



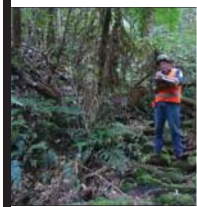


APPENDIX 4

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CENTENNIAL NEWSTAN PTY LTD

SUBSIDENCE ASSESSMENT – MAIN WEST AREA

AEast-06 FEBRUARY 2011

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Tuesday, 22 February 2011
REF: AEast-06

Mr M Cairney
Project Manager - Newstan Lochiel
Centennial Newstan Pty Ltd
PO Box 1000
Toronto NSW

Dear Mick

We are pleased to provide the following assessment of the subsidence that will develop above the Main West area. As you will see, the subsidence is predicted to be less than 20mm.

Please contact the undersigned if you require further details

Yours truly

Ross Seedsman

AusIMM
GEOTECHNICAL
ROSS SEEDSMAN

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1 INTRODUCTION

Centennial Newstan Pty Limited (Centennial Newstan) owns and operates the Newstan Colliery. The Newstan Colliery Surface Facilities Area is located in the township of Fassifern, approximately 25 kilometres south-west of Newcastle and 140 kilometres north of Sydney within the Lake Macquarie Local Government Area.

Centennial Newstan is seeking a modification to the existing Development Consent (DA 73-11-98) to allow for the recommencement of first workings bord and pillar mining in an area referred to as Main West located beyond the existing Development Consent boundary.

The Main West mining area will utilise bord and pillar mining in the West Borehole Seam with long-term stable pillars.

Seedsman Geotechnics Pty Ltd (SGPL) has been requested by Centennial Newstan to complete a subsidence assessment of the proposal. SGPL has provided the subsidence predictions at Newstan since 1998.

The Main West mining area (Figure 1) is located to the west of the recently completed Newstan longwalls, and there are some Awaba Colliery workings (in particular 1A North, 7 West, 8 West) along the south eastern margin. Two TransGrid powerlines cross the area. The Northern Railway is some 1000m to the south east.

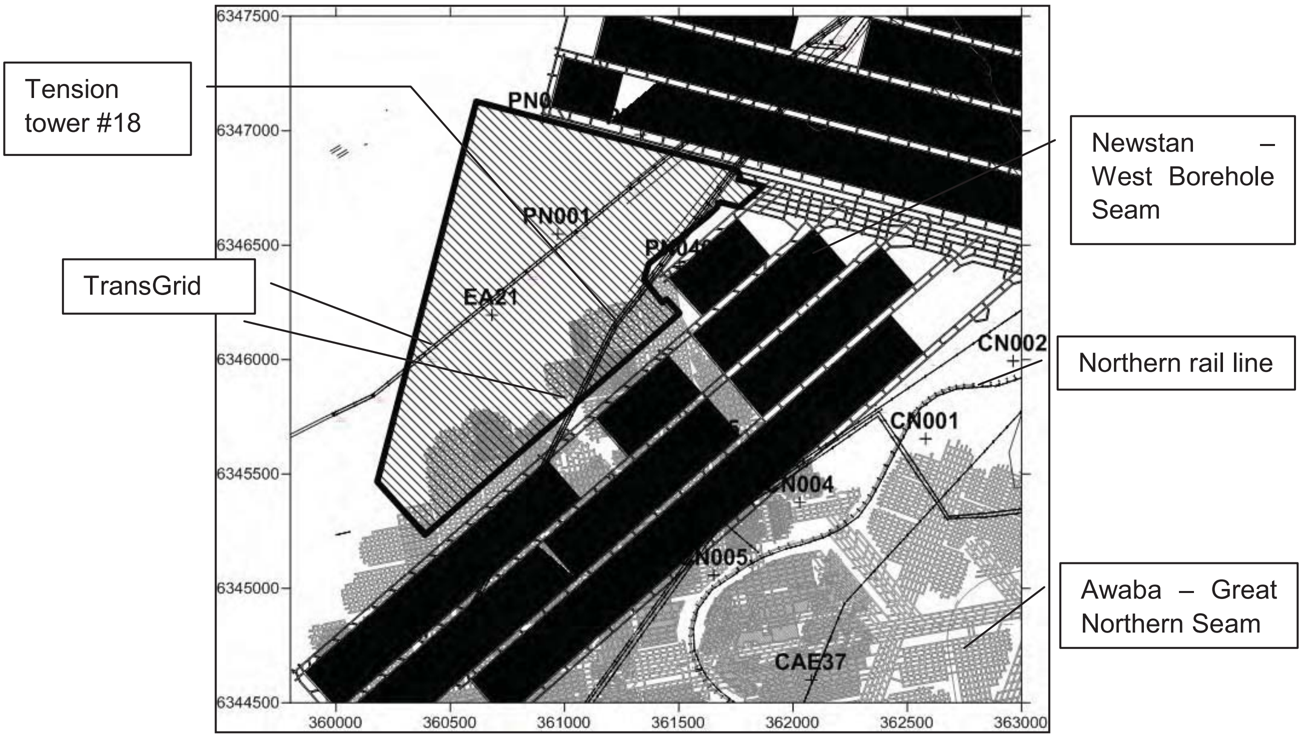


Figure 1 The Main West mining area (diagonal lines), previous mining and borehole location plan

2 SUBSIDENCE RISK MANAGEMENT

Subsidence risk management is required if the subsidence presents a hazard to the surface or the overburden. Risk management strategies can be drawn from a hierarchy of controls:

1. Elimination – no mining at all

2. Substitution – use of a mining system that has lesser impacts

3. Engineering – leaving of barriers

4. Administration – monitoring and inspection of the surface and remediation as necessary.

It is understood that the surface in the Main West mining area can be characterised as presenting negligible subsidence hazards. Despite this lack of significant subsidence hazards, the decision has been made substitute longwall mining with a bord and pillar/continuous miner operation with long term stable pillars. This mining will be eliminated in the immediate vicinity of the Transgrid tension (or turning) tower.

The Main West pillars are planned to be 22m by 22m (solids) in the panels and 22m by 30m in the main headings. With the 5.5m wide bords, this gives pillar dimensions of 16.5m or 24.5m. The dimensions give long term stable pillars on the assumption of a 2.4m working height at 130m depth (see below).

3 PREVIOUS MINING

A layout such as proposed has not been used at Newstan in the West Borehole seam so no subsidence data is available to demonstrate the outcomes. A layout based on similar geotechnical design approaches in a different seam at Mannering Colliery has been shown to produce vertical subsidence outcomes of less than 20mm.

The Main West area lies to the west of the recently completed longwalls in the same seam – West Borehole Seam. The Newstan longwalls were extracted without adverse impacts on the northern railway or the Transgrid powerlines. The longwall panels were 227m wide and the chain pillars were 24.5m wide. An example of the subsidence deformations that were induced by the longwalls is shown in the crossline data of Figure 2. For this longwall district, the maximum measured subsidence was 2560 mm, the maximum tilt was 70mm/m and the maximum strains were 14mm/m tensile and 25 mm/m compression. The vertical subsidence above the chain pillar was 300mm. It is noted that the Newstan longwalls operated under the Awaba Mine and the subsidence deformations were well within the anticipated range – the maximum vertical subsidence was typical of longwalls and there were some localised high tilts and strains.

At Awaba, pillar extraction is being conducted in the Great Northern Seam. The original pillars were formed in the 1940s and 1950s and some of those pillars are now being extracted. The panel and pillar method exploits the spanning capability of the Teralba Conglomerate in the roof of the seam. More detail of the extraction layout is shown in Figure 3 where panels up to 95m wide are shown. Subsidence to date has been less than 130mm (Figure 4). The associated strains have been less than 0.5 mm/m. Figure 5 shows the prediction for the end of mining at Awaba Colliery.

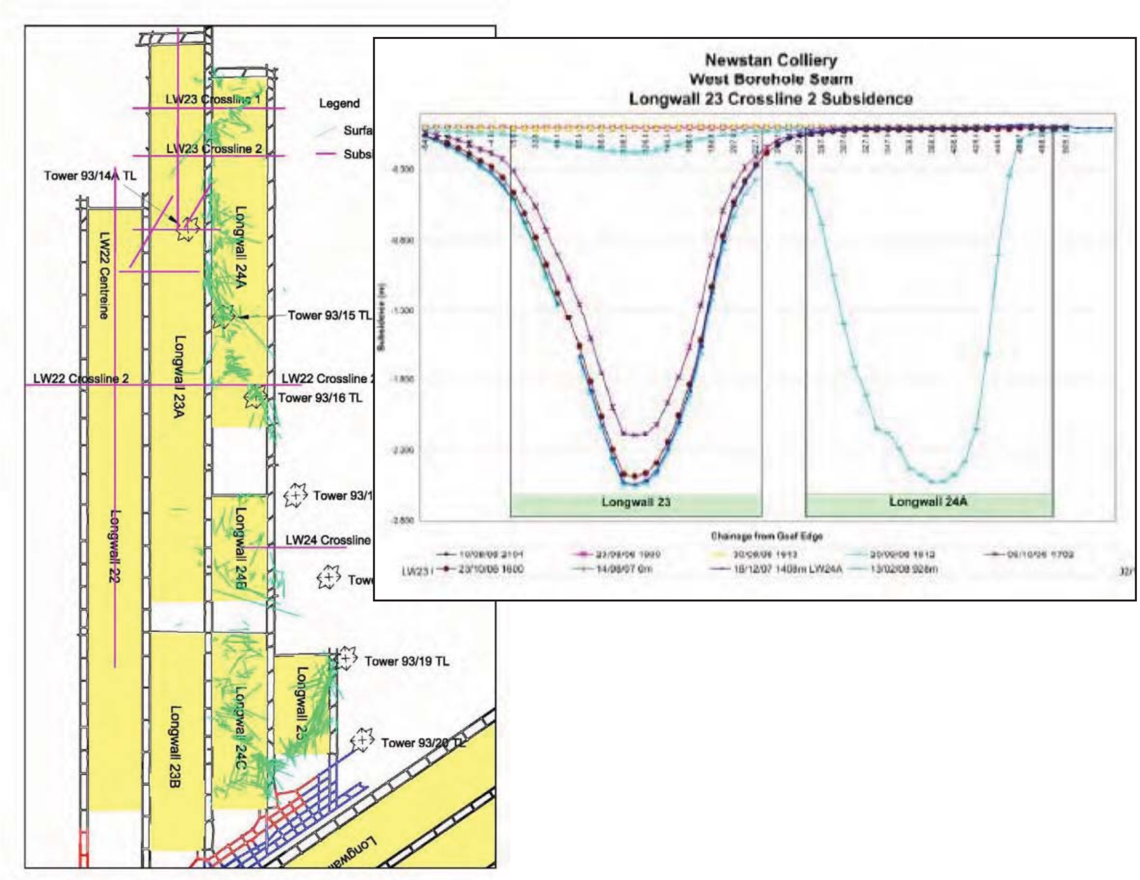


Figure 2 Subsidence data from the Newstan longwalls

Figure 3 Recent and proposed panel and pillar mining at Awaba (white – extraction panels, black – interpanel pillars)

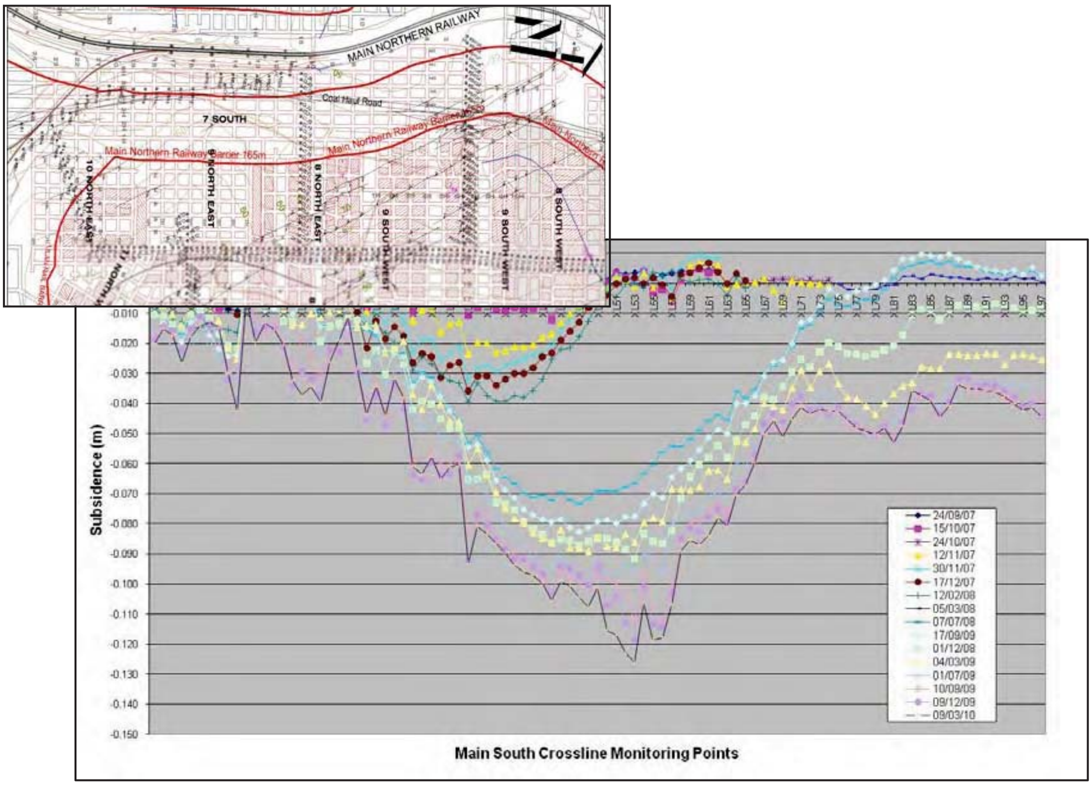


Figure 4 Vertical subsidence along the Main South Crossline.

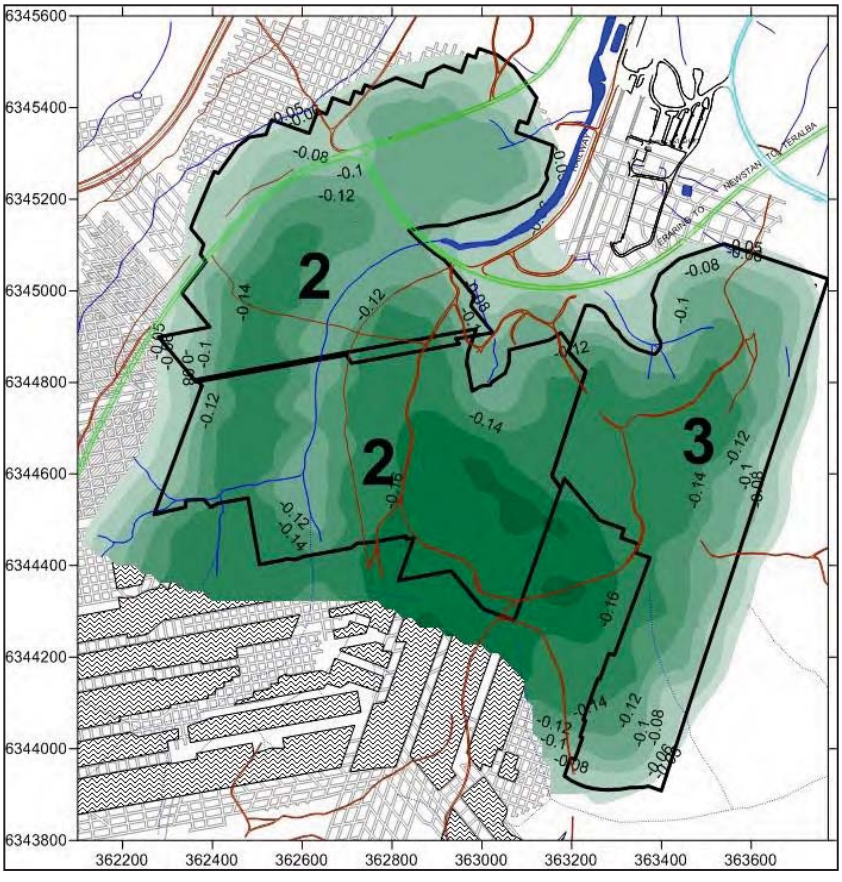


Figure 5 Visualisation of the likely vertical subsidence above the last of the proposed Awaba workings

Earlier mining in the Great Northern Seam at Awaba Colliery involved both bord and pillar mining and the recovery of pillars. In 1977, part of the 1A North Headings (Figure 6) experienced a rapid floor heave event as documented in a note soon after by M Bevan[1]. The pillars in 1A North were 14.5m square and formed at depths of about 25m - 30m. Subsidence survey lines, established over the 7 West and 1A North panels prior to the floor heave event, reveal in excess of 1.25m of vertical subsidence (Figure 6). The tension tower (#18) was exposed to about 0.1m of vertical subsidence. The subsidence was the result of the pillars punching into the floor and not a kinematic failure of the coal component.

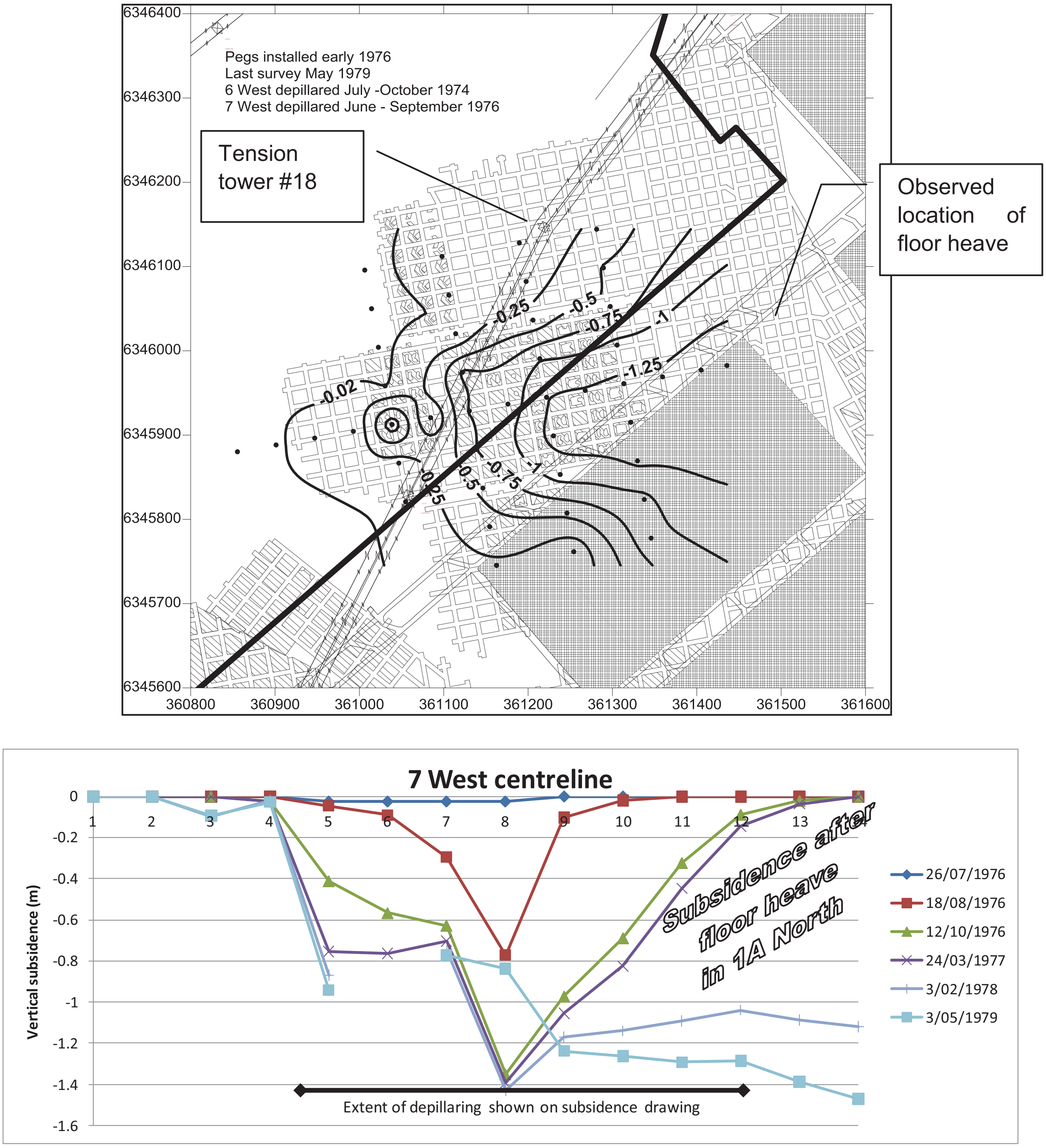


Figure 6 Subsidence developed above 1A North and 7 West

[1] The recovery of machinery from 1A North and 8 West Panel at Awaba State Mine, Appendix to Galvin (2008).

4 ENGINEERING GEOLOGY

4.1 COAL SEAM – TOP C

The West Borehole Seam is the combination of the Young Wallsend (YW), Yard (YD), and Borehole (BH) Seams (Figure 7). The roadways in the Main West mining area will mine under the Dudley Clay Band(DCL) and leave the upper 2 plies of the Young Wallsend Seam as the immediate roof. From inspections of the core, the relatively uniform geophysical traces, and observations at Newstan, the coal above the Dudley Clay Band is a particularly massive coal.

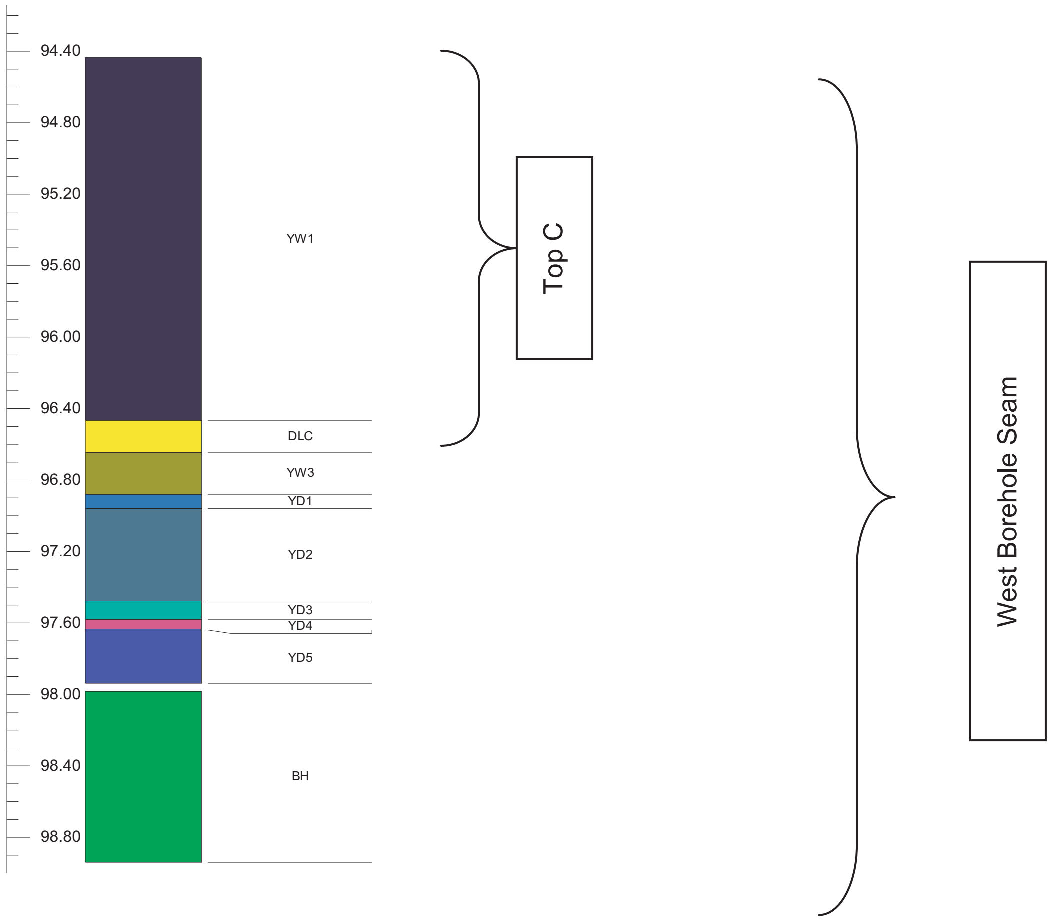


Figure 7 Detail of the overburden in the Main West area

Figure 8 shows a plan of the thickness of what is locally referred to as TopC across the area. In the Main West mining area, the TopC thickness is about 1.0m to 1.1m.

The thickness of coal below TopC is approximately 2.4m, and the depth of cover ranges between 80m and 130m (Figure 9). There is some early ACIRL testing of Young Wallsend coal – an unconfined compressive strength (UCS) of 28 MPa was obtained. The floor of the West Borehole Seam is a massive high strength sandstone unit – the Waratah Sandstone.

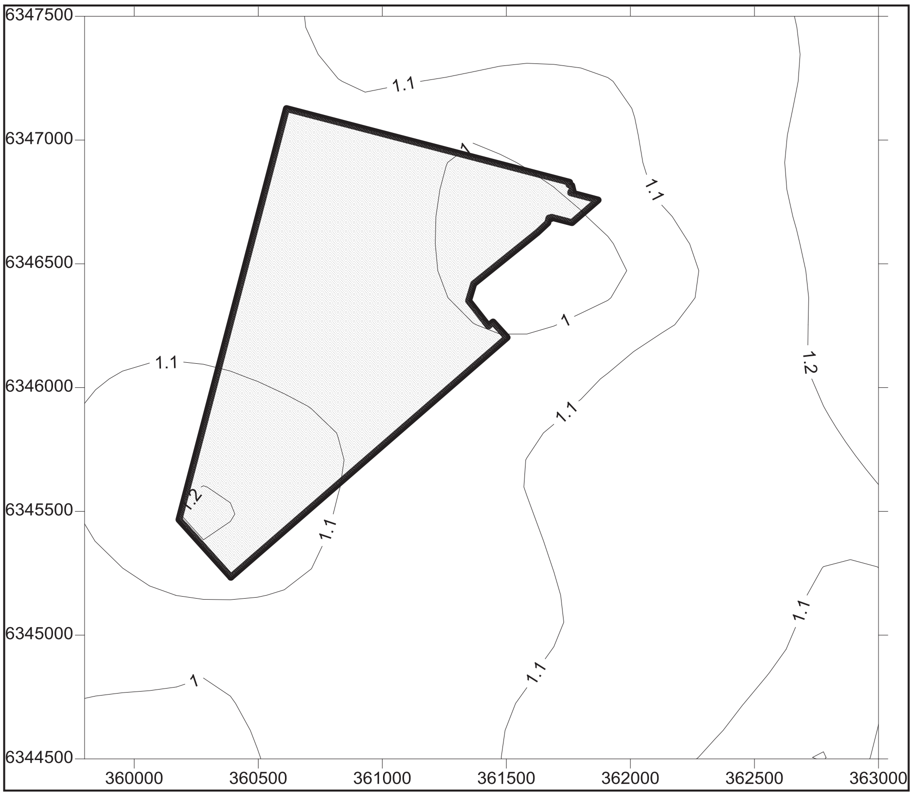


Figure 8 Thickness of Top C

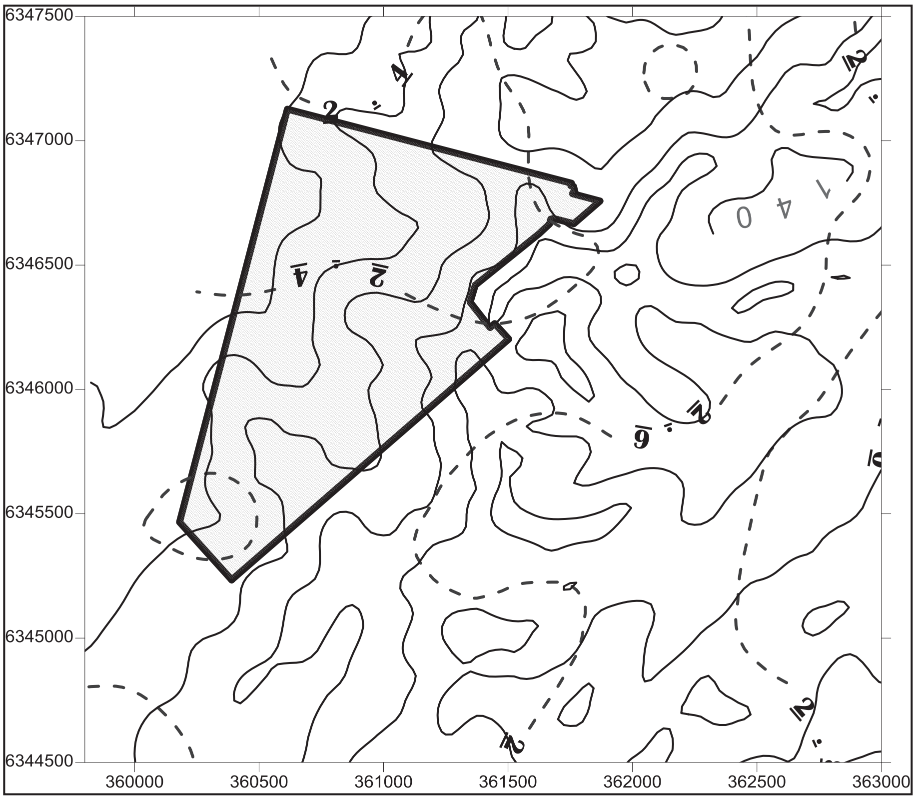


Figure 9 Depth of cover (lines) and seam thickness (dashes)

4.2 OVERBURDEN

Details of the logging from EA 21 in the Main West area are shown in Figure 10, and while the roof is indicated to be dominated by named coal seams, the thicker seams are shown to contain only 27% to 44% coal (they are not economic for underground mining).

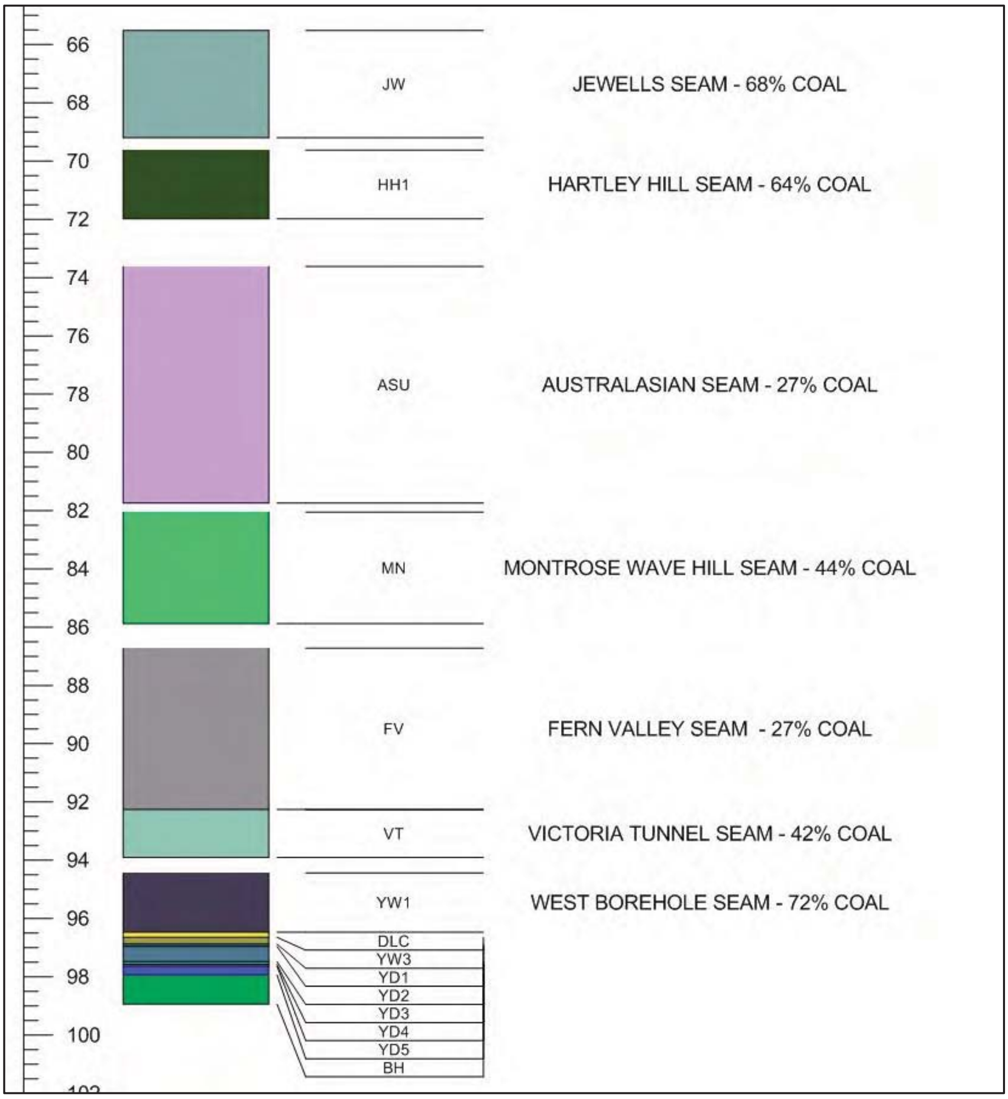
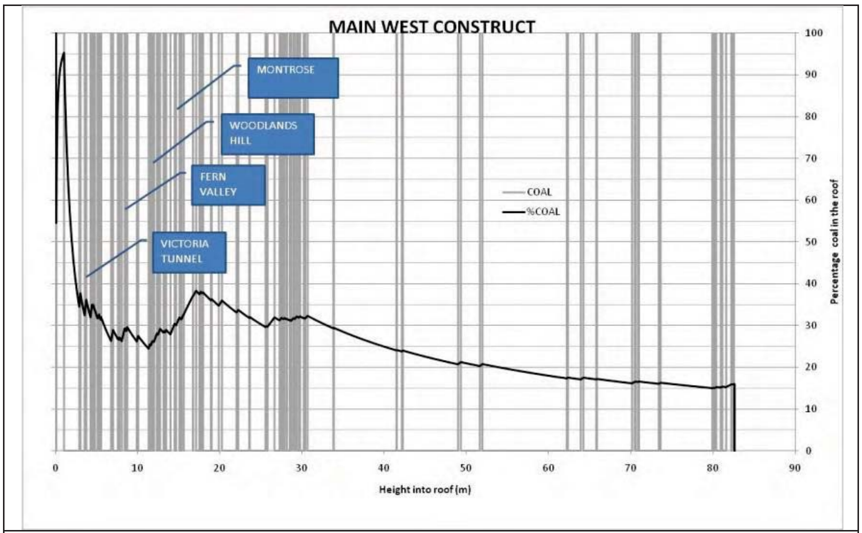


Figure 10 Coal seams in the roof of the West Borehole Seam in EA 21.

One of the standard exploration tools is the down-hole density log. Coal has a significantly lower density (1.4 t/m^3 - 1.6 t/m^3) compared to that of rock (2.3 t/m^3 - 2.5 t/m^3). The density logs from a number of holes have been processed to identify coal or stone based on a density threshold. A density log for EA 21 Main West was not collected so an adjacent log has been manipulated to show the trends (Figure 11). The log indicates that the roof of the seam has approximately 30% coal.

Also of significance is the distance between the Great Northern and West Borehole Seams – 90m-130m in the small area where the Great Northern Seam is present (Figure 12).



Proxy for EA21 which does not have a density log.
At 30m above the working roof, the overall coal percentage is 30% .

Figure 11 Incremental coal percentages into the roof

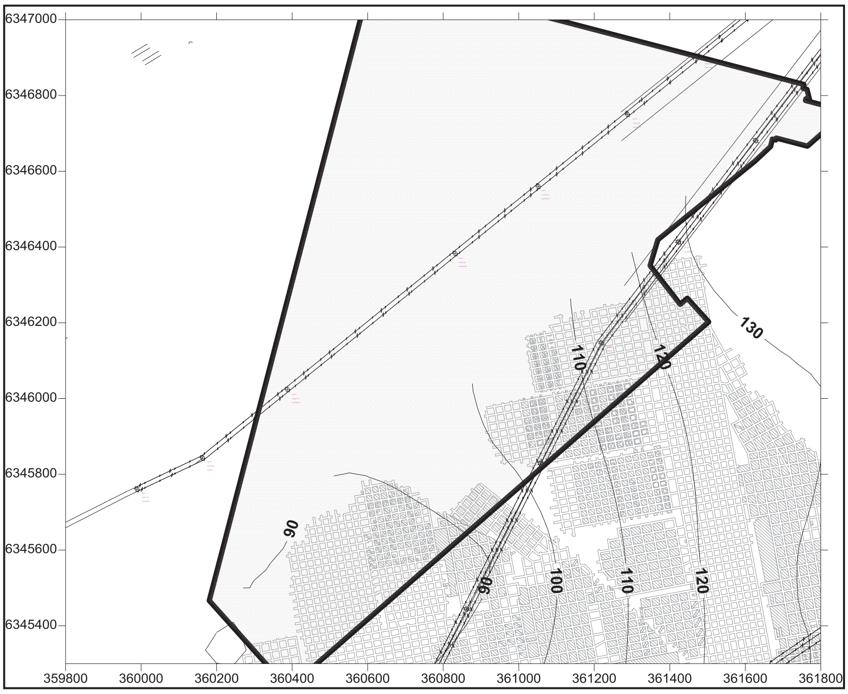


Figure 12 Great Northern to West Borehole Seam interburden.

5 GEOTECHNICAL MODEL

To allow analysis of the stability and deformation of the proposed mining system, it is necessary to establish a geotechnical model that includes consideration of the material properties in and around the openings and the pillars.

The pillar stresses are determined using tributary area loading. The interburden distance to the Awaba workings on the south east margin of the project is sufficiently large so as not to alter the vertical stresses at the West Borehole Seam.

The strength of the coal will be assumed to be 25 MPa, although it is emphasised that coal strength is not an input to coal pillar strength calculations.

For consideration of compression of the coal in the pillar and the coal plies in the roof, a mass modulus of Young's modulus of 1500 MPa will be used. For the rock units, assessments are made of the laboratory strength and the rock mass reductions using the Geological Strength Index (GSI).

SGPL predicts the surface subsidence above pillars using analytical models drawn ultimately from foundation engineering. It is noted that the use of foundation engineering, and particularly for pillar design, has a long history that goes back many decades – it was certainly recognised in the classic Brady and Brown (1985) text.

Deformations under a pillar are determined using the Poulos and Davis (1976) solution for a rigid footing and this solution implies that the areas that undergo significant deformation are within 1.4 times the pillar width. Given the contrast between the deformation properties of coal and stone, the amount of coal in the immediate roof is an important parameter.

6 ANALYSIS

6.1 STABILITY

By reference to Figure 9, the maximum depth of cover is approximately 130m, and the extracted seam thickness is 2.4m. There is 1.1m of TopC as the coal roof (Figure 8), and then the Victoria Tunnel Seam.

For pillars with a minimum width of 22m and at 130m, the factor of safety against kinematic failure of the coal pillar itself is 5.18 at a 2.4m pillar height assumption (Figure 13), 3.00 at a 3.5m pillar height (assuming Top C falls) and 1.74 if a roof fall to a height of 5.5m with vertical sides develops and there is no stone in the collapse zone (Figure 11 suggests there is 70% stone).

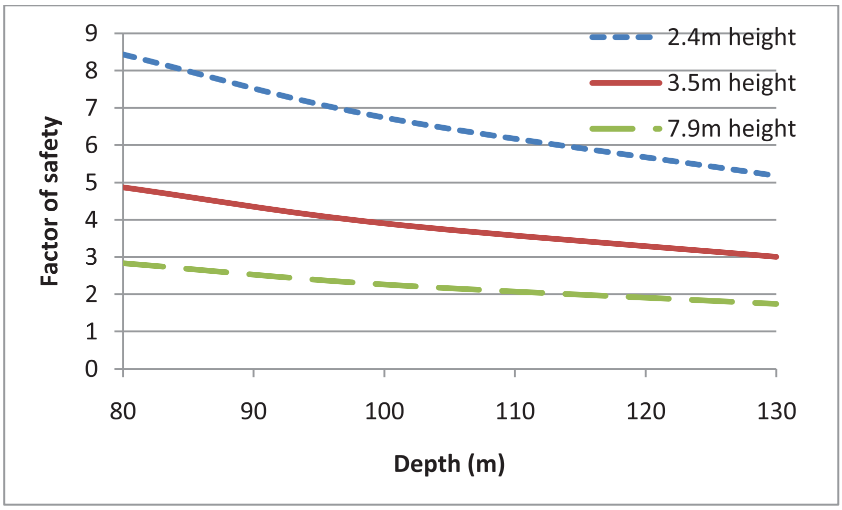


Figure 13 Pillar stability as a function of depth and pillar height

The high strength of the Wallarah Sandstone mitigates against the onset of floor failure as characterised parts of Awaba Colliery in the Great Northern Seam.

6.2 DEFORMATION

The calculations of the deformation of the roof/pillar floor system are shown in Table 1. It can be seen that the deformations are less than 20mm.

Table 1 Calculations of subsidence above the proposed bord and pillar layouts

	Main West
PILLAR WIDTH (m)	16.5
PILLAR LENGTH (m)	16.5
SEAM THICKNESS (m)	2.4
DEPTH	130
ROADWAYS	5.5
VERTICAL STRESS	2.93
Extraction (%)	0.44
PILLAR STRESS	5.21
COAL MODULUS (MPa)	1500
ROOF STRENGTH (MPa)	80
ROOF MODULUS RATIO	300
ROOF GSI	40
ROOF MODULUS (MPa)	3832
ROOF COAL MODULUS (MPa)	1000
% COAL IN ROOF	30
EFFECTIVE ROOF MODULUS (MPa)	2982
FLOOR STRENGTH (MPa)	80
FLOOR MODULUS RATIO	300
FLOOR GSI	70
FLOOR MODULUS (MPa)	17588
Stress change (MPa)	2.28
Pillar compression (mm)	4
Roof compression (mm)	9
Floor compression (mm)	1
TOTAL (mm)	**14**

7 ASSESSMENT

The vertical subsidence over the Main West mining area induced by mining in the West Borehole Seam will be less than 20mm. There is negligible likelihood that the 20mm will be exceeded. At 20mm vertical subsidence, surface impacts are negligible and cannot be measured. It is assessed that this level of subsidence will not be sufficient to remobilise subsidence in the Great Northern Seam along the south eastern boundary. The subsidence previously induced by the Great Northern Seam workings is shown in Figure 6.

The long-term stability of the coal pillars may be the subject of some conjecture by the government agencies as the empirical database which is relied on for coal pillar design does not include cases of thick coal roofs such as will be encountered in Main West. Even at the worst-case assumption of a 5.5m high roof fall, the resultant stability of the pillars is still greater than the long-term threshold (2.11) for depths less than about 105m and, in a risk framework, still at acceptable levels for 130m depths.

Bord and pillar mining was conducted under TransGrid tension tower 18 in 1977 and this tower was subsided to some degree as a result of the floor heave event in 1A North. It is unlikely that government agencies and TransGrid would approve any additional mining at all under this tower. You should anticipate leaving a 100m diameter block of coal at this tower location. The other towers are suspension towers and do not present a constraint to the proposed bord and pillar mining.

Subsidence monitoring should be used to confirm the predictions of less than 20mm of mining-induced movement. These levels are close or below the level of detection for standard survey techniques – care will be need to install survey pegs that do not move due to meteorological changes.