DONALDSONCOAL
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ABEL MINE

Subsidence Management Plan

Blackhill Road & Taylors Road Management Plan

SMP AREA 2

November 2012

Document Control

Description

Document No.	Abel Mine SMP Area 2
Title	Blackhill Road & Taylors Road Management Plan SMP Area 2
General Description	To ensure the safety and serviceability of Blackhill Road and Taylors Road that may be affected by the mining of Panels 21 & 22 in the Upper Donaldson Seam at Abel Mine
Key Support Documents	Abel Mine SMP Area 2 Subsidence Management Plan

Approvals

ORIGINATOR	Matthew Wright	Position Registered Mining Surveyor	Signed	Date 14-11-12
APPROVED	Tony Sutherland	Position Technical Services Manager – Donaldson Underground Operations	Signed	Date 14-11-12
APPROVED		Cessnock City Council	Signed	Date
APPROVED		Mine Subsidence Board	Signed	Date

Revisions

Version #	**Date**	**Description**	**By**	**Checked**	**Approved**	
					Name	**Signed**
2	25/10/2012					
3	13/11/2012	Following Review by Cessnock Council				

The nominated Coordinator for this document is	Technical Services Manager

APPENDICES

FIGURES & TABLES

1 INTRODUCTION

1.1 Background

Blackhill Road is approximately 5.7km long and intersects with John Renshaw Drive to the West and the F3 Freeway to the East. A 700m section of road from a point approximately 2.8km East of the John Renshaw Drive Intersection may be impacted by partial pillar extraction. This Management Plan has been developed to address the monitoring, management, mitigation and remediation of any impacts.

Subsidence predictions and impact assessment have been completed for Blackhill Road & Taylors Road by Ditton Geotechnical Services (DGS).

A risk assessment was conducted by Donaldson Coal and facilitated by HMS Consultants to determine the risks and impacts of partial pillar extraction on all surface infrastructure including the subject roads.

The effects of maximum theoretical subsidence were assessed and the outcomes incorporated in the mitigation strategy. This Management Plan utilises the risk assessment and the predictions of the subsidence consultant and outlines the consultation, investigations, monitoring, and actions to be performed prior, during and following the partial extraction of the pillar panels.

1.2 Scope

The management plan relates to those activities involved with managing the possible impacts of subsidence on Blackhill Road and Taylors Road during and after the mining period until final subsidence has been realised. This plan is limited to the management of the possible impacts of subsidence on Blackhill Road and Taylors Road that lie within the Abel SMP Area 2 partial pillar extraction Panels 21 & 22.

1.3 Objective

The objective of the management plan is to ensure the safety and serviceability of Blackhill Road and Taylors Road that may be impacted by the mining of the partial pillar extraction panels in the SMP Area 2 and gather information to aid planning in regard to future mining beneath Blackhill Road.

1.4 Stakeholder Consultation

Donaldson has developed this plan in consultation with Cessnock City Council, Mine Subsidence Board and the Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS).

1.5 Reference to Plans & Procedures

This plan forms part of the Abel SMP Area 2 Management Plan and should not be read in isolation. The following table shows the document hierarchy.

Management Plan
Abel SMP AREA 2 Subsidence Management Plan Containing: • Background information • Identified risks • Subsidence Monitoring Plan • Public Safety Management Plan • Individual Property, feature and infrastructure TARP's
Blackhill Road and Taylors Road Management Plan

Photo 1 – Blackhill Road looking East

Photo 2 – Intersection of Blackhill Road and Taylors Road

2 SUBSIDENCE MANAGEMENT

2.1 Site Characteristics

Blackhill 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 3m deep. The condition of this section of 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 the mining area.

There are two concrete pipe culverts (No.s 1 & 2) in up to 3m of fill below Blackhill Road (Cessnock City Council). Culvert No.1 has twin 1200mm diameter pipes with a 1.8m high x 2.5m long gabion head wall and cobble sized dolerite rip rap on the downstream side. Culvert No.2 is a single 900mm diameter pipe. Both culverts have upstream and downstream reinforced concrete head walls, and the pipe segments are 3m long.

2.2 Predicted Subsidence Impacts

Detailed descriptions and predictions of the worst case transient and final subsidence related to SMP Area 2 are provided in the report `Subsidence Contour Predictions and Impact Assessment for the Proposed Partial Pillar Extraction of Panels 19 to 22 at the Abel Mine – ABL-002/4 (refer **Appendix B**).

2.2.1 Worst Case Subsidence, Tilt and Strain Profile and Contour Predictions

Based on the DGS report the worst case subsidence of the proposed Panels 21 & 22 are as follows:

- Maximum Subsidence: < 0.15m
- Maximum Tilt: <3mm/m
- Maximum Curvature: < 0.2 km^{-1} (radius of curvature > 5 km)
- Maximum Horizontal Strain: < 2mm/m (compressive and tensile)
- Maximum Horizontal Displacement < 30mm
- Angle of Draw to 20mm of subsidence <10° or 0.18 x Cover Depth.

3 RISKS

Based on the predicted credible worst case subsidence of <150mm, tilts of < 3mm/m and tensile/compressive strains < 2mm/m, it is assessed that it would be very unlikely to cause visual impact or damage (i.e. cracking or erosion) to the surface including Blackhill Road and Taylors Road above the proposed panels.

4 CONTROLS

4.1 Pre-Mining Inspection and Report

A pre mining inspection will be conducted by and in consultation with Cessnock City Council to ascertain the condition of the road prior to extraction. In addition an independent pre extraction dilapidation report with particular attention to culvert condition will be conducted.

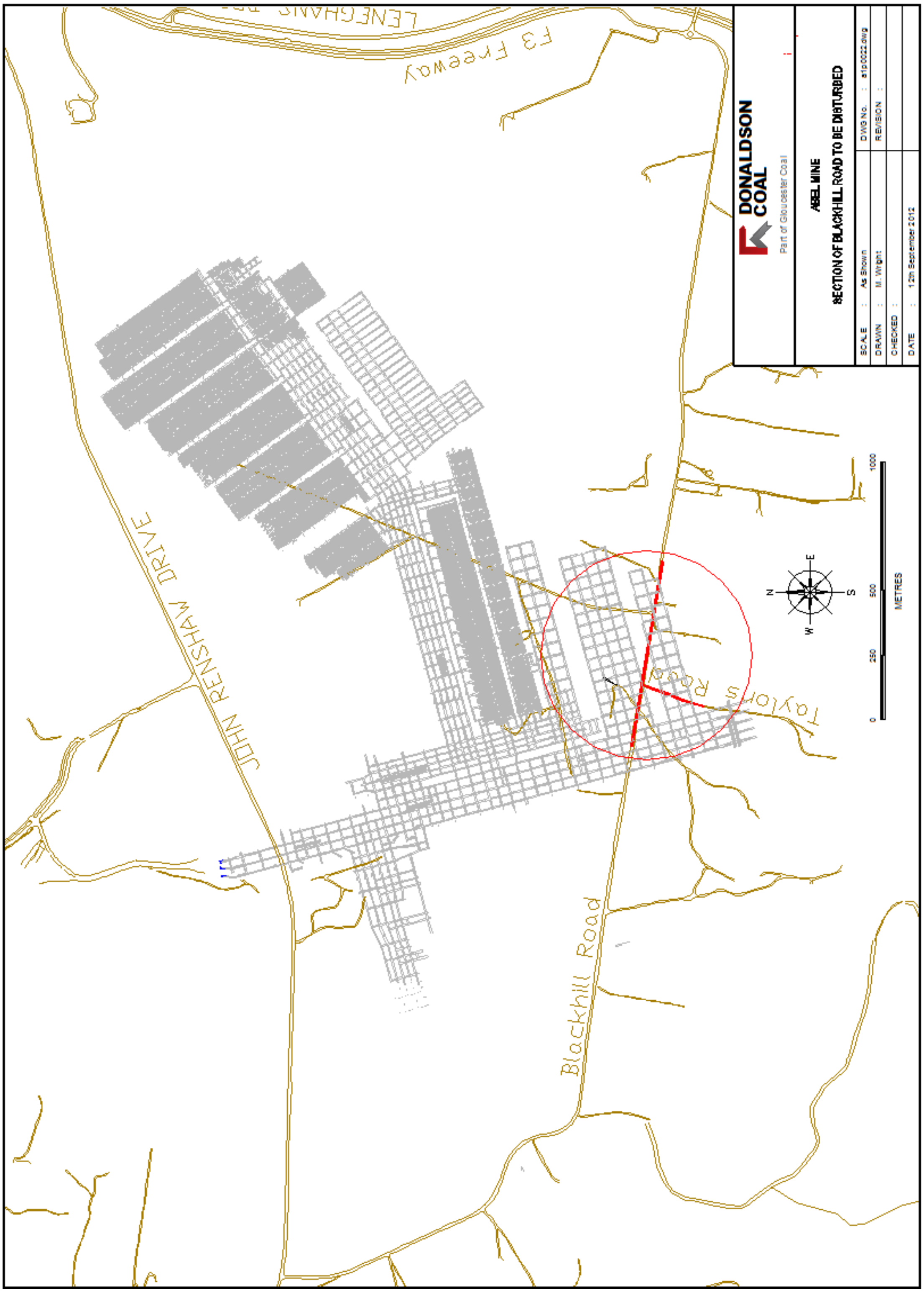
4.2 Subsidence Monitoring Program

Monitoring of Blackhill Road and Taylors Road will be undertaken using conventional surveys. Monitoring will be conducted to a minimum standard noted in Section 4.3. Additionally an Abel Surface Subsidence Monitoring Program will be submitted to and approved by the Principal Subsidence Engineer (DTIRIS).

4.3 Conventional Surveys

Stable marks will be established along the edge of the road generally at 10m spacings along the potentially impacted section of the road. Surveys will be conducted at fortnightly intervals using precision level and measurements by steel band to provide information for tilt and strain calculations. The face position will also be recorded at the time of each survey. Donaldson Coal will be responsible for all costs associated with monitoring.

Figure 1
Location Plan



4.4 Signage

Signs advising that mining is being conducted under the relevant section of roads are to be erected and maintained by Donaldson Coal while mining is being conducted in the active mining zone.

4.5 Subsidence Inspections

Subsidence inspections will be carried out daily by mine staff while the Blackhill Road and Taylors Road are located in the active mining zone. The inspections will be carried out to assess impact on the surface. The "Subsidence Inspection Checklist" will be used for this task (**Appendix C)**.

4.5.1 Scope of Inspections

Donaldson

The inspections will cover a zone defined as being 200 metres behind and 100 metres in front of the current face position. The inspections will cover the full subsidence bowl out to the 26.5° angle of draw.

Inspections will be carried out by trained persons and will follow the inspection checklist. Inspections will identify the following subsidence impacts:

- Surface cracking - edges of extraction void plus start and travelling abutments particularly in rock outcrop areas.
- Surface humps (compression) - near centre of extracted panels and travelling abutment
- Step change in land surface - associated with cracking
- Impact on culverts – headwall movement or cracking, pipe separation

4.5.2 Public and/or Road Safety Issues Identified During Inspections

If any public safety issue is identified during inspections the person conducting the inspection shall:

- If necessary take action to restrict any vehicle movement across the impacted area.
- Immediately notify the Abel Mine Technical Services Manager of issue.
- Immediately notify the Mine Subsidence Board and Cessnock City Council of the issue.
- Arrange for the Mine Subsidence Board and Cessnock City Council to inspect and Mine Subsidence Board to effect immediate repairs if necessary.
- Liaise with the Mine Subsidence Board and Cessnock City Council to arrange long term repairs.

4.6 Monitoring Results

If any routine monitoring results are higher than the prediction for subsidence at that location, Donaldson Coal will notify the Mine Subsidence Board and Cessnock City Council.

The Event Response Procedure is outlined in **Appendix E - TARPs.**

4.7 Survey Standards and Accuracy

All surveys are to be carried out in accordance with the. NSW Surveyor General Directions – *No. 8B Survey and Drafting Directions for Mine Surveyors 2007 (NSW Coal)*

Benchmarks:

- Are to be established at each survey line outside the influences of subsidence and horizontal movement.
- Benchmarks are to be reviewed from time to time pending any anticipated ground movement.

Levelling:

- All subsidence levels are to be in AHD.
- All levels shall be to ICSM SP1 Class LD standards of accuracy.
- Levels are to be carried out by automatic level or digital level.
- All level surveys are to be closed.

Strains:

- All strains are to be measured to $\pm$1mm with a standardised steel band.
- All strains measurements are to be checked (measured twice).

5 TRIGGER ACTION RESPONSE PLANS (TARP's)

As part of the Subsidence Management Plan for the Management of Blackhill Road and Taylors Road the following protocols are to be implemented as detailed in **Appendix E.**

6 RESPONSIBILITIES

6.1 Abel Manager of Mining Engineering

- Promptly notify the District Inspector of Coal Mines of any identified public safety issue.

6.2 Technical Services Manager Donaldson Underground Operation

- Authorise the Plan and any amendments thereto.
- Ensure that the requisite personnel and equipment are provided to enable this Plan to be implemented effectively.
- Inform the Manager of Mining Engineering of issues requiring notification to DTIRIS (Mine Safety).
- Immediately notify the Mine Subsidence Board and Cessnock City Council of the issue.
- Arrange for the Mine Subsidence Board and Cessnock City Council to inspect and Mine Subsidence Board to effect immediate repairs if necessary.
- Liaise with the Mine Subsidence Board and Cessnock City Council to arrange long term repairs

6.3 Registered Mining Surveyor

- Ensure the TARPS are followed.
- Review and assess subsidence results and inspection checklists.
- Ensure subsidence Inspections are carried out to the required schedule and the persons conducting the inspections are trained in the requirements of this plan and understand their obligations.
- Ensure that all audits and reviews are carried out at the required intervals.
- Arrange for subsidence monitoring to be carried out in accordance with this plan.
- Collate subsidence data and present in an appropriate format.
- Maintain a record of any major impact.
- Ensure that all data, records and reports arising from the provisions of this plan are maintained and archived.
- Liaise with the Mine Subsidence Board and Cessnock City Council as necessary.

6.3 Cessnock City Council

- Ensure that the provisions of the Management Plan are followed.
- Ensure any necessary signage is placed warning of road conditions.
- Ensure the TARP's are followed and any necessary remediation work is undertaken.

6.4 Mine Subsidence Board

- Ensure that the provisions of the Management Plan are followed.
- Ensure the TARP's are followed and arrange any necessary remediation work to be undertaken.

6.5 Surface Inspection Personnel

- Conduct the subsidence inspection within the required active mining zone to the standard required in the subsidence inspection checklist form.
- Take actions to restrict any vehicle movement across any impacted area.
- Immediately notify the Technical Services Manager Donaldson Underground Operations of the issue.

6.6 Payment of Cost in Relations to Repairs

- Abel Mine will liaise with the Mine Subsidence Board in relation to payment for any necessary repairs such that no cost will be borne by Cessnock City Council.

7 TRAINING

All personnel who conduct surface inspections will be trained in the requirements of this plan. Training will be conducted on the identification of the various subsidence impacts and safety aspects of those inspections.

8 AUDIT AND REVIEW

Management will audit and review this system on a regular basis to identify any issues that may affect its integrity and effectiveness. These reviews can be either event based or time based.

Event Based

- Any monitoring results that are outside the subsidence prediction range.
- The indication of subsidence impact is greater than predicted.

9 COMMUNICATION

9.1 Data Analysis – Subsidence Monitoring

If any unexpected movements outside the predicted range occur on the roads, the Mine Subsidence Board, Cessnock City Council and the Principal Subsidence Engineer DTIRIS will be informed immediately by phone.

All subsidence data will be reported to the Principal Subsidence Engineer DTIRIS as outlined in the Subsidence Monitoring Program.

A Monthly Status Report will be forwarded to the Mine Subsidence Board and Cessnock City Council.

9.2 Contact List

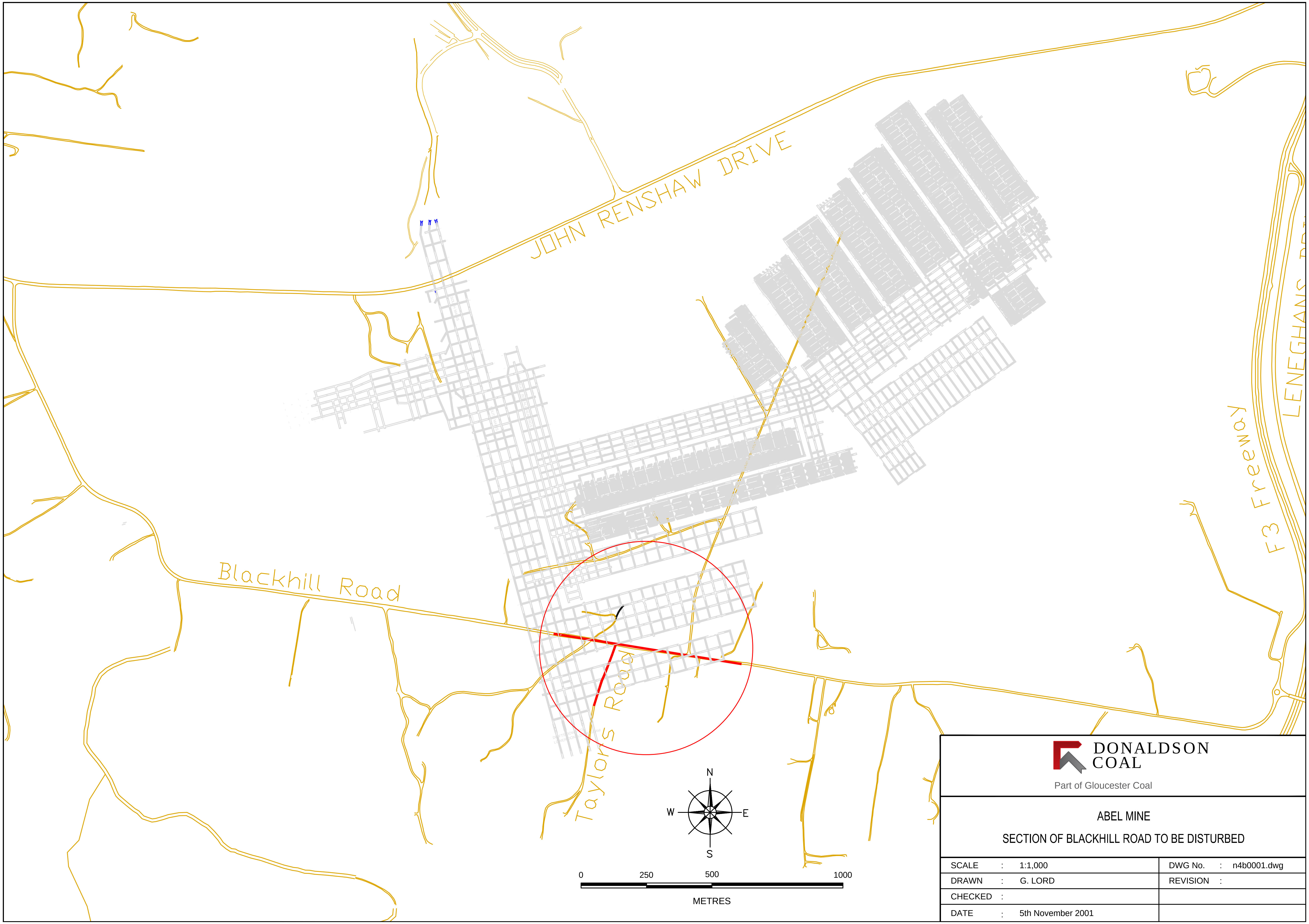
Contact Details of key personnel referred to in the Subsidence Management Plan are detailed in **Appendix D.**

9.3 Review Meeting

If any Stakeholder deems it necessary to consult with other Stakeholders, a meeting shall be convened to review these concerns and determine appropriate action.

APPENDIX A

LOCATION PLAN



DONALDSON COAL

Part of Gloucester Coal

ABEL MINE

SECTION OF BLACKHILL ROAD TO BE DISTURBED

SCALE : 1:1,000		DWG No. : n4b0001.dwg	
DRAWN : G. LORD		REVISION :	
CHECKED :			
DATE : 5th November 2001			

APPENDIX B

REPORT ON SUBSIDENCE IMPACT PREDICTIONS

Ditton Geotechnical Services Pty Ltd
82 Roslyn Avenue Charlestown NSW 2290
PO Box 5100 Kahibah NSW 2290

DgS
Ditton Geotechnical Services

19 July 2012

Mr Tony Sutherland
Technical Services Manager - Underground Operations
Abel Mine
1132 John Renshaw Drive,
Black Hill NSW 2322

Report No. ABL-002/4

Dear Tony,

Subject: Subsidence Contour Predictions and Impact Assessment for the Proposed Partial Pillar Extraction of Panels 19 to 22 at the Abel Mine, John Renshaw Drive, Black Hill

1.0 Introduction

This letter provides revised worst-case subsidence contour predictions and impact assessment of the surface features due to the proposed partial pillar extraction panels 19 to 22 at the Abel Mine.

To-date, the mine has completed eight total extraction panels (No.s 1 to 7 and 15) and is currently mining Panel No. 8. The mine has decided to amend the mining schedule to now include six partial pillar extraction panels (Panels 19, 19a, 19b and 20 to 22) in lieu of the eleven total extraction panels (Panel No.s 16 to 26) previously proposed in the SMP Submission to the Department of Resources and Energy (DRE).

The proposed partial extraction panel locations are shown in **Figure 1a**, together with the total extraction panels and surface features. Cover depth contours above the panels are presented in **Figure 1b** and range from 100 m to 130 m. The six panels will be mined in the 2.6 m to 4.0 m thick Upper Donaldson Seam (see **Figure 2**) using a technique known as the Modified Duncan Method (MDM), which was developed at the nearby Tasman Mine. A maximum mining height of 2.8 m is proposed for the six partial extraction panels.

The MDM mining method requires large first workings pillars to be formed on a centre spacing of 45 m to 50 m and a three to five heading layout. The pillars are then reduced in size through ‘lifting’ along all four sides to leave a long-term stable remnant pillar in the panel to support the overburden. Maximum subsidence above the pillars is likely to be < 150 mm, and will be dependent on the panel geometry and strength and stiffness properties of the roof and floor strata.

2.0 Surface Features

The surface above or within a 26.5^{o} angle of draw to the newly proposed Panels include the following natural features and man-made developments:

Natural Environment

- Gently undulating rural terrain with mild slopes ranging from 1^{o} to 10^{o} that steepen locally to 15^{o} along Viney Creek tributaries.
- Topographic relief ranges from 50 m AHD to 30 m AHD across the panels.
- Headwaters of Viney Creek (a Schedule 2 Stream) and several unnamed drainage gullies (DECCW listed Schedule 1 watercourses).
- Silty sand and sandy clay surface soils that are likely to be mildly to highly erosive / dispersive if exposed to concentrated runoff during storm flow events.
- 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 study area.
- One scattered Aboriginal artefact sites (Site No 3) that is located outside the limits of proposed secondary extraction. The artefacts are listed as silcrete stone axe flakes and were identified by the Mindaribba Local Aboriginal Land Council and Awabakal Traditional Owners.

Land Use

- Semi-cleared and undeveloped land (Catholic Diocese and Black Hill Land Pty Ltd) to the North of Black Hill Road.

  The Catholic Diocese Land is presently being used for cattle grazing with one area designated a future high school development area. At this stage, the Black Hill Land Pty Ltd land is likely to be redeveloped into industrial lots with sealed access roads and drainage works. No development applications have been indicated yet for the Catholic Diocese land.

- Semi-cleared rural-residential zoned land to the south of Black Hill Road

  The land is currently used for cattle grazing with some domestic vegetable growing adjacent to the Principal Residences.

Public Roads and Infrastructure

- 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 the mining area.

- Two concrete pipe culverts (No.s 1 to 2) in up to 3 m of fill below Black Hill Road (Cessnock City Council) and one culvert (No. 3) in 0.5 m of fill below Central Road (Catholic Diocese Land).

  Culvert No.1 has twin 1200 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.

  Culvert No. 3 exists approximately 0.34 km from Black Hill Road on the Central Road within the Catholic Diocese Land. The culverts consist of a pair of circular, 1.8m diameter reinforced concrete pipes. The direction of water flow is from the west to the east. The pipes appear to be in reasonable structural condition however some issues exist in regards to differential settlement and embankment fill erosion damage (refer to **Aurecon, 2011** for details).

Private Structures and Developments

- Two Principal Residences and associated All 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 sceptic tanks and on-site effluent disposal fields.

- Two non-Principal residences (rental properties) and associated sheds (Catholic Diocese Land).

- Two buildings associated with the former chicken farm (Catholic Diocese Land) which are currently used as storage facilities and/or meeting rooms by the Catholic Diocese).

- Demolished former chicken farm building rubble and disused houses / office buildings (Catholic Diocese Land).

- Areas within the Catholic Diocese land where rehabilitation, including capping of contaminated areas, has been conducted.

- Two buildings associated with the former chicken farm (Catholic Diocese Land) which are currently used as storage facilities and/or meeting rooms by the Catholic Diocese).

- Demolished former chicken farm building rubble and disused houses / office buildings (Catholic Diocese Land).

- Areas within the Catholic Diocese land where rehabilitation, including capping of contaminated areas, has been conducted.

Utilities

- Two Transgrid Towers (28B and 29B) supporting 330kV transmission lines. The towers are galvanised, bolted steel frame structures approximately 45m high. The base of the towers are 9 m x 9 m square with 4 legs encased in a 1m wide x 2m deep cruciform, shaped footing and are partially buried.
- A 132 kV transmission line suspended on pairs of un-guyed, timber poles with bolted steel cross bracing (Ausgrid). Two pole pairs (EA12 and EA13) are located within a 26.5^{o} angle of draw of the proposed MDM panels.

- Domestic 11 kV and 415V suspended power lines suspended on fourteen timber poles (No.s 24 to 33 and 38 to 35) (Ausgrid).

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

- Redundant domestic buried copper cable telephone lines (Telstra). 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.

- Buried water reticulation pipelines and above ground troughs for livestock watering and supply to Principal and non-principal residences (Catholic Diocese Land).

Private dams, property access roads and fences

- 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.

- One earth embankment dam with < 1ML capacity (Private Residence). The dam is only partially full of water due to numerous piping failures through the embankment and used for stock watering.

- Unsealed and bitumen sealed property access roads, driveways and fences (Catholic Diocese, Black Hill Land Pty Ltd and other Principal Residences).

The locations of the above features (and surface gradients) are shown in **Figures 1a,b** and **3**.

3.0 Sub-surface Conditions

Reference to the 1:100,000 Geological Sheet for the Newcastle Coalfield (**DMR, 1995**), indicates the proposed Partial Extraction Panels 19 to 22 are located within the Dempsey Formation of the Permian Tomago Coal Measures.

The overburden for the area will consist 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, Buttai, Beresfield, Upper and Lower Donaldson, Big Ben and Ashtonfield Seams.

The Upper Donaldson Seam comprises several plies (A-G), of which Abel Mine extracts the C-E or C-G plies; see **Figure 4**.

The Upper Donaldson Seam has low strength with sonic derived unconfined compressive strength (UCS) values ranging from 7 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.

The immediate roof and floor of the proposed mining horizon will typically consist of 5 to 10 m or more of thinly 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.

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 for the Abel Mine.

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 1**.

Table 1 - Laboratory 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	5 - 10	10.5 - 93 [18 - 51]	3 - 20 [5 - 15]	Non-Sensitive to Moderately Sensitive
Interbedded sandstone/ shale beds below the UD Seam	5 - 10	11.5 - 130 [31 - 72]	3 - 15 [5 - 10]	Non-Sensitive to Slightly Sensitive
Upper Donaldson Seam	1.9 - 3.2	5 - 15 [10]	2 - 4 [3]	Non- Sensitive to slightly sensitive stone bands

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**.

Average rock mass elastic modulii for the floor and roof materials within the significant area of influence of the pillars (i.e. approximately the pillar width or 24 m to 26.5 m above and below the mine workings) are estimated below, based on the intact laboratory data and their relationship with the Geological Strength Index (GSI), refer to **Hoek and Diederichs, 2006**:

$$E_{rockmass} = E_{laboratory}(0.02+1/(1+e^{(60-GSI)/11})$$

The lower and upper bound rock mass Young's Modulus (E_{rm}) for the roof, floor and coal materials have been estimated for an assessed GSI range of 60 for blocky to very blocky strata with good to fair bedding parting surface quality as follows:

$E_{rockmass}$ = $0.5E_{laboratory}$

E_{roof} = 5 GPa (for an estimated laboratory modulus of 10 GPa)

E_{floor} = 5 GPa (for an estimated laboratory modulus of 10 GPa)

E_{coal} = 1.5 GPa (for an estimated laboratory modulus of 3 GPa)

The above parameters have been used in an elastic and non-linear analytical model of the pillar-roof-floor system for estimating surface subsidence above stable remnant pillars in **Section 8.0**.

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. The south-eastern bedding dip across the site is associated with the southern arm of the Four Mile Creek Anticline, which is also located to the west of the site.

Surface joint patterns measured on the sandstone cliff lines and outcrops to the south of the mining 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.

To-date, the mine has avoided the significant geological structure, but where is has been encountered, barrier pillars have been left in the workings directly beneath them due to poor roof conditions. Groundwater make has also been observed to increase where these features have been undermined.

The proposed partial extraction panels may also require pillar lifts not to be taken if poor roof conditions around geological structure are encountered.

4.0 Pillar Stability Assessment

4.1 Mining Geometry and Remnant Pillar Design

The proposed partial extraction mining method to be used in the proposed panels will be the Modified Duncan Method. This method has been used successfully to-date at the Tasman Mine in controlling subsidence to <150 mm generally, provided the stress acting on the remnant pillars does not exceed the bearing strength of the floor (or roof strata).

Note: The softening of claystone floor units exposed to ponding mine water has resulted in subsidence of approximately 500 mm to develop >18 months after completion of the panels under service loading of 18 MPa at a depth of cover of 100 m. In this instance, it was necessary to increase the size of the remnant pillars to limit floor stress to < 14 MPa and subsidence to < 150 mm in subsequent panels.

The proposed Abel panels will be developed on a 3 and 5-heading layout with 50 m and 45 m centre-centre square pillar spacing respectively and 5.5 m wide headings and cut-throughs. The mining height has been assumed to equal the seam thickness and ranges from 2.85 m to 3.3 m for pillar stability assessment and subsidence prediction purposes.

The panels will typically have final mined widths (W) of 118 m and 211 m with cover depths (H) ranging between 100 m and 130 m. The panels will have *super-critical* to *critical* W/H ratios of 1.91 to 0.94, indicating the maximum pillar loads will be close to or equal to full tributary area magnitudes; see **Figure 5a**.

The pillars will then be 'stripped' or reduced in width along four sides on retreat, leaving square remnant pillars with factors of safety (FoS) > 2.11 (under the assumed design loading conditions) and w/h ratios >7.

The proposed remnant pillar widths for each panel are summarised in **Table 2**.

Table 2 - Proposed Partial Extraction Panel Remnants for Panels 19 to 22

Panel No	Cover Depth (m)	Panel Width (m)	Panel W/H	Seam Thickness (m)	First Workings Pillar Dimensions* (m)	Remnant Pillar Dimensions* (m)
19	110 - 125	118.0	0.94 - 1.07	3.60 - 4.00	44.5 x 44.5	26 x 26
19a	96 - 110	130.3	1.18 - 1.61	2.90 - 3.60	44.5 x 44.5	25.5 x 25.5
19b	115 - 120	130.3	1.09 - 1.13	2.80 - 3.90	44.5 x 44.5	26 x 26
20	103 - 106	128.0	1.21 - 1.24	2.90 - 3.05	44.5 x 44.5	25 x 25
21	110 - 115	210.5	1.83 - 1.91	2.85 - 3.15	39.5 x 39.5	24 x 24
22	120 - 130	130.3	1.00 - 1.09	2.90 - 3.15	44.5 x 44.5	26.5 x 26.5

* - solid pillar dimensions in plan with 2.8 m mining height assumed.

The proposed rib-stripping will result in effective cut widths of 8.25 m to 12.4 m along all four sides, which indicates a plunge distance range of 9.5 m to 14.3 m, based on a continuous miner angle to the rib of 60^o. The pillar w/h ratios for the proposed remnants will range from 8.6 to 9.5 for the likely seam thickness ranges.

Reference to **ACARP, 2005** and **Zipf, 1999**, indicates that the pillar dimensions proposed will have strain-hardening characteristics (i.e. pillar w/h ratios > 5) and will limit subsidence to tolerable levels in the unlikely event of pillar overload conditions developing, see **Figure 5b**.

The stability of the proposed remnant panel and barrier pillars has been assessed based on reference to **ACARP, 1998** and summarised in **Tables 3A** and **3B** respectively. The barrier pillar stability assessment has assumed worst-case loading conditions would occur if remnant pillars went into yield along both sides of a barrier, and resulting in double abutment loading conditions; see **Figure 5c**.

Table 3A - Proposed Remnant Panel Pillar Dimensions and Stability Parameters for Panels 19 to 22

Panel No.	Cover Depth (m)	Pillar Height h (m)	Remnant Pillar Width (m)	Pillar w/h	e (%)	Max Lift Width (m)	Pillar Strength (MPa)	Pillar Load* (MPa)	Pillar FoS
19	110	2.8	26	9.3	73	9.25	24.98	10.17	2.46
	125	2.8	26	9.3	73	9.25	24.98	11.56	2.16
19a	96	2.8	25.5	9.1	74	9.50	24.30	9.23	2.63
	110	2.8	25.5	9.1	74	9.50	24.30	10.57	2.30
19b	115	2.8	26	9.3	73	9.25	24.98	10.63	2.35
	120	2.8	26	9.3	73	9.25	24.98	11.09	2.25
20	103	2.8	25	8.9	75	9.75	23.84	10.03	2.30
	106	2.8	25	8.9	75	9.75	23.84	10.60	2.23
21	110	2.8	24	8.6	72	7.75	22.39	9.67	2.32
	115	2.8	24	8.6	72	7.75	22.39	10.11	2.21
22	120	2.8	26.5	9.5	72	9.00	25.67	10.68	2.40
	130	2.8	26.5	9.5	72	9.00	25.67	11.57	2.22

* - Pillars all assessed for Full Tributary Area (FTA) loading conditions.
e% = Areal extraction ratio (%);
FoS = Factor of Safety.

Table 3B - Proposed Remnant Barrier Pillar Dimensions and Stability Parameters for Panels 19 to 22

Panels	Cover Depth (m)	Pillar Height h (m)	Remnant Pillar Size (solid) (m)	Pillar width/ height	e (%)	Max Lift Width (m)	Pillar Strength (MPa)	Pillar Load* (MPa)	Pillar FoS
19a-19b	115	2.8	20.7 x 512	7.4	59	12.40	26.2	13.2	1.98
	113	2.8	20.7 x 512	7.4	59	12.40	26.2	12.9	2.03
TG - 20	103	2.8	21 x 680	7.5	55	9.75	26.7	10.6	2.53
	110	2.8	21 x 680	7.5	55	9.75	26.7	10.9	2.44
20 - 21	110	2.8	54.4 x 561	19.4	36	12.30	129.6	6.6	19.6
	115	2.8	54.4 x 561	19.4	36	12.30	129.6	6.8	19.1
21 - 22	125	2.8	33.7 x 582	12.4	48	12.40	52.2	10.5	4.98
	130	2.8	33.7 x 582	12.4	48	12.40	52.2	11.1	4.71

* - Pillar load of Full Tributary Area plus Double Abutment Loading conditions assumed if remnant pillars go into yield on both sides of the barrier pillar (a very unlikely scenario).
e% = Areal extraction ratio (%); FoS = Factor of Safety.

The results of the stability assessment are consistent with the minimum design FoS and w/h values required for Panels 19 to 22.

4.2 Bearing Capacity of Immediate Mine Roof and Floor Strata

Reference to **Pells *et al* , 1998** indicates that the bearing capacity of sedimentary rock under shallow footing type loading conditions is 3 to 5 times its UCS strength. Based on the estimated range of UCS values in the immediate floor and roof strata, the average bearing capacity of the immediate roof and floor strata is estimated to range between 50 and 84 MPa.

A similar outcome was assessed by applying 2-layered bearing capacity theory presented in **Brown and Meyerhoff, 1969** as follows:

$q_u = N_{square} \times UCS_1/2 = [5.14 + 0.33(w/t)]\ UCS_1/2$

where

N_{square} = Modified bearing capacity coefficient for a square footing.
w = 24 to 26.5 m (proposed stripped widths)
UCS_1 = weak claystone strength = 16.7 MPa

For pillars with widths ranging from 24 m to 26.5 m wide and acting on a 10 m thick weaker layer overlying a stronger one, a bearing capacity of 49 to 50 MPa is estimated for a weaker floor layer UCS of 16.7 MPa. A summary of the results is presented in **Table 4**.

The results of the bearing capacity analysis indicate that the factor of safety against bearing failure of roof and floor strata generally exceeds 4 for the range of pillar geometries and loading conditions assessed.

As the slake durability of the floor materials was indicated to be 'moderate' to 'high' by the laboratory testing results, it is considered that long-term degradation or weakening of the floor materials is unlikely.

Table 4 - Roof and Floor Stability Assessment Results for Remnant Pillars in Proposed Panels 19 to 22

Panel No.	Pillar Dimensions w x l (m)	Pillar Height h (m)	Cover Depth (m)	Roof & Floor Strength (MPa)	Pillar Load* (MPa)	Roof & Floor FoS$^+$
Remnant Pillars						
19	26 x 26	2.8	110 - 125	50.2	10.2 - 11.6	4.93 - 4.34
19a	25.5 x 25.5	2.8	96 - 110	50.0	9.20 - 10.6	5.42 - 4.73
19b	26 x 26	2.8	115 - 120	50.2	10.6 - 11.1	4.72 - 4.93
20	25 x 25	2.8	103 - 106	49.9	10.3 - 10.6	4.71 - 4.84
21	24 x 24	2.8	110 - 115	49.6	9.7 - 10.1	5.13 - 4.91
22	26.5 x 26.5	2.8	120 - 130	50.3	10.7 - 11.6	4.71 - 4.35
Barrier Pillars						
19a-19b	20.7 x 512	2.8	113 - 115	48.7	12.9 - 13.2	3.68 - 3.78
TG-20	21 x 680	2.8	103 - 106	48.8	10.5 - 10.9	4.65 - 4.46
20-21	54.4 x 561	2.8	110 - 115	58.1	6.4 - 6.8	9.06 - 8.54
21-22	33.7 x 582	2.8	120 - 130	52.3	9.8 - 11.0	5.34 - 4.76

* - Remnant Pillars assessed for FTA loading. Barrier pillars assessed for double abutment load if remnant panel pillars yield.

5.0 Subsidence Predictions for Panels 19 to 22

5.1 Maximum Panel Subsidence Predictions

Maximum panel subsidence has been estimated for the proposed Panels, based on the post-mining pillar stresses (FTA) and the material properties presented in **Section 4.0.** The following equations were derived from elastic solid mechanics theories have been applied to predict maximum panel subsidence for super-critical panel geometries:

$s_{max} = s_{pillar} + s_{roof} + s_{floor}$

where

s_{pillar} = σ_{net} h/E_{coal} = compression of pillar

s_{roof} = σ_{net} w I(1-v^2)/E_{roof} = compression roof strata

s_{floor} = σ_{net} w I(1-v^2)/E_{floor} = compression of floor strata

σ_{net} = net pillar stress (FTA stress - virgin stress)

E_{coal} = Young's Modulus for coal;

E_{roof} = Average Young's Modulus for the roof strata within one pillar width of the roof

E_{floor} = Average Young's Modulus for the floor strata with one pillar width of the floor

v = Poisson's Ratio = 0.25 for roof and floor strata;

I = shape factor for square footing = ~ 1 (for a semi-rigid footing)

w = pillar width.

h = pillar height.

The subsidence over the panel pillars in the event of overloading and subsequent yielding will be governed by the post-yielded modulus of the coal pillars as follows:

s_{yield} = σ h/E_{yield} = compression of yielded pillar

where

σ = applied design stress (i.e. FTA loading scenario)

E_{yield} = Post-yielded modulus of coal pillar = -1750/(w/h) + 437 (MPa) (see **Figure 5b**)

The collapsed roof rubble will also provide load bearing capacity but only after significant subsidence has occurred (i.e. 10% of the seam thickness or ~300 mm of subsidence has occurred).

The maximum super-critical subsidence predictions for a range of cover depths and proposed remnant pillar geometries are presented in **Table 5**. The table shows the expected subsidence, together with the 2 times and 5 times the expected values for risk assessment purposes.

Table 5 - Predicted Maximum Subsidence above Proposed Partial Extraction Pillar Panel Geometries

Panel No	Cover Depth (m)	Pillar Height h (m)	Pillar Width w	w/h	Pillar Stress* (MPa)	Pillar FoS	Expected Panel S_{max} (mm)	2 x S_{max} (mm)	5 x S_{max} (mm)
Remnant Pillars									
19	110	2.8	26	9.3	10.17	2.46	**55**	**110**	275
	125	2.8	26	9.3	11.56	2.16	**62**	**125**	312
19a	96	2.8	25.5	9.1	9.23	2.63	**50**	**100**	249
	110	2.8	25.5	9.1	10.57	2.30	**57**	**114**	286
19b	115	2.8	26	9.3	10.63	2.35	**57**	**115**	287
	120	2.8	26	9.3	11.09	2.25	**60**	**120**	300
20	103	2.8	25	8.9	10.03	2.30	**56**	**111**	278
	106	2.8	25	8.9	10.60	2.23	**57**	**115**	286
21	110	2.8	24	8.6	9.67	2.32	**48**	**97**	242
	115	2.8	24	8.6	10.11	2.21	**51**	**101**	278
22	120	2.8	26.5	9.5	10.68	2.40	**58**	**115**	253
	130	2.8	26.5	9.5	11.57	2.22	**63**	**125**	313
Barrier Pillars									
19a-19b	110	2.8	20.7 x 512	7.4	13.2	1.98	**66**	**131**	328
	125	2.8	20.7 x 512	7.4	12.9	2.03	**64**	**127**	319
TG-20	103	2.8	21 x 680	7.5	10.6	2.53	**51**	**101**	253
	110	2.8	21 x 680	7.5	10.9	2.44	**53**	**106**	265
20-21	110	2.8	54.4 x 561	19.4	6.6	19.6	**48**	**96**	241
	115	2.8	54.4 x 561	19.4	6.8	19.1	**52**	**103**	258
21-22	125	2.8	33.7 x 582	12.4	10.5	4.98	**61**	**122**	305
	130	2.8	33.7 x 582	12.4	11.1	4.71	**69**	**139**	347

* - Remnant Pillars assessed for FTA loading. Barrier pillars assessed for double abutment load if remnant panel pillars yield.

The results for the remnant pillars indicate an expected subsidence range of 48 mm to 69 mm under FTA loading conditions, 106 m to 137 mm for the 2 x expected subsidence scenario and 212 to 300 mm for the 5 x expected subsidence scenario.

The 2 x expected subsidence case represents a 50% reduction of the rock mass stiffness and represents the credible worst-case scenario for the proposed mining geometry.

The 5 x expected subsidence case represents an 80% reduction of the rock mass stiffness, and represents the yielded remnant pillar scenario. It is considered, however, that as the estimated FoS values at this design loading scenario ranges between 2.19 and 2.63, it is very unlikely that the remnant pillars will go into yield after mining is completed for the squat pillar geometry proposed.

Based on the above, the 2 x expected values have subsequently been used to generate credible worst-case subsidence contours above the proposed MDM panels ; see **Figure 7**.

5.2 Subsidence Over Inter-Panel Barriers

Using the same methodology presented in **Section 7.2**, predicted subsidence above the inter-panel barrier pillars under DA loading conditions (worst-case) ranged from 96 mm to 139 mm for cover depths of 100 m to 130 m.

The FoS for the 20 m to 59 m wide pillars ranges from 1.98 to 19.6 under DA loading conditions (i.e. the result of pillar remnants going into yield on both sides of the barrier).

The strain hardening characteristics of the remnant and barrier pillars means that a double abutment load scenario is very unlikely to develop on the barriers.

5.3 Worst-Case Subsidence, Tilt and Strain Profile and Contour Predictions

Based on the supercritical subsidence predictions presented in **Sections 5.1** and **5.2** and the methodology presented in **DgS, 2011**, the predicted worst-case subsidence, tilt, curvature, horizontal displacement and strain profiles are presented in **Figures 6** to **11** herein and indicate the following maximum values for the proposed panels:

- Maximum Subsidence: < 0.15 m
- Maximum Tilt: < 3 mm/m
- Maximum Curvature: <0.2 km^{-1} (radius of curvature > 5 km)
- Maximum Horizontal Strain: < 2 mm/m (compressive and tensile)
- Maximum Horizontal Displacements < 30 mm
- Angle of Draw to 20 mm of subsidence < 10^o or 0.18 x Cover Depth.

The predicted subsidence impacts on specific surface features are discussed in **Section 6.0**.

For risk management purposes, the above numbers may be doubled to assess potential subsidence effects if 5 times the expected subsidence occurs due to yielding of the pillars or roof/floor strata at some time in the future.

6.0 Subsidence Impact Predictions on Surface Features

Based on the predicted credible worst-case subsidence of < 150 mm, tilts of < 3 mm/m and tensile/compressive strains < 2 mm/m, it is assessed that it will be 'very unlikely' to cause visual impact or damage (i.e. cracking or erosion) to the surface and existing features above the proposed panels. A similar outcome is also assessed for the 5 x expected subsidence predictions.

It is also considered unlikely that the two principle residences to the south of Panel 22 will be inside the 20 mm angle of draw and therefore, unlikely to be effected or impacted by mine subsidence.

The assessment has assumed that provided the workings roof and floor do not lose significant strength and stiffness after mining is completed (due to groundwater ponding or eventual flooding of the workings) over 95% of subsidence development is expected to occur within one month to 6 weeks after the panels are completed.

7.0 Subsidence Impact Management Strategies

The proposed partial pillar extraction panels, are assessed to have a worst-case, long-term subsidence of < 0.15 m after mining is completed.

Based on previous experience in the Newcastle Area, it is considered highly unlikely that the predicted subsidence values will generate any cracking or visual impacts to features on the surface.

Due to the strain hardening characteristics of the remnant coal pillars and collapsed mine roof in between them, it is also considered very unlikely that significantly greater subsidence will develop and cause visual impact or surface disturbance to the overlying slopes and ephemeral drainage gully above the panels.

On-going review of the performance of the pillar-floor-roof system in each panel is however recommended. If measured subsidence exceeds the worst-case values (i.e. 2 x expected) or floor heave develops, then a review of pillar lift depths and final pillar geometry may be required before second workings in the next scheduled panel. The design of the panels should be flexible enough to adjust the final remnant pillar dimensions (i.e. by reducing lifting widths) if considered necessary.

8.0 Proposed Monitoring

The measurement of surface subsidence and in-line strain development along representative cross line and centrelines within the angle of draw limits of the mined panels is recommended for surface impact and remnant pillar stability assessment purposes. A minimum of one baseline survey should be completed before mining commences.

Visual inspections and photographs of the proposed mining area and existing features (ie dilapidation surveys) should also be completed before and after second workings to enable mining impact claims to be assessed rationally. Subsidence and ground strain monitoring of utilities and buildings is considered necessary for assessment of any subsidence impact claims to the Mine Subsidence Board.

All other monitoring and impact management strategies developed for the SMP may still be applied to the features above the proposed panels.

For and on behalf of
Ditton Geotechnical Services Pty Ltd

Steven Ditton
Principal Engineer

Attachments:

Figures 1 - 11

References:

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Key

Schedule 2 Creek and Buffer Zone (DECCW)

26B Transmission Towers (Transgrid, 330 kV)

Optic Fibre Cable (Optus)

Sealed Road (Cessnock/ Newcastle City Councils)

Water Supply Pipeline (Hunter Water)

Principle Residences

Non-Principle Residences and out buildings

Disused Buildings

EA12 P 132 kV Power Line and Poles (Energy Australia)

P 11 kV Domestic Powerline and Poles (Energy Australia)

Proposed Blackhill Land Pty Ltd Lot Layout (Preliminary)

Second Workings - Total Extraction

Second Workings - Partial Extraction

Telstra Copper Cabling (buried)

Schedule 1 creeks/ gullies

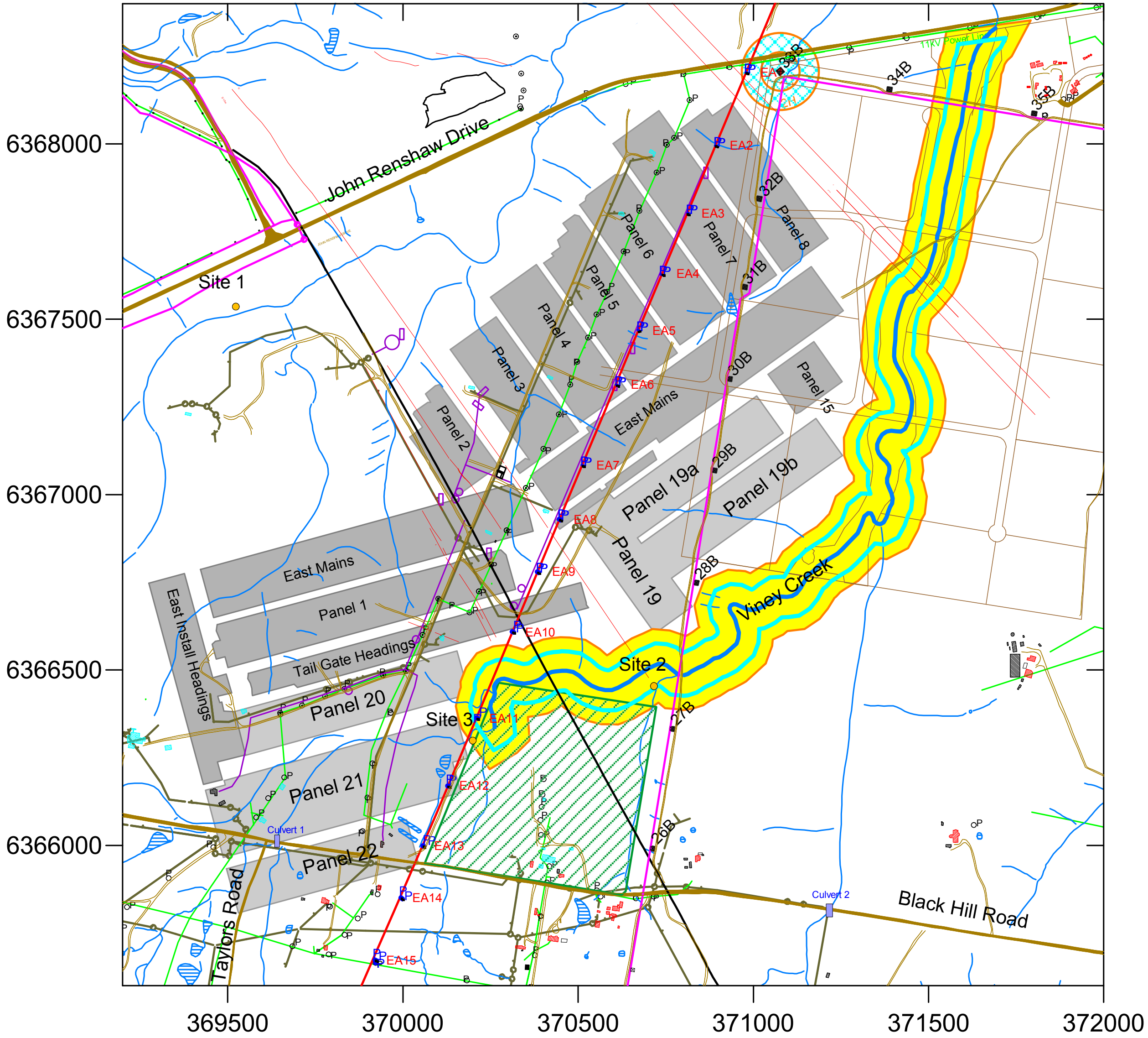
Stock Watering System

Catholic Land - Proposed Development Area

Geological Structure

Site 1 Aboriginal Artefact Site

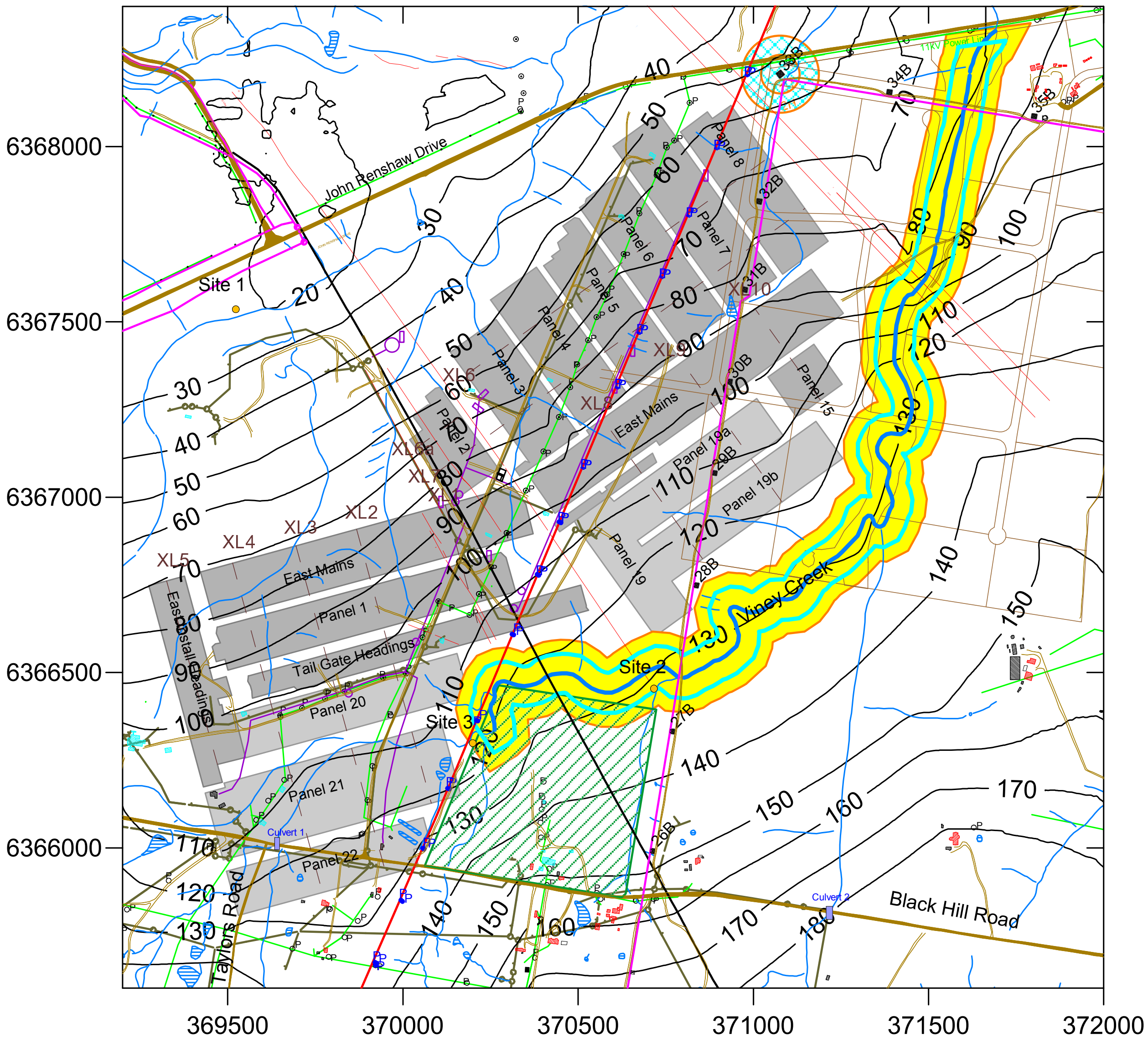
Culvert 1 Culvert



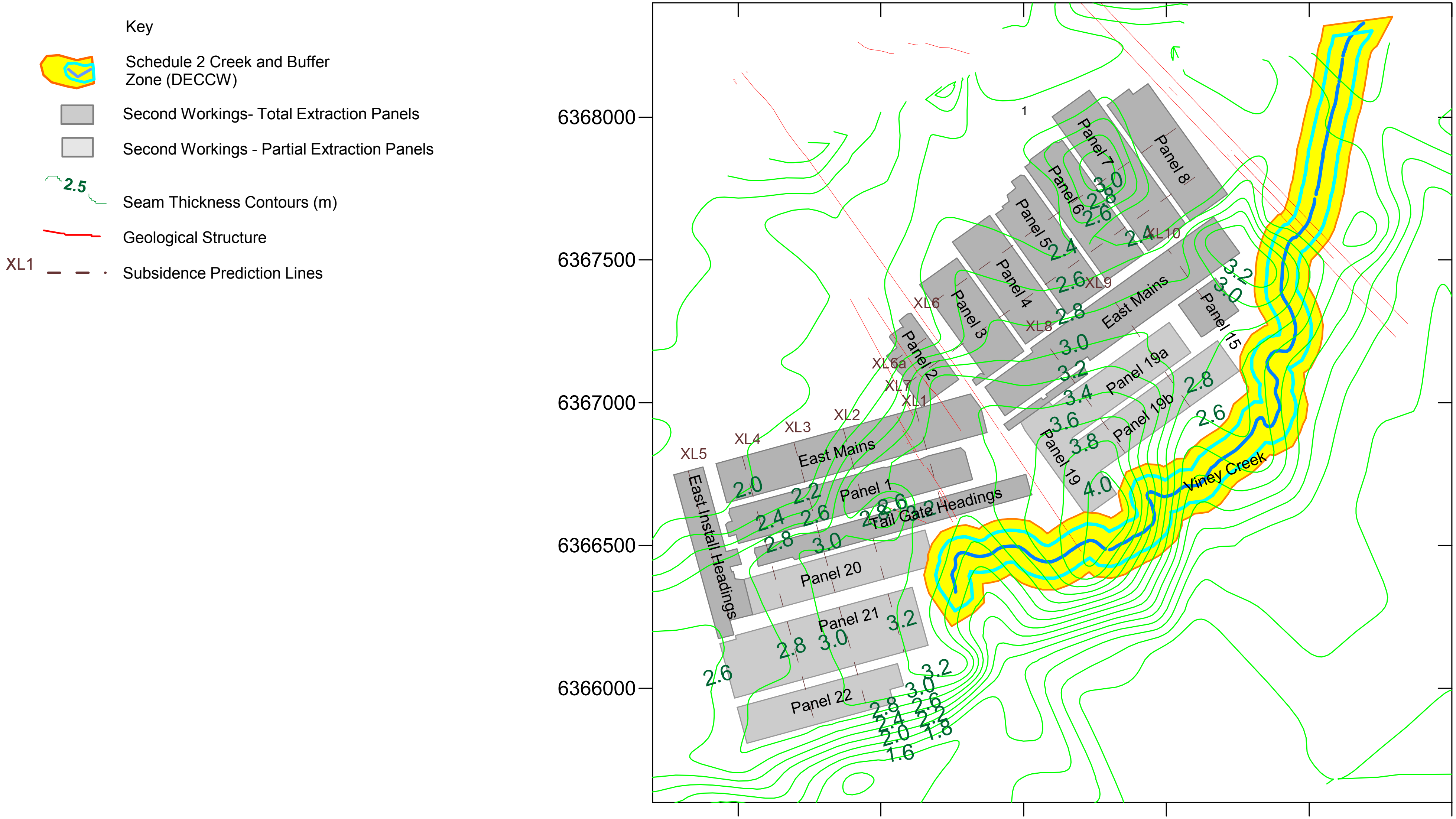
DgS	Engineer:	S.Ditton	Client:	Donaldson Coal ABL-002/4		
	Drawn:	S.Ditton				
	Date:	15.07.12	Title:	Proposed Abel Mine's SMP Layout with Partial Pillar Extraction Panels 19 to 22 (Modified Duncan Method)		
	Ditton Geotechnical Services Pty Ltd		Scale:	1:25,000 (A4)	Figure No:	1a

Key

- Schedule 2 Creek and Buffer Zone (DECCW)
- 26B — Transmission Towers (Transgrid, 330 kV)
- Optic Fibre Cable (Optus)
- Sealed Road (Cessnock/ Newcastle City Councils)
- Water Supply Pipeline (Hunter Water)
- Principle Residences
- Non-Principle Residences and out buildings
- Disused Buildings
- P — 132 kV Power Line and Poles (Energy Australia)
- P — 11 kV Domestic Powerline and Poles (Energy Australia)
- Proposed Blackhill Land Pty Ltd Lot Layout (Preliminary)
- Second Workings - Total Extraction
- Second Workings - Partial Extraction
- 90 — Cover Depth Contours (m)
- Telstra Copper Cabling (buried)
- Schedule 1 creeks/ gullies
- Stock Watering System
- Catholic Land - Proposed Development Area
- Geological Structure
- Site 1 — Aboriginal Artefact Site
- Culvert 1 — Culvert
- XL1 — Subsidence Prediction Lines



DgS	Engineer:	S.Ditton	Client: Donaldson Coal ABL-002/4
	Drawn:	S.Ditton	
	Date:	15.07.12	Title: Proposed Abel Mine's SMP Layout with Partial Pillar Extraction Panels 19 to 22 (Modified Duncan Method)
	Ditton Geotechnical Services Pty Ltd		Scale: 1:25,000 (A4) — Figure No: 1b



Engineer:	S.Ditton	Client:	Donaldson Coal ABL-002/4
Drawn:	S.Ditton	Title:	Upper Donaldson Seam Thickness Contours for the Proposed Abel Mine's Modified Duncan Panels 19 to 22
Date:	25.06.12	Scale:	1:20,000 (A4)

DgS
Ditton Geotechnical Services Pty Ltd

Figure No: 2

Key

Schedule 2 Creek and Buffer Zone (DECCW)

26B Transmission Towers (Transgrid, 330 kV)

Optic Fibre Cable (Optus)

Sealed Road (Cessnock/ Newcastle City Councils)

Water Supply Pipeline (Hunter Water)

Principle Residences

Non-Principle Residences and out buildings

Disused Buildings

EA9 P 132 kV Power Line and Poles (Energy Australia)

24 P 11 kV Domestic Powerline and Poles (Energy Australia)

Proposed Blackhill Land Pty Ltd Lot Layout (Preliminary)

Second Workings - Total Extraction

Second Workings - Partial Extraction

50 Surface Level Contours (m)

Telstra Copper Cabling (buried)

Schedule 1 creeks/ gullies

0.5H Subsidence Control Zones

Stock Watering System

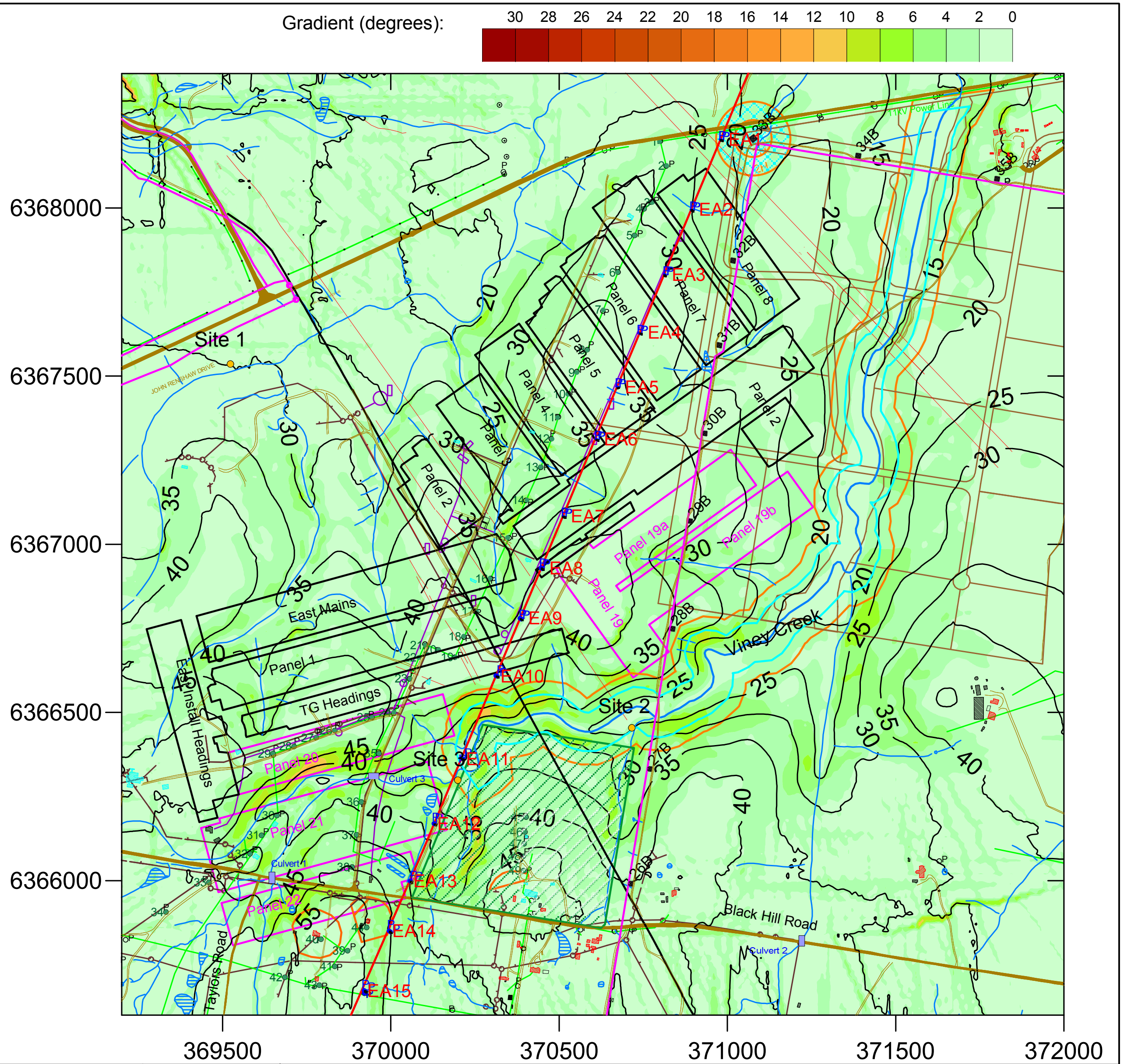
Catholic Land - Proposed Development Area

100 Year ARI Flood Extent

Geological Structure

Site 1 Aboriginal Artefact Site

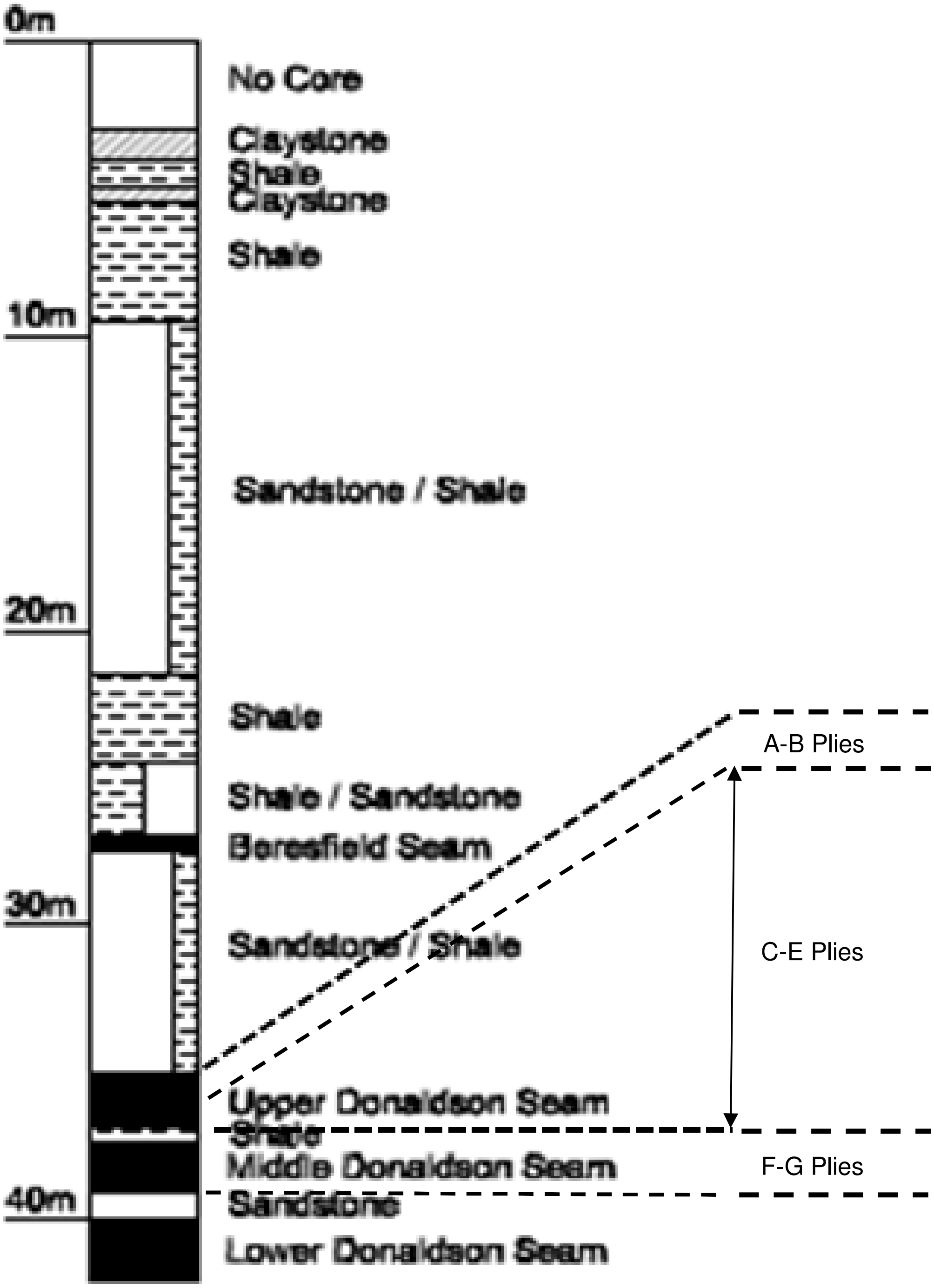
Culvert 1 Culvert



Engineer:	S.Ditton	Client:	Donaldson Coal ABL-002/4
Drawn:	S.Ditton		
Date:	15.07.12	Title:	Pre-mining Surface Level Contours above the Proposed Partial Extraction Panels 19 - 22 at the Abel Mine
Ditton Geotechnical Services Pty Ltd		Scale:	1:25,000 (A4)

DgS

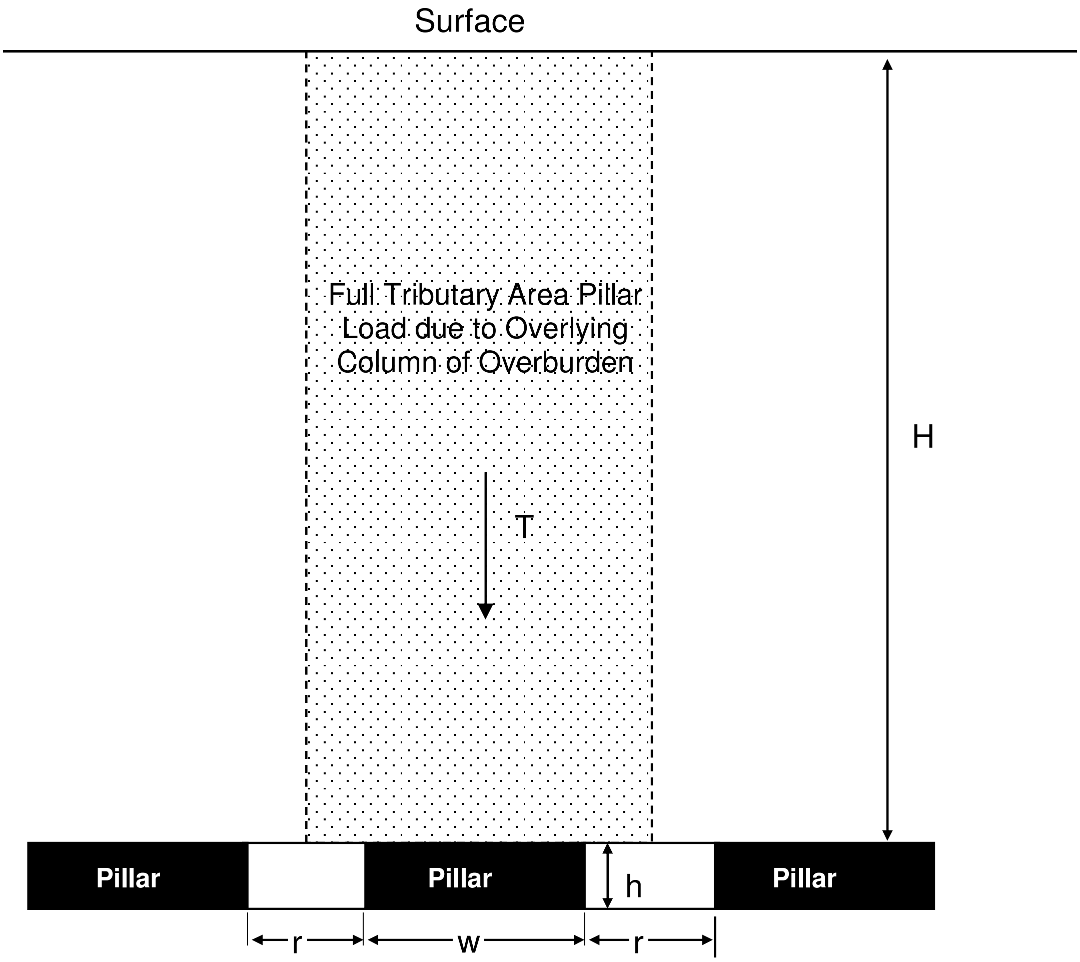
Figure No: 3



Notes:

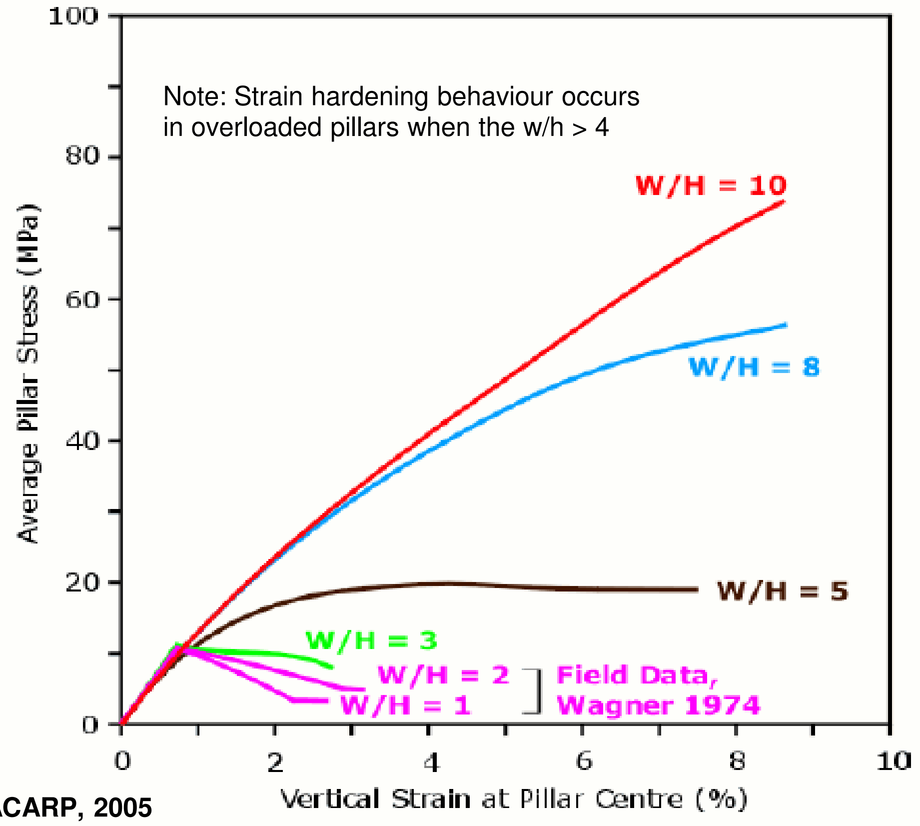
1. Mining Horizon located in C-E and C-G Plies and range in thickness from 2.8 m - 3.3 m.
2. Typical mining height likely to range between 2.8 m and 3.3 m with development heights of 2.5 - 2.6 m throughout mining area.

DgS	Engineer:	S.Ditton	Client:	Donaldson Coal Pty Limited ABL-002/4	
	Drawn:	S.Ditton			
	Date:	25.06.12	Title:	Typical Overburden Stratigraphy above the Abel Mine's SMP Areas	
	Ditton Geotechnical Services Pty Ltd				
			Scale:	NTS	Figure No: 4



Notes:
r = bord width (m)
w = pillar width (m)
h = mining height (m)
H = depth of cover (m)
e = extraction ratio = 1 - [wr/(w+r)(l+r)]
T = Pillar Load = 0.025H/(1-e) (MPa)

DgS	Engineer:	S.Ditton	Client:	Donaldson Coal
	Drawn:	S.Ditton		ABL-002/4
	Date:	25.06.12	Title:	Analytical Model for Calculating Full Tributary Area Loads on Pillars in Partial Extraction Panels
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS — Figure No: 5a



Ref: **ACARP, 2005**

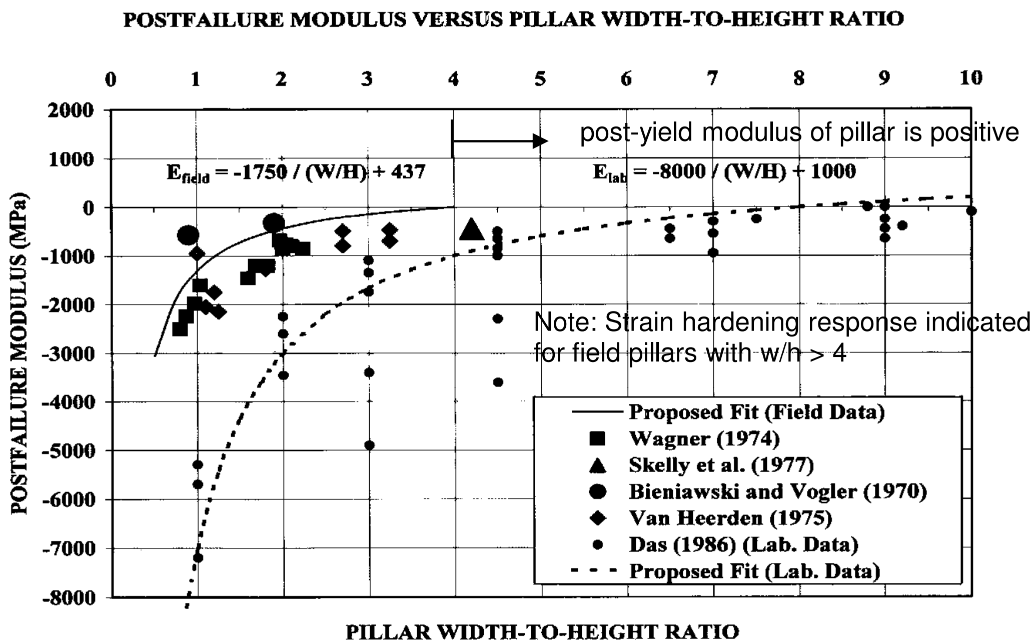
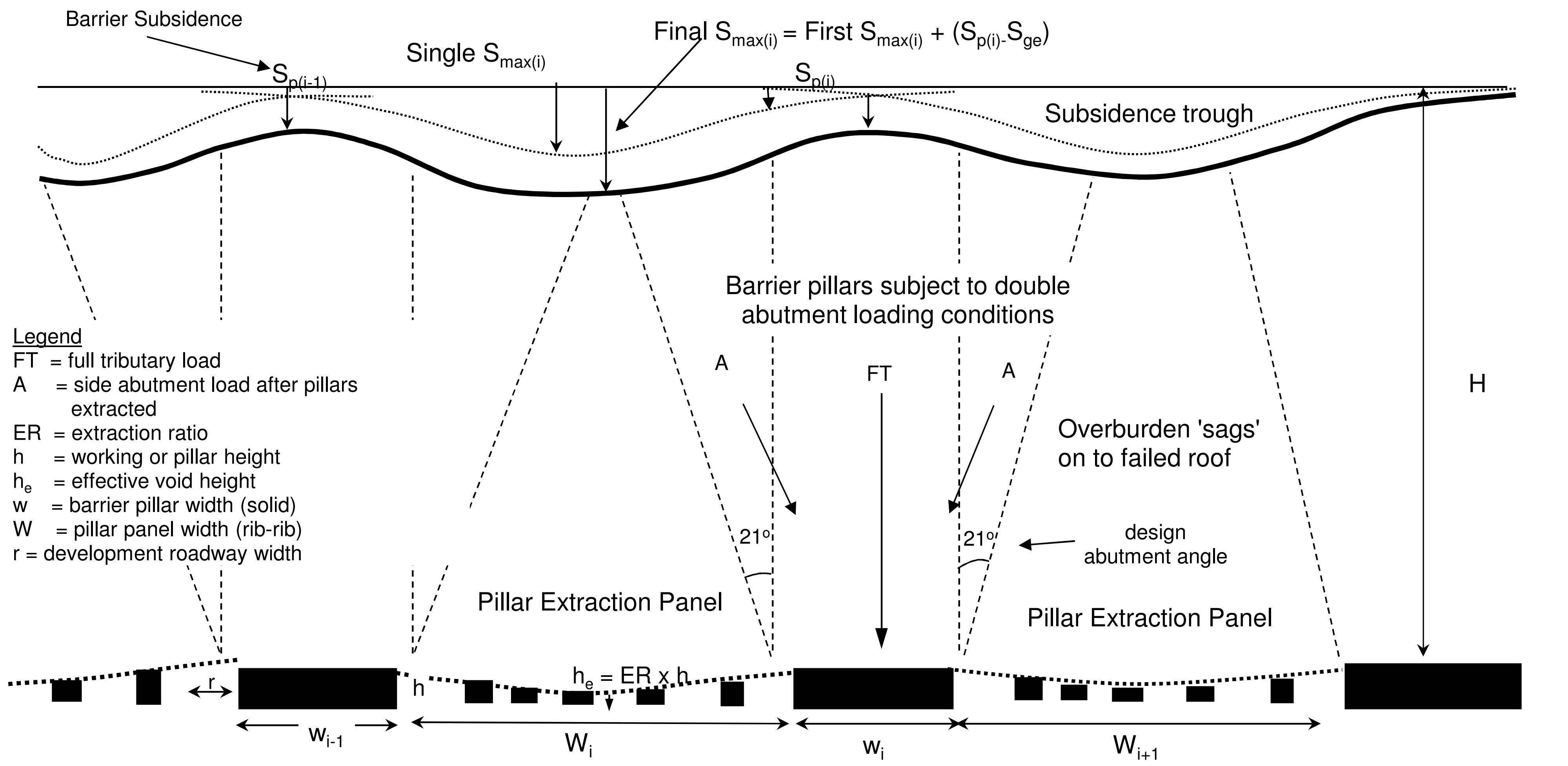


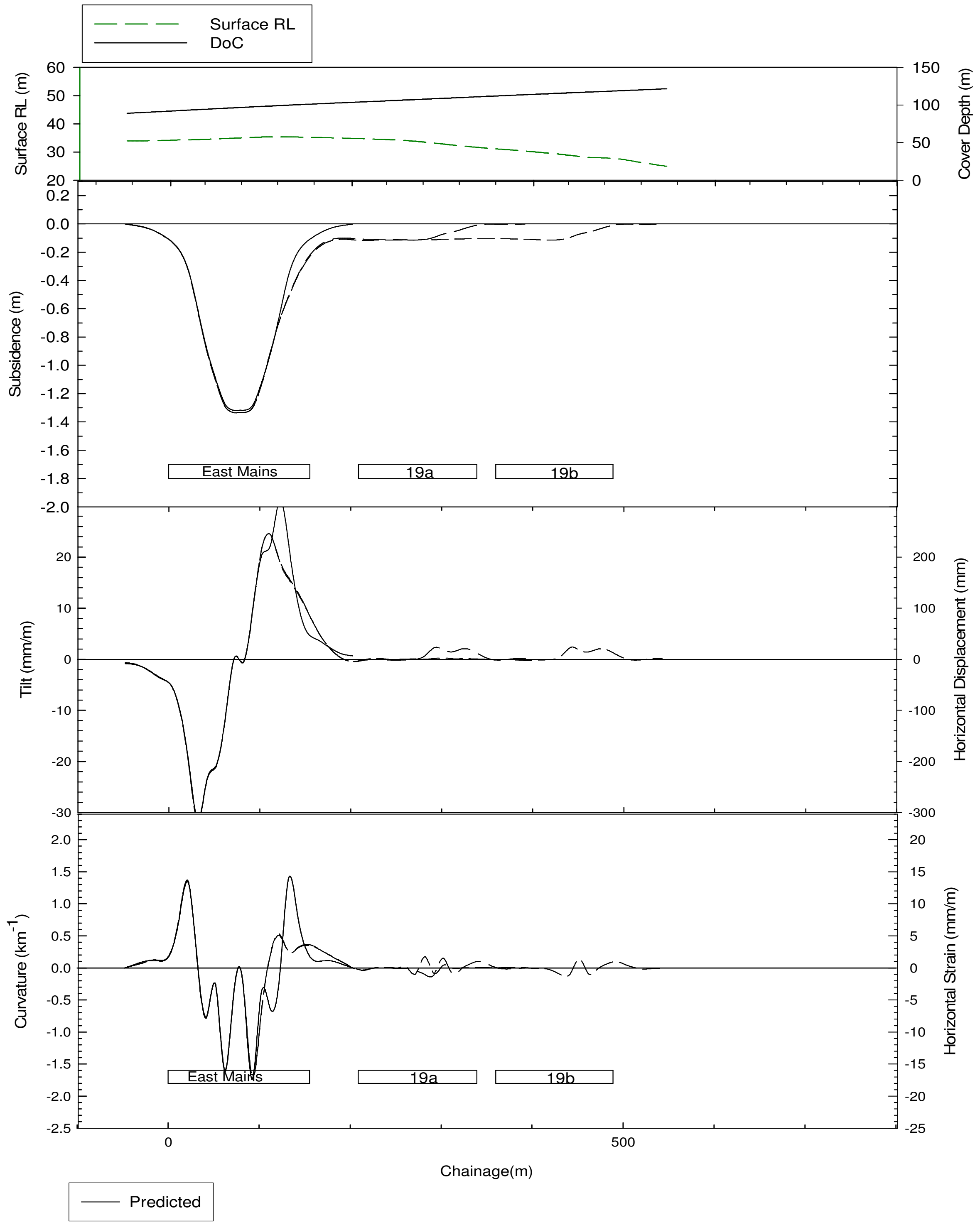
Figure 5.—Summary of postfailure modulus data for full-scale coal pillars and laboratory specimens. Also shown is proposed approximate equation for E_p.

Ref: **Zipf, 1999**

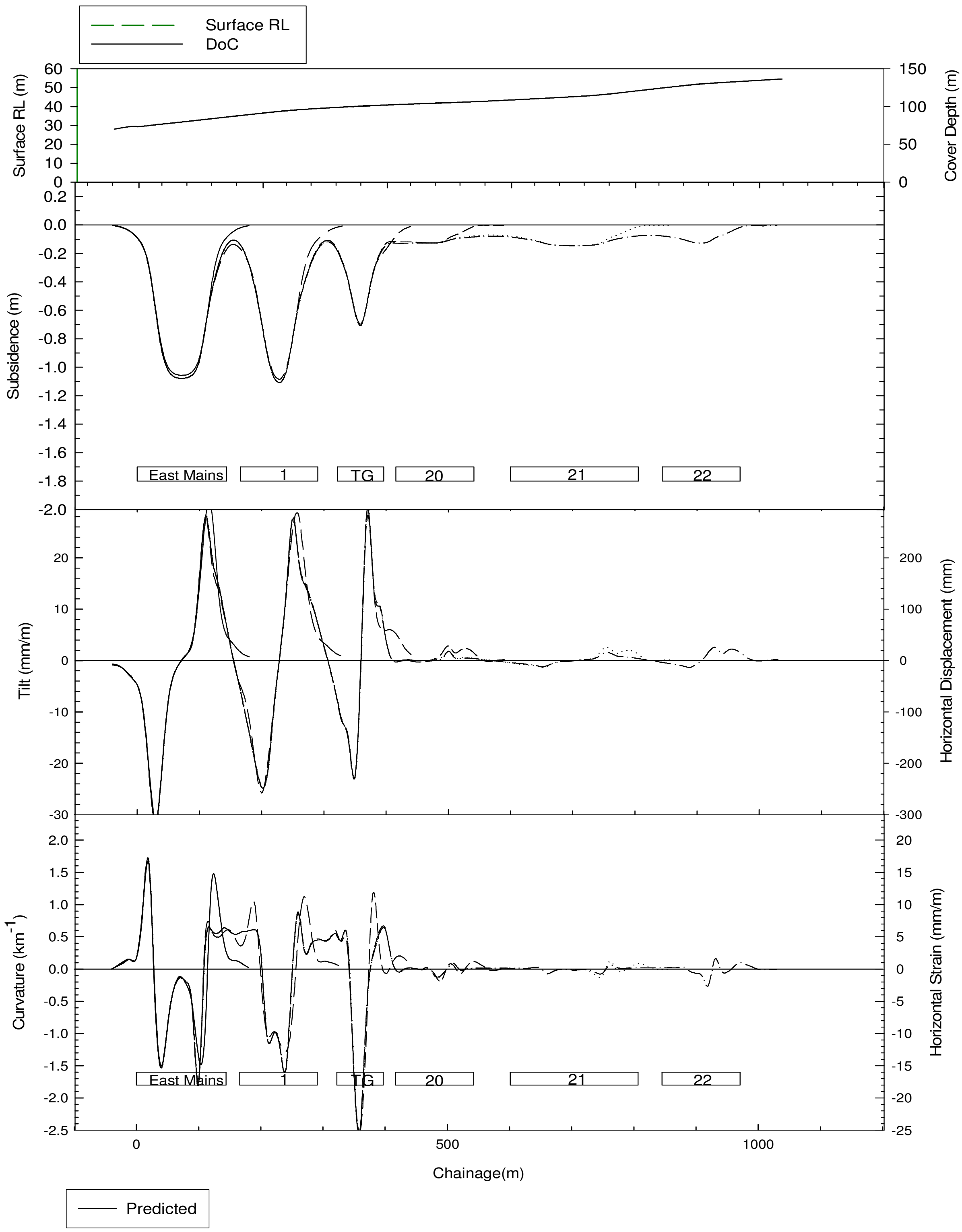
DgS	Engineer:	S.Ditton	Client:	Donaldson Coal		
	Drawn:	S.Ditton		ABL-002/4		
	Date:	25.06.12	Title:	In-situ Pillar Stress v. Strain Behaviour for a Range of Pillar Width/Height Ratios		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	5b



DgS	Engineer:	S.Ditton	Client:	Donaldson Coal ABL-002/4		
	Drawn:	S.Ditton				
	Date:	25.06.12	Title:	Conceptual Model of Multiple Pillar Extraction Panels and Barrier Pillar System Interaction at the Proposed Abel Mine		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	5c



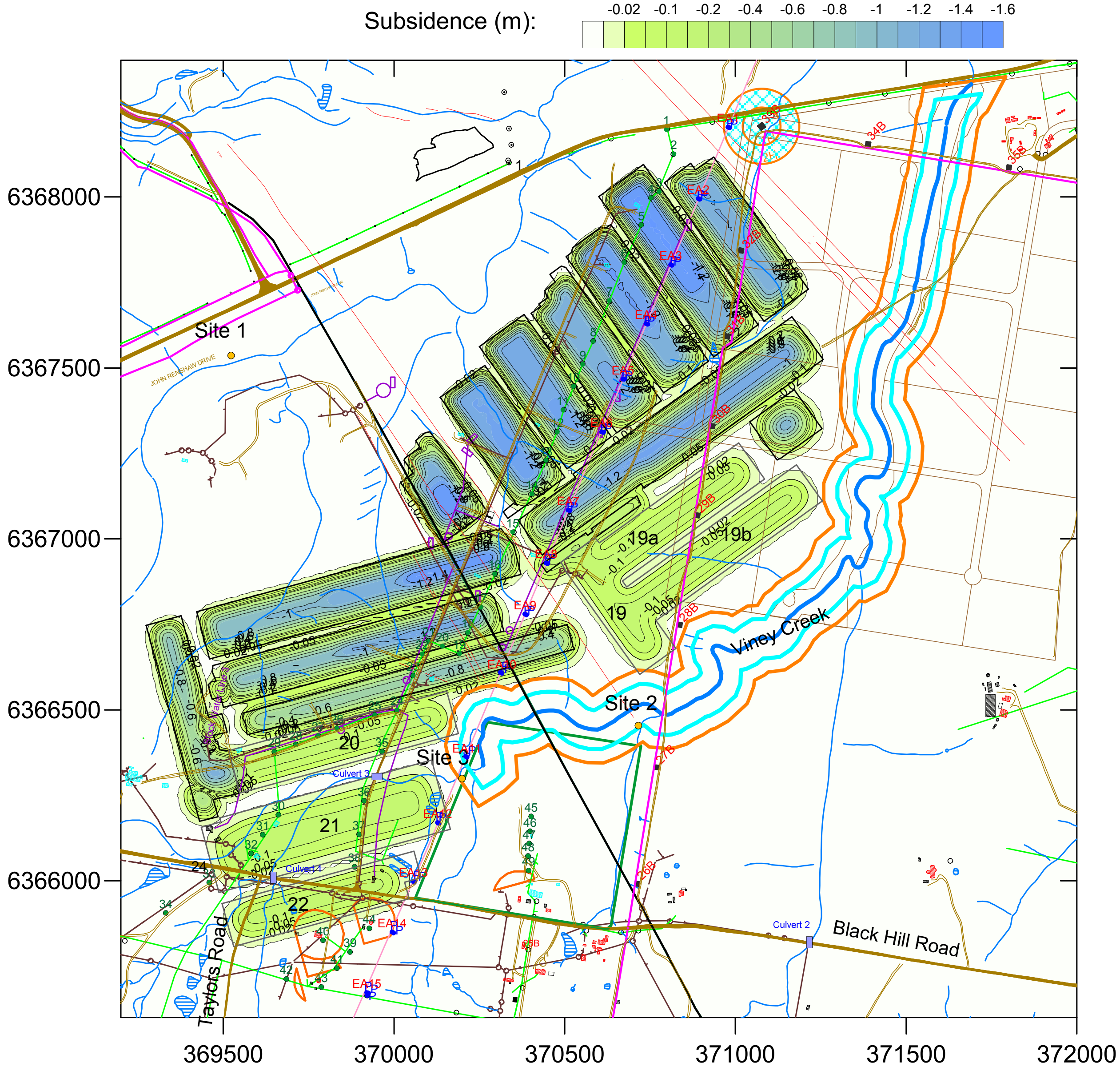
DgS	Engineer:	S.Ditton	Client:	Donaldson Coal
	Drawn:	S.Ditton		ABL-002/4
	Date:	25.06.12	Title:	Predicted Subsidence Effect Profiles for XL9 Above Proposed Partial Extraction Panels 19,a,b
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS
			Figure No:	6a



DgS	Engineer:	S.Ditton	Client:	Donaldson Coal		
	Drawn:	S.Ditton		ABL-002/4		
	Date:	25.06.12	Title:	Predicted Subsidence Effect Profiles for XL3 Above Proposed Partial Extraction Panels 20-22		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	6b

Key

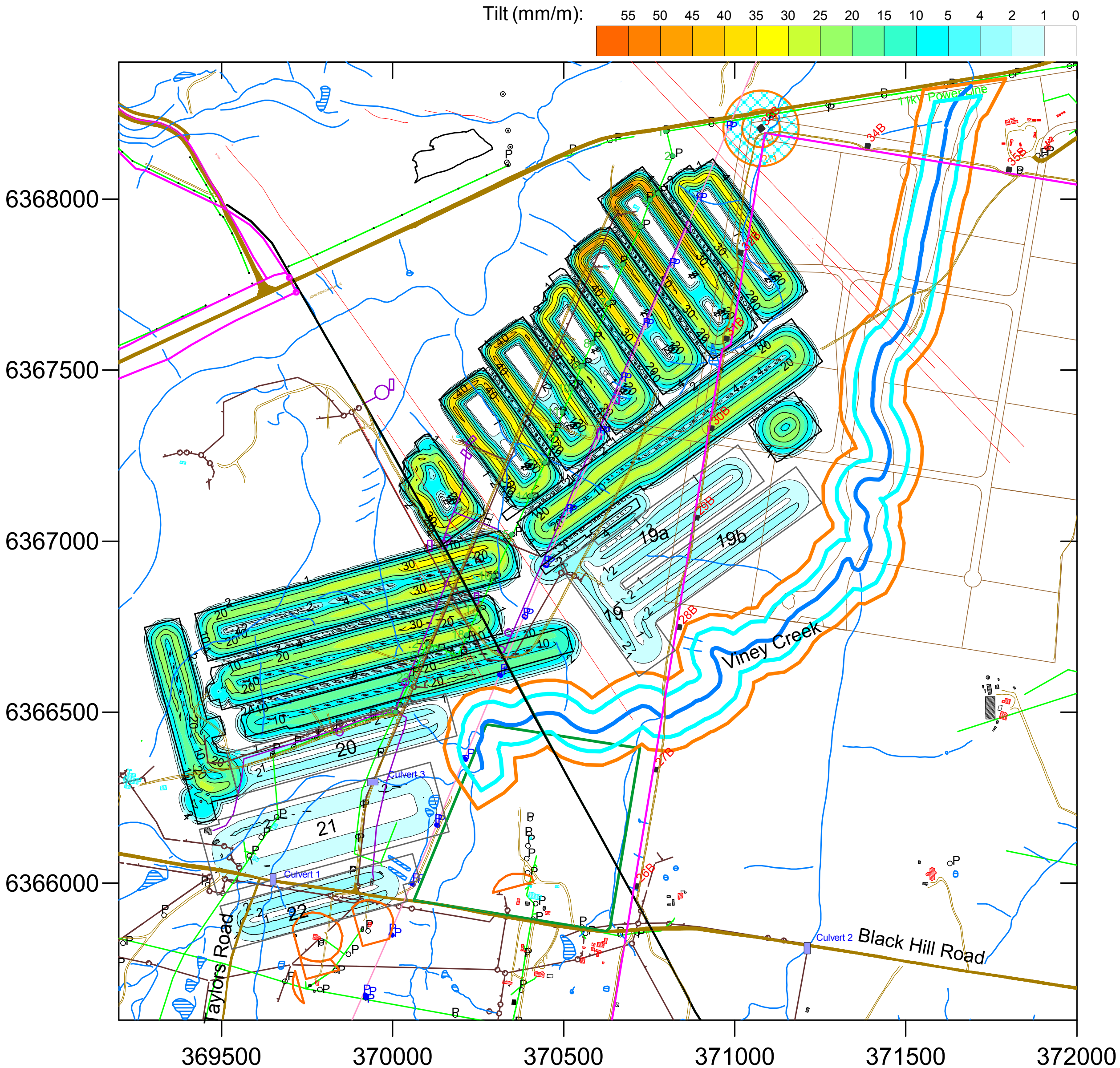
- Schedule 2 Creek and Buffer Zone (DECCW)
- 26B — Transmission Towers (Transgrid, 330 kV)
- Optic Fibre Cable (Optus)
- Sealed Road (Cessnock/ Newcastle City Councils)
- Water Supply Pipeline (Hunter Water)
- Principle Residences
- Non-Principle Residences and out buildings
- Disused Buildings
- EA9 P — 132 kV Power Line and Poles (Energy Australia)
- 24 P — 11 kV Domestic Powerline and Poles (Energy Australia)
- Proposed Blackhill Land Pty Ltd Lot Layout (Preliminary)
- Second Workings - Total Extraction
- Second Workings - Partial Extraction
- 0.1 — Subsidence Contours (m)
- Telstra Copper Cabling (buried)
- Schedule 1 creeks/ gullies
- 0.5H Subsidence Control Zones
- Stock Watering System
- Catholic Land - Proposed Development Area
- Geological Structure
- Site 1 — Aboriginal Artefact Site
- Culvert 1 — Culvert



DgS	Engineer:	S.Ditton	Client: Donaldson Coal ABL-002/4
	Drawn:	S.Ditton	
	Date:	15.07.12	Title: Predicted Final Worst-Case Subsidence Contours above the Proposed Modified Duncan and Total Extraction Panels at the Abel Mine
Ditton Geotechnical Services Pty Ltd			Scale: 1:20,000 — Figure No: 7

Key

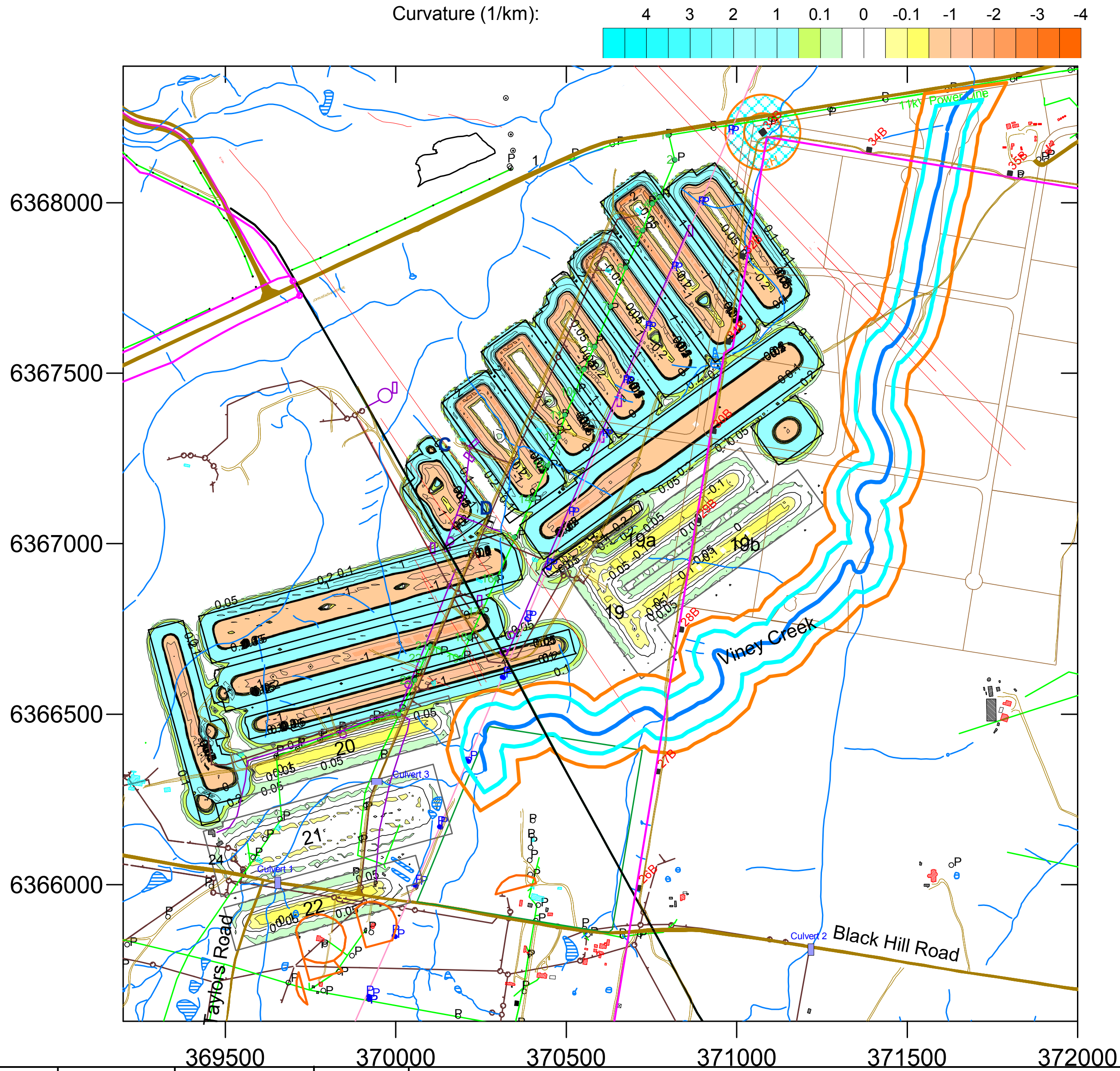
- Schedule 2 Creek and Buffer Zone (DECCW)
- 26B Transmission Towers (Transgrid, 330 kV)
- Optic Fibre Cable (Optus)
- Sealed Road (Cessnock/ Newcastle City Councils)
- Water Supply Pipeline (Hunter Water)
- Principle Residences
- Non-Principle Residences and out buildings
- Disused Buildings
- EA9 P 132 kV Power Line and Poles (Energy Australia)
- 24 P 11 kV Domestic Powerline and Poles (Energy Australia)
- Proposed Blackhill Land Pty Ltd Lot Layout (Preliminary)
- Second Workings - Total Extraction
- Second Workings - Partial Extraction
- 10 Tilt Contours (mm/m)
- Telstra Copper Cabling (buried)
- Schedule 1 creeks/ gullies
- 0.5H Subsidence Control Zones
- Stock Watering System
- Catholic Land - Proposed Development Area
- 100 Year ARI Flood Extent
- Geological Structure
- Site 1 Aboriginal Artefact Site
- Culvert 1 Culvert



DgS	Engineer:	S.Ditton	Client:	Donaldson Coal ABL-002/4
	Drawn:	S.Ditton		
	Date:	15.07.12	Title:	Predicted Final Worst-Case Tilt Contours above the Proposed Modified Duncan and Total Extraction Panels at the Abel Mine
Ditton Geotechnical Services Pty Ltd			Scale:	1:15,000 — Figure No: 8

Key

- Schedule 2 Creek and Buffer Zone (DECCW)
- 26B — Transmission Towers (Transgrid, 330 kV)
- Optic Fibre Cable (Optus)
- Sealed Road (Cessnock/ Newcastle City Councils)
- Water Supply Pipeline (Hunter Water)
- Principle Residences
- Non-Principle Residences and out buildings
- Disused Buildings
- EA9 P — 132 kV Power Line and Poles (Energy Australia)
- 24 P — 11 kV Domestic Powerline and Poles (Energy Australia)
- Proposed Blackhill Land Pty Ltd Lot Layout (Preliminary)
- Second Workings - Total Extraction
- Second Workings - Partial Extraction
- 0.1 — Curvature Contours (km-1)
- Telstra Copper Cabling (buried)
- Schedule 1 creeks/ gullies
- 0.5H Subsidence Control Zones
- Stock Watering System
- Catholic Land - Proposed Development Area
- Geological Structure
- Site 1 — Aboriginal Artefact Site
- Culvert 1 — Culvert



Engineer:	S.Ditton	Client:	Donaldson Coal ABL-002/4
Drawn:	S.Ditton		
Date:	15.07.12	Title:	Predicted Final Worst-Case Curvature Contours above the Proposed Modified Duncan and Total Extraction Panels at the Abel Mine
DgS Ditton Geotechnical Services Pty Ltd		Scale:	1:15,000
		Figure No:	9

Key

Schedule 2 Creek and Buffer Zone (DECCW)

26B Transmission Towers (Transgrid, 330 kV)

Optic Fibre Cable (Optus)

Sealed Road (Cessnock/ Newcastle City Councils)

Water Supply Pipeline (Hunter Water)

Principle Residences

Non-Principle Residences and out buildings

Disused Buildings

EA9 P 132 kV Power Line and Poles (Energy Australia)

24 P 11 kV Domestic Powerline and Poles (Energy Australia)

Proposed Blackhill Land Pty Ltd Lot Layout (Preliminary)

Second Workings - Total Extraction

Second Workings - Partial Extraction

5 Strain Contours (mm/m)

Telstra Copper Cabling (buried)

Schedule 1 creeks/ gullies

0.5H Subsidence Control Zones

Stock Watering System

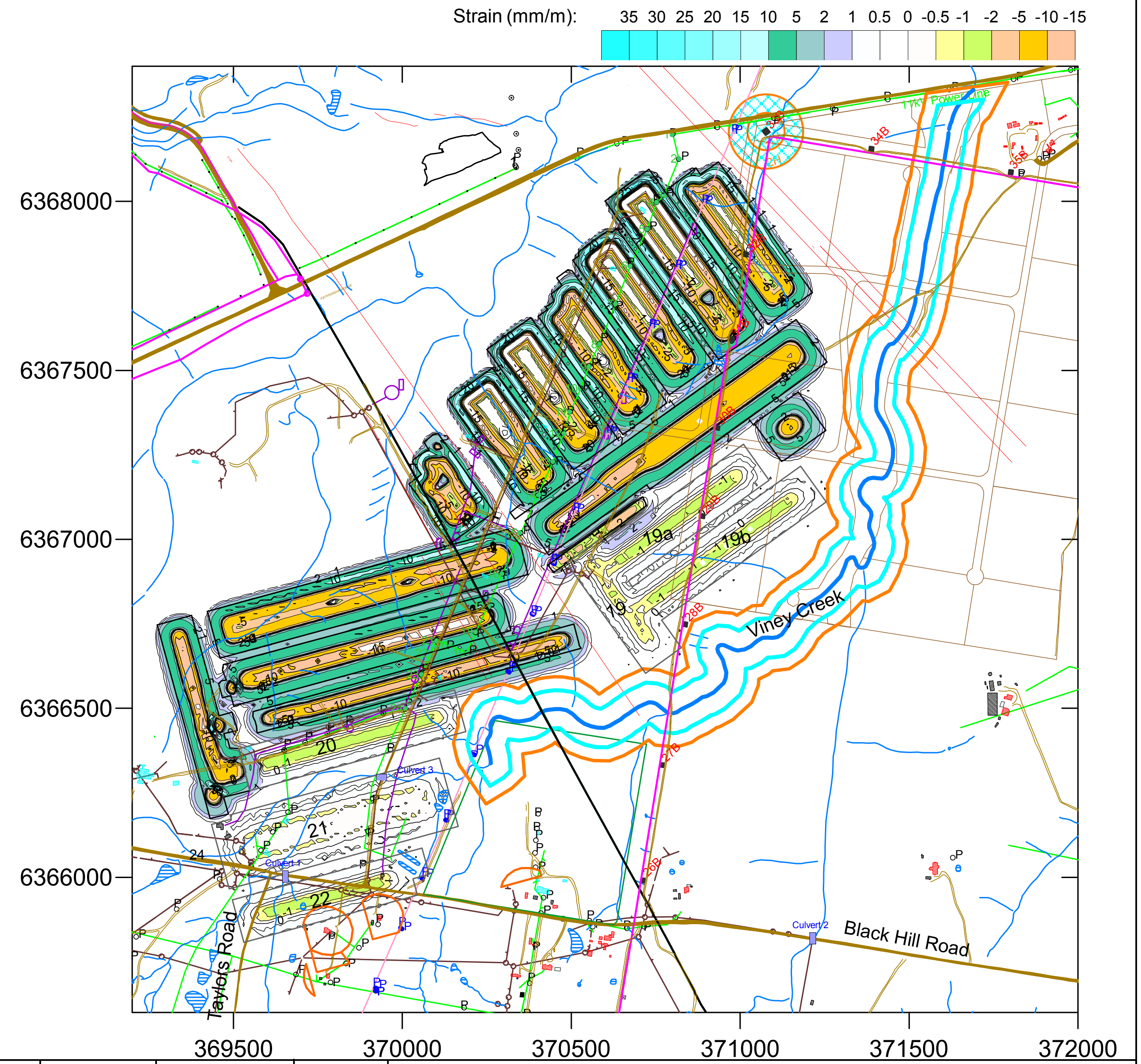
Catholic Land - Proposed Development Area

100 Year ARI Flood Extent

Geological Structure

Site 1 Aboriginal Artefact Site

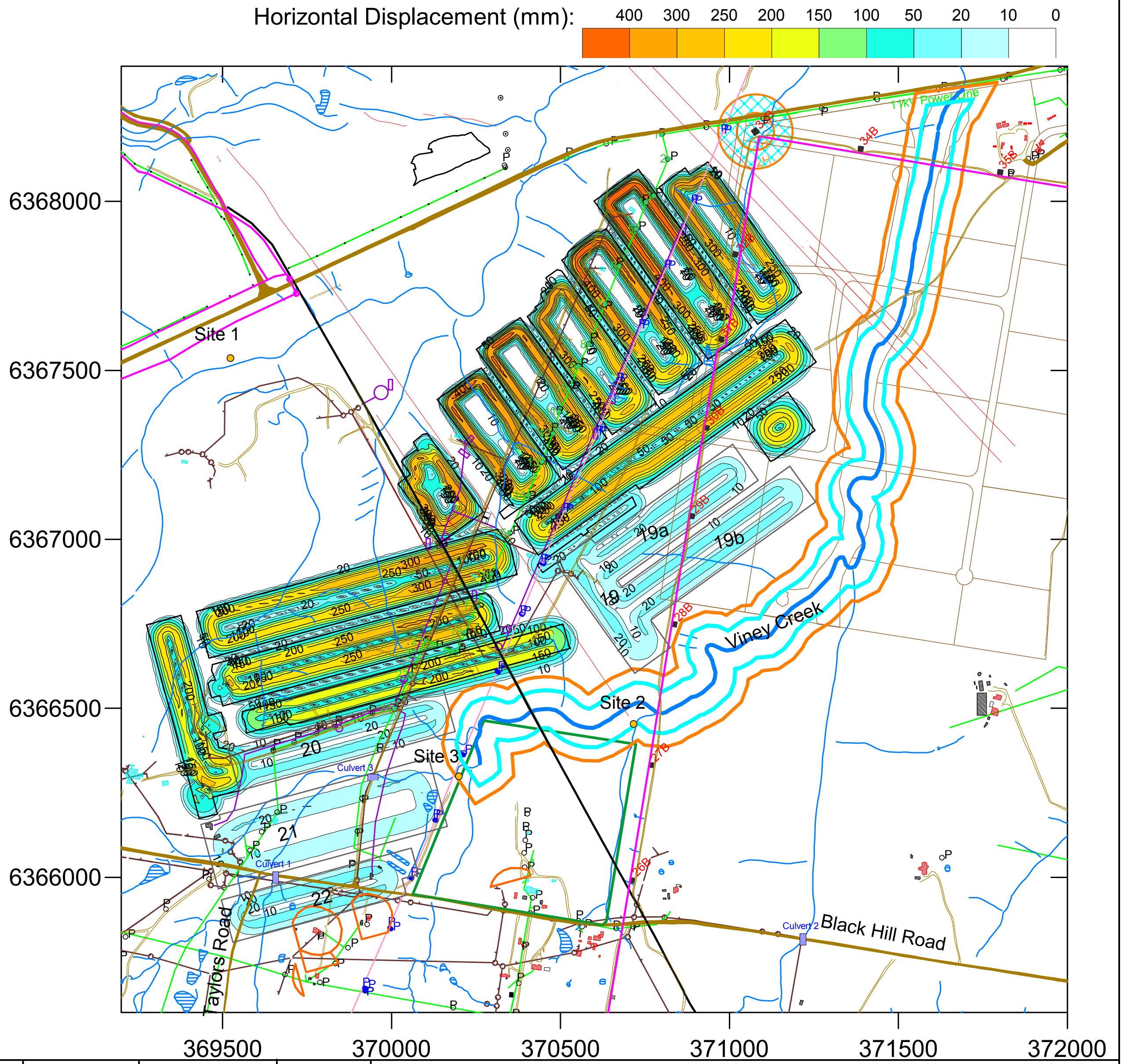
Culvert 1 Culvert



DgS	Engineer:	S.Ditton	Client:	Donaldson Coal ABL-002/4
	Drawn:	S.Ditton	Title:	Predicted Final Worst-Case Horizontal Strain Contours above the Proposed Modified Duncan and Total Extraction Panels at the Abel Mine
	Date:	15.07.12		
Ditton Geotechnical Services Pty Ltd			Scale:	1:20,000
			Figure No:	10

Key

- Schedule 2 Creek and Buffer Zone (DECCW)
- 26B — Transmission Towers (Transgrid, 330 kV)
- Optic Fibre Cable (Optus)
- Sealed Road (Cessnock/ Newcastle City Councils)
- Water Supply Pipeline (Hunter Water)
- Principle Residences
- Non-Principle Residences and out buildings
- Disused Buildings
- EA9 P — 132 kV Power Line and Poles (Energy Australia)
- 24 P — 11 kV Domestic Powerline and Poles (Energy Australia)
- Proposed Blackhill Land Pty Ltd Lot Layout (Preliminary)
- Second Workings - Total Extraction
- Second Workings - Partial Extraction
- 100 — Horizontal Displacement Contours (mm)
- Telstra Copper Cabling (buried)
- Schedule 1 creeks/ gullies
- 0.5H Subsidence Control Zones
- Stock Watering System
- Catholic Land - Proposed Development Area
- 100 Year ARI Flood Extent
- Geological Structure
- Site 1 — Aboriginal Artefact Site
- Culvert 1 — Culvert



DgS	Engineer:	S.Ditton	Client:	Donaldson Coal
	Drawn:	S.Ditton		ABL-002/4
	Date:	15.07.12	Title:	Predicted Final Worst-Case Horizontal Displacements Contours above the Proposed Modified Duncan and Total Extraction Panels at the Abel Mine
	Ditton Geotechnical Services Pty Ltd		Scale:	1:15,000 — Figure No: 11

APPENDIX C

INSPECTION CHECKLIST

APPENDIX C - INSPECTION CHECKLIST

BLACKHILL ROAD SUBSIDENCE INSPECTION CHECKLIST		
Date		
Abel Panel Number		
Face Position (Pillar No / Panel row)		
Inspection Zone Start (Panel row -200m)		
Inspection Zone End (Panel row +100m)		
Area Inspected		
INSPECTION ITEM	**CHECKED**	**COMMENTS**
Surface cracking		
Surface humps (compression)		
Step change in road/track surface		
Culverts – headwall movement or cracking, pipe separation		
Other		

APPENDIX D

CONTACT LIST

Appendix D

KEY CONTACTS

Organisation	Contact Person	Phone Number
Donaldson Coal	Tony Sutherland – Technical Services Manager Donaldson Underground Operations	02 4015 1105 0407 239 820
Donaldson Coal	Matthew Wright – Registered Mining Surveyor	02 4015 1118 0488 206 172
Cessnock City Council	Les Morgan – Asset Engineer	0427 234 077
Mine Subsidence Board	Richard Pickles – District Manager	4908 4350

APPENDIX E

TARPS

Appendix E

Table 2: Trigger Action Response Plan – Blackhill Road & Taylors Road

Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Subsidence Monitoring – Subsidence	Trigger	Subsidence results within predicted range	Subsidence results greater than but less than 15% above predictions	Subsidence results are greater than 15% above predictions
	Notification	N/A.	Notify the Mine Subsidence Board, Cessnock City Council and Principal Subsidence Engineer (PSE) DTIRIS	Notify the Mine Subsidence Board, Cessnock City Council and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to monitor at specified frequency	Inspection by the Mine Subsidence Board, Cessnock City Council and Donaldson. The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	Inspection by the Mine Subsidence Board, Cessnock City Council and Donaldson. The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE
	Mitigation / Remediation	N/A	Review mine plan in consultation with the Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE	Review mine plan in consultation with the Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE

Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Subsidence Monitoring – Tilt	Trigger	Results within predicted range	Results greater than but less than 15% above predictions	Results are greater than 15% above predictions
	Notification	N/A.	Notify the Mine Subsidence Board, Cessnock City Council and Principal Subsidence Engineer (PSE) DTIRIS	Notify the Mine Subsidence Board Cessnock City Council and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to monitor at specified frequency	Inspection with the Mine Subsidence Board, Cessnock City Council and Donaldson. The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	Inspection with the Mine Subsidence Board, Cessnock City Council and Donaldson. The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Risk Assessment to be conducted to consider and evaluate the requirement for repairs and possible suspension of mining activities while repairs completed. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE
	Mitigation / Remediation	N/A	Consider remedial action Review mine plan in consultation with the Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE	Consider remedial action Review mine plan in consultation with the Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE

Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Subsidence Monitoring – Strain	Trigger	Results within predicted range	Results greater than but less than 15% above predictions	Results are greater than 15% above predictions
	Notification	N/A.	Notify the Mine Subsidence Board, Cessnock City Council and Principal Subsidence Engineer (PSE) DTIRIS	Notify the Mine Subsidence Board, Cessnock City Council and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to monitor at specified frequency	The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE
	Mitigation / Remediation	N/A	Review mine plan in consultation with the Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE	Review mine plan in consultation with The Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE

Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Subsidence Monitoring – Horizontal Displacement	Trigger	Results within predicted range	Results greater than but less than 15% above predictions	Results are greater than 15% above predictions
	Notification	N/A.	Notify The Mine Subsidence Board, Cessnock City Council and Principal Subsidence Engineer (PSE) DTIRIS	Notify the Mine Subsidence Board, Cessnock City Council and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to monitor at specified frequency	Inspection with the Mine Subsidence Board, Cessnock City Council and Donaldson. The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	Inspection with the Mine Subsidence Board, Cessnock City Council and Donaldson. The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE
	Mitigation / Remediation	N/A	Consider remedial action Review mine plan in consultation with the Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE	Consider remedial action Review mine plan in consultation with the Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE

Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Visual Inspection	Trigger	Nil ground cracking, step changes, surface humps	Ground cracking, step changes, surface humps, culvert headwall or pipe movement or hairline cracking (> pre existing condition)	Ground cracking >20mm, step changes, surface humps more than 25% above predicted range, culvert headwall or pipe cracking or separation
	Notification	N/A.	Notify the Mine Subsidence Board, Cessnock City Council and Principal Subsidence Engineer (PSE) DTIRIS	Notify the Mine Subsidence Board, Cessnock City Council, and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to inspect at specified frequency Maintain warning signs	Maintain warning signs, erect additional signs in immediate area and consider traffic restrictions. Inspection with the Mine Subsidence Board, Cessnock City Council and Donaldson. Risk Assessment to be conducted to consider and evaluate the requirement for repairs and possible suspension of mining activities while repairs completed. The Mine Subsidence Board, Cessnock City Council and Donaldson develop appropriate agreed remediation program (if required). The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	Maintain warning signs, erect additional signs in immediate area including traffic restrictions if required. Inspection with the mine Subsidence Board, Cessnock City Council and Donaldson. The Mine Subsidence Board, Cessnock City Council and Donaldson develop appropriate agreed remediation program (if required). The Mine Subsidence Board, Cessnock City Council and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE

Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
	Mitigation / Remediation	N/A.	Repair impacts in accordance with the agreed remediation program (if required). Suspension of mining activities in vicinity of Cessnock City Council assets (if required). Review mine plan in consultation with the Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE.	Repair impacts in accordance with the agreed remediation program (if required). Suspension of mining activities in vicinity of Cessnock City Council assets (if required) Repairs to Cessnock City Council assets Review mine plan in consultation with the Mine Subsidence Board, Cessnock City Council, appropriate consultant and PSE