW SURFACT groundwater model. Potential impacts from mining were identified as resulting from dewatering and fracturing of overlying strata (including aquifers) during subsidence. These mechanisms have the potential to affect the interaction of surface and groundwater resources by reducing groundwater levels in alluvial aquifers with potential subsequent reductions in stream baseflow.

Assessment of impacts to groundwater focused on four key areas where mining will occur closest to the alluvium including:

- Glennies Creek alluvium to the east of ULD LW1;
- Glennies Creek and Hunter River alluvium to the south of the ULD LW 1;

- Hunter River alluvium directly south of ULD LW 5-8; and
- Bowmans Creek alluvium, west of ULD LW 4.

Modelled impacts were presented as total impacts for PG and ULD Seams and additional impacts from ULD only, for LW 1-4 and LW 5-8, and are presented in **Table 8** below. **Table 8** also includes the predicted cumulative drawdown and baseflow impacts that were predicted as part of the BCD EA (Evans & Peck, 2009).

Glennies Creek Alluvium
During development and longwall extraction of LW1 in the PG Seam, higher than anticipated mine inflows were experienced into TG1. The area of higher inflows is shown in **Figure 7**. Groundwater inflows in this area continue to be monitored, with observed inflows remaining consistent with predictions provided in the EIS and EA for the ACP (RPS Aquaterra, 2012).

Substantial effort has been made to understand potential groundwater interactions in this area, including additional field investigation, modelling, and monitoring. The geology, hydrogeology, and geotechnical aspects of the area between the mine workings and Glennies Creek are therefore considered to be well known and understood. A cross section is provided in the Coal Resource Recovery Plan that shows the relationship of the natural topography, location of Glennies Creek, as well as workings in the PG Seam. This plan illustrates how the PG Seam subcrops beneath Glennies Creek and the offset of the ULD mine plan (providing a greater barrier to the creek).
Based on this understanding, it is considered that the higher inflows resulted from a pre-existing localised area of permeability and not as a result of dilation (caused by mining) of the existing cleats / fracture network within the coal seam. Analysis by Winton Gale of SCT into the effects of subsidence on hydraulic conductivity east of LW1 concluded that "*Overall, the impact on the conductivity within the PG seam about Glennies Creek of extraction in the ULD Seam, and subsequently lower seams down to the LB Seam, as per the planned extraction layout, was found to be essentially unmeasurable.*" (SCT, 2012).

Revised modelling of groundwater impacts by Aquaterra (using research by SCT into the impacts of mining on hydraulic conductivity) found that impacts of ULD mining will include an increased drawdown in the Glennies Creek alluvium: increasing by 0.06m to 0.11m to the south east of LW1 and increasing by 0.04m to 0.18m to the east of LW1 (refer to **Table 8**). This revised impact is consistent with the BCD EA estimates, and considerably less than the EIS predictions.

Hunter River Alluvium
All proposed ULD panels are outside of the 26.5^{o} (angle of draw) to the Hunter River alluvium. The startlines for LWs 5-7 are all located more than 200m from Hunter River alluvium, as per Development Consent Commitment 3.2. LW 1 and 2 are also located more than 200m.

The groundwater modelling indicates no significant impacts to the Hunter River alluvium as a result of ULD mining. A slight reduction in the baseflow contribution to the Hunter River is predicted, however the predicted baseflow reduction is less than that estimated in the 2009 EA and 2001 EIS for this stage of mining.

Bowmans Creek Alluvium
When comparing the revised predictions to those contained in the BCD EA, the revised model predicts a lesser total drawdown in the Bowmans Creek alluvium near the oxbow (of

up to 1.0m) and reduced baseflow impacts. Most of the total baseflow reduction is due to ongoing effects from PG Seam mining and the cumulative impact of other mining operations. The total cumulative baseflow impact to Bowmans Creek is predicted to increase to 0.59L/s at the cessation of ULD LW4 and 0.86L/s at the completion of LW8. These revised baseflow impacts are lower than those previously predicted in the BCD EA.

This reduction in predicted groundwater impacts for the ULD mine plan in these locations is attributed to the offset of the ULD mine plan compared to the stacked layout which was considered in the BCD EA. ACOL has subsequently adopted an offset panel arrangement to provide better management of subsidence impacts (in line with current best practice) and greater flexibility in future mine planning and design.

Table 8 Predicted Groundwater Impacts from ULD Seam Extraction

	Modelled Impact ULD LW 1-4		Modelled Impact ULD LW 5-8		BCD EA 2009 LW 1 -8
	Total (PG + ULD)	Additional (ULD only)	Total (PG + ULD)	Additional (ULD only)	Total (PG+ULD)
Drawdown to the Glennies Creek alluvium south of ULD LW 1	0.11 m	0.06 m	0.16 m	0.11 m	-
Drawdown to Glennies Creek alluvium east of ULD LW 1	0.18 m	0.04 m	0.2 m	0.06 m	-
Drawdown impacts to Hunter River alluvium south west of LW 1	0 m	0 m	0 m	0 m	0.0 m
Drawdown impacts to the Hunter River alluvium south of LW 5 to 7	0.01 m	0.01 m	0.01 m	0.01 m	0.01 m
Drawdown impacts to the Bowmans Creek alluvium at the oxbow – LW4	0.45 m	0.13 m	0.73 m	0.41 m	1.7 m
Baseflow impacts to Glennies Creek	2.9 L/s	0.3 L/s	3.0 L/s	0.4 L/s	-
Baseflow impacts to Bowman Creek	0.59 L/s	0.14 L/s	0.86 L/s	0.41 L/s	1.2 L/s
Baseflow impacts to Hunter River	0.13 L/s	0.06 L/s	0.23 L/s	0.16 L/s	0.5 L/s
Total underground inflows	16L/s	1 – 10L/s	14 – 16L/s	14L/s	14 – 16L/s

5.2.2 Riparian and Terrestrial Ecology

An assessment of riparian and terrestrial ecological impacts was undertaken by PEA Consulting. The aim of the assessment was to establish any threatened species or ecological communities which have the potential to be impacted by extraction. No additional surveys were undertaken in support of this report as surveys have been undertaken since 2005 with the most recent surveys undertaken in 2011. Recent surveys included intensive quantitative methods and provided a detailed assessment of the ecological characteristics and significant ecological issues in the Extraction Plan area. No additional survey was considered necessary.

PEA Consulting concluded there will be minimal impact on significant species, populations and communities or their habitats. Where impacts were identified additional management and monitoring actions were outlined. Impacts identified are:

- A moderate to high level of impact indentified to approximately 15% of potential habitat available within the Extraction Plan area for the Grey-crowned Babbler population. This impact will occur over a relatively short timeframe and monitoring programs will be designed to identify impacts and allow for timely remediation and therefore impacts to the Grey-crowned Babbler are unlikely to be significant.
- A moderate to high level of disturbance will be experienced across approximately 21% of Speckled Warbler habitat located within the Extraction Plan area. Surface cracking and subsidence is expected to result in a greater impact to Speckled Warbler habitat than that predicted for Grey-crowned Babbler habitat, however the level of impact is not expected to significantly affect the Speckled Warbler population.

5.2.3 Groundwater Dependent Ecosystems

Previous site investigations and assessments of the ACP associated with the development consent and subordinate approvals have concluded that "*there are no known or likely wetland, terrestrial or aquifer/cave ecosystem GDEs in the study area*" (MPR, 2011- Technical Report 5).

Previous site assessments identified small stands of *Eucalyptus camaldulensis* (River Red Gum) on the banks of Bowmans Creek, Glennies Creek and the Hunter River. This species (in the Hunter Valley) is protected as an endangered population under the *Threatened Species Conservation Act 1995*. The aquatic ecology assessment by Marine Pollution Research (MPR, 2011 - Technical Report 5) states: "*It is concluded that possible aquatic and hyporheic GDEs in Bowmans Creek within the study area would not be considered significantly dependent on baseflow groundwater"* and *"the impacts of proposed mining on aquatic biota and habitats in Bowmans Creek, the Hunter River and Glennies Creek are expected to be negligible based on the assessment of predicted subsidence induced changes to stream morphology, water quantity and quality."*

Further, assessment by RPS Aquaterra (2012) concluded that the stands of River Red Gum on Hunter River, Glennies Creek and Bowmans Creek are unlikely to be impacted by ULD LW 1 – 8 due to their relative position to the underground workings and negligible impacts to watercourse flows and associated alluvium at those locations.

5.2.4 Aquatic Ecology

An assessment of impacts on aquatic ecology in Bowmans Creek from subsidence was undertaken by Marine Pollution Research. Marine Pollution Research has undertaken aquatic ecological monitoring in Bowmans Creek since 2007; therefore it was considered that adequate data was available for impact assessment without gathering additional data.

Existing sub-catchment drainage lines within the mining area are affected by agricultural practices and have little environmental value with respect to aquatic habitat diversity or drought refuge. Therefore the impacts from subsidence on this heavily modified aquatic environment were considered to be minor. Potential effects on drainage lines were identified as:

- Lowering of sections of sub-catchment drainage lines resulting in ponded or swampy sections with steeper drainage sections between ponded areas; and
- Destabilisation of unconsolidated drainage banks with resultant accelerated bank erosion and increased sedimentation within the drainage line.

Subsidence is expected to have a negligible impact on aquatic biota and habitat in Bowmans Creek, Glennies Creek and the Hunter River. There is not expected to be any significant impact on fish passage or drought refuge within and between these waterways. Impacts on sub-catchment drainages can be managed and mitigated under the existing management framework. Impacts to sub-catchment drainages are considered to be negligible with respect to consequences for receiving waters and aquatic habitat in Bowmans Creek and the Hunter River.

5.2.5 Fluvial Geomorphology

An assessment of impact from subsidence on the fluvial geomorphology of Bowmans and Glennies creeks was undertaken by Fluvial Systems.

The assessment concluded that there are no implications for fluvial geomorphology in Bowmans Creek. While there are no direct effects on fluvial geomorphology in Glennies Creek, the assessment identified a small potential risk for slumping on the steeper banks of Glennies Creek. However, the actual effects on Glennies Creek geomorphology will depend on the assessed geotechnical risk of bank slumping into the creek. This risk was assessed in detail in the geotechnical assessment.

5.2.6 Geotechnical – Slope Stability

A geotechnical impact assessment of subsidence on the steep natural slopes adjacent to Glennies Creek and the Hunter River was undertaken by Geotech Solutions. The assessment particularly examined the potential for subsidence induced ground instability leading to creek bank slumping and potential temporary obstruction of Glennies Creek.

The assessment found that previous mining of the PG Seam has resulted in surface deformation however this has not adversely impacted the stability of sloping landform units adjacent to Glennies Creek (or the Hunter River). The risk of slope instability from predicted subsidence induced by mining the ULD Seam was undertaken using a classification system formulated by the Australian Geomechanics Society. Predictions indicate there is a very low to low risk of slope instability leading to partial or complete temporary blockage of either Glennies Creek or the Hunter River.

The assessment identified that no additional monitoring beyond that typically required for monitoring of subsidence impacts is required. Further, that mitigation of surface cracking (e.g. regrading, ripping, or infilling of cracks) which develops after mining will reduce the likelihood of localised shallow slumping in areas with steeper slopes.

6 SUBSIDENCE MONITORING AND MANAGEMENT

6.1 SUBSIDENCE PERFORMANCE MEASURES

Subsidence performance measures are specified under conditions 3.9 and 3.10 to Schedule 2 of DA 309-11-2001-i:

3.9 The Applicant shall ensure that underground mining does not cause any exceedances of the performance measures in Table 1, to the satisfaction of the Director-General.

Table 1: Subsidence Impact Performance Measures

Watercourses	
Bowmans Creek	No greater subsidence impact or environmental consequences than predicted in the documents referred to in condition 1.2 ac)
Bowmans Creek – Eastern and Western Diversions	Hydraulically and geomorphologically stable
Bowmans Creek alluvium	No greater subsidence impact or environmental consequences than predicted in the documents referred to in condition 1.2 ac)
Biodiversity	
Threatened species, threatened populations, or endangered ecological communities	Negligible impact or environmental consequences
Aboriginal heritage features	
Waterhole Site	Negligible impact or environmental consequence
Other Aboriginal heritage sites	No greater subsidence impact or environmental consequences than approved under a permit issued under section 90 of the *National Parks and Wildlife Act 1974*

Notes:

1) The Applicant will be required to define more detailed performance indicators for each of these performance measures in the various management plans that are required under this consent (see condition 3.12 below).

2) The requirements of this condition only apply to the impacts and consequences of mining operations undertaken following the date of approval of modification 6.

3.10 The Applicant shall ensure that underground mining does not cause any exceedances of the performance measures in Table 2, to the satisfaction of the Director-General of DRE.

Table 2: Subsidence Impact Performance Measures

Built features	
New England Highway, including the bridge over Bowmans Creek	Always safe and serviceable. Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.
Brunkers Lane	In accordance with recommendations of the report prepared under condition 7.14
Other built features, including other public infrastructure	Always safe. Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated. Damage must be fully repaired or replaced, or else fully compensated.
Public safety	
Public safety	No additional risk

Notes:

1) *The Applicant will be required to define more detailed performance indicators for each of these performance measures in Built Features Management Plans (see condition 3.12 below).*
2) *The requirements of this condition only apply to the impacts and consequences of mining operations undertaken following the date of modification 6.*
3) *Requirements regarding "safe" or "serviceable" do not prevent preventative or mitigatory actions being taken prior to or during mining in order to achieve or maintain these outcomes.*
4) *Compensation required under this condition includes any compensation payable under the Mine Subsidence Compensation Act 1961 and/or the Mining Act 1992.*

3.11 Any dispute between the Applicant and the owner of any built feature over the interpretation, application or implementation of the performance measures in Table 2 is to be settled by the Director-General of DRE. The Director-General of DRE may seek the advice of the MSB on the matter. Any decision by the Director-General of DRE shall be final and not subject to further dispute resolution under this consent.

6.2 SUBSIDENCE MONITORING

The detailed Subsidence Monitoring Program is provided in **Appendix C** and includes a program for survey monitoring. The purpose of the Subsidence Monitoring Program is to enable subsidence effects to be quantified (i.e. vertical movements, ground tilts and strains).

The surface survey monitoring program for the ULD Seam is generally consistent with that previously established and monitored during longwall extraction of the PG Seam and incorporates the following:

- Centrelines to identify centreline subsidence, travelling abutment subsidence rate and residual strains and tilts at abutment; and
- Cross lines to measure subsidence, pillar compression and residual strains and tilts, assist with refinement of visualisation model, and monitor effects of adjacent longwall on creeks (natural and manmade).

Survey monitoring is also conducted for significant surface infrastructure that is sensitive to subsidence movements, such as (but not limited to):

- Electricity transmission lines to measure changes in tilt, strain, and line clearance;
- New England Highway to measure changes in pavement levels, movements of Bowmans Creek Bridge or changes in pits/culverts; and
- Monitoring of established survey pegs associated with the Prescribed Dams (Ravensworth – Narama Dam and MacGen – Void 5 Ash Dam).

Other techniques included in the Subsidence Monitoring Program include increasing the use of remote sensing (e.g. LiDAR), for monitoring subsidence movements across the Mining Lease, and use of a survey control network for the monitoring of far-field subsidence movements.

The Subsidence Monitoring Program also summarises the monitoring of environmental and built features (documented in other sub-plans – **Appendices D** through **J**).

6.3 SUBSIDENCE MANAGEMENT

Surface and sub-surface features within the Extraction Plan area are listed in **Table 9** and **Table 10**. These features may be potentially impacted by the secondary extraction of LW 1-8. The location of built features is shown in **Figure 6** and environmental features are

shown in **Figure 7**. Descriptions of each of these features are contained within the relevant management plan referenced in **Table 9**.

Revised subsidence predictions and impacts to these surface and sub-surface features have been provided in **Appendix A**. Management and monitoring actions for each feature are included in each of the management plans as indicated in **Table 9** and **Table 10** below.

Table 9 Surface and Sub-Surface Features

Feature	Reference
Natural Features	
Bowmans Creek and Bowmans Creek diversion	Water Management Plan (Appendix G), Extraction Land Management Plan (Appendix I)
Bowmans Creek floodplain	Extraction Land Management Plan (Appendix I)
Hunter River	Water Management Plan (Appendix G)
Glennies Creek	Water Management Plan (Appendix G)
Steep slopes	Extraction Land Management Plan (Appendix I)
Groundwater resources	Water Management Plan (Appendix G)
Threatened flora and fauna	Flora and Fauna (Biodiversity) Management Plan (Appendix H)
Voluntary Conservation Area	Flora and Fauna (Biodiversity) Management Plan (Appendix H)
Public Utilities	
New England Highway	Built Features Management Plan (Appendix D)
Brunkers Lane	Built Features Management Plan (Appendix D)
Private access roads	Built Features Management Plan (Appendix D)
Electricity transmission lines	Built Features Management Plan (Appendix D)
Telecommunications lines	Built Features Management Plan (Appendix D)
Farm Land and Facilities	
Fences and gates	Built Features Management Plan (Appendix E)
Farm dams	Built Features Management Plan (Appendix E)
Farm buildings	Built Features Management Plan (Appendix E)
Mine Infrastructure	
Rehabilitated open cut (Ravensworth mine)	Built Features Management Plan (Appendix E)
Water and tailings pipelines, sediment dams	Built Features Management Plan (Appendix E)
Prescribed Dam Notification Area – Narama Dam/Ravensworth In pit Storage and Void 5 Dam	Built Features Management Plan (Appendix E)
Underground Mine Workings (Ravensworth mine)	Built Features Management Plan (Appendix E)
Gas Infrastructure	Built Features Management Plan (Appendix E)
Archaeology and/or Heritage Significance	
Aboriginal archaeological deposits	Archaeology and Cultural Heritage Management Plan (Appendix J)
Residential Establishments	
Rural residences	Built Features Management Plan (Appendix E)

Table 10 Surface and Sub-surface Features by Asset Owner

Asset	Brief Description	Built Features MP - Sub-Plan Reference
Ausgrid		
Electricity transmission lines	132 kV traversing the southern extent of the ACOL Mining Lease	Appendix C (Ausgrid)
	Combined 132 kV and 66/11 kV located parallel to the New England Highway	
	11 kV transmission lines traversing the ACP	
Xstrata – Ravensworth Operations		
Electricity transmission lines	33 kV transmission line	Appendix D (Ravensworth Operations)
	Proposed 330 kV	
Pipelines	315 mm PN10 PE100 pipeline	
Prescribed dam	Narama Dam	
Public Roads	Relocation of Lemington Road (i.e. Brunkers Lane to be upgraded and dedicated as a public road)	
Fences	Fences, gates, and cattle grids.	
Xstrata – Ravensworth Underground Mine		
Underground Mine Workings	Underground mining activity in proximity to the ACP and No.5 Shaft (proposed)	Appendix E (Ravensworth Underground)
Macquarie Generation		
Roads	Brunkers Lane, Site Access Road	Appendix F (Macquarie Generation)
	Relocation of Lemington Road by Xstrata (i.e. Brunkers Lane to be upgraded and dedicated as a public road)	
Farm buildings	Dilapidated farm shed	
Prescribed Dam	Void 5 Dam (planned for future construction) and proposed associated clean water drainage	
Surface Water Storages	Four clay-lined basins and existing clean water drainage	
	Two downstream dams	
Gas pipeline	Proposed surface gas pipeline to Liddell Powerstation	
Goaf Gas Drainage Boreholes	Proposed Goaf Gas Drainage Boreholes (by ACOL)	
Fences	Boundary fencing, internal fencing and gates.	
NSW Roads & Maritime Services		
Public roads	New England Highway and associated infrastructure	Appendix G (RMS)
Telstra		
Telecommunication lines	Telstra cables providing service access to Property No. 153 (Xstrata - Ravensworth Operations Pty Ltd).	Appendix H (Telstra)
	Telstra cables providing service access to NoW Stream Gauging Station on Bowman's Creek	

Asset	Brief Description	Built Features MP - Sub-Plan Reference
	Telstra cables providing service access to Property No. 130 (Private Property).	
	Telstra cables providing future service access to subdivided blocks on Ravensworth Operations Pty Ltd lease area.	
NSW Office of Water (NoW)		
Stream gauging station	'Foy Brook' Station No. 210130, on Bowmans Creek	Appendix I (NoW)
Powertel (AAPT)		
Telecommunication lines	Sydney to Brisbane fibre optic cable	Appendix J (Powertel)
Property No. 130		
Agricultural Land	Generally grazing land with irrigated cropping land and dairying on the alluvial flats	Appendix K (Property No. 130)
Farm buildings	Two farm sheds	
Roads	Property access including Ashton access road, registered Right of Way access & private unsealed roads	
Fences	Boundary fencing, internal fencing, gates and cattle grids	
Surface water storages	2 dams, levee banks and irrigation infrastructure	
Telecommunication Lines	Telstra owned telecommunication line providing service access to the property.	
Electricity transmission lines	11kV transmission lines providing power supply to the property (no subsidence impact).	
ACOL		
Private roads	Ashton access road	Appendix L (ACOL)
Farm buildings	Two rural residences (incl. various sheds)	
	Two farm sheds	
Fences	Boundary fencing, internal fencing, gates and cattle grids	
Pipelines	Hunter River pipeline (200 mm PE80 PN8)	
	Underground borehole pump pipeline (200 mm PE100 PN8)	
	Clean water line (90OD PN12.5 PE100)	
	Mine water line (250OD PN20 HDPE PE100)	
	Two tailings lines (280OD PN20 HDPE PE100)	
	Decant return (250OD PN20 HDPE PE100)	
Surface water storages	Farm Dams and Spill Basin	
Landform	Bowmans Creek Diversion	
Storage Tanks	BOC Plant – Nitrogen (inert)	
Goaf Gas Drainage Boreholes	Proposed Goaf Gas Drainage Boreholes.	
Singleton Shire Council		
Roads	Relocation of Lemington Road (i.e., Brunkers Lane to be upgraded and dedicated as a public road)	Appendix M (Singleton Shire Council)

Note: Additional information regarding the assets described in the BFMP (**Appendix E**).

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Legend

- Ashton Mining Leases
- ACOL First Workings (ULD)
- ACOL Second Workings (ULD)
- Ravensworth Underground Workings
- GW04 — ACOL Proposed Goaf Gas Drainage BH (PG)
- 11kV Power line
- 33kV Power line
- 66kV Power line
- 132kV Power line
- Proposed 132-66kV Relocation
- Fibre Optic Cable
- Telstra U/G Cable
- Polyethylene Water Pipe
- Existing Clean Water Drainage
- 315mm PN10 PE 100 Pipeline
- Road
- New England Highway
- Culverts
- Pond / Dam
- Dam Notification Area
- Old Open Cut Spoil Heaps
- Proposed Bowmans Creek Diversion
- Proposed Gas Pipeline (Surface)
- Proposed Gas Pipeline (Easement)
- Proposed Ravensworth Ops 330kV Powerlines
- Proposed No.5 Shaft
- Proposed Lemington Road Alignment
- Buildings
- Nitrogen Plant

Incremental Subsidence Contours

- 20mm
- 0.1m
- 0.5m
- 1.0m
- 1.5m
- 2.0m
- 3.0m

Subsidence contours are based on empirical estimates and reflect predicted incremental subsidence contours for extraction of the ULD Seam only.

0 150 300

1 : 15000 (A3)

AECOM

PROPOSED VOID DAM 5
RUM Shaft No. 5
SEDIMENTATION DAMS
ACCESS RD
CULVERTS
BOWMANS CREEK BRIDGE
NEW ENGLAND HIGHWAY
CREEK
BOWMANS
315mm PN10 PE 100 PIPELINE
BRUNKERS LANE
ULD LW8
ULD LW7B
ULD LW6B
PROPOSED EASTERN DIVERSION
GAUGING STATION
BOWMANS CREEK
ULD LW4B
NARAMA DAM 3
PROPOSED WESTERN DIVERSION
ULD LW7A
ULD LW6A
ULD LW5
ULD LW4A
ULD LW3
ULD LW2
ULD LW1
GLENNIES CREEK
HUNTER RIVER
NITROGEN PLANT

AshtonCoal

Extraction Plan
Upper Liddell Seam LW 1 - 8

Figure 6
Location of Existing & Proposed Built Features

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Legend

- Ashton Mining Leases
- Upper Liddell First Workings
- Bowmans Creek Diversion
- Grey-Crowned Babbler
- Speckled Warbler
- Spotted Tail quoll
- Squirrel Glider
- Large-footed Myotis
- Yellow-bellied sheathtail-bat
- Common Bent Wing Bat
- Brown Treecreeper
- Hooded Robin
- *Eucalyptus camaldulensis*
- *Acacia pendula*
- *Voluntary Conservation area*
- AHIMS Sites (OEH 2012)
- AHIP Boundary - 1130976
- AHIP Boundary - 1131017
- Creeks / Water
- Saturated Alluvium
- Alluvium
- 200m Hunter River Offset
- PG LW1 Footprint

0 150 300 450 600 750m

AECOM

N

0798 1014 1015 1016 0496 0499 0495 1017 0542 1018 0556 0543 0558 1147 0514 0555 0513 0512 1148 1141 0006 0502 0557 0517 0581 0537 0501 0511 0518 0802 1059 1153 0535 0737 0554 0552 0551 0547 0799 1142 1145 1144 1146 1143 0546 0548 0516 0544 0545 0533 0541 0536 0515 0534

BRUNKERS LANE
BOWMANS CREEK
NARAMA DAM
PROPOSED EASTERN DIVERSION
PROPOSED WESTERN DIVERSION
ULD LW8
ULD LW7B
ULD LW6B
ULD LW7A
ULD LW6A
ULD LW5
ULD LW4A
ULD LW4B
ULD LW3
ULD LW2
ULD LW1
NEW ENGLAND HIGHWAY
HUNTER RIVER
GLENNIES CREEK

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AshtonCoal

Extraction Plan
Upper Liddell Seam ULD LW 1-8

Figure 7
Environmental Features

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6.4 CONTINGENCY RESPONSE

In the event that observed subsidence impacts exceed the performance measures identified in Section 6.1 (and relevant management plans), the following process and actions will be implemented (further detail is provided in **Table 11**):

- The observation will be reported to the Technical Services Manager (Underground) or Environment and Community Relations Manager as soon as practicable, ideally within 24 hours.
- The observation will be recorded for the purposes of the SMP Status Report (provided to DRE, refer to Section 7.5).
- Assess public safety and where applicable, implement safety measures in accordance with the Public Safety Management Plan or as otherwise necessary to prevent injury or harm to any person.
- Report any incident to the relevant stakeholders (as identified in each sub-plan to this Extraction Plan) as soon as practicable after ACOL becomes aware of the exceedance.
- Assess impacts on known Aboriginal heritage sites and where appropriate implement measures in accordance with the Archaeology and Cultural Heritage Management Plan (ACHMP) and Aboriginal Heritage Impact Permit (AHIP).
- **Investigate**, in consultation with affected stakeholders (where appropriate) to evaluate the contributing factors to the exceedance. The investigation may include (where applicable):
    - Re-survey of the relevant subsidence monitoring lines;
    - Re-sampling or re-surveying of the applicable environmental monitoring locations (i.e. groundwater bores, surface water monitoring sites);
    - Review measured subsidence parameters against the observed impact, and latest subsidence predictions; and
    - Determine appropriate remedial response
- **Implement** remedial action and/or adaptive management measures, dependent on the outcomes of the above investigation. Any such measures will be undertaken in consultation with the relevant stakeholder and/or to the satisfaction of the appropriate government agency and DP&I.
- **Review** the subsidence management and subsidence monitoring program, where appropriate, to reduce the risk of future incidents; and
- **Revise** future plans and implement change where required.

Table 11 Contingency Plan & Responsibilities

	Normal Subsidence and associated consequences within predicted limits.	**Level 1** Subsidence and associated consequences considered likely to exceed predictions *or* Minor incident / exceedance observed.	**Level 2** Subsidence and associated consequences considered likely to significantly exceed predictions *or* Major incident / exceedance observed.
Person Responsible	⇩	⇩	⇩
Surveyor	Work to continue as normal and in accordance with development consent and mining / environmental management plans.	– Report to TSM and ME – Additional survey of surface area to confirm subsidence impacts and effects, where required	– As per Level 1 but respond **immediately**
Mining Engineer (ME)		– Investigate area and advise of additional works or remediation, where required – Increase monitoring frequency in immediate vicinity, where required – Consult with external expert for advice where appropriate – Report findings and recommendations to TSM – Report incident / response in SMP Status Report	– As per Level 1, and – **Immediately** report findings and recommendations to TSM (may include to stop mining)
Technical Services Manager (TSM)		– Review investigation(s) – Review information, and **approve** and instruct implementation of remediation / corrective action / or compensation, if necessary – Review safety of stopping mining – Report findings and recommendations to MM and/or ECRM and/or GM, where required	– As per Level 1 but respond **immediately**, and – In making recommendations review need to stop mining, – Consult with external expert for advice where appropriate, – As soon as practical notify DRE, MSB and PSE on corrective actions, – As soon as practical notify relevant stakeholders, including infrastructure owners, of impacts
Environment & Community Relations Manager (ECRM)		– Investigate area and advise of additional works or remediation where required – Increase monitoring frequency in immediate vicinity, where required – Consult with external expert for advice where appropriate – Review information, and **approve** and instruct implementation of remediation / corrective action / or compensation, if necessary – Report findings and recommendations to TSM and/or MM and/or GM where required – Report incident and response in AEMR, where required	– As per Level 1 but respond **immediately**, and – As soon as practicable, notify DP&I and relevant agency of impacts where required (e.g. OEH, DRE, NOW) and report on corrective actions.
Mine Manager (MM)		– Ensure adequate resources are available for implementation of remediation / correct actions – Report to GM, where required.	– As per Level 1 but respond **immediately** – If recommended, direction operations to stop mining in a safe manner
General Manager (GM)		– Review information, and **approve** and instruct implementation of remediation / corrective action / or compensation, if necessary.	– As per Level 1 but respond **immediately**

Table 11 is designed to work in conjunction with Trigger Action Response Plans (TARPs) provided in the individual management plans appended to this Extraction Plan. **Table 11** and the responses described above are designed to ensure that where monitoring results (subsidence or environmental consequences) indicate that impacts are exceeding (or likely to exceed at some future point) predicted or approved limits, consistently clear actions, levels of responsibility with ACOL, and reporting requirements are assigned. This contingency response plan is generic in nature, but is the overarching contingency response plan that would apply to any exceedence of a trigger level or performance measure in the subordinate management plans. It is designed to complement the technically-specific nature of the developed TARPs.

Responses within the subordinate management plan TARPs include, *inter alia*:

- Increase frequency of monitoring (to confirm impact);
- Targeted investigations of impact(s) and development of recommendations for preventative / remediation / corrective actions;
- Consultation with external experts; and
- Implementation of contingency responses.

Each of the TARPS, where possible, identifies a specific contingency response for key performance measures or triggers. **Table 12** below provides a summary of these contingency responses for key impacts (outside predicted limits) that would not be already addressed as part of routine management measures within the specific environmental or built features management plans.

Table 12 Summary of Key Contingency Responses

Impacted Natural and Built Features *	Trigger – Key Impacts	Summary of Responses / Contingency Response(s)
Surface watercourses	Subsidence movement of creek diversions greater than predicted.	As per Section 6.4 and Table 11.
	Sudden variation in flow connectivity between surface and groundwater within a flowing stream.	As per Section 6.4 and Table 11. Engage specialist to inspect and prepare preliminary report / recommendations, repeat sampling to confirm observations. Repeat flow measurements to confirm. To identify likely water sources and flow directions, conduct water quality sampling of adjacent bores on monthly basis, and identify/implement contingency measures such as: remediation of stream bed with impervious material (e.g. clay and layers of protection material – rock against future scour). See also *Groundwater – Loss of streamflow or baseflow impact* below
	Degradation of surface water quality outside established criteria	As per Section 6.4 and Table 11. Report as per statutory obligations, visual inspection to identify cause and repair (if applicable), engage specialist to undertake investigation (including review of preceding hydrological conditions and potential external contributions), confirm trends or anomalies by repeating sampling.
Groundwater	Loss of stream flow or baseflow impact greater than predicted	As per Section 6.4 and Table 11. All: Increase licence allocation to offset additional losses. **Glennies Creek** Investigation planning and design of remediation measures. Feasible remediation measures considered in the WMP include possible injection / filling of PG workings in vicinity of high flow area, construction of a cut-off wall (sheet pile) or bentonite slurry wall. Detailed review of mine plan of lower seams. **Bowmans Creek** Inspect channel beds for visible subsidence cracks and repair. If there is any indication that significant drainage of the alluvium is occurring, the full height block banks will be constructed immediately (as described in the BCD EA). **Hunter River** Review potential mitigation measures (such as in seam grouting and/or change of mine plan).

Impacted Natural and Built Features *	Trigger – Key Impacts	Summary of Responses / Contingency Response(s)
	Increased mine inflows greater than predicted	As per Section 6.4 and Table 11. Initial investigation to identify if alluvial sources are potentially reporting to underground as a result of subsidence. Where this is the case – refer to *Groundwater – Loss of stream flow or baseflow impacts* above. In addition: review surface impacts with regard to surface cracking and ponding and prioritise repair (ripping and or filling) of subsidence cracking and construction of drainage works to allow ponded areas to freely drain to nearest surface watercourses (i.e. providing channels over chain pillars etc).
	Trend in measured water quality outside of baseline levels or triggers	As per Section 6.4 and Table 11. Repeat sampling to confirm trends. Review by hydrogeologist to report on changes and identify cause and determine if impacts may potentially impact on adjacent bores or surface water users. Develop final contingency response dependent on cause and downstream effects.
	Reported adverse impact on yield of an existing water supply well or bore	As per Section 6.4 and Table 11. Repeat sampling to confirm trends. Review by hydrogeologist. Where ACOL impact is confirmed, affected bore will be deepened, alternative water source provided or alternative compensation agreed with affected owner.
Ecology	Groundwater level fall in alluvium of 0.5m (not attributable to natural conditions) in the alluvium adjacent to River Red Gum stands	As per Section 6.4 and Table 11. Repeat bi-annual survey and groundwater level to confirm potential for adverse impact. Review by hydrogeologist and ecologist to undertake investigation and report on any identified changes in tree health. Contingency measures – as per impacts to groundwater alluvium, and any specific recommendations developed by experts.
	Exceedance of Performance Measures in Table 1 of the Flora and Fauna (Biodiversity) Management Plan (performance measures include weed and pest control, biodiversity indices, habitat linkages, ecosystem health, endangered and threatened species).	As per Section 6.4 and Table 11. The Flora and Fauna (Biodiversity) Management Plan incorporates a process chart and detailed 'Key Assessment Considerations' for all of the biodiversity performance measures. This process is to be applied as the contingency response if any of the identified performance measures are exceeded. In summary, this process includes: engage specialist ecologist to review (as per Key Assessment Considerations) to confirm the impact, identify the nature of the risk, potential factors that have/are contributing to the impact and determine what actions are required to mitigate the observed impact and minimise the potential for future long-term impacts. Potential mitigation measures include: provision of additional habitat resources (i.e. nest boxes, ground logs/hollows), compensatory habitat, additional weed/feral animal control, rehabilitation and additional planting.

Impacted Natural and Built Features *	Trigger – Key Impacts	Summary of Responses / Contingency Response(s)
Electricity transmission lines	Risk or damage to stability of 132kV subtransmission line - power poles	As per Section 6.4 and Table 11. A detailed TARP has been developed for longwall mining as it progresses and passes beneath the 132kV transmission lines that incorporates survey monitoring of the poles, evaluation by an industry specialist as well as windspeed and preceding rainfall. If the installed preventative correction actions are not considered adequate, contingency response will include stopping the longwall in a controlled manner, with ongoing daily assessment and reporting until it is considered safe to proceed. In the event that any damage to powerlines occurs, Ausgrid will be notified and appropriate measures implemented to prevent injury until repairs can be made.
New England Highway	No significant impacts are expected.	As per Section 6.4 and Table 11. Detailed response plans are included in the Pothole Management Plan (as developed in consultation with Roads and Maritime Services – RMS) and the RMS Asset Management Plan in the unlikely event of impacts.
Fibre optic cable	No significant subsidence impacts are expected.	As per Section 6.4 and Table 11. No specific contingency response proposed.
Local telecommunication lines	Potential for strains to exceed cable tolerance causing service disruption.	As per Section 6.4 and Table 11. No specific response proposed –users provided with alternative communications for duration of potential impact.
Private access roads	Cracking, potential for roads to become partially waterlogged. Potential safety risk for road users	As per Section 6.4 and Table 11. Implement safety measures as per the Public Safety Management Plan and relevant AMP, including road closure / warning signage, traffic diversions, and repairs.
Brunkers Lane / Lemington Road	Surface cracking / changes in vertical alignment etc. Potential safety risk for road users	As per Section 6.4 and Table 11. *Note: Detailed plan for this asset yet to be developed in consultation with Xstrata and Singleton Shire Council prior to seeking approval for LW5-8*
Prescribed Dams	No significant subsidence impacts are expected.	As per Section 6.4 and Table 11. As per any requirements in an approval issued by the Dams Safety Committee.
Mine infrastructure	No significant impacts are expected	As per Section 6.4 and Table 11. Repair as required and continue to monitor as necessary.
Farm land and facilities, residential establishments	No impacts to residential establishments are expected. Some farm infrastructure (dams, sheds) may experience minor impacts.	As per Section 6.4 and Table 11. Repair as required and continue to monitor as necessary. Provide information to Mine Subsidence Board.
Archaeology	Approaching cracking or proximity of erosion threatening the integrity of a significant site.	As per Section 6.4 and Table 11. Implement procedures (such as salvage) as per the approved Archaeology and Cultural Heritage Management Plan and approved AHIP.

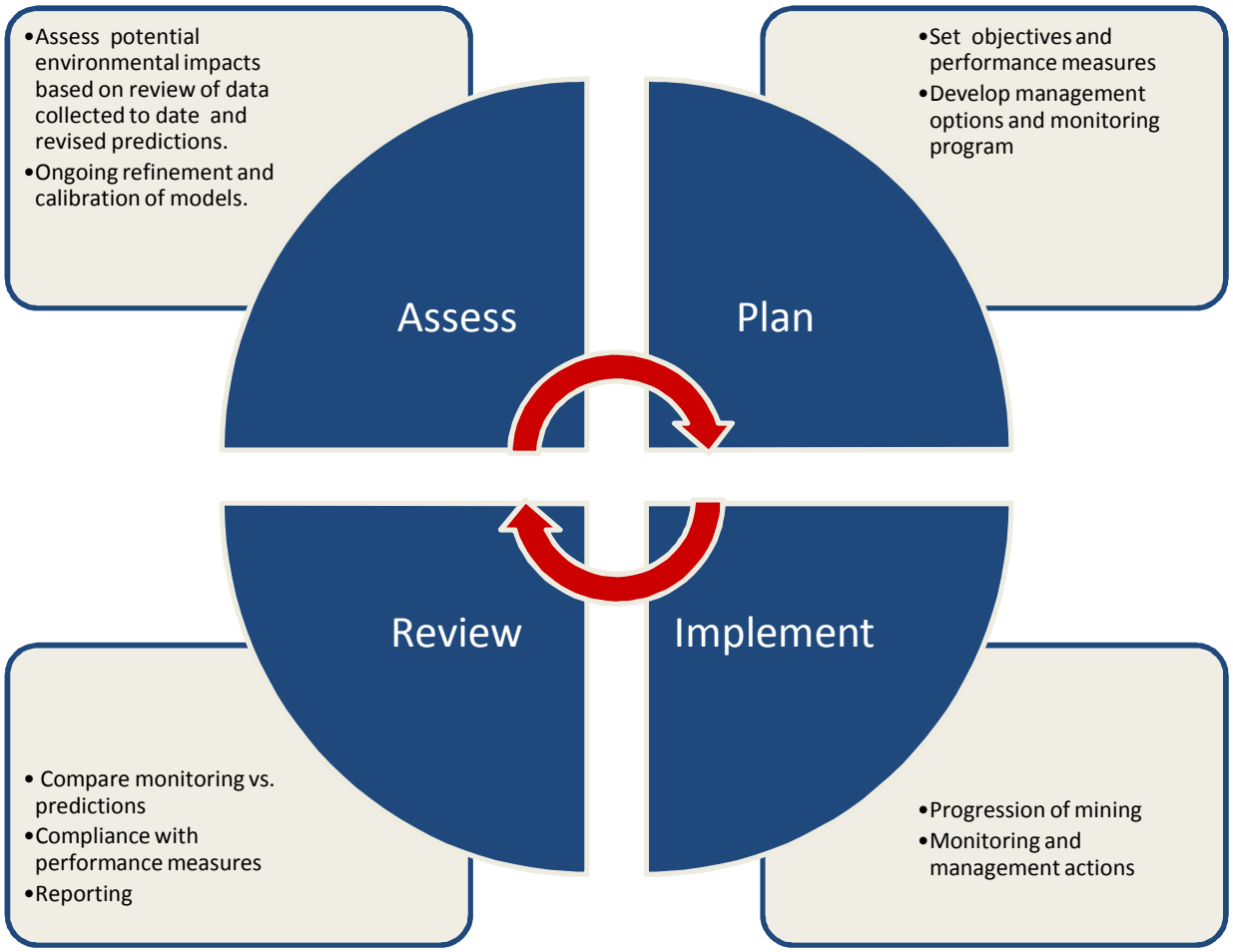
7 IMPLEMENTATION AND OPERATION

7.1 ADAPTIVE MANAGEMENT

ACOL's approach to managing subsidence and environmental impacts at the ACP includes using past performance to guide and improve future monitoring and management actions.

Monitoring of the environment, geological conditions and the subsequent response to mining has been in place at ACOL since prior to mining and has led to an improved understanding of the environment and site-specific subsidence behaviour. Updated information is then incorporated into ACOL's management plans through each phase of mine planning (e.g. Extraction Plans) and reviewed when required. This adaptive management approach is illustrated in **Figure 8** and described below.

Figure 8 Adaptive Management Loop



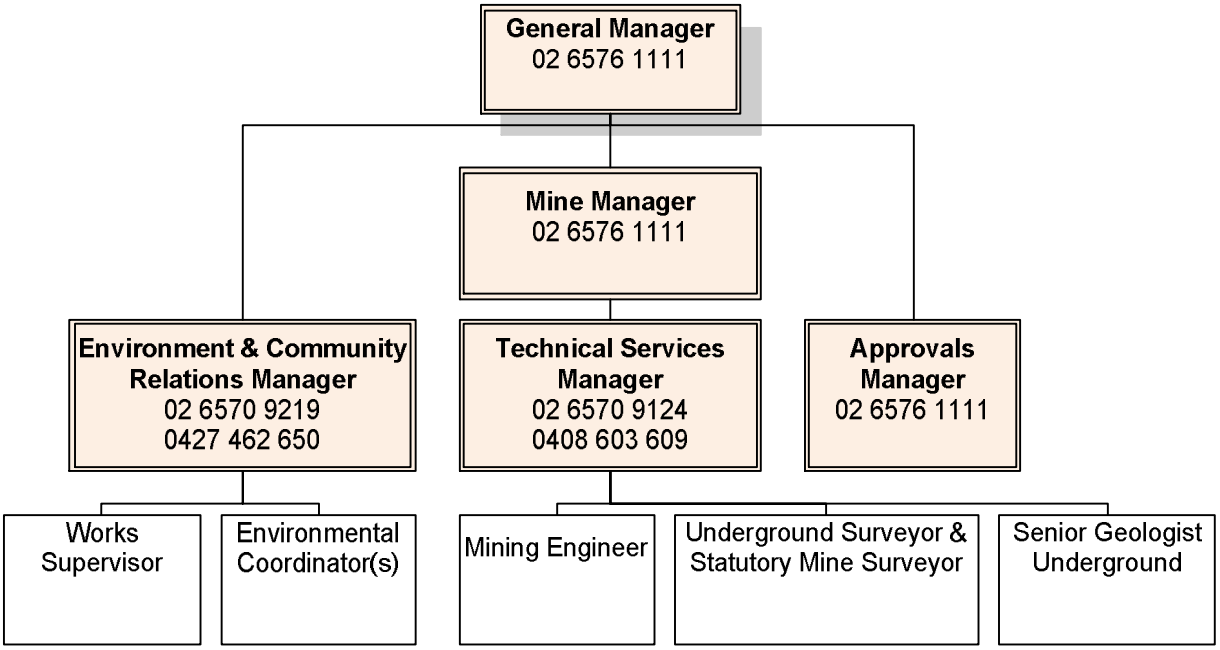
7.2 RESPONSIBILITIES AND RESOURCES

Table 13 Summary of Key Roles and Responsibilities

Role	Responsibilities
General Manager	▪ Ensure whole Site is committed to implementing the monitoring and management regime described in the Extraction Plan. ▪ Ensure that adequate resources are available to ACOL personnel to facilitate the completion of their responsibilities under this Extraction Plan.
Mine Manager	▪ Ensure the Subsidence Monitoring Program, Built Features Management Plan and Public Safety Management Plan are adhered to.
	▪ Ensure that adequate resources are available to ACOL personnel to facilitate the completion of their responsibilities under the Built Features Management Plan and Public Safety Management Plan.
Environment and Community Relations Manager	▪ Ensure that all environmental monitoring and reporting is undertaken in accordance with the relevant environmental management plans and various approval requirements, and is checked, processed, filed and appropriately reported.
	▪ Ensure that the ongoing community consultation processes detailed in the Built Features Management Plan are carried out.
	▪ Prepare, maintain and distribute a stakeholder contact register.
	▪ Ensure that audits and reviews are carried out as detailed in the Plans.
Technical Services Manager	▪ Ensure that all monitoring and reporting is carried out within the timeframes specified, checked, processed, filed and appropriately reported.
	▪ Liaise with stakeholders regarding subsidence impact management.
Underground Surveyor and Statutory Mine Surveyor	▪ Ensure that all subsidence monitoring is carried out to the accuracy required within specified timeframes and are checked, processed, filed and appropriately reported.
Private Landowners and Residents	▪ Notify ACOL of any concerns or issues related to subsidence management.
	▪ Provide access or permission where required for the implementation of monitoring and management actions identified under this plan.
	▪ Continue to participate in discussions with ACOL representatives regarding subsidence management.
Asset and Utility Owners	▪ Asset Management Plans have been developed in consultation with relevant stakeholders. Responsibilities, contact details and communication protocols are detailed within these plans .

The ACOL organisation chart, as relevant to this Extraction Plan is provided in **Figure 9**. The full organisation structure for the underground mine is contained within ACOL's Site Safety Standards "Structure and Responsibility Charts".

Figure 9 Organisation Chart



7.3 COMMUNICATIONS

Each of the detailed environmental and infrastructure management plans (see **Appendices E-J**) include communications protocols and notification schedules with affected landowners, infrastructure owners, government agencies and the community, along with responsibilities for undertaking those tasks.

Any amendments to the individual management plans will be completed in consultation with the relevant stakeholders and in accordance with the development consent requirements.

7.4 REVIEW

All review processes will be implemented in accordance with ACOL's EMS to ensure that the performance of this Extraction Plan and sub-plans is monitored and to indicate whether improvements to subsidence monitoring or management are required.

While the scope of this plan addresses all longwall panels in the ULD Seam, as noted in Section 1.2, ACOL is currently only seeking second workings approval for LW 1-4. This being due to delays in gaining subordinate approvals for diverting Bowmans Creek and the subsequent restrictions this imposes on ACOL to fully extract LW 6B, 7A and 7B in accordance with the approved mine plan and development consent conditions 1.18, 4.5 and 4.6 to Schedule 2 of DA 309-11-2001-i.

Therefore, this Extraction Plan will be reviewed prior to seeking approval for second workings in ULD LW 5A-LW 8. The review would include as a minimum:

- Comparison of predicted subsidence versus multi-seam subsidence and confirmation that actual subsidence observed falls within predicted range;
- Review of monitoring data and confirmation that observed performance indices fall within expected range;
- Review of the effectiveness of management actions undertaken to date in managing or mitigating subsidence impacts; and
- Modifications to the monitoring program or management actions where required.

The results of the review and updated version of this Extraction Plan would then be submitted to the DP&I and DRE for approval and copies provided to relevant stakeholders where applicable.

7.4.1 Audits and Reviews

In addition to the above, an internal review of the Extraction Plan and/or associated sub plans may be conducted if:

- An incident is recorded as a result of subsidence (refer to **Section 6.3**);
- There is a significant change in operation that may affect the environment or the community;
- Required to do so by any statutory requirements or directions/conditions of approvals; or
- Recommended as a result of internal or external audits.

This Extraction Plan may also be audited (when required) under the scope of any external environmental compliance audits.

Consideration will be given to updating this plan, or sub-plans, as a result of audits/ reviews, on in response to feedback on the following reports.

7.5 REPORTS

7.5.1 Annual Environmental Management Report

The Annual Environmental Management Report (AEMR) is the primary reporting tool for the Extraction Plan and sub plans. The AEMR will summarise all extraction activities, subsidence monitoring results and management actions taken on an annual basis. Once finalised and approved, the AEMR will be made publicly available on the ACOL website. A copy of the approved Extraction Plan will also be placed on the ACOL website for public information.

In addition to the AEMR reporting requirements, other reports are required under various conditions of consent and other statutory obligations. This includes:

- SMP Status Reports;
- End-of-Panel Reports; and
- Reporting required for any monitoring undertaken (includes water and groundwater quality, heritage, land and flora and fauna monitoring).

ACOL also undertake to prepare and submit a mid-panel data review report for the first three longwalls in the ULD Seam. These reports are summarised below.

7.5.2 Subsidence Management Plan (SMP) Status Reports

ACOL will prepare and maintain a Subsidence Management Plan (SMP) Status Report which will include:

- Current face position of the longwall being extracted and a note on the current location of development;
- Summary of any subsidence management actions undertaken by ACOL in the period subsequent to the last regular submission of the status report;
- Summary of any comments, advice and feedback from consultation with stakeholders in relation to subsidence management undertaken in the reporting period and a summary of ACOL's responses;
- Summary of the observed and/or reported subsidence impacts, incidents, service difficulties, community complaints, asset owner and stakeholder complaints, and any other relevant information reported to ACOL in the reporting period and a summary of ACOL's response to these issues;
- Summary of subsidence development based on monitoring information compared with any defined triggers and/or the predicted subsidence (to facilitate early detection of potential subsidence impacts);
- Summary of the adequacy, quality and effectiveness of the implemented management processes based on the monitoring and consultation information summarised above;
- Notification of landowner and residents of Property No. 130 of longwall progression and potential impacts to infrastructure or access issues. Summary to include timeframe and proposed management measures or proposed remedial work; and
- Statement regarding any additional and/or outstanding management actions to be undertaken or the need for early response or emergency procedures to ensure adequate management of any potential subsidence impacts due to longwall mining.

The SMP Status Report will be updated at least every 14 days and regularly submitted to the Principal Subsidence Engineer (DRE), DP&I , NOW, and owners of affected infrastructure. The status report will also be available upon request to the Mine Subsidence Board, and Director of Environmental Sustainability (DRE). .

7.5.3 End of Panel Report

ACOL has also committed to the ongoing preparation of End of Panel reports at the completion of each longwall under the development consent (a typical condition of a Subsidence Management approval under the Mining Lease). End of Panel reports will include:

- Summary of the subsidence monitoring results for the applicable longwall panel;
- Analysis of the monitoring results against the impact assessment criteria, predictions in the Environmental Assessment and monitoring results from previous panels;
- Discussion of any trends in the monitoring results over the life of the mine;

- Description of actions taken to ensure adequate management of any subsidence impacts due to longwall mining; and
- Any significant mine plan changes made to the panel mined or planned for future panels (as per SMP guidelines) or any variations that may be minor in nature, but which are still beneficial to advise upon

End of Panel reports will be submitted to DP&I, DRE, and NOW for information.

7.5.4 Mid-Panel Data Review

ACOL will also prepare a succinct summary review of observed data for LWs 1, 2, and 3 in the ULD Seam, within two weeks of passing XL5 (nominally located above 10ct). A copy of this review will be provided to DRE and NOW for reference.

This review will focus on the subsidence survey monitoring and groundwater monitoring data collected to that point. The review will comment on the adequacy of the mine plan, provide a brief comparison of the observed data to the predicted subsidence and ground water effects, and whether it is considered that there have been any impacts to Glennies Creek or the Hunter River.

7.6 DOCUMENT CONTROL AND QUALITY ASSURANCE

This Extraction Plan and supporting documents will be controlled as part of the ACOL Safety, Health, Environment and Community Management (SHECM) Document Control System. This system provides for all SHECM documents to be available via an electronic control system to personnel whose activities are dependent upon them. Furthermore, all documents and data must be:

- Prepared, reviewed and revised to determine adequacy, by authorised personnel;
- Dated, with revision status indicated;
- Legible, and maintained in an orderly manner; and
- Retained for specific periods.

8 REFERENCES

Department of Mineral Resources (DMR) (2003) **Guidelines for Applications for Subsidence Management Approvals** Department of Mineral Resources NSW.

Department of Planning (2010) **Notice of Modification (DA 309-11-2001-i)**, Department of Planning & Infrastructure NSW, Australia.

Evans and Peck (2009). **Bowmans Creek Diversion Environmental Assessment**. Evans and Peck, Sydney NSW Australia.

Li G, Stewart P, Paquet R and Ramage R (2010) **A case study on mine subsidence due to multi-seam longwall extraction**". Proceedings of Second Australasian Ground Control in Mining Conference, Sydney NSW 23-24 November 2010, pp 191-200.

GE Holt & Associates Pty Ltd (2001) **Ashton Coal Project: Assessment of the Impact of Subsidence From Longwall Mining**, prepared for White Mining Ltd, GE Holt & Associates Pty Ltd, Maitland, NSW, Australia.

Holla (1991) **Evaluation of Surface Subsidence Characteristics in the Western Coalfield of New South Wales**, Australian Coal Journal No. 31 1991, pp19-31.

MPR (2011) **Aquatic Ecology Assessment Upper Liddell Seam LW1-8,** prepared for Ashton Coal Operations Pty Ltd, Marine Pollution Research Pty Ltd, Church Point, NSW, Australia.

SCT (2009) **Multi-Seam Subsidence Assessment for Ashton Coal Mine Longwalls 5 to 8 (ASH3391A)** prepared for Ashton Coal Mine, Strata Control Technology Operations Pty Ltd, Wollongong, NSW, Australia.

SCT (26 June 2012) **Summary report of ' Subsidence and Hydraulic Conductivity Effects East of LW1 Pikes Gully Seam (ASH3560A)'**

SCT (2011) **Subsidence Assessment for Ashton Coal Mine Longwalls 6B to 8 in the Pikes Gully Seam based on the Bowman's Creek Diversion Mine Plan (ASH3657)** , prepared for Ashton Coal Mine, Strata Control Technology Operations Pty Ltd, Wollongong, NSW, Australia.

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