Ashton Coal Underground
Volume 1 - Written Report

Longwall & Miniwall Panels 5 to 9

Ashton Coal Operations Limited

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Prepared for

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Executive Summary

This report has been prepared as part of an application for a Subsidence Management Plan (SMP) Approval for the underground mining of Longwalls and Miniwalls 5 to 9 (LW/MW 5-9) in the Pikes Gully Seam at Ashton Coal Mine. A SMP Approval from the Department of Primary Industries, Minerals is required under the terms of the Mining Lease. This document has also been prepared to meet the requirements of the development consent issued by the Minister for Planning for the Ashton Coal Project. These requirements include the preparation of a Subsidence Environmental Management Plan and a Subsidence Monitoring and Impact Assessment Report.

The Proposal

The SMP Application Area lies within Mining Lease No. 1533 and includes the construction of mains headings, maingates/tailgates, and associated infrastructure for LW/MW 5-9 within the Pikes Gully Seam. The proposed mine plan is overlain by Bowmans Creek and an associated alluvial aquifer. The inclusion of miniwalls in the mine design is based on extensive data collected during monitoring of longwall panels 1 and 2 and use of detailed groundwater and geotechnical models, with ongoing calibration using real data, to determine and minimise the potential impacts of underground mining on Bowmans Creek and its associated alluvial and groundwater resources.

A key feature of the mine plan is the incorporation of both full-width longwall blocks and also a series of narrow panels (miniwalls) beneath Bowmans Creek and associated alluvium. The incorporation of miniwalls in the mine plan and leaving some of the coal seam in situ aims to maintain a substantially intact barrier of overburden between the caving zone above the goaf and the base of the Bowmans Creek alluvium. Subsidence and interconnected cracking in key areas will be minimised to ensure minimal risk of adverse environmental impacts to groundwater quality or Bowmans Creek flows.

Whilst some coal within the Pikes Gully Seam will remain in situ as a result of the use of miniwalls, the orientation of the panels aims to maximise recovery of the coal (65% recovery of available resource) within the site-specific physical and environmental constraints.

Construction of the development headings and first workings within the longwall and miniwalls 5 to 9 (LW/MW 5-9) SMP Application Area is planned to commence in approximately February 2009 to ensure continual operation of the longwall equipment. LW9 is estimated to be complete in 2012, at which time, Ashton have planning approval to descend to the next viable coal seam, the Upper Liddell Seam.

Site Description

The land is largely owned by Ashton Coal and consists predominantly of agricultural grazing land. Other landowners include Macquarie Generation, the NSW Roads & Traffic Authority, Ravensworth Operations Pty Ltd and Glendell Tenements.

Construction of the development headings and first workings within the longwall and miniwalls 5 to 9 (LW/MW 5-9) SMP Application Area is planned to commence in approximately February 2009 to ensure continual operation of the longwall machine.

The topography of the Application Area ranges from gentle slopes to floodplain areas associated with Bowmans Creek. Surface elevations range from approximately 82 to 55 mAHD, Depth of cover over the Pikes Gully Seam is variable and generally increases in the direction of seam dip (to the southwest). The depth of cover ranges from a minimum of approximately 100 metres at the northern end of MW5 to a maximum of 190 metres at the southern end of MW9.

The Pikes Gully Seam overburden comprises sandstone and minor siltstone units. These sandstone units are categorised as being moderate to strong in terms of their structural competency (with associated UCS values of generally >60MPa) and are largely self-supporting on drivage. The underground workings have proven to be typically highly stable during both development and extraction to-date.

Geological exploration of the underground area has been ongoing since commencement of operations. Existing mining development provides additional geological information which has been incorporated into the modelling. Structural geological mapping is an integral part of the understanding of the framework of the sedimentological and tectonic characteristics of the deposit. An aeromagnetic survey was undertaken of the underground area in early 2008, with no magnetic anomalies detected.

This data provides confidence that there are no major geological structures within the SMP Application Area, however investigation is ongoing to identify and delineate any minor structures.

Surface and Subsurface Features

As part of the SMP preparation process, all surface and subsurface features within the Application Area were identified and are described in this report. Overall, land use of the site predominantly features agricultural land and rehabilitated open cut. Significant environmental features include:

- Bowmans Creek, associated natural environment, surface water flows and alluvial aquifer;
- Major public utilities and infrastructure, including 132kV high-voltage sub-transmission lines, the New England Highway and a fibre-optic cable;
- Groundwater resources;
- Indigenous archaeology sites; and
- Notification Areas of one existing and one planned Prescribed Dam.

Other features in the SMP Area also include habitat for threatened species, private access roads, private electricity transmission lines, a DWE Stream Gauging Station, farm land and associated infrastructure, telecommunications cables, and mine-related infrastructure.

All these features are detailed individually in this report. In particular, key environmental features such as the Bowmans Creek environment and alluvial aquifers were subject to detailed assessment in accordance with the requirements of the development consent. Many of these assessments are based on detailed baseline surveys and ongoing monitoring which has been in place at Ashton since prior to the commencement of underground mining.

Proposed Mine Plan

The proposed layout of LW/MW 5 to 9 is based on extensive investigation into the overburden and groundwater properties of the site. The main objective of these investigations and resulting mine design was to ensure compliance with Condition 3.9 of the Development Consent:

> *3.9 The Applicant shall design underground mining operations to ensure no direct hydraulic connection between the Bowmans Creek alluvium and the underground workings can occur through subsidence cracking. In order to achieve this criteria the Applicant shall assess levels of uncertainty in all subsidence predictions, and provide adequate contingency in underground mine design to ensure sufficient sound rock is maintained to provide an aquaclude between the Bowmans Creek alluvium, and the underground mine goaf.*

One of the key considerations taken into account in the design of the mine plan was the potential of a mining-induced hydraulic connection from the underground mine to the surface and saturated alluvium of Bowmans Creek. Creation of a hydraulic connection may result in any of the following:

- Water ingress into the mine causing operational or safety issues;
- Potential contamination of the water flowing into Bowmans Creek and the Hunter River after mine decommissioning and flooding of the mine; and
- Flow of highly saline water from the Permian coal measures into the lower salinity alluvial groundwater.

A study of the inflow potential for mining under the Bowmans Creek area was conducted involving a review of empirical data of inflow experience, computer modelling of caving and water flow potential for the Ashton site and field site investigations of conductivity and connectivity of the fracture systems in the over burden of the existing Longwall 1.

The potential for hydraulic connection from the mine to surface aquifers was found to be related to the magnitude of subsidence, overburden, panel geometry and geological nature of the overburden. The height of cracking above extraction panels typically extend 1 to 1.5 times the panel width, however these cracks may not be interconnected and allow any significant fluid migration. It was found that the extent of cracking and interconnection potential above the extraction panels increases with increasing subsidence.

Computer modelling was used to assess the extent of fracture and potential for inter-connection of the mine to the surface for various panel widths. Predictions relating the nature and extent of fracturing were further used in computer modelling of the site groundwater aquifers to look at the impact various panel widths had on groundwater interactions and flows.

It was concluded that the impact on the Bowmans Creek aquifer system can be controlled by limiting the panel width to dimensions that do not induce significant subsidence. Modelling of a width to depth ratio of up to 0.7 at the site indicated that an unimpacted zone was maintained between the longwall goaf and base of the alluvial aquifer with hydraulic conductivity values similar to the in-situ state. A conservative width to depth ratio of 0.6 was adopted into the proposed mine plan design.

Subsidence Assessment

Subsidence predictions for the proposed mine plan were then developed using empirical data for similar sites and the previous subsidence monitoring at Ashton Coal. These predictions were then used to quantify impacts to surface and subsurface features across the SMP Application Area.

An upper limit approach to subsidence predictions was adopted to ensure that there is no potential for greater levels of maximum vertical subsidence to occur. In general, the SMP Area can be differentiated into three zones: full width panels, miniwalls, and a narrower panel associated with LW9.

This assessment found very low levels of subsidence associated with the miniwalls. Maximum subsidence for the full-width panels (LW5 and 6) is predicted not to exceed 1.6m, whilst a maximum value of 0.35m is predicted for the miniwalls.

Subsidence Impacts

The detailed baseline data and predicted subsidence values were then used to quantify likely impacts to the site environment, including both natural and man-made features.

A key feature to note is that Bowmans Creek and areas of saturated alluvium will experience only very low levels of subsidence and that this will be up to a maximum of 350mm in the centre of the miniwall panels. Where the creek traverses the chain pillars, subsidence due to pillar compression is predicted to be approximately 100 to 150mm.

The low level of subsidence in these areas significantly reduces the likelihood of major consequences to the environment. In particular, the following results of the subsidence impact assessment are noted.

Groundwater impacts were subject to extensive investigation, numerical modelling, and independent peer review. Overall, it was found that there will be only minor impacts to Bowmans Creek alluvium through an increase in the existing exchange of groundwater with the Permian Coal Measures. This is predicted to occur as a result of depressurisation of the Pikes Gully Seam during mining and the associated head differential between the alluvium and the Permian coal measures groundwater. This will result in a temporary reduction in groundwater levels within the alluvium, representing a reduction in stored water by about 12%. Baseflow to Bowmans Creek will also be reduced by approximately 1.2L/s which represents only 4% of median flow in the creek and 32% of very dry flows (as recently experienced in the severe drought). One of the benefits of this reduction in contribution of baseflow to surface flows in Bowmans Creek will be the reduction of saline water contribution and associated improvement in water quality.

Impacts to aquatic and riparian vegetation are expected to be minor and will largely occur indirectly. The minor differential subsidence movements along the creek may cause a redistribution of the current pool/riffle sequence and cause the creek to shift within its channel or alter the slope of stream banks. These changes are expected to be minor and within the normal range of a typical meandering stream. Risks to water quality will be increased due to erosion of the land surface and stream banks, however these can be readily monitored and remediated where necessary.

Archaeological assessment of scattered artefacts within the SMP Application Area found they are generally of low to moderate significance and due to their nature, are at low risk of damage by subsidence. Impacts are more likely to occur through the implementation of remediation works to erosion or surface cracking, and hence can be identified and avoided.

The highest priority risks to surface infrastructure were considered to include the potential impacts to a 132kV electricity transmission line through the south of the SMP Area. This line is supported by poles which are located over LW5 and 6 and as such is expected to undergo a full range of subsidence movement. Were this line to be damaged, supply to Singleton would be affected. Consultation with EnergyAustralia is being undertaken to prevent this occurrence. No impacts are predicted to other items of major public infrastructure.

Private roads to adjoining properties will experience some damage as a result of subsidence including pavement damage and changes in longitudinal grade and cross fall. The road is expected to remain trafficable and will be managed to minimise the risks to the safety of road users.

Impacts to mine infrastructure include cracking and damage to sedimentation basins, potential cracking or damage of water pipelines and tilting of a private electricity transmission line owned by an adjacent mine. The Notification Area of a proposed dam overlies the proposed workings and Ashton has been liaising with the Dam Safety Committee and the dam owner. No perceptible subsidence movements are predicted at the dam itself.

Statutory Requirements

The proposal is largely within the existing approved planning framework for the Ashton Coal Project. As a result of mine plan changes to minimise impacts to Bowmans Creek and meet the consent requirements, LW/MW9 is considered to be partially outside the originally approved extent of mining. Therefore, a modification of the development consent is being submitted to Department of Planning and this is being assessed in parallel with this application for SMP Approval.

Consultation

This report and accompanying Subsidence Management Plan (Volume 2) has been prepared in conjunction with an extensive consultation program. Relevant stakeholders contacted and consulted regarding the proposal have included all relevant government agencies, the local and wider community, affected landowners, public utility owners and the local indigenous community. Overall, feedback has been supportive of the approach adopted by Ashton to minimise the impacts of mining on Bowmans Creek. The development of management actions to both private and public infrastructure has been undertaken in consultation with the relevant stakeholders.

Conclusion

Overall, it has been found that the proposed miniwall design has significantly reduced subsidence of Bowmans Creek when compared with the original proposal detailed in the EIS (HLA, 2001) and therefore, environmental impacts to this feature will be avoided or significantly reduced. Furthermore, subsidence impact to the surface infrastructure within the SMP Application Area is also significantly reduced in magnitude and extent. Methods to manage and monitor subsidence impacts and confirm they are within the predicted range are detailed in Volume 2.

Abbreviations

μS/cm	microSiemens per centimetre
ACOL	Ashton Coal Operations Limited
ACP	Ashton Coal Project
AEMR	Annual Environmental Management Report
CHPP	Coal Handling and Preparation Plant
CMHSA	*Coal Mines Health and Safety Act 2002*
CMRA	*Coal Mines Regulation Act 1982* (repealed)
DECC	Department of Environment and Climate Change
DoP	Department of Planning
DPI	Department of Primary Industries
DSC	Dam Safety Committee
DWE	Department of Water and Energy
EC	Electrical conductivity
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPL	Environmental Protection Licence
ERM	Environmental Resources Management (Australia) Pty Ltd
FDC	Flow Duration Curve
LGA	Local government area
LW	Longwall
m	metres
mm	millimetres
MOP	Mining Operations Plan
MSB	Mine Subsidence Board
POEO Act	*Protection of the Environment Operations Act 1997*
SCT	SCT Operations Pty Ltd
SEMP	Subsidence Environmental Management Plan
S_{max}	Maximum subsidence
SMIAR	Subsidence Monitoring and Impact Assessment Report
SMP	Subsidence Management Plan
W/D Ratio	width / depth ratio (effective panel width to overburden depth)
WAL	Water Access Licence

Document Compliance

This document has been prepared in accordance with the guidelines issued by the Department of Primary Industries, Minerals *Guidelines for Applicants for Subsidence Management Plan Approvals* (Department of Mineral Resources 2003).

Guideline Section		Report Reference
6.2	The SMP Area	**Section 1.1**
6.3	Mining System and Resource Recovery	**Section 1.4**
6.4	Site Conditions of the SMP Area	**Section 1.5**
6.5	Stability of Underground Workings	**Section 1.5.9**
6.6	Characterisation of Surface and Sub Surface Features within the SMP Area	**Section 2.0**
6.7	Subsidence Predictions	**Section 3.0**
6.8	Community Consultation	**Section 7.0**
6.9	Statutory Requirements	**Section 5.0**
6.10	Subsidence Impacts	**Section 4.0**
6.10.2	Risk Assessment	**Section 6.0**
7.0	Proposed Subsidence Management Plan	**Volume 2**
9.0	Plans	**Volume 2 Appendix B** (reduced)
10	SMP Approved Plan	**Volume 2 Appendix B** (reduced)

1.0 Introduction

1.1 The Application Area

The Ashton Coal Project (ACP) is located near Camberwell, 14 kilometres northwest of Singleton in the Hunter Valley, New South Wales. The ACP lies adjacent to the open-cut mines of Mt Owen to the north, Camberwell to the east, Lemington to the south and Ravensworth to the west. Nearby underground mines include Integra to the north east and Newpac to the west.

The Application Area lies wholly within the Singleton Local Government Area. A locality plan and extent of the Application Area is shown in **Figure 1**. The Subsidence Management Plan (SMP) Application Area includes the following workings in the Pikes Gully Seam:

- First workings for longwall and miniwall panels 5 to 9; and
- Secondary extraction of longwall and miniwall panels 5 to 9.

The Application Area is illustrated in detail in the SMP Approved Plans prepared by Ashton Coal and which form part of the application to the Department of Primary Industries (Minerals) for SMP Approval (Drawing Reference: A-4032 Approved Plan).

1.2 Company Background

The ACP is structured as an unincorporated joint venture between Felix Resources, Itochu Corporation (Japan) and the IMCI Group (Singapore). Ashton Coal Operationgs Limited is the nominated operator or the ACP. Felix Resources has 100% ownership of ACOL. Felix, Itochu and IMC have coal marketing responsibilities for the project with Itochu providing exclusive coverage in Japan and IMCI in Asia and China.

1.3 History of Operations

Initial exploration of the area dates back to late 1969, however, more detailed exploration of the site did not occur until approximately 2000 to 2001 by White Mining Limited. This exploration work was followed by the preparation of an Environmental Impact Statement (HLA, 2001) and lodgement of a Development Application for both open-cut and underground mining in November 2001. The development application for the ACP included the following activities:

- Site preparation and clearing of specified areas;
- Open-cut coal mining in two pits to the north of the New England Highway between the Main Northern Railway and Glennies Creek Road;
- Underground coal mining using longwall techniques to the south of the New England Highway (mine operation for up to 21 years);
- Construction of a coal handling and preparation plant;
- Construction of stockpiling and coal loading facilities and a new rail siding;
- Construction of administration, car parking, stores and bathhouse facilities; and
- Construction of site access (from Glennies Creek Road).

Development consent was granted in October 2002 by the Minister for Planning under the *Environmental Planning and Assessment Act 1979* (EP&A Act) and open-cut mining commenced in 2004.

Development of first workings for the underground mine commenced in 2005 with secondary extraction of Longwall (LW) 1 commencing in February 2007 following government agency approval of the SMP for secondary extraction of the LW 1 to 4.

The current SMP approval for longwall extraction applies to first workings and longwall extraction of panels 1 to 4 of the Pikes Gully Seam.

1.4 Mining System and Resource Recovery

1.4.1 Resource Description

The ACP is located within the Hunter Coalfields of the Sydney basin. The coal seams and surrounding strata are assigned to the Foybrook Formation which is a stratigraphical unit of the Late Permian Singleton Supergroup. This formation is part of the Vane Subgroup within the Whittingham Coal Measures and is the basal coal bearing sequence of the Singleton Supergroup.

The SMP Application Area is located on the western limb of the Camberwell Anticline which is the principal structural feature of the project area. The axis of this structure trends along the eastern boundary of Exploration Lease 4918 which coincides with sub crop of the coal seams of principal interest. These sub crops define the westerly dipping limb of the Camberwell Anticline. The stratum consists of a mix of sandstone, shale, and interbedded to finely laminated sandstone/shale with a number of coal seam splits between. A cross section of the Ashton site showing all coal seams is provided in **Appendix A**.

The Foybrook formation contains at least six named coal seams which commonly split and coalesce. Within ACOL's mining lease, the economically viable seams proposed for extraction include (in descending order):

- Pikes Gully Seam;
- Upper Liddell Seam;
- Upper Lower Liddell Seam; and
- Lower Barrett Seam.

The Foybrook Formation coals at ACP are bituminous, high-volatile, low sulphur, vitrinite rich and low in other elements such as chlorine and phosphorous. Ash content of the Pikes Gully Seam is variable and ranges between 20% and 28% (HLA 2001). Raw coal is processed in the Ashton Coal Handling and Preparation Plant (CHPP) and a low ash product (8.5% average) with strong coking properties is recovered. The underground operation produces a semi soft coking coal for the export market.

The coal matter within the Pikes Gully to Hebden Seam interval is markedly uniform and contains large proportions of vitrinite. An analysis of polished sections that were prepared from a selection of composite samples reveals that reactive macerals (vitrinite and liptonite) comprise between 75 – 85% of total litho types. Vitrinite reflectance (R_o Max for telovitrinite) is in the order of 78 – 82%. This places the resource at ACP at the upper end of the rank profile for the Hunter Valley (White Mining Limited 2002).

The EIS (HLA 2001) noted that an assessment of total desorbable gas was carried out on seven coal samples representing the four major seams proposed for underground extraction at the ACP. Sample depths ranged from 180 to 280 metres, and results indicated that the coal seams contain low to moderate quantities of gas which is predominantly methane (CH_4: 70-90%), with nitrogen (N: 8-22%) and carbon dioxide (CO_2: 1.5%) making up the remainder. Additional testing on core intersections has provided data on the target and other seams within the stratigraphic sequence. The desorbable gas contents are within the range reported in the EIS.

1.4.2 Mining Methods

The Ashton underground operation uses the retreating longwall method for secondary extraction. Construction of development main headings, maingates and tailgates is undertaken using continuous miners. The proposed layout for panels 5 to 9 is shown in **Figure 2**. The layout has been developed based on extensive drilling, groundwater modelling and consultation with relevant authorities to minimise the risk of impacting on Bowman's Creek and associated alluvial aquifer.

This SMP proposal in support of mining panels 5 to 9 within the Pikes Gully seam is based on the extensive data collected during monitoring of longwall panels 1 to 4. This data has been collected and incorporated into groundwater and geotechnical models, with ongoing calibration using real data, to determine the potential impacts of underground mining on Bowmans Creek and its associated alluvial and groundwater resources.

Following modelling of the impacts of subsidence to the geological strata and estimating the pre and post mining hydraulic conductivities (refer to **Appendix B**) the original longwall layout has been redesigned to include a number of "miniwalls". The incorporation of miniwalls in the mine plan and leaving some of the coal seam in situ aims to maintain a substantially intact barrier of overburden between the caving zone above the goaf and the base of the Bowmans Creek alluvium. Subsidence and interconnected cracking in key areas will be minimised to ensure minimal risk of adverse environmental impacts to groundwater quality or Bowmans Creek flows. A detailed subsidence assessment of the proposed mine plan has been prepared and which demonstrates very low levels of subsidence to Bowmans Creek (**Appendix C**).

Whilst some coal within the Pikes Gully Seam will remain in situ as a result of the use of miniwalls, the orientation of the panels aims to maximise recovery of the coal within the Mining Lease boundaries and within the site-specific physical and environmental constraints.

Within the Application Area, the Pikes Gully Seam ranges in thickness from 2.4 metres to 2.5 metres. ACOL's longwall equipment is capable of operating within a height range of 1.8 to 3.1 metres and therefore the proposal involves extracting the full seam thickness.

The overburden depth of the Pikes Gully Seam within the Application Area is variable as a result of seam dip, and ranges from 100 metres at the out-bye (northern) end of MW5 to 190 metres at the in-bye (southern) end of MW9.

1.4.3 Schedule

Ashton'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 LW2 is completed and extraction of LW3 has commenced.

As shown in **Table 1,** the longwall panels covered by the LW1-4 SMP approval are scheduled for completion in October 2009. Construction of the development headings and first workings within the longwall and miniwalls 5 to 9 (LW/MW 5-9) SMP Application Area is planned to commence in approximately February 2009 to ensure continual operation of the longwall equipment.

Table 1 – Proposed Mining Schedule

Longwall Panel	Start Date	Estimated Completion
Currently Approved Panels		
LW1	Complete	
LW2	Complete	
LW3	Commenced September 2008	March 2009
LW4	April 2009	October 2009
Proposed Panels		
LW/MW5	November 2009	May 2010
LW/MW6	June 2010	December 2010
MW7	December 2010	April 2011
MW8	May 2011	September 2011
LW/MW9	October 2011	April 2012

1.4.4 Resource Recovery

The Pikes Gully layout has been optimised to maximise resource recovery within the lease boundary whilst minimising subsidence impacts on the overlying Bowmans Creek and alluvium. No other mining method is likely to achieve greater recovery with the subsidence constraints applied.

The estimated recovery of the total resource contained within the proposed layout, as a percentage and in tonnes is presented in **Table 2**.

Table 2 – Estimated Resource Recovery

	Reserves (Tonnes)
Pikes Gully Seam Reserve (LW5-9)	6,167,000
Inventory Resources (LW5-9)	9,470,000
Recovery (%)	65%

The development consent for the mine is based on extraction of 4 seams recoverable by underground longwall mining methods. The current whole of mine proposal is for a stacked longwall layout in order to maximise recovery of the resource in the lower seams. A stacked layout will allow future miniwalls to be located directly beneath the Pikes Gully miniwalls and provide for the ongoing stability of the established essentially unimpacted low permeability beam.

As a result of secondary extraction of coal within the Pikes Gully Seam, there will be some subsidence impacts on the overlying strata as discussed further in this document. Depth of the Pikes Gully Seam within the Application Area ranges from 100 to 190 metres and the overlying strata contains no currently identified viable coal seams within the geographical and depositional constraints of the deposit.

Some stress-related impacts on the strata immediately below the floor of the Pikes Gully Seam may occur as a result of longwall extraction; however this will not impact the ability of lower seams to be extracted in the future.

Consideration of multi-seam extraction has been included in the mine plan design. In particular, modelling the subsidence behaviour of proposed future mining in the Upper Liddell Seam was used to identify potential issues relating to the stability of the Pikes Gully Seam chain pillars and reactivation of the goaf. In order to minimise impacts from multi-seam extraction it is likely that a miniwall approach will also be required in the lower seams.

1.4.5 Future Extraction Plans

Following completion of LW9 and in accordance with the Development Consent and life of mine plan, the Upper Liddell, Upper Lower Liddell and Lower Barrett seams will be progressively extracted in descending order over a total of 18 years operating life. Panel geometry and orientation are expected to be similar to the layout adopted for the Pikes Gully Seam.

1.5 Site Conditions

1.5.1 Land Ownership and Use

The land within the Application Area is predominantly owned by Ashton Coal. Small areas to the north and north west are owned by others, as indicated in **Figure 3**.

A proportion of the land overlying the mains headings includes the New England Highway Road Reserve, which is owned and managed by the Roads and Traffic Authority. Land in the north western corner of the Application Area (Property No. 155) is owned by Macquarie Generation, whilst a small portion of land on the northern side of the New England Highway which will overly mains headings is owned by Glendell Tenements.

To the west of LW9 – subsidence and therefore the extent of the Application Area extends into Brunkers Lane, and marginally into Property No. 153 (owned by Ravensworth Operations Pty Ltd).

Property details, land owner, and current land use of each property within the Application Area is summarise in **Table 3**.

Table 3 – Land Ownership and Land Use

Property	Lot / DP	Owner	Land Use
New England Highway road reserve	-	Roads & Traffic Authority	Transportation – regional arterial route
Property No. 3	Lot 11 DP261916	Glendell Tenements	Agricultural
Property No. 155	Lot 2 DP 1089848	Macquarie Generation	Rehabilitated open cut (former Ravensworth void)
Ashton holdings	Lot 3 DP1114623	Ashton Coal Operations Pty Ltd	Agriculture, underground mine
Property No. 153	Lot 164,165, 166, 167, DP2328	Ravensworth Operations Pty Ltd & Renison Ltd	Mining, agriculture

1.5.2 Surface Topography

The topography of the Application Area ranges from gentle slopes to floodplain areas associated with Bowmans Creek. The area generally slopes from east to west, towards these floodplains and generally reflects the dip of the seam and overburden strata. Elevations within the SMP Application Area range from approximately 82 to 55 metres Australian Height Datum (mAHD). The site topography is shown in **Figure 4**.

1.5.3 Cover Depths

Depth of cover is variable and increases in the direction of seam dip (to the southwest). The depth of cover ranges from a minimum of 100 metres at the northern end of MW5 to a maximum of 190 metres at the southern end of MW9.

A summary of panel widths for proposed longwalls, overburden depths and resulting maximum Width / Depth ratios is provided in **Table 4**.

Table 4 – Longwall panel widths, cover depths and width/depth ratio

Panel	Panel Width (m)	Overburden Depth (m)	Width/Depth Ratio
LW5	216	110 - 155	1.4 – 2.0
MW5	60	100 - 125	0.5 – 0.6
LW6	216	130 - 160	1.3 – 1.7
MW6	70	115 - 150	0.5 – 0.6
MW7	81	130 - 170	0.5 – 0.6
MW8	87	140 - 175	0.5 – 0.6
MW9	93	160 - 190	0.5 – 0.6
LW9	141	140 - 180	0.8 – 1.0

1.5.4 Overburden Stratigraphy

The Pikes Gully Seam is overlain by sediments assigned to the Singleton Supergroup as described in **Section 1.4.1**. The stratum within the Foybrook Formation is deltaic in origin and comprises in order of predominance: fine to coarse grained sandstone, siltstone, conglomerate, mudstone, shale and coal. The top of this formation corresponds with the base of the overlying Bulga Formation which is in turn overlain by the Archerfield Sandstone and Jerrys Plains Subgroup respectively. The Bulga Formation and Archerfield Sandstone are marine sandstones or laminates. The Jerrys Plans Subgroup includes the Bayswater Seam which has been mined (open cut methods) in the adjacent Ravensworth development and only a remnant portion of it exists in the far western part of the ACP. In-situ coal attributed to this seam does not form part of the ACP.

These strata are of Late Permian age and consist of coal seams, siltstone, lithic sandstones, shale and conglomerate. The coal seams contain many splits, and only a few are suitable for mining either by open cut or underground methods. Conglomerates outcrop at several locations along Bowmans Creek (i.e. near the New England Highway Bridge and the Department of Water and Energy (DWE) stream gauging station).

1.5.5 Location of Existing and Future Workings

The site is within an area of extensive past, current and future open cut and underground mining operations, however there are no existing workings within the Application Area. Existing workings within the vicinity include the currently extracted longwall panels within the Pikes Gully Seam to the east (refer to **Figure 2**) the ACOL Open Cut pit to the north of the New England Highway, the Newpac underground mine and Ravensworth open cut to the west. Other mining operations in the area include:

- Former underground workings (Hunter No. 1) beneath the Ashton CHPP
- Hunter Valley operations to the south;
- Rixs Creek and Glennies Creek to the east; and
- Mount Owen to the north.

1.5.6 Lithological and Geotechnical Characteristics (Overburden)

The Pikes Gully Seam overburden comprises sandstone and minor siltstone units. These sandstone units are variable in nature, and range from coarse-grained, bedded to massive, with zones of sub-vertical jointing (Strata Engineering 2006). The principal features of the overburden are:

- Depth of cover ranging from 90 to 200 metres;
- Strong durable sandstone are consistently within the roof bolting horizon providing a competent roof; and
- Regional trends in the sandstones suggest the presence of channels, this has been confirmed in the existing underground operations.

The Pikes Gully Seam is on average between 2.2 and 2.4m thick, excluding the rider seam. The immediate roof of the seam is typically a layer of carbonaceous mudstone / shale (0.2 to 0.3m thick), overlain by the rider seam (0.1 to 0.2m thick) and followed in turn by a second layer of carbonaceous mudstone / shale, varying in thickness from zero to 0.5m, with an average of 0.25m. This second carbonaceous mudstone is overlain in turn by sandstone and minor siltstone units. The general intention on development is to cut down the rider seam and the adjacent mudstone units, such that the sandstone forms the immediate roof (i.e. a typical drivage height of around 2.6 to 2.7m). However, there are areas in which the mudstone above the rider seam thickens to the extent that a portion of this material is left in the roof; this material is weak and necessitates the use of mesh. In places the rider seam diverges or splits from the main Pikes Gully Seam and a zone of relatively weak roof dominated by mudstone units tends to be associated with the split. This zone is commonly of the order of 300m wide and requires increased support densities on drivage, notably at intersections due to the increased spans involved.

1.5.7 Lithological and Geotechnical Characteristics (Roof and Floor Strata)

The sandstone units forming the main roof are variable in nature, ranging from fine to coarse grained / conglomeritic, bedded to massive, with typically widely spaced zones of sub-vertical jointing. These sandstone units are categorised as being moderate to strong in terms of their structural competency (with associated UCS values of generally >60MPa) and are largely self-supporting on drivage.

The floor generally consists of moderately competent, thinly bedded sandstone and siltstone units with UCS values of 30 to 60MPa. Often a weak (i.e. UCS <15MPa) mudstone unit is encountered in the immediate floor (typically <0.5m thick), but this does not create significant difficulties for either development or longwall retreat.

1.5.8 Existence and Characteristics of Geological Structures

Exploration of the underground area has been ongoing since commencement of operations, with a combination of surface and long hole drilling. Mining development provides additional geological information which has been incorporated into the modelling. Structural geological mapping is an integral part of the understanding of the framework of the sedimentological and tectonic characteristics of the deposit. An aeromagnetic survey was undertaken of the underground area in early 2008, with no magnetic anomalies detected.

Whilst this data provides confidence that there are no major structures within the footprint of the SMP area there has been two minor structures encountered during the first three longwall panels:

1) A north south trending dolerite dyke was intersected at 7 cut through in Maingate 2 development and again in the LW 2 installation road. The dyke in both places was less then 1m thick with approximately 0.50m of cindered coal on either side. Some clay alteration had occurred and strength testing determined a maximum compressive strength of 80Mpa. Long hole drilling was undertaken from Maingate 2 which confirmed the dyke's presence along the block. As the longwall production progressed, a zone of thicker (up to 4m), fresher and harder dyke was encountered. Underground blasting and excavation was required to enable the longwall to progress through this localised hard zone. Additional long hole drilling is currently underway to determine the thickness and strength of the dyke in the underlying Upper Liddell Seam.
2) A small north-south trending graben fault structure was intersected in the installation road of LW3, the initial displacement was downthrown 0.80 metres to the east followed by an upthrow of 1.80 metres to the east 20 metres away. Both surface and long hole drilling has determined this structure decreases in displacement to the north and will have relatively minimal impact on production.

During 2009 a focus on delineating small scale structures within the SMP area will be undertaken. This will include in-seam long hole drilling, further targeted surface drilling and the evaluation and implementation of geophysical techniques, as well as ongoing mapping of geological conditions in first workings development.

1.5.9 Stability of Underground Workings

The underground workings have proven to be typically highly stable during both development and extraction to-date, with very low levels of roof displacement recorded and very little rib or floor deformation. This reflects both the general competency of the strata and the low levels of in situ stress associated with the mining depths of less than 120m. Given the continuation of similar roof and floor lithology into future Pikes Gully Seam mining areas, significantly increased levels of roof and floor deformation are not anticipated, noting the maximum planned depth of cover of around 200m. A minor increase in the level of rib deterioration is anticipated at the increased depths, but this is expected to manifest itself largely as increased skin deterioration only (i.e. loosening of the first 0.5m of the rib), which can be readily addressed with appropriately matched levels of rib bolting. Minor levels of roof deformation have been associated with anomalies (primarily seam split zones), which have warranted increased levels of support.

2.0 Surface and Sub-surface Features

2.1 Overview

Table 5 – Checklist of Surface and Subsurface Features

Surface or subsurface feature	Present within the Application Area?	Description	Detailed in Section:
Natural Features			
Catchment areas and declared Special Areas	-		
Rivers and Creeks	Yes	Bowmans Creek	2.2.1
Aquifers, known groundwater resources	Yes	Bowmans Creek alluvial aquifer and Permian coal measures	2.2.4
Springs	-		
Sea / lake	-		
Shorelines	-		
Natural dams			
Cliffs / pagodas	-		
Steep slopes	-		
Escarpments	-		
Land prone to flooding or inundation	Yes		2.2.5
Swamps, wetlands, water related ecosystems	Yes	Bowmans Creek	
Threatened and protected species	Yes	Eight threatened fauna species recorded or likely to occur.	2.2.6
National Parks	-		
State recreation areas	-		
State forests	-		
Natural vegetation	Yes		2.2.7
Areas of significant geological interest	-		
Other	-		
Public Utilities			
Railways	-		
Roads	Yes	New England Highway, Brunkers Lane, private access roads	2.3.1
Bridges	Yes	New England Highway, Bridge over Bowmans Creek	2.3.1
Tunnels	-		
Culverts	-		
Water / gas / sewerage pipelines	-		
Liquid fuel pipelines	-		
Electricity transmission lines	Yes		2.3.2

Surface or subsurface feature	Present within the Application Area?	Description	Detailed in Section:
Telecommunication lines	Yes		2.3.3
Water tanks, water and sewage treatment works	-		
Dams, reservoirs and associated works	-		
Air strips	-		
Other	Yes	DWE Gauging Station	2.3.4
Public Amenities			
Hospitals	-		
Places of Worship	-		
Schools	-		
Shopping centres	-		
Community Centres	-		
Office buildings	-		
Swimming pools	-		
Bowling greens	-		
Ovals and cricket grounds	-		
Race courses	-		
Golf courses	-		
Tennis courts	-		
Other	-		
Farm land and facilities			
Agricultural utilisation or agricultural suitability of farm land	Yes	Grazing land, limited cropping. Class II IV and V land capability	2.4.1
Farm buildings / sheds	Yes		
Gas and / or fuel storages	-		
Poultry sheds	-		
Glass houses	-		
Hydroponics systems	-		
Irrigation systems	-		
Fences	Yes		2.4.3
Farm dams	Yes		2.4.4
Wells, bores	-		
Other	-		
Industrial, commercial and business establishments			
Factories	-		
Workshops	-		
Business or commercial establishments	-		
Gas and / or fuel storages and associated plants	-		

Surface or subsurface feature	Present within the Application Area?	Description	Detailed in Section:
Buildings, equipment and operations that are sensitive to surface movements	-		
Surface mining (open cut) voids and rehabilitated areas	Yes	Rehabilitated open cut (Ravensworth)	
Mine infrastructure including tailings dams and emplacement areas	Yes	Water and tailings pipelines, sediment dams	2.5
Other	Yes	Prescribed dam notification area - Narama Dam.	2.6
Areas of Archaeological and/or Heritage Significance	Yes	Archaeological deposits	2.7
Items of Architectural Significance	-		
Permanent Survey Control Marks	-		
Residential Establishments			
Houses	Yes	Rural residences	
Flats / units	-		
Caravan Parks	-		
Retirement / aged care villages	-		
Associated structures such as workshops, garages, on-site wastewater systems, water or gas tanks, swimming pools and tennis courts	Yes	Associated rural garages/sheds, water tanks, septic systems.	2.4.2
Other	-		

2.2 Natural Features

2.2.1 Bowmans Creek

Bowmans Creek travels through the Application Area and is a tributary of the Hunter River. Bowmans Creek catchment area is approximately 265 square kilometres (km^2) and the head of the catchment is located in the Mount Royal Range to the north. From its headwaters, the creek meanders in a mostly southerly direction until it reaches its junction with the Hunter River immediately south-west of the Application Area.

The reach of Bowmans Creek between the New England Highway and its junction with the Hunter River is approximately 6 kilometres (km) long. Approximately 5 km of this reach is located within the Application Area. The floodplain associated with Bowmans Creek ranges in width from approximately 700m near the New England Highway to 1300m near the Hunter River. Floodplain elevations range from approximately 67mAHD to 61mAHD at these locations respectively.

Stream Flows

A stream gauging station is located on Bowmans Creek (DWE Station “Foy Brook”, Station No. 210130). This station has been operating since 1993. Provisional stream gauging data for this station was obtained from the DWE website ‘NSW Water Information’ and plotted in **Figure 5**.

Review of the provisional data revealed some limitations for use in the estimation of hydrologic indices. These include:

- Relatively short timeframe over which data has been gathered;
- Only two significant flood events have been recorded in this period (August 1998 and June 2007) and recorded levels were likely to be strongly influenced by backwater flooding from the Hunter River (therefore overestimating discharge);
- Drought conditions - region was dominated by low rainfall conditions for a large percentage of the available data set; and
- Incomplete data set.

A flow duration curve (FDC) was prepared based on the provisional data, noting that the above limitations have implications for the accuracy and error margins of the analysis. The FDC is provided in **Figure 6**. Due to these limitations the estimates for low flow indices (95^{th} percentile, 90^{th} percentile etc) are likely to be substantially lower than if a longer, more representative data set was available.

Based on this curve and the data set, the following characteristics of stream flow for Bowmans Creek can be inferred:

- Median flow (Q_{50}) of approximately 2.5 ML/day;
- Low flow – 95^{th} Percentile (Q_{95}) of approximately 0.32 ML/day; and
- Longest recorded period of consecutive zero-flow days occurred in April-May 2007 (40 days).

The curve of the FDC below the median flow (Q_{50}) represents low flow conditions. The FDC in **Figure 6** below Q_{50} has a low slope and therefore suggests continuous discharge to the stream. The ratio of discharge which is equalled or exceeded 90% of the time (Q_{90}) and the median flow Q_{50} is commonly used to estimate the baseflow contribution. This ratio (Q_{90}/Q_{50}) for Bowmans Creek was estimated to be approximately 28%. However, this is likely to be a substantial overestimate due to the sustained drought conditions experienced during much of the stream gauging data period.

Due to the limitations discussed above, the above indicators are a worst case and not truly representative of long-term hydrological conditions for Bowmans Creek. However, the data supports the conclusions that Bowmans Creek is:

- A perennial stream which ceases to flow only on a relatively infrequent basis; and
- Has some baseflow contribution from groundwater sources but that this contribution may cease during drought conditions.

The conclusion that baseflow provides a constant but a relatively low contribution to surface flows in Bowmans Creek is further supported by the surface and ground water quality monitoring data (particularly salinity) discussed below and in (Aquaterra 2008a).

Water Quality

Ashton Coal has been monitoring surface water quality in Bowmans Creek since at least 2004. The location of monitoring sites is shown in **Figure 7**.

Water quality monitoring sites are located on Bettys and Bowmans Creek upstream of the New England Highway (SM1, SM2, SM3 and SM4A). Another three sites are located on Bowmans Creek between the highway and the confluence with the Hunter River (SM4, SM5 and SM6). SM9 and SM10 are on the Hunter River, upstream and downstream of the Bowmans Creek confluence.

Marine Pollution Research (2008:16) presents summary statistics for surface water quality at these monitoring locations for the period September 2004 to March 2008. This report is attached as **Appendix D**. The values presented by MPR (2008:16) are reproduced below in **Table 6** and compared with upper and lower trigger values developed for the monitoring program based on the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) for slightly, to moderately disturbed ecosystems.

Table 6 – Water Quality Summary Statistics

Site	SM1	SM2	SM3	SM4A	SM4	SM5	SM6	SM9	SM10
Alkalinity (mg/L CaCO3)									
Lower Trigger Level (20th percentile band)			360						
Upper Trigger Level (80th percentile band)			580						
N	3	3	38	12	42	42	42	42	42
Min	39	71	102	106	97	105	107	131	112
Max	283	303	383	344	1590	363	371	358	356
Mean	147	159	301	251	683	291	241	218	221
SE of Mean	72	72	10	22	64	8	10	8	9
Total Suspended Solids (TSS mg/L)									
Lower Trigger Level (20th percentile band)			-						
Upper Trigger Level (80th percentile band)			-						
N	3	3	38	12	42	42	42	42	42
Min	8	18	2	2	2	2	2	1	2
Max	504	98	160	103	278	31	36	204	160
Mean	175	48	23	24	49	11	15	26	26
SE of Mean	165	25	5	9	8	1	1	5	4
Acidity (pH)									
Lower Trigger Level (20th percentile band)			7.8						
Upper Trigger Level (80th percentile band)			8.0						
N	3	3	39	13	43	43	43	42	42
Min	7.2	6.6	6.9	7.5	7.4	6.9	6.9	7.8	7.9
Max	7.9	7.6	7.9	7.9	9.1	8.1	8.3	8.5	8.5
Mean	7.6	7.1	7.5	7.7	8.0	7.7	8.0	8.1	8.2
SE of Mean	0.20	0.29	0.04	0.04	0.06	0.03	0.04	0.02	0.02
Conductivity (µS/cm)									
Lower Trigger Level (20th percentile band)			2500						
Upper Trigger Level (80th percentile band)			3350						
N	3	4	39	12	43	43	42	42	42
Min	277	574	421	434	428	432	453	304	319
Max	1800	1950	1750	1980	14400	2040	1850	1270	1290
Mean	951	1032	1375	1263	4574	1486	1001	740	767
SE of Mean	448	313	46	139	590	48	53	32	33
Total Dissolved Solids (TDS mg/L)									
Lower Trigger Level (20th percentile band)			1380						
Upper Trigger Level (80th percentile band)			1950						
N	3	3	38	12	42	42	42	42	42
Min	578	586	294	300	286	296	308	236	255
Max	1190	1120	976	1130	8820	1160	1080	658	672
Mean	919	791	818	734	2833	870	539	385	401
SE of Mean	180	166	25	76	364	27	31	18	18

Based on conductivity and TDS values (mean) presented above, water within Bowmans Creek is suitable for livestock (ANZECC 2000: Table 4.3.1) and irrigation use of moderately sensitive crops (ANZECC 2000: Table 4.2.4) with the occasional exception of conductivity at SM4. Water quality across most sites (with the exception of SM4) is generally consistent with the objectives for the protection of aquatic ecosystems.

Channel Morphology and Stability

The channel of Bowmans Creek is generally incised below the surrounding alluvial flats, with the depth of channel incision generally increasing as the stream progresses downstream. The sinuosity characteristics of the creek are typical of a meandering stream and the channel location has been relatively stable over at least the past twenty years (ERM, 2006c). The pool-riffle sequence along this length of stream is formed by gravel shoals and in-channel point bars. The bed of the channel is typically lined by cobbles of varying size with occasional outcrops of bedrock. Bowmans Creek is generally perennial, however ceased to flow during the recent drought, retaining water in only the larger pools.

A pre-mining survey and geomorphology assessment was undertaken of Bowmans Creek in 2006 (ERM, 2006c) in accordance with the Development Consent. During 2007, heavy rains and flooding resulted in some changes to the creek banks and pool-riffle sequence. Therefore, ACOL engaged consultants to resurvey Bowmans Creek and prepare an updated pre-mining baseline assessment. A copy of the most recent assessment is attached as **Appendix E** and includes an updated monitoring methodology following changes to the mine plan.

Drainage Lines and Gullies

Ephemeral drainage lines and gullies within the Application Area are relatively small and minor. The majority of these small tributaries contribute directly to Bowmans Creek and catchment extent is limited to both the east and west.

2.2.2 Hunter River

The Hunter River lies outside the SMP Application Area to the south. The underground workings are located more than 260 metres from the Hunter River.

In this area, the Hunter River Channel is deeply incised within the floodplain and reflects various anthropogenic influences (i.e. clearing, grazing and irrigation) with respect to its general overall physical and water quality characteristics.

2.2.3 Aquatic Ecosystems

Aquatic ecosystem health of Bowmans Creek and Glennies Creek adjacent to the ACP has been subject to a baseline assessment and pre-mining monitoring since 2001. A qualitative assessment for the preparation of the EIS (MPR 2001) concluded that Bowmans Creek provides significant aquatic habitat. In accordance with the development consent, monitoring of Bowmans Creek is carried out biannually in spring and autumn and includes:

- Water quality sampling;
- Macroinvertebrate sampling;
- Fish sampling; and
- Riparian vegetation surveys.

Bowmans Creek shows various signs of anthropogenic disturbance including weed invasion, erosion, low dissolved oxygen, high salinity, low fish diversity and a macroinvertebrate community dominated by pollution tolerant species. The aquatic ecology monitoring of Bowmans Creek has adopted the Australian River Assessment System (AusRivAS) as developed by the Federal Government's National River Health Program in 1994. AusRivAS can be used to assess the biological health of rivers.

To-date, two separate sub-consultants have been employed to undertake the sampling and analysis (TEL – The Ecology Lab, MPR- Marine Pollution Research). It is noted that these consultants have used slightly different monitoring methodologies. The monitoring sites for each are shown in **Figure 8**. SIGNAL (Stream Invertebrate Grade Number Average Level) is a pollution tolerance index for stream macroinvertebrates and is a simple scoring system for quantifying the ecological health of streams. It is based on average sensitivity to disturbance of the aquatic macroinvertebrates present within a sample. Higher scores generally indicate healthier aquatic conditions as follows:

- SIGNAL Index > 6 = Healthy Unimpaired
- SIGNAL Index 5 – 6 = Mildly Impaired
- SIGNAL Index 4 – 5 = Moderately Impaired
- SIGNAL Index < 4 = Severely Impaired

Summary results of the macroinvertebrate surveys and SIGNAL scores are provided in **Table 7**.

Table 7 – Summary of Aquatic Sampling Results, Bowmans Creek 2001 to 2008

Sampling Period	Total No.Taxa	SIGNAL Index Range	Native Fish Species	Introduced/Pest Fish Species
Sprint 2001 (MPR)[1, 5]	8	3.00 - 4.80	-	Plague Minnow Carp
Spring 2005 (TEL)[2]	44	3.00 - 4.22	Flathead Gudgeon (4) Longfinned Eel (22)	Plague Minnow (1000's) Carp (3)
Autumn 2006 (TEL)[3]	38	3.22 - 4.47	Australian Smelt (77) Flathead Gudgeon (4) Empire Gudgeon (1) Striped Gudgeon (9) Bully Mullet (4) Australian Bass (2) Freshwater Catfish (4)	Plague Minnow (135) Carp (11)
Autumn 2007 (MPR)[4]	25	3.00 - 4.00	Cox's Gudgeon (1) Gudgeon sp. (1)	Plague Minnow (2)
Autumn 2008 (MPR)[5]	32	4.97 - 5.19	Short-finned Eel Long-finned Eel Darling Hardyhead Striped Gudgeon Cox's Gudgeon Empire Gudgeon Flathead Gudgeon Dwarf Flathead Gudgeon Sea Mullet Australian Bass Freshwater Catfish Australian Smelt	Plague Minnow Carp

References: 1 – MPR 2001; 2 – TEL 2006a; 3 – TEL 2006b; 4 – MPR 2007; and 5 – MPR 2008

As shown in **Table 7**, pre-mining monitoring of Bowmans Creek indicates that it currently ranges from a severely to moderately impaired ecosystem depending on the prevailing season and flow regime (Autumn 2007 was conducted in late June due to flood conditions). The SIGNAL Index scores for Bowmans Creek are within a similar range (if not slightly lower) as concurrent monitoring at Glennies

Creek and Rouchel Brook. These scores ranged from 3.47 to 4.71 also indicating that nearby aquatic systems are in a similar state of health.

2.2.4 Groundwater Resources

Within the Application Area groundwater is present within the coal seams and unconsolidated aquifers within the alluvium associated with Bowmans Creek and the Hunter River. Investigations to identify the physical and chemical properties of these groundwater aquifers was initially undertaken for the preparation of the EIS (HLA, 2001) with ongoing investigations and monitoring continuing in accordance with the requirements of the development consent by Peter Dundon & Associates Pty Ltd (now Aquaterra).

A detailed Investigation to identify the extent of saturated and unsaturated alluvium has been undertaken by Aquaterra (2008a) (**Appendix F**). This investigation included a combination of aerial photography, aeromagnetic survey, ground mapping, exploration drilling, and groundwater level monitoring. The exploration program included drilling of 42 bores into the alluvium (and flanking colluvium), of which 21 were constructed as piezometers. The results of this investigation by Aquaterra (2008a) are summarised below.

Alluvium Extent

Bowmans Creek alluvium is characterised by fine silts, sometimes containing large cobbles, and silty sands. It is noted that the alluvium merges with colluvium along the flanks of the floodplain and has an abrupt boundary with the Hunter River alluvium at the southern end of the valley.

The thickness of the Bowmans creek alluvium is limited and in some locations Bowmans Creek has incised through the alluvium to bedrock. Bowmans Creek alluvial deposits include poorly sorted gravels whilst Hunter River alluvial deposits are much thicker and consist of well-sorted quartz sands. The Hunter River alluvium is confined to a narrow strip, approximately 100m wide, along the river bank, with no evidence of an embayment of Hunter River alluvium into the valley of Bowmans Creek.

Groundwater is present in the alluvium and is in varying degrees of hydraulic connection with the Permian coal measures. The thickness of the saturated alluvium is generally in the range of 4 to 4.5 metres, however extensive areas of the alluvium are dry to full depth where the upper surface of the underlying coal measures rises above the water table level.

The lateral extent of the Bowmans Creek alluvium and its properties is shown in **Figure 9**.

Groundwater Quality

Typically the Bowmans Creek alluvium groundwater is moderately saline with Electrical Conductivity (EC) ranging between 1190 to 6420 μS/cm, whilst salinity in the Permian coal measures generally ranges between 6000 to 11000 μS/cm. However the upper portions of the Permian at some locations are much less saline because the near surface weathered zone tends to be more readily recharged by rainfall infiltration. In some of these locations, salinity in the Permian coal measures is actually less than the salinity of the Bowmans Creek alluvium. Groundwater salinity is believed to reflect the proximity of the monitoring site to rainfall recharge areas. Based on the variation in salinity across the site and between the aquifers, Aquaterra (2008a) concluded that the pattern of recharge across the site is not uniform and that in some areas the Permian is more readily recharged than the alluvium. This conclusion is supported by the results of major ion chemistry analysis of the ground water quality samples.

Other water quality analysis found that the water quality at some of the monitoring locations exceeded ANZECC (2000) guidelines for the protection of freshwater ecosystems.

Groundwater Levels

Water levels across the ACP are recorded monthly and groundwater contours prepared by Aquaterra (2008a) show that groundwater flow within the alluvium is generally toward Bowmans Creek and also from north to south (ie in the same direction as surface water flows). Water table levels in the alluvium are generally slightly higher than the levels in the immediately underlying coal measures. Overall however, under pre-mining conditions, groundwater levels in the Permian are generally higher than that of the alluvium.

Hydraulic Properties

Hydraulic conductivities were determined using constant rate pumping tests, and falling head slug tests. Summary results of this hydraulic testing program are presented in **Table 8**.

Table 8 – Summary of Hydraulic Conductivity Values

Aquifer	No. Valid Tests	Hydraulic Conductivity (m/day)		Confined Storativity	Unconfined Specific Yield
		Tested Range	Median		
Bowmans Creek Alluvium	14	0.0002 to 15	0.7	0.0001	0.05
Hunter River Alluvium	1	50	50	0.0001	0.05
Colluvium	4	0.0006 to 13	0.02		
Weathered Permian Coal Measures	9	0.01 to 3.3	0.1		
Coal Seams		0.01 to 10	0.04	0.0001	0.005
Interburden/overburden		<0.0000001 to 0.008	0.0003	0.00001	0.005

Source: Aquaterra (2008a:20 and 2008b)

Hydraulic conductivity in Bowmans Creek alluvium was found to be highly variable and is a result of the variation in alluvial material. Higher conductivity values reflect the presence of localised lenses of clean coarse gravels, while the lower values are typical of the clay-silt matrix which encloses gravels over most of the floodplain area.

The hydraulic properties of Bowmans Creek and Hunter River alluvium further support the conclusion that they are distinctly different in character. Whilst only a single valid test result is presented above (50m/day) this value is consistent with the results of extensive testing (45m/day) reported by HLA (2001).

The permeability of the near-surface was found to be more consistent with a median hydraulic conductivity significantly lower than the alluvial deposits.

The Permian coal measures are described by Aquaterra (2008b) as a fractured rock aquifer with flow occurring predominantly in the coal seams. This strata has little primary or intergranular permeability but joints and fissures result in secondary or fracture permeability. The coal seams tend to have a relatively higher hydraulic conductivity (one to two orders of magnitude than the interburden/overburden). Furthermore, vertical conductivity in the coal seam is much lower than the horizontal conductivity.

Groundwater Flows

Groundwater levels suggest that the groundwater flow pattern is dominated by recharge via rainfall infiltration into outcrop/subcrop areas. Flow then travels down-dip towards discharge points in low-lying areas. Where coal seams subcrop beneath the alluvium, there is natural potential for exchange of groundwater between the alluvium and the Permian coal measures.

Groundwater discharge from the Permian measures occurs through evapotranspiration, baseflow contributions to the creeks, rivers and the alluvium, and through abstraction. Baseflow contribution has been determined as small and intermittent (Aquaterra 2008b).

There is no existing groundwater abstraction in the study area apart from mine dewatering. Ashton is currently extracting approximately 7L/s of mine inflows which includes an average 3.5L/s of external water pumped into the mine for the purpose of operating the mine.

Alluvial groundwater is sparingly used for stock and domestic purposes in the local area, however no registered bores are located on the ACP. The nearest bores are located in Camberwell village and on the south bank of the Hunter River.

Bowmans Creek alluvial groundwater discharges via evapotranspiration, baseflow discharge, and to the Hunter River.

Baseflow to Bowmans Creek

Groundwater salinity ranges in the alluvium overlaps the salinity range typically seen in Bowmans Creek surface flows. The highest alluvium salinity values are much higher than typical streamflow salinity values.

Salinity values (refer to **Table 6**) for Bowmans Creek surface flows suggest that there is minimal baseflow contribution along Bowmans Creek between SM3 and SM5 from the Permian coal measures. The major exception to this occurs at the rock pool near the Bowmans Creek Bridge (surface water monitoring location SM4). The pattern of EC values at this location are strongly influenced by climatic conditions. EC at this point increased markedly during periods of very low flow and reflect the influence of groundwater baseflow discharge from the Permian at this point.

Based on flow data and recorded salinity ranges, Aquaterra (2008a) conclude that there is minimal baseflow contribution from either the alluvium or the Permian between SM3 and SM5.

Aquifer Interactions

There is only limited hydraulic interconnection between the Bowmans Creek alluvium and the underlying weathered coal measures based on clear differences in water quality and groundwater levels. The near-surface weathered coal measures have similar heads and water quality to the overlying alluvium in some locations, but elsewhere show distinct differences. These variations reflect the variation in rainfall recharge across the site.

Groundwater in deeper zones within the Permian is quite separate and hydraulically unconnected with the alluvium. These aquifers display higher salinity and groundwater heads (except where they have been lowered by current mining activities). There is no evidence that drawdown of these deeper aquifers by Ashton's mine dewatering in the Pikes Gully Seam has had any impact on levels in the Bowmans Creek alluvium. Aquaterra (2008a) have therefore concluded that there is no direct hydraulic connection between these systems.

2.2.5 Flood Prone Land

The proposed panels and associated first workings lie beneath the floodplain of Bowmans Creek (refer to **Figure 10**). Based on flood modelling by Patterson Britton (2001) overbank flood flows occur in even relatively small, frequent flood events. Mapping of the 1 in 5, 20 and 100 year Average Recurrence Interval (ARI) floods indicate that large areas of the floodplain is inundated in the 1 in 5 year floods. The majority of the floodplain is affected by the 1 in 20 year ARI flood within only a minor increase in extent associated within the 1 in 100 year ARI flood despite the increase in depth (due to topographical constraints).

Patterson Britton (2001) reported that during 1955, flood levels within the Hunter River are estimated to have reached approximately 64.2m AHD in the vicinity of the Application Area. This flood is generally considered to be equivalent to a 1 in 100 year ARI design flood. During this event, backwater flooding and catchment flows are predicted to have resulted in a flood level of 67.8m AHD at the New England Highway Bridge over Bowmans Creek.

2.2.6 Threatened and Protected Species

A flora and fauna assessment of the Application Area was conducted by ERM (2008) and is included in **Appendix H**. This report includes a description of existing site flora and fauna, known and potential threatened and protected species and potential impacts as a result of the proposed mining activities in LW/MW 5-9. Information from the ERM (2008) report is summarised below.

Threatened Flora

No threatened fauna species have been previously recorded within the Application Area during the various ecological surveys of the ACP.

Searches by ERM (2008) identified one threatened flora species, *Digitaria porrecta* (Finger Panic Grass) within 10km of the Application Area. Habitat for three threatened flora species has been recorded in the DEWHA database within 10km of the Application area. These include *Diuris tricolor* (Pine Donkey Orchid), *Eucalyptus glaucina* (Slaty Red Gum) and *Thesium australe* (Austral Toadflax).

Threatened Fauna

There are three threatened bird and four threatened bat species that are known to occur within the SMP Application Area or areas immediately adjacent. Threatened fauna previously recorded within the site or immediate surrounds include:

- Speckled Warbler (*Pyrrholaemus sagittatus*);
- Grey-crowned Babbler (*Pomatostomus temporalis*);
- Hooded Robin (*Melanodryas cucullata cucullata*);
- Grey-headed Flying Fox (*Pteropus poliocephalus*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Eastern Bent-wing Bat (*Miniopterus schreibersii oceansis*); and
- Large-footed Myotis (*Myotis adversus*).

Endangered Populations and Ecological Communities

As discussed further in **Section 2.2.7**, a small area of River Red Gum Open Woodland occurs on Bowmans Creek outside the Application Area. The River Red Gum population within the Hunter Valley is listed as an endangered population under the NSW *Threatened Species Conservation Act 1994*. The NSW Scientific Committee has also made a preliminary determination to list the 'Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Bioregions' as an Endangered Ecological Community.

The Hunter Valley is the only coastal catchment in which River Red Gum occurs in NSW and its distribution has been significantly reduced by changing land use and hydrological impacts to its habitat. There are currently only 19 known stands occupying approximately 100ha within the Hunter Valley, most of which is within private land and therefore not formally conserved (DECC, 2005).

The regeneration / reproduction of the species in the Hunter Valley are threatened or limited by weed incursion, changing environmental flows and changed fire regime and grazing/cropping. Dieback has been associated with various causes including altered hydrologic regime (changes to the incidence and depth of flooding) or increasingly saline soils (due to the mobilisation of saline groundwater).

In addition to listed threatened vegetation communities, the Hunter Remnant Vegetation Project has described the Hunter Valley River Oak Forest as regionally significant as they predict that up to 98.9% of this community has been cleared and it is poorly represented in conservation areas.

2.2.7 Natural Vegetation

The Application Area has been previously cleared for agricultural uses, including grazing and some improved pasture. Large areas of the site are therefore currently open grasslands and natural vegetation within the Application Area is limited to a narrow riparian corridor along the banks of Bowmans Creek. This vegetation corridor is not continuous and in some parts consists only of a single row of trees/shrubs on the creek bank with grasses/sedges within the creek channel. This corridor consists of up to three vegetation communities, being:

- Hunter Valley River Oak (*Casuarina cunninghamia)* Forest;
- River Red Gum (*Eucalyptus camaldulensis*) Woodland; and
- Grassland.

Scattered trees recorded within the pasture areas include *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus melliodora* (Yellow Box)*, and Eucalyptus mollucana* (Grey Box). Some exotic weed species occur and these are identified and managed under the ACOL Weed Management Plan.

Improved pasture occurs on the alluvial floodplain areas and various exotic herbaceous species typically used for pasture improvement are present, such as Rye Grass, Rhodes Grass, Paspalum, Lucerne, White Clover and Kikuyu.

River Oak Forest

Riparian vegetation is dominated by an over storey of River Oak (*Casuarina cunninghamia*) with a sparse to absent midstorey and moderate groundcover. Isolated occurrences of Pepper Tree (*Schinus areira*), Rough-barked Apple (*Angophora floribunda*), White Poplar (*Populus alba*) and Weeping Willow (*Salix babylonica*) have been recorded through this community.

ERM (2008) noted the following species in the shrub and groundcover layers:

- Shrub layer:
  - scattered thickets of African Boxthorn (*Lycium ferrosum*); and
  - occasional stand of Bamboo (*Arundo donax*).
- Groundcover:
  - Purpletop (*Verbena bonariensis*);
  - Common couch (*Cynodon dactylon*);
  - Narrow-leaved Cotton Bush (*Gomphocarpus fructicosus*); and
  - Cobblers Pegs (*Bidens pilosa*).

In lower lying areas, sedges and rushes dominated the groundcover (including *Juncus usitatus, Schoenus apogon,* and *Typha orientalis).*

River Red Gum Woodland

This community lies outside the Application Area and Mining Lease boundary to the west of LW9 on the banks of Bowmans Creek as shown on **Figure 11**. This area is downstream of the proposed longwall mining extent of LW9.

The canopy of this community is dominated by River Red Gum (*Eucalyptus camaldulensis*) with isolated occurrences of Narrow-leaved Ironbark (*E.crebra*) and Grey Box (*E.moluccana*) occurring into adjacent paddocks. Weeping Willow has been noted where this community transitions with the River Oak Woodland. River Red Gum forests provide habitat for fish and waterbirds. They possess deep sinker roots that grow down towards zones of higher water supply (CSIRO 2004).

The CSIRO (2004) notes that *E.camaldulensis* prefers deep moist subsoils and commonly grows on riverine sites and is most extensive on heavy clay soils along river banks and floodplains subject to frequent or periodic flooding. *E.camaldulensis* has a moderate salinity tolerance and obtains its water from three main sources: groundwater, rainfall, and river flooding and its high water use contribute to maintaining water tables at depth.

2.3 Public Utilities

2.3.1 Roads

Both public and private roads occur within the Application Area including the New England Highway. As shown in **Figure 12**, first workings are aligned sub-parallel to the New England Highway.

New England Highway
The New England Highway is located over the proposed development headings and after crossing Bowmans Creek lies on a fill embankment. Within the Application Area it includes a single northbound travel lane, two southbound lanes and the bridge over Bowmans Creek.

Private Access Roads
Two private access roads intersect with the Highway and provide access to the properties listed in **Table 9**.

Table 9 – Properties with Private Access Roads within the Application Area

Property Reference	Land Use / Description	Ownership
Lot 2, DP1089848 (Property No 155)	Mining	Macquarie Generation
Lot 3, DP 1114623	Agriculture, mining	ACOL
Lot 70, 1107703 (Property No. 130)	Dairy, agriculture	Private – referred to as "Property No. 130" in the EIS and Development Consent

The gravel access roads to Ashton's property and Property No. 130 is currently affected by subsidence related to extraction of longwall panels 1 to 4 and only the secondary access road will be partially impacted by LW5. This road is used by residents, owners, Ashton personnel, dairy milk truck and other authorised visitors.

The private access roads on Property No. 155 includes the sealed road Brunkers Lane and an unsealed "Site Access Road". These roads will be impacted during extraction of panels 6, 7, 8 and 9.

The Site Access Road is currently used predominantly by Ashton to access the void for tailings emplacement. Ashton has a general maintenance responsibility for this road. Future use of this road may include heavy construction traffic during the construction phase of the Void 4 dam.

Based on advice by a Registered Surveyor, Brunkers Lane no longer has a legal status as a Public Road or Right of Way to any other properties. Macquarie Generation maintains the road as a sealed private roadway and recently upgraded the road and highway intersection. Whilst not a critical access road, it is used for occasional access when other routes are limited due to mining activities. Ravensworth Operations also make use of this road as a rear access to their site.

2.3.2 Electricity Transmission Lines

The Application Area includes a number of overhead electricity transmission lines (refer to **Figure 13**). These include:

- A 132kV transmission line supported on a combination of dual and triple timber poles – travels east-west across the southern half of the Application Area;
- A 132kV and a 66/11kV (combined) transmission lines on single concrete poles, travelling parallel to the New England Highway road reserve, over the main headings;
- A 11kV transmission line on single timber poles travels from the New England Highway, south west across the Application Area with off takes to residential dwellings and Hunter River pump (supplies ACOL); and
- A privately-owned 33kV transmission line on single pole structure is located over the northern end of LW9. This asset is located on land owned by Macquarie Generation (Property No 155), and is owned by Ravensworth Operations Pty Ltd.

With the exception of the private Ravensworth line, these assets are owned and managed by Energy Australia.

2.3.3 Telecommunications Lines

Previous survey, a Dial Before You Dig search and consultation with Telstra and Powertel indicate that there are the following types of telecommunications lines within the Application Area:

- Powertel (AAPT) Sydney to Brisbane fibre optic cable parallel and immediately to the south of the New England Highway road reserve;
- Telstra cables to private residences within ACOL property, Property No. 130 and through Property No. 155.

The location of these cables relative to the Application Area are shown in **Figure 13** and were located using the services of a communications consultant/engineer. It is noted that the line through Property No. 155 previously serviced the DWE gauging station and provides future connection for subdivided blocks that form part of the southern eastern extent of the Ravensworth lease.

The fibre optic cable approaches within 100m of the northern end of MW6 and the overburden depth at this location is approximately 120m.

2.3.4 DWE Stream Gauging Station

A flow gauging station, “Foy Brook”, Station No. 210130 is located on Bowmans Creek above the centre of MW9. This station is owned and maintained by the DWE and was originally installed in approximately 1993 as part of the Hunter River Salinity Trading Scheme.

The station consists of a small concrete v-notch weir in the stream channel, with instrumentation and housing located on the western creek bank. Data transmission is via radio link with repeater station located elsewhere.

2.4 Farm Land and Facilities

2.4.1 Land Capability and Agricultural Suitability

Both the pre-mining land capability and agricultural suitability was considered in the EIS (HLA, 2001). Rural Land Capability and Agricultural Suitability are two differing land classifications systems developed by the Soil Conservation Service of NSW and Department of Agriculture respectively. Whilst similar in intent, the two systems are not comparable as the aims and approaches of the two different classification systems are (Cunningham *et al*, 1988):

- Land Capability – delineates the various classes of rural land on the basis of the physical ability of the land to remain stable under particular rural land uses; and
- Agricultural suitability uses land capability as a basis and then incorporates other factors such as infrastructure, geographic location and market factors to determine the lands productive potential.

Land capability has been used for the purpose of the subsidence impact assessment and management. The particular capability class into which land is placed depends of the physical characteristics of the site, the soils and specific limitations to their use, land management constraints and the local climate. The capability of land can be affected if not protected from various forms of soil degradation such as erosion and loss of topsoil, water logging, and so on.

As shown in **Figure 14** Land Capability across the Application Area ranges from Class II to Class V. Class II land generally follows the alluvial soils along the floodplain of Bowmans Creek with Class IV and V land located on the surrounding slopes. The land classes are defined as follows:

Class II – Land capable of being regularly cultivated. Usually gently sloping land suitable for a wide range of uses. Has a high potential for production of crops on fertile soils similar to Class I but due to limitations, soil conservation practices such as strip cropping, conservation tillage and adequate crop rotations required.

Class IV – Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation. Limitations usually include slope gradient, soil erosion, shallowness or rockiness, climate or a combination of these factors. Soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for establishment or re-establishment of permanent pasture.

Class V - Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation. Considerable limitations include slope gradient, soil erosion, shallowness or rockiness, climate or a combination of these factors. Structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for establishment or re-establishment of permanent pasture.

2.4.2 Farm buildings

There are approximately nine buildings within the Application Area (refer to **Figure 15**). Of these structures, there are two rural residences located on Ashton-owned land. These dwellings are currently leased to tenants. Associated with each of these dwellings are various lightweight sheds (garages, storage sheds and farm machinery sheds). There are an additional two farm sheds (ACOL owned) located within the southern end of LW 5 and LW6 and a small dilapidated shed on land owned by Macquarie Generation near the northern extent of MW6.

2.4.3 Fences

Given the site's predominant use for agriculture, a number of fences traverse the site. These fences act both as boundary fences and to divide individual landholdings into paddocks for the management of grazing stock. Location of fences within the area is shown in **Figure 16**.

Fences throughout the Application Area are predominantly constructed of wooden or iron posts with multiple wire strands. Farm gates provide access between paddocks at various locations.

2.4.4 Farm Dams

There are four farm dams within Ashton's property that lie within the Application Area. Dams within the Application Area are excavated dams fed predominantly by overland flow and used for stock watering. They are all of earth-wall construction using locally sourced material.

2.5 Mine Infrastructure

2.5.1 Pipelines

Ashton owns and manages the following water pipelines that occur within the Application Area:

- Hunter River pipeline (200mm PE80 PN8 pipeline) transports licenced water flows from south to north across the mining lease from a pump on the river bank to the Ashton coal surface storage dam;
- Underground borehole pump pipeline (200mm PE100 PN8 Pipeline) transports mine water return, from south to north across the lease from a submersible pump in an underground storage sump to the Ashton coal surface storage dam.

The location of the above pipelines is shown in **Figure 18**. Pressure-loss activated cut off valve meters are installed on both ends of these lines to ensure water losses can be detected.

The following pipelines occur within the northern area of lease:

- One clean water line (90OD PN12.5 PE100 pipeline)
- One mine water line (250OD PN20 HDPE PE100 pipeline)
- Two tailings lines (280OD PN20 HDPE PE100 pipelines)
- One decant return (250OD PN20 HDPE PE100 pipeline)

In addition to the above, a PN10 PE100 315mm diameter pipeline owned by Ravensworth Operations Pty Ltd connects the Narama Dam to Mount Owen mine. This pipeline crosses the northern end of MW 7, MW8 and LW9. This pipeline is buried for most of its length, but is exposed where it passes through a culvert beneath Brunkers Lane.

The group of pipes associated with Ashton's tailings transfer and water return from Void 4 lie in an open trench across Property No. 155. These lie predominantly within an open trench, but pass beneath Brunkers Land and travel under the New England Highway at the Bowmans Creek Bridge.

2.5.2 Sedimentation Basins

Within the spoil dump area on Property No 155, a number of sedimentation dams exist (refer to **Figure 17**). Whilst built on spoil, these structures are clay lined and have the ability to hold water (MacGen. *pers.comm).*

South of the sedimentation basins, contour banks on the spoil dump slopes exist to control erosion and aid rehabilitation.

2.6 Prescribed Dam

The Ravensworth Mine Water Storage Dam (or Narama Dam) is located to the west of the ML1533 western boundary and therefore outside the SMP Application Area. The toe of the dam lies 270m from the nearest goaf edge of MW9. However, this 1ML storage is a Prescribed Dam under the *Dam Safety Act 1978* and the Dam Safety Committee has also declared a notification area around the storage under the *Mining Act 1992* (Narama Notification Area).

The proposed workings occur partially within the Narama Notification Area as shown in **Figure 17**.

Narama Dam provides water for Mt Owen Mine and other Xstrata mining operations. A concrete structure downstream of the dam on the original watercourse and associated steel pipes are located approximately 400m from the nearest goaf edge of LW9.

An ash disposal dam is planned by Macquarie Generation west of the north-western corner of the Application Area. This dam is also likely to be prescribed under the *Dam Safety Act 1978* and the associated notification area will also overlap the proposed underground workings.

2.7 Areas of Archaeological or Heritage Significance

The Application Area lies within the central part of Wonnarua tribal country. Over one hundred archaeological sites have been identified within the ACP, of which nine occur within the SMP Application Area for LW-MW 5 to 9 (refer to **Figure 19**).

A review of the site archaeology and management requirements was conducted for the SMP by Insite Heritage Pty Ltd (2008). A copy of this assessment is provided as **Appendix I.**

Table 10 lists the sites that were identified by Witter (2002) and which are located above the LW-MW 5 to 9. The majority of the sites are isolated finds (5 sites), with three sites containing three or less artefacts. Ten artefacts were located at an open camp site (EWA 82) which was designated of moderate significance. There may be further artefact deposits on the creek terraces particularly where these are intersected by creek tributaries.

Table 10 – Archaeological Sites

Site Name	Site Type	Site Dimensions	Landform	Visibility
EWA 82	Open Camp site	20x2m	Terrace	20%
EWA 81	Isolated find	50x2m	Terrace	10%
EWA 80	Isolated find	50x2m	Flat spur	20%
EWA 89	Isolated find	50x5m	Terrace	20%
EWA 50	2 artefacts	1x 2m	Trib flat	50%
EWA 51	Isolated find	2x1m	Trib flat	50%
EWA 52	Isolated find	1x2m	Trib flat	80%
EWA 57	2 artefacts	5x50m	Trib bottom	20%
EWA 97	3 artefacts	20x20m	Terrace edge	20%

The isolated finds and small artefact scatters are considered to be of low archaeological significance as they are consistent with the isolated finds found throughout the region. EWA82 is considered to have moderate significance and may be an indicator of further artefact deposits on the creek terraces.

2.8 Residential Establishments

ACOL currently leases two rural residences within its landholdings to tenants. There are no other existing or future plans for residential buildings within the Application Area.

2.9 Areas of Environmental Sensitivity

The SMP Guidelines (Department of Mineral Resources, 2003) outlines the definition of "areas of environmental sensitivity" for the purposes of the SMP Approval Process. These definitions and their relevance to the current application are listed in **Table 11**.

Table 11 – Areas of Environmental Sensitivity

Definition	Comment
Land reserved as a State conservation area under the *National Parks and Wildlife Act 1974*	No
Land declared as an Aboriginal place under the *National Parks and Wildlife Act 1974*	No
Land identified as wilderness by the Director, National Parks and Wildlife under the *Wilderness Act 1987*	No
Land subject to a 'conservation agreement' under the *National Parks and Wildlife Act 1974*	No
Land acquired by the Minister for the Environment under Part 11 of the *National Parks and Wildlife Act 1974*	No
Land within State forests mapped as Forestry Management Zone 1, 2 or 3	No
Wetlands mapped under SEPP 14 - Coastal Wetlands	No
Wetlands listed under the Ramsar Wetlands Convention	No
Lands mapped under SEPP 26 - Coastal Rainforests	No
Areas listed on the Register of National Estate	No
Areas listed under the *Heritage Act 1977* for which a plan of management has been prepared	No
Land declared as critical habitat under the *Threatened Species Conservation Act 1995*	No critical habitat present.
Land within a restricted area prescribed by a controlling water authority	No
Land reserved or dedicated under the *Crown Lands Act 1989* for the preservation of flora, fauna, geological formations or other environmental protection purpose;	No
Significant surface watercourses and groundwater resources identified through consultation with relevant government agencies	Bowmans Creek and alluvial aquifer – refer to Sections 2.2.1 and 2.2.4.
Lake foreshores and flood prone areas	Flood prone areas associated with Bowmans Creek – **Section 2.2.5**
Cliffs, escarpments and other significant natural features	No
Areas containing significant ecological values	Value of site ecology discussed in **Section 2.2.3** to **2.2.7**
Major surface infrastructure	Electricity transmission lines – **Section 2.3.2**, Prescribed Dam – **Section 2.6**
Surface features of community significance (including cultural, heritage or archaeological significance)	Archaeological sites as described in **Section 2.7** of low to moderate archaeological significance
Any other land identified by the Department to the titleholder	No

3.0 Subsidence Assessment

3.1 Overview

The proposed layout of LW/MW 5 to 9 is based on extensive investigation into the overburden and groundwater properties of the site. The main objective of these investigations and resulting mine design was to ensure compliance with Condition 3.9 of the Development Consent:

> *3.9The Applicant shall design underground mining operations to ensure no direct hydraulic connection between the Bowmans Creek alluvium and the underground workings can occur through subsidence cracking. In order to achieve this criteria the Applicant shall assess levels of uncertainty in all subsidence predictions, and provide adequate contingency in underground mine design to ensure sufficient sound rock is maintained to provide an aquaclude between the Bowmans Creek alluvium, and the underground mine goaf.*

SCT Operations Pty Ltd (SCT) were engaged by Ashton Coal during the mine plan design phase to assess the potential for hydraulic connection with Bowmans Creek alluvium and to prepare subsidence predictions based on the adopted layout.

This assessment was carried out in conjunction with investigations and modelling by Aquaterra. Based on the predicted caving and fracturing behaviour predicted by SCT (2008a), Aquaterra were able to model changes in groundwater conductivity and subsequent impacts to the alluvial aquifer associated with Bowmans Creek. Various iterations of the mine design were investigated until a conservative width/depth ratio of 0.6 was adopted as it provided a mechanism by which the mine could proceed in compliance with the requirements of Condition 3.9 above. This constraint was then applied to the shallowest most outbye section of each longwall

This chapter outlines the results of the assessment of caving and fracturing as a result of coal extraction within LW/MW 5 – 9, the observations of subsidence versus predictions available to date for the ACP, and subsidence predictions for the proposed LW/MW 5 – 9 mine design.

3.2 Assessment of Caving and Hydraulic Connection

This section provides a summary of the report by SCT (2008a) *Assessment of Longwall Panel Widths and Potential Hydraulic Connection to Bowmans Creek – Ashton Mine*. This report is reproduced in full in **Appendix B.**

One of the key considerations taken into account in the design of the mine plan was the potential of a mining-induced hydraulic connection from the underground mine to the surface and saturated alluvium of Bowmans Creek. Creation of a hydraulic connection may result in any of the following:

- Water ingress into the mine causing operational or safety issues;
- Potential contamination of the water flowing into Bowmans Creek and the Hunter River after mine decommissioning and flooding of the mine; and
- Flow of highly saline water from the Permian coal measures into the lower salinity alluvial groundwater.

A study of the inflow potential for mining under the Bowmans Creek area was conducted by SCT (2008a). The study involved a review of empirical data of inflow experience, computer modelling of caving and water flow potential for the Ashton site and field site investigations of conductivity and connectivity of the fracture systems in the over burden of the existing Longwall 1.

The potential for hydraulic connection from the mine to surface aquifers was found to be related to the magnitude of subsidence, overburden, panel geometry and geological nature of the overburden. The height of cracking above extraction panels typically extend 1-1.5 times the panel width, however these cracks may not be interconnected and allow any significant fluid migration. It was found that the extent of cracking and interconnection potential above the extraction panels increases with increasing subsidence.

The computer modelling undertaken was used to assess the extent of fracture and potential for inter-connection of the mine to the surface for various panel widths at depths ranging from 100m to 150m. The results were consistent with overburden behaviour from the empirical data available on subsidence measurements and experience of water flows into mines. The results indicate that panel width can provide a method of control on subsidence, overburden fracture and induced conductivity. It was found that narrow panels are likely to maintain a reliable zone of substantially intact strata above the induced cracking zone to provide a natural control on water flow.

It was concluded that the impact on the Bowmans Creek aquifer system can be controlled by limiting the panel width to dimensions that do not induce significant subsidence. Modelling of a width to depth ratio of up to 0.7 at the site indicated that an unimpacted zone was maintained between the longwall goaf and base of the alluvial aquifer with hydraulic conductivity values similar to the in-situ state. Also, subsidence for such panels is expected to be less than 10% of extraction thickness. For a normal rock section (without aquacludes) longwall panels with a width to depth ratio above 1 have a higher probability of cracking extending to the surface and may allow some water migration through a network of fractures and bedding planes having enhanced conductivity of the overburden.

3.3 Subsidence Monitoring

3.3.1 Ground Monitoring

Monitoring of subsidence within the currently approved longwalls (LW1-4) is being conducted in accordance with the development consent and SMP (LW1-4) conditions. Subsidence monitoring for LW1 was analysed by SCT and detailed in the most recent Annual Environmental Monitoring Report (AEMR) (ACOL, 2008).

Subsidence associated with LW1 has been monitored using:

- Two longitudinal subsidence lines over the start and finish of the panel;
- Seven cross lines along the Tailgate side of the panel extending downslope to Glennies Creek; and
- One diagonal line extending from the northeast corner of LW1 to the New England Highway.

The locations of the above monitoring lines are shown in **Figure 20.**

Comparison of the maximum predicted and observed subsidence parameters is provided in **Table 12**. The review by SCT (February 2008) indicates that subsidence behaviour above LW1 was consistent with supercritical subsidence behaviour. Subsidence movements were predominantly less than the maximum predicted values with the exception of tensile strains at the start of LW1 (49mm observed, 42mm predicted).

Table 12 – LW1 Maximum Predicted vs. Maximum Observed Subsidence Parameters

	Maximum Predicted	Maximum Observed	
North End of LW1		CL2	XL8
Subsidence (mm)	1800	1528	1500
Tilt (mm/m)	244	100	103
Horizontal Movement (mm)	500+	476	500
Tensile Strain (mm/m)	73	40	15
Compressive Strain (mm/m)	98	28	27
Remainder of LW1		CL1	XL5
Subsidence (mm)	1700	1318	1377
Tilt (mm/m)	141	60	75
Horizontal Movement (mm)	300 - 500	480	384
Tensile Strain (mm/m)	42	49	24
Compressive Strain (mm/m)	56	23	16

Source: SCT, February 2008b

Measured vertical subsidence was within the range predicted by SCT (2006) for LW1-4. High levels of predicted tilt and strain at the north end of the panel did not eventuate due to an absence of the rippling effect occurring at Ashton that has been observed at other sites with shallow cover. Horizontal movements of up to 500mm were observed and were noted as slightly unusual in that it tended to occur upslope/up dip as opposed to more commonly observed down slope / down dip movement.

SCT (February 2008) notes that the subsidence monitoring results from LW1 provide a good indication of the subsidence behaviour that can be expected over future longwall panels at Ashton. In addition to the subsidence behaviour being within the maximum predicted bounds, there did not appear to be any significant far-field horizontal movements involving mass movement of the overburden strata. No indications of horizontal movements with capacity to impact the New England Highway were observed.

It was also noted that based on the results from the start of LW1, that dynamic bridging of the overburden strata at the start of the panel was significantly greater than is typical for the Southern, Hunter and Western Coalfields. Subsidence movements of less than 50mm were observed when the effective panel width (measured from the longwall face and the back rib of the goaf) to overburden ratio (W/D Ratio) was more than 1.0. Subsidence of at least several hundred millimetres was expected when the W/D Ratio increased above approximately 0.7 for this level of extraction thickness.

As a result of the subsidence monitoring, it was concluded that the maximum subsidence was less than would be expected. The ratio of maximum subsidence (S_{max}) to seam thickness was 46% (observed) which is much lower than the 55-65% ratio observed at other sites. Subsequent monitoring of LW2 and LW3 startup lines resulted in data more consistent with the typical data set.

3.3.2 Observed Subsidence Impacts

As reported in the AEMR (ACOL, 2008), the access road to Property No 130 experienced some cracking in accordance with predictions. A diversion was put in place during the impact period and until the road was repaired.

Surface cracking appeared and progressed over the chain pillars, along the length of the maingate, however a portion of the tailgate displayed no visible cracking. Cracks through the Voluntary Conservation area (VCA) were rehabilitated using a small excavator and skid steer loader. Cracks within open pasture were remediated using a D6 dozer with ripping tynes.

Small farm dams in areas of shallow cover were dewatered prior to the longwall face passing beneath them. These were allowed to be refilled during subsequent rain events and were observed to be holding water.

Only one location required surface remediation to be undertaken that impacted on an identified archaeology site. As per the SMP for LWs 1 and 4, a process was followed that involved contacting the community groups and archaeologist, recording in-situ the site (an isolated find) by photograph and peg the location of the artefact. The artefact was then collected and stored under lock on-site at the Ashton office. Once the area is fully remediated the artefact will be returned to the location as marked by the peg, and a report will be prepared and circulated to the Aboriginal groups.

3.4 Subsidence Prediction Methodology

The subsidence predictions prepared by SCT (2008b) are based on empirical evidence gained from:

- Other sites with similar panel width and overburden depth; and
- Previous subsidence monitoring over LW 1, 2 and 3.

The Ashton subsidence monitoring completed to date is relevant to the prediction of subsidence behaviour over the proposed full-width panels (LW5 and 6). The two centreline subsidence monitoring lines over the start of LW1, 2 and 3 (refer to **Section 3.3.2**) provide an indication of the bridging characteristics of the overburden strata for the miniwall panels. Having said this however, the results of the start line monitoring from LW1 showed significantly greater overburden bridging than that previously measured at other sites (including the start of LW2) and are therefore considered an aberration and have been disregarded for the purposes of estimating subsidence over LW/MW 5 – 9.

The subsidence profiles for Ashton are based on the profiles measures for LW 1 and 2 (allowing for differences in overburden depth and panel geometries). Estimates of strains and tilts are based on guidelines developed in the Western Coalfields and the results of subsidence monitoring at Ashton. The Western Coalfields guidelines are relevant because this database represents similar overburden depths and panel geometries to those proposed at Ashton.

An upper limit approach to subsidence predictions has been adopted to ensure that there is no potential for greater levels of maximum vertical subsidence to occur.

Over the narrower panels where lower levels of subsidence are predicted, SCT (2008b) note there is some potential for natural variations in overburden behaviour to cause predicted subsidence to be exceeded because of the low levels involved, but the approach is still considered to be conservative.

SCT describes that within the SMP Application Area there are three different subsidence zones relating to:

- **Full width panels** (LW5 and 6): subsidence behaviour is likely to be similar to Longwalls 1 – 4 and develop over each panel effectively independently of any subsidence that has occurred in the adjacent panels. Maximum subsidence has been calculated to reach approximately 65% of the mined seam height. Experience in LW1, 2 and 3 indicates that actual subsidence of 50 to 55% seam extraction thickness is more likely.
- **Miniwalls** (MW5, 6, 7, 8 and 9): low subsidence areas where panel widths are approximately 0.6 times the overburden depth (at the shallowest point of the panel). Sag subsidence above these panels associated with overburden bridging is reduced to less than 10% of the seam thickness. However in addition to the sag subsidence, there will be some elastic compression of the chain pillars and surrounding strata resulting in a general lowering of the surface.
- **Longwall 9**: LW9 is a mid-width block with a panel width to overburden ratio ranging between 0.8-1.0. Therefore the panel is of sub-critical width but too wide for effective bridging to occur. Maximum subsidence in this area is likely to be sensitive to local variations in overburden characteristics and therefore a conservative approach in subsidence estimation has been adopted.

Appendix C (SCT 2008b) provides additional detail on how subsidence predictions were determined, assumptions made and discussion of the relevance of the input data and the reliability of predictions.

3.5 Subsidence Predictions

As noted above, subsidence behaviour within the SMP Application Area can be differentiated into three different zones which reflect the layout and geometry of the longwall blocks. Subsidence predictions for all panels is summarised in **Table 13** below followed by individual discussion of subsidence behaviour in each zone.

Table 13 – Subsidence Predictions (from SCT 2008)

Panel	Maximum Subsidence	Maximum Tensile Strain	Max. Compressive Strain	Maximum Tilt
	(mm)	(mm/m)	(mm/m)	(mm/m)
LW5	1600	20	27	67
MW5	200	3.2	4.2	11
LW6	1600	17	23	57
MW6	350	3.2	4.2	11
MW7	350	3.2	4.2	11
MW8	350	3.2	4.2	11
MW9	200	3.2	4.2	11
LW9	1200	15	20	50

3.5.1 Full Width Panels

Maximum subsidence over LWs 5 and 6 is expected to be less than the predictions shown in **Table 13**. Actual experience at Ashton (LW1 and 2) has observed maximum subsidence of between 50-55% of seam thickness, however for impact assessment purposes a conservative approach has been adopted and 65% of the seam thickness has been used and these values are provided above.

Subsidence above the chain pillars has been determined using relevant empirical evidence and is expected to be in the range of 150-250mm. Chain pillar compression is expected to be less than 200mm between LW4 – LW5 and less than 250mm between LW5 – LW6.

Goaf edge subsidence is expected to be less than 100mm and the Angle of Draw to the 20mm subsidence line (the practical extent of subsidence) is expected to be less than 17°. Horizontal movements of 0.3 to 0.5 metres can be expected with the ground initially moving in a direction toward the approaching longwall panel and then, once the longwall face has travelled past by approximately 0.2 to 0.3 times the depth of overburden, the direction of movement reverses. Typically the magnitude of the reverse movement is less than the initial movement resulting in a permanent offset of up to 0.2m in the direction of mining. Areas of sloping surface topography may experience a down-slope movement of about 0.3m and this will be superimposed onto the horizontal movement.

Surface cracks are expected to be less than 200mm at 100m overburden depth and less than 50mm wide at 200m overburden depth. Permanent tension cracks are expected to develop over all the goaf edges in this zone in a direction parallel to the goaf edge. Surface cracking is likely to commence just outside the goaf edge and increase in size with distance over the goaf, with the largest cracks expected approximately 25- 40m from the goaf edge.

3.5.2 Miniwalls

Maximum subsidence for MW5, MW6, MW7, MW8 and MW9 will be a combination of low levels of sag subsidence over individual panels and more general lowering of the ground surface associated with elastic compression of the chain pillars and rock strata above and below the chain pillars.

Maximum sag subsidence is predicated to be less than 10% of seam thickness and may be as low as 2% depending on the overburden strata behaviour. Therefore maximum sag subsidence is predicted to range between 0.05 and 0.24m.

Subsidence associated with elastic compression of the chain pillars depends on the relative geometry of individual pillars and the weight of overburden strata at those locations:

- MWs 5 and 9 are isolated between large barrier pillars so there is unlikely to be any significant chain pillar compression and subsidence is due entirely to sag subsidence, with a maximum subsidence range of 0.05 to 0.24m;
- MWs 6, 7 and 8 are separated by 30m wide chain pillars at depths ranging between 120 and 180m. Subsidence due to elastic chain pillar compression is likely to be in the range 0.1 to 0.2m. Therefore the total subsidence in the centre of the panels is the sum of sag subsidence and chain pillar compression (less an allowance for goaf edge subsidence of approximately 40mm).

Horizontal subsidence movements of up to 200mm are considered possible in sloping terrain adjacent to Bowmans Creek, but horizontal movements over these panels is likely to generally be less than 50mm.

Surface cracking over these panels is possible on hard surfaces such as rock outcrops or tarsealed roads, but most of the area over the narrow panels is pasture and therefore perceptible surface cracking is not expected.

3.5.3 Longwall 9

This panel is less than full width and maximum subsidence of up to 50% seam thickness has been adopted for prediction purposes. Much of the surface above LW9 is part of an out of pit spoil dump and SCT (2008b) note that 0.2m of subsidence at the top of the spoil pile may occur.

On natural surfaces, goaf edge subsidence is expected to be less than 100mm and the angle of draw to the 20mm subsidence line less than 17^{o} however these may increase in spoil areas depending on the thickness of spoil and level of compaction.

Horizontal subsidence movements of up to 0.5m are considered possible in sloping terrain in the spoil dump area, but horizontal movements over these panels is likely to generally be less than 0.2m.

Permanent tension cracks of up to 200mm are expected in the vicinity of longwall goaf edges.

4.0 Subsidence Impacts

4.1 Overview

This chapter presents the summary results of investigations into subsidence impacts based on the subsidence predictions prepared by SCT (2008b).

4.2 Natural Features

4.2.1 Bowmans Creek

The mine plan has been specifically designed to control the hydraulic interaction between the surface water in Bowmans Creek, associated alluvial aquifer and the underground mine. By limiting the panel width, the various studies (SCT 2008a, 2008b, and Aquaterra 2008b) have demonstrated that the mine plan will prevent direct hydraulic connection.

Bowmans Creek is expected to experience maximum vertical subsidence of up to 350mm where it crosses MW7 and MW8 (SCT 2008b). Over MW6, vertical subsidence of up to 300mm is expected, whilst 240mm subsidence is expected over MW5 and MW9. Sections of the stream that will be subject to this maximum level of subsidence are expected to only be 5 to 10 metres in length (i.e. through the centre of the sag subsidence trough) with subsidence decreasing to 150mm over the chain pillars.

Stream Flows

Small groundwater losses are predicted by Aquaterra (2008a) to occur from the Bowmans Creek alluvium to the Permian coal measures as a result of depressurisation of the coal seam during longwall mining. The reduction in baseflow contribution to surface flows within Bowmans Creek is predicted to be no greater than 1.2L/s (equivalent to 0.103ML/day).

Analysis of stream flow data discussed in **Section 2.2.1** noted that Bowmans Creek stream flow has the following statistics/characteristics:

- Median flow (Q_{50}) of approximately 2.5 ML/day; and
- Low flow (95^{th} Percentile or Q_{95}) of approximately 0.32 ML/day.

Therefore, seepage from the alluvium would equate to a potential 4% and 32% reduction in surface flows for Q_{50} and Q_{90} respectively. These percentage losses are conservative in that:

- Predicted groundwater losses are considered to be conservative as they are based on worst case parameters for the proposed mine plan and include substantial contingency;
- Seepage from the alluvium will not necessarily translate to an equivalent loss in surface flow; and
- Estimates for Q_{50} and Q_{95} are based on data which is dominated by a period of severe drought conditions.

Therefore the actual percentage loss of environmental flows due to mining impacts will be actually somewhat less than 32% and this percentage loss presents a predicted upper limit. It is estimated that under average rainfall and stream flow conditions, loss of surface flows as a result of mining will be negligible, and flows would still exceed those observed during the bulk of the recent drought in the region.

If severe drought conditions are experienced again during the period of mining or prior to post-mining groundwater recovery, low flows may be reduced by a maximum of 27%. This would result in slightly longer periods of zero flow and the stream pools would become disconnected slightly more frequently. Pool persistence and duration under these conditions would depend on individual factors such as surface area to volume ratio of each pool, aspect, vegetative cover, and localised interactions with the saturated alluvium and Permian measures.

Water quality

As noted in the Aquaterra reports (**Appendix F** and **Appendix G**), reduction of baseflow to Bowmans Creek will include a reduction in saline water from the Permian coal measures discharging to Bowmans Creek at the rock pool downstream of the New England Highway. This is likely to have negligible impact during normal flow conditions given the low baseflow contribution to Bowmans Creek, however water quality during drought and low flow conditions at this location and downstream will benefit from the reduced volume of saline discharge.

There are mine water and tailings pipelines that lie within the catchment extents of Bowmans Creek. SCT (2008) - note that there is potential for these pipes to become overstressed and break or leak (refer to **Section 4.5.1** for more detail). These pipelines are used for mine water, tailings and extraction from the Hunter River. However, the ability of any breaks or leaks in these pipes to cause water quality pollution in Bowmans Creek or the Hunter River is limited. The tailings and decant return lines are contained within an earth bund, when on the surface and are double pipe in pipe where buried. They are also fitted with differential flow alarms managed by the CHPP control. The mine water return line is fitted with pressure-loss activated cut off switches on the pumps. Further management actions to reduce the risk of off-site discharge of mine water or loss of tailings are discussed in **Volume 2**.

Erosion of the land surface as a result of subsidence cracking, if unremediated, could contribute to suspended sediment and turbidity of surface waters. Monitoring and remediation of erosion and cracking is implemented across Ashton's site in accordance with the Erosion and Sediment Control Plan and Land Management Plan. The risk of this impact is therefore considered relatively low.

Channel Morphology and Stability

Strains of less than 3-4m/mm are expected in the floor of the creek channel, and local tilting of the surface may cause the stream to move sideways in the creek bed (i.e. scour banks or existing in-channel point bars). This low degree of subsidence may result in:

- Minor changes to creek channel morphology, including redistribution of alluvial material within the existing pool and riffle sequences;
- Low probability of any major channel changes to channel cross-section or location; and
- Potential for increased bank loosening and instability of existing steep erosion banks.

These changes also have potential implications for aquatic ecosystems which are discussed in **Section 4.2.3**.

Drainage Lines and Gullies

The drainage lines within the Application Area drain to Bowmans Creek and may experiences changes of grade along their length as they travel through subsidence troughs/chain pillars. This may result in the initiation of erosion knick points or minor ponding. These impacts are not considered to have a high likelihood of occurring given the relatively low levels of subsidence across most of the Application Area and limited length / catchment area for the affected subcatchments.

The level of vertical subsidence and naturally low grades over the land surface above LW5 and LW6 is likely to result in natural water channels to be unable to drain. There is also potential for ponding on the flatter ground either side of the spur that leads down to the residence and farm buildings above the northern end of LW6. It is noted however that Bowmans Creek is sufficiently incised below the floodplain in these areas to enable these areas to be remediated.

Areas considered at risk of potential temporary or permanent ponding are shown in **Figure 21**.

4.2.2 Hunter River

The Hunter River is located 260m outside the SMP Application Area and there is no potential for subsidence movements to occur at this location. Furthermore, no perceptible impact to the Hunter River alluvial aquifer is predicted (Aquaterra 2008b).

Potential impacts to the Hunter River would be minor and include indirect impacts that would occur as a result of changes to water quality or flow in Bowmans Creek. Any water quality impacts such as increases or decreases in salinity, stream flow, increased sediment transport or turbidity in Bowmans Creek would discharge to the Hunter River.

Subsidence-initiated erosion and overland flow to the Hunter River would also contribute to turbidity and suspended sediment transport in the river. There are currently no mine water pipelines or tailings lines that could contribute to unplanned discharge directly to the Hunter River if pipelines were broken by subsidence movements.

4.2.3 Aquatic Ecosystems

Based on the subsidence predictions and other factors likely to influence the aquatic health of Bowmans Creek (channel morphology, groundwater / surface water interactions), the following potential impacts to aquatic ecosystems may occur as a result of the proposal:

- Minor reduction baseflow contribution - however this contribution to overall stream flow in Bowmans Creek is relatively small under most conditions (refer to **Section 4.2.1**);
- Potential improvement in water quality during low flow conditions due to a reduction in saline water contribution from Permian groundwater sources;
- Minor changes in creek channel morphology; and
- Localised increases in bank instability and erosion with consequent increase in sedimentation and turbidity.

SCT (2008) note that whilst there is some potential for ponding within the creek channel, this level of ponding is unlikely to be outside the currently experienced variability within pool volumes, location and depth as a result of high and low flow periods. SCT also note that the local tilting that will be experienced is at low levels and will occur over only short time distances. Therefore, these changes are also expected to be within the natural variation range that is naturally occurring within the stream given its meandering nature.

Overall, Marine Pollution Research (2008) concluded that there will be no discernable impacts on biota or aquatic habitats within Bowmans Creek, that are directly attributable to the mining process, that could not otherwise result from current agricultural practices or natural climatic variability.

Based on the predicted impacts, specific mitigation measures and monitoring programs have been developed and these are discussed in more detail in Volume 2. They include:

- Monitoring of aquatic health at numerous locations;
- Undertaking regular survey monitoring of the established steam cross sections;
- Riparian ecology monitoring
- Photographic monitoring; and
- Water quality monitoring.

4.2.4 Groundwater Resources

The development of the LW/MW 5-9 mine plan is based on extensive interactive studies of subsidence resulting from various panel widths and mine layouts and the resultant changes to the hydraulic properties of the coal seam overburden.

These investigations aimed to improve the understanding of the local hydrogeological conditions and provide reliable predictions of the impact of mining. Studies into existing groundwater and mining impacts on the hydrogeology by Aquaterra included:

- Ongoing review of the groundwater and surface water response to longwall mining at the ACP through monitoring of LW1 and LW2;
- Detailed investigation of the extent and properties of Bowmans Creek alluvial aquifer;
- Numerical groundwater modelling of the proposal and impact assessment.

The numerical groundwater modelling and impact assessment by Aquaterra 2008b in **Appendix G** had the following objectives:

- Asses the potential inflow rates into the open cut and underground mine during longwall mining
- Assess the potential impacts from alternative underground mine plan and longwall/miniwall mine layouts
- Predict potential impacts of the open cut and underground mining on local and regional levels and surface water resources; and
- Assess the potential impacts on alluvial aquifers associated with Bowmans Creek, Glennies Creek and Hunter River.

Aquaterra noted that the impacts of mining on aquifer properties include:

- Development headings create a void with semi-infinite permeability and storativity of 1.0;
- Goaf and immediate roof collapse zone result in an area of very high permeability and storativity;
- Caving zone consists of intense to moderate fracturing, the nature and height of which depends on the longwall geometry and depth, geology and geotechnical characteristics of the overburden. This fracturing results in moderately to highly altered vertical and/or horizontal permeability and increase in storativity; and
- Shallow surface fracturing due to tensile and compressive strains near the surface can result in temporary increase in near-surface vertical permeability.

Aquaterra's investigations to quantify these changes were undertaken with reference to the DWE guidelines and other best practice guidelines and include the use of detailed numerical models (MODFLOW) which have been calibrated based on observed groundwater responses to mining in LW1 and 2. The assessment was also subject to independent peer review. Details of this modelling are presented in full in **Appendix G**, with a summary of the results discussed below.

Predicted mine inflow rates over the anticipated duration of mining in LW/MW 5 – 9 are presented in **Appendix G**. These predicted inflows range are approximately 40% lower than predictions made in the EIS (HLA 2001) for LW5 through to the completion of LW7. Following this point, predicted mine inflow rates are similar to the EIS predictions (Aquaterra 2008b).

Some reduction in baseflow is likely during the mining period. The maximum predicted baseflow reduction for Bowmans Creek is 1.2L/s. The impact of this reduction on surface flows is discussed in **Section 5.2.1**. This reduction is a result of mine dewatering in the Pikes Gully Seam / groundwater drawdown and not due to subsidence induced fracturing and draining of the alluvium. The EIS predicted that the loss of baseflow for full-width longwall blocks (the LW1-8 layout) would be in the order of 4.8L/s.

The Pikes Gully Seam subcrops beneath Glennies Creek to the west of the SMP Application Area and some loss of water is predicted due to increased permeability of the Pikes Gully Seam (due to the goaf and immediate roof collapse zone) following extraction of LW1-4. Maximum predicted reduction in baseflow for Glennies Creek during the life of mining is 2.3L/s, however this is not predicted to increase as a result of mining LW/MW 5 – 9.

Leakage from Bowmans Creek is predicted to be reflected in an average drawdown in groundwater levels across the alluvium of 0.8m. This drawdown equates to approximately 12% of the total volume of groundwater storage in the alluvium over the extent of the area between the New England Highway and the confluence with the Hunter River.

4.2.5 Flood Prone Land

Subsidence of the Bowmans Creek overbank areas is likely to increase flood depths in these areas during major flow events, particularly backwater flooding of the Hunter River. However, this moderate increase (no greater than the experienced subsidence) is unlikely to significantly increase the risk of flooding to surface infrastructure or the life/property of landowners and residents.

4.2.6 Threatened and Protected Species

Impacts to threatened and protected species were assessed by ERM (2008) (refer to **Appendix H**). This assessment identified one endangered population (River Red Gum) and seven threatened fauna species within the Application Area or potentially at risk from the proposal.

The assessment of impacts was carried out using the 7-part test under the EP&A Act and considered the potential effects of strain, tilt, surface cracking, ponding, water table changes, salinity, clearing (for remediation) and changes to flooding frequency/surface drainage on the threatened species and their habitat. The following key threatening processes were also considered:

- Alteration of habitat following subsidence due to longwall mining; and
- Alteration of natural flow regimes of rivers, streams, floodplains and wetlands.

It was concluded that the known threatened and protected species potentially affected by the proposal will not be significantly impacted either directly or indirectly as a result of the proposal (ERM, 2008).

4.2.7 Natural Vegetation

In a general sense, subsidence can potentially disturb natural vegetation through the following mechanisms:

- Damage due to tilts or strains;
- Ponding around vegetation;
- Lowering/raising of the watertable;
- Clearing to enable subsidence remediation works (ripping of surface cracks or erosion control works); or
- Cumulative impact of the above.

Areas over miniwalls are unlikely to experience impacts as a result of subsidence due to the generally minor nature of subsidence resulting from extraction. Over longwall blocks, subsidence is predicted to be greater, and therefore the risk of subsidence impacts occurring increases. These areas will experience more surface cracking, tilt and so on. Assessment of impacts (**Appendix H**) concluded that there will be no significant impacts on native vegetation as a result of the proposal.

4.3 Public Utilities

4.3.1 Roads

New England Highway

The southern edge of the New England Highway is located some 70 to 90 metres from the northern extent of MWs 6 to 9 and LW9. Mains headings pass directly beneath the highway and the depth of overburden in this area ranges from 90 to 130 metres.

The configuration of the mains headings is such that the pillars are only lightly loaded and are predicted by SCT (2008b) to remain stable in the long term.

No perceptible subsidence impacts to the New England Highway, the road embankment or the Bowmans Creek Bridge are predicted as a result of the proposal.

Private Roads on Property 153

The Site Access Road is an unsealed (gravel) road that will be impacted during extraction of both MW8 and LW9. Subsidence movements are expected to cause perceptible cracking and grade changes, but these impacts are expected to be relatively minor and easily remediated.

Brunkers Lane is a sealed road and is expected to subside by up to 350mm over MW6, 7 and 8 and up to 1200m above LW9. Impacts from MW 6 to 8 are expected to include some perceptible tilt of the alignment, minor dips and minor cracking. However this section is likely to remain serviceable throughout mining. Impacts from LW9 may potentially cause cracking and buckling of the pavement surface along with tilts /change in grade.

Subsidence-related impacts on the access roads, including surface cracking, formation of compression humps and dips and changes to drainage patterns could pose a hazard for persons travelling along the road in a vehicle, on a motorbike or other. However, this risk is considered relatively low considering the low levels of subsidence expected.

4.3.2 Electricity Transmission Lines

No impacts are expected to the electricity transmission lines adjacent to the New England Highway.

The 132kV transmission line crossing the southern end of all the longwall panels will experience subsidence movements. The two and three pole structures located over the full width panels, LW5 and LW6, are expected to experience the full range of subsidence movements.

The three-pole structure over LW5 sit approximately 40m from the edge of the maingate goaf edge and may become permanently tilted in a westerly direction of about 70mm/m and move horizontally in the same direction at the base by up to 200mm. Assuming the poles are 18m high, up to 1.5m of permanent westward movement at the top of the poles is possible.

The braced three-pole structures are located approximately 45m from the goaf edge. With maximum horizontal strains of up to 25mm/m, differential horizontal movements of up to 500mm are possible, although in reality they are likely to be less than 300mm because the direction of maximum strain is not likely to coincide directly with the axis of the structure. Most of the early differential movement is likely to be tensile or stretching with some late stage compressive movement. Maximum tilts are expected to cause up to 1.3m of movement at the top of each pole. The three poles are joined together at the top in tension and differential movements in each pole will likely result in some load redistribution.

Based on discussions with Energy Australia, three-pole structure over LW5 is a key concern and assessment of pole stability is planned with any required works or modifications to be undertaken as detailed in the Electricity Transmission Lines SMP (refer to Volume 2).

Single pole transmission structures over miniwall panels are unlikely to be significantly impacted or require mitigation. However the single pole structures over LW5, LW6 and LW9 are likely to require sheaves placed over the conductors. Any poles located near the edge of panels (where tilts are permanent) may require straightening once mining is complete. Poles that are braced with wire stays will require individual assessment to determine any management/mitigation works.

4.3.3 Telecommunications Lines

The PowerTel (AAPT) fibre optic cable adjacent to the New England Highway will not be affected by perceptible subsidence movements. The location of this cable has been surveyed and marked as part of previous subsidence management works. It is located over the mains headings and is unlikely to experience any vertical subsidence or differential movements.

Advice by SCT (2006) quotes experience mining beneath buried multi-core cables that indicates that usually, such cables can accommodate strains up to about 20mm/m. Mining subsidence in longwall panels (LW1 to LW6) is predicted to result in strains exceeding this tolerance threshold, however to date note that the cables over LW1-4 have remained serviceable with tilts up to 40mm/m.

Subsidence induced strains over the miniwall panels (MW5 – MW9) is expected to be generally less than 5mm/m and therefore the telecommunications cable connecting Ravensworth Operations Pty Ltd and the DWE stream gauging station is likely to remain serviceable during extraction of these panels. However strains associated with LW9 may reach 20m/mm and therefore this cable may be potentially compromised during extraction of this panel.

4.3.4 DWE Stream Gauging Station

Subsidence of the weir is likely to reach a maximum of 200mm at the western end and 140mm at the eastern end. The gauging house is expected to subside approximately 200mm. However, overall the relative subsidence of the weir and channel is likely to be only a few centimetres once subsidence is complete.

Tilting of the weir and possible structural cracking of the concrete may affect the data accuracy of the flow gauging station. However, it is predicted that the station will be able to be returned to operation following recalibration and minor repairs.

Any cable connections between the weir and gauge house are likely to only experience low levels of strain and therefore no damage is anticipated.

4.4 Farm Land and Facilities

4.4.1 Land capability

In order to determine potential impacts to land capability, the definitions of the land capability classes (Emery, 1986) were reviewed. The pre-mining land capability classes discussed in **Section 2.4.1** within the Application Area include Class II, IV and V. Of these only Class II is suitable for regular cultivation.

The overall criteria for the classification of land as Class II are:

1) Favourable climatic and environmental conditions;
2) Deep to moderately deep, well-drained with adequate water available;
3) Soils can be maintained in good structure and productivity (may require a fallow phase to allow soil structure to re-establish);
4) Productivity is variable, ranging from moderate to high;
5) Gently sloping to undulating (upper slopes may range from 2-5%);
6) Terrain: floodplain, coastal plain or drainage depressions where horizontal or transverse gradients exceed 1.5% but are less than 5% grade; and
7) Erosion damage is nil to moderate and potential future soil erosion is low to moderate.

However, areas that would otherwise qualify for the above but are affected by the following factors are excluded from Class II lands:

- Soils that have a low water holding capacity or that are excessively drained and therefore require constant irrigation to support cropping;
- Land with excessive salt accumulation or adjacent to such areas; and
- Areas of poorly drained soils, suitable only for a crop with a high water requirement or ability to withstand water logging or flooding for prolonged periods.

Of the above factors, subsidence only has the potential to affect the site land capability through changes in grade, initiation of erosion or changes in drainage.

Cracking and increased subsurface permeability will increase the drainage of the soil profile and therefore reduce the amount of water available for pasture and cropping. Conversely, increased ponding and water logging of the floodplain areas (where Class II land predominantly exists) as a result of subsidence changes to the land surface, could result in soils becoming poorly drained and place limitations on the types of crops that could be used and/or limit pasture establishment and grazing.

Another potential impact of subsidence on land capability is increased salinity within the soil profile as a result of surface ponding. If allowed to remain over periods of time, ponding may lead to localised or short-term increases in the water table (due to water infiltration). The unconfined aquifer (alluvium) across the Application Area varies in quality, however is generally more saline than the adjacent rivers and creeks and in some areas can be classified as highly saline.

4.4.2 Farm buildings

The two Ashton-owned rural dwellings and associated farm storage sheds located over LW5 and 6 are predicted to experience the full range of subsidence movements during extraction of LW5 and LW6. Strains of between 20-27mm/m are expected. Typically structural damage occurs when strains exceed 7mm/m and therefore subsidence is likely to render these houses and associated buildings unserviceable.

These buildings may require isolation or removal prior to subsidence.

4.4.3 Fences

Fences will be impacted by subsidence movements of the ground surface. Increased sag or tension in the wire strands will occur when posts tilt towards or away from each other. Fence posts may also lay over at an angle to the run of the fence line. Gates may also be adversely affected if movement of a gate hinge post or hitching post occurs, resulting in the gate being unable to open or close effectively. These impacts to both fences and gates may result in unplanned stock movements between properties or from paddocks onto public roads.

Cattle grids may also tilt resulting in not only unplanned stock movements but also a potential traffic hazard.

Fences impacted by subsidence movements are likely to require mending and re-tensioning once mining is complete. Temporary electric fencing may be required in the interim to control stock and exclude them from grazing over the active longwall face until subsidence cracks can be repaired. Stock may also be excluded from paddocks subject to active subsidence.

4.4.4 Farm Dams

Specific subsidence predictions for individual farm dams are dependent on their location relative to the longwall panels. Only low levels of subsidence are expected directly over the chain pillars and a maximum subsidence of up to 1.6 metres is predicted in the centre of the full-width longwall panels. Dams 10, and 11 (refer to **Figure 17**) are located centrally over full-width longwall panels, in the area where subsidence and associated impacts are expected to be greatest. Dams 12 and 13 are situated at the outer edges of longwall panels, over chain pillars, or over miniwall panels and are therefore at lower risk of subsidence movement related damage.

SCT (2006) identified a strong possibility that the dam walls over full-width longwall panels will experience cracking and distortion due to mining subsidence. The generally dispersive nature of the clay materials used to construct the dam walls will render them susceptible to erosion and tunnelling after they have been undermined.

Cracking of dam walls has the potential to initiate erosion points that could subsequently expand and compromise the storage capacity of affected dams and facilitate release of impounded water. The estimated storage capacity of each of the dams is considered insufficient to cause a safety hazard to any person downstream if a dam wall collapsed, releasing stored water, though temporary localised flooding may occur. None of the dams have storage capacities that would present a hazard for inundation in the underground workings.

Ground tilts of 11 - 67mm/m are possible in the vicinity of the goaf ahead of and following the passage of the longwall face. Tilts in the upper range of these values may result in damage to the dams in these locations. It is possible that there may be locally higher values of tilt associated with horizontal ground movements, valley closure and outcrops of contrasting strata, such as low strength bedding planes. Tilting of dam walls may affect overall storage capacity and potentially cause overtopping or spillway losses if the dam were full at the time of tilting. In addition, tilt induced changes in relative elevation may potentially alter overland flow paths which could affect recharge of dams. However, overall, ground tilts are unlikely to significantly affect the serviceability of the dams.

Subsidence induced cracking could occur in the contour banks designed to channel overland flow into dams and initiate erosion points, thereby compromising their integrity. Tilting and alteration of ground levels may also result in the contour banks ponding water or no longer diverting water into the dams. Leaking or failure of contour banks would possibly cause a reduction in the volume of water reaching the dams.

Subsidence related reduction in dam storage capacities or replenishment, or loss of impounded water, have the potential to reduce stock water supplies (adversely impacting farm drought proofing capacity), reduce the drinking resource for native species and impact on frogs and birds. However the farm dams have relatively low aquatic habitat value (MPR 2008) and the Application Area is bordered by Bowmans Creek, Glennies Creek and the Hunter River, which provide an alternate aquatic habitat and water resource for native fauna and stock.

4.5 Mine Infrastructure

4.5.1 Pipelines

Buried polyethylene pipes over LW5, LW6 and LW9 are expected to experience tensile and compressive strains of up to 27mm/m, which is in excess of the 5-10mm/m working strains of the material. SCT (2008b) predict that there is a high likelihood of the buried pipes becoming overstressed and cracking/breaking within these areas. Pipes located in open trenches or lying on the ground surface are not expected to be impacted by mining subsidence.

Therefore, pipelines potentially at risk of damage include:

- Ashton Hunter River extraction pipeline;
- Ashton underground borehole pump pipeline; and
- Narama Dam to Mount Owen mine pipeline.

4.5.2 Sedimentation Basins

The four sedimentation basins and water storage dam on Property No. 153 are located over LW9 with overburden depths of approximately 150m. They are expected to experience the full range of subsidence movements.

Impacts to these basins are predicted to include temporary and permanent tensile cracking in the ponds with up to 1.0m differential settlement across the two western ponds and downstream dam. The function of the basins to capture and store sediment may be compromised by these impacts through loss of storage, cracking of walls or permanent cracking of the clay lining.

Contour banks which lie south of the sedimentation dams to prevent hillside erosion are also likely to be affected by changes in grade and cracking.

4.5.3 Prescribed Dams

Subsidence movement at Narama Dam is likely to be imperceptible. Therefore no impacts to the dam are expected. However, monitoring is proposed as a precautionary measure as detailed in Volume 2.

The additional Prescribed Dam proposed by Macquarie Generation is still in the planning stages. Further consultation with Macquarie Generation and the Dam Safety Committee will be undertaken to identify and manage any subsidence related impacts that may occur with this proposal.

4.6 Areas of Archaeological or Heritage Significance

The archaeological sites within the subsidence impact zone are stone artefact scatters and are relatively durable and therefore, vertical subsidence, horizontal movement or tensile strains will not directly cause significant disturbance or damage to these sites. The indirect impact of subsidence on artefact scatters potentially includes the following:

1) Cracking: The ground may crack as a result of the underground goaf collapse. The cracks are usually a few millimetres wide but may be several centimetres wide which may require ripping by a bulldozer to prevent erosion or soil degradation. Generally where cracking requires repair, a single pass by a bulldozer would be sufficient.
2) Nick points and erosion: Changes in slope can cause changes in erosion patterns and may hasten the movement of nick points upslope. Earthworks may also be required to repair or control erosion.
3) Ponding: Ponds may develop where subsidence forms depressions. The deposition of sediment can bury artefacts. The dewatering of ponds and remediation may also impact artefacts by vehicle movements and requirement of earthworks.

The risk of these impacts to archaeological sites is dependent on their location relative to the longwall or miniwall panels. Cracking is more likely to occur parallel to the edges of the longwall panel (where tilts and strains are greatest) and increase in severity with increasing maximum subsidence. **Table 14** summarises each site and potential subsidence risk. Cracking over miniwall panels is likely to occur in the same location (near the goaf edge, parallel to the panel) however will tend to be less severe.

Table 14 – Risk of Subsidence Impacts to Known Archaeological Sites

Site Name	Site Type	Site Dimensions	Risk of impact	Comment
EWA 82	Open Camp site	20x2m	Medium	Edge of the panel
EWA 81	Isolated find	50x2m	Medium	As above
EWA 80	Isolated find	50x2m	Low	In the middle of the panel
EWA 89	Isolated find	50x5m	No impact	To the west of LW9
EWA 50	2 artefacts	1x 2m	Low	In the middle of the panel
EWA 51	Isolated find	2x1m	Low	In the middle of the panel
EWA 52	Isolated find	1x2m	Medium	Edge of Panel
EWA 57	2 artefacts	5x50m	Medium	Edge of Panel
EWA 97	3 artefacts	20x20m	Medium	Edge of Panel

Source: Insite Heritage (2008)

Further detail of the archaeological impact assessment is provided in **Appendix I**.

Remediation works to address cracking, erosion or ponding may potentially damage or reduce the integrity of archaeological sites. Any such works would need to be conducted in accordance with the relevant management plans, and approvals to disturb the sites obtained prior to proceeding. The need for such approvals would be identified as part of the subsidence management and monitoring process outlined in Volume 2.

4.7 Areas of Environmental Sensitivity

Areas of environmental sensitivity as defined by the SMP Guidelines (Department of Mineral Resources 2003)(refer to **Table 11**) have been addressed as part of this report. They include:

- Significant surface watercourses and groundwater resources identified through consultation with relevant government agencies;
- Flood prone areas;
- Areas containing significant ecological values;
- Major surface infrastructure; and
- Surface features of community significance (including cultural, heritage or archaeological significance).

4.8 Public Safety

Risks to public safety, as a result of the proposed underground mining, were identified as part of a risk assessment (refer to **Section 6.0**). Surface disturbance such as surface cracks and ground tilt were considered the highest risk to public safety as they may cause personal injury from trips/falls or vehicle accidents on roads due to pavement damage.

Other potential hazards identified include damaged/fallen electricity transmission lines, farm dam wall failures, damage to site buildings, falling trees and unplanned stock movements onto adjoining roadways (such as the New England Highway).

A Public Safety Management Plan to address these risks is discussed and presented in Volume 2 (SMP).

4.9 Cumulative Impacts

As per the SMP Guidelines (Department of Mineral Resources 2003), and the Development Consent the cumulative impacts of subsidence due to multiple seam extraction was considered.

The EIS predicted that following extraction of all four seams (Pikes Gully, Upper Liddell, Upper Lower Liddell and Lower Barrett, the land surface will experience up to 5.9 metres of subsidence. However, as a result of the proposed miniwall design, in sensitive areas, this has been significantly reduced.

Coal extraction will result in a series of continual movements as the longwall proceeds along each panel with maximum subsidence reached within approximately 6 months following the completion of the panel. This process will then repeat until extraction of all four seams is completed.

The development consent requires that the project progresses in stages through each seam such that the impacts from each stage support the application for the subsequent stage. As a result, minimal work has been done in assessing future impacts from the extraction of subsequent seams. It can be expected, however, that the majority of impacts addressed in this proposal will be repeated in subsequent seams, namely:

- Increases in flooding depth;
- Surface re-cracking and erosion;
- Disturbance to access roads;
- Increased ponding extents; and
- Minor damage to infrastructure.

Extraction of the next seam (Upper Liddell) for LW/MW 5 to 9 is not expected to commence until approximately 2015. This provides ample opportunity to monitor and stabilise any subsidence-impacted features prior to further extraction and subsidence of lower seams.

4.10 Impact Assessment Based on Increased Subsidence Predictions

The SMP Guidelines (Department of Mineral Resources, 2003) require that the assessment of subsidence impacts be repeated based on appropriately selected subsidence parameters that are multiples (i.e. 1.5, 2, or 2.5 times) the subsidence predictions where for any areas or surface features the following conditions are satisfied:

(1) Where there are significant uncertainties and / or significant potential deviations from the subsidence predictions and / or from the impact assessments, due to factors such as topographic, geological / hydrogeological, geotechnical or any other site condition variations or uncertainties;

The investigations on which the underground mine design is based, which include extensive geological investigation, geomechanical modelling and groundwater modelling are extensive and based on conservative assumptions and parameters. Furthermore, the subsidence predictions on which the impact assessment has been based are also conservative and maximum predicted values were adopted. Therefore it is considered that there are no significant uncertainties or significant potential deviations likely to occur.

(2) Where there are uncertainties in the assumptions used, which may significantly affect the outcome of subsidence predictions and/or impact assessments;

As above.

(3) Where the consequences of the expected subsidence impacts are likely to be severe to the community and the environment, even though the probability for the expected impacts to occur may be low;

The Risk Workshop conducted in June 2008 (refer to **Appendix K**) defined catastrophic consequences as:

- Environmental (Flora/Fauna/Water) = Long-term irreversible impacts - multi/ licence or consent breach / prosecutions / fines / revocations;
- Community Economic/Social = Permanent loss of businesses / employment opportunities / social history.

The risk assessment is further described in **Section 7**, however the following risks with potentially severe consequences included:

- Drainage of Bowmans Creek alluvium;
- Cracking of the creek bed and loss of surface water; and
- Subsidence cracking resulting in interconnections of aquifers.

The likelihood of all the above was considered to be Rare "*Generally expected to occur once every 10+ years or not expected to occur within the resource recovery activities*". It is noted that the extensive investigation undertaken in support of the miniwall design was exclusively undertaken to avoid the above consequences, ensure compliance with the development consent, and is based on very conservative assumptions and analysis. Predictions for subsidence are also conservative.

The groundwater monitoring program and Trigger-Action-Response Plan (refer to Volume 2) will also ensure that early indicators of any of the above are recognised and preventative action taken promptly.
Therefore, a consideration of impacts based on multiples of the predicted subsidence is not considered warranted in this instance.

(4) Any other circumstances where the use of increased subsidence predictions is appropriate for the development of subsidence management and/or contingency plans.

The mine plan is based on a conservative design approach and subsidence management strategies and contingency plans are based on maximum subsidence predictions or worst-case scenarios. Use of increased subsidence predictions is therefore not considered to be required.

5.0 Statutory Requirements

5.1 Overview

Under current legislation, the major approvals required for longwalls and miniwalls 5 to 9 and associated first workings include:

- A mining lease granted under the *Mining Act 1992;*
- Development Consent under the EP&A Act;
- Approval of a SMP that addresses various government agency requirements with respect to environmental impacts

It is noted that as of the 1st July 2008, the requirements for an additional approval for longwall extraction under Section 88 of the Coal Mines Health and Safety Regulation 2006 expired (formerly Section 138 of the Coal Mines Regulation Act 1982). However, discussions with DPIM indicate that the expiry of this clause has been extended to September 2009 (Mr J.Smith - DPI, *pers.comm*).

A summary of all current approvals relative to the SMP Application is summarised in **Table 15** below.

Table 15 – Current Approvals and Licences for ACOL Underground operations

Type of Lease / Approval	Issuing Authority	Date of Issue	Expiry	Comments
Mining Lease 1533	DPI	26/2/2003	25/02/2024	Application Area extends marginally outside lease extent. Application is in process to extend lease boundary – Reference MLA310.
Development Consent 309-11-2001-i	DoP	11/10/2002	11/10/2023	Application for development consent modification for inclusion of MW9 and LW9 has been lodged with the Department of Planning.
Environmental Protection Licence 11879	DECC	27/12/2007	06/11/2011 (Review Date)	
Bore Licences 20BL136766 20BL168848 20BL168849	DWE	 12/01/1988 27/08/2003 27/08/2003		
SMP Approval	DPI DoP	08/03/2007 13/03/2007	01/03/2014 -	Amended approval 06/07/2007

In addition to the above licences and approvals, Ashton holds three Water Access Licences (WALs) for the Hunter River and 2 for Bowmans Creek (and approximately 9 for Glennies Creek). Details of the Hunter River and Bowmans Creek licences are summarised in **Table 16**.

Table 16 – Current Water Licences Summary

WAL No.	Licence No.	Total Allocation (ML)	Sub Category	Commencement	Expiry Date
Hunter River					
1120	20AL201624	3.00	High Security	01/07/2004	7/04/2009
1121	20AL201625	335.00	General Security	01/07/2004	7/04/2009
6346	20AL203106	15.50	Supplementary	01/07/2004	7/04/2009
Bowmans Creek					
NA	20SL044434	366.00	Irrigation/industrial		16/10/2009
NA	20SL042214	14.00	Irrigation		23/02/2012

A summary of all licence and development consent conditions with relevance to subsidence management is provided in **Appendix J**.

5.2 Mining Act 1992

The *Mining Act 1992* is administered by the DPIM. Under the Act, nearly all exploration or mining activities require an exploration licence or mining lease. The Act also sets out the responsibilities with respect to royalties, compensation and environmental responsibilities.

Statutory control over mining activities is exercised through the provisions of the *Mining Act 1992* and the conditions attached to mining leases. The ACP lies within Mining Lease 1533, the conditions of which are summarised in **Appendix K**. In addition to these conditions, a new mining lease imposed by the Minister on all mining leases under Section 239(2) of the *Mining Act 1992* requires the preparation and approval of a Subsidence Management Plan prior to underground mining operations being carried out. The new lease condition states:

Subsidence Management

(a) The leaseholder shall prepare a Subsidence Management Plan prior to commencing any underground mining operations which will potentially lead to subsidence of the land surface

(b) Underground mining operations which will potentially lead to subsidence include secondary extraction panels such as longwalls or miniwalls, associated first workings (gate roads, installation roads and associated mains headings etc) and pillar extractions, and are otherwise defined by the Guideline for Applications for Subsidence Management Approvals.

(c) The leaseholder must not commence or undertake underground mining operations that will potentially lead to subsidence other than in accordance with a Subsidence Management Plan approved by the Director-General, an approval under the Coal Mines Regulation Act 1982 or the document New Subsidence Management Plan Approval Process – Transitional Provisions.

(d) Subsidence Management Plans are to be prepared in accordance with the Guideline for Applications for Subsidence Management Approvals.

(e) Subsidence Management Plans as approved shall form part of the Mining Operations Plan required under Condition 2 and will be subject to the Annual Environmental Management Report process as set out under Condition 3. The SMP is also subject to the requirements for subsidence monitoring and reporting set out in the document New Approval Process for Management of Coal Mining Subsidence – Policy.

As a result of minor changes to the longwall layout and adoption of miniwalls, the current boundaries of ML1533 required modification. An application to the DPI for extension to the Mining Lease area has been lodged and is in the process of being approved.

5.3 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) establishes the framework under which environmental planning instruments (state environmental planning policies, regional environmental plans and local environmental plans) are prepared and which, in turn, guide and control development within the state of NSW and provide the basis for determining whether development is acceptable in a given location given the objectives for the area and the social, economic, and environmental impacts of the proposal.

The extent of MW9 and LW9 sits partially outside the originally approved longwall layout (EIS extent / impact) and an application for modification of the development consent is being lodged with the DoP for consideration.

As part of the SMP approval process, DoP are referred a copy of the application for concurrence prior to approval by the DPI. In addition to this process, ACOL's development consent, which pre-dates the current SMP framework, requires the preparation and approval of Subsidence Environmental Management Plans (SEMP) and Subsidence Monitoring and Impact Assessment Reports (SMIAR) prior to longwall mining.

Approval to integrate the SEMP process into the requirements of the SMP was granted by the DoP prior to the preparation of the SMP for longwalls 1 to 4. The DoP approved the integration of the SEMP/SMP/SMIAR process for Ashton Coal, provided that the requirements of the development consent for the preparation of SEMPs and SMIARs is integrated into the SMP document.

The ACP development consent has over 260 consent conditions relating to the site (refer to **Appendix J**).

5.4 Coal Mines Health and Safety Act 2002

The *Coal Mines Health and Safety Act 2004* (CMHSA) repealed the *Coal Mines Regulation Act 1982* (CMRA). The enactment of the CMHSA and related amending acts has revised the former approval process for underground workings. All potential impacts, other than safety are now dealt with via an approval under the *Mining Act 1992* through the new condition imposed on Mining Leases. Occupational health and safety, and public safety are now dealt with under the CMHSA.

Section 88 of the Coal Mines Health and Safety Regulation 2006 maintains the existing approval process for underground mining (formerly Section 138 of the CMRA):

1) *A method of mining other than the bord and pillar system must not be used in an underground mine except with the approval of the Minister given on the recommendation of the Chief Inspector and subject to such conditions as the Minister may impose.*

5.5 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is administered by the DECC. The POEO Act establishes the framework in which the NSW Government can protect the environment through a range of measures, including licensing of activities and issuing of notices and penalties for particular offences.

The POEO Act provides a single licensing arrangement to capture air, water and noise pollution and waste management from Scheduled premises or activities. Ashton Coal holds one Environmental Protection Licence (EPL No 11879). The EPL sets out various requirements for the monitoring and reporting of surface and ground water.

No amendments to the terms of the EPL are required as a result of the proposal.

5.6 Dam Safety Act 1978

The *Dam Safety Act 1978* aims to ensure that all "prescribed dams" are in such as condition as to not pose an unacceptable danger to downstream residents and property or to adversely affect the public welfare and environment. A "prescribed dam" is one listed in Schedule 1 of the Act. The Dam Safety Committee (DSC) is created under the powers of the Act and has a general responsibility to ensure the safety of all dams, and a special responsibility regarding prescribed dams.

"Notification Areas" are defined by the DSC under Section 369 of the Mining Act 1992. Where mining within a Notification Areas is proposed, an application to the DSC is required. The longwalls and miniwalls 5 to 9 lie within the Notification Area for Narama Dam as described in **Section 2.6**.

Based on advice received from the DSC, ACOL has commissioned a detailed technical assessment of potential impacts to the Narama Dam and approval from the DSC will be sought prior to commencement of mining within the Notification Area.

5.7 National Parks and Wildlife Service Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) protects Aboriginal objects and places in NSW. It is an offence under the NPW Act to disturb or destroy Aboriginal heritage without a permit under Section 90 of the Act – which are issued by DECC.

Aboriginal objects include:

- Physical objects, such as stone tools, Aboriginal-built fences and stockyards, scarred trees and the remains of fringe camps;
- Material deposited on the land, such as middens; and
- The ancestral remains of Aboriginal people.

The NPW Act can also protect areas of land that have no Aboriginal objects – no physical evidence of Aboriginal occupation or use. These areas can be declared 'Aboriginal places'. The Minister for the Environment can declare an area to be an 'Aboriginal place' if the Minister believes that the place is or was of special significance to Aboriginal culture. An area can have spiritual, natural resource usage, historical, social, educational or other types of significance.

It is an offence to do any of the following things without a permit:

- Disturb or move an Aboriginal object
- Excavate land for the purpose of discovering an Aboriginal object
- Knowingly destroy, damage or deface an Aboriginal object or Aboriginal place
- Knowingly cause or permit the destruction, damage or defacement of, an Aboriginal object or Aboriginal place.

Surface cracking and/or erosion in the vicinity of Aboriginal objects has the potential to place them at risk of disturbance either from the cracking/erosion or the earthworks required to undertake remediation or repair. A Section 90 permit will be required prior to any such works being carried out.

5.8 Water Management Act 2000

Where works adjacent to watercourses are required for remediation or other purposes (i.e. within 40 metres of Bowmans Creek), a controlled activity permit may be required from DWE under the *Water Management Act 2000*.

6.0 Risk Assessment

6.1 Overview

Risk management, particularly in relation to subsidence, will continue to be integrated into the planning and delivery phases of the mining operations and will involve operations staff in ongoing hazard identification, risk assessment, implementation of mitigation measures and their management.

A risk management workshop was held on 17th June 2008 to enable the identification and assessment of possible subsidence and related risks that might arise from extension of the Ashton Coal Operations Limited underground mining operations of LW/MW 5-9.

The Australian Centre for Value Management (ACVM) was commissioned to facilitate and report on the workshop and prepare a Subsidence Risk Management Plan. A copy of this report is contained within **Appendix K**.

The purpose of the risk management plan and workshop was to provide a basis for:

- Acknowledgement of the relevant subsidence hazards/risks and how best to manage these risks to the mine's successful operations and rehabilitation;
- A systematic process for ongoing monitoring of the occurrence and amelioration of subsidence risk over the life of the mine operations; and
- To provide input to the preparation of the Subsidence Management Plan that is to be lodged for approval to extend underground longwall mining operations to panels 5-9.

6.2 Risk Assessment Methodology

Corporate risk management procedures apply to all aspects of the mine's planning and operations to ensure their risks are adequately identified and analysed to enable effective risk management. The procedure adopted by Ashton Coal is based on the Risk Management Standard for Australia introduced on 24 September 2004 – AS/NZS 4360.

The risk assessment used the following methodology:

- Determine relevant risk areas related to subsidence;
- Identify hazards/risks through the facilitated stakeholder workshop;
- Assessment of potential consequences/likelihood;
- Determine appropriate management action(s) for the identified risks; and
- Determine appropriate monitoring / review schedule.

The subsidence risk plan will be further developed and updated in the lead-up to commencement of the mining of panels 5-9 and then ongoing as works proceed and the circumstances, risk context or as events require.

Full details of the risk criteria used and resulting risk register is provided in **Appendix K**.

7.0 Community Consultation

7.1 Stakeholders

Identification of relevant stakeholders was undertaken using the following methods:

- Review of development consent requirements
- Review of the SMP guidelines requirements for consultation
- Land title searches
- Dial Before You Dig
- Public advertisements

In general, stakeholders were identified as falling into one of the following groups:

- Affected landowners;
- Government agencies;
- Public utility owners; and
- Community (local residents, indigenous community and general public).

7.2 Consultation Methodology

7.2.1 Landowners

The following landowners were identified as being directly affected by subsidence or subsidence impacts:

- Macquarie Generation – direct subsidence impacts to landholdings and access roads
- Ravensworth Operations Pty Ltd – subsidence impacts to Brunkers Lane which is being used as an alternative access to portions of Property No.153 and to private electricity transmission line.
- Private Landowner (Property No. 130) – no direct subsidence impacts from this series of panels, however ongoing alterations and repairs to property access road as a result of underground mining (LW1-4).
- Glendell Tenements – small portion of land overlying north west mains headings. No impacts predicted.

Consultation with the Roads & Traffic Authority who is responsible for the New England Highway is discussed in **Section 7.2.2**. Notification letters and individual meetings were used to consult with landowners. A summary of these activities is provided in **Table 17**.

Table 17 – Summary of consultation with landowners

Stakeholder	Date Consulted	Description
Macquarie Generation	30 June 2008	Notification letter
Ravensworth Operations Pty Ltd	30 June 2008	Notification letter
Private Landowner – Property No. 130	20 June 2008	Notification Letter
Ravensworth Operations Pty Ltd	3 July 2008	Meeting
Ravensworth Operations Pty Ltd	11 July 2008	Email response
Glendell Tenements	21 July 2008	Notification Letter
Macquarie Generation	26 August 2008	Meeting

7.2.2 Government Agencies

Government agencies identified requiring consultation as part of the SMP process or development consent conditions included:

- Department of Primary Industries (Minerals, Fisheries, and Agriculture);
- Department of Planning;
- Department for the Environment and Climate Change;
- Department of Water and Energy;
- Mine Subsidence Board;
- Dam Safety Committee;
- Roads and Traffic Authority; and
- Singleton Shire Council

Consultation with these agencies was undertaken via the following:

- **Aquaclude Committee Meeting** - this meeting aimed to present the mine plan and subsidence/groundwater investigations to the Aquaclude Committee, comprising representatives of the DPI, DoP, DWE, ACOL, Aquaterra, SCT Operations, and Maunsell. Copies of the presentation and minutes of the meeting are included in **Appendix L**.
- **SMP Interagency Committee** - ACOL presented the proposed mine plan to the SMP Interagency Committee which included representatives of MSB, DPI, DWE, DECC and DoP. Copies of the presentation of the meeting are included in **Appendix L**.
- **Notification Letters -** Letters to agencies not contacted during either of the above committee meeting, were sent to notify the relevant agencies of the upcoming preparation of the SMP and requesting any input/comment. Copies of the notification letters are attached as **Appendix L**.

A summary of the consultation undertaken with relevant government agencies is provided in **Table 18**.

Table 18 – Summary of SMP Consultation with relevant government agencies

Stakeholder	Date Consulted	Description
DPI (Minerals)	12 Feb 2008	Aquaclude Committee Meeting
	21 May 2008	Aquaclude Committee Meeting
	4 June 2008	SMP Interagency Committee
	30 June 2008	Meeting with Subsidence Executive Officer
	15 July 2008	Meeting with Principal Subsidence Engineer
DPI (Fisheries)	4 June 2008	SMP Interagency Committee
	23 June 2008	Notification Letter
DPI (Agriculture)	23 June 2008	Notification Letter
DoP	21 May 2008	Aquaclude Committee Meeting
	4 June 2008	SMP Interagency Committee
	23 June 2008	Letter regarding clarification of conditions of consent
DECC	4 June 2008	SMP Interagency Committee
DWE/DIPNR	15 Nov 2005	Aquaclude Committee Meeting
	5 April 2006	Aquaclude Committee Meeting
	1 Nov 2006	Aquaclude Committee Meeting
	12 Feb 2008	Aquaclude Committee Meeting
	21 May 2008	Aquaclude Committee Meeting
	4 June 2008	SMP Interagency Committee
	15 July 2008	Meeting with DWE Senior Hydrogeologists
MSB	4 June 2008	SMP Interagency Committee
	19 June 2008	Notification Letter
DSC	20 Dec 2007	Initial Meeting
	19 June 2008	Notification Letter
	27 Aug 2008	Meeting
RTA	19 June 2008	Notification Letter
	28 Aug 2008	Meeting
Singleton Shire Council	17 June 2008	ACOL Community Consultative Committee
	19 June 2008	Notification Letter

7.2.3 Local Community and General Public

The community consultation was undertaken via a range of methods in order to ensure both local residents and the broader community were provided an opportunity to comment. The community was generally grouped into the following:

- ACOL Community Consultative Committee;
- Local indigenous community;
- Camberwell residents and residents of nearby rural properties; and
- General public.

The consultation methodology was developed to ensure that all of the above groups were given notice of ACOL's intention to prepare a SMP and outlining opportunities to obtain further information on the proposal and make comment. The consultation methods used are summarised in **Table 19**.

Table 19 – Community Consultation Summary

Date	Description
17 June 2008	**ACOL Community Consultative Committee** Presentation outlining the proposed mine plan to the CCC.
27 June 2008	**Public Notice - Newspaper** Advertisements placed within the Public Notices section of the Sydney Morning Herald and Singleton Argus
1 July 2008	**Public Notice - Newspaper** Advertisements placed within the Public Notices section of the Singleton Argus
	ACOL Community Newsletter Posted on Ashton Coal's website and mailed to regular distribution list.
23 June 2008	**Correspondence to local Aboriginal groups:** • Ungooroo Aboriginal Corporation • Wattaka Wonnarua C.C. Service • Wonnarua Local Aboriginal Land Council • Wonnarua Aboriginal Custodians • Junburra Consulting • Yarrawalk Enterprises [*letter returned – undeliverable*] • Aboriginal Native Title Heritage Consultants [*letter returned – undeliverable*] • Lower Wonnarua Tribal Council
26 June 2008	• Aboriginal Native Title Elders Consultants • Biami Pty Ltd
15 July 2008	• Wonnarua Nation Aboriginal Corporation
7 July 2008	**Public Information Day** Held at Singleton Library and previously advertised in the Sydney Morning Herald, Singleton Argus (two separate days), via the community newsletter, and in various correspondence listed above.
25 Sep 2008	**Updated plans and draft archaeological impact assessment for LW/MW5-9 forwarded to:** • Ungooroo Aboriginal Corporation • Wattaka Wonnarua C.C. Service • Wonnarua Local Aboriginal Land Council • Wonnarua Aboriginal Custodians Corporation • Junburra Consulting • Biami Pty ltd • Aboriginal Native Title Heritage Consultants • Lower Wonnarua Tribal Council.
18 – 22 Oct 2008	Phone Conversations – Ungooroo, Wattaka Wonnarua CC Service, Lower Wonnarua Tribal Council, Biami advising closure/final date for commenting on draft assessment and plan.

7.2.4 Public Utilities

The location of public utilities in the area is well known to ACOL as a result of its current operations and implementation of the LW1-4 SMP. The existing location and type of underground services was reconfirmed using Dial Before You Dig, and notification letters forwarded to Energy Australia, Telstra and PowerTel. Copies of these letters are provided in **Appendix L**.

Table 20 – Consultation with Public Utilities

Stakeholder	Date Consulted	Description
Energy Australia	19 July 2008	Notification letter
	8 July 2008	Meeting
Telstra (Network Integrity Services)	19 June 2008	Notification letter
Telstra (consultant)	29 July 2008	Site meeting
PowerTel (AAPT)	19 July 2008	Notification letter

7.3 Summary of Consultation Outcomes

The formal responses and direct feedback received by Ashton from representatives of the stakeholders consulted are summarised in **Table 21**.

Table 21 – Summary of Consultation Outcomes

Date	Respondent / Organisation	Type of Response / Consultation	Key Issues	Comment
15 Nov 05	DPNIR	Meeting	Aquaclude to prevent direct hydraulic connection to Bowmans Creek alluvium	Initial meeting on aquaclude parameters for Bowmans Creek alluvium area. Review of monitoring program for Longwalls 1-4
5 April 06	DPNIR	Meeting	Aquaclude to prevent direct hydraulic connection to Bowmans Creek alluvium	Consultation on investigation program for delineation of alluvium extent/nature and program to investigate aquaclude
1 Nov 06	DPNIR	Meeting	Aquaclude to prevent direct hydraulic connection to Bowmans Creek alluvium	Refinement of aquaclude investigation program and overview of data gained to date
12 Feb 08	DWE/DPI	Meeting	Aquaclude to prevent direct hydraulic connection to Bowmans Creek alluvium	Report on outcomes of investigation to date and planned additional investigations to be done leading up to submission of SMP
21 May 08	DWE/DPI/DoP	Meeting	Aquaclude to prevent direct hydraulic connection to Bowmans Creek alluvium	Presentation of aquaclude investigation outcomes including geotechnical and hydrogeological presentations and mine plan for SMP.
3 Jul 08	Registrar of Aboriginal Owners	Letter	No Registered Aboriginal Owners within the subject land.	-
7 Jul 08	Mr Barry French on behalf of Yarrawalk (Biami)	Pers.Comm – Public Information Day	Requested copy of management plan once it has been prepared.	Copy of the draft archaeology management plan will be forwarded to all interested Aboriginal groups once prepared.
3 Jul 08	Ravensworth Operations Pty Ltd	Meeting	Brunkers Lane	Upgrading of Brunkers Lane is a condition of consent for Ravensworth (timeframes approx. 2 years). Ashton will remediate any subsidence damage.
			Electricity Transmission Lines	Need for the management of existing transmission line and planned HT power line beside the road. Suggest location of planned line be move west to avoid future subsidence impacts.

Date	Respondent / Organisation	Type of Response / Consultation	Key Issues	Comment
			Narama Storage Dam	Ravensworth have a monitoring network in place. If additional monitoring required by the DSC as result of LW/MW 5-9 proposal, this could be done by Ashton survey team following relevant site inductions.
			Telstra cables	Not known to connect to anything on Ravensworth landholdings
			Groundwater monitoring	Future discussions proposed on formal information sharing and data gathering.
8 Jul 08	Mr Noel Downs / Wannaruah Local Aboriginal Land Council	Letter	WLALC do not and will not agree to the disturbance or destruction of any Aboriginal Cultural sites within the Conservation offset area, of the conservation area itself.	This area will not be impacted by LW-MW 5 to 9. Impacts to the Conservation Area were previously considered in the SMP for LW 1-4 and the WLALC consulted. No impacts to Aboriginal sites have occurred in conservation zone as a result of underground mining in LW 1 or 2.
30 Jun 08	Mr Garry Moore, Mine Subsidence Board	Letter	Requirements for information to be included in the SMP.	This SMP includes the requested information.
30 Jun 08	Telstra Network Integrity Services	Email	Telstra provided NIS Request for service forms and documentation.	No relocation or protection is proposed.
15 Jul 08	Principle Subsidence Engineer, Mr Gang Li DPIM	Meeting	Pillar stability and hydraulic connections – Principal Subsidence Engineer concerns on mine design and need to understand lithology and potential for different strata to propagate features. DPIM noted need for contingency planning in event of unexpected mine inflows and that this should be submitted as a management plan with the SMP to demonstrate preparedness.	SCT to compare a lithology core from Ashton with Beltana/Wambo to demonstrate lithology is consistent with other Hunter Valley sites. DPIM to compare DPI data for Tmax vs W/H against data set developed by SCT. TARP has been developed and incorporated into the Groundwater Management Plan.

Date	Respondent / Organisation	Type of Response / Consultation	Key Issues	Comment
26 Aug 08	Mr Robert Cullen, Macquarie Generation	Meeting	Proposed construction of a spoil dam adjacent to LW9. Dam will be prescribed under the *Dam Safety Act 1979*. Undermining of site access road.	Ashton will consult with DSC in accordance with prescribed dam requirements prior to mining within this proposed notification area. Notification will be provided to Macquarie Generation and Ravensworth prior to undermining road. Ashton has already general maintenance responsibility of this road. Road is to be maintained to provide access to the MacGen Void 4 access gate.
			Access to site – locked gate. Induction requirements.	Ashton will ensure any staff or contractors under its responsibility will undertake an approved Macguarie Generation induction process conducted prior to entering MacGen site to undertake works for Ashton.
			Spontaneous combustion in spoil piles	Not a major risk for Ashton as dump is initial out-of-pit spoil and unlikely to contain coal. To be captured in Ashton's Spontaneous Combustion Management Plan.
			Reporting	MacGen to be included in weekly report that is being generated and communicated to DPI and other affected landowners.
29 Aug 08	RTA	Meeting	Process of RTA approval – impacts and risks to New England Highway	Existing Work Authorisation Deed will be carried forward. Update and review of existing New England Highway Management Plan in consultation with RTA (Note: Draft Management Plan forwarded to RTA on 28/10/08). Review of survey requirements. RTA will review the proposal and indicate either acceptance or additional requirements if deemed necessary. The RTA will also organise a baseline survey prior to mining that

Date	Respondent / Organisation	Type of Response / Consultation	Key Issues	Comment
				will be at Ashtons expense and include photographic records. RTA also to conduct post impact survey of previous SMP area at completion of LW4. If a Risk Assessment is required, this will be done by the RTA in-house and later sent to Ashton for review/comment. Management plan is being developed by Ashton together with RTA based on a review of the existing management plan for LW1-4.
22 Oct 08	Wannaruah LALC	Letter response	Agreement with proposed conservation methods of impacted sites	Recommended that:Regular monitoring of the Bowmans Creek sites is maintained throughout the mine life. Where surface remediation works are identified, further fieldwork will be required. Any known sites that may be impacted are either to be avoided or and AHIP permit for salvage obtained prior to disturbance.
24 October	Biami	Letter Response	Did not agree with the issuing of a Section 90 for the area	Called Scott Franks and left a message advising that there was no Section 90 application at this time. The report was an SMP report.

8.0 Summary of Assessment and Impacts

This document and accompanying Subsidence Management Plan in Volume 2 has been based on extensive investigation and analysis of the site conditions and likely subsidence behaviour of the proposed underground to ensure the environmental impacts of mining beneath Bowmans Creek and associated sensitive environments are avoided.

Overall, it has been found that the proposed miniwall design has significantly reduced subsidence of Bowmans Creek and that therefore, environmental impacts to this feature will be avoided or significantly reduced. Furthermore, subsidence impacts to the limited amount of surface infrastructure within the SMP Application Area is also significantly reduced in magnitude and extent.

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