# ABEL MINE

# SUBSIDENCE MANAGEMENT PLAN APPLICATION

## SMP AREA 2

## May 2011

## Volume 1

## Report & Appendix A

## LIST OF FIGURES

## LIST OF TABLES

# 1 LETTER OF APPLICATION

6 June 2011

Director Environment Sustainability
Industry & Investment NSW – Minerals and Energy
P O Box 344
**HUNTER REGION MAIL CENTRE NSW 2310**

**Attention: Mr Paul Langley**

Dear Sir,

**Subsidence Management Plan Application for Pillar Extraction from Area 2 at Abel Mine**

Abel Mine is an underground coal mine located approximately 23 km north-west of Newcastle in the Newcastle Coalfield of New South Wales.

In accordance with the *Guideline for Applications for Subsidence Management Approvals* dated December 2003 (SMP Guideline 2003) application is hereby made for approval to extract coal, in an area (Area 2) held under Mining Lease ML 1618 (Act 1992), by an underground mining method in the Upper Donaldson seam, which may potentially lead to subsidence of the land surface. The SMP application area is shown on the Subsidence Management Plan Approved Plan.

Project Approval 05-0136 (Development Consent) for the mine was granted by the Department of Planning on 7 June 2007. Mining (first workings and pillar extraction, subject to an SMP approval) is presently approved under the Project Approval, Mining Operations Plan and lease conditions to take place within Mining Lease ML 1618.

SMP Approval for Area 1 was obtained on 26 May 2010 with minor variations to Panels 1 and 2 approved since that date and Clause 88 (2)(e), under the Coal Mine Health and Safety Regulation 2006, was obtained on 10 June 2010.

The purpose of this application is to gain approval for mining of coal from the Upper Donaldson seam using pillar extraction mining methods, similar to the previously approved Area 1, in Area 2. Extraction within this area is scheduled to commence in October 2011. This application area includes mining from pillar extraction panels Panel 14 to Panel 26 inclusive, plus two main heading development panels (South East Mains and Tailgate Headings) which will be extracted on retreat as shown on the attached SMP plans.

This application consists of a number of components detailed on the following pages.

If you require any further information or have any queries please do not hesitate to contact the undersigned.

Yours faithfully,

Tony Sutherland
**Technical Services Manager- Underground Operations**
**Donaldson Coal**
**Abel Mine**

**Abel Mine Subsidence Management Plan Contents**

- **Subsidence Management Plan Application Written Report March 2011**
    - Appendix A Subsidence Predictions and Impact Assessment for the Proposed SMP Area 2 Pillar Extraction Panels at Abel Mine, Black Hill – DGS Report No ABL – 002/1 – May 2011- Ditton Geotechnical Services Pty Ltd
    - Appendix B Abel Coal Mine Area 2 Surface Water Assessment - ABL3– R1A Report - May 2011 –Geoterra Pty Limited.
    - Appendix C Abel Coal Project Groundwater Assessment – Peter Dundon and Associates Pty Ltd
    - Appendix D Flora and Fauna appendix J out of Abel Environmental Assessment
    - Appendix E Abel Underground Mine Part 3A Project Application Aboriginal Heritage – Peter Kuskie South East Archaeology Pty Ltd
    - Appendix F Community Consultation
    - Appendix G Abel Mine Subsidence Risk Assessment (HMS Consultants Report No 973 September 2010)
- **Subsidence Management Plan**
    - **Attachment A- Public Safety Management Plan**
    - **Attachment B- Subsidence Community Consultation Process**
    - **Attachment C- Environmental Management Plan**
- **Plans - Subsidence Management Plans Abel Mine**

- **Plan 1** Existing & Proposed Workings
- **Plan 2** Natural & Man-made Features
- **Plan 3A** Upper Donaldson Depth of Cover Isopachs and Seam Thickness
- **Plan 3B** Upper Donaldson Seam floor Isopachs and geological structures
- **Plan 5** Mining Titles & Land Ownership
- **Plan 6** Geological Sections/Strata Profile
- **Plan 7** Aerial Photograph
- **SMP Approved Plan**

## Distribution list

Mr Paul Langley
Subsidence Executive Officer
**INDUSTRY & INVESTMENT NSW – MINERALS & ENERGY** – PO Box 344, HUNTER REGION MAIL CENTRE NSW 2310

Mr Greg Cole-Clark
Chief Executive Officer, Chair Inter Agency Committee
**MINE SUBSIDENCE BOARD** – PO Box 488G, NEWCASTLE NSW 2300

Mr Ian Landon-Jones
Executive Director Dam Safety
**SYDNEY CATCHMENT AUTHORITY** – PO Box 323, PENRITH NSW 2750

Mr Scott Carter
Senior Conservation Manager
**INDUSTRY & INVESTMENT NSW – FISHERIES** –Port Stephens Fisheries Centre, Private Bag 1, NELSON BAY NSW 2315

Mr William Ziegler
Project Officer,
Mining Regulation
**NSW DAMS SAFETY COMMITTEE** – PO Box 3720, PARRAMATTA NSW 2124

Mr Howard Reed
Manager- Mining and Extractive Industries
Major Development Assessments
**DEPARTMENT OF PLANNING** – GPO Box 39, SYDNEY NSW 2001

Mr Mark Mignanelli
Manager
Major Projects and Mining Assessment
**DEPARTMENT OF PRIMARY INDUSTRIES** - **NSW Office of Water**
Level 3 26 Honeysuckle Drive Newcastle NSW 2300
PO Box 2213, DANGAR NSW 2309

Mr Grahame Clarke
Hunter Regional Manager
**DEPARTMENT OF ENVIRONMENT CLIMATE CHANGE & WATER** – PO Box 488G, NEWCASTLE NSW, 2300

Mr Johannes Honnef
Senior Urban Planner
**NEWCASTLE CITY COUNCIL –** PO Box 489, Newcastle, 2300

Mr Rod Sandell
Senior Planning Assessment Officer
**CESSNOCK CITY COUNCIL-** PO Box 152 Cessnock NSW 2325

Mr Damien Harrigan
Projects /OHS Officer - (Diocesan Sites & Parishes)
**CATHOLIC DIOCESE OF MAITLAND-NEWCASTLE-** PO Box 756 Newcastle NSW 2300.

Mr Sean Scanlon
Business Development Manager
**CATHOLIC DIOCESE OF MAITLAND-NEWCASTLE-** PO Box 756 Newcastle NSW 2300.

Mr Geoff Rock
Project Specialist - Land Development
Coal Development Group- Rio Tinto
**BLACK HILL LAND PTY LTD-** PO Box 267 Singleton NSW 2300

Mr Mark Hickey
Acquisitions Manager
**HUNTER WATER CORPORATION-** PO Box 5171 HRMC NSW 2310

Mr Bruce Fraser
Mains Manager / Northern Region
**TRANSGRID-** PO Box 93 Waratah NSW 2298

Mr Greg Skinner
Area Manager- Lower Hunter
**ENERGY AUSTRALIA-** 145 Newcastle Road, Wallsend, NSW 2287

Ms T McDonald
Acting CEO
**MINDARIBBA LOCAL ABORIGINAL LAND COUNCIL-** 1a Chelmsford Drive, Metford NSW 2300

Committee Members
**ABEL COMMUNITY CONSULTATIVE COMMITTEE**

**Individual Landowners above SMP Area 2**

# 2 EXECUTIVE SUMMARY

This Subsidence Management Plan (SMP) application has been prepared to seek approval for the extraction of coal by pillar extraction mining methods from the Upper Donaldson coal seam in the north east area (Area 2) of Abel Mine. The SMP application consists of pillar extraction panels Panel 14 to Panel 26 inclusive, plus three main headings development panels (South East Mains, Tailgate Headings and East Install Headings) to be extracted on retreat as shown on the attached SMP plans. The SMP application has been prepared in accordance with the NSW Department of Mineral Resources *New Approval Process for the Management of Coal Mining Subsidence* and SMP Guideline 2003.

Abel commenced coal production in May 2008 and will progressively increase production to 4.5mtpa run of mine. The SMP application area contains 211 ha, approximately 8% of the current lease area of 2,755 ha.

Mining will take place in the application area under a combination of land owned by Black Hill Land Pty Limited, the Catholic Diocese of Maitland - Newcastle, a narrow strip traversing the area owned by Hunter Water Corporation and ten private rural residential land holdings. The current application seeks approval to mine coal by the pillar extraction method from the Upper Donaldson Seam at depths of cover ranging generally from 100 to 150 metres.

The layout of the panels has been designed to provide management outcomes of subsidence impacts in line with the Statement of Commitments and Project Approval and to conduct the mining operations in a responsible manner, considering the existing and future environment and the community, while optimising resource recovery in the area in accordance with the principles of ecologically sustainable development. It is proposed to conduct mining in the proposed extraction panels generally bounded by the previously approved SMP Area 1 to the north, the lease boundary / F3 Newcastle to Sydney Freeway / resource thickness / quality to the east, Black Hill Road for part and resources thickness / quality to the south and existing and proposed main underground development workings to the west.

Maximum subsidence predicted for the pillar extraction panels in the application area ranges between 760 mm and 1,450 mm, maximum predicted strains from 5 to 24 mm/m and tilts from 14 to 36 mm/m excluding areas nominated to be protected.

The SMP application area surface is a combination of native bushland, cleared livestock grazing land (some previously used for poultry farms) and rural residential. Management measures are proposed to address any predicted environmental impacts for the surface above the application area.

Natural features are generally limited to Viney Creek, a Schedule 2 stream and associated tributaries. One Endangered Ecological Community and various Threatened Species are located within the application area with no adverse impacts predicted for these or other flora and fauna. Proposed management measures of natural features are listed in **Table 1**.

**Table 1 - Summary of Natural Features Impact Assessment SMP Area 2**

| Feature/s | Summary of feature/s | Proposed Management Measures |
|---|---|---|
| Creeks/surface water features | Viney Creek – Schedule 2 | Protected by Subsidence Control Zone |
| Creeks/surface water features | Ephemeral tributaries | Monitoring and remediation through Property Subsidence Management |

| Feature/s | Summary of feature/s | Proposed Management Measures |
|---|---|---|
| | | Plan |
| Groundwater | Sub surface aquifer | Monitoring through Groundwater Management Plan |
| Ecology | Flora and Fauna | Monitoring through Environmental Management Plan |

Man – made features include:

- Principal residences, Other Surface Structures and outbuildings;
- Disused, unoccupied residences;
- Transgrid 330kV power line;
- Energy Australia (EA) 132kV power line;
- Energy Australia rural 11kV and 415V domestic power lines;
- Optus fibre optic cable;
- Active and redundant Telstra copper communication cables;
- Hunter Water Corporation water pipeline;
- Permanent survey control marks;
- Buried stock and domestic water supply lines;
- Public roads and culverts (Black Hill and Taylors Road);
- Access roads and tracks;
- Cattle stockyards, holding areas and water troughs;
- Various fences, gates and cattle grids;
- Several buried and clay liner capped contaminated material areas; and
- Several small (<1ML capacity) stock watering dams.

Proposed management measures of man-made features are listed in **Table 2**.

**Table 2 - Summary of Man-Made Features Impact Assessment SMP Area 2**

| Feature/s | Summary of feature/s | Proposed Management Measures |
|---|---|---|
| Residences | Principal | Protected by Subsidence Control Zone and/or Subsidence Specific Commitment A Principal Residence (see page 18). |
| Residences | Other Surface Structures and outbuildings | Property Subsidence Management Plan to be developed for each area prior to impact of subsidence. See Subsidence Specific Commitment E Any Other Surface Structures (page 19) |
| Residences | Disused, unoccupied | Proposed for Demolition |
| Electrical services, easements and towers | Transgrid 330kV power line | Management actions and Plan being developed in consultation with Transgrid |
| Electrical services, easements and towers | EA 132kV power line | Management actions and Plan developed for Area 1 in consultation with Energy Australia. To be reviewed for Area 2. |
| Electrical services, easements and towers | EA rural 11kV and domestic power lines | Management actions and Plan developed for Area 1 in consultation with Energy Australia. To be reviewed for Area 2. |
| Telecommunication cables | Optus fibre optic cable | Following consultation with Optus and MSB on options, relocation of the Optus fibre optic cable has been scheduled. |
| Telecommunication cables | Telstra copper cables | Continuing consultation with Telstra. |
| Water pipelines and services | Hunter Water Corporation pipe line | Management actions and Plan developed for Area 1 in consultation with Hunter Water Corporation. To be reviewed for Area 2. |
| Water pipelines and services | Stock water supply line | Continuing consultation with Catholic Diocese on Management Plan. Currently repairing as required in Area 1 in consultation with the Catholic Diocese. |
| Water pipelines and services | Domestic water supply line | Include in Property Subsidence Management Plan for each individual property |
| Permanent survey control marks | PMs (two) within Area 2 | Notification to Land and Property Information (LPI) survey department relating to mining and reestablishment including resurvey on completion of subsidence. |
| General surface | Mixture of natural bushland and grazing land | Include in Property Subsidence Management Plan for each individual property |
| Public Roads | Black Hill and Taylors Road | Public Road Management Plan to be developed in consultation with Cessnock City Council prior to any |

| Feature/s | Summary of feature/s | Proposed Management Measures |
|---|---|---|
| | | subsidence impact. |
| Roads, tracks | Various sealed and unsealed – private | Include in Property Subsidence Management Plan for each individual property |
| Fences, gates and cattle grids (including cattle stockyards and holding areas) | Various types | Include in Property Subsidence Management Plan for each individual property |
| Dams | Small stock watering dams | Include in Property Subsidence Management Plan for each individual property. See Subsidence Specific Commitment F Dam Monitoring Strategy (page 21). |

A Subsidence Monitoring Program for the panels will be developed and implemented in consultation with the Principal Subsidence Engineer – Industry & Investment NSW.

A Risk Assessment, in which these predicted subsidence values were used, was conducted on 16 September 2010 to identify, assess and evaluate potential subsidence impacts to surface and sub-surface as a result of mining these future panels. The potential impact arising from maximum theoretical subsidence was also considered. The risk assessment concluded that any impacts were likely to be manageable. No high risk issues were identified, generally attributable to the mine design. Some agreed further actions were developed, that have either been established or are planned.

The Risk Assessment took account of matters raised during the community consultation process, which included a Stakeholder Meeting consisting of a presentation, site inspection, and question / comment opportunity conducted on 9 September 2010. In particular, matters relating to groundwater, watercourses, Threatened and Protected Species and infrastructure, particularly residences and improvements, were considered.

Community consultation during the preparation of the SMP application was undertaken in accordance with the Department of Mineral Resources Guideline for Applications for Subsidence Management Approvals and the NSW Minerals Council Community Engagement Handbook Towards Stronger Community Relationships.

A presentation followed by a site inspection was made to Industry & Investment NSW – Mineral Resources (I & I – MR) and identified stakeholders on 9 September 2010. Advertisements were placed in regional and State newspapers on 19 June 2010 to notify the community of Abel’s intent to submit a SMP application. No submissions were received following this community consultation.

Continuing consultation has been carried out with the infrastructure owners, relating to potential impacts to the infrastructure, the management of these impacts by suitable mine plan design, remediation / mitigation and development of appropriate Management Plans. Similarly, consultation with some landholders has consisted of further presentation of mine design, information on subsidence and potential impacts with discussions continuing to develop an agreed Property Subsidence Management Plan to manage / mitigate / remediate any impacts.

Updates on the SMP development have also been presented to the Abel Community Consultative Committee at meetings held on 1 February 2010, 3 May 2010, 16 August 2010, 5 November 2010, 21 February and 2 May 2011.

# 3 INTRODUCTION

## 3.1 BACKGROUND

Abel Mine is an underground coal mine operated by Donaldson Coal Pty Limited. The mine access, entries and primary surface facilities are located approximately 23 km north-west of Newcastle on John Renshaw Drive. The SMP application area is located to the north of Black Hill School with the mine entries within the former mining area of Donaldson Open Cut (See **Figure 1**).

The mine access, associated facilities and SMP area are located in the Weakleys Flat Creek (and Viney Creek) sub-catchment area which drains northward into Woodberry Swamp prior to entering the Hunter River Catchment.

Abel commenced operations in May 2008. The mine currently employs approximately 200 personnel and currently produces approximately 1.8 million tonnes per annum (tpa), with a proposed maximum production of 4.5 million tonnes of thermal / soft coking coal from the Upper and Lower Donaldson coal seams. Abel's production is railed to Newcastle for the export market. Abel currently operates under a number of approvals relevant to this SMP, including:

- Project Approval (Development Consent) 05_0136 granted 7 June 2007;
- Mining Lease ML 1618;
- Mining Lease ML 1653;
- Abel Mine Mining Operations Plan submitted to I&I in December 2009;
- Environmental Protection Licence 12856 under the Protection of the Environment Operations Act 1997.
- SMP Approval for Area 1 dated 26 May 2010 and minor approved variations to Panels 1 and 2, and
- Clause 88 Approval for Area 1 dated 10 June 2010.

The key features of the Project Approval (Development Consent) 05_0136 for the mine include:

- Construction and operation of an underground coal mine.

**Obligations to Minimise Harm to the Environment**

1. The Proponent shall implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.

**Terms of Approval**

2. The Proponent shall carry out the project generally in accordance with the:
    a) EA;
    b) Statement of Commitments; and
    c) Conditions of this approval.
3. If there is any inconsistency between the above documents, the later document shall prevail to the extent of the inconsistency. However, the conditions of this approval shall prevail to the extent of any inconsistency.
4. The Proponent shall comply with any reasonable and feasible requirements of the Director-General arising from the Department's assessment of:
    (a) any reports, plans or correspondence that may be submitted in accordance with the conditions of this approval; and
    (b) the implementation of any actions or measures contained in these reports, plans or correspondence.

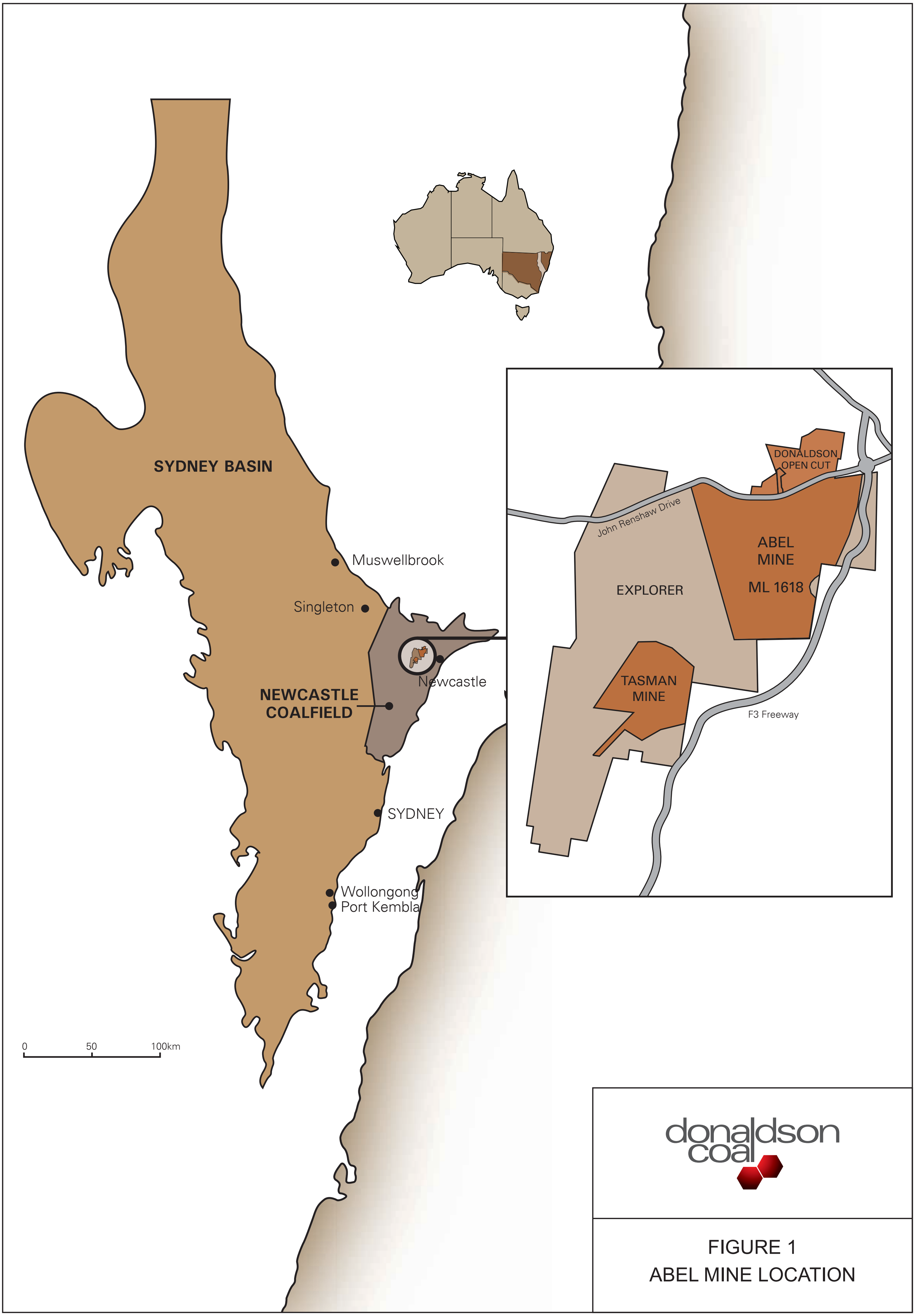



FIGURE 1
ABEL MINE LOCATION

**Limits of Approval**

5. Mining operations may take place until 31 December 2028 on the Abel site.
6. The Proponent shall not extract more than 4.5 million tonnes of ROM coal a year from the Abel site.
7. No more than 6.5 million tonnes of ROM coal may be processed a year on the Bloomfield site.
8. All product coal produced on the Bloomfield site shall be transported by rail via the rail loading facility on the Bloomfield site, except in an emergency. In an emergency, product coal may be transported from the Bloomfield site by road with the prior written approval of the Director-General, subject to any restrictions that the Director-General may impose.

The following subsidence related and monitoring / management consent conditions and Statement of Commitments items relevant to this SMP Application are noted in **Table 3.**

**Table 3 - Summary of Project Approval Conditions and Statement of Commitments Relevant to SMP Area 2**

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| **Schedule 4 – Specific Environmental Conditions** | | |
| **Subsidence Impact Limits** | | |
| 1 | The Proponent shall ensure that the project does not result in any subsidence impacts on Pambalong Nature Reserve or the surface of the F3 Freeway. | Pambalong Nature Reserve and F3 Freeway outside of SMP Application Area 2 |
| 2 | The Proponent shall limit mining operations to first workings beneath and ensure that mining causes no subsidence impacts requiring mitigation works on, the following features:<br>(a) All principal residences located above the mining area;<br><br>(d) all Schedule 2 streams and rainforest areas located above the mining area. | <br><br>(a) First workings only and protected by Subsidence Control Zone<br><br>(d) Viney Creek (Schedule 2) first workings only and protected by Subsidence Control Zone |
| 3 | The Proponent shall ensure that the following sites are treated as "principal residences " under this approval:<br>(a) all buildings and structures on, or proposed to be constructed on, the Catholic School site;<br>(b) all buildings and structures on the Boral Hotmix Asphalt Plant site | <br><br>(a) Noted.<br><br>(b) Not in SMP Application Area 2 |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| 5 | Within 6 years of the Project Approval, the Proponent shall ensure that any subsidence caused by undermining the following land has been effectively completed:<br>(a) The Catholic Diocese of Maitland-Newcastle owned land; and<br>(b) Coal and Allied Operations (Now Black Hill Land Pty Limited) owned land. | (a) and (b) Noted and part of land included in this SMP Application Area |
| 6 | With the written agreement of the relevant landowner, the Proponent may:<br>(a) conduct additional mining operations and/or cause additional subsidence impacts beyond those permitted under conditions 2(a) or 3; and<br>(b) increase the time within which subsidence must be effectively completed under condition 5 | (a) and (b) noted but not relevant to this SMP Application Area |
| **Subsidence Management Plan** | | |
| 7 | Prior to carrying out any underground mining operations that could cause subsidence, the Proponent shall prepare a Subsidence Management Plan (SMP) to the satisfaction of the Director-General of the DPI. This plan must be prepared in accordance with the:<br>(a) *New Approval Process for Management of Coal Mining Subsidence – Policy;* and<br>(b) *Guideline for Applications for Subsidence Management Approvals* (or the latest versions or replacements of these documents). | (a) and (b) This SMP application prepared in accordance with these documents. |
| 8 | In preparing the Subsidence Management Plan, the Proponent shall pay particular attention to assessing and limiting the potential subsidence impacts on all areas of the proposed underground mining area where:<br>(a) cover depths are less than 100 metres, or<br>(b) overlying abandoned mine workings occur (e.g. Stockrington Colliery and beneath Black Hill Quarry) | (a) Considered in SMP application<br>(b) No abandoned mine workings overlying or underlying proposed workings in this SMP application area. |
| **First Workings Hazard Management Plan** | | |
| 9 | If the Proponent intends to carry out first workings under the following surface features, | |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | then it shall include a First Workings Hazard Management Plan for these workings, which describe in detail how these workings would be managed and monitored to ensure compliance with this approval and the contingency measures that would be implemented if the impact on these surface features are greater than predicted:<br>• all buildings and structures on the Black Hill Public School, Black Hill Church and cemetery, and Boral Hotmix Plant sites;<br>• all buildings and structures on, or proposed to be constructed on the Catholic School site;<br>• all Schedule 2 streams , rainforest areas and the Blue Gum Creek alluvium. | • No first workings planned under these areas as part of this SMP application.<br>• Required<br>• Required for Viney Creek (Schedule 2 stream) |
| **Water Management Plan** | | |
| 11 | The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Director-General. To include Surface Water Monitoring Plan, and Groundwater Monitoring Program. | Submitted and approved |
| **Surface Water Monitoring Program** | | |
| 14 | The Surface Water Management and Monitoring Plan must include:<br>(a) detailed baseline data on surface water flows and quality in the creeks and other waterbodies that could be affected by the project;<br>(b) surface water impact assessment criteria;<br>(c) a program to monitor the impact of the project on surface water flows and quality;<br>(d) procedures for reporting the results of this monitoring. | Submitted and approved |
| **Groundwater Monitoring Program** | | |
| 15 | The Groundwater Monitoring Program must include:<br>(a) further development of the regional and local groundwater model;<br>(b) detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality (including at any privately owned bores in the vicinity of the site);<br>(c) groundwater impact assessment criteria; | Submitted and approved |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | (d) monitoring of the Pambalong Nature Reserve and the rainforest areas identified;<br>(e) a program to monitor the impact of the project on groundwater levels, yield and quality; and<br>(f) procedures for reporting the results of this monitoring. | |
| **Aboriginal Heritage Management Plan** | | |
| 28 | The Proponent shall not destroy any known Aboriginal objects (as defined in the *National Parks and Wildlife Act 1974)* without the written approval of the Director-General. | Noted – no subsidence impacts predicted for aboriginal artefacts identified in SMP Application Area 2 which are limited to scatter items |
| 29 | The Proponent shall prepare and implement an Aboriginal Heritage Management Plan for the project to the satisfaction of the Director-General. This plan must:<br>(a) be submitted to the Director-General within 6 months of this approval;<br>(b) be prepared in consultation with the DEC and the Mindaribba and Awabakal Local Aboriginal Land Councils;<br>(c) include a:<br>• comprehensive Aboriginal heritage surveys across both the Abel site and the Bloomfield site staged so as to be complete prior to any disturbance;<br>• salvage program for temporarily storing and then replacing retrieved material; and<br>• protocol for ongoing consultation and involvement of aboriginal communities in the conservation and management of Aboriginal heritage on site<br>(d) Describe the measures that would be implemented to protect Aboriginal sites on site, or if any new Aboriginal objects or skeletal remains are discovered during the project. | Submitted and approved<br>Two surveys have been undertaken by the property owners. |
| **Schedule 5 – Environmental Management , Monitoring, Auditing and Reporting** | | |
| **Environmental Management Strategy** | | |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| 1 | The Proponent shall prepare and implement an Environmental Management Strategy for that project to the satisfaction of the Director-General within 6 months of this approval, and:<br>(a) provide the strategic context for environmental management of the project;<br>(b) identify the statutory requirements that apply to the project;<br>(c) describe in general how the environmental performance of the project would be monitored and managed;<br>(d) describe the procedures that would be implemented to:<br>• keep the local community and relevant agencies informed about the operation and environmental performance of the project;<br>• receive, handle, respond to and record complaints;<br>• resolve any disputes that may arise during the course of activities associated with the project;<br>• respond to any non-compliance<br>• manage cumulative impacts; and<br>• respond to emergencies; and<br>(e) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project | Submitted and approved |
| **Environmental Monitoring Program** | | |
| 2 | The Proponent shall prepare and implement an Environmental Monitoring Program for the project to the satisfaction of the Director-General. This program must be submitted to the Director-General within 6 months of this approval, consolidate the various monitoring requirement s in Schedule 4 of this approval into a single document, and be integrated as far as practicable with the monitoring programs of the adjoining Bloomfield, Donaldson and Tasman mines. | Prepared, submitted, approved and implemented |
| **Community Consultative Committee** | | |
| 8 | Within 3 months of this approval, the Proponent shall establish a Community Consultative Committee for the project. This committee shall:<br>(a) be comprised of: | Community Consultative Committee (CCC) has been established |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | • 2 representatives from the Proponent, including the person responsible for environmental management at the mine;<br>• at least 1 representative from Council (if available); and<br>• at least 3 representatives from the local community whose appointment has been approved by the Director-General;<br>(b) be chaired by an independent chairperson, whose appointment has been approved by the Director-General;<br>(c) meet at least four times per year during the construction phase and first year of mining operations, and thereafter at least twice per year;<br>(d) review the Proponent's performance with respect to environmental management and community relations;<br>(e) undertake regular inspections of mining operations;<br>(f) review community concerns or complaints about the mine operations, and the Proponent's complaints handling procedures;<br>(g) provide advice to:<br>• the Proponent on improved environmental management and community relations, including the provision of information to the community and the identification of community initiatives to which the Proponent could contribute;<br>• the Department regarding the conditions of this approval;<br>• the general community on the performance of the mine with respect to environmental management and community relations; and<br>(h) be operated generally in accordance with any guidelines the Department may publish in regard to the operation of Community Consultative Committees for mining projects. | |
| 9 | The Proponent shall, at its own expense:<br>(a) ensure that 2 of its representatives attend CCC meetings;<br>(b) provide the CCC with regular information on the environmental performance of the project;<br>(c) provide meeting facilities for the CCC;<br>(d) arrange site inspections for the CCC, if necessary;<br>(e) respond to any advice or recommendations | Updates on the SMP development have been presented to the Abel Community Consultative Committee at meetings held on 1 February 2010, 3 May 2010, 16 August 2010, 15 November 2010, 21 February and 2 May 2011.<br><br>Copies of the CCC minutes are available on the Donaldson Coal web |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | the CCC may have in relation to environmental management or community relations;<br>(f) take minutes of the CCC meetings;<br>(g) forward a copy of these minutes to the Director-General; and<br>(h) put a copy of these minutes on the website. | site www.doncoal.com.au<br><br>Community newsletter issued in June 2010 (Refer Appendix F). |
| **Access to Information** | | |
| 10 | Within 3 months of the approval of any plan/strategy/program required under this approval (or any subsequent revision of these plans/strategies/programs), or the completion of audits or AEMRs required under this approval, the Proponent shall:<br>(a) provide a copy of these relevant document/s to the relevant agencies;<br>(b) ensure that a copy of the relevant document/s is made publicly available at the mine; and<br>(c) put a copy of the relevant document/s on its website. | Copy of the AEMR is available on Donaldson Coal web site **www.doncoal.com.au** |
| 11 | During the project, the Proponent shall:<br>(a) make a summary of monitoring results required under this approval to be publicly available at the mine and on its website; and<br>(b) update these results on a regular basis (at least every three months) | |
| **Statement of Commitments** | | |
| 5.1 Schedule I streams | (a) Schedule 1 streams (as defined in the DIPNR 2005 guideline, "Management of stream/aquifer systems in coal mining developments") will be managed via the implementation of mitigation and remediation works where needed to ensure that:<br><br>stream stability is maintained where subsidence occurs<br>stream fractures are minimised<br>stream channels are maintained with minimal incision from bed grade change and<br>stream bed grade change minimised to provide stable stream length<br><br>(b) Where any stream stability controls are required they will be designed in accordance with the Rehabilitation Manual for Australian Streams (Land and Water Resources Research and | Management/ remediation as required |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | Development Corporation, 2000) and will be provided primarily by vegetation. | |
| 5.2 Schedule 2 streams | (a) Schedule 2 streams (as defined by DIPNR, 2005) will be managed so as to ensure that:<br>• they maintain pre-mining course, and maintain bed channel gradients which do not initiate erosion;<br>• they maintain pool riffle sequences where they pre-existed, or have pool riffle sequences installed where appropriate;<br>• they maintain connectivity to underground workings, and flow loss to fracture zones in similar levels to pre-mining;<br>• they maintain geomorphic integrity of the stream;<br>• the ecosystem habitat values of the stream are protected;<br>• no significant alteration of the water quality occurs in the stream.<br><br>(b) The above commitments for Schedule 2 streams will be achieved by:<br>• the provision of a minimum barrier of 40m between the 20 millimetre line of subsidence and the bank of any Schedule 2 streams; or<br>• the carrying out of further detailed studies and the development of a Surface Water Management Plan for the Abel Underground Mine which clearly demonstrates that the above commitments can be met prior to any mining occurring which will impact on any Schedule 2 streams. | Subsidence Control Zones have been established for the Schedule 2 streams |
| **Subsidence Specific Commitments** | | |
| A. Principal Residences | The Company commits to producing and implementing a plan of management for each Principal Residence existing at the date of approval of this project. A Principal Residence is defined as an existing building capable of being occupied as a separate domicile and used for such purpose. The plan of management will | In progress |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | be produced and implemented as follows:<br><br>A1. Each Principal Residence will be individually assessed by the Mines Subsidence Board /structural engineer who will determine tolerable levels for individual subsidence parameters. Tolerable limits are those limits which will result in no mitigation works being required to the Principal Residence due to subsidence impacts from the Abel Underground Mine.<br><br>A2. Each Principal Residence will have a pre-mining survey to identify and record pre-existing imperfections that will not be covered by the Mines Subsidence Board.<br><br>A3. Such assessments will be done as and when the progression of the mining process dictates – i.e. mining may have commenced in other areas prior to the individual Principal Residence assessment being undertaken.<br><br>A4. Tolerable levels will be set according to such factors as dwelling construction (e.g. brick veneer, clad), type (single, double storey), size (length and width), footings (slab, strip footings, piers), surface conditions (sand, rock, clay, steep slope) etc, with reference to the MSB Graduated Guidelines (compatible with AS 2870 and the Building Code of Australia).<br><br>A5. The mine plan in proximity to each Principal Residence will be modified by the Company to maintain subsidence parameters within the tolerable levels determined above for each Principal Residence.<br><br>A6. The mine plan will be reviewed by the MSB and the DPI prior to any Subsidence Management Plan being approved under the relevant lease.<br><br>A7. Each Principal Residence will have a specific subsidence monitoring plan to monitor subsidence impacts before and after mining at the Principal Residence and to ensure that tolerable limits are achieved in practice.<br><br>A8. The Mine Subsidence Board has the | |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | responsibility to rectify any impacts to structures that may occur as a result of mining.<br><br>In cases where the owner of the Principal Residence and the Company can agree to terms which permit second workings under the Principal Residence greater than those permitted above, the Company agrees to negotiate a plan of management similar to that proposed in the section of this Statement of Commitments titled "All Other Surface Structures". | |
| B. Future Principal Residence | If there is no existing residence on a landholding and a residence is planned to be built, the site for this Future Principal Residence will be protected in the same way as that proposed above for Principal Residences. This commitment applies to a maximum of one Future Principal Residence per landholding.<br><br>NOTE: Once the Mine Subsidence District is declared for the area all Future Principal Residences will require approval from the Mine Subsidence Board and must comply with the Mine Subsidence Compensation Act 1961. | Noted |
| E. All Other Surface Structures | "All Other Surface Structures" is defined as any building or structure impacted by mining-induced subsidence from the Abel Underground Mine Project which is not categorised as a Principal Residence, Future Principal Residence, Black Hill Church and Cemetery or Black Hill School.<br><br>The Company shall prepare and implement plans of management for the mitigation and remediation of any damage to All Other Surface Structures prior to any mining occurring that would impact on them.<br><br>The plan of management will include:<br><br>(a) pre-mining audit of the structure;<br>(b) the provision of a plan of management as part of the SMP approval process which requires the Company to mitigate/remediate any damage to improvements associated with the structure in conjunction with the Mine | Noted in SMP Application as Other Surface Structures |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | Subsidence Board;<br>(c) post-mining monitoring of the improvements associated with the Structure.<br><br>The mitigation/remediation measures to be undertaken will be related to the extent of damage experienced – see Schedule 1 for details. | |
| F. Dams | A Dam Monitoring and Management Strategy (DMMS) will be formulated for all dams prior to any mining occurring which will impact on the dams. The DMMS will provide for:<br><br>F1. The individual inspection of each dam by a qualified engineer for:<br>• current water storage level;<br>• current water quality (EC and pH);<br>• wall orientation relative to the potential cracking;<br>• wall size (length, width and thickness);<br>• construction method and soil / fill materials;<br>• wall status (presence of rilling / piping / erosion / vegetation cover);<br>• potential for safety risk to people or animals;<br>• downstream receptors, such as minor or major streams, roads, tracks or other farm infrastructure; and<br>• potential outwash effects.<br><br>F2. Photographs of each dam will be taken prior to and after undermining, when the majority of predicted subsidence has occurred.<br><br>F3. Dam water levels, pH and EC will be monitored prior to and after undermining to assess the baseline and post mining dam water level and water quality in order to determine whether rehabilitation is required.<br><br>F4. In the event that subsidence / crack development monitoring indicates a significant potential for dam wall failure, dam water will be managed in one of the following manners:<br><br>• pumped to an adjacent dam to lower the water level to a manageable height that | A Dam Monitoring and Management Strategy (DMMS) will be established or will be included in the relevant Property Subsidence Management Plan |

| **Item / Condition** | **Description** | **Relevance to SMP Application Area/ Management Measure** |
|---|---|---|
| | reduces the risk of dam wall failure,<br>• discharged to a lower dam via existing channels if the water cannot be transferred, or<br>• not transferred if the dam water level is sufficiently low to pose a minor risk.<br><br>An alternate water supply will be provided to the dam owner until the dam can be reinstated.<br><br>F5. In the event of subsidence damage to any dams the Company shall remediate the damage and reinstate the dam in conjunction with the Mine Subsidence Board. | |
| H. Powerlines | The Company shall prepare and implement a plan of management as part of the SMP process which will ensure the safety and serviceability of powerlines. | Management actions and Plan being developed in consultation with Energy Australia and Transgrid. |
| L. Water Supply | In the event of interruptions to water supplies due to subsidence impacts on farm dams, water tank pipelines, water mains and irrigation systems within the application area, the Company commits to providing water supplies of equivalent quality and quantity to locations convenient to those affected until such time that the affected farm dams, water tanks, pipelines, water mains and irrigation systems are restored. | Continuing consultation with Catholic Diocese on Management Plan. Currently repairing any identified impacts as required in Area 1 in consultation with the Catholic Diocese. |
| M. General Surface Water Flow | The Company shall prepare and implement a plan of management to maintain the surface drainage of areas surrounding any dwellings and other structures or infrastructure, where required. This plan shall include but not be limited to monitoring, mitigation or remediation of mining-induced ponding, drainage pattern changes and any resulting serviceability difficulties and/or hazards to the public.<br><br>NOTE: Also see Water Supply. | |
| N. Public Safety | The Company shall prepare and implement a surface safety management program to ensure public safety in any surface areas that may be affected by subsidence arising from the proposed underground mining. This program shall include, but not be limited to, regular monitoring of areas posing safety risks, erection of warning signs, entry restrictions, backfilling of dangerous surface cracks and securing of unstable man-made structures or rockmass, where required and appropriate, and the provision of timely | Public Safety Management Plan was approved for SMP Area 1, has been reviewed for SMP Area 2 and is included in this SMP application. |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | notification of mining progress to the community and any other relevant Stakeholders where management of public safety is required. | |

Additionally Mining Lease 1618 includes as the standard Condition 8 requiring the preparation of a Subsidence Management Plan prior to commencing any underground mining operations which will potentially lead to subsidence of the land surface which includes the pillar extraction proposed by Abel.

## 3.2 REPORT STRUCTURE

This application has been prepared in accordance with the NSW Department of Mineral Resources *New Approval Process for the Management of Coal Mining Subsidence* and SMP Guideline 2003.

The approval requirements have been addressed within this report and the relevant guideline and report references are listed below in **Table 4.**

**Table 4 - SMP Guideline Requirements**

| Item | Guideline reference | Report reference |
|---|---|---|
| • Letter of application | Section 5 | Section 1 |
| • Mining system,<br>• Recovery,<br>• Statutory requirements,<br>• Expected subsidence,<br>• Potential subsidence impacts | Section 6.1 | Sections 3, 5, 10 and 11 |
| • Application area description | Section 6.2 | Section 4 |
| • Mining method,<br>• Mining system,<br>• Seam details,<br>• Recovery,<br>• Other seams | Section 6.3 | Section 5 |
| • Site conditions,<br>• Cover,<br>• Stratigraphy,<br>• Lithology & Geology | Section 6.4 | Section 7 |
| • Stability of workings,<br>• Working height,<br>• Detail of lithology,<br>• Geotechnical,<br>• Geology | Section 6.5 | Sections 5, 6 7 and plans |
| • Surface structures,<br>• Natural features,<br>• Monitoring,<br>• Identification | Section 6.6 | Sections 8 and 9 |
| • Subsidence predictions,<br>• Individual features subsidence | Section 6.7 | Section 10 |
| • Community consultation | Section 6.8 | Section 13 |
| • Legislation,<br>• Approvals,<br>• Licences | Section 6.9 | Section 15 |
| • Subsidence impacts,<br>• Impact on increased subsidence, Summary,<br>• Risk Assessment | Section 6.10 | Sections 11 and 12 |
| • Proposed Subsidence Management Plan | Section 7 | Separate document |
| • Plans | Section 9 | Section 17 and attachments |
| • Approved Plan | Section 10 | Section 17 and attachments |

# 4 THE APPLICATION AREA

## 4.1 APPLICATION AREA

The SMP application area is defined as the surface area enclosed by a 26.5 degree angle of draw from the limit of proposed mining, as defined in Section 6.2 in the SMP Guideline 2003 **(Plan 1)**.

The proposed mining layout, SMP area and lease boundaries are shown on **Plan 1**.

SMP Area 2 has a total area of 211 hectares within the full ML1618 area of 2,755 hectares **(Figure 2)**.

The Upper Donaldson Seam mine workings in the SMP application area lie between 100 and 150 m below the surface **(Figure 3)**. The surface area consists of predominately native vegetation and grazing land.

## 4.2 LAND USES AND LAND OWNERSHIP

The surface of the SMP application area is contained within land owned by Black Hill Land Pty Limited, the Catholic Diocese of Maitland - Newcastle, a narrow strip traversing the area owned by Hunter Water Corporation and ten private rural residential land holdings **(Plan 5)**.

Land use in the area is a combination of the following:

- Native bushland;
- Cleared livestock grazing land, and
- Rural residential land.

Infrastructure above the mining area consists of;

- Principal Residences and Other Surface Structures residences and outbuildings;
- Disused, unoccupied residences;
- Transgrid 330kV power line;
- Energy Australia (EA) 132kV power line;
- Energy Australia rural 11kV and 415V domestic power lines;
- Optus fibre optic cable;
- Active and redundant Telstra copper communication cables;
- Permanent survey control marks;
- Hunter Water Corporation water pipeline;
- Buried stock and domestic water supply lines;
- Public roads (Black Hill and Taylors Road);
- Access roads and tracks;
- Various fences, gates and cattle grids;
- Cattle stockyards, holding areas and water troughs; and
- Several small (<1ML capacity) stock watering dams.

Potential future development includes (but may not be limited to) an industrial subdivision of the Black Hill Pty Limited land (Lower Hunter Lands – Black Hill MP08_0124) and yet to be determined development of the Catholic Diocese land. This potential development and any infrastructure is not expected to be adversely impacted by any potential subsidence due to the requirement of the Project Approval that effective subsidence is required to be completed to these parcels of land by 7 June 2013 unless this time frame is increased with the written agreement of the relevant landowner.

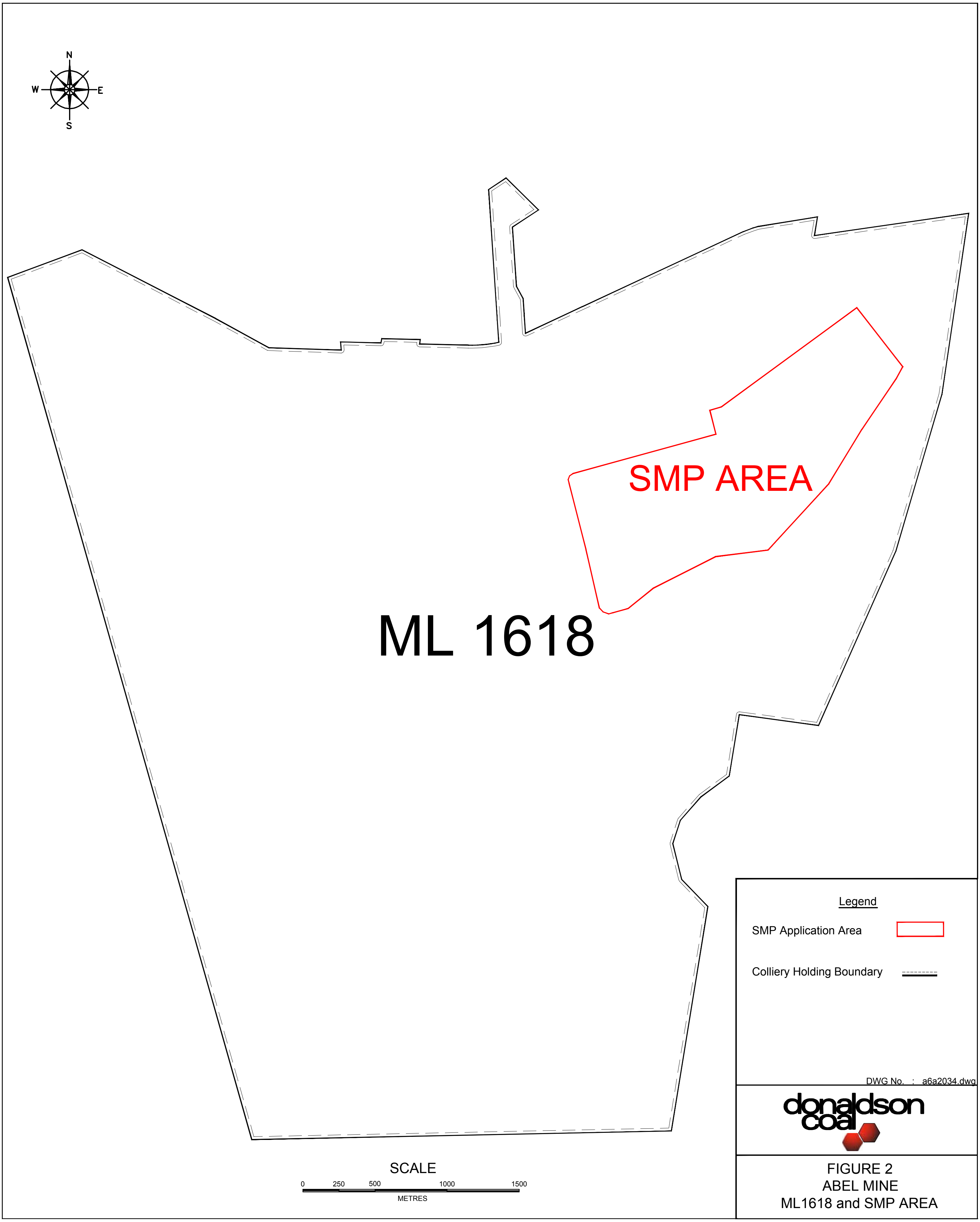



FIGURE 2
ABEL MINE
ML1618 and SMP AREA

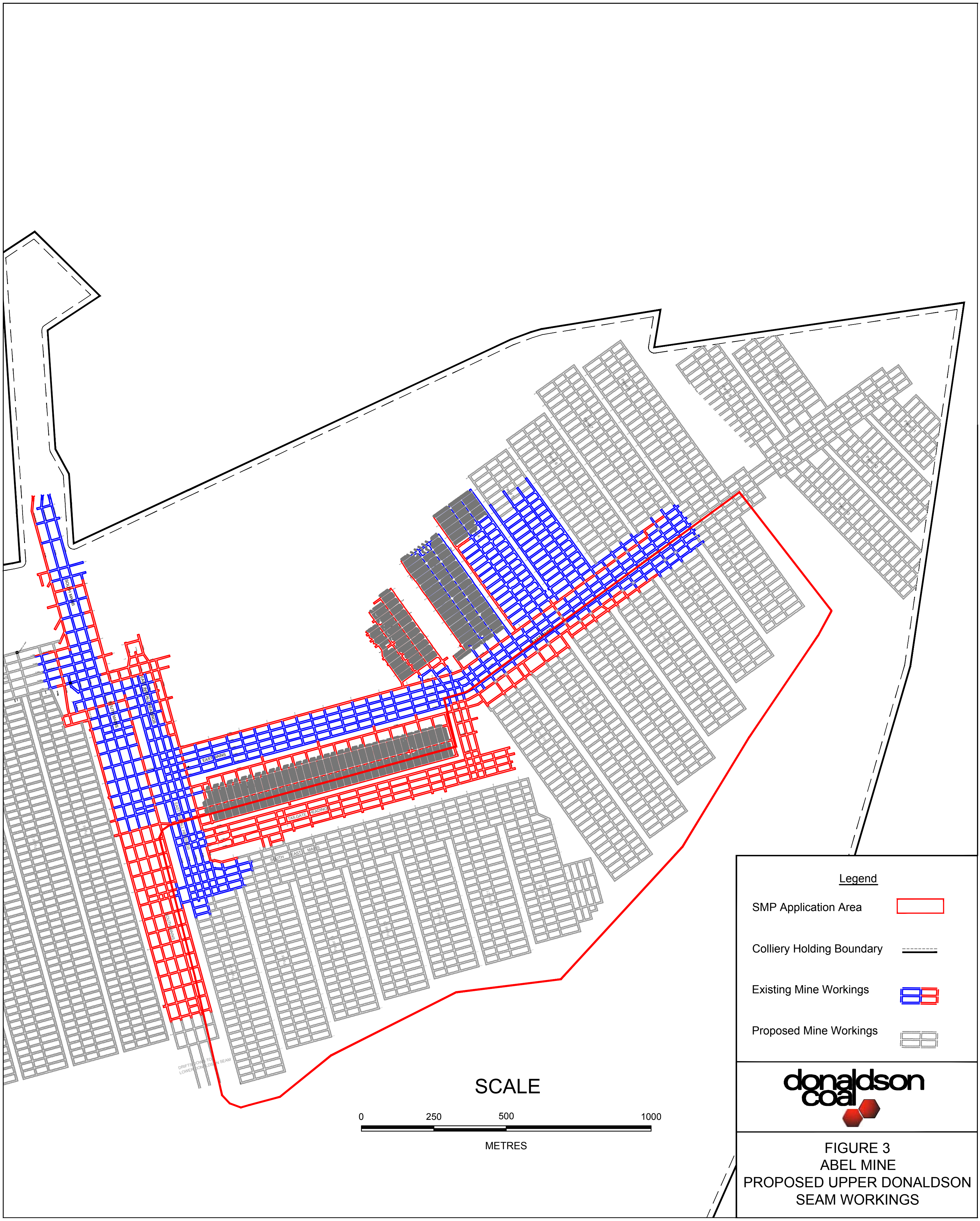



FIGURE 3
ABEL MINE
PROPOSED UPPER DONALDSON
SEAM WORKINGS

## 4.3 PROPERTY DESCRIPTION AND MINING TITLES

The SMP application area is located within land (Lots 684, 685 DP 619758, Lots 1 – 4 inclusive DP 214493, Lot 1 DP 359638, Lot 1 DP 811514, Lot 10 DP 829154, Lot 30 DP 870411, Lot 70 DP 755260 and Lot 1131 DP 1057179) in the Parishes of Hexham and Stockrington County of Northumberland and the Cessnock and Newcastle local government areas. The relevant mining title is Mining Lease ML 1618 **(Plan 5)**.

# 5 MINING METHOD AND RESOURCE RECOVERY

## 5.1 PROPOSED MINING METHOD

Abel will use the bord and pillar method of mining with pillar extraction as the secondary working method in the Upper Donaldson seam within this application area.

The Upper Donaldson coal seam within the SMP application area of the Abel lease ranges from 1.8 to 4.2 metres in thickness. Abel currently mines up to 2.8m of the coal seam. The seam dips up to 1 in 12 generally towards the south within the SMP application area. Pillar extraction will take place generally in both a west to east and east to west direction.

Secondary extraction panel pillars are designed to exceed one tenth the overburden depth while long term mains development pillars (located outside the current application area) are designed to be long term stable and hence not cause subsidence, thus rendering the roads serviceable for the life of the mine.

Development roads will nominally be driven at a width of up to 5.5 metres using a combination of single and dual pass continuous miners. The secondary extraction panel pillars will typically be developed within a range of 45 to 65 metre centres and are proposed to be in the order of 19.5 metres wide (rib to rib).

The purpose of the development is to form pillars suitable to be extracted on the retreat.

## 5.2 MINE PLAN

### 5.2.1 Justification of the Mine Plan

The method of extraction selected allows for maximum resource recovery whilst providing enhanced safety for the workforce. The layout and method also provide an extraction layout which provides flexibility in extraction, allowing areas to be left for support of sensitive surface features thus limiting surface subsidence effects where appropriate. Subsidence effects are dependent on extraction thickness and width, depth of cover and strata conditions. There are no significant environmental impacts that preclude pillar extraction within the current SMP application area.

In the initial planning of the area an option study was conducted whereby a number of alternative mine plans were considered having regard to the lease boundaries, exploration geological data and initial environmental assessment details. The plan and layout have been continually reassessed and reviewed as additional exploration, geological, environmental and subsidence monitoring data from SMP Area 1 have become available.

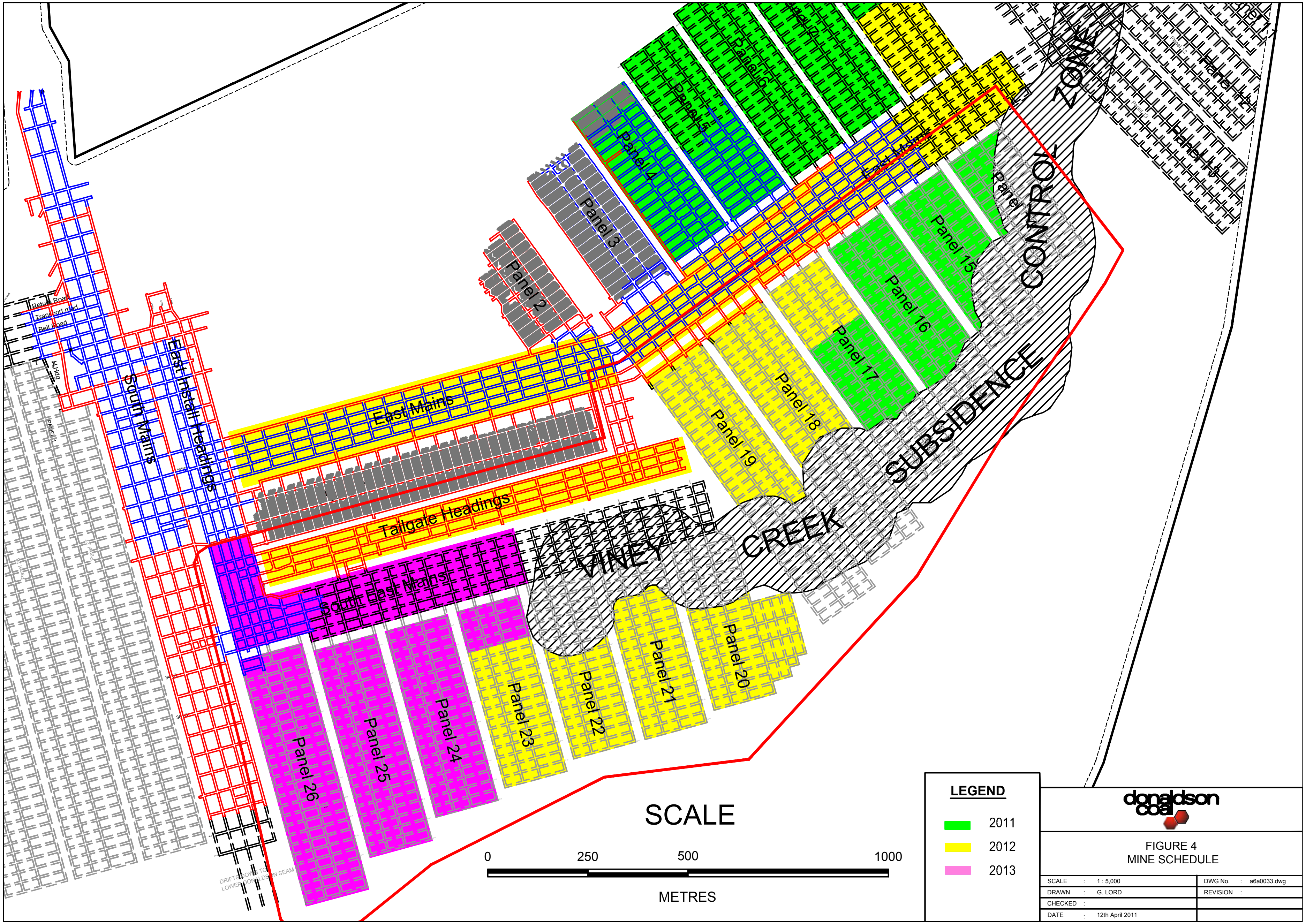
The resultant mine plan provides for optimum resource recovery within the bounds created by geological and surface constraints. It is considered to be a layout which will result in subsidence being minimised in sensitive areas while allowing total extraction and resultant subsidence to be completed in accordance with the Project Approval conditions relating to the Catholic Diocese and Black Hill Land Pty Limited land.

## 5.3 SCHEDULE OF PROPOSED MINING

The mining schedule plan for the SMP application area is shown on **Figure 4.** Pillar extraction will generally progress towards the East Mains and South East Mains in each panel. Development rates are budgeted from 18 to 25 metres per shift dependent on geological conditions and support regime. Pillar extraction will typically produce in the order of 1,000 tonnes per shift.

Normally operations are carried out 24 hours per day six days per week. Generally, only maintenance operations (e.g. stonedusting, roadway maintenance etc) are undertaken on Sundays.

Panel 15 extraction is scheduled to commence in October 2011. The proposed development and extraction schedule is shown in **Figure 4**.




donaldson coal

FIGURE 4
MINE SCHEDULE

| | | | |
|---|---|---|---|
| SCALE : | 1 : 5,000 | DWG No. : | a6a0033.dwg |
| DRAWN : | G. LORD | REVISION : | |
| CHECKED : | | | |
| DATE : | 12th April 2011 | | |

## 5.4 ESTIMATED RECOVERY

As noted in **Section 5.1** the Upper Donaldson coal seam within the SMP Application Area is up to 4.2 metres in thickness. Abel currently mines between 2.4 and 2.6 metres of coal in development and between 2.0 and 2.8 metres in extraction of the coal seam, the only marketable seam within the SMP application area.

The proposed panel layout for the SMP application area (as shown on **Plan 1**) will provide the following tonnages, based on an average working height of 2.4 metres development and extraction, development width of up to 5.5 metres and Relative Density of 1.5.

**Table 5 - Development and Extraction Tonnages**

| Panel | Panel Length (m) | Development (m) | Development Tonnes | Extraction Tonnes | Total Tonnes |
|---|---|---|---|---|---|
| Panel 14 | 390 | 3,578 | 71,550 | 58,275 | 129,825 |
| Panel 15 | 470 | 4,293 | 43,170 | 106,411 | 149,580 |
| Panel 16 | 550 | 5,247 | 78,350 | 157,379 | 235,729 |
| Panel 17 | 650 | 5,963 | 82,000 | 205,030 | 285,030 |
| Panel 18 | 750 | 6,917 | 72,110 | 167,544 | 239,654 |
| Panel 19 | 770 | 7,394 | 83,522 | 167,269 | 250,791 |
| Panel 20 | 430 | 5,009 | 99,280 | 98,830 | 158,110 |
| Panel 21 | 450 | 4,293 | 85,940 | 108,408 | 194,348 |
| Panel 22 | 450 | 4,293 | 79,210 | 104,597 | 183,807 |
| Panel 23 | 480 | 4,532 | 90,990 | 185,467 | 276,457 |
| Panel 24 | 500 | 4,770 | 95,760 | 202,556 | 298,316 |
| Panel 25 | 580 | 5,247 | 105,310 | 208,502 | 315,812 |
| Panel 26 | 650 | 5,963 | 118,520 | 229,713 | 348,233 |
| South East Mains | 1,130 | 9,380 | 157,800 | 256,885 | 414,685 |
| Tailgate Headings | 1,100 | 5,696 | 110,120 | 269,663 | 379,783 |
| East Install Headings | 270 | 1,908 | 38,160 | 50,269 | 88,429 |
| | **TOTAL** | | **1,411,792** | **2,576,797** | **3,988,589** |

The total resource within the SMP application area in the Upper Donaldson seam is 5,562,000 tonnes.

The total mineable tonnage from the SMP application area is 3,988,589 tonnes providing a resource recovery of 71.71%.

## 5.5 POSSIBLE EFFECTS ON OTHER SEAMS

Exploration drilling has encountered seams below the Upper Donaldson seam in the SMP area, including the Lower Donaldson and Ashtonfield seams. Other thin seams (0.5 to 1.0 metres) exist above the Upper Donaldson, however these seams are not considered economically mineable by underground methods.

The Lower Donaldson is positioned only a few metres below the Upper Donaldson and is effectively sterilised in this application area, while the Ashtonfield seam is non-economic in the application area.

As there are no other economically recoverable seams in the SMP application area there are no effects on potentially mineable coal seams.

## 5.6 FUTURE PLANS FOR MINING IN OTHER SEAMS

There are no future plans for mining these other seams in the SMP application area due to the currently non economic nature of these seams.

# 6 STABILITY OF UNDERGROUND WORKINGS

The proposed pillars in the application area are designed to provide stable underground workings for the period of development and subsequent extraction. Detail on predicted subsidence impacts, the associated method of prediction and relevant subsidence parameters can be found in **Appendix A**.

Long term pillar stability is of concern only in relation to the remnant “barrier” pillars between extracted panels and between the panels and the mains.

The barriers between the extracted pillar panels will generally have widths of 24.5 m wide and be 390m to 1,130m long. The pillar height will range from 2.2 m to 2.8 m, depending on the seam thickness. The inter-panel barrier will have w/h ratios ranging from 9.4 to 11.1. These pillars are expected to yield gradually and behave elastically (strain-harden if the unlikely scenario of overloading occurs).

A solid barrier between the finishing ends of the production panels and the adjacent East Mains, East Install Headings and South East Mains will generally be from 21.5m to 37.8m wide with pillar width/height ratios of 8.3 to 14.5 and are also expected to behave elastically in the long term.

Remnant pillars between the previously extracted Panel 1, Tailgate Headings and South East Mains will have widths of 16.3 m and 21m with pillar width/height ratios of 6.3 to 8.1 and are also expected to behave elastically in the long term.

# 7 SITE CONDITIONS OF THE APPLICATION AREA

## 7.1 SURFACE TOPOGRAPHY

The surface above the proposed mining area is generally bounded by the previously approved SMP Area 1 to the north, the lease boundary / F3 Newcastle to Sydney Freeway / resource thickness / quality to the east, Black Hill Road for part and resources thickness / quality to the south and existing and proposed main underground development workings to the west and is currently owned by the Catholic Diocese, Black Hill Land Pty Limited, Hunter Water Corporation and ten private land owners.

The land is semi-cleared, dry-sclerophyll forest, consisting of Lower Hunter Spotted Gum-Ironbark Forest and Coastal Plains Smooth-Barked Apple Woodland, with generally flat to gently undulated terrain. The Catholic Diocese land is presently used to graze cattle (and previously as intensive poultry farming). The section of the Black Hill Land Pty Ltd land overlying this SMP application area is generally native bushland. The privately owned land consists of generally cleared land used for rural residential activities.

The Black Hill Land Pty Ltd land is proposed to be re-developed into industrial lots with sealed access roads. An application to Planning (Lower Hunter Lands - Black Hill MP08_0124) has been lodged. No development applications have been lodged for the Catholic Diocese land at this stage.

The surface slopes range from $1^{o}$ to $10^{o}$ and steepen locally to $15^{o}$ along Viney Creek (defined as a Schedule 2 stream as per the *Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DIPNR, 2005), which drains the site towards the north-east. Topographic relief ranges from 16 m AHD to 68 m AHD across the panels.

The majority of the area drains northwards in the form of a number of ephemeral creeks which drain to Viney Creek, flow to the north and eventually discharge into Woodberry Swamp, a wetland system of the Hunter River estuary.

The natural features of significance within the SMP area include:

- Gently undulating terrain and mild slopes.
- Headwaters of Viney Creek (a Schedule 2 Stream) and several unnamed drainage gullies (Schedule 1 watercourses).
- Sandy alluvial deposits (up to 3 m deep) exist along the lower reaches of the creek with no rock exposures evident.
- Silty sand and sandy clay surface soils present on the site are likely to be mildly to highly erosive / dispersive if exposed to concentrated runoff during storm flow events.
- The 1 in 100 Year ARI flood levels exist along the creeks within the site.
- Vegetation on the site consists of dense stands of dry schlerophyll forest with shrubs, ferns and grasses. The riparian zones along creeks have sparse to dense stands of melaleucas, vines and grasses.

- Common flora/fauna habitats within the SMP area

The prominent features are described in detail in **Section 8.4.1** to **8.4.4**.

## 7.2 DEPTH OF COVER

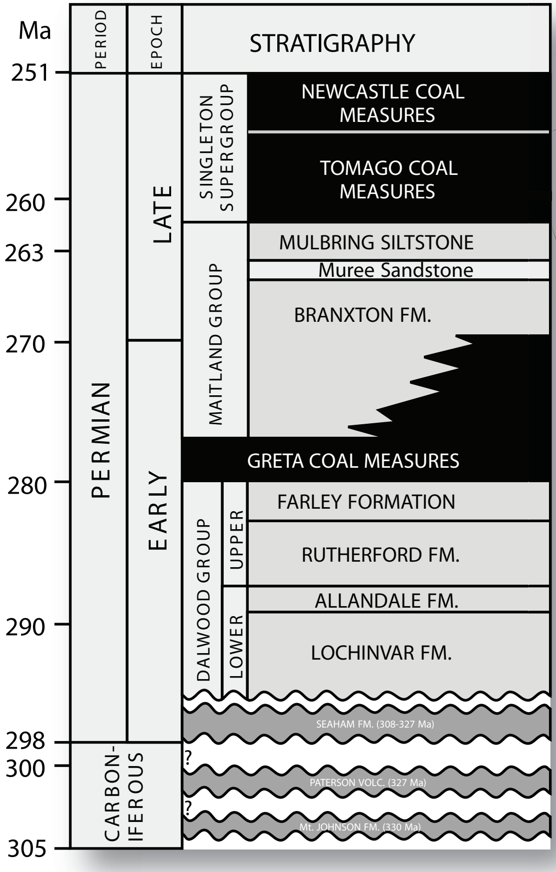
The depth of cover, in the pillar extraction area, varies from 100 to 150 metres over the application area. Details of cover and location of relevant natural features are included in **Plan 2.**

## 7.3 OVERBURDEN STRATIGRAPHY

The SMP application area lies in the Newcastle Coalfield within the Sydney Basin. The overburden comprises part of the Dempsey Formation, which is part of the Permian Aged, Tomago Coal Measures.

The overburden for the area consists of gently, south-west dipping (i.e. 2 to 5 degrees) sedimentary strata of the Tomago Coal Measures, which generally comprise interbedded sandstone, shale, carbonaceous mudstone, tuffaceous claystone and coal. The coal seams present in the overburden (in descending order) include the Sandgate, Upper and Lower Buttai, Beresfield, Upper and Lower Donaldson, Big Ben and Ashtonfield Seams.

The generalised stratigraphy of the Tomago Coal measures (after Robinson 1969) is shown in **Figure 5**.




| Group | Subgroup | Formation | Coal Seam |
|---|---|---|---|
| Tomago Coal Measures | Hexham | Shortland | |
| | | Sandgate | Upper Sandgate<br>Lower Sandgate |
| | | Dempsey | |
| | Four Mile Creek | Ironbark | Upper Buttai<br>Lower Buttai<br>Beresfield<br>Upper Donaldson<br>Middle Donaldson<br>Lower Donaldson |
| | | Thornton Claystone | |
| | | Alnwick | Big Ben<br>Buchanan Maitland<br>Ashtonfields<br>Tomago Thin |
| | Wallis Creek | Stoney Pinch | |
| | | Scotch Derry | Scotch Derry |
| | | Surveyors Creek | |
| | | Rathluba | Upper Rathluba<br>Lower Rathluba |
| | | Metford | |
| | | Morpeth | Morpeth |
| | | Raworth Claystone | |
| | | Tenambit Sandstone | |

donaldson coal

Stratigraphy of the Tomago Coal Measures

**Figure 5**

# 7.4 LITHOLOGICAL AND GEOTECHNICAL CHARACTERISTICS

## 7.4.1 Overburden

The overburden comprises predominately sandstones and shales, interbedded with a number of coal seams including the Upper and Lower Donaldson seams.

Strength testing has been undertaken at selected horizons (**Table 6**).

**Table 6 - Typical Geotechnical Properties for Abel SMP Area 2 (*Based on Boreholes C189, C159R, C101 & C062)***

| Depth to Top of Unit | Depth to Base of Unit | Strata Description | Modeled UCS Range (MPa) |
|---|---|---|---|
| 0.0 | 7.8 | No Recovery | |
| 7.8 | 33.1 | Shale with minor sandstone and claystone bands | 15-50 |
| 33.1 | 34.6 | Coal (Upper Buttai Seam) | 10-20 |
| 34.6 | 38.5 | Sandstone and shale | 15-50 |
| 38.5 | 50.2 | Shale and claystone | 15-60 |
| 50.2 | 51.3 | Coal (Lower Buttai Seam) | 10-20 |
| 51.3 | 70.0 | Shale and sandstone with minor claystone bands | 15-80 |
| 70.0 | 72.0 | Sandstone and shale | 20-60 |
| 72.0 | 75.1 | Shale and sandstone | 40-85 |
| 75.1 | 79.5 | Sandstone with minor shale bands | 25-80 |
| 79.5 | 83.4 | Shale and sandstone with minor claystone bands | 20-45 |
| 83.4 | 87.6 | Shale with minor claystone and sandstone bands | 25-45 |
| 87.6 | 88.1 | Sandstone | 50-80 |
| 88.1 | 91.6 | Shale and sandstone | 30-90 |
| 91.6 | 94.4 | Sandstone | 60-90 |
| 94.4 | 97.5 | Shale | 20-30 |
| 97.5 | 99.8 | Shale and sandstone | 20-95 |
| 99.8 | 101.5 | Shale | 20-30 |
| 101.5 | 102.3 | Coal and claystone (Beresfield Seam) | 10-20 |
| 102.3 | 106.4 | Sandstone and shale | 40-95 |
| 106.4 | 108.0 | Sandstone | 30-90 |
| 108.0 | 110.0 | Shale and sandstone | 20-50 |
| 110.0 | 113.0 | Coal (Upper Donaldson Seam) | 10-20 |

### 7.4.2 Roof and Floor

The immediate roof and floor of the proposed mining horizon will typically consist of 5 to 10 m or more of thin to medium interbedded shale and sandstone with low to medium strength (10 to 50 MPa). The weaker materials, such as carbonaceous mudstone, mudstone and claystone are very thin (< 0.1 m thick) and exist in both the roof and floor.

The immediate roof above the Upper Donaldson Seam comprises shales and sandstones with localised variations where sandstones grade into shales, and shales grade into sandstones, with common changes in the thickness and areal extent of the bands or lenses of material. Thickly bedded or massive units are rare and have not been identified as existing in bands greater than two to three metres thickness.

Low strength immediate roof and floor materials were also generally noted in several boreholes in the north, where the cover depths are less than 40 m. This is also considered to be the depth of weathering on the Donaldson open cut mine to the north of the underground mining area. The sonic UCS results indicated thinly bedded strata with strengths ranging between 10 and 50 MPa and generally from 30 to 50 MPa for the overburden materials at depths > 40 m.

The UCS and stiffness properties of the immediate roof and floor materials have been derived from laboratory and point load strength test results from core taken from six boreholes and in-situ geophysical testing data. Good correlation was apparent between the laboratory derived and *in situ* sonic UCS results presented in the Environmental Assessment.

Estimates of the range of material strength and stiffness properties present in the roof and floor of the Upper Donaldson Seam are summarised in **Table 7**.

**Table 7 - Strength Property Estimates for Upper Donaldson Seam, Roof and Floor Lithology**

| Lithology | Strata Thickness (m) | UCS Range+ [Average] (MPa) | Elastic Moduli Range* (GPa) | Average Moisture Sensitivity^ |
|---|---|---|---|---|
| Interbedded sandstone/ shale beds above the UD Seam | <10 | 10.5 - 93 [18 - 51] | 3 – 20 [5 –15] | Non-Sensitive to Moderately Sensitive |
| Upper Donaldson Seam | 1.9 - 3.2 | 5 - 15 [10] | 2 – 4 [3] | Non- Sensitive to slightly sensitive stone bands |
| Interbedded sandstone/ shale beds below the UD Seam | <10 | 11.5 - 130 [31 - 72] | 3 – 15 [5 – 10] | Non-Sensitive to Slightly Sensitive |

Note:
+ - Unconfined Compressive Strength derived from point load testing to **ISRM, 1985** on bore core samples taken from SMP area.
* - Laboratory Young's Modulus (E) derived from laboratory and sonic UCS data, E = 300 x UCS (units are in MPa).
^ - Moisture sensitivity testing determined from the Immersion Test procedure presented in **Mark & Molinda, 1996**.

For further geotechnical details see **Table 6**.

## 7.5 EXISTENCE AND CHARACTERISTICS OF GEOLOGICAL STRUCTURES

The seam generally dips towards the south of the mining area at approximately 1 in 12.

Based on reference to the DMR Geological Sheet, there are several significant NW:SE striking geological structure zones (i.e. faults and dykes) which occur along Buttai Creek and Long Gully Creek to the west of the site, and also an 8 m throw reverse fault in the north-east corner of the SMP area on a north westerly strike. The south-eastern bedding dip across the site is associated with the southern arm of the Four Mile Creek Anticline, which is located to the west of the site.

Surface joint patterns measured on the sandstone cliff lines and outcrops to the south of the SMP area consist of a sub-vertical, widely spaced, planar to wavy, persistent joint sets striking between 025º and 035º (NNE to NE). A sub-vertical joint set striking at approximately 135º (NW:SE) is also present. The trends of the cliff faces are similar to the above joint sets.

The Upper Donaldson Seam has low strength with sonic derived unconfined compressive strength (UCS) values ranging from 5 to 15 MPa. Some medium to high strength stone bands up to 0.5 m thick are present within the coal seam, with UCS values ranging between 30 and 90 MPa.

# 8 IDENTIFICATION AND CHARACTERISATION OF SURFACE AND SUB-SURFACE FEATURES

## 8.1 MINE SUBSIDENCE DISTRICT

The SMP application area is not located within a current Mine Subsidence District but was previously located within the Ironbark Mine Subsidence District which was revoked in October 1994. Discussions have been held with the MSB relating to the future reclassification of the area as a Mine Subsidence District.

## 8.2 PROPOSED DEVELOPMENTS

Proposed and potential developments within or adjacent to the SMP application area includes (but may not be limited to):

1. an application for approval for a concept plan including an industrial subdivision of the Black Hill Pty Limited land (Lower Hunter Lands – Black Hill MP08_0124); and
2. a, yet to be determined, development of the Catholic Diocese land.

The Abel Project Approval Conditions reference this scenario thus:
"Within 6 years (June 2013) of this approval, the Proponent shall ensure that any subsidence caused by undermining the following land has been effectively completed:

- The Catholic Diocese of Maitland-Newcastle owned land; and
- Coal and Allied Operations (now Black Hill Land) owned land;" and

"With the written agreement of the relevant landowner, the Proponent may:

- conduct additional mining operations and/or cause additional subsidence impacts beyond those permitted under conditions 2(a) or 3; and
- increase the time within which subsidence must be effectively completed under condition 5."

## 8.3 GENERAL DESCRIPTION

The following sections identify and describe all the significant natural features and surface improvements that lie within the SMP application area, which is shown on **Plan 2**.

Reference to the SMP Guideline 2003 was made to assist in identifying these features that may be affected by mining. In addition to this, and as part of the Risk Assessment conducted on 16 September 2010, additional sources were used to confirm the features within the SMP application area.

These sources included:

- aerial photos;
- digital cadastral information also showing surface features;
- on site surveys by mine surveyors;
- field surveys by Donaldson Coal personnel and consultants, local knowledge of the area by mine personnel and various consultants; and
- Information provided by Public Utilities and landholders.
- Information from Abel EA and Black Hill Land Pty Limited EA.

## 8.4 NATURAL FEATURES

Natural features contained within the SMP application area are limited to the following as listed under **Appendix B** of the SMP Guideline 2003.

- Catchment areas – Hunter River Catchment;
- Rivers and creeks – Schedule 1 and 2 streams only. (**Section 8.4.1**);
- Aquifers, known groundwater resources – Various aquifers (**Section 8.4.2**);
- Land prone to flooding and inundation (**Section 8.4.3**);
- Threatened and Protected Species – see also Flora and Fauna section. (**Section 8.4.4**); and
- Natural vegetation – Section of application area contains native vegetation (**Section 8.4.4**).

Listed in the following Table is a check list of natural features from Appendix B of the SMP Guideline 2003.

**Surface and Sub-Surface features that may be affected by Underground Coal Mining.**

**Table 8 - Item 1 – Natural Features**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Catchment areas and declared Special areas | Reviewed classification of catchment areas | |
| 2 | Rivers and creeks | Reviewed classification of catchment areas | No rivers. Schedule 1 and 2 streams only Viney Creek (Schedule 2), tributaries to Weakleys Flat Creek |
| 3 | Aquifers, known groundwater resources | Hydrogeological assessment | Aquifers |
| 4 | Springs | Some ground truthing | Nil located |
| 5 | Sea / Lake | Reviewed aerial photo and topographical plan | Nil |
| 6 | Shorelines | Reviewed aerial photo and topographical plan | Nil |
| 7 | Natural dams | Reviewed aerial photo and topographical plan | Nil |
| 8 | Cliffs / Pagodas / Rock Formations | Reviewed aerial photo and topographical plan, targeted ground truthing | Nil |
| 9 | Steep slopes | Reviewed topographical plan, targeted ground truthing | Nil excluding creek banks |
| 10 | Escarpments | Reviewed Aerial photo and topographical plan | Nil |
| *11* | Land prone to flooding or inundation | Reviewed Aerial photo and topographical plan | Yes |
| 12 | Swamps, wetlands, water related ecosystems | Reviewed Aerial photo and topographical plan. Ground truthing, vegetation mapping | Nil in SMP area |
| 13 | Threatened and protected species | Surveys, literature, ground truthing, monitoring | Yes |
| 14 | National parks | Reviewed NPWS website | Nil |
| 15 | State recreation areas | Reviewed NPWS website and plans | Nil |
| 16 | State Forests particularly area zoned Forestry Management Zones 1,2 or 3 | Obtained State Forest map. | Nil |
| 17 | Natural vegetation | Surveys, literature | Yes |
| 18 | Areas of significant geological interest | | Nil |
| 19 | Any other feature considered significant | | Nil |

### 8.4.1 Watercourses

Watercourses in the SMP application area consist of Viney Creek and various tributaries of Viney Creek.

These are Schedule 1 and 2 streams as defined by the *Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DIPNR, 2005

**Surface Water Catchments and Watercourses**

The Abel Underground Mine area is located within the lower section of the Hunter River catchment and consists of low undulating forested hills with patches of cleared land for rural/residential properties. A ridgeline associated with Black Hill runs east-west through the proposed underground mine area, with tributaries of Buttai Creek, Viney Creek, Weakleys Flat Creek and Four Mile Creek draining northwards from this ridgeline. Long Gully & Blue Gum Creek drain the southern side of the ridgeline eastwards towards Pambalong Nature Reserve. The only distinct sub-catchment area within the SMP Area 1 is described as follows:

> The ephemeral Viney Creek sub-catchment area drains northward into Weakleys Flat Creek then Woodberry Swamp prior to entering the Hunter River. The sub-catchment is approximately 935 hectares, which represents about 34 percent of the total underground mine area. A large portion of the sub-catchment area is cleared land that previously supported intensive chicken production. The watercourses in this sub-catchment area are ephemeral.

**Surface Water Quality**

Surface water quality data has been collected from the main watercourses in each of the sub-catchment areas identified within the underground mine area.

Donaldson conducts a regular surface water monitoring program of the three main creeks (Scotch Dairy Creek, Weakley's Flat Creek and Four Mile Creek) that traverse the existing Donaldson Mine property. These creeks are sampled above and below the existing mine operations on a monthly basis for a suite of parameters. A baseline survey of these creeks was undertaken in 1997 and routine monitoring has been undertaken since June 2000.

Water quality data has been compared to the lower and upper limits of the default trigger values outlined for lowland rivers in south-east Australia (ANZECC 2000, Ch 3 – Aquatic Ecosystems). For Weakleys Flat Creek, Scotch Dairy Creek and Four Mile Creek substantial background data is available due to the long term monitoring undertaken by Donaldson. The average water quality data for these watercourses is within the range outlined by ANZECC, however, there is a wide range of variability in the water quality measured over time, including some measured recordings above the upper limits as outlined by ANZECC. For example, the maximum recorded values for pH, EC and TSS within Weakleys Flat Creek are all above the upper limits of the default trigger value range. The water quality samples obtained for Viney Creek are within the range outlined by ANZECC.

The long term data collected by Donaldson and the data collected during the full suite analysis was also used to assess the source of the water within the watercourses. Based on the relative composition of the major ions the following interpretation has been made:

- Viney Creek samples appear to be predominately surface runoff, but with some proportion of groundwater baseflow;

- The Weakleys Flat Creek has been sustained by groundwater baseflows over recent dry years; and

- The Four Mile Creek appears to be mostly surface runoff, but with some proportion of groundwater baseflow.

In all cases above, the groundwater is probably from the near surface zone (ie: alluvium/colluvium and/or weathered bed rock) and is not connected with deeper regional groundwater.

**Watercourse Characteristics**

In early 2006 a watercourse survey was undertaken to collect typical data for the watercourses throughout the Abel Underground Mine area. Information was collected on the following characteristics:

- Bed material type (grain size/depth etc);
- Notable stream features (exposed rock, bed controls, etc);
- Channel geometry;
- Existing erosion;
- General vegetation communities; and
- Flow & Ponding conditions.

A summary of the observations made during the watercourse survey for each sub-catchment area is presented as follows.

**Weakleys Flat Creek (and Viney Creek) sub-catchment**

Weakleys Flat Creek and Viney Creek were observed to have bed and bank material predominantly consisting of soil and gravel, with occasional outcropping sandstone. The channel widths generally ranged from 1.5 to 3 metres wide, and the channel height ranged from 0.5 to 1.5 metres. There was no flow in the creeks during the survey, but small ponds were observed. An inspection of Viney Creek conducted in March 2009 by Geoterra Pty Ltd showed that the creek is heavily vegetated and in places is almost fully choked with weeds and reeds. Where the creek isn't heavily vegetated with weeds/reeds, it has a high cover of natural forest / riparian shrub vegetation (with lesser, although prevalent weeds). The banks along the creek are predominantly composed of dark brown silty clay, which is eroded in places with vertical banks of up to 1.5-2.0m high, and the stream bed is composed of a sandy/small gravel alluvium resting on top of the incised silty clay stream bed.

**Key Surface Water Features**

All watercourses within the underground mine area have been categorised as Schedule 1 or 2 Streams in accordance with the *Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DIPNR, 2005). No Schedule 3 Streams are present in the underground mine area.

The Scheduled Stream within the SMP area (Viney Creek) is shown on Plan 2.

### 8.4.2 Aquifers and Groundwater Resources

**Explanation of terms**

“Aquifer” is a term generally applied to any stratum that has a high groundwater carrying capacity relative to the surrounding rocks.
“Aquicludes” and “Aquitards” are the terms used to describe the strata above and below the aquifer.
“Aquicludes” effectively seal off the aquifer so that groundwater flow is restricted to the aquifer.
“Aquitards” allow some minor leakage of groundwater from the aquifer either through the roof or floor.

**Summary**

**Study Objectives**

A groundwater investigation has been undertaken for the Abel Underground Mine and is provided as **Appendix C**. A Peer Review of the groundwater study was also completed. The Peer Review found that the data and methods used were consistent with best practice approaches and that the arguments and conclusions were robust and appropriate.

The groundwater investigations aimed to:

- Assess and describe the existing groundwater environment in the vicinity of the Abel Underground Mine;
- Identify potential risks to the environment from the proposal;
- Evaluate the potential impacts of the proposal on the regional and local groundwater resources, incorporating any necessary management and mitigation strategies; and
- Assess any residual post-project impacts and any ongoing management requirements.

The study has been undertaken with reference to the following relevant policies:

- NSW State Rivers and Estuaries Policy;
- NSW Wetlands Management Policy;
- NSW Groundwater Policy Framework Document – General;
- NSW Groundwater Quantity Management Policy;
- NSW Groundwater Quality Protection Policy; and
- NSW Groundwater Dependent Ecosystem Policy.

The following relevant best practice guidelines have been referenced:

- *Groundwater Flow Modelling Guideline* (Middlemis, 2001);
- *Independent Inquiry into the Hunter River System* (Healthy Rivers Commission, 2002);

- *Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DIPNR, 2005); and
- *Groundwater Monitoring Guidelines for Mine Sites within the Hunter Region (DIPNR, 2003).*

**Study Methodology**

A series of piezometers were installed across the proposed Abel Underground Mine area to enable separate sampling, testing and monitoring of the principal coal seams and the overburden and interburden sediments, both within the shallow northern part of the deposit, and downdip at the southern end. Some bores were also installed along the strike to the east. A number of shallow piezometers were also installed around the Pambalong Nature Reserve. The location of these piezometers and bores is shown on **Figure 6.** Piezometer design and testing details are provided in **Appendix C**.

A hydraulic testing program was carried out on the standpipe piezometers, comprising either slug tests or short duration pumping tests, to determine aquifer permeabilities. Water samples were also collected from each piezometer during hydraulic testing. The samples were submitted to a NATA-registered laboratory for comprehensive analysis of physical properties and the major inorganic parameters.

The specific investigations carried out for the Abel Underground Mine project were supplemented by relevant parts of earlier studies carried out for the Donaldson Open Cut Coal Mine. Ongoing monitoring of groundwater levels and groundwater and surface water quality have provided additional information.

A limited test program was also carried out on existing bores on the Bloomfield project site.

The hydrogeological investigations (including modelling) have also been undertaken with reference to the *Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DNR, 2005), with the model developed in accordance with the best practice guidelines on groundwater flow modelling (MDBC, 2001).

**Existing Hydrogeological Environment**

**Introduction**

A detailed description of the existing hydrogeological environment that interacts with or influences groundwater is provided in **Appendix C.** This includes:

- Climate – rainfall and evapotranspiration;
- Geology;
- Hydrogeology;
- Recharge and Discharge;
- Groundwater Quality; and
- Groundwater and Surface Water Interaction.

**Hydrogeology**

In the Abel Underground Mine area, permeability was found to be generally highest in the coal seams and areas of significant fracturing or faulting. However, overall the coal measures were found to be poorly permeable. The interbedded sandstones and siltstones are of lower permeability and offer very limited intergranular porosity and little secondary permeability and storage in joints.

Groundwater was also found to occur in the alluvial overburden, which comprises mainly swamp, floodplain and estuarine sediments. There is considered to be limited hydraulic connectivity between the alluvium and the coal measures.

**Recharge and Discharge**

Groundwater flow within the coal measures is controlled by the regional topography, with recharge occurring in areas of elevated terrain and then slow movement down-dip or along strike to areas of lower topography. There is considered to be a component of lateral flow in the coal measures out of the project area over the southern and eastern boundaries. This flow is believed to be limited due to the substantial overburden cover (up to several hundred metres).

Groundwater level contours for the Donaldson Seam show an overall pattern of flow to the east, south and west from a central ridge which extends southwards from the Donaldson Open Cut Mine. The flow pattern is largely independent of the local topography. The contours also show the influence of dewatering in the Donaldson Open Cut Mine area with a prominent cone of depression located to the north of John Renshaw Drive.

A similar flow pattern is apparent for the rest of the coal measures. Groundwater levels are about 5 to 10 metres higher in the overburden above the Donaldson Seam. There is a consistent pattern of lower pressure heads with depth.

Groundwater levels in the near surface material, which includes alluvium/colluvium and weathered bedrock, show a much closer relationship to the local topography. While groundwater levels in the deeper coal measures are not influenced by local topography, the surficial groundwater levels are locally influenced.

Groundwater flow within the deeper coal measures is therefore believed to be more regionally controlled, whereas flow within the near-surface material is subject to local topographic influences.

Rainfall recharge occurs to the coal seams where they outcrop and to the alluvial aquifers. The alluvial aquifers are likely to be in hydraulic continuity with Hexham Swamp in the east and Wallis Creek to the west of the Abel Underground Mine area. During periods of high stream flow, surface water courses are likely to contribute to this alluvial aquifer recharge. However, stream flows from rainfall runoff are reported to be short-lived after rainfall events.

The coal seams, where covered by overburden, are recharged mainly by flow along the bedding from elevated areas where the beds are exposed in outcrop, with minimal downward percolation through the overburden. After reaching the water table, flow is predominantly down-gradient along the more permeable horizons, but also with a component of continuing downward flow to recharge underlying coal seam aquifers. Rainfall recharge rates within the hard rock outcrop area are believed to be relatively low (below 10 mm/yr). However, where alluvial deposits occur, recharge rates may be as high as 100mm/yr.

Groundwater discharge occurs through evaporation, seepage and spring flow where the water table intersects the land surface, and through baseflow contributions to creeks, rivers and Hexham Swamp, including discharge to the alluvium where it occurs. There is almost no existing groundwater abstraction in the Abel Underground Mine area other than for coal mine dewatering at Donaldson Open Cut Mine and Bloomfield Colliery.

**Groundwater and Surface Water Interaction**

Limited interaction is assessed between the surface drainage system and the deeper groundwater within the coal measures. The limited occurrences of localised surficial groundwater are also assessed to be in reasonable hydraulic connection with the high level streams, and there is expected to be some interchange of water between the creek-beds and the shallow weathered bedrock beneath. These localised occurrences of surficial groundwater do not represent a significant or regionally extensive aquifer system, and should be considered to be an integral part of the surface water flow system.

### 8.4.3 Land Prone to Flooding and Inundation

Viney Creek and the tributaries of Viney Creek are considered areas where potential for flooding may occur.

The pre-mining 1 in 100 Year ARI flood levels for the Black Hill Pty Ltd were provided by the stakeholder to assess potential flooding impacts due to the proposed mining layout.

The post-mining 1 in 100 Year ARI flood levels will require a hydrological assessment based on the predicted surface levels prepared in this study. For indicative purposes, the worst-case flood levels have been estimated from the predicted post-mining contours, as shown in **Figure 28b** in **Appendix A**.

It is estimated that the areal extent of flooding due to the 1 in 100 year may increase by up to 5% for the subsided reaches of two Viney Creek tributaries above Panels 15, 17 and 18.

### 8.4.4 Flora, Fauna and Natural Vegetation

**Underground Mine Area**

This area consists of the land potentially subject to subsidence impacts over the underground mine, being approximately 1,900 hectares of relatively undisturbed vegetation and 900 hectares of fragmented vegetation in a farmland mosaic. The topography consists of a complex system of ridges (elevation around 300 metres) and steep gullies which drain across alluvial flats ultimately into the Hexham flood plain. Subsidence will be varied over the mine area due to factors such as depth of workings, mining sequence, geological conditions, surface features and topography. Therefore, not all surface areas will be subject to the same degree of subsidence, with some experiencing no change.

The SMP application area encompasses only 211 hectares. A baseline survey of the proposed mining area was undertaken as part of the EA process.

The complete flora and fauna lists and descriptions are provided as **Appendix D**.

**Methodology**

The investigation for this area was directed at classifying the various ecosystems extent across the area based on the vegetation, floristic content and structure. Habitat surrogates were used to develop a list of species of threatened flora and fauna that were considered likely to occur. Particular attention was given to the likelihood of species being present that were listed as rare or threatened from a local, State and Commonwealth perspective.

The vegetation communities present across the underground mining area were first assessed by ground-truthing. Summary data describing the composition and structure of the vegetation was collected at points across the area and this data was used to direct more detailed sampling of the variation found to be present. The summary data was obtained by driving all available tracks and by walking into areas not accessible by track.

Detailed sampling was in the form of standard 20m x 20m floristic plots in which all species present were recorded using the modified Braun-Blanquet 6-point scale of cover-abundance. The data from these floristic plots was analysed against data from the wider region using PATN (Belbin 1989) in order to assess what groupings were present. The floristic content of the various groupings was then assessed against the vegetation communities detailed in the regional vegetation model as prepared by NPWS (2000).

Finally the ground-truthed data and the community classification data was combined and, using an extrapolation process in a GIS, a map of the vegetation communities extant over the area subject to potential subsidence impacts was prepared.

The available published data on the ecological requirements of species from a range of sources was used to determine which species of fauna were likely to be present in the vegetation communities mapped for the area.

**Results and Discussion**

**Vegetation Communities**

370 ground-truth data points and 31 detailed floristic plots were used to determine the vegetation communities extant across the Abel surface area. Analysis of the detailed floristic plots using PATN (Belbin 1989) showed 7 separate communities to be present (See **Appendix D** for detailed dendrogram).

**Table 9** lists the vegetation communities and their present area. Two listed and one preliminarily listed endangered ecological communities (EEC) were found to be present.

**Table 9 - Vegetation Communities Mapped Across the Underground Mine Area**

| Map Unit | Description | Area (ha) |
|---|---|---|
| MU1a | **Sub-tropical Rainforest | 27 |
| MU5 | Alluvial Tall Moist Forest | 153 |
| MU12 | Hunter Valley Moist Forest | 174 |
| MU15 | Coastal Foothills Spotted Gum – Ironbark Forest | 593 |
| MU17 | *Lower Hunter Spotted Gum – Ironbark Forest | 643 |
| MU18 | Central Hunter Spotted Gum – Ironbark Forest | 20 |
| MU19 | *Hunter Lowlands Redgum Forest | 6 |
| MU30 | Coastal Plains Smooth-barked Apple Woodland | 108 |

*Endangered ecological community, **Preliminarily listed endangered ecological community.

A detailed description of each vegetation community listed above is provided in **Appendix D.**

**Groundwater Dependent Ecosystems**

No Groundwater Dependent Ecosystems have been identified in the SMP Area.

## Flora

Over 350 species of flora were identified during the field assessment of the total Abel EA area. The full list can be found in **Appendix D.** There are no threatened flora species located within the SMP Area.

**Table 10** lists the significant species found during this investigation.

**Table 10 - Significant Plant Species Found Across the Investigation Area.**

| Species | Status | Description | Habitat |
|---|---|---|---|
| *Arthropteris palisotii* | E | A climbing fern | One plant found in the Long Gully Sub-tropical Rainforest |
| *Tetratheca juncea* | V, C | A small wiry generally leafless plant with pink flowers | Restricted to the Smooth-barked Apple (MU30) vegetation |
| *Eucalyptus fergusonii* | R (2RC-) | An ironbark | MU15 and MU12 |
| *Callistemon shiressii* | R (3RC-) | A small paper bark tree with small cream 'bottle brush' flowers | Moist gullies (MU5) and rises (MU12) |

KEY: C = vulnerable Commonwealth EPBC Act, E = endangered NSW TSC Act, V = vulnerable NSW TSC Act, R = rare ROTAP (Briggs & Leigh 1995), 2RC- = geographic range <100k Rare Conserved but numbers unknown, 3RC- as for 2RC- but geographic range >100k.

## Fauna

The results of a database search of the Atlas of NSW Wildlife for an area within 5 kilometres of the boundary of the total Abel EA Investigation Area are shown in **Table 11**.

**Table 11 - Threatened Fauna Species Recorded Within 5km Radius of EA Investigation Area**

| Family | Species | Common Name | Status |
|---|---|---|---|
| **Frogs** | | | |
| Hylidae | *Litoria aurea* | *Green and Golden Bell Frog | E1 |
| **Birds** | | | |
| Acanthizidae | *Pyrrholaemus sagittatus* | Speckled Warbler | V |
| Accipitridae | *Hamirostra melanosternon* | Black-breasted Buzzard | V |
| Accipitridae | *Lophoictinia isura* | Square-tailed Kite | V |
| Anatidae | *Stictonetta naevosa* | *Freckled Duck | V |
| Anseranatidae | *Anseranas semipalmata* | *Magpie Goose | E1 |
| Ardeidae | *Botaurus poiciloptilus* | *Australasian Bittern | V |
| Cacatuidae | *Calyptorhynchus lathami* | Glossy Black-Cockatoo | V |
| Ciconiidae | *Ephippiorhynchus asiaticus* | *Black-necked Stork | V |
| Climacteridae | *Climacteris picumnus* | Brown Treecreeper | V |
| Columbidae | *Ptilinopus magnificus* | Wompoo Fruit-Dove | V |
| Haematopodidae | *Haematopus longirostris* | *Pied Oystercatcher | V |
| Jacanidae | *Irediparra gallinacea* | *Comb-crested Jacana | V |
| Meliphagidae | *Melithreptus gularis gularis* | Black-chinned Honeyeater (eastern subsp.) | V |

| Family | Species | Common Name | Status |
|---|---|---|---|
| Meliphagidae | *Xanthomyza phrygia* | Regent Honeyeater | V |
| Petroicidae | *Melanodryas cucullata* | Hooded Robin | V |
| Psittacidae | *Lathamus discolor* | Swift Parrot | E1 |
| Psittacidae | *Neophema pulchella* | Turquoise Parrot | V |
| Rostratulidae | *Rostratula benghalensis australis* | *Painted Snipe (Australian subspecies) | E1 |
| Strigidae | *Ninox connivens* | Barking Owl | V |
| Tytonidae | *Tyto novaehollandiae* | Masked Owl | E1 |
| **Marsupials** | | | |
| Petauridae | *Petaurus australis* | Yellow-bellied Glider | V |
| Petauridae | *Petaurus norfolcensis* | Squirrel Glider | V |
| Phascolarctidae | *Phascolarctos cinereus* | Koala | V |
| **Megachiropteran Bats** | | | |
| Pteropodidae | *Pteropus poliocephalus* | Grey-headed Flying-fox | V |
| **Microchiropteran Bats** | | | |
| Emballonuridae | *Saccolaimus flaviventris* | Yellow-bellied Sheathtail-bat | V |
| Molossidae | *Mormopterus norfolkensis* | Eastern Freetail-bat | V |
| Vespertilionidae | *Chalinolobus dwyeri* | Large-eared Pied Bat | V |
| Vespertilionidae | *Falsistrellus tasmaniensis* | Eastern False Pipistrelle | V |
| Vespertilionidae | *Miniopterus australis* | Little Bentwing-bat | V |
| Vespertilionidae | *Miniopterus schreibersii oceanensis* | Eastern Bent-wing Bat | V |
| Vespertilionidae | *Myotis adversus* | Large-footed Myotis | V |
| Vespertilionidae | *Scoteanax rueppellii* | Greater Broad-nosed Bat | V |

E1-Engangered, V-Vulnerable as per Schedule 2 of the *Threatened Species Assessment Act 1995.* * Species dependant on the Pambalong Nature Reserve or similar habitat.

During the field investigation a family of Powerful Owls (*Ninox strenua*), including adults and fledged young, were found in the rainforest gully at the southern part of the investigation area and a Sooty Owl (*Ninox tenebricosa*) was found in the Long Gully rainforest. A full list of fauna species considered likely to be present in the various habitat types across the area is provided in **Appendix D.**

## 8.5 MAN - MADE STRUCTURES

Man - made structures contained within the SMP application area are limited to the following:

- Roads (All types) - various public and private roads plus access tracks (**Section 8.5.1**);
- Culverts – (**Section 8.5.2**)
- Water supply pipelines – Hunter Water supply line, domestic and stock water pipelines (**Section 8.5.3**);
- Electricity transmission lines – Transgrid 330kV, Energy Australia 132kV and Energy Australia 11kV and 415V rural supply to various properties (**Section 8.5.4**);
- Telecommunication lines - Optus fibre optic plus active and redundant Telstra copper cables (**Section 8.5.5**);
- Farm buildings, sheds - (**Section 8.5.6**);
- Fences, stockyards, cattle grids, water troughs and holding areas - Various rural fences (**Section 8.5.7**);

- Farm dams - Two (**Section 8.5.8**);
- Catholic Diocese Water Reticulation System (**Section 8.5.9**);
- Aboriginal Places, Archaeology and Heritage Sites - Aboriginal artefacts (**Section 8.5.10**);
- Permanent survey control marks (**Section 8.5.11**); and
- Houses - (**Section 8.5.12**).

Listed in **Tables 12** to **17 (inclusive)** is a check list of man - made structures from **Appendix B** in the SMP Guideline 2003.

**Man - Made Only Surface and Sub-Surface features that may be affected by Underground Coal Mining**

**Table 12 - Item 2 - Public Utilities**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Railway | Reviewed aerial photo and topographical plan | Nil |
| 2 | Roads (all types) | Reviewed aerial photo and topographical plan | Various public and private roads and access tracks. |
| 3 | Bridges | Reviewed aerial photo and topographical plan | Nil |
| 4 | Tunnels | Reviewed aerial photo and topographical plan | Nil |
| 5 | Culverts | Reviewed aerial photo and topographical plan | Several |
| 6 | Water / gas / sewerage pipelines | Reviewed aerial photo. Dial Before You Dig website enquiry | Hunter Water pipeline, other domestic water pipelines for stock / domestic use |
| 7 | Liquid fuel pipelines | Reviewed aerial photo. Dial Before You Dig website enquiry | Nil |
| 8 | Electricity transmission lines (overhead / underground) and associated plants | Reviewed aerial photo. Dial Before You Dig website enquiry | Transgrid 330kV line, Energy Australia 132kV, Energy Australia 11kV and 415V supply to individual properties. |
| 9 | Telecommunication lines (overhead / underground) and associated plants | Reviewed aerial photo. Dial Before You Dig website enquiry | Optus fibre optic, active and redundant Telstra copper services |
| 10 | Water tanks, water and sewerage treatment works | Reviewed aerial photo. Dial Before You Dig website enquiry. | Domestic water tanks only |
| 11 | Dams, reservoirs and associated works | Reviewed aerial photo and topographical plan | Nil |
| 12 | Air strips | Reviewed aerial photo and topographical plan | Nil |
| 13 | Any other infrastructure items | Reviewed aerial photo and topographical plan | Nil |

**Item 3 - Public Amenities**

**Table 13 - Item 3 – Public Amenities**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Hospitals | Reviewed aerial photo | Nil |
| 2 | Places of worship | Reviewed aerial photo | Nil |
| *3* | Schools | Reviewed aerial photo. | Nil. Proposed Catholic Diocese School site. |
| 4 | Shopping Centres | Reviewed aerial photo | Nil |
| 5 | Community centres | Reviewed aerial photo | Nil |
| 6 | Office buildings | Reviewed aerial photo | Nil public |
| *7* | Swimming pools | Reviewed aerial photo | Nil |
| 8 | Bowling greens | Aerial photos, mine plans | Nil |
| 9 | Ovals and cricket grounds | Reviewed aerial photo | Nil |
| 10 | Race courses | Reviewed aerial photo | Nil |
| 11 | Golf courses | Reviewed aerial photo | Nil |
| 12 | Tennis courts | Reviewed aerial photo | Nil |
| 13 | Any other amenities considered significant | Reviewed aerial photo | Nil |

## Item 4 – Farm Land and Facilities

**Table 14 - Item 4 – Farm Land and Facilities**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Agricultural utilisation or agricultural suitability of farm land | Reviewed aerial photo | Yes |
| 2 | Farm buildings / sheds | Reviewed aerial photo | Yes |
| 3 | Gas and / or fuel storage | Reviewed aerial photo | No |
| 4 | Poultry sheds | Reviewed aerial photo | No |
| 5 | Glass houses | Reviewed aerial photo | No |
| 6 | Hydroponic systems | Reviewed aerial photo | No |
| 7 | Irrigation systems | Reviewed aerial photo | No |
| 8 | Fences | Aerial photos, mine plans | Yes, various plus stockyards, holding areas, cattle grids, gates and water troughs |
| 9 | Farm dams | Reviewed aerial photo | Yes, several small stock watering dams |
| 10 | Wells / bores | Consultant report | No |
| 11 | Any other feature considered significant | Catholic Diocese Water reticulation system for livestock | Yes |

**Table 15 - Item 5 – Industrial, Commercial and Business Premises**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Factories | Reviewed aerial photo | Nil |
| 2 | Workshops | Reviewed aerial photo | Nil |
| 3 | Business or commercial premises | Reviewed aerial photo | Nil |
| 4 | Gas and / or fuel storage and associated plants | Reviewed aerial photo | Nil |
| 5 | Waste storages and associated plants | Reviewed aerial photo | Nil |
| 6 | Buildings, equipment and operations that are sensitive to surface movements | Reviewed aerial photo | Nil |
| 7 | Surface mining (open cut) voids and rehabilitated areas | Reviewed aerial photo | Nil |
| 8 | Mine infrastructure including tailings dams and emplacement areas | Aerial photos, mine plans | Nil |
| 9 | Any other feature considered significant | Reviewed aerial photo | Nil |

**Table 16 - Items 6, 7 and 8 - Archaeological, Heritage, Architectural Significance**

| Item | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Areas of archaeological and / or heritage significance (including aboriginal) | Reviewed Aerial photo. Inspections of area conducted during various EA studies plus archaeological surveys by property owners | Yes |
| 2 | Items of Architectural significance | Reviewed Aerial photo. Inspections of area conducted during various EA studies. | Nil |
| 3 | Permanent survey control marks | Inquiry to Department of Lands Survey. Search of department of Lands website | Two PMs 113285 and 113293 (see **Plan 2**) |

**Item 9 – Residential Establishments**

**Table 17 - Item 9 – Residential Establishments**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Houses | Reviewed aerial photo | Yes, Principal residences, Other Surface Structures and disused unoccupied houses. |
| 2 | Flats / Units | Reviewed aerial photo | Nil |
| 3 | Caravan Parks | Reviewed aerial photo | Nil |
| 4 | Retirement / aged care villages | Reviewed aerial photo | Nil |
| 5 | Associated structures such as workshops, garages, on-site waste water systems, water or gas tanks, swimming pools and tennis courts | Reviewed aerial photo | Yes |
| 6 | Any other feature considered significant | Reviewed aerial photo | Nil |

### 8.5.1 Roads (All Types)

**Public Roads**

Black Hill Road and Taylors Road (Cessnock City Council).

Black Hill road is a bitumen spray sealed dual carriageway with gravel shoulders. The road is mainly on-grade, with some sections in cut and fills up to 3 m deep. The condition of the road is considered good to fair, with only minor 'crocodile' cracking and rutting observed.

Taylors Road is an unsealed gravel dual carriageway which provides access to private residences to the south of SMP Area 2.

**Private Roads and Access Tracks**

A combination of unsealed and bitumen sealed property access roads, driveways and fences (Catholic Diocese, Black Hill Land Pty Ltd and other Principal Residences) refer **Plan 2**).

### 8.5.2 Culverts

Two concrete pipe culverts (No.s 1 and 2) in up to 3 m of fill below Black Hill Road (Cessnock City Council).

Culvert No.1 has twin 1,200 mm diameter pipes with a 1.8 m high x 2.5m long gabion head wall and cobble-sized dolerite rip-rap on the downstream side.

Culvert No.2 is a single 900 mm diameter pipe. Both culverts have upstream and downstream reinforced concrete head walls, and the pipe segments are 3 m long.

### 8.5.3 Water Supply Pipelines

One buried 200mm diameter UPVC water supply pipeline (pressurised) with rubber ring joints and a disused 375mm diameter welded steel pipeline (Hunter Water). The Hunter Water pipeline is buried within a trench that traverses the site (see **Plan 2**).

Several feeds to property services exist, including a water main on the Catholic Diocese land that supplies dwellings and the livestock watering system.

### 8.5.4 Electricity Transmission Lines

Five 330kV Transgrid Transmission towers, 26B to 30B. The towers already have cruciform footings installed in the early 1980’s in anticipation of substantial mine subsidence impacts from another proposed mine (which was never developed). Transgrid have confirmed that the cruciform foundations appear adequate for the predicted levels of subsidence (including strain & tilt).

A 132kV Energy Australia Transmission Line with seven pairs of timber power poles (EA8 to EA14) which will be within the zone of mine subsidence. The pole pairs are unguyed, approximately 15 m high and 5 m apart and are connected by a bolted, galvanised steel brace between the top section of the poles.

Domestic 11 kV and 415V transmission lines suspended on twenty three timber poles (Energy Australia).

### 8.5.5 Telecommunication Lines

An Optus fibre optic cable is buried within a shallow trench located within the Transgrid Powerline easement (see **Plan 2**).

Domestic buried copper cable telephone lines to the residences along Black Hill Road (Telstra).

Redundant Telstra domestic buried copper telephone lines approximately 1.5 km long formerly servicing the disused poultry farms on the Catholic Diocese land (see Plan 2).

*Note : This local cable reticulation was used when the property was functioning as a chicken farm and the cable provided services to the individual properties located on the land. It has not been used for some time and the cable has fallen into disrepair due to lack of maintenance.*

### 8.5.6 Farm Buildings / Sheds

Various outbuildings associated with both Principal and Other Surface Structures within SMP Area 2.

Demolished chicken battery farm shed rubble and disused houses/buildings (Catholic Diocese Land).

### 8.5.7 Rural Fences

Various rural type fences throughout SMP Area 2 including boundary fences between the neighbouring landholders, internal fences for stock control and boundary fences between the landholders and public roads.

### 8.5.8 Farm Dams

Several abandoned earth embankment dams with < 1ML capacity (Black Hill Land Pty Ltd and Catholic Diocese Land). The dams have been filled in and are dry.

Several earth embankment dams with < 1ML capacity (Private Residences). The dams are generally full of water (except for one dam with numerous piping failures) and used for stock watering.

### 8.5.9 Catholic Diocese Maitland – Newcastle Water Reticulation System

Buried water reticulation pipelines and above ground troughs for livestock watering and supply to Principal and Other Surface Structures (Catholic Diocese Land). This is a critical water supply for the Catholic Diocese Land.

### 8.5.10 Aboriginal Places, Archaeological and Heritage Sites

Reference to three separate studies of the area (**Parsons Brinkerfhoff, 2003**, **South Eastern, 2006** and **ERM, 2008)** have identified two scattered Aboriginal artefact sites in SMP Area 2 (see **Plan 2**). The artefacts are listed as silcrete stone axe flakes and were identified by the Mindaribba Local Aboriginal Land Council.

The two scattered artefact sites identified within SMP Area 2 are located within the Subsidence Control Zone (SCZ) associated with Viney Creek.

Further artefact sites may be present along Viney Creek which have yet to be identified (**ERM, 2008**). It is very unlikely that any unidentified sites located above Viney Creek will be affected or damaged by subsidence impacts such as surface cracking and increased erosion rates as Viney Creek is located within a Subsidence Protection Zone.

### 8.5.11 Permanent Survey Control Marks

Two Permanent Marks (PMs) 113285 and 113293 are located within SMP Area 2 (see **Plan 2**). Notification will be provided to LPI prior to the commencement of mining followed by further notification of completion of subsidence.

### 8.5.12 Houses

Three Principal Residences and associated Other Surface Structures south of Black Hill Road on rural residential zoned land (privately owned). The associated structures include sheds, cottages, above ground concrete water tanks, in-ground septic tanks and on-site effluent disposal fields.

One Principal Residence and other structures within the proposed Catholic School (which is located on the south-eastern section of Lot 131 DP 1057179).

Additional buildings within the proposed high school site include;

- Small single storey, full-Masonry Office Building on raft slab (currently used as an office/amenities facility by the Catholic Diocese)
- Large single storey shed on raft slab (currently used as a storage facility by Catholic Diocese)

A second Principal Residence is within the Catholic Diocese Land but not within SMP Area 2.

Two Non-Principal Residences and various out buildings (defined in the Project Approval as “All Other Surface Structures” (Catholic Diocese Land). These include

- Two storage buildings
- Garage/kit home
- Storage building on the central road.
- Building Farm 15

## 8.6 AREAS OF ENVIRONMENTAL SENSITIVITY

**Section 6.6.3** of the **SMP Guideline 2003** sets out a list of potentially environmentally sensitive areas that must be assessed as part of the SMP application. In **Table 18** below each item has been assessed with respect to the Abel SMP application area.

**Table 18 - Assessment of Environmental Sensitivity**

| Item | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Land reserved as State Conservation Area under National Parks and Wildlife Act 1974 (NPWA74) | Reviewed National Parks database.<br>Also Industry & Investment | Nil |
| 2 | Land reserved as an Aboriginal Place under NPW Act 74 | Review of Archaeological reports | Nil |
| 3 | Land identified as wilderness by the Director NPWS under the Wilderness Act 1987 | Reviewed National Parks database | Nil |
| 4 | Land subject to a conservation agreement under NPWA74 | Historic Knowledge, title search | Nil |
| 5 | Land acquired by Minister for the Environment under Part 11 NPWA74 | Reviewed National Parks website. | Nil |
| 6 | Land within State Forests mapped as Forestry Management Zones 1, 2 or 3 | No State Forests in SMP Area 2 | Nil |
| 7 | Wetlands mapped under SEPP14 – Coastal Wetlands | Internet search | Nil |
| 8 | Wetlands listed under the Ramsar Wetlands Convention | Website, internet search | Nil |
| 9 | Lands mapped under SEPP 26 – Coastal Rainforests | Website, internet search | Nil |
| 10 | Areas listed on the Register of National Estate | Reviewed by internet search | Nil |
| 11 | Areas listed under the Heritage Act 1977 for which a plan of management has been prepared | Reviewed Australian Heritage Register | Nil |
| 12 | Land declared as critical habitat under the Threatened Species Conservation Act 1995 | Reviewed NSW NPWS website | Nil |

| Item | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 13 | Land within a restricted area prescribed by a controlling water authority | Enquiry to Hunter Water Corporation | Nil |
| 14 | Land reserved or dedicated under the Crowns Land Act 1989 for the preservation of flora, fauna, geological formations or other environmental protection purposes | Government Gazette searches | Nil |
| 15 | Significant surface watercourses and groundwater resources identified through consultation with relevant government agencies | Aerial photos, topo maps, some ground truthing. | Viney Creek (Schedule 2) |
| 16 | Lake foreshores and flood prone areas | Cessnock and Newcastle City Council LEP | Yes |
| 17 | Cliffs, escarpments and other significant natural features | Aerial photographs, topographical maps, ground truthing | Nil in SMP Area 2 |
| 18 | Areas containing significant ecological values | Internet searches, review of websites. Also as part of other reviews within this section | Nil |
| 19 | Major surface infrastructure | Aerial photographs, topographical maps, ground truthing | None that were not previously identified |
| 20 | Surface features of community significance (including cultural, heritage or archaeological significance) | Reviewed by archaeological survey. Aerial photos, ground truthing | Nil |
| 21 | Any other land identified by the Department to the titleholder | | Nil |

# 9 BASELINE DATA AND MONITORING

Various monitoring programs have been conducted since Abel commenced production. Refer to **Figure 6** for location of current monitoring sites within and adjacent to the SMP application area. Monitoring programs currently in place are described in Sections 9.1 to 9.5.

## 9.1 SUBSIDENCE

No subsidence monitoring has been conducted within SMP Area 2. A subsidence Monitoring Program will be developed in consultation with the Principal Subsidence Engineer. Subsidence Monitoring Programs have been developed, approved, installed and are currently being monitored for Panels 1 to 4 inclusive in SMP Area 1. Information obtained from this monitoring is reviewed and the available information has been summarized in the subsidence predictions for SMP Area 2. The subsidence model is continually updated and reviewed as additional monitoring information becomes available.

## 9.2 WATER

The location of the water quality sampling locations is shown on **Figure 6**.

Analytes measured in the laboratory include pH, Electrical Conductivity (EC), Total Dissolved Solids, Total Suspended Solids (TSS), Chloride, Sulfates, Alkalinity (Bicarbonate), Alkalinity (Carbonate), Calcium, Magnesium, Sodium and Potassium. Data for the main watercourses within the Abel underground mine area is presented in **Table 19**. This data has been sourced from sampling undertaken as part of the Abel Project and routine sampling undertaken by Donaldson Mine.

**Table 19 - Background Surface Water Quality Data**

| Sample Site | | PH | EC μS/cm |
|---|---|---|---|
| Viney Creek | Max | 8.8 | 2,230 |
| | Min | 6.2 | 340 |
| | Average | 7.12 | 1252 |

## 9.3 GROUNDWATER

Ongoing groundwater quality and level monitoring is undertaken as part of the integrated network of monitoring bores for the Bloomfield, Abel, Donaldson and Tasman mines. Measurement of the quality and volume of inflow water to the underground workings is also undertaken. Results of the groundwater monitoring are shown in **Table 20.**

**Table 20 - Groundwater Sampling Results**

| Sample Site | ECµS/cm | | | pH | | |
|---|---|---|---|---|---|---|
| | **Max** | **Min** | **Mean** | **Max** | **Min** | **Mean** |
| Bartter South | 20,000 | 5,490 | 9,453 | 11.7 | 5.9 | 6.9 |
| Barter North | 14,400 | 6,710 | 10,559 | 13.0 | 7.0 | 10.0 |
| Bore 1 (Panel 1 shallow piezometer) | 19,700 | 12,400 | 16,050 | 7.05 | 7.0 | 7.03 |
| Bore 2 (Panel 2 shallow piezometer) | 17,400 | 12,600 | 14,450 | 7.24 | 6.81 | 7.0 |
| Panel 3 Development Heading | 3,025 | 2,990 | 3,010 | 8.0 | 7.9 | 8.0 |

**Groundwater Levels**

Groundwater levels are monitored approximately monthly in all piezometers on the Abel project area. Overall, there are almost 14 years of relevant groundwater level monitoring records extending from July 1997 to the present time. The earliest records were collected during the pre-project investigations for the adjacent Donaldson mine in 1997. Routine monthly monitoring at Donaldson commenced in 2000, prior to the commencement of mining in the Donaldson open cut in January 2001.

Monitoring of groundwater levels near current Abel underground workings have recently been enhanced with the addition of two piezometers targeted at monitoring early mine development. Two multi level vibrating wire piezometers were installed during 2010 to monitor the impacts of early coal extraction. The locations of these bores are shown in Figure 6 with Piezo 1 (C257) adjacent to Panel 1 and Piezo 2 (C262) adjacent to Panel 2.

The impact on water levels from the extraction of Panel 1 is shown in Figure 27a of Appendix A. Vibrating wire piezometers transducers are located at 30, 50 and 70 m below ground level. Piezometers located at 30 and 50 m depth are within overburden above the Upper Donaldson seam. The piezometer at 50m depth shows depressurisation as the panel progresses with dewatering occurs at this horizon. The reaction of groundwater pressures at shallow levels (30m) is subdued by comparison and although depressurisation occurs, the strata at this level remains saturated indicating that there is no direct connection with deeper, however depressurisation continues to occur. The piezometer at 70 m is installed within the Upper Donaldson Seam and indicates that the strata at mining levels has been summarized although the seam remains partially saturated due to the location of the monitoring bore on the down dip side of Panel 1.

The impact on water levels from the extraction of Panel 2 is shown in Figure 27d of Appendix A. Vibrating wire piezometers transducers are located at 35, 55 and 75 m below ground level with piezometers at 35 and 55 m depth located within Permian/

overburden above the Upper Donaldson seam while the piezometer at 75 is within the Upper Donaldson seam.

The response to panel progression can be seen with completed depressurisation of the Upper Donaldson seam as the panel extraction passes the location of C262. The uppermost transducer shows a slightly delayed response to extraction and associated subsidence. Although the stratum at 30 m depth has been dewatered, the timing of dewatering is delayed in comparison to the deeper strata at 50m depth indicating that although there is a connection with deeper mining levels, the connection is not direct.

The piezometer at 70 m is installed below the Upper Donaldson Seam indicates that the strata remains saturated although depressurisation continues to occur following completion of Panel 2.

Impacts on groundwater levels to date are limited to areas at close proximity to mining. No impact from mining activities at Abel Underground Mine has been seen at other monitoring locations within the local and regional monitoring network.

**Groundwater Quality**

Groundwater quality across the area is variable, both in terms of key field parameters such as salinity and pH, and also in terms of major and minor hydrochemical constituents.

The groundwater in much of the coal measures aquifer system is saline. Typical salinities range from around 3,000 μS/cm EC (electrical conductivity) to more than 27,000 μS/cm EC within some of the less permeable Permian overburden layers. The salinity of groundwater sampled from within the Abel Underground Mine is variable (PDA 2006, Aquaterra 2008), with total dissolved solids (TDS) ranging from less than 500 mg/L to 16,000 mg/L.

Recent groundwater inflow into Panel 3 during heading development shows that initial water quality parameters have remained relatively consistent with electrical conductivity in the range of 2,500 – 3,500 μS/cm and pH in the range of 7.8 – 8.2.

Because salinity is often high in the colluvium, salinity in the creeks is highly variable. During periods of high runoff, salinity can be very low (<300mg/l TDS). However, during dry periods, shallow groundwater seepages (often from temporary, perched regolith aquifers) can increase creek salinities to higher levels, with values of between 1,000 and 15,000mg/L TDS (recorded in Four Mile Creek). Because of this high variability in surface water flow rates and quality, and the presence of high salinity in the shallow colluvium, salinity is not generally a good indicator of the degree of connectivity between surface water systems and deeper regional groundwater in this case.

## 9.4 FLORA

A program of vegetation monitoring has been introduced to assist in determination of the environmental effect of the mining operation on vegetation.

## 9.5 FAUNA

Long term fauna monitoring sites have been established to identify impacts (if any) of mining induced subsidence on native fauna.

## 9.6 MINE WATER MAKE

Pumping quantities from various mine pump lines are currently monitored with some water recycled for use within both the mine surface and underground in accordance with the approved Water Management Plan.

All underground water is pumped to a sump in the Abel Mine box cut. Excess water from here is pumped to the Big Kahuna Dam (surface water dam located within ML 1461 for the Donaldson mine) for re use.

Although the current mine water make at the Abel mine shows a minor variation compared to that predicted at the time of the preparation of the Water Management Plan, the analysis contained in the Plan indicates that the overall system is capable of accommodating such variation without detracting from the objectives of providing a reliable supply for mining and CHPP operations as well as the discharge to the environment.

Groundwater is currently pumped from the mine at a rate of approximately 1.0 to 1.5ML/day.

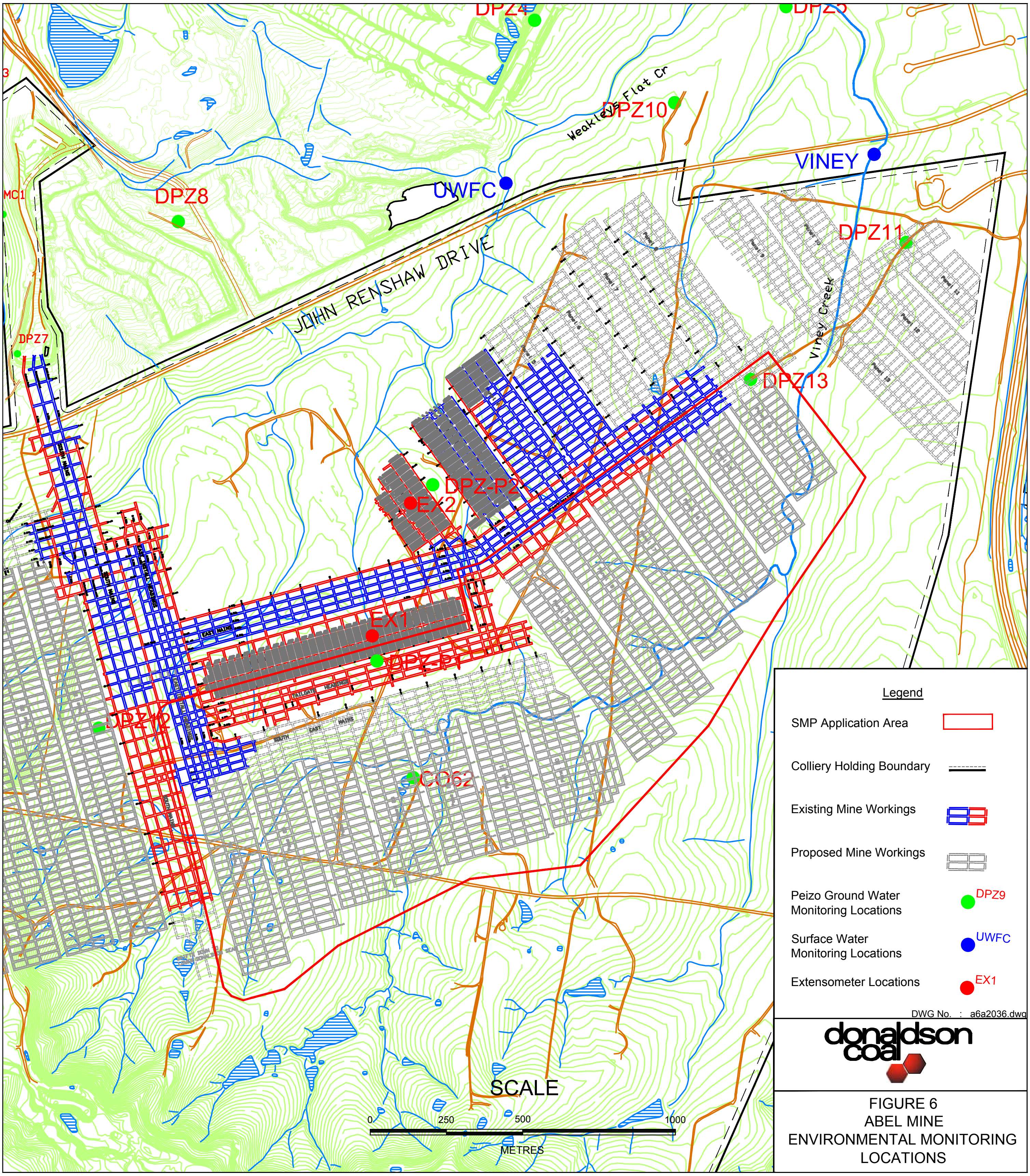



FIGURE 6
ABEL MINE
ENVIRONMENTAL MONITORING
LOCATIONS

# 10 SUBSIDENCE PREDICTIONS

## 10.1 GENERAL DESCRIPTION OF SUBSIDENCE FEATURES

Following is a general description of the type of subsidence effects associated with both development and pillar extraction mining within the SMP application area.

Development headings are first workings, involving the formation of a series of headings (tunnels) driven up to 5.5 metres wide and up to 2.6m in height. Development headings are designed to remain stable for extended periods of time. Consequently, no collapse of overlying rock strata into the area from which coal is extracted is anticipated. Subsequently, there are no subsidence impacts from first workings.

Pillar extraction mining within the SMP application area involves the progressive removal of substantial portions of the coal seam (the pillars formed during development), creating a void up to 160.5 metres wide (Panels 14-26). The extraction of this coal, and subsequent collapse of the immediate overlying strata, results in surface subsidence. Subsidence of the ground surface normally occurs to an extent less than the extracted seam thickness. The extent of the subsidence depends on a number of factors including the height and width of the coal seam extracted, mining sequence, surface topography, characteristics of the overlying strata and the depth of mining.

In pillar extraction mining situations the roof is unable to support itself with the strata above subsequently fracturing and caving into the resultant void. The caved material fills the void (goaf) to a height dependent upon the bulking factor of the fractured / broken material, with the strata above lowering and settling onto the goaf. The settlement and bending of the strata to the surface is such that a subsidence trough develops that is wider than the area of coal that has been extracted.

The angle at which subsidence tapers out to the limit of subsidence at the surface is referred to as the angle of draw. The angle of draw is defined in the Department of Mineral Resources SMP Guideline 2003 as being 26.5 degrees from the vertical to the subsidence limit, which is taken to be a point where subsidence is equal to 20mm. This is also dependent on the strength of the strata, the lithology and other parameters. The angle of draw observed for the first four panels extracted in Area 1 has ranged from 0 degree to 24 degrees (mean 8 degrees).

### 10.1.1 Subsidence Parameters

Key parameters used in the description, prediction and assessment of surface movements resulting from underground mining are:

- Subsidence;
- tilt;
- strain;
- closure;
- uplift / upsidence; and
- scarp development.

### Subsidence

The general term "subsidence" is commonly used to describe the overall occurrence of ground movement as a result of mining. Vertical subsidence is actually the vertical distance (usually measured in millimetres) that the ground surface lowers as a result of mining. Maximum subsidence generally occurs within the central portion of the depression in the surface profile, which occurs over the extracted panel or panels.

Ground strains and tilt are more critical parameters in terms of effects on watercourses, cliffs, rock formations, buildings or other surface infrastructure.

## Tilt

As noted above, subsidence develops in a typical profile that generally results in the land surface having different degrees of vertical subsidence. Tilt is calculated as the difference in subsidence between two points on the land surface, divided by the distance between those two points (that is, the change in slope of the surface landform as a result of mining). The maximum tilt, or the steepest portion of the subsidence profile, occurs at the point of inflection in the subsidence trough where the subsidence is roughly equal to one half of the maximum subsidence. Tilt is usually expressed in mm/m. The Mine Subsidence Board (1991) indicates that the surface features that are most likely to be affected by tilts are tall structures and structures that are dependent on gravity to operate such as gutters, drains, sewers and water and sewerage works.

## Strain

Strain is determined by calculating the horizontal change in length of a section of land surface and dividing this by the horizontal length of that section. The length of land (bay length) is also typically one twentieth of the depth of cover. If the section has been lengthened, the ground is in tension, referred to as tensile strain. Alternatively, if the section has been shortened, the ground is in compression, referred to as compressive strain. The unit adopted for strain is mm/m. The maximum strains coincide with the maximum curvature of the profile and hence the maximum tensile strains occur over the side of the panel whilst the maximum compressive strains occur towards the bottom of the subsidence profile.

## Closure

Closure is often associated with valley bulging, particularly in deep, steep sided valleys. Closure refers to the measured horizontal displacement of the flanking ridges towards the centre of the valley.

With predicted subsidence some closure is anticipated, however it will not be perceptible nor have a significant impact due to the nature of the ephemeral watercourses and topography.

## Uplift / Upsidence

Where a valley is undermined it is often observed that the valley floor subsides less than the surrounding ridge tops. This is known as bulging. While this term implies that the ground experiences an upward vertical movement, the normal vertical movement is still generally downwards. The difference in subsidence between the ridge top and floor in these cases is called “uplift”. In extreme cases the valley floor may actually rise rather than subside and the rise in the ground surface is known as “upsidence”.

## Scarp Development

Scarps refer to small steps in the surface that are the result of sub-vertical shear failure above the limits of total extraction and solid or partial extraction boundaries.

## 10.2 SUBSIDENCE PREDICTION METHOD AND ASSESSMENT CRITERIA

Due to the variability in rock strata composition, strength and behaviour, all subsidence assessments / predictions involve estimations based on historical data (empirical method) and may involve computer based mathematical modeling. Empirical subsidence estimation methods have been extensively documented and the accuracy of this method has been demonstrated, by monitoring to be in the order of +/-10%.

The following information was provided by the mine to Ditton Geotechnical Services Pty Ltd for the subsidence study:

- The proposed mining layout.
- Cover depth contours to the Upper Donaldson Seam and seam thickness isopachs.
- Borehole log and core testing data from the SMP Area.
- Geological structure (fault and dyke) locations.
- Surface topographic levels and existing drainage regime locations.
- Locations of surface developments and infrastructure in the study area.
- Locations of Aboriginal Artefact Scatter sites.
- Subsidence monitoring results from Panels 1-4 in SMP Area 1

Plans of the proposed mining layout with cover depth contours, seam thickness isopachs and pre-mining surface topography are presented in **Figures 1** to **3** of **Appendix A**.

Bore core log and testing data from various boreholes were also included in this assessment.

The subsidence study, conducted by Ditton Geotechnical Pty Ltd (Ditton), included the following activities and the application of several industry established empirical models to predict the ‘mean’ and ‘credible worst-case’ subsidence for a given mining layout:

- Development of a geotechnical model for the study area (i.e. mining geometry, geology, material properties etc).
- Calculation of maximum subsidence impact parameter predictions and representative parameter profiles using the **ACARP, 2003** and **Holla, 1987** empirical subsidence models and the mining geometries proposed.
- Assessment of barrier and chain pillar stability, based on **ACARP, 1998a** and **ACARP, 1998b.**
- Development and calibration of **SDPS®** models (using the subsidence, tilt and strain profiles from above) to generate subsidence and associated impact parameter contours above the proposed mining layouts.
- Generation of subsidence, tilt, strain, horizontal displacement, post mining topography, potential cracking width, ponding location and surface slope gradient

change contours for the proposed mining layouts using **Surfer8®** contouring software.

- Estimation of sub-surface fracturing heights above the panels using empirically based models in **ACARP, 2003, Forster, 1995** and **Mark, 2007**.

- Estimation of the extent and magnitude of far-field displacements (FFD) and strains (FFE), based on empirically based models developed from Newcastle Coalfield data by **DgS, 2008**.

The two subsidence predictions models used in this study are summarized below:

- **ACARP, 2003** – An empirical model that was originally developed for predicting maximum single and multiple longwall panel subsidence, tilt, curvature and strain in the Newcastle Coalfield. The model database includes measured subsidence parameters and overburden geology data, which have been back analysed to predict the subsidence reduction potential (SRP) of massive lithology in terms of 'Low', 'Moderate' and 'High' SRP categories.

- The model database also includes chain or barrier pillar subsidence, inflexion point distance from panel edges, inflexion point subsidence, goaf edge subsidence and angle of draw prediction models. These models allow subsidence profiles to be generated for any number of panels within a range of appropriate statistical confidence limits. The mean and Upper 95% Confidence Limit (U95%CL) values have been adopted in this study for predictions of the average and Credible Worst-Case values expected, due to the proposed mining activities.

The **ACARP, 2003** model may also be used for predicting maximum subsidence above pillar extraction panels by applying the 'effective' mining height principal (i.e. extraction ratio x mining height) defined in **Van de Merwe and Madden, 2002**. The principle allows for subsidence reducing effect of crushed out remnant coal that will be left behind in the workings.

Based on a comparison between high extraction panel and longwall panel subsidence databases in **ACARP, 2003** and **Holla, 1987**, a conservative extraction ratio of 95% and a maximum longwall panel subsidence of 58% of the mining height, give a maximum pillar extraction panel subsidence of 55% of the mining height for supercritical panels.

It is also apparent from mining experience in Panels 1 and 2 in the Stage 1 SMP Area that additional stooks have been left to support mine roof where sub-vertical faults have intersected the workings. The stooks at these locations are estimated to have decreased maximum subsidence to a range of 40% to 44% of the mining height with panel extraction ratios of approximately 75% to 85%.

A summary of the **ACARP, 2003** model, which defines the parameters and terms used, is presented in the report Appendices.

- **SDPS®, 2007** – A US developed (Virginia Polytechnical Institute) influence function model for subsidence predictions above longwalls or pillar extraction panels. The model requires calibration to measured subsidence profiles to reliably predict the subsidence and differential subsidence profiles required to assess impacts on surface features.

- The model also includes a database of percentage of hard rock (i.e. massive sandstone / conglomerate) that effectively reduces subsidence above super-critical and sub-critical panels, due to either bridging or bulking of collapsed material. An extract from the **SDPS®** user manual defining the parameters and terms used is presented in the report appendices.

Overall, the SDPS® model should preferably be calibrated to measured subsidence profiles above pillar extraction workings with similar conditions as Abel. However, due to the lack of similar mining data, the calibration procedure applied in this study is considered best practice for a 'green fields' study. A re-calibration of the model may be necessary, however, if the predicted outcomes of this study are significantly different to measured ones.

The modifications to the **ACARP, 2003** model by DgS included adjustments to the following key parameters, which were made to improve compatibility between the two models used in this study:

- Chain (and barrier) pillar subsidence prediction is now based on pillar subsidence over extraction height ($S_p/T$) v. pillar stress (under double abutment loading conditions).

- Distance of the inflexion point from rib sides and inter-panel pillars in similar terms to **SDPS®** software (i.e. d/H v. W/H).

- The horizontal strain coefficient ($\beta_s$) is the linear constant used to estimate strain based on predicted curvature, and is equivalent to the reciprocal of the neutral axis of bending, $d_n$ used in **ACARP, 2003**. Based on NSW coalfield data, a value of $d_n$ = 7.3 m or a $\beta_s$ = 0.136 $m^{-1}$ has been applied to predict 'smooth' profile strains using the calibrated **SDPS®** model.

Multiple-panel effects are determined by the **ACARP, 2003** model by adding a proportion of the chain (or barrier) pillar subsidence to the predicted single panel subsidence. Estimates of first and final subsidence above a given set of pillar extraction panels use this general approach. The definition of First and Final $S_{max}$ is as follows:

First $S_{max}$ = the first maximum subsidence after the extraction of a panel, including the effects of previously extracted panels adjacent to the subject panel;

Final $S_{max}$ = the final maximum subsidence over an extracted panel, after at least three more panels have been extracted, or when mining is completed.

First and Final $S_{max}$ for a panel are predicted by adding 50% and 100% of the predicted subsidence over the respective barrier pillars (i.e. between the previous and current panel), less the goaf edge subsidence (which occurs before the barrier pillar is loaded from both sides). The maximum subsidence is limited to 58% of the effective mining height for the panels.

The subsidence above barrier pillars has been defined in this study as follows:

First $S_p$ = first subsidence over a barrier pillar after panels have been extracted on both sides of the barrier pillar;

Final $S_p$ = the final (total) subsidence over a barrier pillar after at least another three more panels have been extracted, or when mining is completed.

A conceptual model of the multiple panel subsidence mechanism is given in **Figure 4a of Appendix A**.

Residual subsidence above chain (and barrier) pillars and extracted panels tend to occur after mining of adjacent panels due to (i) increased overburden loading on the pillars, and (ii) on-going goaf consolidation or creep of the collapsed roof or goaf in the panel. The residual movements can increase subsidence by a further 10 to 30% above chain (and barrier) pillars after the first pillar subsidence occurs. Residual subsidence is likely to decrease exponentially as mining moves further away from a given panel.

A subsidence increase of 20% after double abutment loading occurs (i.e. First $S_p$) has been assumed in this study to allow for long-term loading effects (i.e. Final $S_p$).

Unless otherwise stated the predicted values presented in the following sections of this report are given as a range from the mean to the U95%CL values. The measured subsidence will be expected to be somewhere between these values.

Tilts and curvatures have been assessed using the empirical techniques presented in **ACARP, 2003** and by also taking first and second derivatives of the predicted subsidence profiles for comparative purposes.

Predictions of strain and horizontal displacement were made based on the relationship between the measured curvatures and tilt respectively as discussed in **ACARP, 1993** and **ACARP, 2003**.

Structural and geometrical analysis theories indicate that strain is linearly proportional to the curvature of an elastic, isotropic bending 'beam'. This proportionality actually represents the depth to the neutral axis of the beam, or in other words, half the beam thickness. **ACARP, 1993** studies returned strain over curvature ratios ranging between 6 and 11 m for NSW and Queensland Coalfields. Near surface lithology strata unit thickness and jointing therefore dictate the magnitude of the proportionality constant between curvature and strain. Similar outcomes are found for tilt and horizontal displacement.

**ACARP, 2003** continued with this approach and introduced the concept of secondary curvature and strain concentration factors due to cracking. The mean peak strain / curvature ratio for the Newcastle Coalfield was assessed to equal 5.2 m with strain concentration effects increasing the 'smooth-profile' strains by 2 to 4 times. A review of the local strain database for Area 1 Panels at Abel has lead to the value of 10.0 being adopted as a more appropriate value for impact prediction purposes.

A $d_n$ value of 10 m has therefore been applied to the predicted 'smooth' curvature and tilt profiles to estimate strain and horizontal displacement respectively above the proposed Abel panels in Area 2. These values may then be compared to the empirical model outcomes to estimate localised, concentrated strain effects due to cracking. Cracking is expected to occur in zones of peak tensile (or compressive) strains when tensile and compressive strains exceed 1 to 3 mm/m respectively and where surface rock exposures are present.

For the Abel mining lease, the presence of deep alluvial soils are likely to reduce the potential for strain concentration, resulting in strain profiles close to the predicted 'smooth' subsidence profile strains presented herein.

Surface crack widths (in mm) may be estimated by multiplying the predicted strains by 10 which is an empirical relationship based on the distance between the pegs in the **ACARP, 2003** model database and the measured strains and crack widths above extracted panels.

## 10.3 PREDICTED SUBSIDENCE PARAMETERS

### Introduction

The SMP application area (SMP Area 2) is that area considered as likely to be affected by the mining of Panels 14 to 26 inclusive plus the South East Mains and Tailgate Headings in the Upper Donaldson seam at Abel mine. SMP Area 2 is defined as the surface area enclosed by a 26.5 degree angle of draw from the limit of proposed mining as defined in **Section 6.2** in the SMP Guideline 2003.

The proposed panel layout, the SMP application area and the 20mm subsidence contour are shown on **Plan 1**.

The following sections describe the detailed subsidence predictions that have been made for Panels 14 to 26 inclusive, plus the South East Mains, East Install Headings and Tailgate Headings, and include predicted subsidence parameters for all significant natural and man – made features within SMP Area 2. The predicted subsidence parameters outlined have been used in completing the subsidence impact assessments listed in **Section 11** of this document.

## 10.4 PREDICTED SUBSIDENCE PARAMETERS AREA 2

Subsidence predictions within the SMP application area have been provided by Ditton Geotechnical Services and a summary is provided for easy reference. Further detail can be found in **Appendix A.**

The pillar extraction panels will have cover depths ranging from 100 m to 150 m and average mining heights ranging from 1.8 to 2.8 m. The East Install, South East Mains and Tailgate Headings will also be extracted on retreat after the production panels are completed. The mining height in the main headings panels will range from 2.0 m to 2.8 m.

Panel development headings will be 5.5 m wide and range from 2.2 m to 2.6 m high (depending on seam thickness).

Barrier pillars between production panels will generally have widths of 24.5 and pillar width/height ratios of 9.4 to 11.1 and are expected to behave elastically in the long term (i.e. strain hardening characteristics are likely to develop if the pillars are overloaded).

A solid barrier between the finishing ends of the production panels and the adjacent East Mains, East Install and South East Mains will be 21.5 m to 37.8 m wide with pillar width/height ratios of 8.3 to 14.5.

Barrier pillars between Panel 1, Tailgate Headings and South East Main Headings will have widths of 16.3 m and 21m with pillar width/height ratios of 6.3 and 8.1 respectively. These pillars are also expected to behave elastically in the long term due to their strain hardening characteristics.

The overburden comprises thinly bedded sandstone, siltstone and mudstones (shale) of the Dempsey Formation, which is part of the Permian Aged Tomago Coal Measures. A persistent geological structure (reverse fault) with an 8 m throw intersects the eastern SMP area on a north westerly strike.

The panel width to cover depth (W/H) ratios for the proposed 160.5 m wide pillar extraction panels 14 to 26 will range from 0.90 to 1.97, indicating ‘critical’ to ‘supercritical’ subsidence behaviour, which are assumed to occur when panel W/H ratios are > 0.6 and >1.4 respectively.

The panel width to cover depth (W/H) ratios for the Tailgate Headings, East Mains and South East Mains will range from 0.90 to 1.46, indicating critical overburden behaviour in regards to subsidence development.

The following subsidence effect parameters for all of the proposed pillar extraction panels are predicted (**Table 21)**:

- First Panel and Final maximum panel subsidence ranging from 0.75 m to 1.45 m (28% to 55% of the average mining height).
- First and Final barrier pillar subsidence ranges from 0.03 m to 0.17 m due to total pillar stresses after mining of 3.9 MPa to 11.7 MPa. The post mining factors of safety (FOS) for the barrier pillars are estimated to range from 2.34 to 24.1 and likely to behave elastically in the long term.
- Final maximum panel tilt ranges from 14 mm/m to 36 mm/m.
- Final maximum panel hogging curvature ranges from 0.51 $km^{-1}$ to 1.89 $km^{-1}$.
- Final maximum panel sagging curvature will range from 0.65 $km^{-1}$ to 2.39 $km^{-1}$.
- Final tensile strains associated with the hogging curvatures will range from 5 mm/m to 19 mm/m.
- Compressive strains associated with the sagging curvatures will range from 7 mm/m to 24 mm/m.
- Final maximum panel horizontal displacement from 140 mm to 360 mm.
- Final goaf edge subsidence ranging from 35 mm to 170 mm.
- Distance from goaf edges to maximum panel tilt (inflexion point) ranges from 16 m to 50 m.
- The angle of draw to the 20 mm subsidence contour ranges from 7 degrees to 21 degrees.
- Predictions of subsidence development curves for 10 m/week, 30 m/week and 50m/week have been derived using the dynamic subsidence analysis module provided in the SDPS program.

The predicted curves are consistent with the measured curves for SMP Area 1 panels 1 to 4 in regards to subsidence development, and indicate that 90% to 95% of First maximum panel subsidence will occur within 4 to 6 weeks after undermining, depending on the inevitable variation in retreat rates that will occur during second workings.

**Table 21 - Maximum Predicted Subsidence Parameters**

| Parameter | SMP Area 2 |
|---|---|
| Depth Range (m) | 100 –150 |
| Panel Width (m) | 89 / 140 / 160.5 |
| Panel W/H Ratio Range | 0.90 to 1.97 |
| Maximum Subsidence (mm) | 750 to 1,450 |
| Barrier pillar subsidence (mm) | 30 to 170 |
| Horizontal Movements (mm) | 140 to 360 |
| Tensile Strain (mm/m) | 5 to 19 |
| Compressive Strain (mm/m) | 7 to 24 |
| Tilt (mm/m) | 14 to 36 |

## 10.5 PREDICTED SUBSIDENCE PARAMETERS SURFACE FEATURES

### 10.5.1 Natural Features

Subsidence predictions have been calculated for the natural features located within SMP Area 2 (**Table 22**). The general nature of the surface topography within the SMP application area at Abel means that the vertical subsidence, of itself, is of no particular significance. Generally vertical subsidence is imperceptible and does not impact significantly on gradients. The only gradient impact, ponding, is discussed in more detail in **Section 11.2**.

**Table 22 - Predicted Maximum Subsidence Parameters for Natural Features**

| Item | Location | Maximum Predicted Subsidence (mm) | Maximum Predicted Tilt (mm / m) | Maximum Predicted Tensile Strain (mm / m) | Maximum Predicted Compressive Strain (mm / m) |
|---|---|---|---|---|---|
| Watercourse – ephemeral tributaries | Panels 14 to 26 | 750 to 1,450 | 14 to 36 | 5 to 19 | 7 to 24 |
| Watercourses – Viney Creek | SCZ | Nil | Nil | Nil | Nil |
| Land prone to flooding | Panels 23 to 26 | 1,200 to 1,400 | 19 to 32 | 7 to 12 | 9 to 15 |
| Swamps, wetlands | Nil in area | Nil | Nil | Nil | Nil |
| Flora | Panels 14 to 26 | 750 to 1,450 | 14 to 36 | 5 to 19 | 7 to 24 |
| Fauna | | 750 to 1,450 | 14 to 36 | 5 to 19 | 7 to 24 |

### 10.5.2 Man – made Features

Subsidence predictions have been calculated for the man-made features located within SMP Area 2 (**Table 23**).

**Table 23 - Predicted Maximum Subsidence Parameters for Man-made Features**

| Item | Location (Panels) | Maximum Predicted Subsidence (mm) | Maximum Predicted Tilt (mm / m) | Maximum Predicted Tensile Strain (mm / m) | Maximum Predicted Compressive Strain (mm / m) |
|---|---|---|---|---|---|
| **Public Roads** | | | | | |
| Blackhill / Talyors | TG,SE, 23 - 26 | 570 to 1,390 | 7 to 30 | 8 to 12 | 5 to 10 |
| Fill / Culverts | 23, 25/26 | 100 to 770 | 6.5 to 23 | 1.5 to 12 | 0 to 2 |
| **Water Supply Lines** | | | | | |
| Hunter Water UPVC | TG,SE, 23 - 26 | 200 to 1,270 | 4 to 29 | 13 | 12 |
| **Electricity Transmission Lines** | | | | | |
| Transgrid 330kV towers | 16 - 20 | 0 to 1,450 | 0 to 43 | 19 | 16 |
| Energy Australia 132kV timber poles | 19, 22-24 | 0 to 1,080 | 0 to 25 | 10 | 9 |
| Energy Australia 11kV and 415V timber poles | TG, SE, 21 - 26 | 0 to 1,380 | 0 to 32 | 11 | 17 |
| **Telecomm Cables** | | | | | |
| Optus fibre optic | 16 - 20 To be relocated | 10 to 1,450 | 25 | 24 | 26 |
| Telstra copper | TG, SE, 23 - 26 | 750 to 1,450 | *14 to 36* | *5 to 19* | *7 to 24* |
| **Non - Principal Residences and Structures** | | | | | |
| Rental Properties | 24, 26 | 70 to 1,300 | 6 to 33 | 11 | 15 |
| Farm buildings / sheds | TG, SE, 24 - 26 | 70 to 810 | 9 to 26 | 3 to 11 | 0 to 15 |
| Rural fences | 14 - 26 | 0 to 1,450 | 0 to 36 | 0 to 19 | 0 to 24 |
| **Permanent Survey Control Stations** | 24,16 | 200 to 800 | 20 to 30 | 5 to 12 | |
| **Farm dams** | 23, 25, 26 | 400 to 1200 | 10 to 22 | 5 to 10 | 5 to 10 |
| **Catholic Diocese Maitland – Newcastle water reticulation system** | TG, SE, 23, 26 | 0 to 1,310 | 0 to 17 | 2 | 8 |
| **Aboriginal Places** | 19/20, 22 outside of subsidence area or within | <20 | *<1* | *<1* | *<1* |

| Item | Location (Panels) | Maximum Predicted Subsidence (mm) | Maximum Predicted Tilt (mm / m) | Maximum Predicted Tensile Strain (mm / m) | Maximum Predicted Compressive Strain (mm / m) |
|---|---|---|---|---|---|
| | SCZ | | | | |
| **Principal Residences plus other structures within Catholic Diocese Proposed High School Site** | | | | | |
| Principal residences | within SCZ | <20 | <2 | <2 | <2 |
| Other Surface Structures | within SCZ | <20 | <2 | <2 | <2 |

## 10.6 ESTIMATION OF THE RELIABILITY OF THE SUBSIDENCE PREDICTIONS

Though no subsidence monitoring or results is available for pillar extraction mining in the Abel SMP Area 2, substantial monitoring results are available for Panels 1, 2 and 3 in SMP Area 1 and substantial monitoring and subsidence history for this type of mining in similar conditions is available.

Several subsidence predictions models were used (see detail in **Section 10.2**) and based on a comparison between high extraction panel and longwall panel subsidence databases in **ACARP, 2003** and **Holla, 1987**, a conservative extraction ratio of 95% and a maximum longwall panel subsidence of 58% of the mining height, give a maximum pillar extraction panel subsidence of 55% of the average mining height. This equates to maximum predicted subsidence of 1,450mm. These models have been previously used with monitoring confirming subsidence and associated strains and tilts below predictions.

As noted earlier in the report, from mining experience in Panels 1 and 2 in SMP Area 1 that additional stooks (remnant pillar sections) have been left to support mine roof where sub-vertical faults have intersected the workings. The stooks at these locations are estimated to have decreased maximum subsidence to a range of 40% to 44% of the mining height with panel extraction ratios of approximately 75% to 85%.

## 10.7 VERIFICATION OF SUBSIDENCE PREDICTIONS

Subsidence monitoring from other mines in the Newcastle Coalfield, is presented in Holla (1991). Subsidence monitoring in the Abel SMP Area 1 has provided information on a panel by panel basis for site specific preliminary verification.

**Predicted v Measured Single Panel Subsidence Data for SMP Area 1 Panels 1 and 2**

As a model validation exercise for the above predictions, predicted values of subsidence for the SMP Area 1 Panels 1 to 4 have also been compared to the measured values. The results are also summarised in **Table 24**.

**Table 24 - Summary of Area 1 Predicted v. Measured Maximum Subsidence**

| Panel No. | Line/ Chain from start | Panel Width W (m) | Cover Depth H (m) | Panel W/H | Mining Height T (m) | Panel# e% | Predicted (mean -U95%CL) | | Measured | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Subsidence $S_{max}$ (m) | $S_{max}$/Te (m/m) | Subsidence $S_{max}$ (m) | $S_{max}$/Te (m/m) |
| 1 | CL 60 | 120 | 105 | 1.14 | 2.8 | 98 | 1.03 - 1.17 | 0.38 - 0.43 | 1.193 | 0.42 |
| | CL 137 | 120 | 100 | 1.20 | 2.8 | 93 | 0.85 - 0.96 | 0.33 - 0.37 | 0.788* | 0.30* |
| | CL 626 | 120 | 90 | 1.33 | 2.35 | 98 | 0.97 - 1.08 | 0.42 - 0.47 | 1.027 | 0.45 |
| | XL 275 | 120 | 98 | 1.22 | 2.35 | 98 | 0.91 - 1.00 | 0.40 - 0.45 | 0.99 | 0.43 |
| 2 | CL 75 | 150 | 67 | 2.24 | 2.5 | 92 | 1.29 - 1.33 | 0.56 - 0.58 | 1.004 | 0.44 |
| | XL 124 | 150 | 75 | 2.00 | 2.5 | 83 | 1.14 - 1.20 | 0.52 - 0.58 | 0.900 | 0.43 |
| 3 | CL 73 | 160.5 | 60 | 2.68 | 2.5 | 95 | 1.33 - 1.38 | 0.56 - 0.58 | 0.835 | 0.35 |
| | CL 260 | 160.5 | 78 | 1.89 | 2.5 | 95 | 1.33 - 1.38 | 0.56 - 0.58 | 0.933 | 0.39 |
| | XL 170 | 160.5 | 70 | 2.29 | 2.5 | 95 | 1.33 - 1.38 | 0.56 - 0.58 | 0.817 | 0.34 |
| 4 | CL 45 | 160.5 | 55 | 2.92 | 2.5 | 95 | 1.22 - 1.27 | 0.56 - 0.58 | 0.900 | 0.41 |

Notes:
# - e% = panel extraction ratio. Panel 1 had only one central row of 3 m wide (average) x 19 m long stooks. Panels 2 to 4 had 2 stook rows with additional stooks left adjacent to the fault through Panel 2.
* - subsidence in Panel 1 reduced by additional coal stooks left beneath a fault and where the Breaker Line supports were buried by a goaf fall.
**Bold** - Measured value exceeded predictions by > 10%.

The outcome of the subsidence review indicates that in general, the measured maximum subsidence values plot below the predicted upper 95% confidence limits for a given panel geometry; see **Figure 6b**.

The typical effective mining heights for Panel 1 were assumed to be 98% of the actual mining heights of 2.25 m to 2.8 m, due to the single row of remnant pillars (stook 'X') left in the goaf. The stooks have effectively reduced the available volume in which the fallen roof and crushed out remnant pillars could occupy, and is in proportion to the overall coal pillar extraction ratio for the panel (i.e. 98%). The typical effective mining heights for Panels 2 to 4 was assumed to be 95% of the actual mining heights of 2.25 m to 2.5 m, due to the two rows of remnant pillars (stook 'X') left in the goaf.

The measured subsidence for Panel 1 ranged between 30% to 45% of the effective mining height, and correlates well with the predicted mean and U95%CL range of 33% to 47% of the effective mining height.

The extra stooks left below the fault through Panel 1 (and where the BLS's were buried by an intersection roof fall) appear to have reduced subsidence by approximately 30%. The effective mining height at this location was 93% of the average mining height of 2.8 m.

The measured subsidence for Panel 2 ranged from 42% to 44% of the effective mining height, and appears to be significantly lower than the predicted mean and U95%CL range of 52% to 58% of the effective mining height, despite the allowance for the additional stooks that were required for roof control (the effective mining heights for the panel ranged from 83% to 92%).

A similar outcome has also been noted for the supercritical Panels 3 and 4, where measured subsidence has ranged from 35% to 41% of the effective mining heights significantly lower than the predicted values of 58% of the effective mining height.

Based on a review of the prediction model databases (**Holla, 1987** and **ACARP, 2003**), it is considered that the prediction models are conservative for supercritical panels where cover depths are relatively shallow (i.e. < 80 m). This is likely to be caused by significantly lower overburden pressures acting on the goaf, which has resulted in a reduced level of subsidence compared to the deeper panels.

It is however, not considered necessary to adjust the prediction models at this stage, as the prediction of tilt, strain and curvature have higher levels of uncertainty associated with the shallower cover depths.

Predicted values of maximum tilt for the SMP Area 1 Panels 1 and 2 have also been compared to the measured values in **Table 25**.

**Table 25 - Summary of SMP Area 1 Predicted v. Measured Maximum Tilts**

| Panel No. | Line/ Chain from start | Panel Width W (m) | Cover Depth H (m) | Panel W/H | Mining Height T (m) | Panel# e% | Predicted Tilts (mean - U95%CL) (mm/m) | Measured (mm/m) |
|---|---|---|---|---|---|---|---|---|
| 1 | CL 60 | 120 | 105 | 1.14 | 2.8 | 98 | 26 - 39 | **49.5** |
| | CL 137 | 120 | 100 | 1.20 | 2.8 | 93 | 20 - 30 | 27 |
| | CL 626 | 120 | 90 | 1.33 | 2.35 | 98 | 24 - 36 | 22 |
| | XL 275 | 120 | 98 | 1.22 | 2.35 | 98 | 22 - 33 | 34 - **42** |
| 2 | CL 75 | 150 | 67 | 2.24 | 2.5 | 92 | 47 - 70 | 44 |
| | XL 124 | 150 | 75 | 2.00 | 2.5 | 83 | 36 - 54 | 19 - 27 |
| 3 | CL 73 | 160.5 | 60 | 2.68 | 2.5 | 95 | 49 - 73 | 41 |
| | CL 260 | 160.5 | 78 | 1.89 | 2.5 | 95 | 43 - 64 | 29 |
| | XL 170 | 160.5 | 70 | 2.29 | 2.5 | 95 | 49 - 73 | 14 - 45 |
| 4 | CL 45 | 160.5 | 55 | 2.92 | 2.5 | 95 | 43 - 65 | 58 |

# - e% = panel extraction ratio. Panel 1 had only one central row of 3 m wide (average) x 19 m long stooks. Panels 2 to 4 had 2 stook rows with additional stooks left adjacent to the fault through Panel 2.
**Bold** - Measured value exceeded predictions by > 10%.

The outcome of the review indicates that 88% of the measured maximum tilts plot within the upper and lower 95% confidence limits for the predicted values. Predicted tilts were exceeded by 1.27 times the measured values at two locations (see below for further discussion).

Predicted values of maximum tensile and compressive strain for the Area 1 Panels 1 to 4 have been compared to the measured values in **Table 26**.

**Table 26 - Summary of Area 1 Predicted v. Measured Maximum Horizontal Strain Data**

| Panel No. | Line | Panel Width W (m) | Cover Depth H (m) | Panel W/H | Mining Height T (m) | Panel# e% | Predicted Strains^ (mean - U95%CL) | | Measured Strains | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Tensile $+E_{min}$ (mm/m) | Compressive $-E_{max}$ (mm/m) | Tensile $+E_{min}$ (mm/m) | Compressive $-E_{max}$ (mm/m) |
| 1 | CL 60 | 120 | 105 | 1.14 | 2.8 | 98 | 11 - 17 | 14 - 22 | 11 | 11 |
| | CL 137 | 120 | 100 | 1.20 | 2.8 | 93 | 9 - 14 | 12 - 18 | 4 | 5 |
| | CL 626 | 120 | 90 | 1.33 | 2.35 | 98 | 11 - 16 | 14 - 20 | 4 | 9 |
| | XL 275 | 120 | 98 | 1.22 | 2.35 | 98 | 10 - 15 | 13 - 19 | 8 | 11 |
| 2 | CL 75 | 150 | 67 | 2.24 | 2.5 | 92 | 20 - 30 | 25 - 38 | 6 | 9 |
| | XL 124 | 150 | 75 | 2.00 | 2.5 | 83 | 16 - 24 | 21 - 31 | 5 | 7 |
| 3 | CL 73 | 160.5 | 60 | 2.68 | 2.5 | 95 | 21 - 31 | 27 - 40 | 7 | 2 |
| | CL 260 | 160.5 | 78 | 1.89 | 2.5 | 95 | 21 - 31 | 24 - 36 | 8 | 6 |
| | XL 170 | 160.5 | 70 | 2.29 | 2.5 | 95 | 19 - 28 | 27 - 40 | n.a. | n.a. |
| 4 | CL 45 | 160.5 | 55 | 2.92 | 2.5 | 95 | 19 - 29 | 24 - 37 | n.a. | n.a. |

\# - e% = panel extraction ratio. Panel 1 had only one central row of 3 m wide (average) x 19 m long stooks. Panels 2 to 4 had 2 stook rows with additional stooks left adjacent to the fault through Panel 2.
**Bold** - Measured value exceeded predictions by > 10%.
^ - Strains calculated by multiplying predicted curvatures by 10.

To-date, maximum measured tensile and compressive strains above Panels 1 to 4 have ranged between +/- 11 mm/m, with local strains of up to 30 mm/m indicated by observed maximum crack widths of 180 mm (Panel 1), 50 mm (Panel 2) 260 mm (Panel 3), 300 mm (Panel 4).

Some compressive shear failures with associated uplift of 100 mm to 150 mm have also been observed above Panel 3.

Predicted values of goaf edge subsidence and angle of draw for the SMP Area 1 Panels 1 to 4 have also been compared to the measured values in **Table 27.**

**Table 27 - Summary of SMP Area 1 Predicted v. Measured Goaf Edge and AoD Data**

| Panel No. | Line | Panel Width W (m) | Cover Depth H (m) | Panel W/H | Mining Height T (m) | Panel# e% | Predicted Goaf Edge Subsidence and AoD (mean - U95%CL) | | Measured Goaf Edge Subsidence and AoD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $S_{goe}$ (m) | AoD (degrees) | $S_{goe}$ (m) | AoD (degrees) |
| 1 | CL 60 | 120 | 105 | 1.14 | 2.8 | 98 | 0.05 - 0.14 | 10 - 19 | 0.049 | 10 |
| | CL 861 | 120 | 85 | 1.41 | 2.25 | 98 | 0.04 - 0.10 | 8 - 16 | 0.050 | 8 |
| | XL 275 | 120 | 98 | 1.22 | 2.35 | 98 | 0.05 - 0.14 | 8 - 16 | 0.026 0.05 | 6 - **23** |
| 2 | CL 75 | 110 | 65 | 2.25 | 2.5 | 94 | 0.03 - 0.09 | 6 - 15 | 0.025 | 2 |
| | CL 264 | 160 | 85 | 1.88 | 2.5 | 88 | 0.04 - 0.10 | 7 - 16 | 0.05 | 7 |
| | XL 124 | 150 | 75 | 2.00 | 2.5 | 83 | 0.035 - 0.10 | 7 - 15 | *-0.035* 0.045 | 7 - 9 |
| 3 | CL 73 | 160.5 | 60 | 2.68 | 2.5 | 95 | 0.04 - 0.12 | 8 - 17 | 0.12 | 20 |
| | CL 260 | 160.5 | 78 | 1.89 | 2.5 | 95 | 0.04 - 0.12 | 8 - 17 | 0.036 | 3 |
| | XL 170 | 160.5 | 70 | 2.29 | 2.5 | 95 | 0.04 - 0.12 | 8 - 17 | 0.001 0.05 | 0 - 4 |
| 4 | CL 45 | 160.5 | 55 | 2.92 | 2.5 | 95 | 0.04 - 0.11 | 7 - 16 | 0.006 | 0 |

Notes:
AoD - Angle of draw to 20 mm subsidence contour.
# - e% = panel extraction ratio. Panel 1 had only one central row of 3 m wide (average) x 19 m long stooks.
Panels 2 to 4 had 2 stook rows with additional stooks left adjacent to the fault through Panel 2.
**Bold** - Measured value exceeded predictions by > 10%.
*italics* - negative goaf edge subsidence values indicate uplift.

The outcome of the review indicates that 100% of the measured goaf edge and angle of draw (to 20 mm subsidence) plot within the upper and lower 95% confidence limits for the predicted values.

The measured goaf edge subsidence has ranged from 35 mm of uplift to 120 mm with angles of draw to the 20 mm subsidence contour ranging between $0^o$ and $24^o$ (mean of $8^o$).

Overall, it is assessed that the **ACARP, 2003** model with the inclusion of the effective mining height, is likely to provide reasonably reliable subsidence impact parameter predictions for the Area 2 Panels.

# 11 SUBSIDENCE IMPACTS AND MANAGEMENT STRATEGIES

## 11.1 DESIGN OF SUBSIDENCE CONTROL ZONES

### 11.1.1 General

The design of a reliable Subsidence Control Zone (SCZ) will require consideration of the following issues:

- The minimum set-back distance from high pillar extraction panels (i.e. panels with > 85% of coal extracted) to control subsidence deformation to below tolerable design limits for the feature.
- The long-term stability of the pillars in the SCZ under abutment loading conditions from adjacent high extraction areas.
- The use of narrower total extraction panels that are sub-critical (i.e. W/H < 0.6) or partial extraction panels with long term stable remnant pillars left beneath sensitive surface features to control subsidence impacts to within tolerable limits.
- Whether the performance of the SCZ needs to be trialled in non-sensitive panels.

Further design criteria, specific to the feature being protected, are provided in the following sections.

### 11.1.2 Minimum Design Set-Back Distances for SCZs

Minimum set back distances required for SCZs will depend upon the type of feature and the consequences of excessive damage, if it occurs. Based on the Statement of Commitments in the Project Approval, it will be necessary to protect the Schedule 2 section of Viney Creek, all Principal Residences and associated structures from mining related impacts.

Viney Creek

The minimum set-back distance from Viney Creek to high extraction mining has been defined in the Abel Mine's Environmental Assessment Report documents and Project Approval as a distance $26.5^{o}$ Angle of Draw (AoD) + 40 m, to limit subsidence of the creek bed and banks to < 20 mm.

Based on consultation with the surface water consultant for the project, it is understood that Viney Creek will tolerate higher magnitudes of subsidence if no hydraulic connection or change in drainage patterns and watercourse ecology occur.

For the Abel mining lease and reference to nearby mine sites, it is assessed that the development of surface cracking > 20 mm wide may be defined as the point where tensile strains exceed 2 mm/m in areas with relatively deep soil cover. Provided the proposed mining method does not result in widespread exceedences of 2 mm/m tensile (or compressive) strains, then it is assessed that the creek may be subsided by up to 0.3 m without significant impact.

Based on the above, it is also considered the following techniques may be adopted to control subsidence impacts to within tolerable limits for Viney Creek:

(i) Extract sub-critical total extraction panels (i.e. with W/H < 0.6) beneath the creek with squat chain pillars (i.e. with pillar w/h ratios > 5) between the panels.

(ii) Alternatively it will be possible to conduct partial pillar extraction beneath the creek, which results in similar minimal subsidence magnitudes and impacts as defined above.

(iii) Adopt an angle of draw of 26.5 degrees or 0.5 x cover depth from the creek centreline to define a 'low' impact set-back distance from total extraction mining limits, pending confirmation from earlier panel monitoring data.

<u>Principal Residences and Designated Structures</u>

Principal residences and designated structures will require adequate set-back distances from total extraction mining panels to protect the structures from differential displacements (pending confirmation of tolerable limits from MSB).

The general advice given by the MSB is to ensure that any damage to the structures due to mining is ‘safe, serviceable and repairable’ and that the tilt of the structures due to mining is not to exceed 5 mm/m (so that the buildings are unlikely to require re-levelling).

The above design criteria for the SPZs is indicative of ‘negligible’ to ‘slight’ (i.e. Category 0 to 2 damage), as defined in **AS2870, 1996**. These damage categories are defined as ‘minor’ and would be considered normal in regards to footing performance over the life of similar types of buildings with moderately reactive clay (Class M) or controlled fill beneath shallow footings.

Another consideration is that the houses within the Abel Mining Lease are not within a proclaimed mine subsidence district, and as a result, the MSB have been unable to impose any development restrictions on the houses built within the lease. As a result, some of the houses may not have been built with a level of articulation that would be considered appropriate for a limited amount of mine subsidence movement, or similar to that for a Class M reactive clay site.

*Note: A Class M site is defined by **AS2870, 1996** as having 20 to 40 mm of vertical surface movement due to natural soil moisture content changes over seasonal cycles of 'wet' and 'dry' conditions*.

It is therefore recommended that the design set-back distances from Principal Residences to total extraction mining will need to consider the surface topography, structure and footing type, the level of building articulation present, performance history of the structure, and clay reactivity to moisture change potential in foundation materials beneath footings.

The following set-back distances from Principal Residences presented in **Table 28** have been adopted at this stage to control subsidence, tilt, curvature and strain to the limits recommended in **Appleyard, 2001** for a given residential structure type.

**Table 28 - Summary of Recommended Design Angles of Draw to Various Principal Residence Structure Types for a Given Topography**

| Principal Residence Structure Type+ | Tolerable Subsidence Impact Parameters (i.e. 'Negligible' to 'Slight' Damage Category in AS2870 - 1996) | | | | Minimum Design Angle of Draw (degrees) [setback distance in terms of cover depth, H] | |
|---|---|---|---|---|---|---|
| | Subsidence# (m) | Tilt (mm/m) | Curvature (1/km) | Strain (mm/m) | Flat-Moderate Topography* | Steep Topography^ |
| Clad Frame on Strip/Pad Footings | <0.05 | <4 | <0.25 | <3 | 17 [0.3H] | 26.5 [0.5H] |
| Articulated Masonry Veneer on Strip/Pad/Slab Footings | <0.03 | <3 | <0.2 | <2 | 20 [0.35H] | 30 [0.6H] |
| Non-articulated Masonry Veneer on Strip/Pad/Slab Footings | <0.02 | <2 | <0.1 | <1.0 | 26.5 [0.5H] | 35 [0.7H] |
| Articulated Full Masonry Strip/Pad/Slab Footings | <0.02 | <2 | <0.1 | <1.0 | 26.5 [0.5H] | 35 [0.7H] |
| Non-articulated Full Masonry on Strip/Slab Footings | <0.01 | <1 | <0.05 | <0.5 | 35 [0.7H] | 45 [1H] |

Notes:
+ - Buildings are single or double storey and have wall lengths ranging between 10 m and 30 m.
# - subsidence limits applied to limit associated tilts, strains and curvatures.
* - ground slopes < 15° between mining limits and structure.
^ - ground slopes > 15° between mining limits and structure.

Further justification for the above design set-back distances are provided in **Section 7** of **Appendix A** in regards to measured subsidence impact parameters outside the limits of high extraction mining observed for SMP Area 1 panels. Results of monitoring and any impacts may provide further review of these values.

## 11.2 ASSESSMENT FOR SUBSIDENCE IMPACTS

### 11.2.1 General Surface

#### 11.2.1.1 Surface Cracking

**Predicted Impacts**

The development of surface subsidence above a total pillar extraction panel is caused by the bending of the overburden strata as it sags down into the newly created void in the workings. The sagging strata are supported in turn by the collapsed immediate roof, which then slowly compresses to a maximum subsidence limit.

The predicted panel subsidence magnitudes of 750mm to 1,450mm are likely to result in surface cracks developing within the limits of the extracted panels. It is very unlikely that surface cracks will develop above first workings pillars, where subsidence magnitudes of < 20 mm are expected.

Cracks are likely to develop in the tensile strain zones that will occur from 18 m to 44 m in from the rib-sides of each total extraction panel. Crack widths of 10 mm may start to develop at the surface where tensile strains exceed 1 mm/m over a distance of 10 m. The maximum crack widths generally develop where maximum tensile strains occur.

Compressive strains > 2 to 3 mm/m can also cause cracking and upward ‘buckling’ of near surface rock beds due to low-angle shear failures. The compressive strains generally peak at one or two locations in the middle third area of the panels.

Based on the predicted range of maximum transverse tensile strains (i.e. 5 to 19 mm/m), surface cracking widths of between 50 mm and 190 mm (based on the Upper 95% Confidence limit) could occur above Panels 14 to 26 and within the limits of extraction (i.e. goaf) beneath the SMP Area 2. The Upper 95% Confidence Limit used in these predictions considers that these values may be exceeded by 5% of the time. Therefore on a small number of occasions, the predicted crack widths may be exceeded (as has been the case with the panels extracted to date in SMP Area 1). These are generally found to be related to the presence of adverse or anomalous geological or topographical conditions. Strain concentration in near surface rock could also double the above cracks widths locally to 100 mm and 380 mm respectively.

The predicted tensile strains above the extracted Tailgate Headings, East Install Headings and South East Mains are estimated to range between 9 mm/m to 16 mm/m, indicating crack widths of between 90 mm and 160 mm (Upper 95% Confidence Limit). Strain concentrations in near surface rock could also double the above crack widths locally to 180 mm and 320 mm respectively.

The tensile cracks will probably be tapered and extend to depths ranging from 5 to 10 m, and possibly deeper if near surface bedrock exposures are present.

The predicted range of maximum transverse compressive strains (i.e. 7 to 24 mm/m) may result in shear displacements or 'shoving' of between 70 mm and 210 mm within the central limits of proposed production and extracted main headings panels.

Based on the strain contour figures, the location of the tensile cracking and total shear displacements for the proposed mining layout are shown in **Figure 22a** of **Appendix A**.

In addition, tensile cracks of similar magnitude to those mentioned above will probably develop up to 30 m behind the advancing goaf edge of the total pillar extraction panels. The majority of these cracks are transient however, and are likely to close in the central areas of the panels where permanent compressive strains develop after mining is completed. The typical crack pattern development behind a retreating pillar extraction face is presented in **Figure 22b** of **Appendix A**.

The previous Area 1 SMP report indicated that the transient cracks widths would be < final crack widths on average. However, based on the similarity in width observed between the transient and final cracks to-date, and the measured average retreat rates for Panels 1 to 4 of 23 m/week to 37 m/week, it is assessed that the extraction face does not move fast enough for the transient crack width reduction to occur generally. The face retreat rates can also vary significantly from < 10 m/week to 50 m/week, depending on mine roof conditions and operational factors, so it is possible that transient cracking will vary between dynamic and final static magnitudes.

It has therefore been assumed in this study that the transient crack widths will be similar in width to final subsidence crack width predictions above the proposed Area 2 Panels.

It is anticipated there could be soil or bedrock crack development with a low potential for sub-surface transfer of stream flow in the Viney Creek tributaries, upstream of the Schedule 2 stream reach. However, as connective cracking between the surface cracks and the “Zone A” cracked overburden are not predicted to inter connect, it is not predicted that surface water flows will enter the underground mine workings.

However, as the extent of the surface cracking, as well as the disconnected (Zone B) and connected (Zone A) fracturing is not definitive, it is possible that re-activation of or focussing of fracturing on an unknown structural feature, such as a fault or dyke, could, although it is considered unlikely, enable limited hydraulic connection between a subsided stream bed and the workings.

If any short reach sub-surface transfer of stream flow occurs, it is anticipated that the transfers to the shallow groundwater system, if they occur, will re-emerge a short distance downstream, on the basis there is no hydraulic connection to the workings. Based on the combination of the mining method with the potential to vary the amount of extraction and use of the Viney Creek Subsidence Control Zone, some creek stretches may have a low potential to be affected by cracking and sub surface transfer of surface flow or bed and / or bank instability.

Creek beds with the shallowest depth of cover are rated with the highest risk, which reduces as the depth of cover increases and with the relative location of maximum subsidence over a panel.

**Impact Management Strategies**

Surface crack repair works may need to be implemented around the affected areas of the site, and in particular, where public roads and ephemeral watercourses are present. Crack repairs may involve ripping, backfilling/compaction and top dressing works or the pouring of cement-based grout, crushed rock into the wider, deeper cracks.

In regards to Viney Creek, surface cracking will be limited by the panel geometries and proposed first working buffer zones. It is considered 'very unlikely' that surface cracks will develop along the creek bed, however, if they do occur, the following remediation strategies may be adopted:

- Undertake pre-mining and post-mining inspections along the creek, with the results of these inspections communicated to the respective stakeholders. Should a significant impact be identified during these inspections, an appropriate remediation strategy will be developed.

- Consultation with DECCW has suggested that natural regeneration may be the favoured management strategy in most scenarios, due to the likely level of disturbance caused by other remediation strategies such as back filling with imported materials from haulage trucks.

## 11.2.1.2 Sub-Surface Cracking

**Sub-Surface Fracturing Zones**

The caving and subsidence development processes above a longwall or pillar extraction panel usually results in sub-surface fracturing and shearing of sedimentary strata in the overburden. The extent of fracturing and shearing is dependent on mining geometry and overburden geology.

International and Australian research on longwall mining interaction with groundwater systems indicates that the overburden may be divided into essentially three or four zones of surface and subsurface fracturing. The zones are generally defined (in descending order) as:

- Surface Zone
- Continuous or Constrained Zone
- Fractured Zone
- Caved Zone

Starting from the seam level, the Caved Zone refers to the immediate mine workings roof above the extracted panel, which has collapsed into the void left after the coal seam has been extracted. The Caved Zone usually extends for 3 to 5 times the mining height above the roof of the mine workings.

The Fractured Zone has been affected by a high degree of bending deformation, resulting in significant fracturing and bedding parting separation and shearing. The Fractured Zone is supported by the collapsed material in the Caved Zone, which usually has a bulked volume equal to 1.2 to 1.5 times its undisturbed volume.

The Continuous or Constrained Zones refer to the section of overburden which has also been deformed by bending action, but to a lesser degree than the Fractured Zone below it.

The Surface Zone includes the tensile and compressive surface cracking caused by mine subsidence and is assumed to extend to depths of 5 to 10 m in the Newcastle Coalfield.

Based on reference to **Whittaker and Reddish, 1990** and **ACARP, 2003**, the impact of mining on the sub-surface aquifers and surface waters, requires an estimate of the ‘Continuous’ and ‘Discontinuous’ heights of fracturing or the A and B Zones (See **Figure 24 of Appendix A**)

Continuous sub-surface fracturing (A-Zone) refers to the zone of cracking above a longwall or pillar extraction panel that is likely to result in a direct flow-path or hydraulic connection to the workings, if a sub-surface (or shallow surface) aquifer was intersected.

Discontinuous sub-surface fracturing (B-Zone) refers to the zone above the A-Zone where there could be a general increase in horizontal and vertical rock mass permeability, due to bending or curvature deformation of the overburden. This type of fracturing does not usually provide a direct flow path or connection to the mine workings like the A-Zone; however, it is possible that B-Zone fracturing may interact with surface cracks, joints, or faults. This type of fracturing can therefore result in an adjustment to surface and sub-surface flow paths, but may not result in a significant change to the groundwater or surface water resource in the long-term.

In regards to the general zones of fracturing mentioned earlier, the A-Zone may be assumed to include the Caved and Fractured Zones, and the B-Zone will develop in the Constrained Zone. Both A and B-Zones can extend to the Surface Zone and will depend on the mining height, cover depth, geology and panel width.

Two empirically-based models (**Forster, 1995** and **ACARP, 2003**) and have been used in this study to predict the A and B-Zone heights of sub-surface fracturing within the study area.

The **Forster, 1995** model was developed from deep multi-piezometer data from subsided overburden in the Central-Coast area of the Newcastle Coalfield and indirectly defines the A and B-Zones as a function of the mining height (the model refers to the A and B-Zones as the tops of the Fractured and Confined Zones respectively.

The **Forster, 1995** model predicts that the height of the Fractured or A-Zone will generally range between 21 and 33 times the mining height (T). The predicted extent or height of the Confined or B-Zone and its thickness will be dependent on the cover depth and height of A-Zone fracturing.

The **ACARP, 2003** model was derived from the **Forster, 1995** Model data, and supplemented with drilling fluid loss records from surface to seam drilling logs in subsided, fractured overburden from the NSW Southern Coalfield and Oaky Creek Mine in the Bowen Basin (**Colwell, 1993**).

The **ACARP, 2003** model includes several of the key parameters defined by **Whittaker and Reddish, 1989** and referred to in **Mark, 2007**. The additional parameters include the panel width, cover depth, maximum single panel subsidence and geological conditions (i.e. Subsidence Reduction Potential). The mining height is not applied directly, but indirectly through the subsidence prediction (further model development details may be found in **Appendix A**).

The measured data in **ACARP, 2003** has been plotted as the height of A or B-Zone fracturing /cover depth v. $S_{max}$/Effective Panel Width$^2$. A log-normal regression line has subsequently been derived to give predictions of mean and U95%CL values for both fracture zones.

**Sub-Surface Fracture Height Predictions**

The predicted values for the **ACARP, 2003** model's continuous and discontinuous sub-surface fracturing heights above the proposed pillar extraction panels are summarised in **Table 29**.

**Table 29 - Summary of Predicted Sub-Surface Fracturing Heights above the Proposed SMP Area 2 Pillar Extraction Panels**

| Panel No. | Cover Depth, H (m) | Panel Width, W (m) | Effective Mining Height, Te (m) | First Panel $S_{max}$ (mean) (m) | Panel $S_{max}/W'^2$ (mean) ($mm/m^2$ or $km^{-1}$) | Predicted Fracture Heights (m) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Continuous Fracture Zone (A Horizon) | | | | Discontinuous Fracture Zone (B Horizon) | |
| | | | | | | **ACARP, 2003** Model (mean - U95%CL) | | **Forster, 1995**) (21-33Te) | | **ACARP, 2003** Model (mean - U95%CL) | |
| **Pillar Extraction Panels 14 to 26** | | | | | | | | | | | |
| 14 | 110 | 96 | 2.66 | 0.75 | 0.075 | 59 | 89 | 56 | 88 | *104* | *123* |
| 15 | 110 | 160.5 | 2.66 | 1.19 | 0.050 | 49 | 79 | 56 | 88 | 96 | *115* |
| 15 | 120 | 160.5 | 2.66 | 1.12 | 0.044 | 50 | 82 | 56 | 88 | 102 | *123* |
| 16 | 105 | 160.5 | 2.66 | 1.23 | 0.057 | 50 | 78 | 56 | 88 | 94 | *112* |
| 16 | 115 | 160.5 | 2.66 | 1.16 | 0.045 | 48 | 79 | 56 | 88 | 98 | *119* |
| 17 | 107 | 160.5 | 2.66 | 1.21 | 0.054 | 49 | 78 | 56 | 88 | 95 | *114* |
| 17 | 120 | 160.5 | 2.66 | 1.12 | 0.044 | 50 | 82 | 56 | 88 | 102 | *123* |
| 18 | 110 | 160.5 | 2.66 | 1.19 | 0.050 | 49 | 79 | 56 | 88 | 96 | *115* |
| 18 | 120 | 160.5 | 2.66 | 1.12 | 0.044 | 50 | 82 | 56 | 88 | 102 | *123* |
| 19 | 110 | 160.5 | 2.66 | 1.19 | 0.050 | 49 | 79 | 56 | 88 | 96 | *115* |
| 19 | 120 | 160.5 | 2.66 | 1.12 | 0.044 | 50 | 82 | 56 | 88 | 102 | *123* |
| 20 | 137 | 270.5 | 2.09 | 1.16 | 0.031 | 46 | 83 | 44 | 69 | 109 | *133* |
| 21 | 137 | 160.5 | 2.19 | 0.89 | 0.035 | 49 | 86 | 46 | 72 | 111 | *135* |
| 22 | 133 | 160.5 | 2.38 | 0.97 | 0.038 | 51 | 86 | 50 | 78 | 110 | *133* |
| 23 | 112 | 160.5 | 2.66 | 1.18 | 0.048 | 49 | 79 | 56 | 88 | 97 | *117* |
| 23 | 127 | 160.5 | 2.66 | 1.09 | 0.042 | 52 | 86 | 56 | 88 | 107 | *130* |
| 24 | 112 | 160.5 | 2.66 | 1.18 | 0.048 | 49 | 79 | 56 | 88 | 97 | *117* |
| 24 | 124 | 160.5 | 2.66 | 1.10 | 0.043 | 51 | 84 | 56 | 88 | 105 | *127* |
| 24 | 130 | 160.5 | 2.66 | 1.09 | 0.042 | 53 | 88 | 56 | 88 | 110 | *133* |
| 25 | 111 | 160.5 | 2.66 | 1.18 | 0.049 | 49 | 79 | 56 | 88 | 97 | *116* |
| 25 | 120 | 160.5 | 2.66 | 1.12 | 0.044 | 50 | 82 | 56 | 88 | 102 | *123* |
| 25 | 125 | 160.5 | 2.66 | 1.09 | 0.042 | 51 | 84 | 56 | 88 | 106 | *127* |
| 26 | 112 | 160.5 | 2.57 | 1.14 | 0.046 | 48 | 78 | 54 | 85 | 96 | *116* |
| 26 | 117 | 160.5 | 2.66 | 1.14 | 0.044 | 49 | 80 | 56 | 88 | 100 | *120* |
| 26 | 130 | 160.5 | 2.66 | 1.09 | 0.042 | 53 | 88 | 56 | 88 | 110 | *133* |
| 23 | 110 | 160.5 | 2.66 | 1.19 | 0.050 | 49 | 79 | 56 | 88 | 96 | *115* |
| 25 | 110 | 160.5 | 2.66 | 1.19 | 0.050 | 49 | 79 | 56 | 88 | 96 | *115* |
| **Tailgate, South East Main and East Install Headings** | | | | | | | | | | | |
| SE | 105 | 140 | 2.66 | 1.03 | 0.066 | 53 | 82 | 56 | 88 | 97 | *115* |
| SE | 103 | 140 | 2.66 | 1.04 | 0.067 | 53 | 80 | 56 | 88 | 95 | *113* |
| TG | 97 | 89 | 2.66 | 0.89 | 0.089 | 56 | 82 | 56 | **88** | 94 | *111* |
| TG | 100 | 89 | 2.38 | 0.77 | 0.077 | 54 | 81 | 50 | 79 | 95 | *112* |
| TG | 110 | 89 | 2.66 | 0.77 | 0.077 | 60 | 89 | 56 | 88 | 104 | *123* |
| EI | 100 | 105 | 2.57 | 0.89 | 0.081 | 55 | 82 | 54 | 85 | 95 | *113* |

Heights of fracturing based on effective mining heights Te= 0.95T.
Effective Panel Width = lesser of actual width and 1.4H (i.e. the super-critical width).
**Bold -** Mean or U95%CL A-Horizon prediction is within 10 m of the surface.
*Italics* - Mean or U95%CL B-Horizon prediction is within 10 m of surface.

### Discussion of A-Zone Horizon Model Predictions Above Pillar Extraction Panels

The **ACARP, 2003** model's predictions for the mean A-Zone horizon above the proposed pillar extraction panels are likely to be within 10 m of the surface if mining occurred at cover depths of < 50 m, regardless of any adverse conditions (such as a fault) being present.

For panel cover depths of between 50 m and 80 m, the predicted U95%CL A-Zone horizon values are within 10 m of the surface, and it is considered that the potential for connective cracking to within 10m of the surface is 'possible'.

Connective cracking to the surface is considered 'unlikely' for depths of cover between 80 m and 100 m, as the A-Zone Horizon is predicted to be between 10 m and 20 m from the surface.

Connective cracking is considered 'very unlikely' for depths of cover > 100 m, as the A-Zone Horizon is predicted to be > 20 m below the surface (range is 19 m to 89 m below the surface for cover depths from 100 m to 140 m)

The **Forster, 1995** model indicates a similar range of connective cracking heights 44 m to 88 m above the workings.

### Discussion of B-Zone Horizon Model Predictions above Pillar Extraction Panels

The **ACARP, 2003** model predicts that the mean B-Zone Horizon values will occur within 10 m of the surface for cover depths < 100 m above the pillar extraction panels for the given mining geometries. Discontinuous sub-surface fracturing for these panels is considered 'likely' to interact with surface cracks.

In areas of shallow or exposed surface rock, creek flows may be re-routed to below-surface pathways and re-surfacing down-stream of the mining extraction limits in these areas.

The predicted U95%CL B-Horizon values are all within 10 m of the surface for cover depths < 140 m. It is therefore assessed that surface water impacts from Discontinuous sub-surface fracturing interaction will be ‘possible’ where cover depths range between 100 m and 140 m.

**Mark, 2007** indicates that the height of Discontinuous fracturing could range between 48 m and 168 m above the workings.

### Impact on Rock Mass Permeability

In regards to changes to rock mass permeability, **Forster, 1995** indicates that horizontal permeabilities in the fractured zones above longwall mines could increase by 2 to 4 orders of magnitude (e.g. pre-mining $k_h = 10^{-9}$ to $10^{-10}$ m/s; post-mining $k_h = 10^{-7}$ to $10^{-6}$ m/s).

Vertical permeability’s could not be measured directly from the boreholes but could be inferred by assuming complete pressure loss in the ‘A-Zone’, where direct hydraulic connection to the workings occurs. Only a slight increase in the ‘B-Zone’ or indirect / discontinuous fracturing develops (mainly due to increase in storage capacity) from bedding parting separation. It is possible however, that minor vertical flows will occur from B-Zone into the A-Zone (and workings) as well.

Discontinuous fracturing would be expected to increase rock mass storage capacity and horizontal permeability without direct hydraulic connection to the workings. Rock mass permeability is unlikely to increase significantly outside the limits of extraction.

**Discussion of Prediction Model Uncertainties**

Due to the complexity of the problem, it is difficult to ascertain which of the two Newcastle Coalfield based models is likely to be the most accurate. It has therefore been considered necessary to review the assumptions made in each model.

Both models indicate that the height of continuous fracturing is fairly insensitive to depth of cover. However, it is apparent that the **Forster, 1995** model predicts a higher A-Zone horizon than the **ACARP, 2003** model and predicts surface connection could occur for cover depths up to 100 m.

The height of fracturing data presented in **Forster, 1995** and **ACARP, 2003** infers that the fracture height is not significantly influenced by the panel width alone.

This seems to contradict arching theory, where the height of the ‘arch’ or fractured zone would be expected to increase as the panel width increases. However, as the effective width of the panel decreases with increasing height above the workings, the spanning capability of the rock ‘beams’ will also increase and limit the height of continuous fracturing to the base of the spanning units, effectively.

What is clear from the above exercise is that there a high degree of uncertainty in predicting the A and B-Zone horizons using any of the available models. The measurement of sub-surface fracturing and their impact on groundwater has therefore been undertaken over the first two panels at the Abel mine for the purpose of validating the prediction models applied in this study.

**Measured v. Predicted Heights of Fracturing above Panels 1 and 2**

The measured heights of fracturing zones (A and B Zones) above Panels 1 and 2 were based on deep borehole extensometer anchor displacements, vibrating wire piezometers and shallow slotted standpipe measurements. The locations of the monitoring bores are shown in **Figure 26** of **Appendix A**.

Pre and post mining piezometric head and extensometer measurements are summarised in **Tables 30 and 31**. Plots of the data are presented in **Figures 27a** to **27f** of **Appendix A**.

**Table 30 - Summary of Measured Deep and Shallow Piezometric Levels above Panels 1 and 2**

| Piezo # | Panel No. | Depth of Cover H (m) | Piezometer Locations (m) | | Pre-mining Piezometric Heads (m) | | Post-mining Piezometric Heads (m) | | Head Drop (m) | Fracture Zone* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | DBG | y | DBG | y | DBG | y | dh | |
| Bore 1 | 1 | 99.3 | **30** | 69.3 | **17.2** | 82.1 | **>28.4** | <70.9 | **>11.1** | B |
| Piezo 1 | | | **35** | 64.3 | **19.6** | 79.7 | **34.9** | 64.4 | **15.3** | B |
| | | | **55** | 44.3 | **22.5** | 76.8 | **>50.5** | <48.9 | **>27.9** | A |
| | | | **75** | 24.3 | **29.6** | 69.8 | **>70.4** | <28.9 | **>40.9** | A |
| Bore 2 | 2 | 73.2 | **30** | 45.2 | **16.7** | 56.5 | **21.2** | 54.8 | **4.5** | B |
| Piezo 2 | | | **30** | 43.2 | **9.3** | 63.9 | **>29.0** | <44.3 | **>19.7** | A |
| | | | **50** | 23.2 | **20.9** | 52.3 | **>47.6** | <25.6 | **>26.7** | A |
| | | | **70** | 3.2 | **34.4** | 38.8 | **>59.8** | <13.4 | **>25.4** | A |

DBG = depth below ground.
y = height above workings.
> or < indicates groundwater depth or level above workings has fallen below piezometer.
* - see **Section 7.3.1** for definitions.

The deep piezometers (Piezo 1 and 2) in the boreholes to the south of Panel 1 and east of Panel 2 respectively, indicated that there are three distinct semi-confined aquifers of thinly interbedded bedded sandstone/siltstone overburden strata that are separated by claystone/mudstone aquitards. The aquifers are gravity fed by seepages into strata unit sub-crops to the north.

Pre-mining piezometric heads in Piezo 1 were 79.7 m, 76.8 m and 69.8 m above the workings. The shallow piezometer (Bore 1) in next to Panel 1 consists of a 30 m deep PVC standpipe with a 3 m to 6 m slotted screen, gavel packing and a bentonite seal. Groundwater level measurements in Bore 1 indicated an uppermost aquifer level of 82.1 m, which was similar to the piezometric head level indicated by the adjacent deep bore piezometer (Piezo 1).

Piezo 2 to the north east of Piezo 1 indicated that the three aquifers in the overburden had pre-mining piezometric heads above the workings of 63.9 m, 52.3 m and 32.8 m. The shallow standpipe piezometer (Bore 2) indicated a piezometric head above the workings of 56.5 m in the uppermost aquifer; however this was 7.4 m below the deep piezo cell water level reading at the same depth. On closer inspection of the borehole locations in **Figure 26** of **Appendix A**. it would appear that the shallow piezometer is located east of a NW trending fault line and the deep piezometer is located to the west of it. It is considered possible that there is a disconnect between the groundwater levels on either side of the fault.

After extraction of Panel 1, the piezometric heads dropped 15.3 m in the uppermost aquifer and > 27.9 m and > 40.9 m in the lower aquifers (ie. the piezometric levels dropped below the cells at these depths). The deep borehole piezometric heads above Panel 2 dropped >19.74 m in the uppermost aquifer and > 25.6 m and > 13.4 m in the lower aquifers. The response of the groundwater levels in the standpipe piezometer to the east of the fault appears to be slower than the deep borehole piezometer, with a total head loss of only 4.5 m occurring to-date.
Again, there appears to be a discrepancy in the groundwater level responses between the two instruments in the upper aquifer adjacent to Panel 2.

In general, the likely causes of the piezometric head drops above both panels is primarily linked to the development of A and B Zone Fracturing above each panel; see **Table 31**.

**Table 31 - Summary of Measured Deep Borehole Extensometer Anchor Displacements above Panels 1 and 2**

| Exto # | Panel No. | Depth of Cover H (m) | Anchor Location DBG (m) | Anchor Location y (m) | Maximum Anchor Displacement (mm) | Fracture Zone* |
|---|---|---|---|---|---|---|
| Exto 1 | 1 | 95 | 10 | 85 | 14 | B |
| | | | 20 | 75 | 13 | B |
| | | | 30 | 65 | 31 | B |
| | | | 40 | 55 | 27 | B |
| | | | **50** | **45** | **33** | **B/A** |
| | | | 60 | 35 | 1351 | A |
| | | | 70 | 25 | 868 | A |
| | | | 80 | 15 | 734 | A |
| Exto 2 | 2 | 76 | 10 | 66 | -13 | B |
| | | | 20 | 56 | -19 | B |
| | | | **30** | **46** | **-18** | **B/A** |
| | | | 40 | 36 | n.m. | A |
| | | | 50 | 26 | 298 | A |
| | | | 60 | 16 | 78 | A |
| | | | 70 | 6 | 264 | A |

DBG = depth below ground
y = height above workings.
* - see **Section 7.3.1** for definitions.

The maximum anchor displacements in **Table 31** are relative displacements and indicate strata dilation or separation of sagging rock beds over extracted areas; see **Figures 27c** and **27f** of **Appendix A**. The extensometer data clearly defines the boundary between the Continuous or Constrained Zone of elastic bending above the workings, and the Fractured and Caved Zones below it.

The piezometric data generally show (i) complete head drop in the Fractured Zone where continuous fracturing to the workings has developed (i.e. the A-Zone), and (ii) partial head loss or lowering of the ground water table in the Constrained Zone, where dilation of strata or bed separations have increased the available storage volumes for groundwater in the affected aquifers (i.e. The B-Zone).

It should also be understood however, that some leakage of the upper aquifer in the B Zone may also be occurring into the A Zone, and this may therefore result in complete drainage of the upper aquifer in the short to medium term. The presence and characteristics of geological structure also appears to be affecting the response of the groundwater regime however, with the piezometer west of the NW fault line indicating drainage to the Continuous fracture zone with a slower, perched aquifer type response to the east of the fault.

Comparison between predicted v. measured heights of sub-surface fracturing zones above Panels 1 and 2 in SMP Area 1 have been assessed for model validation purposes.

The predicted values of A and B Zone Horizons are summarised in **Table 32** and compared to measured values in **Table 33**. Graphical comparisons are also presented in **Figures 27g** and **27h** of **Appendix A**.

**Table 32 - Summary of Predicted Sub-Surface Fracturing Heights above the Panels 1 and 2 in Area 1 Pillar Extraction Panels**

| Panel No. | Cover Depth H (m) | Panel Width W (m) | Effective Mining Height Te (m) | First Panel $S_{max}$ (mean) (m) | Panel $S_{max}/W'^2$ (mean) ($mm/m^2$ or $km^{-1}$) | Predicted Fracture Heights (m) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Continuous Fracture Zone (A Horizon) | | | | Discontinuous Fracture Zone (B Horizon) | |
| | | | | | | **ACARP, 2003** Model (mean - U95%CL) | | **Forster, 1995**) (21-33Te) | | **ACARP, 2003** Model (mean - U95%CL) | |
| 1 | 95 | 120 | 2.55 | 1.03 | 0.071 | 50 | 76 | 54 | 84 | *89* | *105* |
| 2 | 76 | 150 | 1.88 | 1.02 | 0.045 | 44 | 64 | 39 | 62 | 74 | *87* |

**Table 33 - Summary of Predicted v Measured Sub-Surface Fracturing Heights above the Panels 1 and 2 in Area 1 Pillar Extraction Panels**

| Panel No. | Panel Width W (m) | Cover Depth H (m) | Effective Mining Height Te (m) | First Panel $S_{max}$ (m) | | Continuous Fracture Zone (A Horizon) | | Discontinuous Fracture Zone (B Horizon) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | P | M | P | M* | P | M |
| 1 | 120 | 95 | 2.55 | 1.03 | 0.96 | 50 - 76 | 47 | 89 - *95* | *85-95* |
| 2 | 150 | 76 | 1.88 | 1.02 | 1.02 | 44 - 64 | 45 | 74 - *76* | *66-76* |

P - Predicted; M - Measured.
*italics* - strata dilation of <13 mm indicated at 10 m depth below surface suggests that interaction of B Zone with surface cracks is possible.
* - Height of continuous fracturing may increase with time due to leakage from B-Zone.

The measurement of the A-Zone horizon above Panels 1 and 2 indicates the height of continuous sub-surface fracturing in the Fractured Zone has extended up to between 45 and 50 m above the 120 m and 150 m wide panels with cover depths of 73 m to 95 m. As mentioned earlier, it is apparent that there is some on-going leakage from the Constrained Zone into the Fractured Zone above Panel 1, which may cause that the effective A-Zone Horizon to increase over time.

The presence of a NW trending fault line east of Panel 2 however, appears to have disconnected the groundwater on either side of it and has lowered the near surface water table by approximately 4.5 m east of the fault and >15.3 m to the west of it. The effective height of Continuous fracturing may also increase with time at this location.

The results of the analysis demonstrates that the measured A and B Zones are located within the **ACARP, 2003** prediction model ranges. The height of continuous fracturing (A Horizon) is located within +/- 3 m of the predicted mean values and the discontinuous fracture zone extends to within 10 m of the surface. It is possible that the measured A Zone may increase over time, but should still be within the U95%CLs presented in **Table 33**.

Overall, it is considered that the measured and predicted fracture zones are in good agreement for Panels 1 and 2 at this stage and indicates the predicted fracture zones for the Area 2 panels are likely to be within the mean and U95%CLs presented.

**Impact Management Strategies**

It is understood that there are no subsurface aquifers of potential resource significance within the overburden that could be affected by continuous and/or discontinuous fracturing above the extracted pillar panels. Subsequent groundwater and surface aquifer impact studies have considered the high level of uncertainty in regards to predicting the height of each zone of sub-surface fracturing.

Based on the studies, the **ACARP, 2003** model outcomes have been assessed in accordance with the Likelihood of Occurrence that continuous fracturing will intersect with surface cracks that extend to 10 m depth below the surface. The results are summarised in **Table 34**.

**Table 34 - Likelihood Assessment for Continuous Fracturing Extending from Mine Workings to Within 10 m of the Surface Above the Proposed Pillar Extraction Panels**

| Likelihood of Occurrence* | Mining Height Range | Cover Depth Range (m) | Probability of a Single Hazardous Event |
|---|---|---|---|
| Likely | 2.2 - 3.0 | < 50 | 50 - 75% |
| Possible | 2.2 - 3.0 | 50 - 80 | 5 - 50% |
| Unlikely | 2.2 - 3.0 | 80 - 100 | 5 - 10% |
| Very Unlikely | 2.2 - 3.0 | >100 | <5% |

* - refer to **Appendix A** for definitions of likelihood of occurrence.

Based on discussions with the specialist surface and groundwater consultants for the project, the absence of significant surface alluvium and ephemeral nature of the creeks/gullies is unlikely to result in significant degradation of the creeks or inrush event into the underground workings should connective cracking to the surface occur. It is considered more likely that any redirected surface flows will be manageable underground and cracks able to be repaired at the surface.

It is therefore recommended that underground water make records for each extracted panels should be reviewed for the purpose of estimating the likely increases in mine water flow due to fracturing of the overlying aquifers. The presence of geological structure should also be viewed with caution and management strategies prepared to deal with disproportionate water inflows into the workings if aquifers become ‘perched’ behind adjacent faults. Undermining faults may also result in higher continuous fracture connectivity and water makes also.

As the height of fracturing measurements are close to the predicted mean values derived from the **ACARP, 2003** model, it is not considered necessary to install too many more borehole extensometers above future panels in Areas 1 and 2. The installation of further deep extensometer and piezometers in other areas of the mine may however provide useful data where further faults exist between the panels.

#### 11.2.1.3 Scarp Development

**Potential Impacts**

It is possible that scarp development or surface steps up to 300 mm could develop above total extraction panels with a depth of cover < 80 m and a panel width/cover depth ratio of > 2. However, the deeper soil conditions above the Abel panels may not be conducive for scarp development due to the more 'flexible' overburden that is present near the surface. It is considered unlikely that scarp development will occur over SMP Area 2 with covers generally in excess of 100 m. There have been no scarp development or surface steps observed in Panels 1 to 3 of SMP Area 1.

**Impact Management Strategies**

Scarps will be remediated by the mine if and when they occur, based on consultation with relevant stakeholders. Remediation work would include the regrading and revegetation of affected areas with locally sourced materials.

#### 11.2.1.4 Slope Instability and Erosion

**Potential Impacts**

To date, local longwall mining experiences in undulating terrain with ground slopes up to 25° has not resulted in any large scale, *en-masse* sliding instability due to mine subsidence (or other natural weathering processes etc). In general, it is possible that localised instability could occur where ground slopes are > 15°, if the slopes are also affected by mining-induced cracking and increased erosion rates.

The rate of erosion is expected to increase significantly in areas with exposed dispersive / reactive alluvial or residual soils or tuffaceous claystone and slope gradients are increased by more than 2% (>20 mm/m).

Based on the difference between the post and pre-mining surfaces presented earlier, the predicted increase or decrease in surface slope gradients after mining are presented in **Figure 29** of **Appendix A**.

The above figures indicate that the maximum gradient changes will be located above Panels 14 to 26 and likely to range between 0.5% and 2.5%. It is assessed that some erosion / sedimentation adjustments may develop at these locations where exposed soils are present.

The predicted changes in surface gradients along Viney Creek are unlikely to exceed 0.5% and therefore unlikely to cause any degradation to the creek directly. Any sediment deposits from actively eroding areas upstream of the Schedule 2 sections of the creek will need to be monitored (and assessed) as mining progresses.

**Impact Management Strategies**

To minimise the likelihood of slope instability and increased erosion potential due to cracking or changes to drainage patterns after mining, the following management strategies may be implemented:

(i) Surface slope monitoring (combined with general subsidence monitoring along cross lines and centre lines);

(ii) Placement of signs along public access ways warning of mine subsidence impacts.

(iii) Infilling of surface cracking to prevent excessive ingress of run-off into the slopes as soon as practicable and preferably after each panel is completed.

(iv) Slopes that are significantly affected by erosion after mining may need to be repaired and protected with mitigation works such as regrading and revegetation of exposed areas, based on consultation with the relevant government agencies.

(v) Ongoing review and appraisal of any significant changes to surface slopes such as cracking, increased erosion, seepages and drainage path adjustments observed after each adjoining panel is extracted.

## 11.2.1.5 Valley Uplift and Closure

**Potential Impacts**

Valley uplift and closure movements may occur along the drainage gullies present above the proposed mining area, based on reference to **ACARP, 2002** and Southern Coalfield experience.

High horizontal stresses have been measured and uplift movements of about 230 mm have occurred along the F3 Freeway cuttings in ridges about 10 km to the south-east of the mine, where massive conglomerate strata existed at the surface.

However, due to the suspected (and observed) low horizontal stress regime in the Abel mine workings roof to-date (i.e. the Upper Donaldson Seam at this location is in relatively flat area with shallow cover), it is considered unlikely that similar magnitude movements will occur in the gullies / broad crested valleys above the proposed panels.

The lack of thick, massive beds of conglomerate and sandstone units along the creeks / valleys at the surface will also mean the development of these phenomena are likely to be limited to < 150 mm. Minor cracking in creek beds may cause some shallow sub-surface re-routing of surface flows due to the valley closure mechanism.

Uplift movements of between 100 mm and 150 mm have occurred just outside the limits of mining above the SMP Area 1 panels to-date. These movements are not due to the valley closure mechanism, but related to systematic subsidence development of compressive strains and cantilevering of the bending rock mass.

**Impact Management Strategy**

The impact of valley uplift closure effects due to mine subsidence may be managed as follows:

(i) Install and monitor survey lines along representative drainage gullies where considered appropriate and along gully crests during and after undermining. Combine with visual inspections to locate damage (cracking, uplift).

(ii) Review predictions of upsidence and valley crest movements after each panel is extracted.

(iii) Assess whether repairs to cracking, as a result of upsidence or gully slope stabilisation works are required to minimise the likelihood of long-term degradation to the environment or risk to personnel and the general public.

## 11.2.1.6 Far-Field Horizontal Displacements and Strains

**Background to Prediction Model Development**

Far-field displacements (FFDs) generally only have the potential to damage long, linear features such as pipelines, bridges and dam walls.

Horizontal movements due to Longwall mining have been recorded at distances well outside of the angle of draw in the Newcastle, Southern and Western Coalfields (**Reid, 1998, Seedsman and Watson, 2001**). Horizontal movements recorded beyond the angle of draw are referred to as far-field horizontal displacements.

For example, at Cataract Dam in the Southern NSW Coalfield, **Reid, 1998**, reported horizontal movements of up to 25 mm when underground coal mining was about 1.5 km away. Seedsman reported movements in the Newcastle Coalfield of around 20 mm at distances of approximately 220 m, for a cover depth ranging from 70 to 100 m and a panel width of 193 m. However, the results may have been affected by GPS baseline accuracy limitations.

Based on a review of the above information, it is apparent that this phenomenon is dependent on (i) cover depth, (ii) distance from the goaf edges, (iii) the maximum subsidence over the extracted area, (iv) topographic relief and (v) the horizontal stress field characteristics.

An empirical model for predicting far-field displacement (FFDs) in the Newcastle Coalfield indicates that measurable FFD movements (i.e. 20 mm) generally occur in relatively flat terrain for distances up to 3 to 4 times the cover depth.

The direction of the FFD movement is generally towards the extracted area, but can vary due to the degree of regional horizontal stress adjustment around extracted area and the surface topography. The movements also appear to decrease around the corners of longwall panels.

The empirical model also indicates that measureable (but diminishing) strains can occur outside the limits of longwall extraction for distances up to one cover depth (based on the Upper 95% Confidence limit curve). It is assessed that strains will be <0.5 mm/m at a distance equal to 0.5 x cover depth.

It should be noted that the model was based on steel tape measurements which did not extend further than a distance equal to the 1.5 times the cover depth from the extraction limits. Any FFS predictions that are >1.5 times the cover depth from the panels in this report are therefore an extrapolation of the regression lines for the database and likely to be conservative.

**Potential Impacts**

The surface features that have been assessed in this study for potential FFD and FFS impacts due to mining of the proposed pillar extraction panels include:

- Transgrid suspension towers 25B and 26B.

- F3 Freeway

As previously discussed, an SCZ setback distance has been applied to the above items that will minimise the potential for significant FFD or FFS impact. The SCZ setbacks are not the same for each feature and have been determined based on conservative tolerance strain limit estimates (shown in brackets below)

The design SCZ setback distances adopted in this study are summarised below in terms of 'angle of draw' from the pillar extraction limits to the surface feature:

**Transgrid Towers No. 25B and 26B** (tensile strain < 2.5 mm/m) - 0.5 x cover depth (26.5$^{o}$ angle of draw), which gives a minimum set-back distance of 74 m for a cover depth of 147 m at the centre of the tower. The proposed panels P20 - P26 are 117 m and 390 m to the south east of the towers respectively (or 0.79 and 2.29 times the cover depth from the tower centres to give angles of draw of 38$^{o}$ and 66$^{o}$).

**F3 Freeway** (tensile strain < 0.5 mm/m and lateral curvature radii > 200 km) - 1 x cover depth (45$^{o}$ angle of draw), which gives a minimum set-back distance range of 132 m to 137 m from the freeway. The proposed panels P14 to P19 are approximately 609 m to 1252 m west of the freeway or 4.61 to 9.13 times the cover depth (i.e. 78$^{o}$ to 84$^{o}$ angle of draw).

The suspension towers within the SMP area all have cruciform footings installed and will therefore tolerate significantly higher ground strains (e.g. > 10 mm/m).

Predictions of worst-case FFDs and FFSs are summarised in **Table 35**.

**Table 35 - Summary of Far-Field Displacement and Strain Predictions for the Proposed Pillar Extraction Panels**

| Panel # | Feature | z (m) | H (m) | z/H | AoD (o) | Final $S_{max}$ (m) | FFD (mm) | FFS (mm/m) | Principal Movement Direction |
|---|---|---|---|---|---|---|---|---|---|
| 15 | F3 Freeway | 609 | 132 | 4.61 | 78 | 1.45 | 0 | 0.0 | W |
| 19 | F3 Freeway | 1252 | 137 | 9.14 | 84 | 1.45 | 0 | 0.0 | W |
| 20 | B26 | 110 | 145 | 0.76 | 37 | 1.20 | 24 | 0.6 | N-NNW |
| 20 | B25 | 406 | 170 | 2.39 | 67 | 1.20 | 3 | 0 | N-NNW |

Notes:
z = normal distance to feature from panel centreline.
H = Cover depth at panel end.
AoD = effective angle of draw.
Final $S_{max}$ = Final maximum panel subsidence (mean values).
FFD = Predicted far-field displacement (mean value).
FFS = Predicted far-field strain (U99%CL value).

The results of the analysis indicate that the Transgrid suspension towers B25 and B26 may be displaced north to north north west by 3mm and 24 mm respectively after Panels 20 to 26 are extracted. Tensile ground strains at the towers range from 0.0 to 0.6 mm/m at an AoD of 72$^{o}$.

The F3 Freeway is assessed to be well outside the limits of measureable displacement and strain (i.e. +/-10 mm and +/- 0.3 mm/m) and will not require any further management plans to be implemented for SMP Area 2.

It is considered that the impact of the predicted FFD and FFS values are within the tolerable limits of the features assessed.

**Impact Management Strategies**

The proposed set-back distances of high extraction mining to the sensitive features will reduce the potential for damage occurring to very low likelihoods (ie < 1% probability of occurrence). Monitoring of ground and feature movements as subsidence develops will still be necessary however at the Transgrid tower 26B.

It should also be understood that the predicted displacements and strains are likely to be < currently available survey accuracy limits and will therefore be practically immeasurable. The monitoring may therefore be limited to visual inspections during mining only.

## 11.2.1.7 Flood Levels on Black Hill Pty Ltd Land

**Potential Impacts**

As noted earlier in this report, the pre-mining 1 in 100 Year ARI flood levels for the Black Hill Pty Ltd were provided by the stakeholder to assess potential flooding impacts due to the proposed mining layout.

The post-mining 1 in 100 Year ARI flood levels will require a hydrological assessment based on the predicted surface levels prepared in this study. For indicative purposes, the worst-case flood levels have been estimated from the predicted post-mining contours.

It is estimated that the areal extent of flooding due to the 1 in 100 year event may increase by up to 5% for the subsided reaches of two Viney Creek tributaries above Panels 15, 17 and 18.

**Impact Management Strategies**

As noted above, a post-mining hydrological assessment of the Black Hill Land Pty Ltd site should be completed by the stakeholder for both the current site and re-developed site conditions. The assessment should determine if any additional drainage system measures may be required as a result of mine subsidence.

## 11.2.2 Watercourses

**Cracking**

**Potential Impacts**

It is anticipated there could be soil or bedrock crack development with a low potential for sub-surface transfer of stream flow in the Viney Creek tributaries, upstream of the Schedule 2 stream reach. This has been discussed in **Section 11.2.1.1**.

**Ponding**

**Potential Impacts**

Ponding refers to the potential for closed-form depressions to develop at the surface after mining of total extraction panels beneath gentle slopes and relatively flat terrain. Ponding could affect drainage patterns, flora, fauna and groundwater dependent ecosystems.

The actual ponding depths will depend upon several other factors, such as rain duration, surface cracking and effective percolation and evapo-transpiration rates.

The potential ponding depths and volumes for the proposed mining layout has been estimated from the 1 m post-mining topographic contours shown in **Figure 28a of Appendix A**. The 1 m pre-mining topographic contours are shown in **Figure 28b of Appendix A** for comparison.

The potential worst-case pond depths, affected area and volume along each creek or flat areas above the middle of proposed panels, before and after mining, are summarised in **Table 36**.

**Table 36 - Potential Worst-Case Ponding Assessment for SMP Area 2 Panels**

| **Location** (see **Figures 28a** and **28b**) | **Pre-Mining Ponds** | | | | **Post-Mining Ponds** | | | | **Ponded Area Increase After Mining#** |
|---|---|---|---|---|---|---|---|---|---|
| | **Max Pond RL** | **Max. Depth (m)** | **Size L x B** | **Area (ha) [Vol] (ML)** | **Max Pond RL** | **Max. Depth (m)** | **Size L x B (m)** | **Area (ha) [Vol] (ML)** | **Area (ha) [Vol] (ML)** |
| Panel 23 (south) | - | - | - | **-** | 35.35 | 0.8 | 80x40 | **0.25 [1.01]** | **0.25 [1.01]** |
| Panel 23 (north) | - | - | - | **-** | 31.60 | 0.8 | 95x23 | **0.17 [0.69]** | **0.17 [0.69]** |
| Panel 24 (north) | 35.0 | 0.9 | 75x29 | **0.17 [0.77]** | 34.1 | 1.0 | 64x25 | **0.13 [0.63]** | **-0.04 [-0.14]** |
| Panel 25 (north1) | 38.1 | 0.3 | 50x28 | **0.11 [0.55]** | 37.50 | 0.9 | 84x39 | **0.26 [1.16]** | **0.15 [0.61]** |
| Panel 25 (north2) | - | - | - | **-** | 38.0 | 1.0 | 35x26 | **0.07 [0.36]** | **0.07 [0.36]** |
| Panel 26 (north) | - | - | - | **-** | 40.0 | 1.0 | 69x26 | **0.14 [0.70]** | **0.14 [0.70]** |

Pond Area = π x pond width x pond length/4;
Pond Volume = Area x Maximum Pond Depth/2.
# - Net increase = Post-mining pond - pre-mining pond.

Based on the results, it appears that approximately six closed form depressions with volumes ranging from 0.36 ML to 1 ML could develop along the Viney Creek tributaries or gullies above the central areas of Panels 23 to 26. The 'ponds' are estimated to have maximum potential pond depths of 0.8 to 1.0 m.

Two of the pond locations exist above Panels 24 and 25 and are already depressions, with one of the depressions above Panel 24 expected to be decrease (after mining) from 0.77 ML to 0.63 ML.

### Impact Management Strategies

An appropriate ponding management strategy may include:

(i) The development of a suitable monitoring and mitigation response plan, based on consultation with the regulatory government authorities to ensure ponding impacts on existing vegetation do not result in long-term environmental degradation.

(ii) The review and appraisal of changes to drainage paths and surface vegetation in areas of ponding development (if they occur), after each panel is extracted.

Overall, the impact of the increased ponding along the creek beds is likely to be 'in-channel' and therefore the potential effects on existing flora and fauna is likely to be minimal. However further assessment on the ponding impacts may be needed by specialist ecological consultants to confirm this assessment. Local experience to-date suggests that increased in channel ponding can either remain as a water source or be remediated if required.

### 11.2.3 Groundwater Resources

#### 11.2.3.1 Impact on Groundwater Supply

Within the SMP application area there are no known groundwater extraction licences issued by the Department of Environment Climate Change and Water (DECCW).

With the absence of any groundwater users in the SMP application area the development will not impact on groundwater users.

There are no dams in the SMP application area that collect water from shallower aquifers relying on groundwater for their water supplies.

As part of the SMP groundwater impact assessment it is necessary to assess the potential for future usage of the groundwater resources in the SMP application area.

It is unlikely that the aquifers identified contain significant groundwater resources that could be used in the future.

#### 11.2.3.2 Impact on Aquifers

The main effect of the underground mining upon the groundwater regime comes from changes in bulk rock mass permeability caused by fracturing associated with subsidence and the pumping out of groundwater that enters the mine as a consequence. This caving and associated extraction of groundwater has a number of effects on the hydrogeological system during mining operations.

These include :

- Inflow of water to the underground mine and the management of that mine water;
- Impacts on groundwater levels during operational mining within the Permian hard rock strata.

Incremental impacts on a regional level are considered to be minimal.

Once mining is completed, and pumping from the mine ceases, the strata will re-pressurise as the mine fills with water. Previous experience indicates that the pre-mining hydrogeological conditions will eventually re-establish following mining.

#### 11.2.3.3 Mine Water Make

Groundwater inflow rates at the Abel mine workings are measured using a flow meter on the mine water extraction pipeline. Comparison with the 2006 Water Management Studies conducted as part of the project environmental assessment is not straightforward, as the mine scheduling and plan utilised in the 2006 study vary slightly to the actual mining carried out. This means that actual mine flows have a slightly different "phasing" than those predicted in the 2006 report. However, in terms of quantity, mine inflow rates to date have been relatively stable, with an average inflow rate of approximately less than 1.5 Ml / day and these rates are in line with the predicted rates from groundwater modeling undertaken during the Environmental Assessment. The impact of mining is expected to lead to a minor increase in water make in the mine.
This increased water make will not impact on the surface environment of the SMP application area as mine water is pumped to the surface but not within the SMP application area.

### 11.2.4 Swamps, Wetlands and Water Related Ecosystems

None located in SMP Area. No impact predicted any of these items located outside the SMP Application Area.

### 11.2.5 Flora and Fauna

#### 11.2.5.1 Impact on Flora Habitat

Some surface disturbance may occur within the SMP application area, but this would have a minor impact upon any flora.

Given the limited extent of weeds throughout SMP Area 2 and the levels of native vegetation cover, it is considered unlikely that the proposed development will result in a significant increase in weed infestations.

#### 11.2.5.2 Impact on Threatened Flora Species

The Atlas of NSW Wildlife published by the National Parks and Wildlife Service indicates that only one plant species listed in schedules to the TSC Act 1995 have been recorded within a 5km radius of the study area. The field survey did not reveal any populations of any of this threatened plant species within the SMP Area 2.

As no confirmed specimens were found and the development is only likely to have a localised impact in terms of surface expression of subsidence, it is considered that there will be no impact on this threatened species.

#### 11.2.5.3 Impact on Fauna Habitat

Some surface disturbance may occur within the SMP application area, but this would have a minor impact upon any fauna.

Subsidence due to underground mining may result in lowering of the surface. This can result in cracking of valley floors and creek lines and with subsequent effects on surface hydrology.

Subsidence may result in some changes to these formations, but the changes are those that occur naturally although there may be some small loss of existing habitat for some species, the new habitats created will allow animals dependent upon rock formations to continue to use the area.

There are no permanent watercourses or swamps within SMP Area 2 that will be subject to pillar extraction (Viney Creek is protected by a SCZ), and the ephemeral nature of these watercourses would not significantly change as a consequence of subsidence. Any cracks within a watercourse bed will be remediated.

The flora and fauna associated with the watercourses within SMP Area 2 are already adapted to intermittent dry conditions, so any changes to surface water flows should not affect plants and animals.

### 11.2.5.4 Impact on Threatened Fauna Species

Impacts on the threatened species are not likely, as habitat areas will not be significantly affected from mining induced subsidence. The predicted subsidence levels will not be sufficient to significantly alter potentially sensitive habitat.

Seven Part Tests of significance were undertaken for each of the species listed under the TSC Act to determine whether the species or their habitat would be significantly impacted by the secondary mining. It was determined that none of the species would be significantly affected, either because subsidence would not have a significant impact, or because it was unlikely that the species occurs in the area due to lack of suitable habitat.

The ongoing effects of subsidence on threatened fauna will be monitored using systematic monitoring surveys in the SMP application area to detect any changes in species diversity and abundance.

### 11.2.5.5 Endangered Ecological Communities

The only Threatened or Endangered Ecological Communities (EEC) within the SMP application area is the Lower Hunter Spotted Gum-Ironbark Forest. No significant impact is predicted.

### 11.2.6 Roads (All types) and Culverts

**Details and Potential Impacts**

Blackhill Road will be undermined by the proposed SMP Area 2 Panels 23 to 26. The road is a bitumen sealed, dual carriageway within the Cessnock City Council district.

The road is 7 m wide with 1m wide unsealed shoulders. The road formation is generally on-grade with two filled embankments up to 3 m high placed where the road crosses ephemeral drainage gullies associated with Viney Creek.

A 900 mm diameter reinforced concrete pipe (RCP) culvert and headwalls provide drainage through the fill above the barrier pillar between Panels 25 and 26. The downstream headwall for this culvert (Culvert No. 1) consists of a 1.8 m high by 2.5 m long gabion basket retaining wall.

The second culvert (Culvert No. 2) consists of two 1200 mm diameter RCP and headwalls in the fill above Panel 23.

Taylors Road is an unsealed gravel dual carriageway which provides access to private residences to the south of SMP Area 2.

A summary of the predicted subsidence effects acting on the road, fill embankments and culverts due to Panels 23 to 26 are presented in **Table 37**.

A number of private sealed and unsealed access roads and tracks (all private) are also located across the surface of SMP Area 2.

The worst-case subsidence predictions along these private roads after mining is completed will be such that remediation work may be required. This remediation strategy will form part of the Property Subsidence Management Plan.

**Table 37 - Summary of Worst-Case Subsidence Predictions for Black Hill and Taylors Road due to Panels 23 to 26**

| Location | Panels | Cover Depth (m) | Final Maximum Subsidence $S_{max}$ (m) | Final Maximum Tilt $T_{max}$ (mm/m) | Final Maximum Tensile Strain * (mm/m) | Final Maximum Compressive Strain* (mm/m) | Final Horizontal Displacement (mm) |
|---|---|---|---|---|---|---|---|
| Black Hill Road | 23 | 135 | 0.60 | 11 | 3 | 3 | 110 |
| | 24 | 125 | 0.57 | 10 | 5 | 3 | 100 |
| | 25 | 120 | 1.39 | 24 | 6 | 4 | 240 |
| | 26 | 110 | 1.34 | 23 | 4 | 4 | 230 |
| Fill & Culvert 1 | 25/26 | 115 | 0.10 | 6.5 | 12 | - | 65 |
| Fill & Culvert 2 | 23 | 135 | 0.77 | 23 | 1.5 | 2 | 230 |
| Taylors Road | 26 | 130 | 1.34 | 17 | 3 | 12 | 124 |

* - Tensile and compressive strains may increase 2 to 4 times locally due to crack development.

Graphical representation of the final subsidence, tilt, curvature, horizontal displacement and strain profiles along Black Hill Road are presented in **Figures 34a** to **34e** of **Appendix A**.

The impacts due to the predicted subsidence effects may include:

- Tensile crack widths of between 30 mm to 120 mm.
- Compressive shearing or shoving between 20 mm to 40 mm
- Loss or increase of super-elevation at bends in the road of +/- 1% to 2.5%.
- Cracking of culverts and fill embankments.
- Erosion and slope instability of fill embankments.

Similar cracking and shearing impacts are also expected along Taylors Road.

**Impact Management Strategies**

Impact management strategies for the Black Hill and Taylors Road will require the following:

(i) Condition assessment survey of road and drainage infrastructure prior to commencement of second workings.

(ii) Installation of subsidence monitoring lines along one side of road to review measured impacts and predictions.

(iii) On-going consultation with Cessnock City Council (CCC) in regards to preparation of a Public Road Management Plan for managing mine subsidence impacts within the road corridors.

The stakeholder should be notified of mine subsidence survey results and mining activities in advance of subsidence development adjacent to the mine. The Public Road

Management Plan will also include an emergency response plan to unanticipated mining related impacts.

## 11.2.7 Water Supply Lines

### 11.2.7.1 Hunter Water Corporation UPVC Supply

**Potential Impacts**

The Hunter Water pipeline is buried within a trench that traverses the site above the proposed East Mains and Panel 2 pillar extraction panels in SMP Area 1 and the Tailgate Headings, Panel 20 and 21 in SMP Area 2.

The worst-case subsidence predictions along the pipeline easement after mining is complete are presented in **Table 38**.

**Table 38 - Worst-Case Subsidence Predictions for the Hunter Water Pipeline Easement**

| Panel | Cover Depth (m) | Mining Height (m) | Final Subsidence $S_{max}$ (m) | Final Tilt $T_{max}$ (mm/m) | Final Curvature $C_{max}$ ($km^{-1}$) | | Final Horiz. Displacement (mm) | | Final Ground Strain* (mm/m) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | In-line | Lateral | In-Line | Lateral | In-Line | Lateral |
| 2 | 70 | 2.5 | 0.58 | 14 | -0.8 to 0.6 | -0.35 to 0.5 | 136 | 370 | -8 to 6 | -3.5 to 5 |
| East Mains | 90 | 2.8 | 1.19 | 29 | -0.9 to 1.0 | -0.1 to 0.2 | 290 | 73 | -9 to 10 | -1 to 2 |
| 1 | 105 | 2.8 | 1.27 | 28 | -1.0 to 1.3 | -0.3 to 0.2 | 280 | 49 | -10 to 13 | -3 to 2 |
| TG Mains | 115 | 2.8 | 0.96 | 21 | -1.2 to 0.6 | -0.1 to 0.1 | 210 | 205 | -12 to 6 | -1 to 1 |
| 21 | 135 | 2.8 | 0.20 | 4 | -0.2 to 0.1 | -0.1 to 0.15 | 40 | 157 | -2 to 1 | -1 to 1.5 |
| 20 | 140 | 2.2 | 0.25 | 4 | -0.2 to 0.1 | -0.1 to 0.05 | 40 | 153 | -2 to 1 | -1 to 0.5 |

* - tensile strain is positive.

Graphical representation of the final subsidence, tilt, curvature, horizontal displacement and strain profiles along the Hunter Water pipeline easement are presented in **Figures 38a** to **38e** of **Appendix A**.

Based on reference to **Ho and Dominish, 2004**, the impact of the predicted subsidence movements will be dependent on the tolerable limits of the UPVC pipeline walls and rubberised ring joints to the induced bi-lateral curvatures and tensile/compressive strains acting along the pipeline. Both parameters are likely to increase or decrease the normal and shear stresses in the pipeline wall.

The generation of stress in the pipeline walls due to curvature in both the vertical and horizontal planes will be a function of the pipe wall thickness, pipe diameter and Young's Modulus of the pipe material and internal operating pressures.

The transfer of strain (and stress) into the pipe wall will also be dependent on the depth of backfill over the pipe and the coefficient of friction between the trench backfill and the pipe wall.

The deformed shape of the pipeline after mining should therefore be assessed by Hunter Water Engineers in order to determine whether mitigation works will be required during subsidence development.

**Impact Management Strategies**

The proposed management strategies required to minimise impact on the pipeline due to subsidence are:

- An agreed Management Plan has been implemented for SMP Area 1 in consultation with Hunter Water. This document will be reviewed and updated for SMP Area 2.
- Confirm tolerable in-line and lateral pipeline deformation limits to be used for trigger action responses based on consultation with Hunter Water engineers.
- Install survey pegs and monitor the deformation of the ground surface along and across representative sections of the pipeline.
- Uncover the pipeline sections where deformations and strains have exceeded the tolerable or agreed trigger action response limits.
- Re-align the pipeline, replace damaged sections and backfill prior to re-commissioning.

## 11.2.8 Electricity Transmission Lines

## 11.2.8.1 Transgrid 330Kv Transmission Towers

**Predicted Subsidence and Potential Impacts**

Due to the decision of the mine to extract coal from SMP Areas 1 and 2 simultaneously, it has been necessary to re-assess the predicted tower subsidence values presented in **DgS, 2009** for the SMP Area 1 panels. A total of eleven Transgrid towers (26B to 36B) are potentially within the zone of vertical and/or horizontal displacement due to SMP areas 1 and 2.

Predictions of worst-case final subsidence, tilt and strain at each of the Transgrid Towers inside SMP Area 2 have been made based on **Figures 16a,b** to **20a,b** of **Appendix A**. Transient or dynamic affects have also been assessed using the measured subsidence development rates for Panels 1 and 2 in SMP Area 1 and the prediction methodology provided in **SDPS, 2007**.

Detailed descriptions and predictions of the worst-case transient and final subsidence related movements at Transgrid Towers (26B to 36B) are provided in a separate report (**DgS, 2010**)

A summary of the subsidence prediction results for each tower (in logistical order of subsidence development) are re-presented in **Tables 39** to **41**.

The location of the towers and graphical representation of the analysis results for each tower are given in the abovementioned report for the predicted subsidence, tilt, strain and horizontal displacement respectively. The results are associated with 'smooth' subsidence profile development and do not include discontinuous strata behaviour effects.

### Table 39 - Transgrid Tower Locations and Mining Geometry

| Tower # | Panel # | Panel Width W (m) | Cover Depth Above Panel Rib H (m) | Average Mining Height (m) | Panel $S_{max}$ (m) | Panel Length L (m) | Inflexion Point Distance from Panel Side d(m) | Tower Distance From Start $y^+$ (m) | Tower Distance from Panel Side x* (m) |
|---|---|---|---|---|---|---|---|---|---|
| 28B | 18 | 160.5 | 127 | 2.8 | 1.36 | 390 | 36 | 11 | 42 |
| 29B | 17 | 160.5 | 112 | 2.8 | 1.43 | 415 | 32 | 281 | 74 |
| 31B | 7 | 160.5 | 85 | 2.2 | 1.31 | 604 | 33 | 552 | 67 |
| 32B | 8 | 160.5 | 74 | 2.2 | 1.25 | 600 | 34 | 346 | 67 |
| 33B | 8<br>9 | 160.5<br>160.5 | 70(54)<br>70(54) | 2.4<br>2.4 | 1.34<br>1.34 | 600<br>394 | 34<br>26 | 70<br>-102 | -165<br>60 |
| 34B | 10 | 160.5 | 67 | 2.4 | 1.34 | 440 | 26 | 31 | 27 |
| 36B | 11 | 160.5 | 100 | 1.9 | 1.04 | 225 | 29 | 63 | -149 |
| 35B | East Mains | 125 | 91 | 2.1 | 1.00 | 281 | 33 | -5 | 0 |
| 30B | East Mains | 125 | 99 | 2.5 | 1.32 | 1265 | 33 | 605 | 15 |
| 27B | 20 | 182 | 136 | 2.2 | 1.21 | 225 | 35 | 49 | 42 |
| 26B | 20 | 182 | 147 | 2.2 | 1.21 | 225 | 35 | -117 | 77 |

**+ -** positive distance measured from starting end of panel and within panel limits.
* - positive distance measured from nearest side of panel and within panel limits.
Negative values indicate tower is located outside of panel limits.
(54) - cover depth at Tower 33B

### Table 40 - Transient* Subsidence Impact Parameter Development at the Transgrid Towers

| Tower # | Final Tower Subsidence $S_{max}$ (m) | Maximum Tilt $T_{max}$ (mm/m) | | Maximum Horizontal Displacement $HD_{max}$ (mm) | | Initial Tower Movement Direction (grid bearing(°) | Maximum Tensile Strain^ $+E_{max}$ (mm/m) | | Maximum Compressive Strain^ $-E_{max}$ (mm/m) | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Face Retreat Rate:** | | **30 m/wk** | **<10 m/wk** | **30 m/wk** | **<10 m/wk** | | **30 m/wk** | **<10 m/wk** | **30 m/wk** | **<10 m/wk** |
| 28B | 0.21 | 16 | 16 | 158 | 158 | 341 | 7 | 7 | 0 | 0 |
| 29B | 1.45 | 0 | 1 | 3 | 10 | 144 | 0 | 2 | 0 | 3 |
| 31B | 0.88 | 17 | 33 | 170 | 330 | 324 | 5 | 13 | 9 | 12 |
| 32B | 1.27 | 21 | 38 | 210 | 380 | 144 | 8 | 15 | 12 | 17 |
| 33B | 0.00 | 0 | 0 | *2* | *5* | 144 | 0 | 0 | 0 | 0 |
| 34B | 0.58 | 43 | 43 | 430 | 430 | 172 | 6 | 19 | 8 | 16 |
| 36B | 0.00 | 0 | 0 | 0 | 0 | 268 | 0 | 0 | 0 | 0 |
| 35B | 0.02 | 2 | 2 | 20 | 20 | 185 | 1 | 1 | 0 | 0 |
| 30B | 0.31 | 25 | 25 | 250 | 250 | 054 | 10 | 10 | 0 | 0 |
| 27B | 0.52 | 19 | 19 | 190 | 190 | 196 | 2 | 2 | 2 | 2 |
| 26B | 0.00 | 0 | 0 | 3 | 6 | 324 | 0.1 | 0.1 | 0 | 0 |

* - Refers to subsidence movements directly associated with the retreating extraction face.
^ - Maximum strains refer to major principal strains. Minor principle strains = 0.25 x major principal strains.

### Table 41 - Final* Subsidence Impact Parameter Development at the Transgrid Towers

| Tower # | Final Tower Subsidence $S_{max}$ (m) | Tilt $T_{max}$ (mm/m) | Horizontal Displacem't $HD_{max}$ (mm) | Final Tower Movement Direction grid bearing (°) | Total Tower Rotation# (°) | Major Principal Strain $E_{max}$ (mm/m) | Minor^ Principal Strain $e_{max}$ (mm/m) |
|---|---|---|---|---|---|---|---|
| 28B | 0.21 | 16 | 158 | 341 | 0 | 7 | 2 |
| 29B | 1.45 | 1 | 10 | 199 | 55 | -2 | 0 |
| 31B | 0.88 | 33 | 334 | 327 | 3 | -9 | -3 |
| 32B | 1.27 | 2 | 22 | 099 | -45 | -2 | -1 |
| 33B | 0.00 | 0 | *5* | 144 | 0 | *0.1* | *0.0* |
| 34B | 0.58 | 43 | 425 | 144 | 0 | -16/19 | -4/5 |
| 35B | 0.02 | 2 | 18 | 188 | 0 | 1.5 | 0.2 |
| *36B* | *0.00* | *0* | *28* | *268* | *0* | *1* | *0.2* |
| 30B | 0.31 | 25 | 249 | 324 | -90 | 3.5 | 1 |
| 27B | 0.52 | 19 | 188 | 196 | 0 | -2/2 | -0.5/0.5 |
| *26B* | *0.00* | *0* | *6* | *324* | *0* | *0.1* | *0.0* |
| *25B* | *0.00* | *0* | *1* | *324* | *0* | *0.0* | *0.0* |

* - Refers to subsidence movements after mining of panel has stopped.
# - Clockwise rotation is positive.
^ - minor principal strains = 0.25 x major principal strains; tension is postive.
*Italics* - Far-field displacements and strains are Upper 99%CL values.

### Towers above the Proposed Pillar Extraction Panels

In summary, nine of eleven towers are within the proposed limits of the pillar extraction panels for SMP Areas 1 and 2, and are likely to be subjected to subsidence ranging from 20mm to 1,450mm at the tower centres.

Transient tilts above the pillar extraction panels are estimated to range from 4 to 43 mm/m for the possible range of retreat rates (30 m/week or less). Transient tensile and compressive strains are expected to range from 1mm/m to 19 mm/m, depending on face retreat rates.

Final tower tilts will range between 2 mm/m and 43 mm/m. Horizontal displacements are estimated to range between 20 mm and 430 mm. Four or five of the tower locations are expected to have residual compressive strains ranging from 2 mm/m to 16 mm/m, with the other towers expected to have residual tensile strains ranging from 1 to 19 mm/m.

Surface cracking may increase the estimated 'smooth' profile values by 2 to 4 times if shallow bedrock exists beneath the towers. Local tilts may exceed the smooth profile tilts by 1.5 times due to secondary surface 'hump' development.

Predicted subsidence impact parameter development profiles for the first two towers likely to be effected by Stage 2 Panels 18 and 17 (i.e. Towers 28 and 29) are presented in **Figures 32a-d** and **Figures 33a-d** respectively of **Appendix A.**

**Towers Outside the Proposed Mining Limits**

The suspension tower 26B is very unlikely to be directly affected by subsidence or tilt, but may experience minor far-field movements, which are unlikely to exceed 24 mm horizontal displacement and 0.6 mm/m tensile strain. Tower 25B is assessed to be located outside the practical limits of measureable displacement and strain.

**Impact Management Strategies**

Based on the predicted subsidence profiles for the transmission towers, it is assessed that cruciform footings or subsidence protection pillars would have been necessary above the proposed mining areas to mitigate subsidence impacts on the towers to tolerable limits.

While the towers already have cruciform footings installed, the design limits for the footings (and towers) to resist the predicted movements are uncertain and should be checked by a structural engineer before mine subsidence occurs. Advice from Transgrid is that their preliminary engineering analysis indicates that the cruciform footings are adequate for the predicted levels of subsidence.

Once the tower footings assessment and any necessary mitigation works have been completed, the following monitoring program may be implemented in accordance with a Transgrid Management Plan that will be prepared in consultation with Transgrid:

(i) Install a minimum of four stable survey pegs or stations in the ground adjacent to each tower leg and on the structure itself (including Tower 33B).

(ii) Determine 3-D coordinates (E, N, RL), levels and in-line strains between the pegs (perimeter distances only) with a minimum of two base-line surveys prior to mining. Survey accuracy should be within the limits discussed below.

(iii) Conduct visual inspections and measurement of subsidence, total horizontal displacements and in-line distances between ground and tower stations during mine subsidence development. Record and photograph details of any changes to the towers and adjacent ground (i.e. cracking).

(iv) Measure the vertical distance from the ground to the conductor catenaries between each tower before, during and after subsidence development.

(v) Prepare and distribute results of each survey to relevant stakeholders.

(vi) Review and implement any Trigger Action Response Plans.

Subsidence should be determined using precise levelling and terrestrial total station traverse techniques to determine 3-D coordinates.

## 11.2.8.2 Energy Australia 132kV Transmission Timber Poles

**Potential Impacts**

There are seven  pairs of timber power poles (EA1 to EA7) in the Stage 1 and seven pole pairs (EA8-EA14) in the SMP Area 2. The pole pairs are approximately 15 m high and 5 m apart and are connected by a galvanised steel brace between the tops of the poles. The pole pairs are spaced from 161 m to 269 m along the easement.

The conductors are supported by relatively flexible vertical 'stringers' that will be able to tolerate some adjustment due to pole movements.

Worst-case predictions of final subsidence, tilt, strain and final tilt direction at each pole are presented in **Tables 42** and **43** for SMP Area 1 and 2 panels respectively. The predictions have been determined from the contour predictions presented in **Figures 16a,b** to **20a,b** of **Appendix A**. The clearances of the conductors have also been assessed based on the predicted final subsidence profile for the easement and presented in the tables below.

**Table 42  -  Worst Case Final Subsidence Predictions for Energy Australia 132 kV Power Poles EA1 to EA7 (SMP Area 1 Panels)**

| Pole Pair and Pole No. | Panel No. | Final Subs $S_{max}$ (m) | Final Tilt $T_{max}$ (mm/m) | Final Tilt Direction (grid bearing) (o) | Final Ground Strain (mm/m) | Final HD* Base (mm) | Final HD^ Top (mm) | Final Pole Pair Closure (mm) | Conductor Clearance Loss (m) |
|---|---|---|---|---|---|---|---|---|---|
| *1.1* | *8* | 0.00 | 0 | 234 | *0.1* | 0 | 0 | 0 | 0.62 |
| *1.2* | *8* | 0.00 | 0 | 234 | *0.1* | 0 | 0 | | 0.62 |
| 2.1 | 8 | 1.24 | -7 | 56 | -13 | 75 | 187 | 53 | 1.37 |
| 2.2 | 8 | 1.25 | -5 | 57 | -9 | 54 | 134 | | 1.38 |
| 3.1 | 7 | 1.52 | -5 | 57 | -10 | 55 | 137 | 34 | 1.51 |
| 3.2 | 7 | 1.53 | -4 | 57 | -8 | 41 | 103 | | 1.51 |
| 4.1 | 6 | 1.54 | 0 | 58 | 0 | 0 | 1 | 1 | 1.37 |
| 4.2 | 6 | 1.54 | 0 | 58 | 0 | 0 | 0 | | 1.36 |
| 5.1 | 5 | 1.30 | -4 | 238 | -6 | 43 | 108 | 79 | 0.78 |
| 5.2 | 5 | 1.29 | -7 | 237 | -9 | 75 | 187 | | 0.72 |
| 6.1 | 4 | 0.36 | -31 | 260 | 12 | 307 | 768 | 120 | 0.87 |
| 6.2 | 4 | 0.27 | -26 | 263 | 13 | 259 | 647 | | 0.82 |
| 7.1 | EM | 1.43 | -7 | 258 | -19 | 72 | 180 | 78 | 0.70 |
| 7.2 | EM | 1.41 | -10 | 306 | -19 | 103 | 258 | | 0.70 |

**Table 43 - Worst Case Final Subsidence Predictions for Energy Australia 132 kV Power Poles EA8 to EA14 (SMP Area 2 Panels)**

| Pole Pair and Pole No. | Panel No. | Final Subs $S_{max}$ (m) | Final Tilt $T_{max}$ (mm/m) | Final Tilt Direction (grid bearing) (o) | Final Ground Strain (mm/m) | Final HD* Base (mm) | Final HD^ Top (mm) | Final Pole Pair Closure (mm) | Conductor Clearance Loss (m) |
|---|---|---|---|---|---|---|---|---|---|
| 8.1 | 19/EM | 0.04 | -5 | 101 | 6 | 53 | 133 | 66 | 0.01 |
| 8.2 | 19/EM | 0.06 | -8 | 104 | 7 | 80 | 199 | | 0.03 |
| 9.1 | TG | 0.00 | 0 | 171 | 0 | 3 | 7 | 8 | 0.04 |
| 9.2 | TG | 0.00 | -1 | 169 | 1 | 6 | 15 | | 0.03 |
| 10.1 | TG | -0.07 | 8 | 346 | 7 | 84 | 211 | 39 | 0.03 |
| 10.2 | TG | -0.05 | 7 | 346 | 6 | 69 | 172 | | 0.03 |
| 11.1 | SCZ | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0.54 |
| 11.2 | SCZ | 0.00 | 0 | 0 | 0 | 0 | 0 | | 0.50 |
| 12.1 | 23 | -1.08 | 22 | 253 | -9 | 224 | 561 | 62 | 0.00 |
| 12.2 | 23 | -1.01 | 25 | 252 | -8 | 249 | 623 | | 0.00 |
| 13.1 | 23 | -0.23 | 15 | 75 | 10 | 148 | 370 | 69 | 0.11 |
| 13.2 | 23 | -0.27 | 18 | 75 | 9 | 175 | 438 | | 0.01 |
| 14.1 | 24 | -0.01 | 1 | 46 | 1 | 9 | 21 | 1 | 0.00 |
| 14.2 | 24 | -0.01 | 1 | 40 | 1 | 9 | 22 | | 0.00 |

Pole pair are numbered from west to east (i.e. Pole 1.1 is west of Pole 1.2).
* - HD Base = Absolute horizontal displacement of pole at ground level.
^ - HD top = Absolute horizontal displacement of pole at conductor level (assumed to be 15 m above the ground)
*Italics* - Far-field displacements and strains.

Each of the power pole pairs will be subject to transient movements towards the retreating pillar extraction face. In SMP Area 1, the poles will generally start moving towards the north and then 'swing' around (up to 90 degrees in bearing) to their final positions after subsidence is fully developed. In the SMP Area 2, the poles will move south initially before “swinging” around to their final position.

The poles will also be subject to tensile and compressive strains associated with the subsidence 'wave' as it passes underneath the poles. The transient tilts and strains are expected to range from 50% to 100% of the final values, and will be dependent on face retreat rates.

During subsidence development the distance between the pole pairs will tend to close by between 0 mm and 120 mm in Stage 1 and from 0 mm to 69 mm in Stage 2 (see **Tables 42** and **43**). These movements are primarily due to the differential tilt between the poles that may be exacerbated or reduced by the ground strains.

Conductor clearances are estimated to be decreased by between 0.02 m and 1.17 m along the easement as shown in **Tables 42** and **43**.

### Impact Management Strategies

Appropriate impact management strategies for the Energy Australia transmission line easements may include:

(i) The review of the existing Management Plan for Area 1 based on consultation with the owners of the power line to ensure the predicted subsidence effects on the poles and powerlines do not result in unsafe conditions or loss of serviceability, as a result of subsidence, during and after mining.

(ii) Replacement of any damaged poles and/or mitigation works to conductors as mine subsidence develops.

Suitable responses to predicted subsidence impacts may be to provide flexible/roller-type conductor sheathing on the poles to control the tension during/after mining impacts. It is noted that shortening of several conductors (to reduce catenary sag) and adjustment to sheathing was necessary above Panel 1.

(iii) Damage from subsidence (i.e. cracking and tilting) can manifest quickly after mining (i.e. within hours). The appropriate management plan will therefore need to consider the time required to respond to an impact exceedence if it occurs. The erection of temporary fencing in critical areas before subsidence develops may also need to be considered.

The Management Plan may include the following actions:

(i) Visual inspections of powerlines in actively subsiding areas

(ii) Measurement of the vertical distance from the ground to the conductor catenaries between each pole pair before, during and after subsidence development.

(iii) Preparation and distribution of survey results of each survey to relevant stakeholders.

(iv) Review and implement Trigger Action Responses as necessary.

## 11.2.8.3 Energy Australia 11kV and 415V Transmission Timber Poles

There are forty-nine timber power poles (1 to 49) in SMP Areas 1 and 2 which will be within or just outside the zone of mine subsidence. The poles are approximately 15 m high and 85 m apart on average (distances vary from 31 m to 132 m).

The conductors are supported by relatively inflexible ceramic insulators that will probably not be able to tolerate the predicted pole movements.

Worst-case predictions of final subsidence, tilt, strain and final tilt direction at each pole are presented in **Table 44**. The predictions have been determined from the contour predictions presented in **Figures 16a,b** to **20a,b** of **Appendix A**. The clearances of the conductors have been assessed from the easement subsidence profiles presented in **Figure 36** of **Appendix A**.

## Table 44 - Worst-Case Final Subsidence Predictions for Energy Australia 11 kV Power Poles in the SMP Areas 1 and 2

| Pole No. | E | N | Maximum Subsidence $S_{max}$ (m) | Final Tilt+ $T_{max}$ (mm/m) | Final Tilt Direction (grid) (o) | Final Ground Strain& (mm/m) | Final HD* Base (mm) | HD^ Top (mm) | Conductor Clearance Loss (m) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 370798 | 6368197 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0.02 |
| 2 | 370820 | 6368126 | 0.04 | 11 | 151 | 19 | 114 | 284 | 0.03 |
| 3 | 370777 | 6368016 | 0.06 | 17 | 236 | 24 | 166 | 416 | 0.68 |
| 4 | 370753 | 6367997 | 1.30 | 40 | 235 | -34 | 397 | 992 | 1.41 |
| 5 | 370724 | 6367918 | 1.52 | 7 | 58 | -13 | 67 | 168 | 1.36 |
| 6 | 370674 | 6367809 | 1.24 | 43 | 235 | -30 | 432 | 1080 | 1.14 |
| 7 | 370631 | 6367696 | 1.03 | 53 | 53 | -18 | 526 | 1315 | 1.11 |
| 8 | 370584 | 6367577 | 1.28 | 1 | 250 | -2 | 8 | 21 | 1.12 |
| 9 | 370553 | 6367510 | 1.10 | 27 | 54 | -21 | 268 | 670 | 0.63 |
| 10 | 370526 | 6367446 | 0.16 | 23 | 233 | 20 | 228 | 571 | 0.68 |
| 11 | 370495 | 6367377 | 1.41 | 2 | 150 | -2 | 23 | 58 | 1.36 |
| 12 | 370479 | 6367313 | 1.31 | 20 | 54 | -18 | 196 | 490 | 0.77 |
| 13 | 370445 | 6367229 | 0.57 | 43 | 234 | 9 | 431 | 1077 | 0.43 |
| 14 | 370405 | 6367131 | 0.29 | 31 | 328 | 17 | 305 | 763 | 0.13 |
| 15 | 370348 | 6367019 | 0.17 | 21 | 151 | 13 | 207 | 518 | 0.15 |
| 16 | 370295 | 6366898 | 0.12 | 15 | 341 | 11 | 149 | 371 | 0.50 |
| 17 | 370255 | 6366800 | 1.05 | 31 | 202 | -9 | 306 | 764 | 0.96 |
| 18 | 370217 | 6366726 | 0.87 | 35 | 344 | -2 | 352 | 880 | 0.49 |
| 19 | 370193 | 6366664 | 0.62 | 25 | 164 | -1 | 250 | 625 | 0.24 |
| 20 | 370143 | 6366685 | 0.34 | 19 | 345 | 19 | 189 | 474 | 0.00 |
| 21 | 370102 | 6366700 | 1.03 | 35 | 344 | -9 | 351 | 877 | 0.00 |
| 22 | 370083 | 6366663 | 0.26 | 9 | 306 | 22 | 86 | 214 | 0.37 |
| 23 | 370057 | 6366600 | 1.00 | 2 | 287 | -17 | 24 | 61 | 0.64 |
| 24 | 370009 | 6366499 | 0.47 | 31 | 164 | 7 | 306 | 765 | 0.00 |
| 25 | 369944 | 6366485 | 0.40 | 28 | 164 | 9 | 280 | 700 | 0.00 |
| 26 | 369833 | 6366446 | 0.63 | 32 | 164 | 1 | 324 | 811 | 0.00 |
| 27 | 369779 | 6366425 | 0.79 | 31 | 164 | -5 | 315 | 787 | 0.00 |
| 28 | 369713 | 6366398 | 1.00 | 26 | 164 | -11 | 258 | 646 | 0.00 |
| 29 | 369650 | 6366377 | 1.08 | 22 | 165 | -12 | 218 | 545 | 1.01 |
| 30 | 369662 | 6366193 | 1.14 | 23 | 80 | -11 | 232 | 581 | 0.52 |
| 31 | 369616 | 6366134 | 0.10 | 6 | 248 | 12 | 61 | 153 | 0.00 |
| 32 | 369582 | 6366080 | 1.02 | 21 | 251 | -10 | 206 | 516 | 0.00 |
| 33 | 369460 | 6365995 | 0.01 | 2 | 78 | 2 | 17 | 42 | 0.00 |
| 34 | 369332 | 6365906 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| 35 | 369965 | 6366377 | 0.25 | 22 | 345 | 11 | 221 | 553 | 0.73 |
| 36 | 369913 | 6366233 | 1.27 | 15 | 255 | -10 | 155 | 386 | 0.00 |
| 37 | 369899 | 6366136 | 1.38 | 3 | 56 | -3 | 28 | 71 | 0.00 |
| 38 | 369885 | 6366040 | 0.88 | 28 | 74 | -5 | 279 | 698 | 0.00 |
| 39 | 369872 | 6365791 | 0.07 | 1 | 260 | -1 | 7 | 17 | 0.00 |
| 40 | 369792 | 6365825 | 0.00 | 0 | 102 | 0 | 2 | 4 | 0.00 |
| 41 | 369834 | 6365744 | 0.02 | 1 | 34 | 0 | 14 | 34 | 0.00 |
| 42 | 369685 | 6365712 | 0.52 | 22 | 271 | 1 | 225 | 561 | 0.00 |
| 43 | 369788 | 6365689 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| 44 | 369929 | 6365860 | 0.00 | 0 | 268 | 0 | 2 | 4 | 0.00 |
| 45 | 370402 | 6366188 | 0.39 | 22 | 73 | 6 | 221 | 552 | 0.00 |
| 46 | 370399 | 6366144 | 0.15 | 9 | 70 | 8 | 93 | 232 | 0.00 |
| 47 | 370396 | 6366109 | 0.10 | 3 | 146 | 8 | 33 | 84 | 0.00 |
| 48 | 370393 | 6366072 | 0.08 | 5 | 302 | 4 | 46 | 114 | 0.00 |
| 49 | 370395 | 6366030 | 0.02 | 1 | 176 | 1 | 13 | 33 | 0.00 |

+ - Transient tilts due to travelling subsidence wave may be assumed to equal the final tilt magnitudes at a given location. Further analysis may be required if marginal conditions indicated.

& - Transient strains may be assumed to range from +/- Final Values.
* - HD Base = Absolute horizontal displacement of pole at ground level.
^ - HD top = Absolute horizontal displacement of pole at conductor level (assumed to be 15 m above the ground)
**Bold** – Area 2 poles.

The power poles will be subject to transient movements towards the retreating pillar extraction face. The poles will generally start moving towards the north and then 'swing' around (up to 90 degrees in bearing) to their final positions after subsidence is fully developed. The poles will also be subject to tensile and compressive strains associated with the subsidence 'wave' as it passes underneath the poles. The transient tilts and strains are expected to range from 50% to 100% of the final values, and will be dependent on face retreat rates.

Conductor clearances are estimated to be decreased by between 0.00 m and 1.21 m along the easement as shown in **Table 44**.

**Impact Management Strategies**

Appropriate impact management strategies for the Energy Australia 415V transmission line easements will be identical to those for the 132kV transmission lines

## 11.2.9 Telecommunication Cables

### 11.2.9.1 Optus Fibre Optic Cable

**Potential Impacts**

The Optus Fibre Optic cable is buried within a shallow trench that is located within the Transgrid transmission line easement.

The worst-case final subsidence predictions along the easement after mining are presented in **Table 45**.

**Table 45 - Worst-Case Subsidence Predictions for the Optus Fibre Optic Cable Easement**

| Panel | Cover Depth (m) | Mining Height (m) | Final Subsidence $S_{max}$ (m) | Final Tilt $T_{max}$ (mm/m) | Final In-Line Ground Strain* (mm/m) | | Final Principal Ground Strain+ (mm/m) | |
|---|---|---|---|---|---|---|---|---|
| 20 | 140 | 2.2 | 1.09 | 16 | -2 | 1 | -5.5 | 5 |
| 18 | 125 | 2.8 | 1.31 | 19 | -3 | 4 | -9 | 12.5 |
| 17 | 110 | 2.8 | 1.45 | 21 | -3 | 4 | -12 | 13 |
| 16 | 105 | 2.8 | 0.08 | 2 | -1 | 1 | - | 3.5 |
| East Mains | 95 | 2.5 | 1.17 | 20 | -4 | 3 | -14 | 13.5 |
| 7 | 85 | 2.2 | 1.19 | 22 | -7 | 5 | -16.5 | 20 |
| 8 | 75 | 2.2 | 1.29 | 25 | -5 | 5 | -22 | 21 |
| 10 | 67 | 2.35 | 1.13 | 25 | -7 | 6 | -24 | 26 |
| East Mains | 92 | 2.10 | 0.01 | 1 | -0.2 | 0.2 | - | 3 |

* - Predicted in-line strains are based on 'smooth' subsidence profiles and may increase locally by 2 to 4 times due to surface cracking.
+ - Predicted principle strains are U95%CL values and include an allowance for surface cracking effects.

Graphical representation of the final subsidence, tilt and strain profiles along the Optus FOC easement are presented in **Figures 37a** to **37c** of **Appendix A**.

**Impact Management Strategies**

Based on discussions with Optus engineers, the following strategies are available to mitigate against cable impacts if horizontal strains exceed 2 mm/m:

- Uncover and relocate the cable prior to mine subsidence impacts
- Reroute and replace the FOC after mine subsidence impact occurs
- Limit subsidence impacts to within tolerable limits (details have been requested and yet to be supplied)

Optus have advised that the predicted subsidence levels exceed the safe characteristics of the fibre optic cable and Optus is of the view that the most appropriate method to manage the possible subsidence impacts is to relocate the cable to a route outside the predicted subsidence area.

Following further consultation, Optus and Donaldson Coal have written to the Mine Subsidence Board, outlining the proposed relocation of the fibre optic cable and requesting acceptance and approval of the works.

### 11.2.9.2 Telstra Copper Cables

**Potential Impacts**

The Telstra copper cables are buried within shallow trenches located throughout the SMP Area (see **Plan 2**).

These cables will be subject to various levels of subsidence effect.

**Impact Management Strategies**

A Management plan will be developed in consultation with Telstra to maintain the serviceability of the currently in service cables. Consultation with Telstra as to the design tolerances, location and Management Plan has already commenced.

### 11.2.10 Farm Buildings / Sheds

The properties on the surface above SMP Area 2 contain various farm buildings, sheds and other outbuildings as well as houses (both Principal Residences and Other Surface Structures.

Potential impact from subsidence and impact management strategies are addressed in **Section 11.2.15**.

### 11.2.11 Fences, stockyards, holding areas, gates and cattle grids

**Potential Impacts**

The impact of up to 1,450mm of subsidence on fencing and associated items could include the development of surface cracks and erosion, breakage of wire fencing strands and the movement and possible failure of strainer posts and cattle grids.

Failure of fencing or associated items or subsidence within holding areas could result in not being able to control movement of cattle around the site or not allow the movement of cattle though certain holding areas to access the cattle yard on the Catholic land.

It is noted that several fence posts have termite damage and are therefore less resistant to mine subsidence effects.

**Impact Management Strategies**

The above impacts may be managed with the rapid repair of any surface cracking and fences and associated items or the combination of fencing off particular areas and/or the installation of additional fencing to allow for the movement of cattle under the existing agistment agreement. The current Draft Property Subsidence Management Plan (PSMP) will be reviewed in consultation with the landowner to address these potential issues.

### 11.2.12 Farm Dams

**Potential Impacts**

Non-engineered farm dams and water storages will be susceptible to surface cracking and tilting (i.e. storage level changes) due to mine subsidence. The tolerable tilt and strain values for the dams would depend upon the materials used, construction techniques, foundation type and likely repair costs to re-establish the dam’s function and pre-mining storage capacity.

The predicted worst-case subsidence deformations (subsidence, tilt and horizontal strain) at the dam sites in the study area are shown in **Figures 16a** to **19a** with potential crack widths presented in **Figure 22a**.

The expected phases of tensile and compressive strain development may result in breaching of the dam walls or water losses through the floor of the dam storage area. Loss or increase of storage areas may also occur due to the predicted tilting. Damage to fences around the dams may also occur and require repairing.

It should be noted that dams similar to those in SMP Area 2 have been subsided by underground coal mines elsewhere in NSW and any damage has been effectively managed. The dams were reinstated in a timely manner and an alternative supply of water was provided by the mine during the interim period.

**Impact Management Strategies**

In accordance with the Project Approval and Statement of Commitments a Dam Monitoring and Management Strategy (DMMS) will be formulated for each dam prior to any mining occurring which will impact on the dams. The DMMS will provide for:

1. The individual inspection of each dam by a qualified engineer for:
   - current water storage level;
   - current water quality (EC and pH);
   - wall orientation relative to the potential cracking;
   - wall size (length, width and thickness);
   - construction method and soil / fill materials;
   - wall status (presence of rilling / piping / erosion / vegetation cover);
   - potential for safety risk to people or animals;
   - downstream receptors, such as minor or major streams, roads, tracks or other farm infrastructure; and
   - potential outwash effects.

2. Photographs of each dam will be taken prior to and after undermining, when the majority of predicted subsidence has occurred.

3. Dam water levels, pH and EC will be monitored prior to and after undermining to assess the baseline and post mining dam water level and water quality in order to determine whether rehabilitation is required.

4. In the event that subsidence / crack development monitoring indicates a significant potential for dam wall failure, dam water will be managed in one of the following manners:

   - pumped to an adjacent dam to lower the water level to a manageable height that reduces the risk of dam wall failure,
   - discharged to a lower dam via existing channels if the water cannot be transferred, or
   - not transferred if the dam water level is sufficiently low to pose a minor risk.

   An alternate water supply will be provided to the dam owner until the dam can be reinstated.

5. In the event of subsidence damage to any dams the Company shall remediate the damage and reinstate the dam in conjunction with the Mine Subsidence Board.

## 11.2.13 Catholic Diocese Maitland – Newcastle Stock Watering System

**Potential Impacts**

The cattle grazing on the Catholic Diocese land are watered by a series of buried pipelines which supply several watering troughs.

There are buried PVC pipelines of varying sizes (Lines 1 to 4) that provide stock water to 8 troughs around the Catholic Diocese Land. Two of the lines (Lines 3 and 4) provide water to two Other Surface Structures residences in the south of the Stage 2 SMP area.

The pipelines are connected to the 200 mm diameter Hunter Water pipeline at different locations above the mine workings. It will be necessary to ensure that the water supply will not be disrupted by mine subsidence effects.

The worst-case subsidence parameter predictions along the pipeline easements and Hunter Water mains connections after mining is complete are presented in **Table 46** and have been derived from the subsidence contours in **Figure 16a** of **Appendix A**.

**Table 46 - Worst-Case Subsidence Predictions for the Stock Watering System on the Catholic Diocese Land**

| Line | Panel | Location | Final Subsidence $S_{max}$ (m) | Final Tilt $T_{max}$ (mm/m) | Final Ground Strain $E_{max}$ (mm/m) | Final Curvature $C_{max}$ ($km^{-1}$) | Final Horiz. Displacement (mm) |
|---|---|---|---|---|---|---|---|
| 1 | TG | HW | 0.95 | 0.9 | -0.01 | -0.001 | 9 |
| | EM | - | - | - | - | - | - |
| | 4 | T1.3 | 0.29 | 23 | 2.2 | 0.22 | 230 |
| | 5 | T1.2 | 1.32 | 0 | -1.0 | -0.10 | 0 |
| | 7 | T1.1 | 0.01 | 3 | 5.5 | 0.55 | 30 |
| 2 | EM | T2.3 | 0.014 | 0 | 0 | 0.0 | 0 |
| | 2 | HW | 0.22 | 0 | 0 | 0.0 | 0 |
| | 2 | kink | 0.02 | 2 | 2.6 | 0.26 | 20 |
| | 2/3 | T2.2 | 0.0 | 18 | 5.8 | 0.58 | 180 |
| | 2/3 | T2.1 | 0.0 | 3 | 2.6 | 0.26 | 30 |
| 3 | 1 | HW | 1.19 | 2 | -3.5 | -0.35 | 20 |
| | TG | T3.1 | 0.93 | 7 | -7.6 | -0.76 | 70 |
| | SE | Junction | 0.41 | 16 | 2.3 | 0.23 | 160 |
| | 23 | - | - | - | - | - | - |
| | 24 | NPR | 1.31 | 3 | -0.1 | -0.01 | 30 |
| 4 | SE | Junction | 0.46 | 2 | -0.2 | -0.02 | 20 |
| | SE | T4.1 | 0.45 | -1 | 0.1 | 0.01 | 10 |
| | 26 | NPR | 0.84 | 17 | -3.1 | -0.31 | 170 |

Notes:
EM = East Mains.
HW = Hunter water pipeline.
T1.3 = Trough #3 on Line # 1.
Kink = High angle change in pipeline direction.
NPR = Other Surface Structures residence

Graphical representation of the final subsidence, tilt, and strain profiles along the three stock watering lines are presented in **Figures 39a** to **39c** (Line 1), **Figures 40a** to **40c** (Line 2), **Figures 41a** to **41c** (Line 3) and **Figures 42a** to **42c** (Line 4) of **Appendix A**.

Based on reference to the comments on the Hunter Water pipeline, it is estimated that the smaller diameter pipeline in shallower trenches will have higher tolerable ground movement impact limits than the Hunter Water Pipeline. However, it is assessed that damage to joints/couplings along the pipelines and at connections between troughs and the mains should be anticipated during mining.

**Impact Management Strategies**

The proposed management strategies that may be required to minimise impact on the stock watering system due to subsidence are:

- Review the existing Draft Property Subsidence Management Plan for the Catholic Diocese land and assess the daily water supply requirements for the stock and Other Surface Structures residences and range of impact management options.

- Determine whether it is possible to isolate sections of line that may be actively subsided in the future through existing valves or installation of additional ones.

- Install flexible couplings at the troughs, Hunter Water mains and residences prior to subsidence development.

- Conduct temporary repairs to maintain water supply during mining and consider replacement of line post mining following inspection and assessment of water line condition.

As noted in the Statement of Commitments, in the event of interruptions to water supplies due to subsidence impacts on farm dams, water tank pipelines, water mains and irrigation systems within the application area, the Company commits to providing water supplies of equivalent quality and quantity to locations convenient to those affected until such time that the affected farm dams, water tanks, pipelines, water mains and irrigation systems are restored.

Transporting potable water to ensure supply could also provide an effective back-up supply provided daily requirements can be delivered in a timely manner. This option may also avoid the need to move livestock from an effected area as water may be delivered to the affected troughs as needed.

## 11.2.14 Aboriginal Places, Heritage and Archaeological Sites

**Potential Impacts**

Two scattered artefact sites exist within the Stage 2 area, with one in the Stage 1 area. All are outside the zone of subsidence (within the Viney Creek SCZ) due to the proposed mining layout. It is therefore very unlikely that the sites above the pillar extraction panels will be affected or damaged by surface cracking and increased erosion rates.

Further artefact sites may be present along Viney Creek which have yet to be identified (**ERM, 2008**) but will also be contained within the Viney Creek SCZ.

**Impact Management Strategies**

In relation to Aboriginal heritage, consistent with the Project Approval and Section 4.6 of the Aboriginal Heritage Management Plan, prior to secondary extraction commencing staged systematic archaeological survey will occur for each section proposed to be undermined. This will ensure that any Aboriginal heritage evidence that may be susceptible to impacts is identified and managed according to the AHMP and Part 3A Approval. As specified in Section 4.6 of the AHMP, the survey will be conducted by a suitably qualified and experienced archaeologist and involve:

- Description of the existing environment and potential impacts;
- An archaeological survey to identify and record any Aboriginal heritage evidence or areas of potential evidence within the SMP area;
- Assessing the significance of any identified heritage evidence within the SMP area;
- Assessing the potential impacts of subsidence upon the identified or potential Aboriginal heritage evidence;
- Consultation with the local Aboriginal community, including the participation of relevant LALC representatives in the archaeological survey;
- Identification and assessment of management and mitigation options for any Aboriginal heritage evidence identified, consistent with the AHMP and Part 3A Approval;
- Provision and implementation of recommendations for the most appropriate management and mitigation options, consistent with the AHMP and Part 3A Approval;

- Provision of a report detailing the above, produced with reference to the DECCW *Aboriginal Heritage Standards and Guidelines Kit* (1997), with copies distributed to DPI, DECC and the LALC within 25 working days of finalisation.

## 11.2.15 Permanent Survey Control Marks

Two Permanent Marks (PMs) 113285 and 113293 are located within SMP Area 2 (see **Plan 2**). Notification will be provided to LPI prior to the commencement of mining followed by further notification of completion of subsidence.

**Potential Impacts**

Subsidence will impact on the two Permanent Marks to the extent that a resurvey will be required.

**Impact Management Strategies**

A protocol exists where mining may impact on Permanent Survey Control Marks. This consists of notification of both commencement of mining and completion of subsidence impact to LPI survey. The Control Marks are then removed from the register until completion of subsidence when reestablishment (if required) and resurvey are conducted.

## 11.2.16 Houses

## 11.2.16.1 Principal Residences

In accordance with the Project Approval and Statement of Commitments, a plan of management for each Principal Residence will be produced and implemented as follows:

1. Each Principal Residence will be individually assessed by the Mines Subsidence Board /structural engineer who will determine tolerable levels for individual subsidence parameters. Tolerable limits are those limits which will result in no mitigation works being required to the Principal Residence due to subsidence impacts from the Abel Underground Mine.

2. Each Principal Residence will have a pre-mining survey to identify and record pre-existing imperfections that will not be covered by the Mines Subsidence Board.

3. Such assessments will be done as and when the progression of the mining process dictates – i.e. mining may have commenced in other areas prior to the individual Principal Residence assessment being undertaken.

4. Tolerable levels will be set according to such factors as dwelling construction (e.g. brick veneer, clad), type (single, double storey), size (length and width), footings (slab, strip footings, piers), surface conditions (sand, rock, clay, steep slope) etc, with reference to the MSB Graduated Guidelines (compatible with AS 2870 and the Building Code of Australia).

5. The mine plan in proximity to each Principal Residence will be modified by the Company to maintain subsidence parameters within the tolerable levels determined above for each Principal Residence.

6. The mine plan will be reviewed by the MSB and the DPI prior to any Subsidence Management Plan being approved under the relevant lease.

7. Each Principal Residence will have a specific subsidence monitoring plan to monitor subsidence impacts before and after mining at the Principal Residence and to ensure that tolerable limits are achieved in practice.

8. The Mines Subsidence Board has the responsibility to rectify any impacts to structures that may occur as a result of mining.

*In cases where the owner of the Principal Residence and the Company can agree to terms which permit second workings under the Principal Residence greater than those permitted above, the Company agrees to negotiate a plan of management similar to that proposed in the section of this Statement of Commitments titled "All Other Surface Structures".*

**Details and Potential Impacts**

The four Principal residences and ancillaries / outbuildings within the SMP Area 2 are typically rural residential properties and include the following features:

<u>House No. 1 above Panel 25</u>

- single storey masonry veneer house with strip/pad footings.
- four 4.5m diameter above ground water tanks.
- septic tank and on-site effluent disposal field.
- weather board clad cottage on raft slab with two PVC water tanks and outhouse.
- corrugated iron clad shed.
- earth dam 4-5 m high with existing piping failures (due to dispersive clay soils).
- slab on ground driveway.
- timber post and wire boundary fences.
- gently undulating terrain with $4^{o}$-$5^{o}$ ground slopes near the house, and increasing to between $5^{o}$-$10^{o}$ towards the north west of the property.
- the property has been cleared of trees and partly used for grazing livestock.
- Unsealed gravel access road to Black Hill Road

<u>House No. 2 above Panel 24</u>

- single storey, 'Forever board' clad house with pad footings.
- 5m diameter above ground concrete water tank.
- septic tank and on-site effluent disposal field.
- corrugated iron clad shed on slab footings.
- gravel driveway.
- vegetable garden.
- timber post and wire boundary fences.
- gently undulating terrain with $3^{o}$-$5^{o}$ ground slopes near the house.
- Unsealed gravel access road to Black Hill Road

<u>House No. 3 outside limits of Panel 25 and 26</u>

- single storey, weatherboard clad house on pad/strip footings.
- 4.5m diameter above ground water tank.
- hardi-plank garage with slab footings.

- septic tank and drainage field.
- corrugated iron clad shed on slab.
- small bird aviary (metal frame on concrete slab).
- vegetable garden (under construction).
- a large fig tree approximately 10 m west of the house.
- gently undulating terrain with $3^o$-$5^o$ ground slopes near the house.
- Unsealed gravel access road to Black Hill Road.
- A 3m high earth embankment dams for watering livestock (cattle). The dam was full and in good condition.

<u>House No 4 - Within Catholic Diocese Proposed Catholic School Site and outside limits of Panel 22</u>

- single storey, timber framed, weatherboard clad house on pad/strip footings.
- Mains water supply.
- septic tank and drainage field.
- yard fencing.
- timber framed, weatherboard clad garage with slab footings.
- Unsealed gravel access driveway to Black Hill Road.

Additional buildings within the proposed high school site include;

- Small single storey, full-Masonry Office Building on raft slab (currently used as an office/amenities facility by the Catholic Diocese)
- Large single storey shed on raft slab (currently used as a storage facility by Catholic Diocese)

*Note: Another house (principal residence) is located on this site but located outside of Area 2.*

Another property is located within Area 2, however the Principal Residence and ancillary structures/features are located outside the limits of the application area. A description of the properties assets is provided below for completeness. It is assessed that some of the property fences and a small stock watering dam will be affected by mine subsidence due to Panel 20.

<u>Residence outside limits of Area 2 and east of Panel 20</u>

- Double storey timber clad building on deep stump footings.
- Above ground 4.5 mm diameter water tank.
- Steel framed and sheet metal clad garage, machinery shed and horse stables on concrete slab footings.
- In-ground concrete swimming pool with 'stencilcrete' paving (uncracked) and timber framed outdoor shelter.
- Biocycle tank and onsite effluent disposal area.
- Small chicken pen.
- Two 'tanked' dams to 3 m depth and 10 m diameter in dispersive clay soils.
- One earth embankment dam 3m deep by 5 m diameter with 1 m high dam wall (a small piping failure with minor seepage was noted). *Note: The dam is above Panel 20.*
- Timber post and wire boundary fences (north-western boundary fests posts severely termite damaged) with a galvanised iron gate at the northern end of the property. *Note: Some of the fences are located above Panel 20.*

- Gently undulating terrain with $3^o$-$5^o$ ground slopes near the house and increasing to $10^o$ to $15^o$ along Viney Creek.
- Unsealed gravel access driveway to Black Hill Road.
- Two reinforced concrete pipe culverts (300 mm diameter) and headwalls in fill across Viney Creek. The culvert was in a generally poor condition with some open cracks and piping failures.
- Some sandstone and siltstone bedrock exposures were observed in the northwest of the property.
- The property has been partially cleared and has several uncleared eucalypt forest areas.
- Very dense stands of melaleucas (paper bark trees) were observed amongst the native eucalypts along the edges of the Transgrid 330 kV powerline corridor.

A draft PSMP for this property has been completed in consultation with the Landowner.

The internal condition of the Principal Residences is generally good with only some minor hairline cracking in internal plasterboard walls and ceiling cornices due to moderately reactive clay movements.

No geotechnical site classifications in accordance with **AS2870, 1996** of the clay soils have been completed at the properties. Observation of piping failures in several earth dams on the properties indicates the clay soils are highly dispersive and susceptible to erosion.

As described previously it is intended to leave sufficient first workings only barriers below and around the Principal Residences to minimise the potential for subsidence impact. Based on reference to the appropriate Table and the conditions at each house site above the SMP Area 2 panels, it is recommended that a minimum set-back distance to second workings limits be set at $26.5^o$ angle of draw (i.e. 0.5 times the cover depth) from the corners of each Principal Residence.

The above Subsidence Control Zones will also limit impacts to the existing water tanks and on-site effluent disposal areas, with subsidence likely to be < 20 mm after completion of the panels. To-date the angle of draw to 20 mm subsidence contour has ranged between $1^o$ and $23^o$ around Panels 1 and 2.

The predicted subsidence effect contours around the Principal Residences are presented in **Figures 43a** to **43e** of **Appendix A.**

Some of the property fences, dams and access road from Black Hill Road that are outside the SCZs may be moderately impacted by mine subsidence. Management of impact to these features will be included in the appropriate property management plan.

**Impact Management Strategies**

As previously discussed, all residences and associated machinery sheds, in-ground tanks and pipes within the SMP Area will be protected from significant damage by the SCZs.

The maximum subsidence is estimated to be < 20mm for minimum set back distances of 26.5 degrees for the proposed SCZ beneath the Principal Residences. Any damage to Principal residences should not be greater than Category 0 to 2 Damage Classification categories (i.e. "Negligible" to "Slight") in accordance with **AS2870, 1996**.

The proposed management strategies required to minimise impact to the Principal Residences due to subsidence are:

- Installation of monitoring pins or pegs around each structure and conduct base line subsidence, peg location and strain measurements prior to undermining.
- In addition to the pre-mining inspections of the properties by representatives of Abel Mine, an inspection of the above properties to be made by the MSB before and after second workings in the vicinity of the site are undertaken.
- Structure surveys and visual inspections should be completed not before one month after second workings of a panel has been completed.
- Any minor repair works to internal/externals cracking or re-levelling of Principal Residences and Other Surface Structures should be implemented as soon as mining related movements have ceased.
- If impacts to Principal Residences exceed a Category 2 damage classification in accordance with AS2870, 1996 or "Moderate" damage, then is it will necessary to review the SCZ set back distance in regards to applying them to other Principal Residences.

## 11.2.16.2 Other Surface Structures

Other Surface Structures Residences are addressed in the Project Approval under “All Other Surface Structures” which is defined as any building or structure impacted by mining-induced subsidence from the Abel Underground Mine Project which is not categorised as a Principal Residence, Future Principal Residence, Black Hill Church and Cemetery or Black Hill School.

The Company shall prepare and implement plans of management for the mitigation and remediation of any damage to All Other Surface Structures prior to any mining occurring that would impact on them.

The plan of management will include:

(a) pre-mining audit of the structure;
(b) the provision of a plan of management as part of the SMP approval process which requires the Company to mitigate/remediate any damage to improvements associated with the structure in conjunction with the Mines Subsidence Board;
(c) post-mining monitoring of the improvements associated with the Structure.

The mitigation/remediation measures to be undertaken will be related to the extent of damage experienced.

**Details and Potential Impacts**

The two non- principal residences (Houses No. 5 and 6) and ancillaries/outbuildings within the SMP area 2 are typically rural residential (rental) properties and include the following features:

<u>House No. 5 (Panel 24):</u>

- single storey, 'Forever board' clad house with pad footings.
- mains water supply.
- septic tank and on-site effluent disposal field.

- corrugated iron clad shed on slab footings.
- timber post and wire boundary fences.
- gently undulating terrain with 3°-5° ground slopes near the house.
- Unsealed gravel access driveway to Black Hill Road

<u>House No. 6 (Panel 26):</u>

- single storey, masonry house with slab footings.
- mains water supply.
- septic tank and on-site effluent disposal field.
- double storey timber framed and weatherboard clad storage building on slab footings.
- timber post and wire boundary fences.
- gently undulating terrain with 5°-8° ground slopes near the house.
- unsealed gravel access driveway to Black Hill Road

<u>Single storey, full-masonry office building (No.1) (Panel 26)</u>

- on raft slab (currently used as a storage facility by Catholic Diocese) with no power connection.

<u>Single storey, external timber framed, corrugated iron clad building (No. 2) (Panel 25)</u>

- with internal masonry walls on slab footings (currently used as a storage facility by Catholic Diocese), with no power connection.

<u>Single storey, external timber framed, corrugated iron clad building (No. 2) (Panel 25)</u>

- with internal masonry walls on slab footings (currently used as a storage facility by Catholic Diocese), with no power connection.

<u>Storage building on Central Road (Tailgate Headings)</u>

<u>Storage building at Farm 15 (South East mains)</u>

The subsidence effects estimated for the above structures are based on **Figures 36a** to **36e** of **Appendix A** and summarised in **Table 47**.

**Table 47 - Worst-Case Subsidence Predictions for the Non-Principal Residences and Structures on the Catholic Diocese Land**

| Panel | Location | Subsidence $S_{max}$ (m) | Tilt $T_{max}$ (mm/m) | Ground Strain* $E_{max}$ (mm/m) | Curvature $C_{max*}$ ($km^{-1}$) | Horiz. Displacement (mm) |
|---|---|---|---|---|---|---|
| 24 | Residence No. 5 | 1.12 - 1.30 | 6 - 19 | -8 to 4 | -0.5 to 0.8 | 60 - 190 |
| | Garage | 1.17 - 1.28 | 9 - 17 | -9 to 5 | -0.7 to -0.9 | 90 - 170 |
| 25 | Storage Building No. 2 | 0.55 - 1.08 | 26 - 33 | -10 to 5 | -1.0 to 0.50 | 260 - 330 |
| 26 | Residence No. 6 | 0.23 - 0.73 | 21 - 30 | -10 to 5 | -1.0 to 0.5 | 210 - 300 |
| | Garage/ Storage Building | 0.60 - 1.00 | 18 - 29 | -10 to 5 | -1.0 to 0.5 | 60 - 190 |
| | Storage Building No. 1 | 0.43 - 0.95 | 25 - 31 | -9 to 7 | -0.9 to 0.7 | 250 - 310 |

| Panel | Location | Subsidence $S_{max}$ (m) | Tilt $T_{max}$ (mm/m) | Ground Strain* $E_{max}$ (mm/m) | Curvature $C_{max}$* ($km^{-1}$) | Horiz. Displacement (mm) |
|---|---|---|---|---|---|---|
| Tailgate Headings | Storage building on Central Road | 0.46 - 0.81 | 17 - 26 | -15 to 3 | -1.5 to 0.3 | 170 - 260 |
| South East Mains | Building Farm 15 | 0.07 - 0.27 | 9 - 23 | 8 to 11 | 0.8 to 1.1 | 90 - 230 |

* - Predictions include transient strains.

Based on the predicted subsidence effects, the existing non-principal residences and buildings on Catholic Diocese Land may be subject to subsidence ranging from 0.07 m to 1.3 m, tilting from 6 to 33 mm/m, radii of sagging and hogging curvatures of -1.5/1.1 $km^{-1}$, horizontal compressive/tensile strains of -15/11 mm/m and horizontal displacements from 60 mm to 330 mm.

It is assessed that the buildings will sustain 'moderate' to 'severe' damage (or Category 3 to 4 damage as defined in **AS2870, 1996**) by the associated tilts, strains and curvatures.

**Impact Management Strategies**

Appropriate management strategies for the existing other structures that may be impacted by mine subsidence should include and address the following issues in consultation between the stakeholders and the MSB and in accordance with the Subsidence Specific Commitments by the Company Section E (from the Abel Project Approval).

- A Plan Of Management shall be prepared and implemented for the mitigation and remediation of any damage by the Company in conjunction with the Mine Subsidence Board to include:

- A pre and post mining condition survey and/or inspection of all structures within the mining lease should be made by the MSB.

- Determine when mining impacts will occur to the buildings and vacate premises prior to any impact. Install temporary fencing to prevent site personal or general public access to any potentially unstable structures.

- A monitoring plan for the property during and post mining and safety/hazard management plan.

- The timing of disconnection of power and water supply etc if required.

- An inspection of mine subsidence damaged properties should be made by registered building inspectors and any repair / mitigation / remediation works to be undertaken will be related to the extent of damage experienced (see Schedule 1 of Project Approval).

Mine subsidence is expected to develop soon after the face retreats beneath a property and would be expected to continue until the face is 1 to 2 times the cover depth past the property. Subsidence movements would also be expected to ‘start again’ soon after the passing of subsequent panels, albeit at decreasing rates and magnitudes. It is considered likely that subsidence movements will affect undermined properties for periods of at least 6 to 8 weeks after each panel is extracted.

### 11.2.16.3 Disused Buildings on Catholic Diocese Land

**Potential Impacts**

Some previous land user buildings on the Catholic Diocese Land are either in various stages of disrepair or are planned to be demolished. Areas of site contamination exist in some of the areas where buildings once stood. Mitigation of this contamination associated with the previous land users in a lined 'control' fill in-situ is in progress.

Mine subsidence is likely to impact existing disused residences and structures above the proposed pillar extraction panels significantly (based on damage criteria presented in **AS2870, 1996**).

**Impact Management Strategies**

An “in principle” agreement has been reached relating to the demolition of some of these structures. Quotations have been received for demolition and these are currently being assessed by an appropriately qualified and agreed consultant.

### 11.2.17 Proposed Redevelopment of Black Hill Land Pty Ltd Land

**Predicted Impacts**

It is understood that there is to be no residual subsidence risk remaining beneath the site after mining has ceased. Effective subsidence relating to this land is to be completed by June 2013.

The impacts to the Black Hill Land Pty Ltd land after the mining of pillar extraction panels 14 to 18 may include the following:

- Maximum surface subsidence ranging from 0.75 m to 1.45 m.
- Surface cracking from 70 mm to 190 mm wide (Upper 95% Confidence Limit).
- Negligible surface ponding.
- Changes to surface gradients of +/- 3.5% above pillar extraction panels.

Approximately 90% to 95% of mine subsidence development will occur within 4 to 6 weeks after undermining occurs. On-going residual settlements due to goaf reconsolidation may continue for a period of up to 1 year, however, these movements are unlikely to result in further impact occurring to the surface.

**Impact Management Strategies**

The predicted impact management strategies for the Black Hill Land Pty Ltd are likely to be adequately addressed by the proposed strategies presented in earlier sections of this report for the management of surface cracking, ponding and slope instability if they occur.

The barrier pillars that will be left between the extracted panels do not represent a future subsidence potential risk to future land re-development and ultimately the users for the following reasons:

- The factor of safety of the barrier pillars after mining of Panels 14 to 19 will be > 2.23 under double abutment loading conditions. Reference to **ACARP, 2005** suggests that the pillars will have a probably of failure of < 1 in 10 million.

- The proposed barrier pillars left between the panels will be strain-hardening and very unlikely to cause further increases in subsidence after the initial subsidence development period. It is unlikely that future pillar rib instability will result in any significant decrease in pillar strength or stiffness. The height of the pillars are also unlikely to increase above 2.6 m in this area of the mine due to practical mining height constraints.

- The goaf adjacent to the pillars will provide support to overburden between the barrier pillars.

Based on the above, it is not considered necessary to remove or extract the pillars to minimise future subsidence potential or demonstrate long-term stability criteria have been satisfied for subsequent re-development. It is an option that may be discussed with Industry & Investment NSW, however there are ventilation and underground safety risks involved with removing the pillars during mining.

A Property Subsidence Management Plan (PSMP) is being developed in consultation with the landowner to address these potential issues.

### 11.2.18 Far Field Displacement F3 Freeway and John Renshaw Drive

**Potential Impacts**

John Renshaw Drive and the F3 Freeway are located 750 m to 2100 m from the proposed mining areas. Based on cover depths of 100 m to 150 m, the roads are well outside the angle of draw around the proposed SMP Area 2 mining areas (with distances ranging from 5 to 15 times the cover depth). Far-field horizontal displacements towards the mining area are very unlikely to occur along some sections of both roads closest to extracted panels 14 to 26. Horizontal strains associated with FFDs are also very unlikely to occur.

It is therefore assessed that it is very unlikely that the proposed Stage 2 Panels will result in impacts to the abovementioned roads.

**Impact Management Strategies**

It is not considered necessary to monitor far-field movements along these roads as any movements that occur will probably be less than survey accuracy limits for horizontal displacement (i.e. <10 to 20 mm).

It is however, considered reasonable to conduct visual inspections along the roads during subsidence development and prepare an impact management response strategy to deal with mining impacts if they do occur.

A series of far-field monitoring stations which monitor total horizontal displacement and strain may be established at strategic points around the mining lease to further understand this phenomenon for defining appropriate set-back distances from other sensitive items of infrastructure that may exist elsewhere within the mining lease.

## 11.3 IMPACT ASSESSMENT BASED ON INCREASED SUBSIDENCE PREDICTIONS

**Section 8** of the report identifies and describes the major natural features and surface improvements within the SMP application area. **Section 10** of the report provides the predicted subsidence parameters at each of the natural features and surface improvements listed in **Section 8**. **Section 11** provides an impact assessment for each of the natural features and surface improvements listed in **Section 10**. **Sections 8, 10** and **11** of this report cover sections 6.6, 6.7 and 6.10.1, respectively of the SMP Guideline 2003.

A Risk Assessment (see **Section 12** of this report and **Appendix G**) and, in certain cases, an Impact Assessment based on Increased Subsidence Predictions are required under Sections 6.10.2 and 6.10.3 of the SMP Guideline 2003.

"Theoretical Worst Case" is considered to be 60 - 65% of the mined seam height. In the SMP application area this equates to 1,580 to 1,715 mm, slightly above the current maximum prediction of 1,450 mm (55% of mined seam height).

It was therefore considered that the "Theoretical Worst Case" of subsidence would not affect the risk matrix due to the minor increase over predicted subsidence.

## 11.4 SUMMARY

### Comparison of Subsidence Profile Predictions to the Environmental Assessment

For completeness the proposed SMP mining layout and impact predictions have been compared to the Environmental Assessment.

A representative predicted subsidence profile (XL B) across EA Panels (UD 15 to UD 6) with similar geometry to the SMP Panels P14 to P26, are presented and has been compared to the predicted profiles for XL 7. The differences between the profiles are primarily due to the seam thickness differences along each cross line that were assumed.

It is considered that the predicted subsidence and associated impacts to the natural and man-made features will be similar in magnitude and location to the EA study outcomes.

### Conclusion

It is concluded that the assessed range of potential subsidence and far-field displacement impacts after the mining of the proposed pillar extraction panels will be manageable for the majority of the site features, based on the analysis outcomes and discussions with the stakeholders to-date.

The measurement of the A-Zone horizon above Panels 1 and 2 indicates the height of continuous sub-surface fracturing in the Fractured Zone has occurred to between 45 and 50 m above the 120 m and 150 m wide panels with cover depths of 73 m to 95 m. The discontinuous subsurface fracturing in the Constrained Zone has lowered the near surface water table by approximately 15.3 m above Panel 1, however it is anticipated that it will recover in the medium to long term after mining is completed. The near surface water table above Panel 2 appears to have dropped below the piezo to a depth > 19.7 m on the western side of a NW striking fault but fell only 4.5 m on the eastern side of the fault.

No practically measureable mine subsidence or far-field displacement movements or impacts are expected along John Renshaw Drive or the F3 Freeway due to the proposed mining layout.

Subsidence Control Zones (SCZ) have been proposed to limit impacts to within tolerable levels from the proposed mining layout at Abel for Viney Creek and Principal Residences. The proposed setback distances are considered conservative, however, they will still need to be confirmed as adequate through subsidence monitoring in less sensitive areas during mining.

The above subsidence impact limit criteria will be achieved in the SCZ with first workings only proposed at this stage. The potential exists however to implement a partial pillar extraction layout provided the long-term stability of remnant pillars and tolerable impacts to surface features can be demonstrated.

Provided the proposed impact management strategies are acceptable to the relevant stakeholders, the proposed mining layout is considered satisfactory at this stage.

If the estimated worst-case impacts cannot be reasonably managed in the event that exceedences occur (however unlikely), through mitigation or amelioration strategies, then it will be necessary to adjust the mining layout further to provide a more acceptable risk to the stakeholders.

The extent of mining layout adjustment will also require further discussions (and review of monitoring data) after the completion of a given panel with stakeholder and government agencies.

# 12 RISK ASSESSMENT

## 12.1 RISK ASSESSMENT AND SUMMARY

A risk assessment was conducted on 16 September 2010 to identify, assess and review any potential subsidence impacts to the surface and sub-surface as a result from the mining of the proposed SMP application area at Abel. A copy of the risk assessment is included in **Appendix G**.

The risk assessment was facilitated by HMS Consultants and involved a team with wide ranging experience. The team consisted of members of Abel staff, specialist consultants in subsidence, surface and groundwater and a community representative (member of Abel Community Consultative Committee).

A key step in the process was the gathering of the data related to the application to present to the team. Once the scope and mandate of the team was determined a number of tools were used to identify issues relating to the application and identify risks as a result of the mining process. Whilst worst case scenarios were discussed by the risk assessment team, the worst case scenario as not necessarily the consequence severity chosen for risk ranking. The risk assessment team used their industry and site experience, as well as their knowledge of the effectiveness of the actual Abel controls, to choose the most appropriate consequence severity for risk ranking. The losses were ranked according to their likelihood and consequences with quantification where possible. Once this had been completed current and additional controls were identified, followed by nominated further actions in order to eliminate or control the identified risk issue to an acceptable level.

In total thirty-seven risk issues were identified. Of those risks assessed, there were nil “High” risks identified, and ten (10) “Significant” risks identified by the risk assessment team. There were nil “Catastrophic” consequences identified and three (3) “Major” consequence identified by the risk assessment team. The “Significant” risks and “Major” consequence relate to Public Utilities and are listed in **Table 48**.

## Table 48 - Summary of Major Consequence Risk Issues

| Risk #<br>Process – Sub-Process | Risk Issue | Possible Causes | Existing Controls and Planned Management Plans | Additional Controls |
|---|---|---|---|---|
| 2.04.01<br>Public Utilities – Electricity transmission lines (overhead / underground) and associated plants | Damage and / or loss of clearance to 330kV Transgrid Power line | 1. Subsidence<br>2. Tilt<br>3. Strains | 1. Cruciform footings<br>2. Conductor strings | 1. Transgrid to review structural integrity and design of cruciform's<br>2. Continual dialogue with Transgrid re Supplied draft management plan<br>3. Investigate need for installation of pulleys on earth wires<br>4. Check conductor clearance<br>5. Pre-mining surveys<br>6. Subsidence data from Panels 1-4 will be available prior to mining under Transgrid 330kV powerlines<br>7. Review mine plan if required |
| 2.01.01<br>Public Utilities - Roads (all types) | Serviceability of public roads | 1. Cracking<br>2. Steps (Scarps)<br>3. Change in road profile<br>4. Reduction in sight distance on road<br>5. Change in drainage<br>6. Tree falling | 1. Develop road management plan with Cessnock City Council<br>2. Develop Public Safety Management Plan<br>3. Ongoing consultation<br>4. Develop road management plan for 4WD tracks for fire fighting access | |
| 1.01.02<br>Natural Features - Schedule 2 Creeks | Hydraulic connection from surface to underground | 1. Connective cracking from stream bed to seam<br>2. Pillar extraction within SCZ | 1. Mine design and layout<br>2. Subsidence control zones (SCZ) 40m + to the 20mm subsidence contour (assumed 26.5 degrees for design purposes)<br>3. Pillar Extraction Management Plan (PEMP) including Authority to Mine (ATM)<br>4. Monitoring arrangements (Subsidence, surface and groundwater)<br>5. Environmental Management Plan (EMP)<br>6. Site water balance review<br>7. TARP | 1. Include visual inspection of stream flow and pool depth in checklist |

The risk assessment identified existing controls but also highlighted a number of additional controls or further actions that the team thought necessary to manage subsidence.

The further action items for Significant Risk Issues and Major Consequences listed in **Table 48** and Other Further Actions listed in **Table 49** were generated from the risk assessment in order to control the associated risks. These actions are either proposed actions or actions in progress. The implementation of the further actions is to be reviewed and updated on a regular basis documenting the status of the implementation process.

The lack of any potential high risk issues is mostly attributable to the proposed mine design layout which includes Subsidence Control Zones.

This approach provides a high level of confidence that the subsidence impacts to these features from pillar extraction will be minimal.

## Table 49 - Summary of Further Actions

| # | Risk Reduction Additional Controls | R#, Risk Issue – Risk Level (Process – Sub-Process) | Causes | Who | When |
|---|---|---|---|---|---|
| **1** | **Transgrid to review structural integrity and design of cruciform's** | 2.04.01, **Damage and / or loss of clearance to 330kV Transgrid Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | Donaldson Technical Services Department<br>(DTSD) | 2011 |
| **2** | **Continual dialogue with Transgrid re Supplied draft management plan** | 2.04.01, **Damage and / or loss of clearance to 330kV Transgrid Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | May 2011 |
| **3** | **Investigate need for installation of pulleys on earth wires** | 2.04.01, **Damage and / or loss of clearance to 330kV Transgrid Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| | | 2.04.02, **Damage and / or loss of clearance to 132kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| | | 2.04.03, **Damage and / or loss of clearance to 11kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| **4** | **Check conductor clearance** | 2.04.01, **Damage and / or loss of clearance to 330kV Transgrid Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |

| # | Risk Reduction Additional Controls | R#, Risk Issue – Risk Level (Process – Sub-Process) | Causes | Who | When |
|---|---|---|---|---|---|
| | | 2.04.02, **Damage and / or loss of clearance to 132kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| | | 2.04.03, **Damage and / or loss of clearance to 11kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| **5** | **Pre-mining surveys** | 2.04.01, **Damage and / or loss of clearance to 330kV Transgrid Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| | | 2.04.02, **Damage and / or loss of clearance to 132kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| | | 2.04.03, **Damage and / or loss of clearance to 11kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| **6** | **Subsidence data from Panels 1-4 will be available prior to mining under Transgrid 330kV power lines** | 2.04.01, **Damage and / or loss of clearance to 330kV Transgrid Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| **7** | **Review mine plan if required** | 2.04.01, **Damage and / or loss of clearance to 330kV Transgrid Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| **8** | **Mining height can be varied** | 1.02.02, **Hydraulic connection from surface to underground** - Significant Risk (Natural Features – Tributaries) | 1. Connective cracking from stream bed to seam<br>2. Shallow cover depth<br>3. Mining height | DTSD | 2011 |

| # | Risk Reduction Additional Controls | R#, Risk Issue – Risk Level (Process – Sub-Process) | Causes | Who | When |
|---|---|---|---|---|---|
| | | 1.02.03, **Ponding or reversal of flow** - Significant Risk (Natural Features – Tributaries) | 1. Tilting<br>2. Subsidence | DTSD | 2011 |
| **9** | **Extraction ratio can be varied** | 1.02.02, **Hydraulic connection from surface to underground** - Significant Risk (Natural Features – Tributaries) | 1. Connective cracking from stream bed to seam<br>2. Shallow cover depth<br>3. Mining height | DTSD | 2011 |
| | | 1.02.03, **Ponding or reversal of flow** - Significant Risk (Natural Features – Tributaries) | 1. Tilting<br>2. Subsidence | DTSD | 2011 |
| **10** | **Assess remediation works of contaminated areas** | 1.02.06, **Long term impact on aquatic ecosystem** - Significant Risk (Natural Features – Tributaries) | 1. Change in flow regime<br>2. Change in water quality | DTSD | 2011 |
| | | 1.03.04, **Contamination of groundwater through leachate from waste areas** - Significant Risk (Natural Features - Aquifers, known groundwater resources) | 1. Connective cracking | DTSD | 2011 |
| **11** | **Update CAD data with contaminated areas** | 1.02.06, **Long term impact on aquatic ecosystem** - Significant Risk (Natural Features – Tributaries) | 1. Change in flow regime<br>2. Change in water quality | DTSD | 2011 |
| | | 1.03.04, **Contamination of groundwater through leachate from waste areas** - Significant Risk (Natural Features - Aquifers, known groundwater resources) | 1. Connective cracking | DTSD | 2011 |
| | | 1.02.05, **Long term effects of change in stream water quality** – Moderate Risk (Natural Features – Tributaries) | 1. Tilting<br>2. Subsidence<br>3. Gradient change<br>4. Contaminants from waste disposal areas | DTSD | 2011 |
| **12** | **Review contaminated areas studies (Douglas Partners)** | 1.02.06, **Long term impact on aquatic ecosystem** - Significant Risk (Natural Features – Tributaries) | 1. Change in flow regime<br>2. Change in water quality | DTSD | 2011 |
| | | 1.03.04, **Contamination of groundwater through leachate from waste areas** - Significant Risk (Natural Features - Aquifers, known groundwater resources) | 1. Connective cracking | DTSD | 2011 |

| # | Risk Reduction Additional Controls | R#, Risk Issue – Risk Level (Process – Sub-Process) | Causes | Who | When |
|---|---|---|---|---|---|
| | | 1.02.05, **Long term effects of change in stream water quality** – Moderate Risk (Natural Features – Tributaries) | 1. Tilting<br>2. Subsidence<br>3. Gradient change<br>4. Contaminants from waste disposal areas | DTSD | 2011 |
| 13 | **Survey pole locations** | 2.04.02, **Damage and / or loss of clearance to 132kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| 14 | **Continual dialogue with Energy Australia to update management plan** | 2.04.02, **Damage and / or loss of clearance to 132kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| 15 | **Continual dialogue with Energy Australia to review existing management plan** | 2.04.03, **Damage and / or loss of clearance to 11kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| 16 | **Energy Australia to review requirement for power line** | 2.04.03, **Damage and / or loss of clearance to 11kV Energy Australia Power line** - Significant Risk (Public Utilities - Electricity transmission lines (overhead / underground) and associated plants) | 1. Subsidence<br>2. Tilt<br>3. Strains | DTSD | 2011 |
| 17 | **Review monitoring results regarding angle of draw** | 4.01.01, **Damage to principal dwellings -** Significant Risk (Residential - Principal dwellings and proposed buildings within Catholic Diocese principal residence area) | 1. Subsidence impacts | DTSD | 2011 |
| | | 4.02.01, **Damage to other structures** – Moderate Risk (Residential - "Other surface structures") | 1. Subsidence impacts | DTSD | 2011 |
| 18 | **Test monitoring of disused houses** | 4.01.01, **Damage to principal dwellings -** Significant Risk (Residential - Principal dwellings and proposed buildings within Catholic Diocese principal residence area) | 1. Subsidence impacts | DTSD | 2011 |
| | | 4.02.01, **Damage to other structures** – Moderate Risk (Residential - "Other surface structures") | 1. Subsidence impacts | DTSD | 2011 |

| # | Risk Reduction Additional Controls | R#, Risk Issue – Risk Level (Process – Sub-Process) | Causes | Who | When |
|---|---|---|---|---|---|
| 19 | **Include tributary management in PSMP** | 1.02.04, **Destabilisation of bank and / or bed** - Significant Risk (Natural Features – Tributaries) | 1. Tilting<br>2. Subsidence<br>3. Gradient change | DTSD | 2011 |
| 20 | **Include visual inspection of stream flow and pool depth in checklist** | 1.01.02, **Hydraulic connection from surface to underground** – Moderate Risk (Natural Features - Schedule 2 Creeks) | 1. Connective cracking from stream bed to seam<br>2. Pillar extraction within SCZ | DTSD | 2011 |
| | | 1.01.01, **Loss of overland flow** - Moderate Risk (Natural Features - Schedule 2 Creeks) | 1. Surface cracking of stream bed<br>2. Pillar extraction within SCZ | DTSD | 2011 |
| | | 1.02.01, **Cumulative loss of overland flow from tributaries** – Moderate Risk (Natural Features – Tributaries) | 1. Surface cracking of stream bed | DTSD | 2011 |
| 21 | **Assess Optus MP** | 2.05.01, **Damage to Optus Optical Fibre Cables** – Moderate Risk (Public Utilities - Telecommunication lines (overhead / underground) and associated plants) | 1. Subsidence | DTSD | 2011 |
| 22 | **Investigate durability of Optus cable** | 2.05.01, **Damage to Optus Optical Fibre Cables** – Moderate Risk (Public Utilities - Telecommunication lines (overhead / underground) and associated plants) | 1. Subsidence | DTSD | 2011 |
| 23 | **Subsidence data from Panels 1-4 will be available prior to mining under Optus Optical Fibre cable** | 2.05.01, **Damage to Optus Optical Fibre Cables** – Moderate Risk (Public Utilities - Telecommunication lines (overhead / underground) and associated plants) | 1. Subsidence | DTSD | 2011 |
| 24 | **Continual dialogue with Optus to confirm appropriate management plan** | 2.05.01, **Damage to Optus Optical Fibre Cables** – Moderate Risk (Public Utilities - Telecommunication lines (overhead / underground) and associated plants) | 1. Subsidence | DTSD | 2011 |
| 25 | **Consider independent assessment of asbestos risk** | 4.02.02, **Exposure to asbestos substances in the disused dwellings** – Moderate Risk (Residential - "Other surface structures") | 1. Subsidence impacts | DTSD | 2011 |
| 26 | **Add inspection of culverts during mining to checklists** | 2.02.01, **Serviceability of culverts** – Moderate Risk (Public Utilities - Culverts associated with Black Hill Road) | 1. Cracking<br>2. Steps (Scarps)<br>3. Change in road profile<br>4. Change in drainage | DTSD | 2011 |

| # | Risk Reduction Additional Controls | R#, Risk Issue – Risk Level (Process – Sub-Process) | Causes | Who | When |
|---|---|---|---|---|---|
| 27 | **Request HWC to install additional gate valve to minimise impact** | 2.03.01, **Damage to HWC 200mm PVC pipe resulting in interruption to water supply** – Moderate Risk (Public Utilities - Water pipeline) | 1. Strains | DTSD | Completed 2011 |
| 28 | **Ground truthing of surface features** | 3.02.01, **Damage to internal property access tracks** – Moderate Risk (Farm Land and Facilities - Internal Access tracks) | 1. Cracking<br>2. Steps (Scarps)<br>3. Change in road profile<br>4. Reduction in sight distance on road<br>5. Change in drainage<br>6. Tree falling | DTSD | 2011 |
| 29 | **Complete identification of water reticulation systems within SMP Area 2** | 3.07.01, **Damage to water reticulation system resulting in loss of service** – Moderate Risk (Farm Land and Facilities - Water Reticulation systems) | 1. Subsidence impacts | DTSD | April 2011 |
| 30 | **Confirm details on sites and location** | 5.01.01, **Disturbance of archaeological significant area contained within Area 2** – Low Risk (Areas of Archaeological and/or Cultural Significance - Areas of Archaeological and / or Heritage Significance) | 1. Subsidence impacts | DTSD | 2011 |
| 31 | **Confirm extent of current service** | 2.05.02, **Damage to Telstra Local Copper Cables** – Low Risk (Public Utilities - Telecommunication lines (overhead/underground) and associated plants) | 1. Subsidence | DTSD | 2011 |
| 32 | **Continual dialogue with Telstra to develop management plan** | 2.05.02, **Damage to Telstra Local Copper Cables** – Low Risk (Public Utilities - Telecommunication lines (overhead/underground) and associated plants) | 1. Subsidence | DTSD | 2011 |

## Table 50 - Risk Table – Risk Rank Order

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Public Utilities | Electricity transmission lines (overhead / underground) and associated plants | 2.04.01 | Damage and / or loss of clearance to 330kV Transgrid Power line | 1. Subsidence<br>2. Tilt<br>3. Strains | 1. Cruciform footings<br>2. Conductor strings | A | 2 | C | 8 | S | 1. Transgrid to review structural integrity and design of cruciform's<br>2. Continual dialogue with Transgrid re Supplied draft management plan<br>3. Investigate need for installation of pulleys on earth wires<br>4. Check conductor clearance<br>5. Pre-mining surveys<br>6. Subsidence data from Panels 1-4 will be available prior to mining under Transgrid 330kV power lines<br>7. Review mine plan if required | Yes |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Public Utilities | Roads (all types) | 2.01.01 | Serviceability of public roads | 1. Cracking<br>2. Steps (Scarps)<br>3. Change in road profile<br>4. Reduction in sight distance on road<br>5. Change in drainage<br>6. Tree falling | 1. Develop road management plan with Cessnock City Council<br>2. Develop Public Safety Management Plan<br>3. Ongoing consultation<br>4. Develop road management plan for 4wd tracks for fire fighting access | P | 2 | D | 12 | S | | |
| Natural Features | Tributaries | 1.02.02 | Hydraulic connection from surface to underground | 1. Connective cracking from stream bed to seam<br>2. Shallow cover depth<br>3. Mining height | 1. Cover depth is greater than 100m<br>2. Mining height is less than 3.2m at this location | A | 3 | C | 13 | S | 1. Mining height can be varied<br>2. Extraction ratio can be varied | Yes |
| Natural Features | Tributaries | 1.02.06 | Long term impact on aquatic ecosystem | 1. Change in flow regime<br>2. Change in water quality | 1. EMP TARPs includes remediation and mine plan review<br>2. Property Management Plans to be developed<br>3. No known acid sulphate soils<br>4. No upward gradient of groundwater | E | 3 | C | 13 | S | 1. Assess remediation works of contaminated areas<br>2. Update CAD data with contaminated areas<br>3. Review contaminated areas studies (Douglas Partners) | Yes |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natural Features | Aquifers, known groundwater resources | 1.03.04 | Contamination of groundwater through leachate from waste areas | 1. Connective cracking | | E | 3 | C | 13 | S | 1. Assess remediation works of contaminated areas<br>2. Update CAD data with contaminated areas<br>3. Review contaminated areas studies (Douglas Partners) | Yes |
| Public Utilities | Electricity transmission lines (overhead / underground) and associated plants | 2.04.02 | Damage and / or loss of clearance to 132kV Energy Australia Power line | 1. Subsidence<br>2. Tilt<br>3. Strains | 1. Timber poles more resilient to subsidence impacts | A | 3 | C | 13 | S | 1. Check conductor clearance<br>2. Survey pole locations<br>3. Continual dialogue with Energy Australia to update management plan<br>4. Pre-mining surveys<br>5. Investigate need for installation of pulleys on earth wires | Yes |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Public Utilities | Electricity transmission lines (overhead / underground) and associated plants | 2.04.03 | Damage and / or loss of clearance to 11kV Energy Australia Power line | 1. Subsidence<br>2. Tilt<br>3. Strains | 1. Timber poles more resilient to subsidence impacts<br>2. Power line Management Plan | A | 3 | C | 13 | S | 1. Check conductor clearance<br>2. Continual dialogue with Energy Australia to review existing management plan<br>3. Pre-mining surveys<br>4. Investigate need for installation of pulleys on earth wires<br>5. Energy Australia to review requirement for power line | |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | Principal dwellings and proposed buildings within Catholic Diocese principal residence area | 4.01.01 | Damage to principal dwellings | 1. Subsidence impacts | 1. Mine design and layout<br>2. Subsidence control zones (SCZ) to the 20mm subsidence contour (assumed 26.5 degrees for design purposes)<br>3. Pillar Extraction Management Plan (PEMP) including Authority to Mine (ATM)<br>4. Monitoring arrangements (Subsidence)<br>5. Mine Subsidence Board pre mining inspections to determine tolerable levels<br>6. Incorporate assessment of vibration into Property Subsidence Management Plan<br>7. Mine schedule provides for substantial amount of subsidence data prior to first workings underneath principal dwellings<br>8. Recalibration of subsidence model after each panel | A | 3 | C | 13 | S | 1. Review monitoring results regarding angle of draw<br>2. Test monitoring of disused houses | Yes |
| Natural Features | Tributaries | 1.02.03 | Ponding or reversal of flow | 1. Tilting<br>2. Subsidence | 1. EMP TARPs includes remediation and mine plan review<br>2. Property Subsidence Management Plans (PSMP) to be developed | E | 4 | B | 14 | S | 1. Mining height can be varied<br>2. Extraction ratio can be varied | Yes |
| Natural Features | Tributaries | 1.02.04 | Destabilisation of bank and / or bed | 1. Tilting<br>2. Subsidence<br>3. Gradient change | 1. EMP TARPs includes remediation and mine plan review<br>2. Property Management Plans to be developed | E | 4 | B | 14 | S | 1. Include tributary management in PMP | Yes |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natural Features | Schedule 2 Creeks | 1.01.02 | Hydraulic connection from surface to underground | 1. Connective cracking from stream bed to seam<br>2. Pillar extraction within SCZ | 1. Mine design and layout<br>2. Subsidence control zones (SCZ) 40m + to the 20mm subsidence contour (assumed 26.5 degrees for design purposes)<br>3. Pillar Extraction Management Plan (PEMP) including Authority to Mine (ATM)<br>4. Monitoring arrangements (Subsidence, surface and groundwater)<br>5. Environmental Management Plan (EMP)<br>6. Site water balance review<br>7. TARP | A | 2 | E | 16 | M | 1. Include visual inspection of stream flow and pool depth in checklist | Yes |
| Natural Features | Schedule 2 Creeks | 1.01.01 | Loss of overland flow | 1. Surface cracking of stream bed<br>2. Pillar extraction within SCZ | 1. Mine design and layout<br>2. Subsidence control zones (SCZ) 40m + to the 20mm subsidence contour (assumed 26.5 degrees for design purposes)<br>3. Pillar Extraction Management Plan (PEMP) including Authority to Mine (ATM)<br>4. Monitoring arrangements (Subsidence, surface and groundwater) | R | 3 | D | 17 | M | 1. Include visual inspection of stream flow and pool depth in checklist | Yes |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natural Features | Schedule 2 Creeks | 1.01.06 | Long term impact on aquatic ecosystem | 1. Change in flow regime<br>2. Change in water quality<br>3. Pillar extraction within SCZ | 1. Mine design and layout<br>2. Subsidence control zones (SCZ) 40m + to the 20mm subsidence contour (assumed 26.5 degrees for design purposes)<br>3. Pillar Extraction Management Plan (PEMP) including Authority to Mine (ATM)<br>4. Monitoring arrangements (Subsidence, surface and groundwater) | E | 3 | D | 17 | M | | Yes |
| Natural Features | Tributaries | 1.02.05 | Long term effects of change in stream water quality | 1. Tilting<br>2. Subsidence<br>3. Gradient change<br>4. Contaminants from waste disposal areas | 1. EMP TARPs includes remediation and mine plan review<br>2. Property Subsidence Management Plans to be developed | E | 3 | D | 17 | M | 1. Update CAD data with contaminated areas<br>2. Review contaminated areas studies (Douglas Partners) | Yes |
| Public Utilities | Telecommunication lines (overhead / underground) and associated plants | 2.05.01 | Damage to Optus Optical Fibre Cables | 1. Subsidence | 1. Optus have own internal management plan<br>2. Location of cable confirmed<br>3. Pre-mining audit has been carried out<br>4. Relocate fibre optic cable if required | A | 3 | D | 17 | M | 1. Assess Optus MP<br>2. Investigate durability of Optus cable<br>3. Subsidence data from Panels 1-4 will be available prior to mining under Optus Optical Fibre cable<br>4. Continual dialogue with Optus to confirm appropriate management plan | |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Public Utilities | State Survey marks | 2.07.01 | Use of disturbed State Survey Marks | 1. Disturbance of State Survey Marks due to subsidence | 1. Location of marks known<br>2. Notify Department of Lands | A | 3 | D | 17 | M | | |
| Residential | "Other surface structures" | 4.02.02 | Exposure to asbestos substances in the disused dwellings | 1. Subsidence impacts | 1. Property Subsidence Management Plan<br>2. Further inspections will be conducted prior to mining underneath | P | 3 | D | 17 | M | 1. Consider independent assessment of asbestos risk | |
| Natural Features | Tributaries | 1.02.01 | Cumulative loss of overland flow from tributaries | 1. Surface cracking of stream bed | 1. EMP TARPs includes remediation and mine plan review | E | 4 | C | 18 | M | 1. Include visual inspection of stream flow and pool depth in checklist | Yes |
| Public Utilities | Culverts associated with Black Hill Road | 2.02.01 | Serviceability of culverts | 1. Cracking<br>2. Steps (Scarps)<br>3. Change in road profile<br>4. Change in drainage | 1. Develop road management plan with Cessnock City Council<br>2. Develop Public Safety Management Plan<br>3. Ongoing consultation<br>4. Preliminary inspections of culverts have been undertaken | A | 4 | C | 18 | M | 1. Add inspection of culverts during mining to checklists | |
| Public Utilities | Water pipeline | 2.03.01 | Damage to HWC 200mm PVC pipe resulting in interruption to water supply | 1. Strains | 1. HWC Waterline Management Plan<br>2. Monitoring of pipeline<br>3. Pipeline was constructed in anticipation of future subsidence | R | 4 | C | 18 | M | 1. Request HWC to install additional gate valve to minimise impact | |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Farm Land and Facilities | Agricultural utilisation or agricultural suitability of farm land | 3.01.01 | Temporary loss of access to grazing areas | 1. Surface cracking | 1. Property Subsidence Management Plans<br>2. Ongoing consultation with property owners | A | 4 | C | 18 | M | | |
| Farm Land and Facilities | Internal Access tracks | 3.02.01 | Damage to internal property access tracks | 1. Cracking<br>2. Steps (Scarps)<br>3. Change in road profile<br>4. Reduction in sight distance on road<br>5. Change in drainage<br>6. Tree falling | 1. Develop Public Safety Management Plan<br>2. Ongoing consultation<br>3. Property Subsidence Management Plans | A | 4 | C | 18 | M | 1. Ground truthing of surface features | |
| Farm Land and Facilities | Fences, gates and cattle grids | 3.03.01 | Damage to fences and / or gates including resulting loss of livestock | 1. Strain<br>2. Subsidence<br>3. Falling tree | 1. Property Subsidence Management Plans<br>2. Ongoing consultation with property owners<br>3. Monitoring arrangements | A | 4 | C | 18 | M | | |
| Farm Land and Facilities | Farm dams | 3.04.01 | Damage to dams resulting in loss of serviceability and integrity of dam wall | 1. Cracking<br>2. Tilting | 1. Dam monitoring and management strategy (DMMS) will be developed for all dams prior to mining impact<br>2. Statement of commitments to provide water in the event of interruption of supply of water from dam | A | 4 | C | 18 | M | | |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Farm Land and Facilities | Water Reticulation systems | 3.07.01 | Damage to water reticulation system resulting in loss of service | 1. Subsidence impacts | 1. Property Subsidence Management Plan<br>2. Monitoring arrangements<br>3. Statement of commitments to provide water in the event of interruption of supply of water from reticulation system | A | 4 | C | 18 | M | 1. Complete identification of water reticulation systems within SMP Area 2 | |
| Farm Land and Facilities | Capping of remediated areas | 3.08.01 | Loss of integrity of capping | 1. Subsidence impacts | 1. See above | A | 4 | C | 18 | M | | |
| Residential | "Other surface structures" | 4.02.01 | Damage to other structures | 1. Subsidence impacts | 1. Mine design and layout<br>2. Monitoring arrangements (Subsidence)<br>3. Mine Subsidence Board pre mining inspections in conjunction with property owner and Abel to determine potential impacts, tolerable levels,<br>4. Management plan to be developed, incorporating responsibilities<br>5. Incorporate assessment of vibration into Property Subsidence Management Plan<br>6. Mine schedule provides for substantial amount of subsidence data prior to workings underneath structures<br>7. Recalibration of subsidence model after each panel | A | 4 | C | 18 | M | 1. Review monitoring results regarding angle of draw<br>2. Test monitoring of disused houses | |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natural Features | Schedule 2 Creeks | 1.01.03 | Ponding or reversal of flow | 1. Tilting<br>2. Subsidence<br>3. Pillar extraction within SCZ | 1. Mine design and layout<br>2. Subsidence control zones (SCZ) 40m + to the 20mm subsidence contour (assumed 26.5 degrees for design purposes)<br>3. Pillar Extraction Management Plan (PEMP) including Authority to Mine (ATM)<br>4. Monitoring arrangements (Subsidence, surface and groundwater) | E | 4 | D | 21 | L | | Yes |
| Natural Features | Schedule 2 Creeks | 1.01.04 | Destabilisation of bank and / or bed | 1. Tilting<br>2. Subsidence<br>3. Gradient change<br>4. Pillar extraction within SCZ | 1. Mine design and layout<br>2. Subsidence control zones (SCZ) 40m + to the 20mm subsidence contour (assumed 26.5 degrees for design purposes)<br>3. Pillar Extraction Management Plan (PEMP) including Authority to Mine (ATM)<br>4. Monitoring arrangements (Subsidence, surface and groundwater) | A | 4 | D | 21 | L | | Yes |
| Natural Features | Schedule 2 Creeks | 1.01.05 | Change in stream water quality | 1. Tilting<br>2. Subsidence<br>3. Gradient change<br>4. Pillar extraction within SCZ | 1. Mine design and layout<br>2. Subsidence control zones (SCZ) 40m + to the 20mm subsidence contour (assumed 26.5 degrees for design purposes)<br>3. Pillar Extraction Management Plan (PEMP) including Authority to Mine (ATM)<br>4. Monitoring arrangements (Subsidence, surface and groundwater) | E | 4 | D | 21 | L | | Yes |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natural Features | Aquifers, known groundwater resources | 1.03.02 | Additional flow to underground workings | 1. Connective cracking | 1. Water Management Plan<br>2. Pumping capacity is approximately 3 times current flows<br>3. Underground water storage area available | A | 4 | D | 21 | L | | |
| Natural Features | Aquifers, known groundwater resources | 1.03.03 | Quality change of groundwater inflows through mine workings | 1. Aquifer depressurisation | 1. Water Management Plan | A | 4 | D | 21 | L | | |
| Natural Features | Natural Vegetation | 1.08.01 | Change in habitat / fauna | 1. Falling tree<br>2. Dieback | 1. Mine design<br>2. Monitoring arrangements<br>3. Visual inspections<br>4. TARPs - remediation works | E | 4 | D | 21 | L | | |
| Natural Features | Natural Vegetation | 1.08.02 | Visual impact | 1. Falling tree<br>2. Dieback | 1. Mine design<br>2. Monitoring arrangements<br>3. Visual inspections<br>4. TARPs - remediation works<br>5. Ongoing Consultation | R | 4 | D | 21 | L | | |
| Areas of Archaeological and/or Cultural Significance | Areas of Archaeological and / or Heritage Significance | 5.01.01 | Disturbance of archaeological significant area contained within Area 2 | 1. Subsidence impacts | 1. Located within Viney Creek SCZ<br>2. ATM<br>3. PEMP | A | 4 | D | 21 | L | 1. Confirm details on sites and location | |
| Natural Features | Aquifers, known groundwater resources | 1.03.01 | Reduction in bore yield and adverse effects on groundwater dependent ecosystems | 1. Connective cracking | 1. No groundwater dependent ecosystems in area<br>2. No bores in area | E | 5 | C | 22 | L | | |

| Process | Sub-process | H# | Risk Issue | Causes | Existing Controls and planned Management Plans | Loss Type | Consequence | Likelihood | Risk Rank | Risk Level | Further Actions | ALARP (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Public Utilities | Telecommunication lines (overhead / underground) and associated plants | 2.05.02 | Damage to Telstra Local Copper Cables | 1. Subsidence | 1. Location of cable confirmed | R | 5 | C | 22 | L | 1. Confirm extent of current service<br>2. Continual dialogue with Telstra to develop management plan | |

# 13 COMMUNITY CONSULTATION

Community consultation during the preparation of the SMP was undertaken in accordance with the Department of Primary Industries – Mineral Resources *Guideline for Applications for Subsidence Management Approvals* dated December 2003 (SMP Guideline 2003) and the New South Wales Minerals Council *Community Engagement Handbook Towards Stronger Community Relationships*. The definition of “Community” adopted for the purpose of developing the SMP community consultation strategy is anyone with an interest in subsidence issues for the proposed SMP application.

**Consultation Process**

The SMP Guideline (DPI-MR, 2003) outlines a process for community consultation with persons or organisations that may be impacted by predicted subsidence following secondary extraction mining in the SMP area. The following describes the consultation undertaken in accordance with these guidelines.

Consultation undertaken has involved:

- Meeting with the Community Consultative Committee
- Identification of relevant stakeholders;
- Letters to the relevant stakeholders advising of the SMP process and providing contact information for comment or questions;
- Advertising of the SMP process in Local and State newspapers, with a request to provide comment;
- Meetings with landowners within and adjacent to the SMP area and with local community groups;
- Specific meetings with the owners of infrastructure located on or near the SMP area; and
- A Risk Assessment process involving various stakeholders; and

**Relevant Stakeholder Identification**

Stakeholders who were identified as having an interest in or concern about subsidence issues relating to the SMP include:

- SMP Inter-agency committee (comprising members included in the list below);
- Department of Industry & Investment;
- Private Landowners within and adjacent to the SMP area, including Catholic Diocese of Maitland – Newcastle and Black Hill Land Pty Ltd;
- Mindaribba Local Aboriginal Land Council;
- Department of Environment, Climate Change and Water (DECCW);
- Department of Primary Industries -NSW Office of Water (DPI- NOW)
- Department of Lands;
- Dams Safety Committee;
- NSW Fisheries;
- Transgrid;

- Energy Australia;
- Optus;
- Telstra;
- Hunter Water Corporation;
- Cessnock City Council;
- Newcastle City Council (NCC);
- Mines Subsidence Board; and
- Abel Mine Community Consultative Committee (CCC).

## 13.1 CONSULTATION DURING THE PREPARATION OF THE SMP APPLICATION

**Stakeholder / Community Consultation**

Stakeholder / Community consultation conducted to date has consisted of:

1. Community Consultative Committee Meetings
2. SMP Stakeholders presentation meeting and site inspection and submission process on 9 September 2010.
3. SMP Advertisements June 2010
4. Community Newsletter June 2010

A presentation followed by a site inspection was made to Industry & Investment NSW – Mineral Resources (I & I – MR) and identified stakeholders on 9 September 2010 *to* outline the SMP process and progress to date, relating to mine design, environmental considerations, results of mining SMP Area 1 to date, subsidence predictions and potential impacts.

The day was structured as follows;

1 Introduction and Meeting Objectives

2 Donaldson Coal Background

3 The Subsidence Management Plan (SMP) Process

4 Abel Mine
   - Project Approval
   - Mine Planning
   - Mining Methods
   - Area 1
   - Area 2
   - SMP Area Surface Environment Assessment

5 SMP Area 1 Approvals and Conditions, Management Plans, Monitoring Programs.

6 Panel 1 (SMP Area 1) progress to date.

7 Subsidence Results Panel 1, impacts and remediation.

8 SMP Area 2 Key surface features,

- Man made and natural features potentially impacted by subsidence including,
    - Properties;
    - Roads;
    - Powerlines;
    - Waterlines;
    - Dams; and
    - Other infrastructure.

9 Abel SMP Area 2 Subsidence Assessment and Predictions.

10 Abel SMP Area 2 Subsidence Impacts.

11 Abel SMP Area 2 Proposed Subsidence Monitoring.

12 Abel SMP Area 2 Mining Schedule.

13 Field Visit SMP Areas 1 and 2.

14 Lunch, open forum.

The objective of the meeting was to consult with interested parties (relevant stakeholders) to identify potential issues and relevant concerns to be considered and addressed in the preparation of the Subsidence Management Plan. A hard copy of the presentation was provided to all attendees.

Following this meeting a copy of the presentation was forwarded to all relevant stakeholders and placed on the company web site. Copy of presentation and minutes is included in Appendix F.

A list of relevant stakeholders and relevant details is provided in **Table 51.**

**Table 51 - Stakeholder / Community Consultation Information**

| Stakeholder | Invitation to Consultation Meeting | Attendance | Apology |
|---|---|---|---|
| Dr Gang Li - Industry & Investment | Yes | No | Yes |
| Ray Ramage – Industry & Investment | Yes | Yes | |
| Jonathon Smith – Industry & Investment | Yes | Yes | |
| Rod Sandell – Cessnock City Council | Yes | Yes | |
| Johannes Honnef - Newcastle City Council | Yes | Yes | |
| Sean Scanlon - Catholic Diocese | Yes | Yes | |

| **Stakeholder** | **Invitation to Consultation Meeting** | **Attendance** | **Apology** |
|---|---|---|---|
| Damien Harrigan - Catholic Diocese | Yes | Yes | |
| Geoffrey Rock – Black Hill Land Pty Ltd | Yes | Yes | |
| Ian Landon-Jones – Sydney Catchment Authority | Yes | No | Yes |
| Scott Carter – DPI Fisheries | Yes | No | Yes |
| David Hilyard – Dam Safety Committee | Yes | No | Yes |
| Garry Moore – Mine Subsidence Board | Yes | Yes | |
| Howard Reed – Department of Planning | Yes | No | Yes |
| Mark Mignanelli – Department of Water and Energy | Yes | No | Yes |
| Fergus Hancock – Department of Water and Energy | Yes | No | Yes |
| Karen Marler– DECCW | Yes | No | Yes |
| Bruce Fraser - Transgrid | Yes | Yes | |
| Brian Magin - Transgrid | Yes | Yes | |
| Energy Australia – Greg Skinner | Yes | No | Yes |
| Colin Dove – Telstra Consultant | Yes | Yes | |
| Mark Schneider - Telstra | Yes | No | Yes |
| Optus | Yes | No | Yes |
| Hunter Water Corporation | Yes | No | Yes |
| Brad Ure – Community Consultative Committee | Yes | Yes | |

| Stakeholder | Invitation to Consultation Meeting | Attendance | Apology |
|---|---|---|---|
| Alan Jennings – Community Consultative Committee | Yes | Yes | |
| Alan Brown – Community Consultative Committee | Yes | No | Yes |
| Terry Lewin – Community Consultative Committee | Yes | Yes | |
| Tony and Rosalie Seton – Residents | Yes | Yes | |
| Carol Fraser - Resident | Yes | Yes | |
| Noel and Daphne Blanch - Residents | Yes | Yes | |
| Peter Allan – Resident | Yes | Yes | |
| Rodney Lodge – Resident | Yes | Yes | |
| Rod Taylor – Resident | Yes | Yes | |
| Bruce and Joyce Doyle – Residents | Yes | Yes | |
| Anne & Doug Clark – Resident | Yes | Yes | |
| Mindaribba Local Aboriginal Land Council | Yes | No | Yes |

**SMP Advertisement**

As per the SMP Guideline 2003, Abel prepared an advertisement to notify the community of the intention to submit an SMP application for approval. The advertisement stated:

*“Donaldson Coal is developing a Subsidence Management Plan to accompany an application to the Department of Primary Industries - Mineral Resources for Pillar extraction mining at Abel Mine in the application area outlined below. Once prepared, the draft Plan will be advertised and displayed for comment. Any person wishing to provide input to the preparation of the Plan can contact the mine on (02) 4015 1100. ”*

The advertisement included a map of the SMP Area, mine lease boundaries, the existing workings and regional locality. Donaldson Coal placed the advertisement in the Newcastle Herald and the Sydney Morning Herald on 19 June 2010. Copies of the advertisements are provided in **Appendix F**.

## 13.2 RESULTS OF COMMUNITY CONSULTATION

A summary of any issues, relevant to this SMP Application raised by the stakeholders is included in **Table 52** below.

Additionally, **Table 52** lists continued correspondence and meetings with landholders and infrastructure owners relating to mine plan design, subsidence predictions and discussions relating to potential impacts, monitoring, remediation / mitigation and management proposals.

**Table 52 - Community Consultation**

| Date | Type | To / From / With | Subject |
|---|---|---|---|
| **Hunter Water** | | | |
| 19/8/10 | Letter | To : Hunter Water | Invite to SMP Area 2 Stakeholder Day |
| 24/8/10 | email | To : Hunter Water | Discussion re Isolation valve on Hunter Water 200 UPVC water line |
| **Optus** | | | |
| | | To : Optus Network Operations | General consultation re relocation of Optus fibre optic cable |
| 23/3/10 | email | To : Inoke Katia ONO | To discuss Pre Mining audit of FOC |
| 26/7/10 | Audit | | Pre Mining audit of FOC conducted |
| 8/10/10 | Meeting in Sydney | Optus Management | To discuss Relocation of fibre optic cable |
| 3/11/10 | email | From : Optus Network Operations | Plan showing 8km diversion line for new cable |
| 1/12/10 | email | From : Optus Network Operations | Cost for the 8km relocation received |
| 21/12/10 | email | From : Optus Network Operations | Letter Optus sent to MSB |
| **Telstra** | | | |
| 23/8/10 | email | To: Colin Dove | Plan showing Abel SMP Area 2 |
| 24/8/10 | letter | To : Mark Schneider | Invite to SMP Area 2 Stakeholder Day |
| 15/9/10 | e-mail | Mark Schneider and Colin Dove | Copy of SMP Area 2 presentation sent |
| **Energy Australia** | | | |
| 1/9/10 | Meeting | With : Greg Skinner - EA | Meeting to discuss Abel Mine SMP Area 2 |
| **Transgrid** | | | |
| 7/9/10 | e-mail | From : Bruce Fraser - Transgrid | update on TransGrid transmission line subsidence impact analysis |
| 19/8/10 | Letter & email | To : Bruce Fraser - Transgrid | Invite to SMP Area 2 Stakeholder Day |
| 19/8/10 | Letter & email | To : Brian Magin - TransGrid | Invite to SMP Area 2 Stakeholder Day |
| 19/8/10 | e-mail | From : Bruce Fraser - Transgrid | Confirming attendance at meeting |
| 5/4/11 | e-mail | To : Bruce Fraser - Transgrid | SMP Area 2 Mining sequence Plan |
| **Catholic Diocese Maitland-Newcastle** | | | |
| 17/8/10 | Letter & email | To: Damien Harrigan– Catholic Diocese | Invite to SMP Area 2 Stakeholder Day |
| 17/8/10 | email | From: Sean Scanlon | Confirming attendance at meeting |
| 30/8/10 | Meeting | With Catholic Diocese | SMP related matters |
| 15/9/10 | e-mail | Sean Scanlon & Damien Harrigan | Copy of SMP Area 2 presentation sent |
| From 3/9/10 | Meetings | Weekly meetings | Discussing SMP related activities |

| Date | Type | To / From / With | Subject |
|---|---|---|---|
| | and inspections | | |
| **Black Hill Land P/L** | | | |
| 17/8/10 | Letter & email | To : Geoff Rock – Black Hill Land P/L | Invite to SMP Area 2 Stakeholder Day |
| 19/8/10 | Meeting | With Geoff Rock – Black Hill Land P/L | SMP Area 2 application. |
| 15/9/10 | email | To : Geoff Rock – Black Hill Land P/L | Copy of SMP Area 2 presentation sent |
| 5/11/10 | Meeting | With : Geoff Rock and Keith Dedden– Black Hill Land P/L | Discussed Black Hill Land concept plan, Access agreement, Property Subsidence Management Plan and Landowner agreement. |
| 15/12/10 | Meeting | With : Geoff Rock – Black Hill Land P/L | Discussed Access agreement, Property Subsidence Management Plan and Landowner agreement. |
| **Mine Subsidence Board** | | | |
| 18/8/10 | email | To Greg Cole Clark | Invite to Abel SMP Area 2 Stakeholder Day |
| 13/10/10 | email | From: Garry Moore District Manager | Confirming attendance at meeting |
| 13/9/10 | email | To Greg Cole Clark | Copy of SMP Area 2 presentation sent |
| 3/11/10 | Meeting | With Greg Cole Clark | To discuss relocation of Optus FOC |
| **I & I NSW - Mineral Resources** | | | |
| 18/8/10 | Letter & email | To: Ray Ramage- Industry & Investment | Invite to Abel SMP Area 2 Stakeholder Day |
| 18/8/10 | Letter & email | To: Gang Li- Principal Subsidence Engineer - Industry & Investment | Invite to Abel SMP Area 2 Stakeholder Day |
| 18/8/10 | Letter & email | To: Jonathon Smith- A/Subsidence Executive Officer – Industry & Investment | Invite to Abel SMP Area 2 Stakeholder Day |
| 18/8/10 | Letter & email | To: Michael McFadyen – Industry & Investment | Invite to Abel SMP Area 2 Stakeholder Day |
| **I & I - Fisheries** | | | |
| 18/8/10 | Letter & /email | To: Scott Carter | Invite to Abel SMP Area 2 Stakeholder Day |
| **Planning NSW** | | | |
| 18/8/10 | Letter & /email | To: Howard Reid | Invite to Abel SMP Area 2 Stakeholder Day |
| **Newcastle City Council** | | | |
| 18/8/10 | Letter & email | To: Judy Jaeger – General Manager | Invite to Abel SMP Area 2 Stakeholder Day |
| 6/9/10 | Email | From: Johannes Honnef – Senior Urban Planner | Confirming attendance for Stakeholder day |
| 15/9/10 | email | To: Johannes Honnef | Copy of SMP Area 2 presentation sent |
| **Cessnock City Council** | | | |
| 18/8/10 | Letter & email | To: Rod Sandell - Senior Planning Assessment Officer | Invite to Abel SMP Area 2 Stakeholder Day |
| **Sydney Catchment authority** | | | |
| 18/8/10 | Letter & email | To: Ian Landon Jones | Invite to Abel SMP Area 2 Stakeholder Day |

| ***Date*** | ***Type*** | ***To / From / With*** | ***Subject*** |
|---|---|---|---|
| ***Department of Water & Energy*** | | | |
| 17/8/10 | Letter & email | To: Fergus Hancock | Invite to Abel SMP Area 2 Stakeholder Day |
| ***NSW Office of Water*** | | | |
| 18/8/10 | Letter & email | To: Mark Mignanelli | Invite to Abel SMP Area 2 Stakeholder Day |
| ***Department of Environment Climate Change and Water*** | | | |
| 18/8/10 | Letter & email | Grahame Clarke - Hunter Regional Manager | Invite to Abel SMP Stakeholder meeting |
| ***Dam Safety Committee*** | | | |
| 18/8/10 | Letter & email | David Hilyard | Invite to Abel SMP Area 2 Stakeholder meeting |
| ***Mindaribba Local Aboriginal Land Council*** | | | |
| 19/8/10 | Letter | Rick Griffiths | Invite to Abel SMP Area 2 Stakeholder meeting. Letter dropped off at Mindaribba office 19/8/10. |
| ***Abel Community Consultative Committee (CCC)*** | | | |
| 17/8/10 | Letter & email | To: Alan Jennings | Invite to Abel SMP Area 2 Stakeholder Day |
| | email | To: Allan Jennings | Copy of SMP Area 2 presentation sent |
| 17/8/10 | Letter & email | To: Alan Brown | Invite to Abel SMP Area 2 Stakeholder Day |
| | email | From: Alan Brown | Confirming attendance at meeting |
| | email | To: Alan Brown | Copy of SMP Area 2 presentation sent |
| 3/9/10 | email | To: Alan Brown | Invite to SMP Area 2 Risk Assessment |
| 18/8/10 | Letter & email | Terry Lewin | Invite to SMP Area 2 Risk Assessment |
| | email | To: Terry Lewin | Copy of SMP Area 2 presentation sent |
| | Letter | Brad Ure | Invite to Abel SMP Stakeholder meeting |
| 15/9/10 | email | To: Brad Ure | Copy of presentation |
| ***Other Landholders*** | | | |
| 15/9/10 | Letter | David Allan | Invite to Abel SMP Stakeholder meeting |
| 15/9/10 | Letter/Fax | Tony & Rosalie Seton | Invite to Abel SMP Stakeholder meeting |
| 15/9/10 | email | To: Doug and Ann Clark | Copy of SMP Area 2 presentation sent |
| 15/9/10 | email | To: Steve Fraser | Copy of SMP Area 2 presentation sent |
| 15/9/10 | email | To: Noel & Daphne Blanch | Copy of SMP Area 2 presentation sent |
| 15/9/10 | email | To: Tony Seton | Copy of SMP Area 2 presentation sent |
| 15/9/10 | email | To: Rod & Julie Taylor | Copy of SMP Area 2 presentation sent |

# 14 ECONOMIC AND SOCIAL IMPACTS AND BENEFITS

Abel currently has approximately 20 years of coal reserves within the current mining lease.

The majority of Abel's production is railed to Newcastle for the export market with a small amount to various local markets.

Abel provides valuable training and industry experience to apprentices and work experience to both local youth and university students (local and intrastate).

In the Abel Project Approval Statement of Commitments Donaldson Coal Pty Ltd committed to providing monetary contributions towards environmental and community enhancements. These Company Contribution Initiatives are listed in **Table 53**.

**Table 53 - Company Contribution Initiatives**

| No. | Proposed Activities | Monetary Value |
|---|---|---|
| **1.** | **Conservation**<br>The company will contribute $1,000,000 to be distributed over ten years by a community trust to be established for the purpose.<br>These monies will be able to be expended by the trust on environmental education or research or environmental management works or activities in State<br>Conservation Area lands or other environmentally valuable lands that lie within or above Donaldson's mining leases and exploration licences or other land owned by the company | $1,000,000 |
| **2.** | **Community Welfare**<br>The company will contribute $250,000 over 5 years to be spent as decided by a community trust on educational needs, community works or other works or<br>activities of benefit to the community within the Abel underground mine area. | $250,000 |
| **3.** | **Road Safety**<br>The company contributed $250,000 towards the cost of upgrading the intersection of Black Hill Rd and John Renshaw Drive, provided that construction of the<br>upgrade is initiated by June 2009 | $250,000 |
| **4.** | **Employment Generation**<br>The Company also operates the **Donaldson Job Creation Trust,** a charitable trust already in operation<br>set up to distribute $1,000,000 over ten years.<br>Monies are expended on job training, job creation and Youth at Risk programs in the Lower Hunter.<br>$500,000 of these monies remain to be spent | $500,000 |
| | | **$2,000,000** |

Abel currently employs 200 personnel and this will increase to 350 once full production level is reached. Town planning calculations anticipate that for each mine employee there are approximately 2.5 indirect employees retained in the community. Consequently the operation of Abel provides approximately 1,200 additional jobs within the local area.

Substantial industry expenditure occurs locally and both federal and state governments will continue to receive income by way of royalty, excise and various taxes.

# 15 STATUTORY REQUIREMENTS

## 15.1 PROJECT APPROVAL

The construction and operation of Abel mine was approved by The Minister for Planning on 7 June 2007, being Project Approval (Development Consent) 05_0136 and allowing mining operations to take place until 31 December 2028.

Abel commenced operations in May 2008. The mine currently employs 200 personnel and currently produces approximately 1.8 million tonnes per annum (tpa), with a proposed maximum production of 4.5 million tonnes of thermal / soft coking coal from the Upper Donaldson coal seam. Abel’s production is railed to Newcastle for the export market.

The key features of the Project Approval (Development Consent) 05_0136 for the mine include:

- Construction and operation of an underground coal mine.

**Obligations to Minimise Harm to the Environment**

1. The Proponent shall implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.

**Terms of Approval**

2. The Proponent shall carry out the project generally in accordance with the:
    d) EA;
    e) Statement of Commitments; and
    f) Conditions of this approval.
3. If there is any inconsistency between the above documents, the later document shall prevail to the extent of the inconsistency. However, the conditions of this approval shall prevail to the extent of any inconsistency.
4. The Proponent shall comply with any reasonable and feasible requirements of the Director-General arising from the Department’s assessment of:
    (c) any reports, plans or correspondence that may be submitted in accordance with the conditions of this approval; and\
    (d) the implementation of any actions or measures contained in these reports, plans or correspondence.

**Limits of Approval**

5. Mining operations may take place until 31 December 2028 on the Abel site.
6. The Proponent shall not extract more than 4.5 million tonnes of ROM coal a year from the Abel site.

7. No more than 6.5 million tonnes of ROM coal may be processed a year on the Bloomfield site.
8. All product coal produced on the Bloomfield site shall be transported by rail via the rail loading facility on the Bloomfield site, except in an emergency. In an emergency, product coal may be transported from the Bloomfield site by road with the prior written approval of the Director-General, subject to any restrictions that the Director-General may impose.

Subsidence related and monitoring / management consent conditions and Statement of Commitments items relevant to this SMP Application are noted in **Table 3** located earlier in this application.

Information regarding all Project Approval conditions is included in each Annual Environmental Management Report (AEMR) lodged with the DII – Minerals and Energy. An annual presentation on the previous year's results and AEMR is made to the DII – Minerals and Energy and other agencies.

## 15.2 MINING LEASE CONDITIONS

The Abel underground mine is accessed through ML 1618. Underground mining is currently undertaken only within this lease.

**Table 54 - Abel Mine Mining Lease ML1618 and ML 1653**

| Primary Facility (underground) | Expiry Date | Area (ha) |
|---|---|---|
| Mining Lease 1618 (Act 1992) | 15 May 2029 | 2,755 |
| Mining Lease 1653 (Act 1992) | 21 January 2032 | 0.25 |

The relevant lease contains one condition relating to subsidence, being that relating to Subsidence Management, which is listed below.

**Subsidence Management**

(a) The lease holder 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 *Applications for Subsidence Management Approvals guidelines (EDG17).*

(c) The lease holder 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 Mine Health and Safety Act 2002*, or the document *New Subsidence Management Plan Approval Process – Transitional Provisions (EDP09).*

(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*.

## 15.3 RELEVANT LEGISLATION

### 15.3.1 Commonwealth Legislation

**Environment Protection and Biodiversity Conservation Act 1999**

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires the approval of the Commonwealth Minister of the Environment, Water, Heritage and the Arts for actions that may have a significant impact on matters of National Environmental Significance (NES). Approval from the Commonwealth is in addition to approvals under the NSW legislation. However a bilateral agreement has been concluded between the NSW and Commonwealth government which provides for the accreditation of the NSW assessment and approvals process such that one approval may be granted covering both State and Commonwealth requirements.

The EPBC Act also provides for the identification, conservation and protection of places of National Heritage significance and provides for the management of Commonwealth Heritage places.

The EPBC Act lists seven matters of NES that must be addressed when assessing the impacts of a proposal which are:

- World Heritage Places;
- National Heritage places;
- RAMSAR wetlands (wetlands of international significance);
- Listed threatened species, critical habitats and ecological communities;
- Listed migratory species;
- Commonwealth land and marine areas or reserves; and
- nuclear actions (including uranium mining).

The flora and fauna study undertaken for the Abel Environmental Assessment considered RAMSAR wetlands, listed migratory species and listed threatened species and populations in accordance with the Commonwealth EPBC Act 1999. The flora and fauna study concluded that there would be no significant impact on these matters resulting from works associated the proposed development and mining. An assessment undertaken in accordance with the requirements of the EPBC Act concluded that the proposed mining will not result in a significant impact on the species' habitat. The proposed mining is therefore not a controlled action and approval from the Commonwealth Minister for the Environment and Heritage is not required.

### 15.3.2 State Legislation and Planning Policies

**Environmental Planning and Assessment Act 1979**

The *Environmental Planning and Assessment Act 1979* (EP & A Act) and the *Environmental Planning and Assessment Regulation 2000* (EP & A Regulation) provide the framework for environmental planning in NSW and include provisions to ensure that proposals which have the potential to impact the environment are subject to detailed assessment, and also provide opportunity for public involvement. is administered by the Department of Planning (DoP). It institutes a system of environmental planning and assessment for the State of New South Wales.

The objectives of the EP & A Act that are relevant to the proposed pillar extraction mining of SMP Area 1 are:

- the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment;
- the promotion and co-ordination of the orderly and economic use and development of land;
- public involvement;
- the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats; and
- ecologically sustainable development.

Abel has Project Approval 05_0136 granted 7 June 2007.

**Protection of the Environment Operations Act 1997**

The *Protection of the Environment Operations Act 1997* (POEO Act) is the principal NSW legislation relating to environmental regulation and in particular contains strict provisions regulating water, air, noise and land pollution. A key feature of the POEO Act is the requirement for certain '*Scheduled activities',* which are listed in Schedule 1 of the POEO Act to have an Environmental Protection Licence (EPL).

Clause 28 of Schedule 1 of the POEO Act relates to mining for coal and provides that coal mines with a capacity to produce more than 500 t of coal per day are classified as '*scheduled activities'*

Abel Mine has this capacity and currently holds EPL No.12856 under the POEO Act. No variation to this licence is required for the proposed extraction of the SMP Area 2.

**Threatened Species Conservation Act 1995**

The *Threatened Species Conservation Act 1995* (TSC Act) provides protection for threatened plants and animals native to NSW (excluding fish and marine vegetation which are protected under the *Fisheries Management Act 1994*). The Act integrates the conservation of threatened species into development approval processes under the EP & A Act. Under the EP & A Act, impacts on threatened species listed under the TSC Act are assessed by a seven-part test. Where a development is likely to have a significant impact on a threatened species, population or ecological community, the preparation of a Species Impact Statement (SIS) is required.

The results of the seven part tests conducted for threatened fauna species identified in the SMP application area conclude that the proposed pillar extraction mining operation is not likely to have a significant effect on these species based on predicted levels of subsidence. Similarly the effects on identified threatened flora species are considered to be minimal, if any.

**Mining Act 1992**

The *Mining Act 1992* (Mining Act) makes provision for a variety of mining authorities, including mining leases and exploration licences which are required for the prospecting and mining of minerals and coal. The Mining Act also makes provision for the protection of the environment in relation to mining activities, including rehabilitation of areas affected by mining activities.

Abel Mine currently holds a mining lease (ML 1618) over the SMP application area. A condition of this lease requires a Subsidence Management Plan to be prepared prior to the commencement of any mining operations which may potentially lead to subsidence.

Part 11 of the Mining Act deals with the protection of the environment and provides that conditions may be imposed upon a mining authority or mineral claim requiring that land affected by mining activities be rehabilitated. Standard conditions generally imposed upon a mining lease include requirements to submit a MOP prior to the commencement of mining operations as well as Annual Environmental Management Reports (AEMR). These documents form the Mining Rehabilitation and Environmental Management Process (MREMP)

The Mining Operations Plan (MOP) is systematically updated to cover the mining operations. The current MOP was accepted in December 2008 and will be modified to include the SMP application area. Environmental performance of the operation will be reported in the Annual Environmental Management Report (AEMR).

**Coal Mines Health and Safety Act 2002 and Coal Mine Health and Safety Regulation 2006**

The *Coal Mines Health and Safety Act 2002* (CMHS Act) operates in conjunction with the *Occupational Health and Safety Act 2000* (OH & S Act) and *Coal Mine Health and Safety Regulation 2006* (CMHS Regulation) with the key objects being:

- to assist in securing the objects of the *Occupational Health and Safety Act 2000* in relation to coal operations;
- to put in place special provisions necessary for the control of particular risks arising from the mining of or exploration for coal;
- to ensure that the effective provisions for emergencies are developed and maintained at coal operations or related places.

Part 5 of the CMHS Act sets out the duties of the mine operator in relation to health, safety and welfare at coal operations. The Act requires that the mine operator have a health and safety management system providing :

- the basis for the identification of hazards, and of the assessment of risks arising from these hazards, by the operator;
- for the development of controls for those risks; and
- for the reliable implementation of those controls.

The Act may also require the operator to have in place:

- Major hazard plan;
- Management structure;
- Contractor management plan; and
- Emergency management system.

These documents form part of the existing general health and safety system in place at Abel.

- Under Clause 88 of the *Coal Mine Health and Safety Regulation 2006* under the CHMSA, Abel must also submit an application for approval to I & I NSW – Mineral Resources prior to the commencement of secondary extraction.

**Mine Subsidence Compensation Act 1961**

The *Mine Subsidence Compensation Act 1961* (MSC Act) establishes a scheme for the payment of compensation for damage sustained to surface improvements by subsidence resulting from the mining of coal or shale.

Section 10 of the Act establishes the Mine Subsidence Compensation Fund. Colliery proprietors are required to make an annual contribution to this fund based upon the land value of the colliery. Under the Act, claims can be made against this fund for damage arising out of subsidence. Abel makes contributions, as appropriate and required under this Act.

Section 15 of the Act makes provision for the establishment of Mine Subsidence Districts (MSD) and requires that an application be lodged with the Mine Subsidence Board (MSB) for the erection or alteration of improvements or the subdivision of land within a mine subsidence district.

The SMP application area is not located within a current Mine Subsidence District but was previously located within the Ironbark Mine Subsidence District. Discussions have been held with the MSB relating to the reclassification of the area as a Mine Subsidence District.

**Water Management Act 2000**

The *Water Management Act 2000* (WM Act) is administered by the NSW Office of Water and provides for the regulation of access to water. The Act, as amended, came into force in July 2004.

The object of the Act is to ensure sustainable and integrated management of water in NSW for present and future generations and it is based on the concept of ecologically sustainable development.

Licensing and approval systems are in place over those areas of NSW subject to an operational water sharing plan. These plans have been compiled for most of the regulated river systems in NSW. The licensing system applies to both surface and groundwaters.

**Water Act 1912**

Licences under the *Water Act 1912* authorise the taking of water and the use of water. Abel currently holds a licence (**20BL171935 valid until 4 August 2013)** issued under the *Water Act 1912* for the purpose of mine dewatering.

The area of proposed extraction does not have any major rivers or streams running through it and the extraction should not require any additional water for processing. It is not anticipated that large volumes of groundwater will be encountered, however, if dewatering beyond licence requirements is required, an amendment to the existing water license would be pursued. It is therefore not anticipated that any new licenses would be required under the WMA 2000.

**State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP)**

*State Environmental Planning Policy (Mining, Petroleum Production and extractive Industries) 2007* (Mining SEPP) recognises the importance of mining, petroleum production and extractive industries and sets out activities which are permissible both with and without development consent, and also specifies prohibited development.

The proposed mining within the SMP application area is permissible with the existing Project Approval.

**Dams Safety Act 1978**

The SMP application area does not contain any dams (including stored waters and reservoirs) and / or structures referred to by the *Dams Safety Act 1978.*

**National Parks and Wildlife Act 1974**

The *National Parks and Wildlife Act 1974* (NP & W Act) provides for the establishment, care, control and management of national parks, historic sites, nature reserves, State Conservation Areas, Aboriginal areas and state game reserves.

The Act also provides for the protection of Aboriginal objects and the protection of native flora and fauna. A consent to destroy permit is required under Section 90 of the Act prior to the destruction of any known Aboriginal Archaeological sites. Aboriginal heritage assessments of the SMP application area have been conducted. Potential impacts to Aboriginal places and objects, native flora and native fauna have been considered in this SMP application with no significant impacts predicted.

**Heritage Act 1977**

The purpose of *Heritage Act 1977* (Heritage Act) is to protect and conserve on-aboriginal cultural heritage, including scheduled heritage items, sites and relics. The Heritage Act is administered by the NSW Heritage Office, which maintains the State Heritage Register, listing heritage items of State significance. The Act also requires that a permit be obtained prior to disturbance of any known heritage items (greater than 50 years old).

An assessment of European heritage has been conducted over SMP application area with no items located.

### 15.3.3 Local Planning

The Abel Underground Mine lease area is within Newcastle and Cessnock local government areas (LGAs). The majority of SMP application area is within Cessnock LGA with the eastern section within Newcastle LGA.

The area within Cessnock LGA is zoned 1(a) Rural A by the Cessnock Local Environment Plan 1989, which permits underground mining and associated surface activities with consent. The eastern section within Newcastle LGA is zoned 7(b) Environmental Investigation by the Newcastle Local Environment Plan 2003, which permits underground mining activities with consent.

The Abel pillar extraction within the SMP application area is permissible in all applicable local government area zonings.

# 16 REFERENCES

**Department of Infrastructure, Planning and Natural Resources 2002** – Draft Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region

**Coal & Allied (2011)-** Black Hill Land Concept Plan Environmental Assessment http://www.coalandallied.com.au/documents/SA1976G_BH_EA_11_Feb_2011.pdf

**Geoterra Pty Ltd (2009)-** Report on Inspection of Viney Creek

**Harden G.J. ed. (1990)** - Flora of New South Wales Volume 1, NSW Uni Press, Kensington.

**Harden G.J. ed. (1991)** - Flora of New South Wales Volume 2, NSW Uni Press, Kensington.

**Harden G.J. ed. (1992)** - Flora of New South Wales Volume 3, NSW Uni Press, Kensington.

**Harden G.J. ed. (1993)** - Flora of New South Wales Volume 4, NSW Uni Press, Kensington.

**Harden G.J. ed. (2002)** - Flora of New South Wales Volume 2, Second Edition, NSW Uni Press, Kensington.

**NSW Department of Mineral Resources (2003) –** Guideline for Applications for Subsidence Management Approvals.

**NSW Department of Mineral Resources (2003) –** New Approval Process for the Management of Coal Mining Subsidence.

**NSW Minerals Council** – Community Engagement Handbook Towards Stronger Community Relationships

**ERM Pty Limited (2008)**- Lower Hunter Estates Development Heritage Impact Assessment Blackhill Estate [http://www.coalandallied.com.au/documents/Heritage_Report_Part_1.pdf]

# 17 PLANS

| **SMP guideline reference** | **Plan Name - Number** |
|---|---|
| Plan 1 | Existing & Proposed Workings |
| Plan 2 | Natural & Man-made Features |
| Plan 3A | Depth of Cover Isopachs and Seam thickness |
| Plan 3B | Seam floor contours and geological structures |
| Plan 5 | Mining Titles & Land Ownership |
| Plan 6 | Geological Sections/Strata Profile |
| Plan 7 | Aerial Photograph |
| Approved Plan | SMP Approved Plan |

# 18 APPENDICES