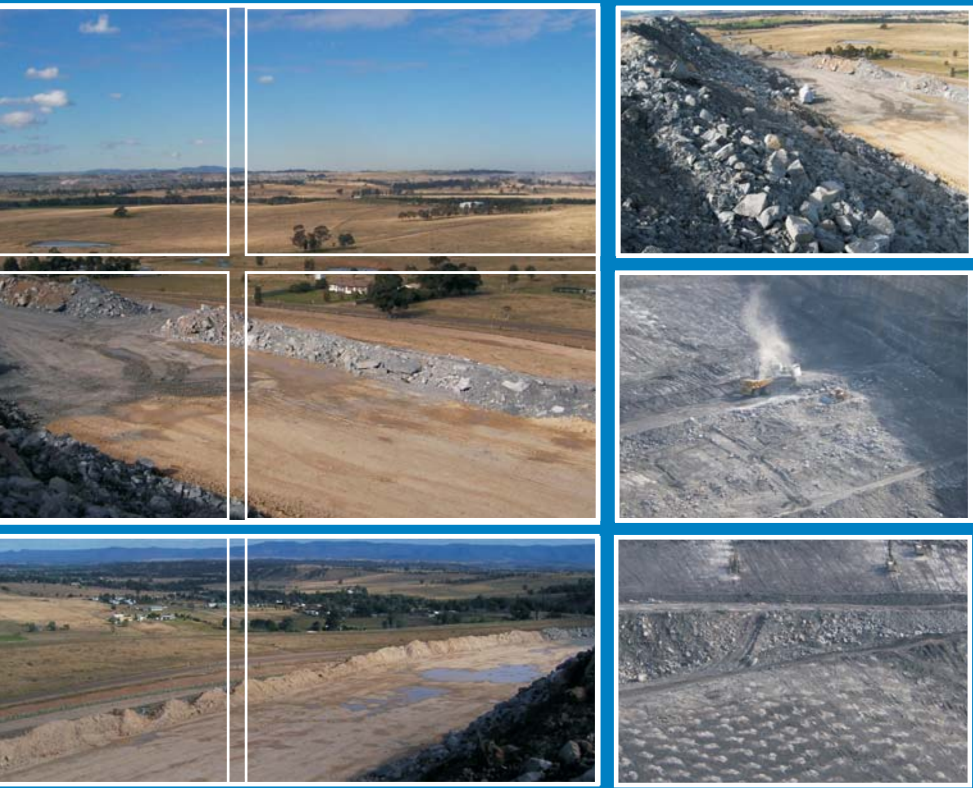

WRITTEN REPORT

Ashton Coal
Longwall Panels 1 - 4

Subsidence Management Plan
Written Report

for Ashton Coal Operations Limited

October 2006

0048045

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Delivering sustainable solutions in a more competitive world

Project Manager:	*Amanda Kerr*
Signed:	
Date:	*27 October 2006*
Project Director:	*Mike Shelly*
Signed:	
Date:	*27 October 2006*
Partner:	*Peter Southern*

Environmental Resources Management Australia Pty Ltd Quality System

Ashton Coal
Longwall Panels 1 - 4

Subsidence Management Plan
Written Report

for Ashton Coal Operations Limited

October 2006

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EXECUTIVE SUMMARY

This Application for Subsidence Management Approval – Written Report is submitted by ACOL as part of an application for approval to cover the extraction of longwall panels (longwalls) 1 to 4 within the Pikes Gully Seam at the Ashton Coal Mine (ACM). Approval of the Subsidence Management Plan (SMP) Application is required as part of the Section 138 (s138) approval process for secondary extraction under the Department of Primary Industries (DPI).

In accordance with correspondence received from the Department of Planning, this SMP has also been aligned with the Subsidence Environmental Management Plan (SEMP) process required as a condition of consent of the Development Approval for the site (which predates the current SMP process).

THE APPLICATION AREA

The ACM underground workings are located south of the New England Highway. Access is from the northern side of the New England Highway via portals into the southern highwall of the Arties Pit. The main headings are generally aligned beneath and adjacent to the New England Highway corridor, thereby minimising the impact of subsidence whilst maximising the recoverable area to the south.

This application for a SMP approval applies to an area wholly within Mining Lease (ML) 1533, and specifically, the proposed longwall panels 1 to 4 within the Pikes Gully Seam as illustrated in the SMP Approved Plans. The application for SMP approval includes:

- longwall panels 1 to 4;
- first workings for longwall panels 1 to 4; and
- development of main headings for longwall panel 5.

First workings for longwall panels 1 and 2 was approved by the Department of Primary Industries in October 2005 however will be superseded by approval of this SMP.

The extent of longwall panels 1 to 4 is defined by a setback from the Hunter River alluvium to the south and by Glennies Creek to the east and Bowmans Creek to the west. The lease boundary defines the extent of potential future extraction to the west.

The Application Area includes properties owned by ACOL, the RTA and one private landowner. The site is used for agricultural activities and contains one rural dwelling (owned by ACOL), and associated infrastructure.

MINING SYSTEMS AND RESOURCE

The ACM is located within the Hunter Coalfields of the Sydney Basin. The coal seams and surrounding strata are assigned to the Foybrook Formation. The 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 subcrop of the coal seams of principal interest. The stratum consists of a mix of sandstone, shale and interbedded to finely laminated sandstone/shale with a number of seam splits between.

Secondary extraction will be by retreating longwall methods. The seam section to be mined ranges from 2.4 to 2.7 metres and as the longwall equipment is capable of operating in the height range of 1.8 to 3.1 metres, the full seam width will be extracted for this stage of the project. The longwall equipment is also capable of negotiating the expected geological conditions, including any sandstone bands.

The underground mine will produce up to 2.4 million tonnes per annum of product coal. Underground coal resources within the Pikes Gully seam are estimated at 17.8 million tonnes (Mt) with a recoverable resource of 12.6Mt.

Following extraction of longwalls 1 to 4, a further four longwall panels are proposed to the west of longwall 4 to the western boundary of the mining lease. Extraction in this area includes coal beneath Bowmans Creek and the method and extent of extraction will depend on the outcomes of monitoring undertaken during the course of extraction within longwalls 1 to 4 in the Pikes Gully Seam.

Ultimately, underground operations will comprise a descending, multi-seam longwall operation. Following extraction of the Pikes Gully Seam and in accordance with ACOL life of mine plan, the Upper Liddell, Upper Lower Liddell and the Lower Barrett seams will be progressively extracted in descending order over a total of 18 years operating life. Extraction of the Upper Liddell seam is not expected to commence until after 2011.

SURFACE AND SUBSURFACE FEATURES

The Application Area is wholly within the Patrick Plains Mine Subsidence District which was proclaimed on 2 July 1980. A number of surface and sub-surface features have been identified within the Application Area. These include the New England Highway, farm buildings and sheds, fences, gates, private access roads, electricity transmission lines, telecommunications cables, water pipelines and tanks, fauna habitat, groundwater systems, archaeological sites, and steep slopes.

Each surface and subsurface feature within the Application Area is described in this report.

Areas of environmental sensitivity include the southern woodland, and Aboriginal archaeological sites. Bowmans Creek, the Hunter River and Glennies Creek are outside of the Application Area and will not be affected by subsidence associated with the proposed longwall panels 1 to 4.

SUBSIDENCE ASSESSMENT

Prediction Methodology and Reliability

Subsidence predictions have been made based on the empirical experience at sites with similar panel width and overburden depths. A maximum subsidence value of 65% of seam thickness has been used as a conservative estimate of subsidence over longwalls 1 to 4 respectively.

Estimates of strains and tilts are based on guidelines developed in the Western Coalfield because the database of experience these values are based on derives from operations with similar overburden depths and panel geometries to those proposed at ACOL.

An upper limit approach to estimating subsidence and subsidence parameters has been used. There is considered to be no potential for vertical subsidence to be greater than the predicted levels and it is likely that actual subsidence will be less than the maxima predicted.

At ACOL, the overburden depth and panel width are such that subsidence is likely to develop over each individual longwall panel effectively independently of any subsidence that has occurred in the adjacent panels. For practical purposes, the subsidence profiles that develop over each goaf edge are likely to be essentially similar. Permanent strains and tilts are expected to develop over each of the longwall goaf edges with transient tilts and strains expected above the retreating longwall face. Some permanent tilts and strains are likely to occur over the centre of each longwall panel, even though full subsidence has developed in this area. The strains and tilts are expected to be sufficiently high to cause significant disturbance to the surface and infrastructure directly over the longwall panels.

Lower than predicted subsidence may occur as a result of different bulking characteristics in the overburden strata at ACOL than the Western Coalfields and near-surface horizontal subsidence movements that cause localised strata dilation and less vertical subsidence. The current subsidence predictions will be refined, and updated, as subsidence monitoring results from longwall panels 1 to 4 become available.

Subsidence Values

Maximum vertical subsidence at ACOL will range from 1.6 to 1.8 metres following extraction of the Pikes Gully Seam. Empirical experience also indicates that, at overburden depths of less than 100 metres, only low levels of subsidence will develop above the chain pillars. For the overburden depths of longwalls 1 to 4, maximum subsidence over the chain pillars is likely to be less than 100mm. Goaf edge subsidence will average about 70mm, though may range up to 100mm. The final subsided surface profile will comprise a series of troughs.

Maximum systematic horizontal movements of up to five to eight times the maximum tilt may develop. Therefore, at shallow depths near the northern end of longwall panel 1, horizontal movements of a similar magnitude to the vertical subsidence may occur. However, horizontal movements of this magnitude are typically observed in steeply dipping terrain and the surface terrain over most of the Application Area is relatively gently sloping. Consequently, horizontal movements are likely to be toward the lower end of the range indicated.

Over most of the longwall panels, surface cracking of up to several hundred millimetres are predicted. Permanent tension cracks are expected to develop over all the goaf edges in a direction parallel to the goaf edge. Surface cracking is expected to occur from just outside the goaf edge and increase in magnitude with distance over the goaf, reaching a peak at the largest crack located approximately 20 to 30 metres from the goaf edge. Cracks are also expected to develop in an arcuate shape around the corners of the longwall panel to become parallel with the longwall face in the centre of each panel.

A series of permanent tension cracks separated by compression humps at intervals of 10 metres or so may develop parallel to the longwall face. This behaviour is most likely to be evident at shallow overburden depths.

Predictions and impacts to each surface and subsurface feature are addressed in this report.

STAKEHOLDER AND COMMUNITY CONSULTATION

Stakeholder consultation has been conducted throughout the preparation of the SMP in accordance with the SMP guidelines and other relevant policies. Methods of consultation included: newspaper advertisements, correspondence, individual and public meetings, and the community consultative committee. The views and feedback received during this process have been accounted for in the preparation of the SMP and are summarised in this report.

STATUTORY REQUIREMENTS

This application complies with the following requirements and documents:

- Development Consent 309-11-2001-i;
- SMP Guidelines (Department of Mineral Resources, 2003);
- Mining Lease 1533; and
- Mining Operations Plan (ACOL, 2005d).

Compliance and consistency with the above documents is demonstrated in this Written Report and the Subsidence Management Plan.

SUBSIDENCE IMPACTS

Based on the subsidence assessment and prediction, this Written Report outlines predicted impacts to all surface and subsurface features within the Application Area.

A comprehensive risk assessment was conducted to identify the hazards, analyse the risks, determine the acceptability of risks and develop recommendations for additional controls related to the impact of subsidence across the Application Area.

This risk assessment was used in the formulation of the Subsidence Management Plan and associated specific subsidence management plans in accordance with the guidelines.

1 *INTRODUCTION*

ACM is located approximately 14 kilometres (km) northwest of Singleton, near the village of Camberwell in the Hunter Valley region of New South Wales (*Figure 1.1*).

The operator of the Ashton Coal Mine (ACM) is Ashton Coal Operations Pty Ltd (ACOL) (ACN 009 713 893), a privately owned, Australian incorporated company.

This Application for Subsidence Management Approval – Written Report is submitted by ACOL as part of an application for approval to cover the extraction of longwall panels (longwalls) 1 to 4 within the Pikes Gully Seam at the Ashton Coal Mine (ACM). Approval of the Subsidence Management Plan (SMP) Application by the Department of Primary Industries (DPI) is required as part of the Section 138 (s138) approval process for secondary extraction

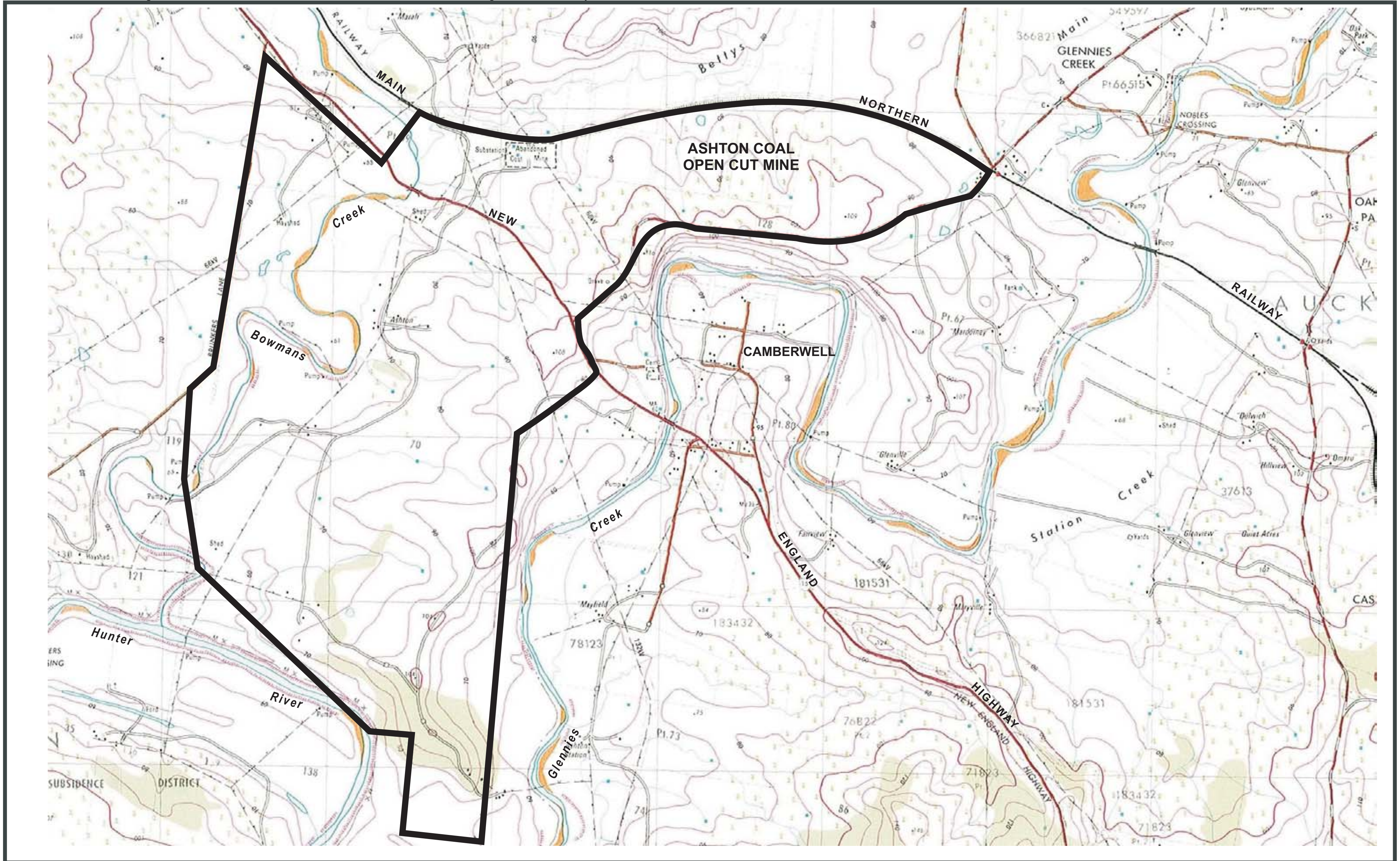
1.1 *HISTORY OF OPERATIONS*

Initial exploration within the area now referred to as the ACM, commenced in late 1969, after the original proponents (Durham Holdings) acquired the mineral rights to the Ashton property. Exploration comprised part of a larger exploration program for Durham Holdings Ltd, a subsidiary of Consolidated Gold Fields Australia Ltd and Dalgety Australia Ltd, which was serviced and managed by the Joint Coal Board.

In September 1999, the Minister for the Department of Mineral Resources (DMR) transferred all rights, title and interests in the Exploration Licence (EL) 4918 to White Mining Limited. Subsequently, White Mining Limited implemented a program of in-fill drilling between February 2000 and June 2001, to augment the earlier exploration conducted by Durham Holdings. In combination, these investigations confirmed the potential of the Ashton Coal Project.

This exploration work culminated in the lodgement of a development application (DA) for the Ashton Coal Mine with the Department of Infrastructure Planning and Natural Resources on 2 November, 2001. The DA sought approval for a range of activities including:

- site preparation and clearing of specified areas of vegetation in the DA area;
- open cut coal mining in two pits (Arties Pit and Barrett Pit) to the north of New England Highway, between the Main Northern Railway and Glennies Creek Road;



ERM

0 500m
Approximate Only

Legend

Mine Lease Boundary

Figure 1.1 **Locality Plan**

ACOL - Subsidence Management Plan, LW1- 4

- underground coal mining using longwall techniques, to the south of New England Highway, to be accessed through the southern wall of the Arties Pit;

- construction of a coal handling and preparation plant (CHPP);

- construction of stockpiling and coal loading facilities and a new rail siding;

- construction of administration, car parking, stores and bathhouse facilities;

- site access from Glennies Creek Road; and

- mine operation for up to 21 years.

Based on advice from relevant government agencies, the DA was amended to exclude the diversion of a section of Bowmans Creek. Development consent (DA No. 309-11-2001-i) was granted on the 11th of October, 2002 by the Minister for Planning pursuant to the provisions of the Environmental Planning and Assessment Act, 1979. The development consent contains over 250 individual consent conditions, including requirements for the development of 22 environmental management plans in consultation with 18 government agencies.

In January 2005, White Mining Limited was acquired by Felix Resources, a privately owned Australian incorporated company. The Ashton Coal Project is an unincorporated joint venture between Felix Resources (60%), Itochu Corporation of Japan (Itochu, 20%) and IMC International Marine Corporation Group, 20%). Felix Resources manages the project, both Felix and Itochu have coal marketing responsibilities, and Itochu provides marketing coverage in Japan. The Singapore-based IMC group purchased a 20 per cent interest from Felix Resources in August 2005 for $30 million and is providing funding support for development of the underground mine.

Open-cut mining operations commenced in the Barrett pit in 2004 and extraction from the Arties pit commenced in June 2005.

Approval for the first workings SMP was granted by the Department of Primary Industries (DPI) in October 2005 (File No. 05/1688). This approval was subject to a number of approval conditions and applies only to first workings for longwalls 1 and 2 within the Pikes Gully Seam only.

2 *THE APPLICATION AREA*

2.1 *OVERVIEW*

The ACM underground workings are located south of the New England Highway. Access is from the northern side of the New England Highway via portals into the southern highwall of the Arties Pit. The main headings are generally aligned beneath and adjacent the New England Highway corridor, thereby minimising the impact of subsidence whilst maximising the recoverable area to the south.

This application for a SMP approval applies to an area wholly within Mining Lease (ML) 1533, and specifically, the proposed longwalls 1 to 4 as illustrated in the SMP Approved Plans. The application for SMP approval includes:

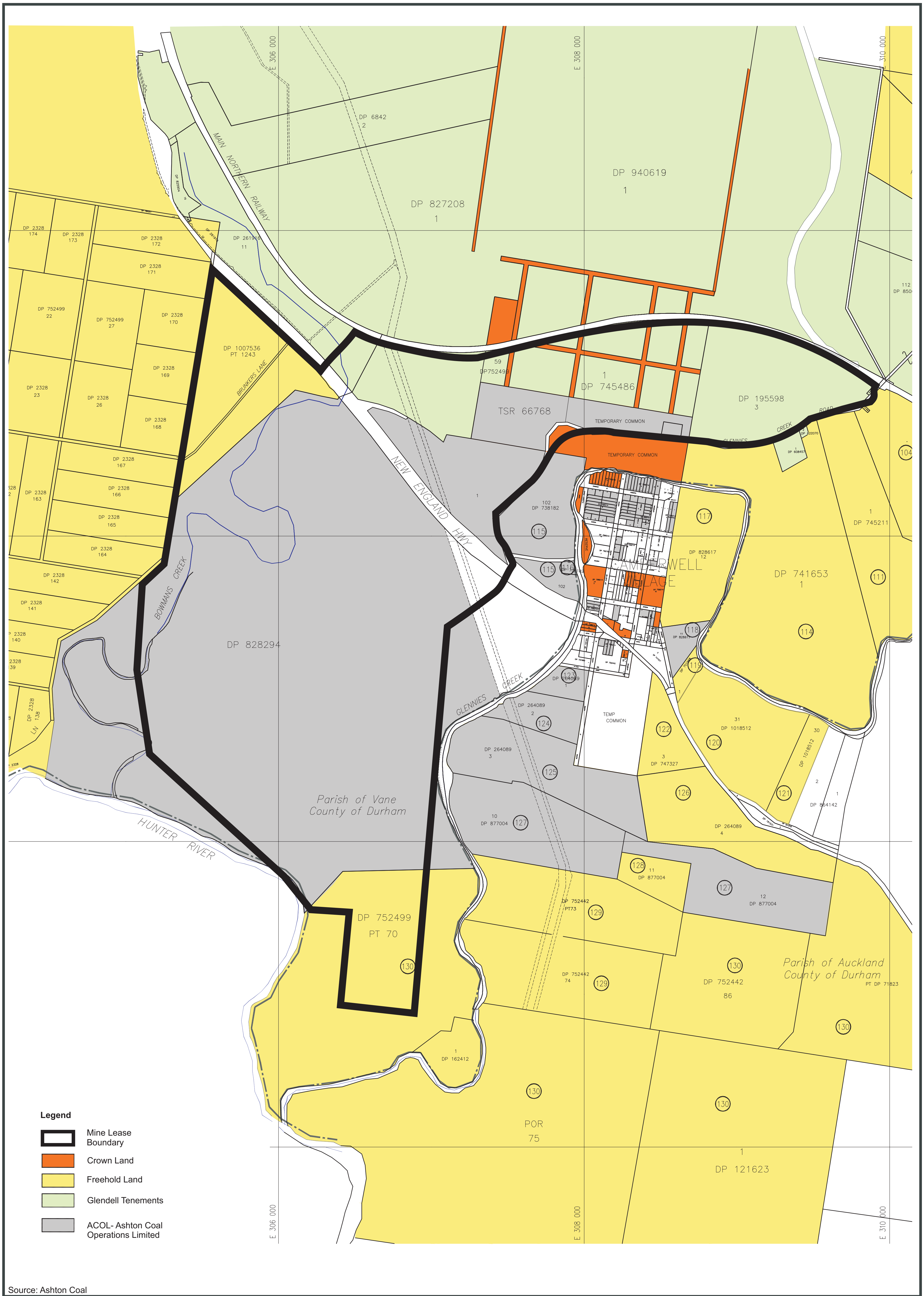
- longwall panels 1 to 4;
- first workings for longwall panels 1, 2, 3 and 4; and
- development of main headings for longwall panel 5.

The First workings SMP for longwall panels 1 and 2 was approved by the Department of Primary Industries in October 2005 however will be superseded by approval of this SMP.

The extent of longwall panels 1 to 4 is defined by a setback from the Hunter River alluvium to the south and by Glennies Creek to the east and Bowmans Creek to the west. The lease boundary defines the extent of potential future extraction to the west.

2.2 *LAND OWNERSHIP AND USE*

The ACM lies wholly within the Singleton local government area. The majority of surface land within the Application Area overlying longwalls 1 to 4 is owned by ACOL. A proportion of land above the main headings includes the New England Highway road reserve which is owned and managed by the Roads and Traffic Authority (RTA). The remainder is owned by a single private landholder. A summary of land ownership and use of is given in *Table 2.1*. *Figure 2.1* shows the land ownership status relative to the Mining Lease area.



Source: Ashton Coal

Figure 2.1 **Land Ownership**

ACOL - Subsidence Management Plan, LW1- 4

0 400m
Approximate Only

ERM

Table 2.1 Land Ownership and Use within the Application Area

Land Ownership	Current Land Use
Ashton Coal Mines Ltd, Lot 701, DP828294	Two rural dwellings and associated infrastructure (leased to tenants) and cattle grazing.
Roads and Traffic Authority of NSW, New England Highway Road Reserve	New England Highway.
Private Owner, Lot 70 DP 752499 (referred to as 'Property No. 130' - follows HLA, 2001)	Agriculture, dairy, one rural dwelling and associated infrastructure.

2.3 *APPLICATION AREA*

The Application Area (or subsidence impact zone) is defined by the 'Guideline for Applications for Subsidence Management Approvals' (DMR, 2003) as the surface area that is likely to be affected by the proposed underground coal mining and is generally considered to be no less than the surface area defined by the cover depth, angle of draw of 26.5 degrees and the limit of the proposed extraction area.

The Application Area is shown in *Figure 2.2*.

Jobs/2006/0048045/SMP- Fg2.2 Application Area.cdr 11 09 2006 SP Environmental Resources Management Australia Pty Ltd

Source: Ashton Coal Operations

0 500m
Approximate only

Figure 2.2 **Application Area**

ACOL - Subsidence Management Plan, LW1- 4

3 MINING SYSTEMS AND RESOURCE RECOVERY

3.1 RESOURCE DESCRIPTION

The ACM is located within the Hunter Coalfields of the Sydney Basin. The coal seams and surrounding strata are assigned to the Foybrook Formation, a stratigraphic unit of the Late Permian Singleton Supergroup. This formation is part of the Vane Subgroup of the Whittingham Coal Measures and is the basal coal bearing sequence of the Singleton Supergroup. The Foybrook Formation contains at least six named coals which commonly split and coalesce.

The 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 subcrop of the coal seams of principal interest. These subcrops 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 seam splits between.

The Foybrook Formation coals at ACOL 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 coal to be recovered is variable and ranges between 20% and 28% (HLA, 2001). Raw coal will be processed in the Ashton CHPP and test work carried out on selected working sections indicates a low ash product (8.5% average) with strong coking properties can be recovered. Alternatively, a slightly higher ash (10.5% average) semi-soft or thermal product can be recovered. Thus, steaming coal and semi soft coking coal can be produced for the export market, and sized raw coal for domestic consumption.

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 to 85 percent of total litho types. Vitrinite reflectance (Ro Max for telovitrinite) is in the order of 78 to 82%. This places the resource at the upper end of the rank profile for the Hunter Valley (White Mining Limited, 2002).

The Environmental Impact Statement (EIS) prepared by HLA Envirosciences (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. Sample depths ranged from 180 to 280 metres, and results indicate that the coal seams contain low to moderate quantities of gas which is predominately methane (CH_4:70-90%), with nitrogen (N: 8-22%) and carbon dioxide (CO_2: 1.5%) making up the remainder.

3.2 MINING METHODS

The proposed underground mining method to be employed at ACOL for all longwall panels is longwall extraction.

3.2.1 *Longwall Extraction*

Secondary extraction will be by retreating longwall methods. The seam section to be mined ranges from 2.4 to 2.7 metres and as the longwall equipment is capable of operating in the height range of 1.8 to 3.1 metres, the full seam width will be extracted for this stage of the project. The longwall equipment is also capable of negotiating the expected geological conditions, including any sandstone bands.

A combination of consistent seam thickness, good roof and floor conditions, low gas and the lack of any significant geological structure or intrusions means that longwall mining methods can be adopted. Longwall extraction was selected as the preferred method of mining as it provides the greatest production and economic efficiencies when compared to other options. It is the only method that can provide acceptable economic returns for extraction of the area based on coal quality, required production levels, current economics and forecasted economic parameters.

The longwall is initially planned to operate 24 hours per day, five to seven days per week, but operating hours may be modified to suit prevailing conditions in the export coal market. The CHPP will need to be upgraded to 1000tph to accommodate the increased production. This will be achieved by the construction of an extra 600tph module on the CHPP.

Longwalls 1 to 4 are all planned to be 206 metres wide and range in length from 2286 to 2610 metres. The chain pillars separating the adjacent panels will be 25 metres rib to rib, with cut throughs nominally at 100 metre centres. *Table 3.1* details the dimensions of the proposed longwall panels 1 to 4.

Table 3.1 Dimensions of Longwall Panels 1 to 4 (metres)

Longwall Panel	Panel Width (rib to rib)	Panel Length
1	206	2610
2	206	2286
3	206	2405
4	206	2512

3.3 MINE LAYOUT

The longwall panels are oriented approximately north / south, aligned parallel to the western boundary of the ML 1533, with main headings being developed below and in alignment with the New England Highway. Longwall blocks of approximately 206 metre face width will be mined. This SMP addresses mining of the Pikes Gully seam only, however, the mine plan is designed to ultimately comprise a descending multi seam longwall operation with longwalls superimposed vertically.

The Pikes Gully seam will be extracted down dip (east to west). An in-seam drift provides conveyor coal transport to the permanent run of mine (ROM) stockpile in the Arties Pit. Coal is transported from the site by rail.

The layout was selected based on the shape of the current mining lease extents to maximise extraction and efficiency of the operation. The southern extent of longwall 1 has been moved north (shortened) compared to the layout approved by Ashton's Development Consent. The start position was moved following investigations into the extent of the Hunter River alluvium in this area. Based on the findings of this drilling program regarding the geology of that area, the current start position of longwall is approximately 90 metres from the alluvium associated with the Hunter River.

3.4 *SEAM TO BE MINED*

The proposed seam to be mined under the current SMP is the Pikes Gully seam with in the proposed longwalls 1 to 4. The overburden depth of the Pikes Gully seam within the Application Area is variable, principally as a result of seam dip, and ranges from 35 metres at the out-bye (northern) end of longwall 1 to 150 metres at the in-bye (southern) end of longwall 4. The thickness of the Pikes Gully Seam within the Application Area varies from 2.4 to 2.7 metres. The full seam thickness will be extracted.

3.5 *MINING SCHEDULE*

The longwall is scheduled to operate five to seven days a week, 24 hours/day on a rotating shift basis. The longwall will commence operation early in 2007.

The proposed mining schedule for longwall panels 1 to 4 is detailed in *Table* 3.2. However, mine scheduling can be impacted by numerous factors and these dates are indicative only.

Table 3.2 ***Proposed Mining Schedule for Longwall Panels 1 to 4***

Longwall Panel	Estimated Start Date	Estimated Completion Date
1	February 2007	November 2007
2	December 2007	May 2008
3	June 2008	January 2009
4	February 2009	August 2009

3.6 *IMPACT OF MINING ON TOTAL RESOURCE RECOVERY*

The longwall layout has been designed to maximise underground extraction within ML 1533 considering the site geological and environmental constraints. The proposed workings are relatively shallow, and the longwall layout has been designed to provide suitable buffers to the Hunter River, Glennies Creek, Bowmans Creek and the New England Highway.

The Pikes Gully Seam is the uppermost viable coal seam within the site. ACOL will be extracting the full width of the Pikes Gully Seam within each longwall panel and extraction will not sterilise the future extraction of other seams.

3.7 *RESOURCE RECOVERY*

Coal resources and reserves are computed using Minex and AutoCAD software. Input sources include:

- survey data;
- cored borehole data;
- underground seam thickness measurements at each roadway intersection; and
- physical and quality data from strip samples at 200 metre intervals.

The underground mine will produce up to 2.4 million tonnes per annum (Mtpa) of product coal. Underground coal resources within the Pikes Gully seam are estimated at 17.8 million tonnes (Mt) with a recoverable resource of 12.6Mt.

Resource estimates for the proposed underground workings are detailed in *Table 3.3*. Reserve estimates for the various components of the Application Area are detailed in *Table 3.4*.

Table 3.3 *Resource and Recovery Estimates for the Proposed Workings*

	Coal Resources (Mt)	Recoverable Resource (Mt)	% Recovered (Nominal)
<u>Area of First Workings</u>			
Northwest mains & longwall barrier pillars, including maingates 1 to 4	3.145	0.900	28.63%
Subtotal	3.145	0.900	28.63%
<u>Longwall Panels</u>			
1	1.911	1.911	100%
2	1.636	1.636	100%
3	1.588	1.588	100%
4	1.607	1.607	100%
Subtotal	6.742	6.742	100%
TOTAL	**9.887**	**7.642**	**77.3%**

Table 3.4 *Reserve Estimates for the Proposed Workings*

	ROM Coal Reserves[1] (Mt)	Marketable Reserves[2] (Mt
<u>Area of First Workings</u>		
Headings & longwall barrier pillars, including maingates 1 to 4	0.900	0.585
Subtotal	0.9	0.585
<u>Longwall Panels</u>		
1	1.911	1.242
2	1.636	1.063
3	1.588	1.032
4	1.607	1.045
Subtotal	6.742	4.382
TOTAL	**7.642**	**4.967**

1. Includes dilution. No moisture adjustment.
2. Washed coal at a nominal 8% moisture and 9% ash

3.8 IMPACT OF MINING ON SURROUNDING SEAMS

The major coal seams identified in the area are, in descending stratigraphic order, the Lemington, Pikes Gully, Arties, Upper Liddell, Middle Liddell, Upper Lower Liddell, Lower Lower Liddell, Upper Barrett and Lower Barrett seams.

As a result of extraction of longwalls in the Pikes Gully seam, there will be subsidence impacts on all overlying strata through to the surface. Whilst there will be some stress related impacts on strata immediately below the floor of the Pikes Gully seam as a result of extraction, this is not expected to impact the ability for seams below to be mined in the future.

3.9 *FUTURE EXTRACTION PLANS FOR OTHER SEAMS*

Following extraction of longwalls 1 to 4, a further four longwall panels are proposed to the west of longwall 4 to the western boundary of the mining lease. Extraction in this area includes coal extraction beneath Bowmans Creek and the method and extent of extraction will depend on the outcomes of monitoring undertaken during the course of extraction within longwalls 1 to 4 in the Pikes Gully Seam.

Ultimately, underground operations will be a descending, multi-seam longwall operation. Following extraction of the Pikes Gully Seam and in accordance with ACOL life of mine plan, the Upper Liddell, Upper Lower Liddell and the Lower Barrett seams will be progressively extracted in descending order over a total of 18 years operating life. Extraction of the Upper Liddell seam is not expected to commence until after 2011.

4 SITE CONDITIONS

4.1 SURFACE TOPOGRAPHY

The topography of the Application Area comprises floodplains adjacent to the Hunter River and Bowmans Creek and undulating slopes. Surface topography reflects the general dip of the overburden strata to the west over most of the Application Area, though there are some steeper slopes dipping to the east down to Glennies Creek and to the south down to the alluvial flats of the Hunter River. Elevations range from approximately 60 metres Australian Height Datum (AHD) to approximately 100 metres AHD.

4.2 DEPTH OF COVER

Depth of cover is variable, largely due to surface topography variations and seam dip to the west. The overburden depth over longwalls 1 to 4 ranges from a minimum of 35 metres at the outbye (northern) end of longwall panel 1 to a maximum of 150 metres at the inbye (southern) end of longwall panel 4.

4.3 OVERBURDEN STRATIGRAPHY

The Pikes Gully seam is overlain by sediments assigned to the Singleton Supergroup as described herein. The strata 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 in turn is overlain by the Archerfield Sandstone and Jerrys Plains Sub group respectively. The Bulga Formation and Archerfield Sandstone are marine sandstones or laminites. The Jerrys Plains Sub group includes the Bayswater Seam which has been mined in the adjacent Ravensworth development and only a remnant portion of it exists in the far western part the project area. In situ coal attributed to this seam does not form part of this development.

These strata are of Late Permian age and consist of coal seams, siltstone, lithic sandstones, shale and conglomerate. The coal seams contain many splits only a few of which are suitable for mining either by open cut or underground methods. Conglomerates outcrop at several locations along Bowmans Creek (ie near the New England Highway bridge and Department of Natural Resources [DNR] stream gauging station).

4.4 *LOCATION OF EXISTING AND FUTURE WORKINGS*

There is extensive coal mining activity in the locality. Neighbouring open cut mines include Camberwell (east), Ravensworth South/Narama (west) and Lemington (south). Underground mines in the vicinity of ACOL include Glennies Creek (northeast), Nardell (northwest) and Cumnock (northwest). As a component of the overall Ashton Coal Project, open cut mining has commenced north of the New England Highway.

This SMP addresses underground mining of longwall panels 1 to 4 in the Pikes Gully Seam. First workings are currently being undertaken in the north-west mains and maingate 1 and tailgate 1 panels.

Future extraction plans include the development and extraction of a further four longwall panels within the Pikes Gully Seam to the west of the Application Area and subsequently an additional three underlying seams (being the Upper Liddell, Upper Lower Liddell and the Lower Barrett seams in sequence).

Any future proposal to mine longwall panels 5 to 8 within the Pikes Gully Seam and lower seams is dependent on the data collected during monitoring of longwall panels 1 to 4 during extraction. The data collected will be used to determine the potential impacts of underground mining on Bowmans Creek and associated groundwater resources. Any extraction in this area will be subject to a separate subsidence management plan application to the DPI.

4.5 *LITHOLOGICAL AND GEOTECHNICAL CHARACTERISTICS OF THE OVERBURDEN*

The Pikes Gully seam overburden comprises sandstone and minor siltstone units. These sandstone units are variable in nature, ranging from coarse grained, bedded to massive, with zones of sub-vertical jointing (Strata Engineering, 2006 – provided as *Annex A*). The principal features of the Pikes Gully Seam overburden (as assessed for Maingate 1 and Tailgate 1) are:

- depth of cover above longwall 1 ranges from 35 to 95 metres with the depth of weathering varying between 7 and 21 metres;
- sandstones within the overburden are more durable and stronger than the mudstone/shale roof and represent a favourable anchorage horizon for roof support and a more competent main roof; and
- regional trends in the overburden are not currently definable, however local variations are evident with regard to the composition and grain size of the sandstone units – suggesting the presence of channels.

4.6 Lithological and Geotechnical Characteristics of the Roof and Floor Strata

The roof of the Pikes Gully Seam is typically a layer of carbonaceous mudstone/shale (0.2-0.3 metres thick) overlain by a rider seam (0.1-0.2 metre thick) followed by a second layer of carbonaceous mudstone/shale varying in thickness from zero to 0.5 metres.

Strata Engineering (2006) outlines the primary roof support requirements for maingate 1 and tailgate 1. They note that the intention on development is to cut down the rider seam and the adjacent mudstone units, such that the sandstone forms the immediate roof. In areas where the mudstone above the rider seam thickens to the extent that this is not practical, this material will be left in the roof and support requirements implemented accordingly.

The roof quality and structural competency has been determined using the Coal Mine Roof Rating system (CMRR) as discussed in *Annex A*. This assessment was based on core exploration holes and covers the area from the outbye end of maingate/tailgate 1 to the inbye limit. CMRR values ranged from 48.2 to 62.5, therefore characterising the roof as 'moderate' to 'strong'.

Whilst most of the weak carbonaceous mudstone above and below the rider seam will be cut down, isolated patches of mudstone will necessitate the use of mesh in these areas.

5 GEOLOGICAL STRUCTURE

5.1 GEOLOGICAL STRUCTURE

Two prominent conjugate joint sets have been identified in the study area:

- Set 1 is a north north-east striking set dipping at 80º to the east south-east;
- Set 2 is a west north-west striking vertical set; and
- occasional mid-angle joints.

Strata Engineering (2006) observed that whilst Joint Set 2 has been generally unseen, Joint Set 1 has been evident in the underground workings to date and that in this location the strike has been much closer to a north-south orientation rather than north north-east. Joint Set 1 has an average spacing between joints of greater than five metres, however joints occasional appear as minor swarms with joint spacings of less than 0.5 metres. The observed dip angle within the first workings range from 75º to vertical with joints dipping to the east south-east and west north-west.

There are no major geological structures (ie faults or dykes) within the highwall area and the resource as a whole is expected to be largely free of significant geological structure (Strata Engineering, 2006).

5.2 OTHER GEOLOGICAL DATA PROVIDED IN SUPPORT OF THE APPLICATION

Other geological data provided in support of the SMP application is provided in *Annex B*. This data is commercially sensitive and not for public viewing.

5.3 STABILITY OF UNDERGROUND WORKINGS

Roof behaviour of underground workings is expected to be static and that generally, the roof will be self-supporting and amenable to the application of low to moderate support densities. Bolts will be used (refer to *Annex A)* to assist in the retention of static roof behaviour given that buckling may develop in the longer-term and to provide some protection against localised 'key-block' roof failure.

6 CHARACTERISATION OF SURFACE AND SUB-SURFACE FEATURES

6.1 IDENTIFICATION OF FEATURES

The Application Area is wholly within the Patrick Plains Mine Subsidence District which was proclaimed on 2 July 1980.

A number of surface and sub-surface features have been identified within the Application Area.

Table 6.1 summarises the features specified in *Guideline For Applications For Subsidence Management Approvals* (DMR, 2003) as potentially affected by underground mining, and states whether each individual feature has been identified within the Application Area.

Table 6.1 also includes features not included in the SMP guidelines (DMR, 2003), but identified within the Application Area.

Table 6.1 *Identification of Surface and Sub-Surface Features*

Feature	Identified in Application Area	Details
Natural Features	**Yes**	***Section 6.3***
Catchment Areas and declared Special Areas	No	
Rivers and creeks	No	*Section 6.3.1*
Drainage paths and channels	**Yes**	*Section 6.3.2*
Aquifers, known groundwater sources	**Yes**	*Section 6.3.3*
Springs	No	
Sea/ lake	No	
Shorelines	No	
Natural dams	No	
Cliffs/ pagodas	No	
Steep slopes	**Yes**	*Section 6.3.4*
Escarpments	No	
Land prone to flooding or inundation	**Yes**	*Section 6.3.5*
Swamps/ wetlands/ water related ecosystems	No	
Threatened and protected species	**Yes**	*Section 6.3.7*
National Parks	No	
State Recreation Areas	No	
State Forests	No	
Natural Vegetation	**Yes**	*Section 6.3.8*
Areas of significant geological interest	No	
Fauna and fauna habitat	**Yes**	*Section 6.3.9*
Public Utilities	**Yes**	***Section 6.4***
Railways	No	
Roads	**Yes**	*Section 6.4.1.*
Bridges	No	
Tunnels	No	
Culverts	No	
Water/ gas/ sewerage pipelines	No	
Liquid fuel pipelines	No	
Electricity transmission lines and associated plant	**Yes**	*Section 6.4.2*
Telecommunication lines and associated plant	**Yes**	*Section 6.4.3*

Feature	Identified in Application Area	Details
Water tanks, water and sewerage treatment works	No	
Dams, reservoirs and associated works	No	
Air strips	No	
Public Amenities	**No**	
Hospitals	No	
Places of worship	No	
Schools	No	
Shopping centres	No	
Community centres	No	
Office buildings	No	
Swimming pools	No	
Bowling greens	No	
Ovals and cricket grounds	No	
Race courses	No	
Golf courses	No	
Tennis courts	No	
Farm Land and Facilities	**Yes**	***Section 6.5***
Agricultural utilisation/suitability of farm land	**Yes**	*Section 6.5.1.*
Farm buildings / sheds	**Yes**	*Section 6.5.2*
Gas and/or fuel storages	No	
Poultry sheds	No	
Glass houses	No	
Hydroponic systems	No	
Irrigation systems	**Yes**	*Section 6.5.3*
Fences/ gates	**Yes**	*Section 6.5.4*
Farm dams	**Yes**	*Section 6.5.5*
Wells/ bores	No	
Industrial, Commercial and Business Establishments	**Yes**	***Section 6.6***
Factories	No	
Workshops	No	
Business or commercial establishments	No	
Gas and/or fuel storages and associated plant	No	
Waste storages and associated plant	No	
Buildings, equipment and operations that are sensitive to surface movements	No	
Surface mining (open cut) voids and rehabilitated areas	No	
Mine infrastructure including tailings dams and emplacement areas	No	
Mine infrastructure – water pipeline	**Yes**	*Section 6.6.1*
Areas of Archaeological and/or Heritage Significance	**Yes**	***Section 6.7***
Archaeological sites	**Yes**	*Section 6.7.1*
Heritage sites	No	
Items of Architectural Significance	**No**	
Permanent Survey Control Marks	**No**	
Residential Establishments	**Yes**	***Section 6.9***
Houses	**Yes**	*Section 6.9*
Flats/ units	No	
Caravan parks	No	
Retirement/ aged care villages	No	
Associated structures (workshops, garages, onsite waste water systems, water or gas tanks, swimming pools, tennis courts)	**Yes**	*Section 6.9*

Feature	Identified in Application Area	Details

It is estimated that man-made structures listed in *Table 6.1* built prior to the proclamation of the Mine Subsidence District in 1980 comprise:

- dwellings;
- sheds;
- farm dams and water tanks; and
- fences/gates/cattlegrids.

There are no known, relevant proposed developments within the Application Area scheduled for development within the next seven years.

6.2 *CHARACTERISATION OF FEATURES*

The Application Area lies within the downstream limits of the Bowmans Creek and Glennies Creek catchments. The land surface generally consists of undulating hills dominated by open grasslands and floodplains of the lower reaches of Bowmans Creek. There is an area of remnant woodland within the south eastern portion of the Application Area.

Land use is predominantly livestock grazing, with some irrigation and cultivation on the Hunter River floodplain. Since European settlement, the most commonly constructed surface features are fences and farm dams required for livestock grazing.

Bowmans Creek lies to the west of the Application Area and is therefore outside the area to be affected by subsidence. There are some ephemeral drainage depressions and minor gullies within the Application Area.

A large number of archaeological sites containing artefacts have been identified within the Application Area, some of which are considered to have high archaeological significance (Witter, 2002).

6.3 *NATURAL FEATURES*

6.3.1 *Rivers and Creeks*

No rivers or creeks have been identified within the Application Area. Bowmans Creek, Glennies Creek, and the Hunter River are outside the subsidence impact zone, however lie within the extent of Mining Lease 1533 and may be affected by indirect subsidence impacts such as changes to drainage patterns and water quality.

The catchment areas of the site are shown in *Figure 6.1*.

Hunter River

The Hunter River lies to the south of the Application Area, and at its closest point (near the corner of longwall 3) the underground workings are approximately 175 metres from the Hunter River and 130 metres from the edge of the Hunter River alluvium (Dundon, 2006). The Hunter River alluvium is closest to longwall panel 1 and is 90 metres from the start of longwall panel 1. The land between the Application Area and the Hunter River consists of floodplain, and steep slopes.

Adjacent to the Application Area, the Hunter River channel is deeply incised within the floodplain and reflects various anthropogenic influences (ie clearing and grazing) with respect to is morphology.

Bowmans Creek

Bowmans Creek is a tributary of the Hunter River and meanders in a southerly direction along the western periphery of the Application Area, with the top of the bank coming within approximately 60 metres of the goaf edge of longwall panel 4. Adjacent to the Application Area, the channel of Bowmans Creek is incised four to five metres below the surrounding topography. The stream exhibits a pool and riffle sequence formed by gravel shoals and in-channel gravel point bars. It comprises a series of one to two metre deep ponds retained behind pebble bars that are typically vegetated. The bed of the channel is lined by cobbles with occasional outcropping of bedrock. Bowmans Creek is generally perennial, although it reportedly ceases to flow during severe droughts.

A pre-mining assessment of Bowmans Creek geomorphology is provided in *Annex C* in accordance the development consent conditions for the site. Ponding surveys conducted by Pegasus Technical in March 2006 and field inspections conducted by ERM in May 2006 have been used to map channel characteristics, including channel bars, pools, riffles, bedrock outcrop, knick points, relic sand bars, vegetation, areas of erosion, terracing, and locations where aquatic fauna were observed.

Adjacent to the Application Area the channel of Bowmans Creek is generally incised up to eight metres below the surrounding alluvial flats and up to twelve metres below the bank as it joins the Hunter River. The channel banks are alternately steep, gently sloping and terraced, with no clear pattern to channel form evident within the study area. The steepest bank is generally located on the outside of bends, as is typical of a meandering stream. Occasional outcrops of bedrock were evident along the length of the creek. With downstream progression, the channel bed graded from cobble lining with a gravely silty substrate, to a silty sand substrate.

Jobs/2006/0048045/SMP- Fg6.1Catchments and Flood Extent.cdr 10 10 2006 JD Environmental Resources Management Australia Pty Ltd

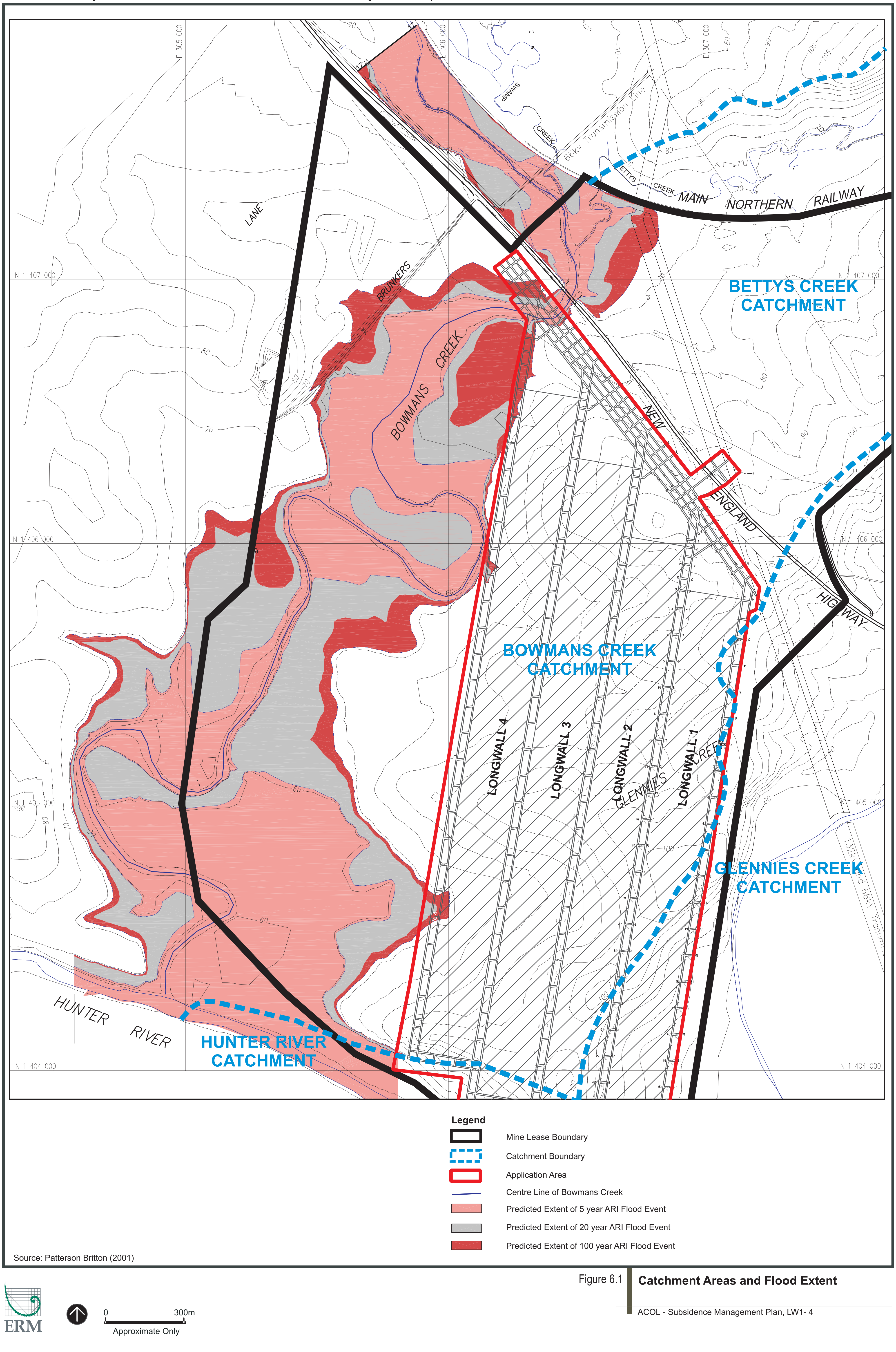


Figure 6.1 **Catchment Areas and Flood Extent**

ACOL - Subsidence Management Plan, LW1- 4

ERM

Glennies Creek

Glennies Creek is located along the eastern periphery of the Application Area. It meanders in a southerly direction till reaching its confluence with the Hunter River, south east of the Application Area. At its closest point, Glennies Creek is separated by approximately 150 metres of steep slope from the goaf edge of longwall panel 1. The depth of cover over the Pikes Gully Seam in this area is approximately 75 metres.

6.3.2 Drainage Paths and Channels

Runoff from the site generally discharges overland into Bowmans Creek as overland sheet flow. It is occasionally concentrated along gullies that serve as poorly defined ephemeral drainage depressions and gullies. Small areas within the eastern and southern portions of the Application Area flow to Glennies Creek or the Hunter River respectively.

6.3.3 Aquifers and Groundwater

Groundwater investigations for the site include studies carried out for the EIS (HLA, 2001) as well as recent investigations for the preparation of the SMP. ACOL commissioned Peter Dundon and Associates Pty Ltd to prepare an assessment of groundwater conditions and impacts for longwalls 1 to 4 for the purposes of this SMP application. The report by Peter Dundon and Associates Pty Ltd (Dundon, 2006) is included as *Annex D* in full, and summarised in this section.

Groundwater is present in the Application Area within the Permian coal measures with groundwater flows occurring within the coal seams, including the Pikes Gully Seam. Within the extent of ML1533, but outside of the Application Area, groundwater is also present in alluvium associated with Bowmans Creek, Glennies Creek and the Hunter River.

The permeability of the coal measures is generally low and is usually one to two orders of magnitude lower than the unconsolidated alluvial aquifers. Within the coal measures, the most permeable horizons are the coal seams, which commonly have a hydraulic conductivity of one to two orders of magnitude higher than the siltstones, shales and sandstone units. The coal seams are generally more brittle and therefore more densely fractured than the overburden and interburden strata and usually have a slightly higher hydraulic conductivity than surrounding rocks. The main coal seam of importance with respect to this SMP is the Pikes Gully Seam.

The alluvium comprises mostly clay- and silt-bound sands and gravel, with occasional coarser horizons where the sands and gravels have become concentrated. There are alluvial aquifers associated with Glennies Creek to the east of Longwall 1, and with Bowmans Creek on the western side of Longwall 4. The Hunter River alluvium aquifer occurs to the south of the southern ends of Longwalls 1 to 4. However, there is no alluvium aquifer within the SMP area. The thin veneer of alluvium and colluvium that blankets the higher elevations away from the above streams is unsaturated within the SMP area.

The permeability of the coal measures has been assessed by HLA (2001) and Dundon (2006) as being generally low. The coal seams are the most permeable horizon with hydraulic conductivity generally an order of magnitude greater than the overburden and interburden seams (siltstones, shales, and sandstone). Dundon (2006) has adopted hydraulic conductivity values, based on drilling results, of:

- 0.05 metres/day for the majority of the Pikes Gully Seam within the Application Area;
- five metres/day within the weathered zone close to where Pikes Gully Seam subcrops along Glennies Creek alluvium; and
- one to 10 metres per day for the alluvial aquifers.

Dundon (2006) notes that there appears to be little hydraulic connection between the coal measures and the alluvium based on the marked difference in observed water quality and groundwater levels.

Groundwater within the coal measures is saline, with electrical conductivity (EC) ranging from less than 6000 to around 11 000 µS/cm. Groundwater within the alluvium is less saline, with EC ranging from 500 to 2000 µS/cm. Surface water flows within the Hunter River and Glennies Creek also has low salinity with EC generally below 1000 µS/cm. However the salinity of Bowmans Creek is more variable with monitoring results for EC ranging from less than 500 to more than 4000 µS/cm which Dundon (2006) indicates may potentially be attributable to baseflow contributions from the upstream catchment.

The water table within the Application Area is between 15 metres and 40 metres below the ground surface, and generally reflects the surface topography. Groundwater flow patterns are controlled by recharge via rainfall infiltration in elevated areas with flow towards low lying areas. The groundwater assessment in *Annex D* (Dundon 2006) notes that recharge to the coal measures groundwater system predominantly occurs via infiltration of rainfall into outcrop/sub-crop areas and to a limited extent via percolation through the overburden to the water table.

During the construction of first workings, monitoring of water inflows into the mine has been undertaken in compliance with the Conditions of Consent. Inflows have been reported to the underground development headings along longwall panel 1 with an approximate inflow rate of 8 litres per second (L/s). The EC of the water is approximately 8500 µS/cm. The EC values are indicative of the groundwater quality in the coal measures as opposed to the water quality of the alluvium.

6.3.4 *Steep Slopes*

The Application Area is predominantly gently sloping with ground slope generally ranging between two and three degrees. However, there are steep slopes at the edges or just outside of the Application Area.

A detailed slope assessment by Parsons Brinkerhoff (2006) is provided as *Annex E.*

Adjacent to Glennies Creek on the eastern edge of the Application Area, the ground slopes steeply to Glennies Creek with a maximum slope of 32 degrees, and slope height of 40 metres. The slope is uniform and grass covered and was noted by Parsons Brinkerhoff to have no outcropping bedrock. Material exposed within scoured areas comprised sandy clay with boulders of up to 0.5 metres in diameter and was assessed to be colluvium. There is no evidence of past or existing instability on the slope.

Ground adjacent to the Hunter River, in the vicinity of the in-bye end of longwall panels 2, 3, and 4, slopes to the south at about 10 to 12 degrees with a maximum slope height of 30 to 40 metres. The slope is grassed and in one section also includes stands of trees. Parsons Brinkerhoff observed outcropping conglomerate bedrock near the crest and approximately midway down the slope. Partial undermining of the slope has occurred adjacent to the Hunter River due to scouring in high flows. The material in areas exposed by scouring comprised silty sands (slopewash). The slopes are expected to be underlain by a thin veneer of silty sand then bedrock.

6.3.5 *Land Prone to Flooding or Inundation*

During 1955, flood levels within the Hunter River are estimated to have reached approximately 64.2 m Australian Height Datum (AHD) in the vicinity of the site (HLA, 2001). This flood is often considered to be equivalent to a design flood with an average recurrence interval (ARI) of one in 100 years for the Hunter River.

An assessment of existing flood behaviour for the Hunter River and Bowmans Creek within the ACOL site was carried out by Patterson Britton and Partners (2001) during the preparation of the EIS (HLA, 2001).

Patterson Britton (2001) note that in 1955, catchment rainfall within the Bowmans Creek catchment and backwater flooding from the Hunter River resulted in flood levels of approximately 67.8mAHD at the New England Highway bridge.

The extent of flooding for a range of design flood events (as determined by Patterson Britton, 2001) are shown in *Figure 6.1.* Based on this information, areas over maingate 4 and the goaf edge of longwall panel 4 are likely be inundated by shallow floodwaters during a one in 100 year ARI flood event.

6.3.6 *Water Related Ecosystems*

There are no water related ecosystems within the Application Area. The farm dams have been assessed as having little habitat value due to the lack of aquatic vegetation, small volumes, and disturbance by stock.

Bowmans Creek, Glennies Creek and the Hunter River are outside of the Application Area and therefore are not predicted to be directly affected by subsidence. However, given the close proximity, they may be potentially affected by indirect subsidence impacts are and therefore included for consideration in this SMP.

Riparian monitoring of Bowmans Creek is being carried out on a bi-annual basis in accordance with Conditions of Consent No. 3.15, 3.20b, and 3.48 for the site. Two rounds of riparian and aquatic assessment of Bowmans Creek have been carried out jointly by ERM and The Ecology Lab (ERM, 2006a). The results of these assessments are summarised below, with the full report provided as *Annex F.*

Bowmans Creek is ephemeral and in the spring 2005 survey there were dry, exposed areas at the time sampling, which were thickly overgrown with grasses and rushes. Pools and riffles were found at three of the six monitoring control sites, and the remaining three had exposed cobble bars which could act as riffles after times of heavy rainfall. The pools and riffles were found to have contracted substantially due to seasonal conditions in the autumn 2006 survey.

Weeds and exotic species, as well as healthy native macrophytes were found at all monitoring sites. Overhanging branches, macrophytes, and snags were present at all monitoring sites that could provide suitable habitat for fish. Deep permanent pools were found at all sites, which are likely to provide fish habitat at times of low flow under natural conditions. Barriers to fish passage existed between all of the monitoring sites.

Most water quality parameters at all sites were within the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) criteria.

The Bowmans Creek riparian corridor was characterised by three vegetation communities being *Casuarina cunninghamia* (river oak) woodland, river red gum open woodland and pasture. The river red gum population in the Hunter Catchment is listed as an endangered population under Part 2 Schedule 1 of the *Threatened Species Conservation Act, 1995* (TSC Act). The river red gum open woodland community is located outside of ML1533 and will not be subject to mining subsidence at any stage of the mine.

In general, Bowmans Creek was assessed as being impaired compared to reference conditions in the AUSRIVAS model. Bowmans Creek showed many signs of anthropogenic disturbance, including weed invasion, erosion, cattle grazing, low dissolved oxygen, high salinity, low fish diversity (particularly natives) and a tolerant macro-invertebrate community.

6.3.7 *Threatened and Protected Species*

The results of the flora and fauna assessment prepared by ERM (2006b) are summarised below, with the full report provided as *Annex G.*

Flora

No vulnerable or endangered flora species as listed within the TSC Act, the *Environmental Protection and Biodiversity Conservation Act, 1999* (EPBC Act) or the *Fisheries Management Act, 1994* have been identified within the Application Area during desktop and field-based investigations.

The river red gum population in the Hunter Catchment is as an endangered population under Part 2 Schedule 1 of the TSC Act, and occurs adjacent to Bowmans Creek to the west of the subsidence impact zone during previous investigations (ERM, 2006a). This population will not be impacted by the current proposal.

Fauna

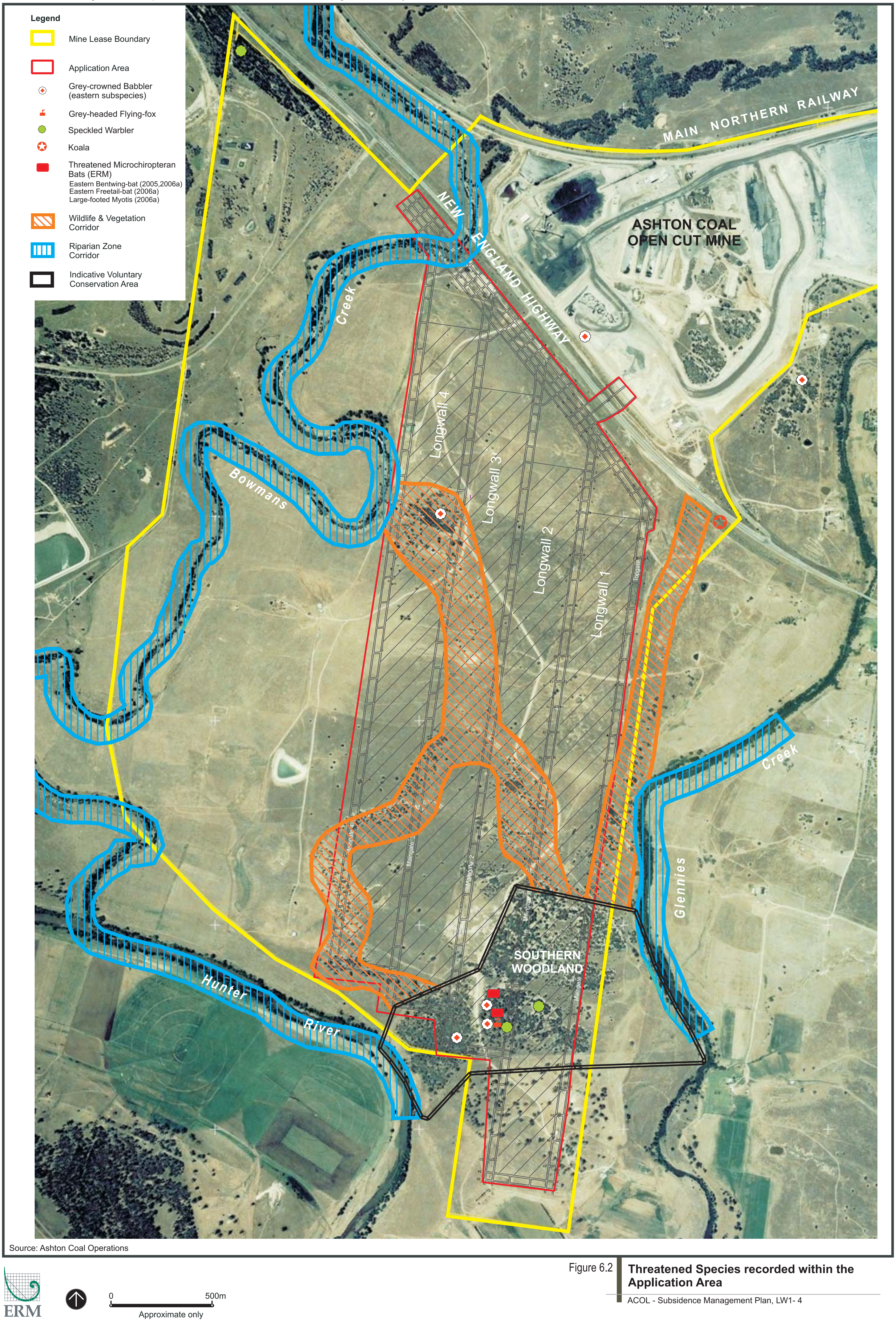
According to flora and fauna assessment (ERM, 2006b), 26 threatened fauna species are listed on the DEC and DEH databases as occurring within ten kilometres of the Application Area. The complete list of these species is included in *Annex G*. Fifteen of these species are likely to occur within the Application Area (ERM 2006b) based on available habitat.

Six species listed as vulnerable under the TSC Act have been recorded within the Application Area (refer to *Figure 6.2*). These species are *Pteropus poliocephalus* (grey headed flying fox), *Miniopterus schreibersii oceansis* (eastern bentwing-bat), *Mormopterus norfolkensis* (eastern freetail-bat), *Myotis adversus* (fishing bat), *Pyrrholaemus sagittatus* (speckled warbler) and a breeding population of *Pomatostomus temporalis* (grey-crowned babbler).

Mormopterus norfolkensis (eastern freetail-bat), *Miniopterus schreibersii oceansis* (eastern bent-wing bat) and *Myotis adversus* (large-footed myotis) were recorded within the southern woodland during previous surveys (*Annex H*). The Application Area provides potential hunting and roosting habitat for *Mormopterus norfolkensis* and hunting habitat only for *Miniopterus schreibersii oceansis* and *Myotis adversus.*

Three *Pyrrholaemus sagittatus* (speckled warbler) have been observed foraging in the southern woodland (*Annex H*). *Pomatostomus temporalis* (grey-crowned babbler) have also been commonly encountered within the southern woodland and near the Bowmans Creek oxbow. The family group occupying the southern woodland appears to be stable at around eleven individuals, with a total of eleven nests identified in recent surveys.

Pteropus poliocephalus (grey headed flying fox) was recorded during previous investigations within the southern woodland (Parsons Brinckerhoff, 2004).



Source: Ashton Coal Operations

ERM

Figure 6.2 **Threatened Species recorded within the Application Area**

The Application Area provides a seasonal foraging resource for this species in the form of flowering eucalypts. No suitable roost sites are available.

6.3.8 *Vegetation*

The Application Area has been considerably disturbed by land clearing and agricultural uses including grazing, and the majority of the area has been cleared of native forest to produce open grasslands.

Two grassland sub-communities occur, namely dry pasture and pasture that has been improved in the past. Within the areas of dry pasture, isolated trees exist and some regeneration is occurring. Scattered trees noted include *Allocasuarina luehmannii* (bulloak), comprise *Eucalyptus crebra* (narrow-leaved ironbark), *Eucalyptus melliodora* (yellow box) and *Eucalyptus mollucana* (grey box). Scattered shrubs of *Maireana microphylla* (eastern cotton bush) and *Acacia amblygona* (fan wattle) occur. Exotic species such as the woody weed *Lycium ferocissimum* (African boxthorn) occur below the canopy of the isolated trees.

The improved pasture community is located on the alluvial creek flats. Many exotic herbaceous species are present. Species used to improve the pasture for grazing value include *Lolium sp*. (rye grass), *Chloris gayana* (rhodes grass), *Paspalum dilatatum* (paspalum), *Medicago sativa* (lucerne), *Trifolium repens* (white clover) and *Pennisetum clandestinum* (kikuyu). Additional common pasture species noted include *Aristida vagans, Cymbopogon refractus, Dichelachne rara, Microlaena stipoides* and *Lomandra glauca.* The percentage cover of the ground layer varies with grazing intensity.

The only substantial area of remnant woodland within the Application Area is identified as the Southern Woodland and is dominated by open grassy woodland characterised by a dominance of *Allocasuarina luehmannii* (bulloak). Sub-dominant species appear to be regenerating and comprise *Eucalyptus crebra* (narrow-leaved ironbark), *Eucalyptus melliodora* (yellow box) and *Eucalyptus mollucana* (grey box).

The understorey consists of juvenile specimens of the canopy species and a relatively sparse shrub layer dominated by *Acacia amblygona, Daviesia genistifolia, Acacia linifolia* (flax-leafed wattle), *Lycium ferocissimum* (African boxthorn) and *Eremophila deserti.* The percentage cover of the ground layer varied being most dense within the open grassy areas and least dense within the areas dominated by bull oak due to the dense layer of Allocasuarina needles.

6.3.9 *Fauna and Fauna Habitat*

The Application Area contains two broad habitat communities being open grassy woodland and grassland. The Southern Woodland has been disturbed by agriculture, grazing and weed invasion, however is significant due to the high rates of clearing in the Hunter Valley and consequently, is subject a

Conservation Agreement under the *National Parks and Wildlife Act, 1974*. A number of vegetated corridors have also been recommended within previous assessments as indicated in *Figure 6.2*. The establishment of these habitat corridors would further enhance the habitat resources available within the Application Area as described below.

The myrtaceous tree species in the canopy and the sparse shrub layers would provide a year-round seasonal foraging resource for nectivorous birds and mammals (*Eucalyptus paniculata* flowers May to January, *Eucalyptus melliodora* flowers September to February and *Eucalyptus moluccana* flowers January to May). The variety of tree species would provide suitable feeding/foraging resources for folivorous fauna such as the common brushtail possum and insectivorous birds such as treecreepers. The limited numbers of mature eucalypt trees provide hollows capable of providing shelter and breeding habitat for a number of bird and arboreal mammal species.

The grasses and sedges provide seed and stem resources for granivorous and herbivorous species. The *Allocasuarina* species in the mid-storey and understorey strata may also provide a limited seasonal foraging resource for highly mobile granivorous fauna such as black-cockatoos. The *Allocasuarina* species and eucalypts also provide suitable nesting habitat for the grey-crowned babbler. Understorey species such as *Lycium ferocissimum* provide foraging resources for many species favouring fruits and berries.

This habitat type has a moderate layer of leaf litter (five centimetres deep), fallen logs and rock outcrops that provide sheltering resources for small ground-dwelling mammals and reptiles. The grassy understorey and fallen timber also provides a suitable foraging substrate for the grey-crowned babbler and speckled warbler.

Aquatic habitat is provided within the numerous farm dams, as well as within the adjacent Bowmans Creek, Glennies Creek and the Hunter River. These water resources provide permanent and ephemeral habitat for aquatic avifauna and amphibians as well as a drinking resource for many native species.

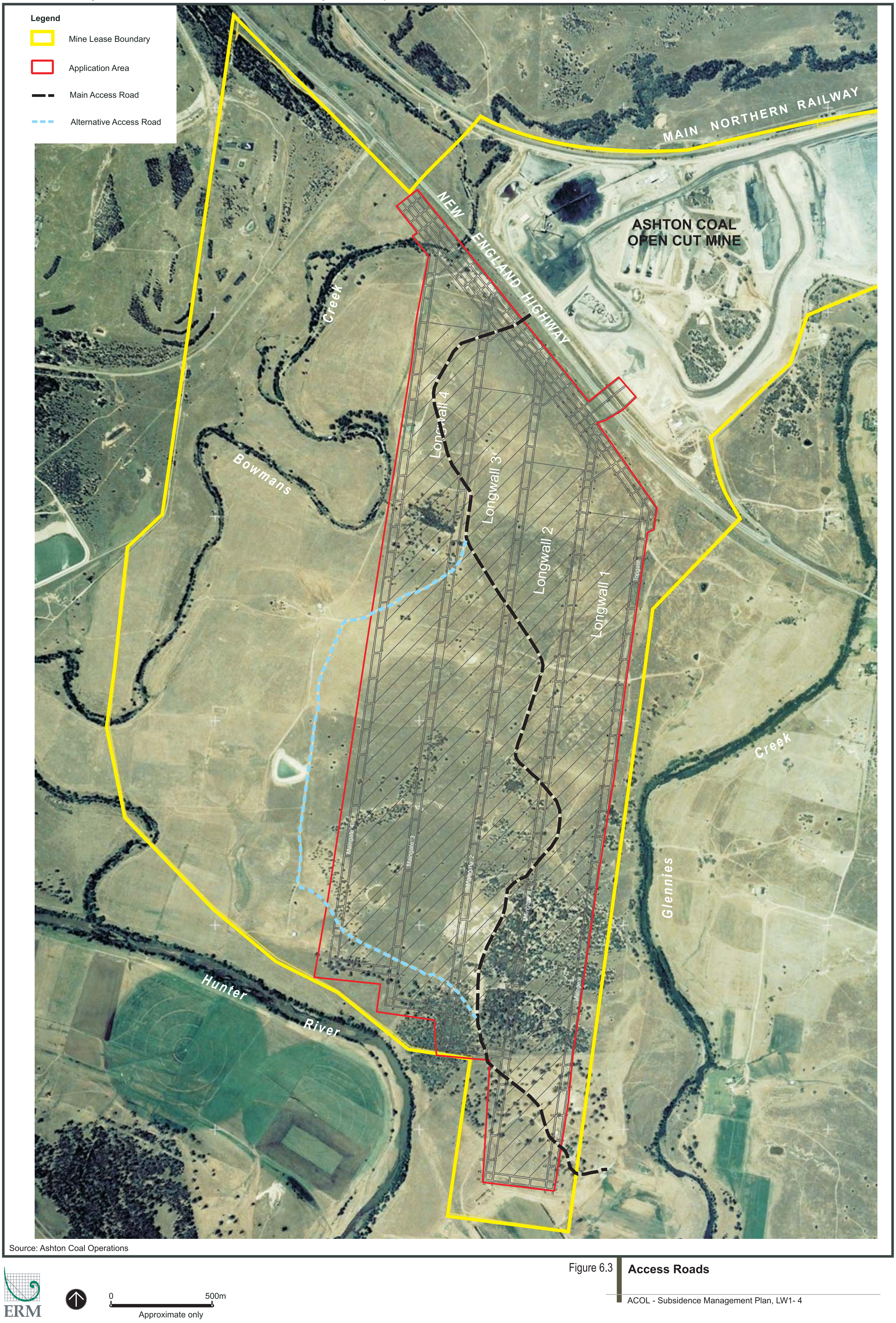
A full list of the fauna species recorded within the Application is provided in *Annex G*.

6.4 PUBLIC UTILITIES

6.4.1 Roads

Private Roads

The site is traversed by private gravel access roads that are maintained by ACOL (*Figure 6.3*). The main access road branches off the New England



Source: Ashton Coal Operations

Figure 6.3 **Access Roads**

ACOL - Subsidence Management Plan, LW1- 4

ERM

Highway and traverses the land overlying longwall panels 1 to 4. It is predominantly located within a 20 metre wide proposed Right of Way to Property No. 130, and on reaching the boundary of Property No. 130, the access road continues to the dwelling on Portion 70.

In some gully crossings, the main access road is underlain by piped culverts for drainage. Several cattle grids are located where the road crosses fence lines, including the boundaries of the ACOL property with the New England Highway and with Property No. 130.

A number of private access roads within the ACOL property branch off the main access road to provide access to other areas of the property, including the two existing dwellings, farm sheds and other infrastructure.

On average, a milk tanker traverses the main access road twice daily, to gain access to and from Property No. 130. The main access road is also used for access to Property No. 130 by the owner, residents and authorised visitors.

The access roads within the ACOL property are used by the tenants, utility owners, ACOL, subcontractors and farmers leasing grazing land within the ACOL property.

New England Highway

The New England Highway is located to the north of the Application Area and travels through a cutting, then over an embankment, prior to crossing Bowmans Creek bridge as it passes the site. The first workings for the proposed underground mine are aligned with the New England Highway to maximise the recoverable coal resources within the mining lease and to minimise subsidence impacts on the highway (compared to longwall extraction in this area).

The goaf edges of longwall panels 1 to 4 are located a minimum of 135 metres from the pavement edge of the New England Highway. The New England Highway pavement and road reserve is not affected by secondary workings, however the first workings are located partially within the road reserve and entry to the underground mine runs beneath the highway pavement.

An assessment of overburden stability and underground roof support requirements for the initial entries at the Ashton underground mine was prepared by Strata Engineering for the First Workings SMP (longwalls 1 and 2) as approved by the DPI (Minerals) in October 2005. A copy of this report and other relevant information is contained in *Annex M.*

6.4.2 *Electricity Transmission Lines*

The Application Area is traversed by three EnergyAustralia overhead electricity supply lines. An 11 kilovolt (kV) overhead local transmission line, suspended on single wooden poles, crosses part of the northern end of proposed longwall 4, with off takes within the Application Area to service residences and farm sheds. A 132kV overhead electricity transmission line, supported on combination dual and triple timber poles, traverses land at the southern extent of proposed longwalls 1 to 4, including the southern woodland. A combined 132/66kV transmission line is located within ACOL's property adjacent to and parallel to the New England Highway and over the main headings. This transmission line is of new construction on single concrete poles.

Figure 6.4 shows the location of the poles supporting the transmission lines within the Application Area. The 132/66kV line will be affected by first workings only whilst the other 132kV line through the middle of the extraction area will be impacted by secondary workings. The dimensions of each 132kV transmission line pole within the vicinity of the longwall panels is summarised in *Table* 6.2.

Table 6.2 Dimensions of 132kV Transmission Line Support Structures

Structure Number	Height (m)	Base (m)	Goaf Edge Distance (m)	Structure
2	13.3	4.4	99	∏
3	13.2	4.6	14	∏
4	15.8	4.9	55	III
5	13.5	4.3	55	∏
6	*16*	*4.4*	*5*	∏

6.4.3 Telecommunication Lines

A fibre-optic telecommunication cable exists within the Application Area adjacent to the New England Highway road reserve. Powertel manage the fibre optic cable which runs on the southern side, and parallel with the highway. These cables are outside of the area of secondary extraction but are above the associated first workings.

Telecommunication cables consisting of copper line in conduit that supply the ACOL and Property No. 130 dwellings traverse the site as shown in *Figure 6.4.*

6.5 FARM LAND AND FACILITIES

Within the Application Area are two disused dairy sheds, one set of cattle yards, concrete water tanks and some lightweight farm sheds. The two farm buildings on Property No. 130 that are located within the Application Area are lightweight timber and steel framed structures clad in corrugated iron, one of which appears to be used as a hay barn and the other as an machinery shed. The concrete water troughs appear to be connected by a network of underground pipes.

Source: Ashton Coal Operations

0 500m
Approximate only

Figure 6.4 **Public Utilities**

6.5.1 *Agricultural Land Use and Suitability*

The majority of the Application Area is owned by ACOL and used for cattle grazing. There is one other property owner within the Application Area (Property No. 130). This property is located in the southwest corner of the Application Area, is privately owned, and is an established and operational dairy farm.

The Agricultural Land Classification Map (NSW Agriculture, 2001) indicates that the relative suitability of the land for agriculture is predominantly classified as Class 3, with Class 1 agricultural land on the flats adjacent to Bowmans Creek and some sections of Class 4 land in the northern and western portions of the Application Area.

Hulme et al (2002) defines Class 3 agricultural lands as grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of edaphic or environmental constraints such as erosion hazard, soil structural breakdown or climate which may limit its capacity for cultivation. This land may require soil conservation or drainage works. Tracts of Class 3 land within the Application Area have previously been pasture improved. Class 1 land is defined as arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent. Some of the Class 1 land within the Application Area has previously been cultivated. Class 4 lands are considered suitable for grazing but not for cultivation. Agriculture on these lands is based on native pastures or improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints. A large portion of the Class 4 lands within the Application Area are within the southern woodland (which is subject to a conservation agreement under the *National Parks and Wildlife Act, 1974*) and whilst it has been historically used for grazing, in future will not be used for agriculture.

6.5.2 *Farm Buildings/Sheds*

Farm buildings – including dwellings and sheds are shown in *Figure 6.5.* There are two farm sheds located on Property No. 130 within the Application Area at the southern end of longwall panel 1. These are lightweight timber framed, steel clad structures. One is currently used as a hayshed and the other, which also has a concrete floor, is used as a machinery shed.

Within ACOL's property there are approximately seven farm buildings (excluding the residence) within the Application Area. These are all lightweight structures and include outbuildings associated with the residence and other farm storage buildings.

Source: Ashton Coal Operations

0 500m
Approximate only

Figure 6.5 **Residences and Farm Buildings**

ACOL - Subsidence Management Plan, LW1- 4

6.5.3 *Irrigation Systems*

Concrete water tanks and associated pipes are located on both the ACOL property and Property No. 130. Concrete tanks and water pipes within Property No. 130 are located on the eastern extent of the Application Area. All storage tanks, watering tanks, and pipelines are shown in *Figure 6.6.*

A buried poly water pipe has recently been connected to the partially buried concrete water tank located near the northern end of longwall 4 within the ACOL property.

6.5.4 *Fences, Gates and Cattle Grids*

As the land within the Application Area is predominantly used for grazing, there are a number of fences which traverse the site. The fences serve to divide the landholdings into paddocks, provide boundary fencing between neighbouring landholdings and those along road sides, including the New England Highway. The fences within the area are shown on *Figure 6.7*.

The fences are constructed of a combination of wooden and iron posts with multiple wire strands. There are also a number of farm gates at various locations in the fence lines.

Cattle grids are located in several locations where fences intersect with access roads, particularly on the main access road where it meets the New England Highway, and where it intersects the boundary of Property No. 130.

6.5.5 *Farm Dams*

A total of nine farm dams have been identified as being potentially impacted by subsidence from longwall mining of panels 1 to 4. Specific locations of farm dams within the Application Area of proposed longwalls 1 to 4, and the dam numbering system are shown in *Figure 6.8*. Hydrological and construction characteristics of each of these dams and identification of relevant landowners are provided in *Tables 6.3*. Estimations of capacity have been based on a range or broad assumptions relating to batter slope and freeboard and are based only on approximate surface area and configuration. The capacity values should be considered as indicative only. Additionally, any existing cracking, tunnelling, or sedimentation which may limit capacity has not been considered.

All of the dams within the Application Area are excavated dams fed predominantly by overland flow and utilised primarily for stock watering. The farm dams are typically constructed from local material without significant design or engineering input. Those dams on land owned by ACOL have been excavated in gullies, and an earth wall constructed on the downstream side. Conversely, the two dams located on Property No. 130 are not positioned in gullies and dam 9 is largely reliant on surface water

0 500m
Approximately only

Figure 6.6 **Water Pipelines and Tanks**

ACOL - Subsidence Management Plan, LW1- 4

Source: Ashton Coal Operations

Figure 6.7 **Farm Fences, Gates and Cattle Grids**

ACOL - Subsidence Management Plan, LW1- 4

0 500m
Approximate only

ERM

Source: Ashton Coal Operations

Figure 6.8 **Farm Dams**

ACOL - Subsidence Management Plan, LW1- 4

ERM

channelled into to it via the contour bank constructed on the eastern side. Contour banks have also been constructed to channel overland flow into dams 1, 6 and 9.

Table 6.3 *Summary of Dams within the Application Area*

Dam	Land Owner	Construction	Water Supply	Estimated Capacity (ML)*	Surface Area (m^2)
1	ACOL	Excavated/ earth wall in gully/ contour bank drainage works	Overland runoff	1.1	690
2	ACOL	Excavated/ earth wall in gully	Overland runoff	2.3	1440
3	ACOL	Excavated/ earth wall in gully	Overland runoff	0.5	410
4	ACOL	Excavated/ earth wall in gully	Overland runoff	2.5	1300
5	ACOL	Excavated/ earth wall in gully	Overland runoff	1.5	960
6	ACOL	Excavated/ earth wall in drainage line/ contour bank drainage works	Overland runoff	1.3	810
7	ACOL	Excavated/ earth wall in gully	Overland runoff	0.7	570
8	Private	Excavated	Overland runoff	0.3	273
9	Private	Excavated/ contour bank drainage works	Overland runoff	1.9	1214

* Rough estimate of capacity based on surface area and assumed storage depth.

6.6 *INDUSTRIAL, COMMERCIAL AND BUSINESS ESTABLISHMENTS*

6.6.1 *Mine Infrastructure - Water Pipeline*

There are two pipelines, travelling generally parallel to each other, that traverse the site from the Hunter River to ACOL's open cut operation, north of the New England Highway. These pipelines are located to the west of longwall panel 4 and travel within the Application Area for a distance of approximately 120 metres. The location of the pipeline is shown in *Figure 6.6.*

6.7 *AREAS OF ARCHAEOLOGICAL AND/OR HERITAGE SIGNIFICANCE*

6.7.1 *Archaeological Sites*

The Application Area is in the central part of Wonnarua tribal country. 102 archaeological sites have been identified within the Ashton coal property, with 42 of these occurring within the Application Area (Witter, 2002). As described later in this section, several of these sites have research potential and the archaeology of this area needs to be treated as unique on the grounds of the precautionary principle.

The sites recorded within the Application Area are listed in *Table 6.4* and depicted in *Figure 6.9.*

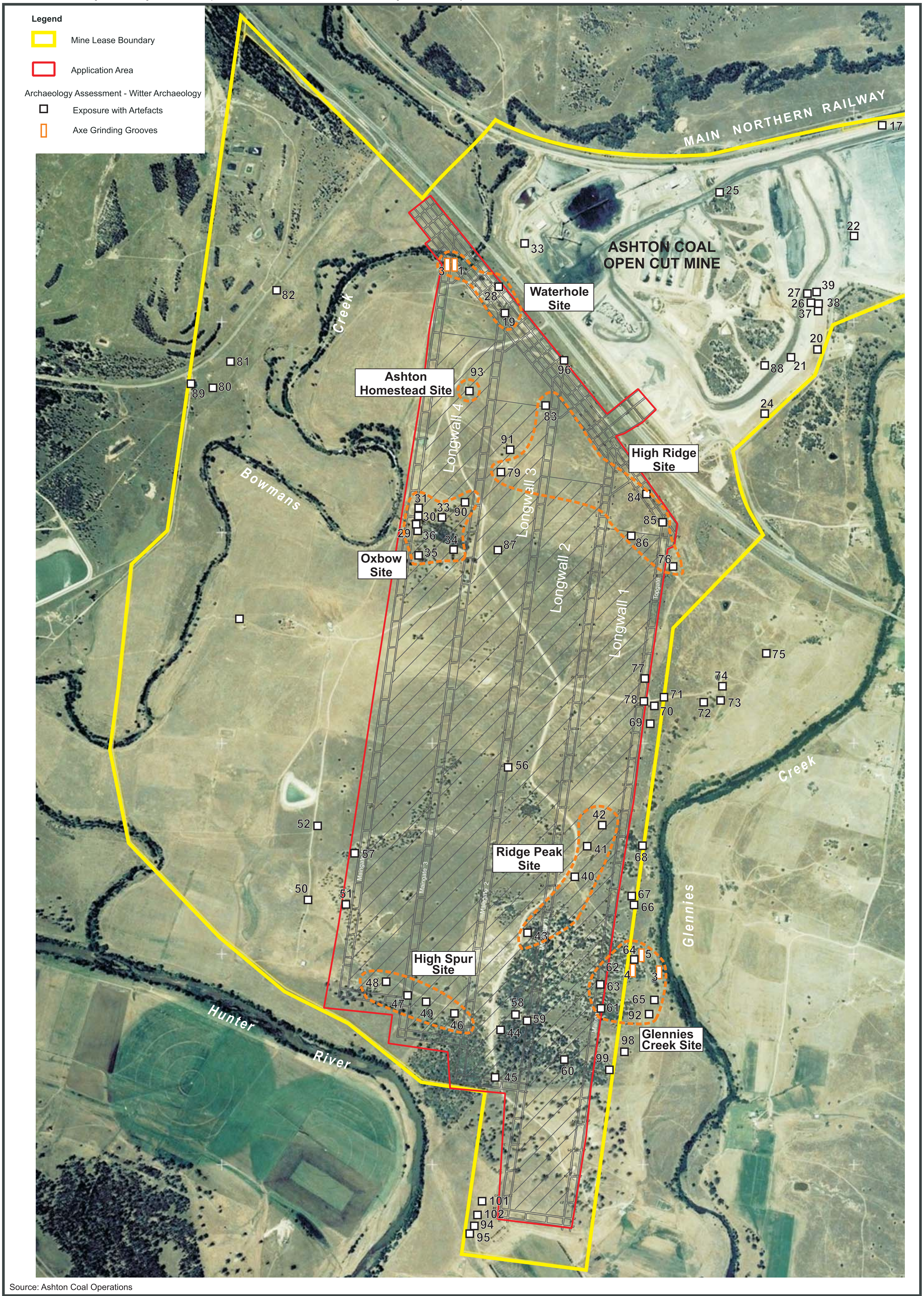


Figure 6.9 **Archaeological Sites Recorded in Witter Report (2002)**

ACOL - Subsidence Management Plan, LW1- 4

ERM

0 500m
Approximate only

Table 6.4 Archaeological Sites

Site Name	Site Type	Site Description	Recorded Site
Waterhole Site	Open Camp Site	256 artefacts, 3 sets of grinding grooves	EWA28, EWA19, GG1, GG3
Oxbow Site	Open Camp Site	204 artefacts	EWA 29, 30, 31, 32, 34, 35, 36, 87, 90
Ashton Homestead Site	Open Camp Site	8 artefacts	EWA 93
Glennies Creek Site	Open Camp Site	238+60 artefacts, grinding grooves	EWA 61, 62,63, 64, 65, 92, GG2
High Ridge Workshop Site (Ashton Ridge)	Open Camp Site	19 artefacts	EWA 76, 79, 83, 84, 85, 86
Ridge Peak Site (Ashton Ridge)	Open Camp Site	34 artefacts	EWA 41, 40, 42, 43, 44, 45, 58, 59
High Spur Site (Ashton Ridge)	Open Camp Site	142 artefacts	EWA 46, 47, 48, 49
	Isolated Find	1 artefact	EWA51
	Isolated Find	2 artefacts	EWA56
	Isolated Find	1 artefact	EWA57
	Isolated Find	1 artefact	EWA60
	Isolated Find	2 artefacts	EWA77
	Isolated Find	2 artefacts	EWA78
	Isolated Find	2 artefacts	EWA91
	Isolated Find	1 artefact	EWA96

Witter (2002)

Several sites were considered outstanding by Witter (2002) due to their size, integrity and overall value as part of a site complex. The waterhole, oxbow, Ashton ridge and Glennies Creek sites were considered unlike other sites reported in the Hunter Valley in respect to artefact assemblage, variability and landscape context as described below.

Waterhole Site

The waterhole site contains a variety of tool types and has aesthetic and educational value to the local Aboriginal people. Places such as these give a sense of former occupants using this place for recreation and work. Most of the site has been severely disturbed although there was one intact deposit associated with the waterhole and grinding grooves. The grinding grooves in this location are formed in sandstone that is currently eroding and has been fenced to prevent inadvertent damage to the site (Witter, 2002).

Oxbow Site

The oxbow site contained numerous artefacts, including rare tool types, the burren and hammerstone. The site is in a tributary valley above the upper terrace and next to the Bowmans Creek oxbow. The most conspicuous debitage was expanded flakes with platform modification suggesting considerable large tool sharpening. The main area of concentration does not appear to have been cultivated and would have high spatial integrity (Witter, 2002).

Glennies Creek Site

The Glennies Creek site is located on the lower slopes and terrace of the creek valley near a large waterhole where grinding grooves were recorded. The site contains a workshop of yellow tuff and rhyolite and contains artefact assemblages that do not appear to be typical of the Hunter Valley. This site has the potential to belong to an archaeological system that has been little studied by previous impact assessments in the Hunter Valley. The site may be a function of a distinct type of land use, such as fish trapping. The southern woodland conservation area located above longwall 1 will preserve both cultural heritage and natural biodiversity (Witter, 2002).

Ashton Ridge Sites

The Ashton Ridge sites are artefact concentrations or clusters of exposures with artefacts on the crest and upper spurs, tributaries and slopes of the Ashton ridge located between Bowmans Creek and Glennies Creek. These sites are reported to be significant due to the abundant and varied occupation indicated. The high level of activity on the ridge is likely to be connected to the use of the three other large sites (Witter, 2002).

6.7.2 Heritage Sites

No European heritage items are listed within the Ashton Coal Project boundaries. St Clements Anglican Church (located west of the village of Camberwell and Glennies Creek) and the Camberwell Community Hall (located south of the New England Highway) are listed in the Singleton local environment plan (LEP) 1996 as being items of environmental heritage of local significance. These items will not be impacted by underground mining.

6.8 ITEMS OF ARCHITECTURAL SIGNIFICANCE

No items of architectural significance have been identified within the Application Area.

6.9 RESIDENTIAL ESTABLISHMENTS

There is one residence (the "Ashton residence") located within the Application Area, near to the eastern edge of longwall 4. This dwelling is occupied and is leased from ACOL. Structures associated with the Ashton residence are a garden shed, gardens, buried water pipes and tanks, and septic system.

6.10 *AREAS OF ENVIRONMENTAL SENSITIVITY*

The Application Area incorporates land subject to a Conservation Agreement under the *National Parks and Wildlife Act, 1974*. Therefore, the area of the southern woodland is considered an area of environmental sensitivity in accordance with the definition given in Section 6.6.3 of the SMP guidelines (DMR, 2003).

7 *SUBSIDENCE PREDICTIONS*

ACOL commissioned Strata Control Technology Operations Pty Ltd (SCT) to undertake a subsidence assessment for longwalls 1 to 4 for the purposes of this SMP application. The SCT (2006) report is included as *Annex I* in full, and summarised in this chapter.

Subsidence assessment for future longwalls, subsequent to longwall 4, will be addressed by future applications for SMP Approvals.

7.1 *PREDICTION METHODOLOGY AND RELIABILITY*

7.1.1 *Prediction Methodology*

For assessment of potential subsidence impacts resulting from proposed longwall operations at ACOL, subsidence predictions have been made based on the empirical experience at sites with similar panel width and overburden depths. There is a large database of experience indicating that for single seam longwall operations in NSW, maximum subsidence does not exceed 65% of seam thickness mined, even when the panels are wide relative to overburden depth as they are at ACOL. Thus, a maximum subsidence value of 65% of seam thickness has been used as a conservative estimate of subsidence over longwalls 1 to 4 respectively.

Subsidence profiles measured for longwall panels with similar overburden depths and panel geometries to those proposed at ACOL have been used to predict profiles of subsidence for ACOL. Estimates of strains and tilts are based on guidelines developed in the Western Coalfield. The Western Coalfield guidelines were used because the database of experience these are based on derives from operations with similar overburden depths and panel geometries to those proposed at ACOL.

An upper limit approach to estimating subsidence and subsidence parameters has been used. There is considered to be no potential for vertical subsidence to be greater than the predicted levels and it is likely that actual subsidence will be less than the maxima predicted.

7.1.2 *Factors Affecting Development of Subsidence*

At ACOL, the overburden depth and panel width are such that subsidence is likely to develop over each individual longwall panel effectively independently of any subsidence that has occurred in the adjacent panels. Maximum subsidence is governed by the thickness of the seam section mined and as described in *Section 7.1.1*, is likely to reach up to 65% of the seam section mined.

For practical purposes, the subsidence profiles that develop over each goaf edge are likely to be essentially similar. The dynamic profile that develops over each longwall panel as it retreats may be slightly flatter than the final goaf edge profiles developed over the start, finish and sides of each panel.

Permanent strains and tilts are expected to develop over each of the longwall goaf edges. Transient tilts and strains up to near maximum values are expected above the retreating longwall face. Some permanent tilts and strains are likely to occur over the centre of each longwall panel, even though full subsidence has developed in this area.

7.1.3 Relevance of Input Data

As no site specific subsidence data is available for ACOL, subsidence estimations have been derived from the Western Coalfield experience. This empirical dataset is considered relevant as overburden stratigraphy, overburden depth and longwall widths on which the Western Coalfield experience is based are similar to those at ACOL, more so than the Newcastle Coalfield. Maximum strains and tilt values from Western Coalfield experience are higher than those indicated by the Newcastle Coalfield guidelines, and have been used to provide a conservative, upper bound estimate of the subsidence that is likely to occur.

In practice, the strains and tilts are expected to be sufficiently high to cause significant disturbance to the surface and infrastructure directly over the longwall panels. Any inaccuracy in the numeric predictions is not expected to alter this outcome.

7.1.4 Subsidence Prediction Assumptions

The subsidence predictions at ACOL are based on the observation that maximum subsidence above longwall panels in NSW single seam operations has not been recorded as exceeding 65% of the seam thickness mined. It is reasonable to expect that the subsidence behaviour at ACOL would be similar.

7.1.5 Prediction Reliability

The subsidence predictions and the goaf edge subsidence profiles are expected to provide an upper limit estimate of the subsidence that will occur. It is considered highly unlikely that maximum subsidence would exceed predictions and, in practice, actual maximum subsidence at any one point may be up to 30% less than predicted.

Lower than predicted subsidence may occur as a result of different bulking characteristics in the overburden strata at ACOL than the Western Coalfields and near-surface horizontal subsidence movements that cause localised strata dilation and less vertical subsidence. The current subsidence predictions will be refined, and updated, as subsidence monitoring results from longwall panels 1 to 4 become available.

The magnitude of vertical subsidence over the chain pillars is not likely to be predicted to the same level of accuracy as the maximum subsidence over the centre of each longwall panel. However, because the vertical subsidence over the chain pillars is generally expected to be less than 100mm, any error in the magnitude of subsidence is likely to be of little significance relative to the adjacent, much larger subsidence movements over the longwall panel.

7.2 *PREDICTED SUBSIDENCE PARAMETERS*

For the purposes of prediction of subsidence parameters, SCT divided the Application Area into four domains based on representative overburden depths and seam thicknesses. A summary of the predicted subsidence values for each domain is given in *Table 7.1*.

Table 7.1 Predicted Subsidence Values (Pikes Gully Seam)

Domain	Max. Vertical Subsidence (m)	Max. Compressive Strain (mm/m)	Max. Tensile Strain (mm/m)	Max. Tilt (mm/m)
North end of LW1	1.8	98	73	244
Remainder of LW1	1.7	56	42	141
LW2	1.6	41	30	102
LW3 and LW4	1.6	31	23	78

7.2.1 *Vertical Subsidence*

Empirical experience indicates that for seam thicknesses of 2.4 to 2.7 metres, and panel width to depth ratios ranging from 1.3 to 6.8 (mostly between 2 and 4), maximum vertical subsidence will be 1.6 to 1.8 metres following longwall extraction of longwall panels 1 to 4 (for the Pikes Gully Seam). Actual maximum subsidence is expected to be less. However, this value has been adopted to enable prediction of impacts resulting from the worst case scenario.

Empirical experience also indicates that, at overburden depths of less than 100 metres, only low levels of subsidence will develop above the chain pillars that separate individual longwall panels. For the overburden depths at longwalls 1 to 4, maximum subsidence over the chain pillars is likely to be less than 100mm.

Goaf edge subsidence is the vertical subsidence measured directly above the goaf edge. It is expected that goaf edge subsidence will average about 70mm, though may range up to 100mm.

With 1.5 to 1.8 metres of subsidence over the centre of each longwall panel and less than 0.1 metres of subsidence over the chain pillars, the final subsided surface profile will comprise a series of troughs. Subsidence, and hence the troughs over each individual longwall panel are expected to be essentially independent of the subsidence over adjacent panels. The expected subsidence profile and contours of the subsidence troughs expected once mining is complete are provided in *Annex I*.

7.2.2 *Tilt*

Maximum curvatures and tilts were predicted by SCT (2006) on the basis of empirical relationships that have been developed from observations in the Western Coalfield (Holla 1991). Based on experience in the Western Coalfield, minimum systematic curvature is expected to be less than 2.5km (Holla 1991).

SCT (2006) indicates that maximum systematic horizontal movements of up to 5 to 8 times the maximum tilt may develop. Thus, at shallow depths near the northern end of longwall 1, horizontal movements of a similar magnitude to the vertical subsidence may occur. However, horizontal movements of this magnitude are typically observed in steeply dipping terrain and the surface terrain over most of the application area is relatively gently sloping. Consequently, horizontal movements are likely to be toward the lower end of the range indicated.

7.2.3 *Horizontal Strains*

Maximum strains are predicted on the basis of empirical relationships that have been developed from observations in the Western Coalfield (Holla 1991 in SCT 2006). In most areas surface cracking of up to several hundred millimetres is expected. Permanent tension cracks are expected to develop over all the goaf edges in a direction parallel to the goaf edge. Surface cracking is expected to occur from just outside the goaf edge and increase in magnitude with distance over the goaf, reaching a peak at the largest crack located approximately 20 to 30 metres from the goaf edge. Cracks are also expected to develop in an arcuate shape around the corners of the longwall panel to become parallel with the longwall face in the centre of each panel.

A series of permanent tension cracks separated by compression humps at intervals of 10 metres or so may develop parallel to the longwall face. This behaviour is most likely to be evident at shallow overburden depths.

7.3 *SUBSIDENCE PREDICTIONS FOR NATURAL FEATURES*

7.3.1 *Hunter River*

The Hunter River will not be directly impacted by mining subsidence. Furthermore, the start position of longwall 1 has been determined to be at least 90 metres from the estimated extent of saturated alluvium associated with the Hunter River (Dundon, 2006). The start position is further north than that originally proposed in the EIS and approved by the Department of Planning.

7.3.2 *Bowmans Creek*

Bowmans Creek will not be directly impacted by mining subsidence movements. Longwall 4 lies within approximately 60 metres from the top of the bank at its closest point, but vertical subsidence is not expected to be perceptible beyond a few tens of metres from the goaf edge. Horizontal movements may extend further, but given the alluvial nature of the base of Bowmans Creek, no perceptible impacts are anticipated directly from subsidence movements.

7.3.3 *Glennies Creek*

Glennies Creek is separated by approximately 150 metres of steep slope from the goaf edge of longwall panel 1 at its closest point, and is not predicted to experience subsidence movements.

The Pikes Gully Seam is believed to subcrop beneath Glennies Creek and Dundon (2006) has identified a potential for increased groundwater flows along the seam into the underground workings. This is discussed further in *Section 7.3.5 and 10.3.3*.

7.3.4 *Drainage Paths and Channels*

The predicted vertical subsidence, subsidence troughs and compression humps is likely to alter grades and drainage paths to a minor extent.

Temporary or permanent ponding of water in flat lying areas following heavy rain or flooding is a potential impact of vertical subsidence. Temporary ponding may occur in areas of water accumulation due to the progress of the longwall face, and will generally cease to be an issue once the face progresses. Permanent ponding may occur where a depression remains once the longwall face has passed but only in low lying and flatter areas. The majority of the site is gently sloping and therefore ponding is likely to be limited to small sections within the southern section of longwall 4 and adjacent to the Bowmans Creek oxbow.

Generally, the infiltration of the entire subsidence area will increase as a result of subsurface and surface cracking, leading to a decrease in total surface runoff volumes.

Surface cracking and subsidence of drainage lines or gullies may lead to the alteration of flow paths and the formation of knick points. If not remediated, knick points may result in erosion of these areas.

7.3.5 *Aquifers and Groundwater*

Continuous sub-surface cracking is predicted (SCT, 2006) for up to 100 metres above the goaf. Therefore, the goaf is likely to become hydraulically connected with the surface for areas where the depth of cover is 100 metres or less. Within the 294 hectare Application Area, this applies to approximately 140 hectares (or 54% of the total Application Area). If a direct hydraulic connection between the surface and the goaf occurs, Dundon (2006) predicts that rainfall recharge to the coal measures aquifer system may increase from a present 0.5-1.0% of annual rainfall to possibly 20% of annual rainfall. This could lead to the average infiltration of an additional 370 m^3/day, some of which may report to the Pikes Gully seam and the underground workings.

Investigations have indicated that the Pikes Gully Seam subcrops beneath the Glennies Creek alluvium. Extraction of coal within longwall panel 1 is assessed as unlikely to change the existing flow rates from the alluvium into the seam, however, there is a low possibility that the lateral slope translation of the steep slope adjacent to Glennies Creek may lead to the formation of a planar bedding-plane fracture at the base of the Pikes Gully Seam. This could create a more permeable pathway between the alluvium and the underground workings. Based on a conservative assumption that a 2mm wide planar fracture could form across the full breadth and length of the seam within the section that is believed likely to subcrop beneath the alluvium, a potential leakage rate from the alluvium to the workings of 38 m^3/d (0.4 L/s) could arise, (about double the potential rate through the undisturbed seam). Even assuming an extreme and highly improbable case of a continuous 5mm fracture plane over the same area, the hypothetical increase in groundwater flow would be only 600 m^3/day (7 L/s). This outcome is considered highly improbable, and is not expected to occur.

No impacts to saturated alluvium associated with Bowmans Creek and the Hunter River are predicted. Draw down in the Glennies Creek alluvium is expected to be less than 0.5 metres.

Groundwater impacts in the coal measures are expected to be limited in extent. Groundwater levels within the Pikes Gully Seam will be drawn down but draw down in near surface groundwater levels are likely to be minor.

7.3.6 *Steep Slopes*

The Glennies Creek slope is not expected to experience surface cracking, Surface cracking associated with longwall panel 4 (at its closest point to Glennies Creek) should cease about 20 to 40 metres back from the slope crest. Tilting associated with subsidence to the west of the slope is expected to cause the gradient of the slope to flatten slightly. However, SCT identified that there is a possibility that horizontal subsidence movements may cause a lateral slope translation of the ridge immediately to the west of Glennies Creek. This slope translation would occur in the direction of Glennies Creek and be approximately 100 to 260 mm. This movement is not expected to impact on the creek itself due to the alluvial nature of the stream channel.

The slopes between the southern end of all four longwall panels and the Hunter River are likely to experience significant surface cracking (SCT, 2006), similar to the cracking that will occur elsewhere on the panels. Lateral slope translation of approximately 10mm is also expected to occur. As discussed in *Section 10.3.3* and the slope stability assessment in *Annex E*, this is not predicted to result in an increased likelihood of slope failure for these two sites.

7.3.7 *Land Prone to Flooding and Inundation*

Subsidence of longwall panel 4 is likely to result in some ponding of surface waters, particularly in the more southern extents of the longwall panel (SCT, 2006).

As parts of this panel are prone to flood inundation during a one in 100 year ARI flood event (as discussed in *Section 6.3.5*) the predicted subsidence of up to 1.6 metres is likely to result in a slightly larger area of the site being inundated, and to a greater depth. However, this additional area of inundation is not likely to include any site residences or associated buildings.

7.3.8 *Water Related Ecosystems*

There are a number of small farm dams within the Application Area. These may potentially be drained by surface cracking and/or damage to dam walls.

Other nearby water related ecosystems (ie Bowmans Creek, Glennies Creek, and the Hunter River) is outside the Application Area and will not be affected by subsidence.

7.3.9 *Threatened and Protected Species*

Threatened species known or likely to use the site would be unlikely to be significantly impacted directly by the proposed longwall mining operations or indirectly through significant alteration to the habitat resources on the Application Area and surrounding lands (ERM, 2006a).

7.3.10 *Natural Vegetation*

Natural vegetation would be unlikely to be significantly impacted by the predicted level of subsidence and vegetation communities are unlikely to be subsided into the watertable. Any isolated tree falls that may occur as a result of increased tilt would not significantly alter the composition of the natural vegetation communities.

Farming, grazing and the nearby open cut mines have resulted in native vegetation clearance. The minor impacts of the Ashton Coal longwall panels 1 to 4 will not significantly increase the effects of the surrounding native vegetation clearance and associated impacts (ERM, 2006a).

7.3.11 *Fauna and Fauna Habitat*

The predicted levels of subsidence are unlikely to significantly impact native fauna and their habitats.

7.4 *SUBSIDENCE PREDICTIONS FOR PUBLIC UTILITIES*

7.4.1 *Roads*

Private Roads

Along the length of the internal access roads, mining subsidence is expected to lead to development of a series of tension cracks and compression humps of up to several hundred millimetres, and localised changes of grade up to an estimated 140mm/m as the longwall passes. These changes of grade are likely to occur over short distances of 5 to 10 metres with 1.7 metres of subsidence accommodated over 40 to 50 metres. Ground deformations may potentially result in reduction of ground clearance, loss of traction in rain and wheels slipping into cracks, and in worst case scenario, render the road unserviceable. At the projected rate of mining of about 100 metres/week, it is likely that each day a different section of road would be impacted by mining subsidence.

Changes in surface elevation due to vertical subsidence may impact on the camber of the access road and the effectiveness of water drainage away from the road surface. Given the type of road construction and likely traffic volumes, slight changes in camber are not expected to significantly impact the road. However, water ponding on the road surface as a result of changes in elevation does have the potential to damage the road and pose a hazard for traffic.

Surface cracking and tilting is expected to have potential to cause some groups of trees to lean permanently at tilts of up to about 150mm/m. Healthy trees are unlikely to fall as a result of subsidence, however individual dead or diseased trees with roots directly impacting by surface cracks may fall over. If any roadside trees fall onto the road, road use would be disrupted and pose a potential hazard to traffic.

Impacts on the road from mining longwall 1 would be expected to occur over two separate periods, one of two weeks duration and the other of about three weeks duration. During a 1400 metre long section of longwall 2 retreat (taking approximately four months), subsidence impacts would be expected on the main access road.

Mining of longwall 3 would affect the alternate route for about one week soon after commencement of mining in that panel. Later in the panel, mining would impact on the main access road for about five weeks, including a three week period when both the main access road and alternate road would be affected. Mining of the northern end of longwall 4 would be expected to impact on both routes for up to six weeks.

Other internal access roads on the ACOL property would be similarly affected by mining subsidence, these roads are used by tenants, contractors, and other authorised visitors and therefore also will need to be managed to provide safe access.

New England Highway

First workings for longwalls 1 to 5 form part of this SMP application and they are aligned with and located under the New England Highway road reserve. The New England Highway is not expected to be directly affected by subsidence from first workings or secondary extraction. However, approximately 250 metres northeast of longwall 1, the highway passes through a cutting, and there is a remote possibility that this cutting could experience horizontal closure and potentially cause pavement uplifting. The available method for estimating valley closure (Waddington and Kay, 2003), indicates 3mm of valley closure for this geometry. This is not predicted to present a hazard to highway traffic (SCT, 2006).

Support requirements determined by Strata Engineering (2005) for the mains headings and entries were prepared for the first workings SMP. These documents are provided as *Annex M* for reference.

7.4.2 Electricity Transmission Lines

The single timber poles supporting the local 11kV distribution power line traversing the northern end of longwall 4 are likely to experience the full range of subsidence movements and some of these poles may finish up tilted at up to 80mm/m. Provided the wires are isolated in temporary sheaves, the timber poles are able to accommodate the expected subsidence movements and remain serviceable.

The 132/66kV adjacent to the first workings will not experience subsidence from secondary extraction as a result of this SMP. Approval for first workings has previously been provided by EnergyAustralia as part of the first workings SMP approval.

Subsidence movements are expected to damage the dual and triple pole structures at the southern end of the Application Area and compromise the serviceability of the 132kV powerline. For instance, structure 2 located over the centre of longwall 1 is expected to experience the full range of subsidence movements as the longwall face passes underneath it. The depth of overburden at this location is approximately 60 metres and thus maximum tilt of up to 150mm/m may occur. This could cause lateral movement at the top of the pole structure up to around two metres relative to the base, and lateral horizontal movement of the whole structure of up to about one metre. Consequently, total misalignment of the conductor supports relative to their original position would be up to three metres. While some bend in the conductor alignment may occur, the hanging insulators are most likely to rotate causing a reduction in the clearance between the conductors and the pole structure.

Differential tilting between the two adjacent poles of structure 2 is difficult to estimate accurately, but at other sites characterised by similar overburden depths, differential tilt of up to 10mm/m/m (radius of curvature of 100m) has been measured. With pole spacing of 4.4 metres, this is equivalent to a differential tilt of 44mm/m, which translated to the cross beam elevation of 13.3 metres above the ground, equates to a differential movement of 585mm. It is considered unlikely that the "∏" pole configuration would be able to accommodate 585mm of differential movement between the two poles at the level of the cross member.

7.4.3 Telecommunication Lines

Subsidence predictions by SCT (2006) indicate that strains induced on the buried telecommunications cables within the Application area are likely to exceed their tolerance of approximately 20mm/m. Therefore, the buried telecommunication cable within the site that services the ACOL residences and residence on Property No. 130 is unlikely to remain serviceable.

The fibre optic cable within the northern end of the longwall panel will not be affected by subsidence (SCT, 2006). The cable is located approximately above the first workings and is unlikely to experience any vertical subsidence or differential movements. This area is subject to a Pothole Management Plan.

7.5 SUBSIDENCE PREDICTIONS FOR FARM LAND AND FACILITIES

7.5.1 *Agricultural Land*

Mining subsidence within the Application Area is likely to cause both permanent and temporary surface cracking with the potential to pose a public safety hazard and a hazard to stock.

Any permanent cracking will need to be filled following mining and prior to recommencing stock grazing in affected areas to avoid the potential for injury to stock (SCT, 2006).

7.5.2 *Farm Buildings/Sheds*

Subsidence effects on the farm buildings immediately adjacent to the only residence within the Application Area are likely to be noticeable. However, they are expected remain in a serviceable condition given their lightweight construction.

The farm buildings located over the longwall panel 3 and 4 goaf, are likely to experience the full range of subsidence movements and therefore may be compromised (SCT, 2006).

The farm buildings located on Property No. 130 are located just outside the mining area and are expected to experience only minor subsidence movements. They are therefore expected to remain serviceable.

7.5.3 *Irrigation Systems*

Buried pipe networks within ACOL's property and Property No. 130 are likely to experience damage as a result of subsidence (SCT, 2006).

7.5.4 *Fences, Gates and Cattle Grids*

Goaf edge subsidence will average about 70mm but may range up to 100mm. Subsidence will only have a minimal impact upon fencing located over chain pillars, however ground tilts of 78 – 244mm/m are considered possible in the vicinity of fences over the goaf ahead of, and following, the passage of the longwall faces. These tilts may damage fencing over the goaf to the extent that it is no longer stock proof and repair and maintenance is required. 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.

Ground tilt is likely to cause posts to tilt in opposite directions or towards each other, causing tension and possible breakage, or sag of wires, respectively. Depending on their location relative to the longwall panels, the posts may also lay over away from the run of the fenceline, effectively flattening the fence. Tilt of a gate's hinge post may result in the gate being unable to fully close which would render the paddock no longer stock proof, or unable to fully open which would affect access to and from the paddock. There is a risk that damage to fence lines could result in unplanned stock movements within Ashton property and to/from Ashton property and other private adjoining properties. There is little or no risk of stock entering the New England Highway road reserve. The fences and the cattle grid along this boundary will not be directly affected by subsidence and therefore, damage to fences and the cattle grid along this boundary is unlikely.

7.5.5 *Farm Dams*

Specific subsidence predictions for individual farm dams are dependent on their location relative to the longwall panels. Only low levels of subsidence (generally less than 100mm) are expected directly over the chain pillars and maximum subsidence up to 1.8 metres is predicted for the centre of longwall panels. Dams 2, 4, 5 and 7 are located centrally over longwall panels, in the area where subsidence and associated impacts are expected to be greatest. Dams 1, 3, 6, 8 and 9 are situated at the outer edges of longwall panels or over the chain pillars.

SCT (2006) identified a strong possibility that the dam walls 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 burst, 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 78 – 244mm/m are possible in the vicinity of the goaf ahead of, and following, the passage of the longwall faces and 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 also occur in the contour banks designed to channel overland flow into dams 1, 6 and 9, and initiate erosion points, thereby compromising their integrity. Tilting and alteration of ground levels may also result in the contour banks ponding water and no longer diverting water into the dam. Leaking or failure of contour banks would most likely cause a reduction in the volume of water reaching the dams. Whilst dams 1 and 6 are on drainage lines, recharge of dam 9 on Property No 130 is largely dependent on water directed to the storage area via the contour bank.

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 and the Application Area is bordered by Bowmans Creek, Glennies Creek and the Hunter River, which provide an alternate water source for native fauna and stock.

7.6 SUBSIDENCE PREDICTIONS FOR INDUSTRIAL, COMMERCIAL AND BUSINESS ESTABLISHMENTS

7.6.1 Mine Infrastructure - Water Pipeline

Specific subsidence predictions for ACOL's two pipelines have not been identified by SCT, however, they travel over the goaf edge of longwall 4 for a short distance and will therefore be partially impacted by subsidence following extraction of this panel. However, given that the pipes are of poly type construction and they will be affected by small vertical subsidence movement (being near the goaf edge) damage to the pipeline is unlikely. This pipeline is owned and managed by ACOL, and damage will not affect any other stakeholders.

7.7 SUBSIDENCE PREDICTIONS FOR AREAS OF ARCHAEOLOGICAL AND/OR HERITAGE SIGNIFICANCE

Specific subsidence predictions for individual archaeological sites are dependent on their location relative to the longwall panels. Given that the sites within the subsidence impact zone are all durable stone artefact scatters, subsidence and tensile strains will not directly cause significant disturbance to these sites. However, subsidence remediation works may be deemed necessary in response to the effects of subsidence-related erosion, cracking or ponding.

The grinding grooves in the waterhole and Glennies Creek sites are outside the subsidence impact zone and are unlikely to be directly impacted by subsidence.

7.8 *Subsidence Predictions for Residential Establishments*

There is only one farm residence located within the Application Area, and it is located close to Bowmans Creek within ACOL owned land. The dwelling itself is located over the chainpillars and is unlikely to be subject to significant tilting or vertical subsidence. It may experience some horizontal stretching movements particularly in the garden. The garage and other structures located nearer to longwall 4 may also experience more subsidence movements.

7.9 *Subsidence Predictions for Areas of Environmental Sensitivity*

The area subject to a Conservation Agreement (the southern woodland) is located over parts of longwall 1, 2 and 3. It will experience varying degrees of subsidence from the full range of subsidence movements to minimal subsidence over the chain pillars.

Some surface disturbance (surface cracking and compression humps) are therefore predicted in this area, which may cause some trees in the southern woodland to permanently tilt or fall. However the likelihood of this occurring is considered small and is likely to be limited to a small number of trees.

8 COMMUNITY CONSULTATION

ACOL considers community consultation to be an ongoing process in all aspects of its mining operations, including subsidence management.

The community consultation undertaken by ACOL has been carried out in accordance with the SMP Guidelines (DMR, 2003) and the Guidelines for Best Practice Community Consultation in the New South Wales Mining and Extractive Industries.

8.1 IDENTIFICATION OF STAKEHOLDERS

8.1.1 Landowners and Tenants

The majority of the Application Area is owned by ACOL. The first workings are partially located beneath land owned by the Roads and Traffic Authority (New England Highway and road reserve).

One private landowner, of Property No. 130, was identified within the Application Area. In addition, one tenant, was identified as leasing a dwelling owned by ACOL, and lying within the Application Area. An additional ACOL tenant is located outside the Application Area. The residents of this dwelling may be affected by indirect subsidence impacts such as access and telecommunications.

The land ownership relative to the Application Area is shown in *Figure 2.1*.

8.1.2 Mine Infrastructure Owners

ACOL are the only mine infrastructure owners within the Application Area.

8.1.3 Government Agencies

Seven state and local government agencies were identified as having interests or responsibilities related to subsidence within the Application Area, namely:

- Department of Primary Industries (DPI);
- Department of Planning (DoP);
- Department of Natural Resources (DNR);
- Department of Environment and Conservation (DEC);
- Roads and Traffic Authority of NSW (RTA);
- Registrar of Aboriginal Owners;

- Singleton Shire Council; and
- Mine Subsidence Board (MSB).

8.1.4 *Indigenous Groups*

Three indigenous groups participated in the survey work conducted by Dan Witter (2002) being the Wonaruah Local Aboriginal Land Council, Upper Wonnarua Tribal Council and the Lower Wonnarua Tribal Council. The results of this survey have been used within this assessment. As no further archaeological work has been undertaken, no additional survey with indigenous groups was conducted as part of the SMP process.

Since that time, a number of other indigenous groups have formed in the area. The indigenous groups in the area currently include:

- Lower Wonnarua Tribal Consultancy Pty Ltd;
- Wanaruah Local Aboriginal Land Council;
- Upper Hunter Wanaruah Council/Upper Hunter Tribal Council;
- Ungooroo Aboriginal Corporation;
- Aboriginal Native Title Elder Consultants;
- Wanaruah Custodians;
- YarraWalk;
- Wattaka Wonnarua C.C. Service;
- Valley Culture;
- Hunter Valley Cultural Consultants;
- Upper Hunter Heritage Consultants;
- Lower Hunter Wonnarua Council Inc;
- Wonnarua Nation Aboriginal Corporation;
- Wonnarua Culture Heritage;
- Black Creek Aboriginal Corporation;
- Giwiirr Consultants;
- Jimmy Woodger;
- Lower Hunter Tribal Council;

- Mimagen Wajaar Pty Ltd;
- St Clair Singleton Aboriginal Corp;
- Wandiyali Aboriginal Corporation;
- Yamuloong Group Initiatives Ltd;
- Yarnteen Aboriginal and Torres Strait Islander Corporation;
- Hunter Valley Aboriginal Corporation;
- Gringai Aboriginal Cultural Tours; and
- Aboriginal Enterprise Development Officer.

The Registrar of Aboriginal Owners was contacted and they confirmed that there are no traditional owners of land within the Application Area.

8.1.5 Public Utility Owners

Three authorities/organisations were identified as being responsible for public utilities within the Application Area, namely:

- Telstra;
- EnergyAustralia; and
- Powertel.

8.1.6 General Community

Additional stakeholders identified from the general community were the Ashton Community Consultative Committee (ACCC) and residents of the village of Camberwell.

8.2 CONSULTATION PROCESS

A chronology of the consultation undertaken is provided in *Table 8.1.*

Table 8.1 Summary of Consultation Undertaken

Date	Stakeholders Consulted	Consultation Method	Details
21/10/2005	RTA, DPI, MSB	Meeting	Meeting regarding the first workings beneath the New England Highway.
27/10/2005	EnergyAustralia	Meeting	Discussion of mine plan, inspection of infrastructure. Provided Strata Engineering report, mine plan, and aerial photographs.
28/10/2005	RTA, DPI, MSB	Meeting	Meeting regarding the first workings beneath the New England Highway.
28/10/2005	RTA, DPI, MSB	Memo	Notification that ACOL has modified the first workings plans beneath the highway in response to comments by the RTA and Principal Subsidence Engineer.
15/11/2005	RTA	Phone call	Discussion regarding the progress of approvals for ACOL to proceed with first workings beneath the New England Highway.
15/11/2005	DNR	Meeting	Meeting with DNR, SCT, PDundon and Associates, and ACOL to discuss ongoing groundwater investigations and assessment.
28/11/2005	EnergyAustralia	Email	Receipt of email from EnergyAustralia confirming no objections to First Workings.
15/12/2005	Powertel	Meeting	Site visit with Mine Engineer to verify cable type and location.
22/12/2005	Telstra	Phone/email	Confirmation of cable details, and provided Strata Engineering report and mine plans for first workings. Email received 23/12 confirming no impact to Telstra workings from first workings.
1/1/2006	Powertel	Letter	Receipt of letter regarding agreement to first workings in vicinity of fibre optic cable.
10/1/2006	RTA	Letter	Letter received from RTA indicating no objection to mining operations under the New England Highway subject to a Works Authorisation Deed for works beneath the New England Highway.
18/1/2006	RTA	Letter	Notes on the definitions and terms of the Works Authorisation Deed for works beneath the New England Highway.
23/1/2006	RTA	Letter	Discussion of the terms of the Works Authorisation Deed for works beneath the New England Highway.
24/1/2006	RTA	Letter	Forwarding copies of the signed Works Authorisation Deed for works beneath the New England Highway.
5/4/2006	DNR	Meeting	Meeting with DNR, SCT, PDundon and Associates, and ACOL to discuss ongoing groundwater investigations and assessment.
12/5/2006	General Community	Newspaper advertisement	Advertisement placed in the Singleton Argus (local newspaper) informing of ACOL's intention to prepare an SMP application (as per SMP Guidelines).
12/5/2006	General Community	Newspaper advertisement	Advertisement placed in the Sydney Morning Herald (state newspaper) informing of ACOL's intention to prepare an SMP application (as per SMP Guidelines).
19/5/2006	DPI, DNR, DEC, MSB, RTA, Singleton Shire Council, Registrar of Aboriginal Owners EnergyAustralia, Telstra, Powertel	Letter	Letter sent informing of ACOL's intention to prepare an SMP application.

Date	Stakeholders Consulted	Consultation Method	Details
22/5/2006	General Community	Newsletter	Newsletter prepared and distributed to local community providing details on the SMP process, ACOL's proposal to prepare and submit an SMP application and inviting any interested or concerned parties to contact ACOL or ERM.
25/5/2006	Owner of Property No. 130	Meeting	Discussions regarding SMP process, landowner concerns and subsidence management strategies.
30/5/2006	ACCC	ACCC Meeting	Presentation regarding subsidence was made to the Community Consultative Committee, and inviting comments relating to the proposal to be provided to ACOL or ERM.
1/6/2006	Michael Lloyd (DPI), Ray Ramage (DPI) and Monique MacDonald (DPI)	Meeting	Discuss the scope of the SMP application and to obtain some guidance on the SMP process, including brief site inspection.
16/6/2006	Owner of Property No. 130	Meeting	Discussions regarding draft management strategies for Property No. 130 and access road.
29/6/2006	General Community	Public Meeting	Presentation by ACOL Environmental Officer to a public meeting regarding predicted subsidence impacts and management strategies.
12/9/2006	RTA	Email	Copy of subsidence assessment report provided to the RTA for comment.
Various	EnergyAustralia	Email, site inspections	Discussions regarding potential relocation options and agreement regarding first stage of subsidence management for the 132kV transmission line.
13/10/2006	DPI, DNR, DEC, MSB, RTA, Singleton Shire Council, Registrar of Aboriginal Owners EnergyAustralia, Telstra, Powertel	Letter	Letter sent informing of ACOL's intention to prepare an SMP application.
27/11/2006	Indigenous Groups	Letter	Notification of the SMP submission and exhibition, outlining the SMP intent, basis upon which the work was based and inviting comments or concerns to relevant party.
27/11/2006	Owner of Property No. 130	Letter	Owner provided with notification of the submission of the SMP application and copy of the Property No. 130 SMP and Access Road SMP as agreed to during prior meetings.
31/10/2006	General Community	Newspaper advertisement	Advertisement placed in the Singleton Argus (local newspaper) informing of ACOL's submission of an SMP application (as per SMP Guidelines).
31/10/2006	General Community	Newspaper advertisement	Advertisement placed in the Sydney Morning Herald (state newspaper) informing of ACOL's submission of an SMP application (as per SMP Guidelines).

8.2.1 *Notification of Intent to Prepare SMP Application*

As described in *Table 8.1*, letters notifying stakeholders of the intention to prepare an SMP application were mailed on 19 May 2006. A copy of the letter, together with the distribution list, is included in *Annex J*.

Advertisement in Newspapers

To ensure that the general community was made aware of Ashton Coal's intention to prepare an SMP application, and to comply with the SMP Guidelines, advertisements were placed in the Singleton Argus (local newspaper) and the Sydney Morning Herald (State newspaper) on 12 May 2006 (see Table 12). A copy of the advertisement is included in *Annex J*.

8.2.2 *Landowners and Tenants*

The private landowner was consulted on an individual basis regarding the SMP process.

Explanation of SMP Process

Letters, phone calls and informal meetings were used to consult with the individual landowners to explain the SMP process and discuss requirements for land access for the purposes of environmental surveys and studies.

Formal Consultation Meetings

Two separate consultation meetings were held with the one private landowner during the course of developing the SMP application, as shown in *Table 8.1*.

The consultation meetings were documented to record the issues raised and discussed, and to ensure the concerns of the landowner were noted. The minutes and agendas of these meetings are included in *Annex J*.

8.2.3 *Government Agencies*

DPI

An initial meeting was held on 1 June 2006 with representatives from DPI involved in the SMP approval process (see *Table 8.1*), to discuss the scope of the SMP application and to obtain some guidance on the SMP process.

Particular areas of concern raised during this meeting included the steep slopes adjacent to Glennies Creek, the start position of longwall panel 1 relative to the saturated alluvium. In response to these concerns, ACOL commissioned Parson Brinkerhoff to prepare a slope stability assessment of the steep slopes adjacent to the longwall panels. Additional drilling has also been carried out and based on the extent of the Hunter River alluvium, as well as other geological features, the start position was amended and is now 90 metres from the Hunter River alluvium.

Department of Natural Resources

Since October 2005, ACOL have conducted a series of 'aquaclude' meetings with relevant experts and representatives of the Department of Natural Resources. These meetings have included discussions regarding appropriate groundwater investigations and mitigation of groundwater impacts that may result from underground mining.

Mine Subsidence Board

Consultation with the MSB in the form of letters, phone calls and e-mails was carried out during the process to understand their requirements for subsidence impact management.

Department of Planning

The Department of Planning were consulted by ACOL with respect to the dual requirement to prepare a SMP application to DPI and a Subsidence Environmental Management Plan (SEMP) as part of the Ashton Coal Project conditions of consent.

Their response is provided in *Annex J.*

8.2.4 Indigenous Groups

The consultation measures were aimed at everyone in the community (refer to *Sections 8.2.6* and *8.2.7*) and inviting any comments or concerns on the proposal. Correspondence was also prepared and forwarded to all Aboriginal groups in the area prior to submission of the SMP.

8.2.5 *Utility Owners*

EnergyAustralia

EnergyAustralia was consulted by ACOL during the SMP application process regarding their infrastructure which traverses the Application Area. Correspondence is provided in *Annex J.*

ACOL also consulted EnergyAustralia regarding the 132/66kV transmission line adjacent to the New England Highway regarding the construction of first workings.

Telstra

Telstra was consulted during the SMP application process regarding their infrastructure within the Application Area. ACOL commissioned Telecommunications Consultant, Colin Dove, to consult with Telstra and develop a subsidence management plan for the Telstra assets.

Telstra were also consulted by ACOL prior to the construction of first workings.

Powertel

Powertel was notified of ACOL's intent to prepare and lodge an SMP application for secondary workings. Powertel manage the fibre optic cable that runs parallel to the New England Highway north of the proposed longwall panels.

Powertel undertook a joint inspection of the fibre optic cable prior to the construction of first workings.

8.2.6 *General Community*

Consultation with the general community was undertaken through the newspaper advertisements as identified in *Table 8.1*. In addition, the ACCC was made aware of the process through a presentation to the ACCC and another presentation at a public meeting.

As part of the formal stakeholder consultation process, a presentation was given to a public meeting on 29 June 2006 as identified in *Table 8.1*. The presentation outlined the SMP progress to date and proposed strategies for subsidence impact management. A copy of the presentation and minutes from the meeting are included in *Annex J.*

8.2.7 *Notification of Submission of SMP Application*

Letters notifying stakeholders of ACOL's submission of an SMP application were sent on 19 May 2005 (see *Table 8.1*). A copy of the letter, together with the distribution list, is included in *Annex J*.

Advertisement in Newspapers

To ensure that the general community was made aware of ACOL's intention to submit an SMP application, and to comply with the SMP Guidelines, advertisements were placed in the Singleton Argus (local newspaper) and in the Sydney Morning Herald (state newspaper) on 12 May 2005. A copy of the advertisement is included in *Annex J*.

8.3 *RESULTS OF CONSULTATION*

8.3.1 *Summary of Views and Perceptions*

It is considered that with adequate management measures in place, the potential subsidence impacts identified by stakeholders and the community would not have high risk levels. In order to most efficiently address the concerns raised by stakeholders, specific management plans have been prepared for the relevant issues so as to ensure the relevance and adequacy of investigations and management responses.

Table 8.2 Summary of Stakeholders' Views and Concerns Regarding the SMP Application

Stakeholder	Views/Concerns Raised	Management Response
Department of Primary Industries	Stability of first workings beneath the New England Highway, land capability, steep slopes, legislative compliance and compliance with conditions of consent and mining operations plan.	The stability of first workings was addressed with DPI prior to their construction. In response to concerns on slope stability, an assessment was commissioned – the recommendations of which have been incorporated into the Land SMP. A compliance audit of relevant consent conditions, and the mining operations plan was prepared and this is incorporated as *Annex K*.
Department of Natural Resources	Groundwater impacts and adequacy of the models and monitoring framework.	The Groundwater Management Plan is currently being updated in consultation with DNR and will be finalised to their satisfaction prior to the commencement of longwall extraction.
Roads and Traffic Authority	Safety of road users, risk of subsidence potholes, stability of workings.	ACOL undertook a risk assessment regarding pothole management and provided relevant documents to the RTA. RTA were satisfied with the mine plan and approved the first workings beneath the highway, subject to a Works Authorisation Deed.
Landowner of Property No. 130	Safety of access for owner, residents, visitors, and particularly unimpeded access for daily milk tanker. Safety issues raised included cracking, humps, fallen/falling trees, and drainage.	A detailed monitoring and remediation plan has been developed and incorporated into a specific subsidence management plan. Includes daily inspections, frequent liaison between appropriate stakeholders, provision of alternative access if required, signposting, and warning signage.
Landowner of Property No. 130	Timely implementation of remediation works and repairs – without inconvenience or substantial effort by landowner or site manager/residents.	Specific management plans have been developed for surface infrastructure on both ACOL's property and Property No. 130. ACOL, along with the MSB are responsible for assessing and implementing timely remediation and repairs to site infrastructure.
General Community	Water quality – salinity, turbidity particularly were raised as a major topic of interest at the public meeting in June 2006.	Water quality issues relating to increased salinity and turbidity are addressed in ACOL's existing management plans, monitoring programs, and reporting requirements.

Stakeholder	Views/Concerns Raised	Management Response
General Community	Water loss from streams/aquifers	Potential losses of water from Glennies Creek into the Pikes Gully Seam has been estimated to be relatively small (7L/s). Monitoring of mine inflows and water quality will enable the identification of impacts outside this value. In the event of this happening (improbable) an appropriate response plan will be prepared in consultation with DPI and DNR.
General Community	Undermining of Bowmans Creek	The mining of future seams may occur beneath Bowmans Creek. This would be subject to a separate SMP application and will require monitoring of the environment under this SMP and the conditions of consent, as well as additional community consultation prior to any approval being issued by government agencies.
EnergyAustralia	132kV transmission line damages	EnergyAustralia have advised that this transmission line is a major interconnection of their electricity network and that supply outages would cause major disruptions. ACOL and EnergyAustralia have jointly developed a management approach to ensure supply outages only occur under controlled conditions (ie for re-routing or reconstruction works only).

8.3.2 *Management Priorities*

Ongoing consultation with stakeholders who will be directly affected by subsidence has been identified as a management priority. This will allow the timely implementation of management processes and strategies as per the Subsidence Management Plan. It will also ensure that stakeholder concerns and issues are addressed in a timely manner and a good working relationship between the mine and stakeholders are maintained.

8.3.3 *Joint Subsidence Management*

Joint management of subsidence impacts will be undertaken to varying degrees for the following identified features:

- telcommunications infrastructure;
- New England Highway; and
- electricity transmission lines.

Telecommunications Infrastructure

Subsidence impacts on the telstra infrastructure will be managed jointly by ACOL and Telstra, as per the specific management plan for the Telstra assets included in the Subsidence Management Plan. Whilst no damages are predicted to the fibre optic cable, this infrastructure is managed by Powertel and any subsidence related issues will be managed jointly with that organisation.

New England Highway

The New England Highway will continue to be managed jointly with the RTA. This includes three-monthly joint survey monitoring in accordance with the conditions of consent.

EnergyAustralia Infrastructure

Subsidence impacts on the EnergyAustralia infrastructure will be managed jointly by ACOL and EnergyAustralia, as per the specific management plan for the electricity transmission lines included as part of the Subsidence Management Plan. Monitoring will be undertaken by ACOL, with any repairs required to be carried out by EnergyAustralia.

8.3.4 *Continuing Consultation*

ACOL intends that community consultation will be an ongoing process for all aspects of its operations. A free-call environmental hotline has been established to facilitate the reporting of any environmental issues, including subsidence related issues: 1800 657 639. This number has been communicated to the local residents and wider community since the commencement of the Ashton Coal Project through advertisements, ACOL's website, and monthly newsletters.

Any individual who has concerns regarding an environmental or subsidence related issue is urged to contact the mine to enable the issue to be addressed promptly. All comments and complaints will are logged into a database and an initial response will be provided within 24 hours.

An internet site (www.ashtoncoal.com.au) has also been established to keep the community informed of progress on the project and the results of recent environmental monitoring and documentation relating to ACM.

The Ashton Community Consultative Committee has been established to address any concerns raised by local members of the community. The ACCC is chaired by a staff member of Singleton Shire Council.

An independent dispute resolution process that is transparent and consistent is available to address any complaints that cannot be directly resolved by ACOL. In the event that the dispute is not resolved, the Independent Dispute Facilitator will be empowered to consult with the Director-General of Planning who will make the final decision.

9 *STATUTORY REQUIREMENTS*

9.1 *CURRENT CONSENTS, APPROVALS, LEASES AND LICENCES*

Table 9.1 lists the consents, approvals, leases and licences currently held for the ACM, the issuing / responsible authority, date of issue, duration (where limited) and relevant comments.

9.1.1 *Mining Lease*

The Ashton Coal Mine (both open cut and underground) operations are undertaken within the boundaries of Mining Lease ML 1533.

9.1.2 *Development Consent*

The Ashton Coal Mine operates under Development Consent DA No. 309-11-2001-i, granted on 11 October 2002. An audit of the Conditions of Consent that relate to subsidence is provided in *Annex K.*

9.1.3 *Conditions Related to Subsidence Impacts*

This section details the conditions of current consents, approvals, leases and licences related to potential subsidence impacts within the Application Area.

The remaining items listed in *Table 9.1* are not relevant to subsidence impacts within the Application Area.

ML 1533

The conditions of ML1533 in relation (specifically or generally) to subsidence are summarised in *Table 9.2.* The conditions of ML1533 set out the process for preparation and submission of the AEMR.

Table 9.1 Current Consents, Leases and Licences relevant to the proposal

Issuing / Responsible Authority	Type of Lease, Licence, Approval	Date of Issue / Registration	Expiry	Comments
NSW Department of Primary Industries - Mineral Resources	Mining Lease 1533	26-02-2003	25-02-2024	Application Area contained wholly within ML extent.
NSW Department of Primary Industries - Mineral Resources	First workings Approval LW1 and LW2	21-10-2005	5-10-2006 (or upon approval for second workings SMP, whichever is sooner)	Approval for first workings for longwall panels 1 and 2.
NSW Department of Primary Industries - Mineral Resources	Mining Operations Plan	23/01/2005	31/10/2010	
Minister for Planning	Development Consent 309-11-2001-i	11-10-2002	11-10-2023	Applies to both open cut and underground operations.
Minister for Planning	Modification to Development Consent	15/10/2003	As above	Allows DEC to specify noise criteria).
Minister for Planning	Modification to Development Consent	27/1/2005	As above	Permits 10 metres increase in height of emplacement area.
Department of Environment and Conservation - Environment Protection Authority	Environment Protection Licence 11879	25-03-2005	Nil. Anniversary Date: 02/09	Licence varied by notice 1032190, issued on 10-Nov-2003, which came into effect on 05-Dec-2003. Licence varied by notice 1043742, issued on 28-Feb-2005, which came into effect on 25-Mar-2005.
Department of Natural Resources (or predecessors)	Bore licences 20BL136766, 20BL168848, and 20BL168849	12/01/1988, 27/08/2003, 27/08/2003	Nil.	
Department of Natural Resources (or predecessors)	Water licences 20AL201564 , 20AL203056, 20AL200568, 20AL201311, 20AL201083, 20AL200508, 20AL201030, 20AL201031, 20AL201624, 20AL201625, 20AL203106, 20SL044434, 20SL042214			Total allocation of 1141.5 ML.

Table 9.2 Mining Lease 1533 – Conditions Related to Subsidence

No.	Condition
11	*"The lease holder unless with the consent of the Minister and subject to such conditions as the Minister may impose shall not work or cause to be worked any seam of coal by underground methods within the subject area within the barrier defined as follows: The land within the zone beneath and adjacent to the* ***Great Northern Railway*** *enclosed by an angle of draw of 35 degrees from the vertical plan of the boundary parallel to a thirty (30) metres horizontally distant from either side of the railway lands, such angle of draw being measured outwards from the point on the vertical plan of the said boundary at the surface or at the level of the horizontal plane of the railway track, whichever may be the higher, to the floor of the coal seam in which mining operations are being carried out."*
14	(Shafts, Drifts, Adits) *"Operations shall be conducted in such a manner as not to cause any danger to persons or stock and the lease holder shall provide and maintain adequate protection to the satisfaction of the minister around each shaft or excavation opened up or used by the lease holder."*
18	*"The lease holder shall not interfere in any way with fences on or adjacent to the subject area unless with the prior written approval of the owner thereof or the Minister and subject to such conditions as the Minister may stipulate."*
19	*"The lease holder shall observe any instruction given or which may be given by the Minister with a view to minimising or preventing public inconvenience or damage to public or private property."*
20	*"If required to do so by the Minister and within such time as may be stipulated by the Minister the lease holder shall carry out to the satisfaction of the Minister surveys of structures, buildings, and pipelines on adjacent landholdings to determine the effect of operations on any such structures, buildings and pipelines."*
21	*"If so directed by the Minister the lease holder shall rehabilitate to the satisfaction of the Minister any lands within the subject area which may have been disturbed by the lease holder."*
25	*"The lease holder shall provide and maintain to the satisfaction of the Minister efficient means to prevent contamination, pollution, erosion or siltation of any river, stream, creek, tributary, lake, dam, reservoir, watercourse, or catchment area or any undue interference to fish or their environment and shall observe any instruction given or which may be given by the Minister with a view to preventing or minimising the contamination, pollution, erosion or siltation of any river, stream, creek, tributary, lake, dam, reservoir, watercourse, or catchment area or any undue interference to fish or their environment."*
27	*"If so directed by the Minister, the lease holder shall ensure that operations are carried out in such a manner so as to minimise disturbance to flora and fauna within the subject area"*
30	*"The lease holder shall conduct operations in such a manner as not to cause or aggravate soil erosion and the lease holder shall observe and perform any instructions given or which may be given by the Minister with a view to minimising the prevention of soil erosion."*
41	*"The lease holder shall as far as practicable so conduct operations as not to interfere with or impair the stability or efficiency of any transmission line, communication line, or pipeline traversing the surface or the excepted surface of the subject area and shall comply with any direction given or which may be given by the Minister in this regard."*
42	*Unless with the consent of Energy Australia, the lease holder shall not carry out any operations within any easement for power transmission line traversing the subject area.*
43	*The lease holder shall not knowingly destroy, deface, or damage any aboriginal place or relic within the subject area except in accordance with an authority issued under the National Parks and Wildlife Act, 1974, and shall take every precaution in drilling, excavating, or disturbing the land against any such destruction, defacement, or damage.*

In addition to the conditions in *Table 9.2*, a new mining lease condition has been imposed on all leases by the Minister under Section 239(2) of the *Mining Act, 1994* which 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 (gateroads, installation roads and associated main 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.

This Subsidence Management Plan application has been prepared prior to the commencement of longwall extraction and in accordance with the conditions outlined above.

Development Consent

The development consent covers a broad range or environmental management and monitoring issues, some of which specifically relate to subsidence. An audit of the Conditions of Consent that relate to subsidence is provided in *Annex K,* including comments as to what action has been taken and compliance/non-compliance.

This report and supporting documents were found to be consistent with the conditions of consent and provide the required documentation where relevant.

The Department of Planning were consulted by ACOL with respect to the dual requirement to prepare a SMP application to DPI and SEMP as part of the Ashton Coal Project conditions of consent.

Their response is provided in *Annex J* and states the following:

"The Department agrees that there is no benefit in the SEMP and SMP processes being run independently of one another. Your proposal that Ashton should apply the processes outlined in the DPI (Minerals) Guidelines for Applications for SMP Approvals, while addressing all relevant requirements of the development consent in an combined SEMP/SMP application, is supported, as is your proposal that the requirements for Subsidence Management Impact Assessment Report (SMIARs) should also be integrated into SMP monitoring and reporting processes."

First Workings SMP (LW1 and LW2)

Approval for the First Workings was issued by DPI (Minerals) in October 2005. The conditions attached to the approval are summarised in *Annex K* along with comments relating to ACOL's compliance with these conditions.

Mining Operations Plan

The Ashton Mining Operations Plan has been prepared in consultation with and approved by DPI (Minerals) – Environmental Sustainability Branch. Through the consultation process discussed in *Section 8*, ACOL were requested that ACOL demonstrate compliance with the MOP, First Workings SMP, and Development Consent.

A summary of all of the commitments made in the MOP are provided in *Annex K* along with where the relevant action can be found in ACOL's suite of environmental management plans, or subsidence management plans for the underground mine.

9.2 MINING UNDER SENSITIVE FEATURES

9.2.1 Lake Foreshores

The proposed mining detailed in this SMP application is not under any lake foreshores.

9.2.2 Land Prone to Flooding or Inundation

As detailed in *Section 6.3.5* there are relatively small areas within the Application Area which are prone to flooding.

9.2.3 Dams (Under Dams Safety Act 1978)

The proposed mining detailed in this SMP application is not under any dams, stored waters, reservoirs or structures referred to by the *Dams Safety Act 1978.*

9.2.4 *Heritage Items*

There are no heritage items identified within the Application Area.

9.2.5 *Area of Archaeological Significance*

As detailed in *Section 6.7*, an archaeological survey was undertaken over the Application Area in 2002 by Dan Witter. This survey identified 42 archaeological sites within the Application Area. Should a site have the potential to be impacted by remediation earthworks associated with subsidence impacts or identified as being at risk from subsidence impacts during the pre-mining mapping (refer to the Archaeology and Cultural Heritage Subsidence Management Plan), a Section 90 approval under the *National Parks and Wildlife Act, 1974* would be required.

10 SUBSIDENCE IMPACTS

10.1 SUBSIDENCE IMPACTS ON APPLICATION AREA

Subsided areas will be predominantly improved pasture with isolated stands of trees, riparian vegetation along waterways and within the southern woodland.

The overall cumulative impacts of subsidence on the Application Area as a whole are predicted to be minor. Farming, grazing and surrounding mining operations have previously impacted on the natural features of the area including vegetation clearance and changes to drainage paths.

Subsidence impacts on identified surface and sub-surface features, including natural features, public utilities, farm land and facilities, infrastructure and archaeological areas are assessed in this chapter.

Overall, the subsidence impacts are capable of mitigation and control through ongoing monitoring and land management practices.

10.1.1 General Impacts on the Land Surface

Vertical subsidence of 1.6 to 1.8 metres is likely to be generally perceptible to the naked eye given that the overburden depth is 35 metres minimum, and the distance from one side of the subsidence trough to the other is less than 400 metres. Even in areas where subsidence is unlikely to be visually noticeable (due to large overburden depths and wide panel widths, sighting along structures that are known to be flat or straight prior to mining such as fences, roads or railway lines generally allows vertical subsidence to be observed directly. Nevertheless, it is usually the secondary effects such as surface cracking, compression humps, tilting of fences etc that are the most prominent visual features of subsidence.

Horizontal ground movements in flat terrain tend to occur towards the mined area and in the direction of mining. There is a tendency for tensile cracking along the goaf edge and over the longwall face as the ground subsides with residual compressive movements over the mining area. These movements are likely to be transient in nature behind the longwall face but be longer term over the goaf edge, with greatest cracking occurring at a distance of 80 to 100 metres from the goaf edge. The magnitude of horizontal cracking is dependent on the general nature of the ground surface, with cracks likely to be less perceptible in agricultural land than on hard, bare surfaces such as a road.

Compression humps are predicted to occur within the Application Area. Subsidence will also create depressions in the land surface, aligned along the proposed longwalls. Surface cracking is predicted to occur as a result of ground strains.

10.2 SUBSIDENCE IMPACTS ON SURFACE AND SUB-SURFACE FEATURES

Subsidence impacts on surface and sub-surface features assessed in *Sections 10.3 to 10.8* consider concerns and issues raised through the community consultation process, in addition to risks identified through the formal risk assessment process detailed in *Section 11.1*.

10.3 NATURAL FEATURES

10.3.1 *Hunter River*

The Hunter River will not be impacted directly or indirectly by subsidence. The start position of longwall 1 has been determined to be 90 metres from the estimated extent of saturated alluvium associated with the Hunter River (Dundon, 2006) and is at least 169 metres from the river bank.

10.3.2 *Bowmans Creek*

Bowmans Creek will not be directly impacted by subsidence. Longwall panel 4 comes within approximately 60 metres (horizontally) of the top of the bank, but vertical subsidence is not expected to be perceptible beyond a few tens of metres from the goaf edge. Horizontal movements may extend further, but given the alluvial nature of the base of Bowmans Creek, no perceptible impacts are anticipated from subsidence movements.

The Application Area drains predominantly to Bowmans Creek, and if surface impacts are unmanaged, increased erosion could increase the sediment bedload and therefore potential result in channel migration. However, the likelihood of sufficient sediment being generated, and the implementation of appropriate monitoring and erosion and sediment controls, makes the risk of this impact occurring very low.

10.3.3 *Glennies Creek*

Glennies Creek will not be directly impacted by subsidence movements, however, may experience an increase in water loss from the alluvium into the Pikes Gully Seam. As a worst case scenario, this increase has been estimated by Dundon (2006) to be approximately 0.6 ML/day. This would occur in the unlikely scenario that slope translation causes a planar bedding fracture within the Pikes Gully Seam, subsequently opening up crack and fissures along which water can enter the underground workings. Dundon notes that this outcome is considered highly improbable.

However, given that the Pikes Gully Seam between the longwall 1 tailgate and Glennies Creek will not be subject to subsidence, the bulk permeability is not expected to change, therefore a more realistic estimate of increased groundwater flow from Glennies Creek, based on existing permeability of the coal seam is less than 0.02ML/day.

These impacts are discussed further in *Annex D.*

10.3.4 Drainage Paths and Channels

Surface cracking is likely to increase the total amount of rainfall infiltration experienced over the goaf areas. The result of which is a decrease in catchment runoff from the site. Decreased runoff will reduce existing erosion of drainage paths and channels. However, reductions in flows of the Hunter River, Bowmans Creek and Glennies Creek will not be perceptible as each of these catchments is substantially larger than the affected area of the site.

Subsurface cracking will potentially provide a direct hydraulic connection between the surface and the goaf in areas where the depth of cover is less than 100 metres (140 hectares). Dundon (2006) estimates that this could increase rainfall infiltration from approximately 0.5% (existing) up to 20% (post subsidence).

Subsidence will alter the topography, potentially impacting on surface catchment flow patterns and altering the minor drainage lines. It will cause a marginal decrease in the water inflow to Bowmans Creek and temporarily increase the percolation characteristics of the strata until the fractures anneal and seal. Localised ponding of water could result in concentrated water flows and associated erosion or the development of "pinch points" that could also result in erosion.

Ponding of water in flat areas following heavy rain or flooding is a perceptible effect of vertical subsidence. Temporary ponding may occur in areas of water accumulation due to the progress of the longwall face, and will cease to be an issue once the face progresses. Permanent ponding may occur where a depression remains once the longwall face has passed but is likely to be restricted to the small section of flats associated with Bowmans Creek within the south western portion of longwall panel 4 and adjacent to the Bowmans Creek oxbow.

Ponding of water for an extended time may affect the submerged grasses in the area or result in a change in the vegetation composition. Given the relatively small size of the likely ponded area, the impact on fodder for livestock would be minimal.

10.3.5 *Aquifers and Groundwater*

SCT (2006) predicts that interconnected cracking will occur up to 100 metres above the goaf. Where depth of cover is less than 100 metres, the directly connected cracking between the goaf and the land surface will increase rainfall infiltration over the site. This increase in infiltration, and therefore recharge to the goaf and Pikes Gully Seam has been calculated (Dundon, 2006) to be approximately 370 m^3/day. This value is an upper limit and should reduce over time as cracks are repaired on the surface, or fill naturally with sediment. It is proposed to measure and monitor this interconnection through the use of multi-level vibrating wire piezometers.

Dundon (2006) has assessed based on existing data that some degree of hydraulic connection between the Glennies Creek alluvium and the Pikes Gully seam aquifer is present. The degree of the hydraulic connection interconnection was assessed on the basis of the pumping tests carried out on bores WML120A and WML119, screened in the Pikes Gully seam, and WML120B screened in the alluvium. An assessment was then been made of the potential for flow between the Glennies Creek alluvium and the Pikes Gully seam at the projected closest point along the Longwall 1 gateroads, and the potential changes as a result of mining.

It is calculated that the current potential natural rate of flow between the Glennies Creek alluvium and the Pikes Gully seam at the nearest point along the eastern gateroad of Longwall 1, is around 170 m^3/day (2.0 L/s). It is predicted that even after longwall extraction, any increase in the permeability of the coal seam is expected to be confined to the region west of the eastern gateroad, within the subsidence zone. Providing the bulk of the region between Glennies Creek and longwall 1 remains unaffected by subsidence-induced cracking, the flow rate between the Glennies Creek alluvium and longwall 1 should remain the same.

In the Groundwater Assessment, a couple of other scenarios were investigated to determine possible "worst case" flow rates from Glennies Creek into the coal measures as a result of secondary extraction. These scenarios and resulting flow rates are as follows:

- a ten-fold increase in bulk permeability over the full width of the contact zone between the Pikes Gully Seam and Glennies Creek alluvium – 20L/s (1700 m^3/day);

- a ten-fold increase in the bulk permeability over a section only 100m wide – 3.4L/s (290 m^3/day); and

- the development of a bedding-plane fracture at the base of the Pikes Gully seam, which could provide a more permeable flow-path than currently exists between the alluvium and the workings with a constant fracture flowpath of 2mm - 0.4L/s (38 m^3/day); and

- the development of a bedding-plane fracture at the base of the Pikes Gully seam, which could provide a more permeable flow-path than currently exists between the alluvium and the workings with a constant fracture flowpath of 5mm - 7L/s (600 m^3/day).

Dundon (2006) notes that an increase in bulk permeability over the full width is unlikely and that the probability of a bedding plane fracture is small. If a bedding plane fracture was to develop along the base of the seam the fracture aperture is more likely to be only 1 to 2mm. Therefore, a predicted potential flow rate of 170m^3/day between the Glennies Creek alluvium and the development headings in the Pikes Gully seam is adopted.

At its closest point, longwall panel 4 will be approximately 70 metres from Bowmans Creek. In this area, the Permian coal measures outcrop at the waters edge. Drilling investigations indicated that there is no saturated alluvium between the creek and longwall panel 4. The Bowmans Creek alluvium does encroach slightly over the western edge of Longwall 4 near its southern end however, the alluvium in this area is unsaturated.

There are no occurrences of saturated alluvium within the SMP, nor within the minimum buffer zone specified in DNR's guideline for coal mining near streams and aquifer systems, ie 40m from the edge of the subsidence angle of draw (DNR, 2005). Hence there will be no direct hydraulic connection created between the Bowmans Creek alluvium and the Longwalls as a result of the proposal (Dundon, 2006).

However, the Groundwater Assessment discussed that there would already be a natural flow, albeit extremely small, between the alluvium and the Pikes Gully seam in this area, the magnitude of which is dependent on the prevailing hydraulic conductivities of the intervening coal measures strata, and the head difference between groundwater in the alluvium and groundwater in the Pikes Gully seam at this location. There will theoretically be potential for a small increase in the natural rate of groundwater to flow from the alluvium. The existing flow rate, determined using Darcy's law, is estimated to be between 0.15 and 0.4 L/s (12 to 37 m^3/day).

The estimated potential flow rate assumes no change in the hydraulic conductivity of the coal measures strata between the alluvium and the goaf as a result of the longwall extraction (in panels 1 to 4). This assumption is based on the flow path lying outside of the subsidence impact zone. Dundon notes that the predicted volume of flow is negligible compared with the natural rate of inflow from the alluvium under recharge conditions.

10.3.6 Steep Slopes

A slope stability assessment has been prepared by Parsons Brinkerhoff (2006), as provided in full as *Annex E* based on the predictions by SCT of lateral slope translation (both steep slopes) and increased infiltration associated with surface cracking (Hunter River steep slope).

Parsons Brinkerhoff investigated the possibility of slope failure based on three potential mechanisms:

- slumping of the colluvium (Glennies Creek) or slopewash material (Hunter River);
- circular slip due to fracturing of the supporting rock mass; and
- planar slip along a low strength sliding plan along or near the Pikes Gully Seam.

A probability assessment of the above events occurring was undertaken for both the Glennies Creek slope and Hunter River slope by Parsons Brinkerhoff. Their conclusions with respect to the probability of the three failure modes occurring at each site are summarised in *Table 10.1*.

Table 10.1 Likelihood Assessment – Slope Instability

Mode of Failure	Hunter River	Glennies Creek
Slump in colluvium/slopewash	Not credible	Rare
Circular slip through rock mass	Not credible	Not credible
Planar slip	Not credible	Rare

Source: Parsons Brinkerhoff, 2006

The probability of slope instability being triggered by natural causes, such as high rainfall events, was assessed to be higher, particularly at the Glennies Creek site where slope gradients are reasonably steep.

10.3.7 Land Prone to Flooding and Inundation

A small proportion of longwall panel 4 is currently subject to flooding during major flood events of Bowmans Creek and the Hunter River. Subsidence is likely to slightly increase the extent of area affected by flooding as well as overall flood depth in these areas. This area also tends to be less sloping and may therefore be more prone to ponding of water due to changes of grade and the formation of a subsidence trough after the longwall face has passed.

10.3.8 Water Related Ecosystems

No direct subsidence impacts are expected on nearby water related ecosystems.

There is some potential for the streambed of Bowmans Creek to be impacted as sediment generated from erosion of the Application Area has the potential to alter the benthic environment and initiate channel migration or other major changes to stream morphology.

10.3.9 *Threatened and Protected Species*

As detailed in *Section 6.3.7*, six threatened fauna species have been identified within the site, with an additional nine species likely to utilise the habitat within the Application Area. An assessment of significance conducted on all threatened species known or likely to occur within the Application Area concluded these species are unlikely to be significantly impacted directly by the proposed longwall mining operations or indirectly through significant alteration to the habitat resources on the Application Area and surrounding lands.

10.3.10 *Natural Vegetation*

All of those flora species identified within the Application Area have been collectively referred to within the flora and fauna impact assessment (*Annex G*). Subsidence impacts could potentially disturb the identified natural vegetation through:

- direct damage from tilt;
- direct damage from strain;
- ponding;
- lowering the watertable beyond the reach of groundwater reliant communities;
- subsiding individual plants into the groundwater zone;
- clearing for subsidence rectification; and
- cumulative impacts.

There is a possibility that trees which already have a steep lean in the direction of subsidence-induced tilt will fall as a result of up to 150mm/m tilt. Conversely any trees leaning away from the subsidence-induced tilt would be straightened. It is unlikely that any isolated falls that may occur would significantly alter vegetation community composition. Tilt will not affect shrubs, herbs or grasses, as they are too short to exert significant leverage on root systems. Strain will have little impact on plant roots due to their inherent flexibility.

Subsidence associated with longwall panel 4 in the vicinity of the flats along Bowmans Creek may result in localised ponding of surface runoff in these areas following rainfall. While ponding may substantially affect any vegetation growing in the area concerned, ACOL proposes to drain any such pond. Assuming that this drainage occurs soon after ponding, few long term affects are predicted.

There have been no groundwater dependent ecosystems identified over longwall panels 1 to 4, although a number of small farm dams supporting limited aquatic vegetation exist across the Application Area. Anecdotal evidence suggests that these dams are not groundwater fed and lowering of the watertable will not directly impact any aquatic vegetation. Given the nature and depth of the groundwater system it is not expected that plant communities would be subsided into the groundwater zone.

Cracking is likely to occur across the Application Area although it is not expected that clearing of vegetation associated with significant remediation works will be required. It may be more difficult to remediate surface cracking that occurs through the woodland areas, meaning that cattle would need to be restricted in these areas until such times as natural remediation had filled the cracks.

Farming, grazing and the nearby open cut mines have resulted in native vegetation clearance. The relatively minor impacts of the Ashton Coal longwall panels 1 to 4 will not significantly increase the effects of the surrounding native vegetation clearance and associated impacts.

10.3.11 Flora and Fauna Habitat

All of those fauna species identified within the Application Area have been collectively referred to within the flora and fauna impact assessment (*Annex G*). Subsidence impacts could potentially harm or exclude fauna through:

- direct clearing and indirect vegetation loss;
- reduction in the size and number of rock shelters;
- change of surface water regimes;
- drying of billabongs, soaks and dams; and
- cumulative impacts.

Only minimal vegetation clearance, if any, is expected to occur. The proposed longwall mining is not likely to isolate or reduce the extent of the local vegetation communities present. The proposal will not remove fallen timber, which provides a foraging resource for the grey-crowned babbler or habitat for other species.

Bats may roost in existing rock cracks and a number of burrowing animals are known to occur within the locality. Subsidence may widen or close these fissures and burrows. It is not possible to quantify the likelihood or number of crack closures or burrow collapses. Whilst subsidence could threaten roosting and shelter sites, similar habitat is common within the local area. In some cases, cracking may actually increase the total roosting and shelter habitat for threatened species within the site.

Bowmans Creek, Glennies Creek and the Hunter River are not expected to be directly impacted by the proposed mining activities and no perceptible impacts to channel morphology are anticipated directly from subsidence movements. The underground mining within longwall panels 1 to 4 will alter the topography within the Application Area, potentially impacting on surface catchment flow patterns and altering the minor drainage lines. It will cause a marginal decrease in the surface water inflow to Bowmans Creek although this is unlikely to impact on the quality of the aquatic habitats given the large seasonal and environmental variations already experienced within Bowmans Creek (*Annex F*).

In general, subsidence may cause surface cracking and a consequent reduction in yield from soaks and springs. Within the Application Area, the loss of individual springs cannot be discounted. However, no spring fed dams have been recorded and it is unlikely there will be significant changes to the way groundwater is released to receiving watercourses.

Dams across the Application Area do not need draining ahead of mining. The farm dams have relatively low aquatic habitat value and the Application Area is bordered by Bowmans Creek, Glennies Creek and the Hunter River, which provide an alternate water source for native fauna. Impacts from the underground mining of longwalls 1 to 4 are unlikely to significantly impact this habitat resource such that a local population of threatened species would be placed at risk

Farming, grazing and the nearby open cut mines have resulted in native vegetation and associated habitat clearance. The relatively minor impacts of the longwall panels 1 to 4 are unlikely to cumulatively increase the effects of the surrounding native vegetation clearance and subsequent habitat loss.

10.4 PUBLIC UTILITIES

10.4.1 Roads

Private Roads

Along the length of the internal access roads, mining subsidence is expected to lead to development of a series of tension cracks and compression humps of up to several hundred millimetres, and localised changes of grade up to an estimated 140mm/m as the longwall passes. These changes of grade are likely to occur over short distances of five to 10 metres with 1.7 metres of subsidence accommodated over 40 to 50 metres. Ground deformations may potentially result in reduction of ground clearance, loss of traction in rain and wheels slipping into cracks, and in worst case scenario, render the road unserviceable. At the projected rate of mining of about 100 metres/week, it is likely that each day a different section of road would be impacted by mining subsidence.

Changes in surface elevation due to vertical subsidence may impact on the camber of the access road and the effectiveness of water drainage away from the road surface. Given the type of road construction and likely traffic volumes, slight changes in camber are not expected to significantly impact the road. However, water ponding on the road surface as a result of changes in elevation does have the potential to damage the road and pose a hazard for traffic.

Surface cracking and tilting is expected to have potential to cause some groups of trees to lean permanently at tilts of up to about 150mm/m. Healthy trees are unlikely to fall as a result of subsidence, however individual dead or diseased trees with roots directly impacting by surface cracks may fall over. If any roadside trees fall onto the road, road use would be disrupted and a potential hazard posed to traffic.

Impacts on the road from mining longwall 1 would be expected to occur over two separate periods, one of two weeks duration and the other of about three weeks duration. During a 1400 metre long section of longwall 2 retreat (taking approximately four months), subsidence impacts would be expected on the main access road.

Mining of longwall 3 would affect the alternate route for about one week soon after commencement of mining in that panel. Later in the panel, mining would impact on the main access road for about five weeks, including a three week period when both the main access road and alternate road would be affected. Mining of the northern end of longwall 4 would be expected to impact on both routes for up to six weeks.

Other internal access roads on the ACOL property would be similarly affected by mining subsidence, however, these are not critical access roads and are on mine-owned land. Consequently the impacts of damage to these roads are not expected to be significant (SCT, 2006).

New England Highway

The New England Highway is not expected to be directly affected by mining subsidence. However, approximately 250 metres northeast of longwall 1, the highway passes through a cutting, and there is a remote possibility that this cutting could experience horizontal closure and potentially cause pavement uplifting. The available method for estimating valley closure (Waddington and Kay, 2003), indicates 3 mm of valley closure for this geometry. While such low levels are at the limit of the technique, they would not present a hazard to highway traffic.

It is unlikely that there will be any subsidence impacts from the first workings on the New England Highway and adjacent infrastructure (ie fibre optic cable, electricity transmission lines). Subsidence from first workings can only occur from a roof fall underground and a risk assessment has been prepared and this is included in *Annex L.*

10.4.2 Electricity Transmission Lines

The transmission lines that cross the Application Area will be affected by subsidence to varying degrees. Ground tilt due to subsidence may impact on aerial transmission lines by causing increased sag or tension in the lines when poles tilt towards, or away, from each other. Depending on their location relative to the longwall panels, the poles may also lay over in a direction at an angle to the run of the lines.

SCT (2006) concluded that the 11kV transmission line is likely to remain serviceable provided the wires are isolated in temporary sheaves. The timber poles will be able to accommodate the subsidence movements and the line will remain serviceable. Once subsidence is complete, it may be necessary to restraighten the poles as part of normal line maintenance.

Subsidence movements are expected to compromise the serviceability of the dual and triple pole structures that support the 132KV transmission line. ACOL have consulted EnergyAustralia regarding potential relocation and reconstruction options and these are addressed in the Subsidence Management Plan.

No subsidence impacts to the 132/66kV line adjacent to the New England Highway are predicted.

10.4.3 Telecommunication Lines

Horizontal strains are expected to be the most likely cause of damage to the Telstra infrastructure. Peak tensile strains of 5 to 6mm/m would have the potential to cause damage to cables and/or service pits if they become concentrated on a small number of single cracks.

SCT (2006) note that their previous mine subsidence experience with larger, more robust copper grease filled cable indicates that this type of lighter cable may be able to sustain ground strains of a similar magnitude to those predicted without a loss of service.

The service pits located within the Application Area are considered to be vulnerable to subsidence movements. It is predicted that they will be susceptible to damage from ground movements.

The affected customers include the residents of Property No 130, and tenants of the residences on mine-owned land.

The fibre optic cable within the northern extent of the Application Area is in close proximity to first workings. No subsidence related damage is predicted for this infrastructure.

10.5 *FARM LAND AND FACILITIES*

10.5.1 *Agricultural Land Use and Suitability*

Ashton has purchased the surface land title for most of the area impacted by subsidence, so subsidence will be largely contained to mine-owned agricultural land.

Subsidence would result in a lowering of the ground surface, possible ponding, changes to runoff characteristics, alterations to the relative surface topography and ground cracking which may concentrate subsequent subsidence movements and lead to erosion. Potential erosion and sedimentation impacts could result, including increased erosion of the ground surface along the eastern ridge. According to SCT (2005a), surface cracking is likely to be less perceptible on agricultural land than on hard, bare surfaces. However, should significant surface cracks develop, there is potential for personal or livestock injury. As discussed in Section 10.2.1.5, adverse impacts to a small area of pasture are possible as a result of temporary or permanent ponding. However, the impact on the quantity and quality of the land suitable for grazing is expected to be minimal and is not expected to significantly impact livestock grazing.

Dynamic cracking and ground disturbance is expected to occur in the central part of each longwall panel. Cracking is also predicted along the goaf edge, perpendicular to the longwall face. While surface cracking of several hundred millimetres magnitude is likely to present a hazard for stock in the area, it may be possible to graze stock elsewhere during the period of active mining. Remediation of surface cracks would be relatively easy and would involve grading material into the cracks, compacting this material and then re-grassing it.

Any buried water pipes would be unlikely to survive the subsidence movements. For the levels of subsidence anticipated, it is usually necessary to replace buried pipe work with poly pipe lying along the surface and then bury the polypipe once mining is finished.

10.5.2 *Farm Buildings/Sheds*

The farm buildings on the same side of the road as the "Ashton" residence may experience higher levels of subsidence impacts than the house, but given that they are lightweight structures, they are likely to remain in a serviceable condition. The farm building currently used as a core shed and the farm buildings on top of the hill are likely to experience the full range of subsidence movements and their serviceability may be compromised. A farm building located to the north of the residence is already partly collapsed. Mining subsidence is not expected to significantly alter its current condition.

The farm buildings located on Property No. 130 are located outside of the mining area, however are just inside the line of intersection between the 26.5^{o} angle of draw and site surface. These structures may experience minor subsidence movements and are predicted to remain serviceable (SCT, 2006).

10.5.3 *Irrigations Systems*

The buried concrete water tank and associated buried polypipe located north-east of the "Ashton" residence is not expected to remain serviceable throughout the cycle of mining subsidence. Replacement of the tank with an above ground, plastic tank located over one of the chain pillars would be recommended. Buried polypipe would need to be exhumed and laid on the surface to ensure ongoing serviceability.

The concrete water tanks on Property No 130 are sitting on the ground surface and are on the edge or just outside the Application Area. Therefore, no impact is expected to the tank, however impacts may be experienced by the associated buried water pipes. It is therefore recommended that these be temporarily replaced temporary polypipes on the ground surface until subsidence is complete.

10.5.4 *Fences, Gates and Cattle Grids*

Fences will be impacted by subsidence movements and are likely to require mending and re-tensioning once mining is complete.

Ground tilt due to subsidence may impact farm fences by causing increased sag or tension in the wire strands when posts tilt towards or away from each other. Depending on their location relative to the longwall panels, the posts may also lay over in a direction at an angle to the run of the fence line. Damage to fences may allow unplanned stock movements between paddocks and other properties. Temporary electric fences may be required to ensure stock control and exclude stock from over the active longwall face until surface cracks can be repaired.

Farm gates may also be adversely impacted by subsidence movements. There is potential that movement of a gate hinge post or hitching post may result in the gate being unable to open or close fully. Again, this may allow unplanned stock movements into other paddocks or properties.

Cattle grids may tilt and potentially cause a traffic hazard or no longer perform their purpose of excluding stock.

10.5.5 *Farm Dams*

Some farm dams and associated structures (ie contour banks) may experience water loss due to subsidence and suffer damage that would require replacement water supplies to be provided, until the drainage is repaired and the dams refilled.

The likelihood of subsidence induced impacts on farm dams is dependent on each dam's location relative to the longwall panels.

Surface cracking associated with mining induced subsidence would have the potential to initiate erosion points that could subsequently expand. This may reduce the holding capacity of the dam and cause release of stored water.

The volume of water stored in each of the dams (see *Table* 6.3) is unlikely to be sufficient to cause a safety hazard to any person downstream if a crack were to initiate erosion and allow stored water to escape. At the time that cracking would be likely to occur, the subsided ground immediately downstream would be expected to act as a temporary ponding area. The loss of water and/or storage capacity, if not remediated, will affect the ability to of the site to carry grazing stock.

10.6 INDUSTRIAL, COMMERCIAL AND BUSINESS ESTABLISHMENTS

10.6.1 *Mine Infrastructure - Water Pipeline*

Specific subsidence predictions and impacts on ACOL's two pipelines have not been identified by SCT, however, they travel over the goaf for a short distance and will therefore be partially impacted by subsidence following extraction of longwall panel 4. These pipelines are owned by ACOL and are located on ACOL property. The pipeline is located just above the western goaf edge of longwall 4 and is therefore not likely to experience full vertical subsidence. It is of poly pipe construction and may withstand the pressures placed against it.

In the event of damage, ACOL will repair the damaged section as required.

10.7 AREAS OF ARCHAEOLOGICAL AND / OR HERITAGE SIGNIFICANCE

10.7.1 *Archaeological Sites*

Subsidence impacts on archaeological sites could be derived from cracking, formation of knick points, rill erosion or ponding. The subsidence of the ground surface itself has little potential to disturb archaeological sites, apart from reducing elevation. However, subsidence remediation works, including earthworks, ripping and revegetation may impact on archaeological sites. The grinding grooves in the waterhole and Glennies Creek sites are outside the subsidence impact zone and are unlikely to be directly impacted by subsidence.

There is some potential for subsidence remediation works to impact archaeological material that was not detected during the survey (either because it was obscured by grass or is buried in or below the topsoil). All landform elements within the Application Area have some potential to contain archaeological material that was not detected in the survey. The predictive model suggests that this would be in the form of a sparse distribution of artefacts, representing evidence of Aboriginal occupation and use of the area. Changes in creek morphology or subsidence remediation works within 30m of Bowmans Creek could impact upon the potential archaeological deposits in this location.

10.7.2 Residential Establishments

The Ashton farm residence is located just outside the goaf edge of longwall 4. This structure is unlikely to be subject to significant tilting or vertical subsidence. It may experience some horizontal stretching movements particularly in the garden. The garage and other structures located nearer to longwall 4 may also experience more subsidence movements. The serviceability of buried services may be impacted, depending on the nature of the pipes, particularly if they are located in front of the property. The concrete tank associated with the dwelling is likely to be unaffected by mining subsidence from longwall 4 because of its location.

10.8 AREAS OF ENVIRONMENTAL SENSITIVITY

The Conservation Area over the southern woodland is unlikely to be significantly affected by subsidence movements. However, indirect impacts such as erosion may result in the degradation of habitat integrity. Repair of surface cracking within the Conservation Area will be difficult to achieve without disturbing surrounding vegetation. It is recommended that cracks are allowed to close or fill naturally and remediation works only be carried out if monitoring indicates that erosion is occurring and requires intervention.

10.9 PUBLIC SAFETY

The risk assessment undertaken as part of the preparation of the SMP (refer to *Section 11)* identified that the major risk to public safety included personal injury from surface cracks or compression humps. These have the potential to cause injury from trips/falls, or causing accidents while driving/riding across the site.

Other potential hazards may occur due to damage to electricity transmission lines, farm dams failing, slope failure (Glennies Creek or Hunter River), damage to the New England Highway, damage to structures, and falling trees.

The probability of these events occurring is considered to be very low. However, management measures such as signage, regular stakeholder notification, remediation works, and monitoring are proposed within the SMP to further reduce the risks of these events (where practical) and to minimise the risk to public safety.

10.10 CUMULATIVE IMPACTS OF SUBSIDENCE

It is a requirement of the Development Consent that the SEMP include a consideration of the cumulative impacts of subsidence due to multiple seam extraction.

As discussed in the EIS (HLA, 2001), following extraction of all four seams (Pikes Gully, Upper Liddell, Upper Lower Liddell, and Lower Barratt) the land surface will experience subsidence up to 5.9 metres. Subsidence will occur in a continual series of small movements as longwall extraction proceeds along each panel, and repeat for each level of mining.

Ground cracking can be expected. Once settlement has occurred over the uppermost workings in the Pikes Gully Seam it is likely that ground cracking may concentrate further movements caused by mining of the other three seams.

It is predicted that the impacts addressed in this proposal will be repeated for each subsequent seam, particularly with respect to the following:

- increased depth of flooding in small sections of longwall panel 4,
- surface re-cracking and erosion;
- access roads – compression humps, tilts and cracking;
- increased ponding extents;
- services – damage, tilting;
- farm dams – loss of storage capacity, damage to walls/spillways; and
- fences – tilting or laying over, damage to gates and cattle grids.

It should be noted however that there are potentially another four seams within the Pikes Gully seam to the west (depending on relevant approvals). It would therefore provide several years between each subsidence event for each surface feature. This would provide ample opportunity to remediate many of the above impacts prior to the area being subsided for the extraction of lower seams.

11 RISK ASSESSMENT

As an integral part of the development of this SMP application a comprehensive risk assessment was conducted to identify the hazards, analyse the risks, determine the acceptability of risks and develop recommendations for additional controls related to the impact of subsidence across the Application Area. The risk assessment was held on the 6 June 2006 at the Ashton Site Office and was facilitated by Peter Southern of ERM who has experience with subsidence related risk assessments. Also present at the risk assessment were:

- Brian Wesley – ACOL Underground Mine Manager;
- James Grebert – ACOL Underground Mine Engineer;
- Peter Horn – ACOL Environmental Officer;
- Paul Gresham – ACOL Geologist;
- Amanda Kerr – ERM Environmental Engineer;
- Joanne Woodhouse – ERM Environmental Scientist;
- Ken Mills – SCT Senior Geotechnical Engineer; and
- Peter Dundon – Peter Dundon and Associates Hydrogeologist.

The risk assessment process was aligned with AS/NZS 4360:199, MDG1010 and MDG1014. ERM used an internal risk assessment diagnostic tool to assist in the ranking of risks and summarise relevant issues.

11.1 IMPACT ASSESSMENT BASED ON INCREASED SUBSIDENCE PREDICTIONS

It was not considered necessary to repeat subsidence impact assessments with increased subsidence predictions for any surface or sub-surface features within the Application Area as the subsidence predictions in this report were intentionally aimed at conservatively estimating subsidence values and impacts.

11.2 SUMMARY

Applying the ranking system defined in *Table 11.1*, *Table L.1* in *Annex L* summarises the predicted subsidence impacts and qualitatively ranks each of the potentially impacted surface and sub-surface features by management priority.

Table 11.1 Risk Classification Matrix

		CONSEQUENCE				
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
People		*No injuries*	*First aid treatment*	*Medical treatment required*	*Extensive injuries*	*Death*
Environment		*No environment effects*	*Could effect the environment*	*Water, soil or air likely to be affected for the short term*	*Water, soil or air affect badly. Damage or death to flora or fauna*	*Long term damage to water, soil or air; Damage or death to significant numbers of flora or fauna*
Equipment Damage		*Under $K damage*	*$5K to $50k Damage*	*$50K to $100k Damage*	*$100K to $500K Damage*	*Above $500K Damage*
Production Loss		*Less than one (1) day*	*One (1) days delay*	*Two (2) days delay*	*Less than one (1) week 7 greater than (2) days delay*	*Greater than one (1) weeks delay*
Likelihood	**Almost Certain** Is expected to occur in most circumstances	15	10	6	3	1
	Likely Will probably occur in most circumstances	19	14	9	5	2
	Moderate Might occur at some time	22	18	13	8	4
	Unlikely Could occur at some time	24	21	17	12	7
	Rare May occur in exceptional circumstances	25	23	20	16	11

Category I	Category II	Category III	Category IV

12 GLOSSARY

12.1 TERMS

angle of draw The angle between the vertical and the line joining the edge of the mining void with the horizontal limit of vertical subsidence, usually taken as 20mm.

Application Area The surface area that is likely to be affected by the proposed underground mining. As a minimum it is defined by the depth of cover, angle of draw of 26.5 and the limit of the proposed extraction area.

community Anyone who is interested in or affected by subsidence issues associated with the proposed mining project.

depth of cover The depth of the coal seam from the ground surface measured in metres.

goaf The mined-out area into which the immediate roof strata breaks.

subsidence Mining induced movements and deformations at the ground surface where:

- the vertical downward surface movements are greater than 20mm; or
- the potential impacts on major surface infrastructure and/or natural features may be significant, notwithstanding that the vertical downward surface movements are less than 20mm.

vertical subsidence Vertical downward movements of the ground surface caused by underground coal mining.

12.2 *ABBREVIATIONS*

ACCC	Ashton Community Consultative Committee
ACM	Ashton Coal Mine
ACOL	Ashton Coal Operations Limited
AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
ANZECC	Australia and New Zealand Environment Conservation Council
ARI	average recurrence interval
CHPP	coal handling and preparation plant
CL	Coal Lease
CMRA	Coal Mines Regulation Act 1982
CMRR	Coal Mine Roof Rating
DA	development application /approval
DEC	Department of Environment and Conservation
DMR	Department of Mineral Resources
DNR	Department of Natural Resources
DO	dissolved oxygen
DoP	Department of Planning
DPI	Department of Primary Industries
EC	electrical conductivity
EIS	environmental impact statement
HLA	HLA Envirosciences Pty Limited
kV	kilovolts
m	metres
ML	Mining Lease
mm	millimetres

MSB	Mine Subsidence Board
Mt	million tonnes
Mtpa	Million tonnes per annum
NSW	New South Wales
ROM	run of mine
RTA	Roads and Traffic Authority
s138	Section 138 of the *Coal Mines Regulation Act, 1982*
SCT	Strata Control Technology Operations Pty Limited
SEMP	Subsidence Environmental Management Plan
SMP	Subsidence Management Plan
TSC Act	*Threatened Species Conservation Act, 1995*

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Subsidence Management Plan

Written Report

ANNEXURES

Ashton Coal
Longwall Panels 1 - 4

Subsidence Management Plan
Written Report