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Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Mine Subsidence Assessment

Proposed Industrial Subdivision
Lot 1131, DP1057179, Black Hill

Prepared for
F & F Properties

Project 91148.00
September 2017

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		7 September 2017
Reviewer		7 September 2017

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Region Mail Centre NSW 2310
Phone (02) 4960 9600
Fax (02) 4960 9601

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Report on Mine Subsidence Assessment
Proposed Industrial Subdivision
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1. Introduction

This report presents the results of a geotechnical assessment of mine subsidence at Lot 1131, DP1057179, Black Hill Road, Black Hill. The assessment was commissioned in an email dated 16 August 2017 by Mr Richard Kerr of ADW Johnson who was acting on behalf of F & F Properties Pty Ltd (F&F) and was undertaken with reference to Douglas Partners Pty Ltd (DP) proposal NCL170270 dated 11 August 2017.

It is understood that the proposed future development of the site comprises an industrial subdivision with general lot sizes in the order of 5 ha, and range from 2.1 ha to 8.7ha. It is understood that cut and fill operations are proposed for the development with excavated material from elevated parts of the proposed industrial subdivision being used as bulk fill in lower lying areas of the site. The site has been previously utilised for large scale poultry farm use.

It is understood that the Donaldson Abel Underground Mine (Donaldson) has extracted coal, by bord and pillar mining and pillar extraction, from a number of panels within the "Donaldson Top Split" coal seam beneath parts of the property. It is understood that the depth of cover over the workings under the site ranges from about 45 m to 135 m.

The purpose of this report was to assess the risk of mine subsidence in relation to the future proposed development at the site.

For the purposes of the desktop assessment, the ADW Johnson provided a report by Coffey titled "Proposed Land Rezoning, Black Hill" Ref GEOTWARA21984AA-AB-AA dated 3 September 2013 (Ref 2).

DP has also completed a previous mine subsidence assessment at this site in 2015 for the Catholic Diocese of Maitland – Newcastle (Ref 1). The purpose of the 2015 assessment was to review available mining data, undertake a site inspection to assess for any signs of mine subsidence as a result of mining that may affect future development at the site.

2. Site Description and Regional Geology

2.1 Site Description

The site is located at Lot 1131, DP1057179, Black Hill Road, Black Hill as shown on Drawing 1 in Appendix C. The property has a plan area of about 285 ha and is approximately a trapezium in plan with side lengths of about 1.46 km and up to 2.85 km. John Renshaw Drive is located to the north of the property, Black Hill Road to the south and densely vegetated properties to the east and west.

The "site" is the parts of the property that were undermined by Donaldson in the "Donaldson Top Split" coal seam. It is understood that mining beneath the site occurred from about 2010 to 2014.

The property generally comprises undulating hills, gullies, open grassed paddocks as well as areas of dense vegetation and mature trees. There were a number of derelict building / shed pads up to about 100 m long and 15 m wide on the property. It is understood the sheds were used for poultry farming. The sheds were demolished prior to commencement of underground mining.

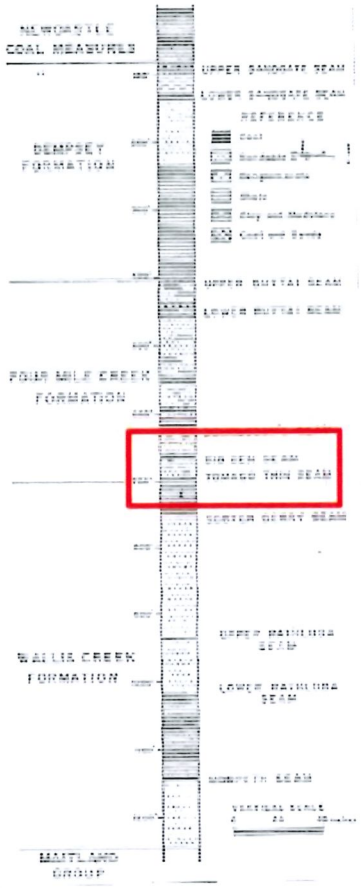
Much of the site is a disturbed landscape following previous use as a series of poultry and pig farms. The site contained buildings such as poultry sheds, incinerators, laboratories, tanks and other structures. It also contained burial pits for animal carcasses, laboratory waste and building demolition waste.

The main sealed access road is oriented in an approximate south – north direction on the property with an entrance off Black Hill Road. Unsealed access tracks branched off the main access road at various locations. There were various rural / stock fences on parts of the property. The property also has an irrigation system for cattle agistment.

Underground mining occurred in districts referred to as South Mains, East Install Headings, East Mains, Tailgate Headings, Panels 1 to 8, 15, 19, 19A, 20, 21 and 22. The locations of the worked sections as per Plan 2B (Ref 5) are shown relative to an aerial image of the site on Drawing 1 in Appendix B.

2.2 Regional Geology

The regional geology is based on the 1:100,000 scale regional geology map for Newcastle (Newcastle Coalfield Regional Geology, Sheet 9321, NSW Department of Mineral Resources). The site is underlain by the Tomago Coal Measures of late Permian age. The lithology of the Tomago Coal Measures consists of shale, siltstone, fine sandstone, coal and minor tuffaceous claystone.



The Tomago Coal Measures underlie the Newcastle Coal Measures, outcropping on the eastern flank of the Lochinvar Anticline near East Maitland (Packham, Ref 3). The Tomago Coal Measures dip gently in the south-easterly direction.

Commercially viable coal seams beneath the site lie within the Four Mile Creek Formation and include the Donaldson Seam (Upper and Lower) and the Big Ben Seam, as shown in Figure 1, the stratigraphic column for the Tomago Coal Measures (Ref 3).

The Donaldson Seam has been mined in the vicinity of Black Hill in both the Upper and Lower splits. The seam has a thickness in the range 1.2 m to 3.7 m (Ref 3). Further information is presented in Section 3.1.

Figure 1: Stratigraphic Column of Tomago Coal Measures

2.3 Mine Subsidence

The site is located within the recently formed Black Hill Mine Subsidence District and therefore any development at this site will require approval through the Subsidence Advisory NSW (SANSW). A copy of the district map is presented in Figure 2 below and can be access via http://www.subsidenceadvisory.nsw.gov.au/sites/default/files/uploads/pp5216_black_hill_district.pdf

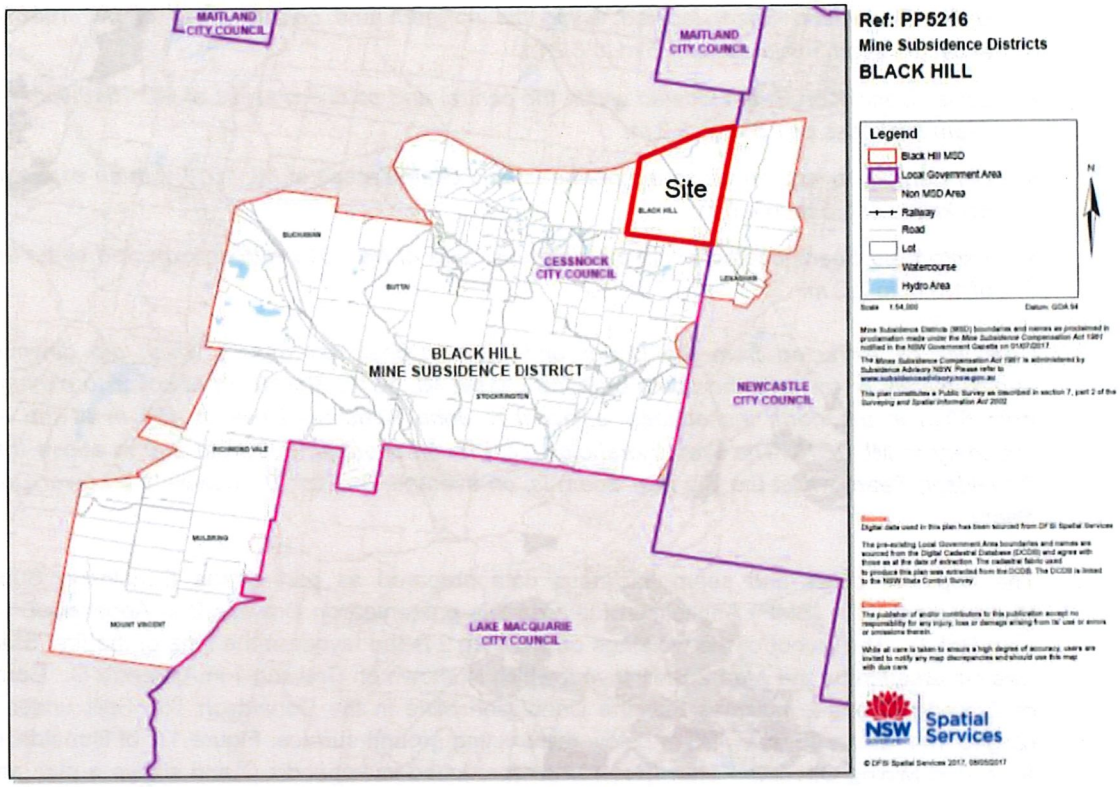


Figure 2: Mine Subsidence District Map for Black Hill

3. Desktop Review

3.1 Mine Workings

As part of the previous mine subsidence assessment undertaken by DP (Ref 1), discussions were made to the SANSW for information on previous coal mining in the vicinity of the site. The SANSW advised that workings within the Donaldson Upper seam have occurred. The mining was carried out by Abel Underground Mine, operated by Donaldson Coal Pty Ltd. The mining method comprised primary bord and pillar mining with subsequent secondary pillar extraction, leading to full collapse and associated surface subsidence. This mining has taken place since 2007 when the Abel Underground Mine was approved (Ref 5). The mining ceased in April 2016 when the mine changed its operations to Care and Maintenance.

Donaldson Coal's Amended Mining Operation Plan (Ref 12) provides a description of the geology and coal seams relevant to Abel Underground Mine, as follows: "The mine is located within the Newcastle Coalfield of the Sydney-Gunnedah Basin. The Newcastle Coalfield contains three coal measures, these being the Tomago, Greta and Newcastle Coal Measures. The mine contains five coal seams from the Newcastle and Tomago Coal Measures, listed in increasing depth as follows.

- *The West Borehole Seam located within the southern and eastern areas of ML 1618 with an expected seam thickness of 3.5 m;*

- *Upper Donaldson Seam located within the northern and central areas of ML 1618 with an expected seam thickness of 1.5 m to 3.2 m;*
- *Lower Donaldson Seam located within the central and southern areas of ML 1618 with expected seam thickness of 1.5 m to 3.3 m;*
- *Big Ben Seam located within the northeast and central areas of ML 1618 with an expected seam thickness of 1.5 m to 4.0 m;*
- *Ashtonfield Seam located within the northeast area of ML 1618 with an expected seam thickness of 1.5 m to 2.2 m.*

Coal will be extracted from the Upper and Lower Donaldson Seams which dip downwards at approximately 5° towards the south of [Mine Lease] ML 1618. The depth of cover to mining ranges from 50 m in the north immediately adjacent to John Renshaw Drive to 450 m at the southern boundary of ML 1618. The West Borehole Seam is, on average, 200 m to 280 m above the Upper Donaldson Seam whilst the Big Ben Seam is, on average, 3 m to 10 m below the Lower Donaldson Seam."

The depth of cover and seam thickness data prepared as part of the Donaldson Subsidence Management Plan (SMP) Application for Area 1 is presented on Drawing 2 in Appendix C (adapted from Ref 4). The layout of the workings on Drawing 2 is the layout at the time of the first SMP which was superseded by the Area 2 SMP layout which is shown on Drawing 1 in Appendix C. Comparison of Drawings 1 and 2 indicates that the Donaldson Mine in the Donaldson Top Split under the site ranges from about 45 m to 135 m below the existing ground surface. Figure 1.2 of Donaldson Coal's Amended Mining Operation Plan (Ref 13) is reproduced in Appendix C and shows a plan and cross sections through Mine Lease ML 1618.

Most of the area under the site was mined under SMP Area 1 and SMP Area 2. These SMP areas are shown on Drawing 1 together with outlines of the mined areas (Panels, Mains and Headings.)

Table 3.8 of Ref 5 (May 2014) indicates that pillar extraction under the site commenced in July 2010 and that pillar extraction had been completed for all the pillar extraction panels underlying the site. At that time extraction remained incomplete for the East Mains, East Install Headings and the East Mains Headings from which pillars were extracted in retreat.

3.2 Future Mining

Future mining in the vicinity of the site relates to continued mining within ML 1618 under the existing development consent and possible future mining within Exploration Licence EL 5497.

Figure 3 shows the location and extent of EL 5497 in the vicinity of the project as shown on MinView. ML 1618 lies within EL 5497 (shaded dark grey). Figure 4 shows more detail (plans downloaded from Resources & Energy website).

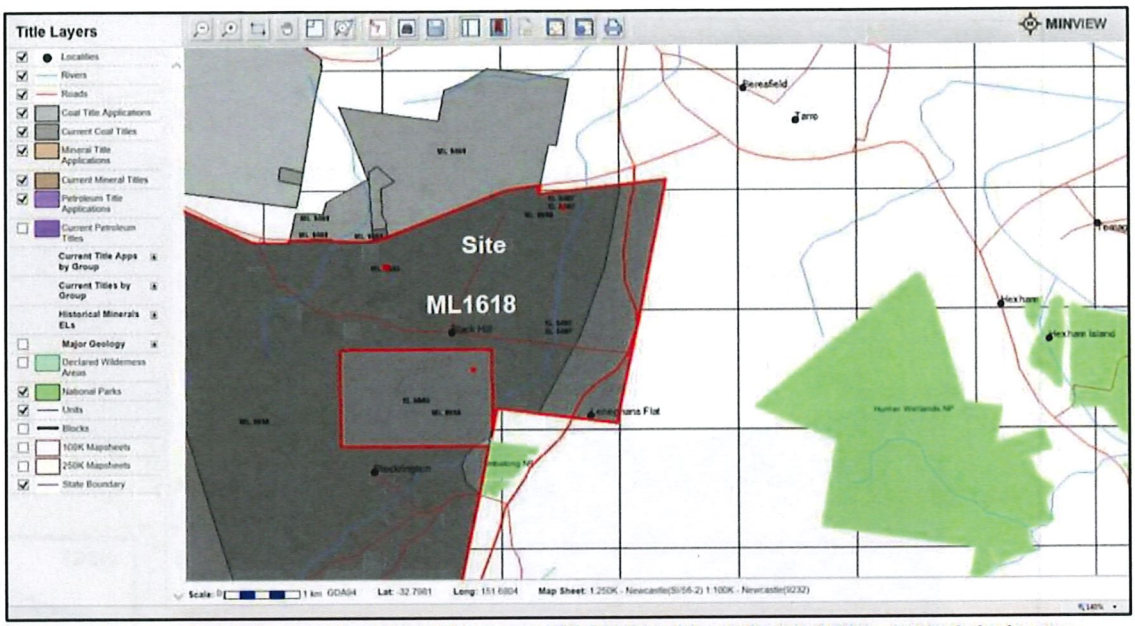


Figure 3: Extent of Coal Exploration Licence 5497 (edged in red); ML1618 shaded dark grey

Figure 3 indicated that the exploration license (EL 5497) lies beneath the entire site.

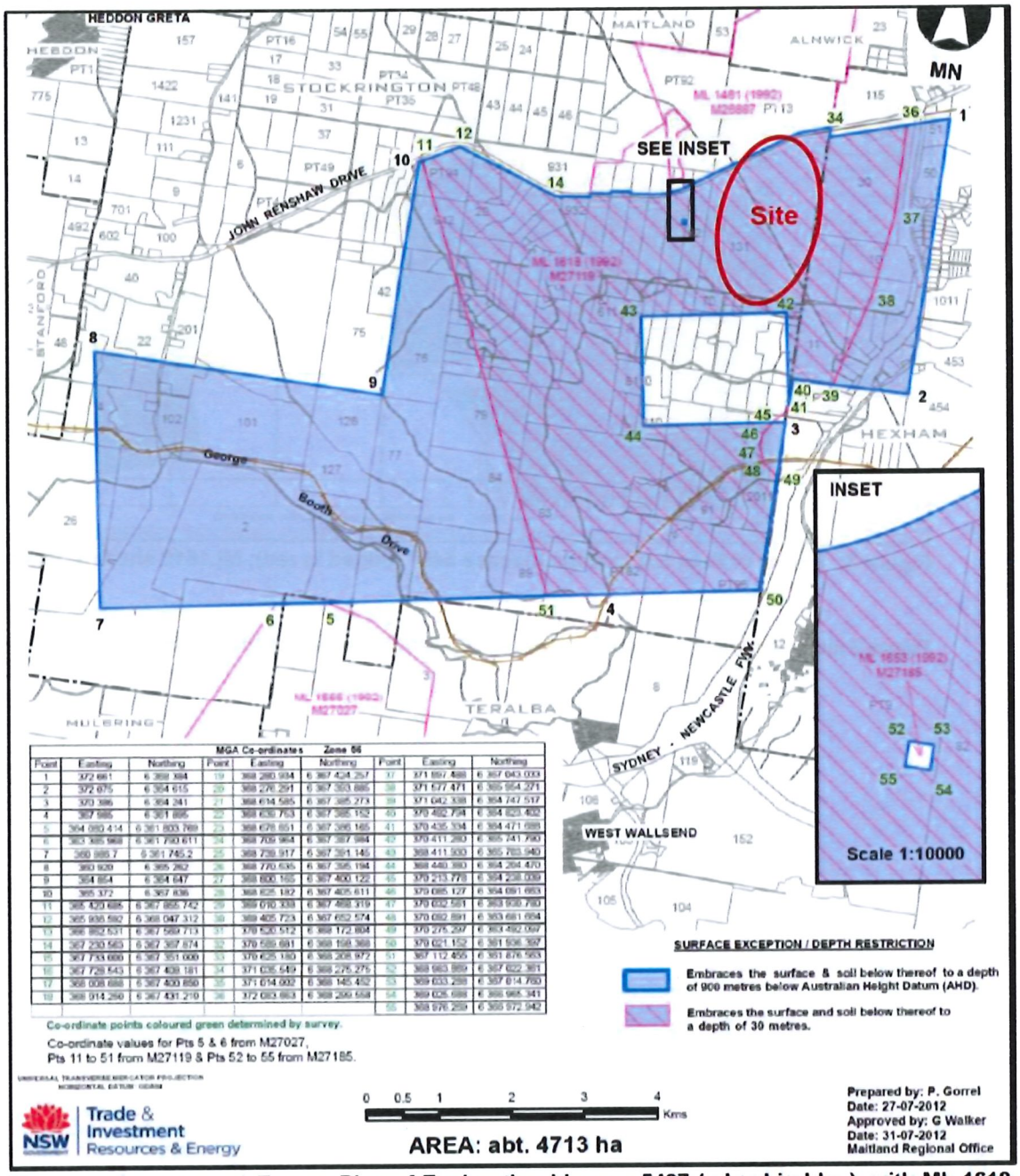


Figure 4: Resources & Energy Plan of Exploration Licence 5497 (edged in blue), with ML 1618 shown hatched in pink.

Documents available on MinView indicate that:

- Donaldson Coal's Amended Mining Operation Plan (Ref 13) indicates that the mine is expected to operate until December 2030.

- An application to NSW Department of Industry to undertake additional exploration investigation within the Exploration Licence EL 5497 was approved for the Donaldson Mine in 3 June 2016. The approval was for additional bores to be drilled to the south of the site;
- The NSW Department of Industry approved the Mining Operation Plan for the Care and Maintenance of the Abel Underground Coal Mine in May 2016.

Previous discussions with Donaldson Coal indicated that the company "reserves the right to mine to Exploration Lease 5497". Prior to mining this area, however, the mining company would need to obtain a mining licence and development consent.

3.3 Donaldson Mine Subsidence Management Plan, End of Year Report 2014

Donaldson Mine Subsidence Management Plan, End of Year Report 2014, (Ref 8), reports the "Final Measured" subsidence parameters for the Tailgate Headings, East Install Headings and East Main Headings which indicates that mining under the site was completed by the end of 2014.

Table 4 of that report presents the predicted subsidence parameters and final measured subsidence parameters. That table is reproduced in Appendix C of this report. Reference to Appendix C indicates that, of the 18 Panels and Headings for which final measured subsidence parameters are quoted, in 13 cases the measured final subsidence is significantly less than the predicted value and is commonly about 20% to 35% less than the predicted parameters.

Comparison of the data given for maximum subsidence in Appendix C, Table 4 (from Ref 8) with the predicted Panel Subsidence given in Refs 3 and 4 indicates that the depth of cover and Seam Thickness (T), and in some case the panel width quoted in Table 4, are different from those given in Refs 6 and 7. The predicted subsidence given in Table 4 is broadly consistent with the predictions of Refs 6 and 8 allowing for the differences in panel geometry.

The reason for the less than predicted subsidence is not discussed in Ref 8.

3.4 Surface Disturbance Post Mining

Douglas Partners were engaged by Catholic Diocese of Maitland – Newcastle to inspect the site following mining and provide comment on any surface disturbance areas impacted by subsidence. The results of the inspection are presented in Ref 1.

In general, the observed subsidence features at the site were minimal and included a damaged irrigation system, leaning fences and possible localised surface depressions / ponding water. It was noted at the time of the assessment that the cause of surface depressions was difficult to determine without comparing pre and post mining LIDAR data.

Based on Ref 6 and Ref 7, cracks of up to 260 mm wide were anticipated during mining for depths of cover < 80 m and up to 150 mm wide for greater depths. Cracking of the ground surface was not observed at the time of the 2015 inspection by DP. It was noted that there may be areas of cracking that were obscured by vegetation or soil cover at the time of the inspection.

It was noted at the time of the previous assessment that some cracking may have been remediated prior to the inspection in accordance with a rehabilitation plan. The rehabilitation plan indicates that the methods used to fill cracks "may include" grouting with "self-cementing material." The statement that "self-cementing material" may be used appears to leave open the use of other options such as earthworks alone.

If self-cementing materials were not used, it was considered possible that the infill material may over time be washed down into the open section of the crack below the depth of infilling. This could allow reopening of the crack, and if not rectified, erosion over time could further widen the re-emerged crack.

It was considered that cracking may occur in the future and if cracking was to occur, the cracks should be appropriately remediated, particularly any cracking that occurs in the clay cap of buried hazardous material.

4. Summary

A review of past and future mining activities was undertaken to assess the risks of subsidence in connection with the proposed industrial subdivision. In summary:

- Existing underground coal mine workings are present in the Upper Donaldson Seam beneath the site. The mining method comprised primary bord and pillar mining with subsequent secondary pillar extraction, leading to full collapse and associated surface subsidence. The final subsidence recorded was commonly about 20% to 35% less than the predicted subsidence. The reason for the lower subsidence is not known. It is possible that some additional movement could occur over time as a result of creep, the magnitude of which is generally commensurate with seasonal ground movement associated with reactive clay soils.
- Exploration Licence 5497, held by Donaldson Coal Pty Ltd, covers the entire site. The mining company advised that it "reserves the right" to mine this area in the future. It is noted, however, that it would need to go through the approvals process to obtain consent. The approvals process is lengthy and would take account of stakeholder interests.
- At the time of this current report, Donaldson Mine is currently operating under a care and maintenance i.e. not producing coal. The mining lease for the site (ML 1618), however, expires on 15 May 2029;
- It is possible (although unlikely) that Donaldson Coal will seek to extend mining. If at some time in the future mining was permitted and undertaken, the mine would be expected to consider the effect of mining of any development in the area of the mining.
- Cracking of the ground surface was anticipated as a result of the secondary pillar extraction. It is possible that cracks may open up over time as material is washed into the cracks. Where cracking is identified, the cracks should be sealed appropriately.

In summary, the mine subsidence risk to the proposed industrial development is relatively low. The development will require approval from SANSW and covered under the Coal Mine Subsidence Compensation Act.

5. References

1. Douglas Partners Pty Ltd, "Report on Geotechnical Assessment, Lot 1131, DP 1057179, Black Hill Road, Black Hill", Project 81771, dated September 2015.
2. Coffey Geotechnics Pty Ltd "Proposed Land Rezoning, Lot 1131 DP 1057179, Black Hill, Preliminary Geotechncial Assessment and Preliminary Mine Subsidence Review", GEOTWARA2984AA-AB dated 3 September 2013.
3. Packham GH (1969), "The Geology of New South Wales", Geological Society of Australia Incorporated Sydney, 1969.
4. "Abel Mine SMP Application - Area 1; Plan 3A - Depth of Cover and Seam Thickness" Drawing No a6a1003.dwg, dated 30 November 2009.
5. R. W. & Corkery Co. Pty. Limited, "Annual Environmental Management Report; Abel Underground Coal Mine, 1 June 2013 to 31 May 2014", dated September 2014, prepared for Donaldson Coal Pty Ltd.
6. Ditton Geotechnical Services, "Subsidence Predictions and Impact Assessment for the Proposed Pillar Extraction Panels at Abel Mine, Black Hill", DGS Report No. ABL-001/1; dated 6 December 2009.
7. Ditton Geotechnical Services, "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, dated 1 June 2011.
8. Donaldson Coal, "Abel Mine, Subsidence Management Plan, End of Year Report 2014".
9. GSS Environmental "Draft – Abel Underground Coal Mine, Rehabilitation Management Plan", Revision 1, dated August 2014 (Ref No. DON3-07-01 Abel LMP).
10. Donaldson Coal, "Abel Mine, Subsidence Management Plan, End of Year Report 2011", dated March 2012.
11. Donaldson Coal (2011), "Abel Upgrade Modification, Project Description and Preliminary Environmental Assessment", December 2011.
12. Donaldson Coal (2012), "Abel Upgrade Modification, Proposed Modification of Workings in ML 1618", 12 August 2012.
13. Donaldson Coal (2014), "Amended Mining Operations Plan for the Abel Underground Coal Mine", 8 October 2014.

6. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Black Hill Road, Black Hill with reference to DP's proposal NCL170270 dated 11 August 2017 and acceptance on 16 August 2017. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of F & F Properties Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are based on a review of existing data as summarised in the report. Conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after the preparation of this report.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawing – Layout of Workings on Aerial Image
Drawing 2: Depth of Cover

Locality Plan

NOTE: Base drawing from Google Earth Image

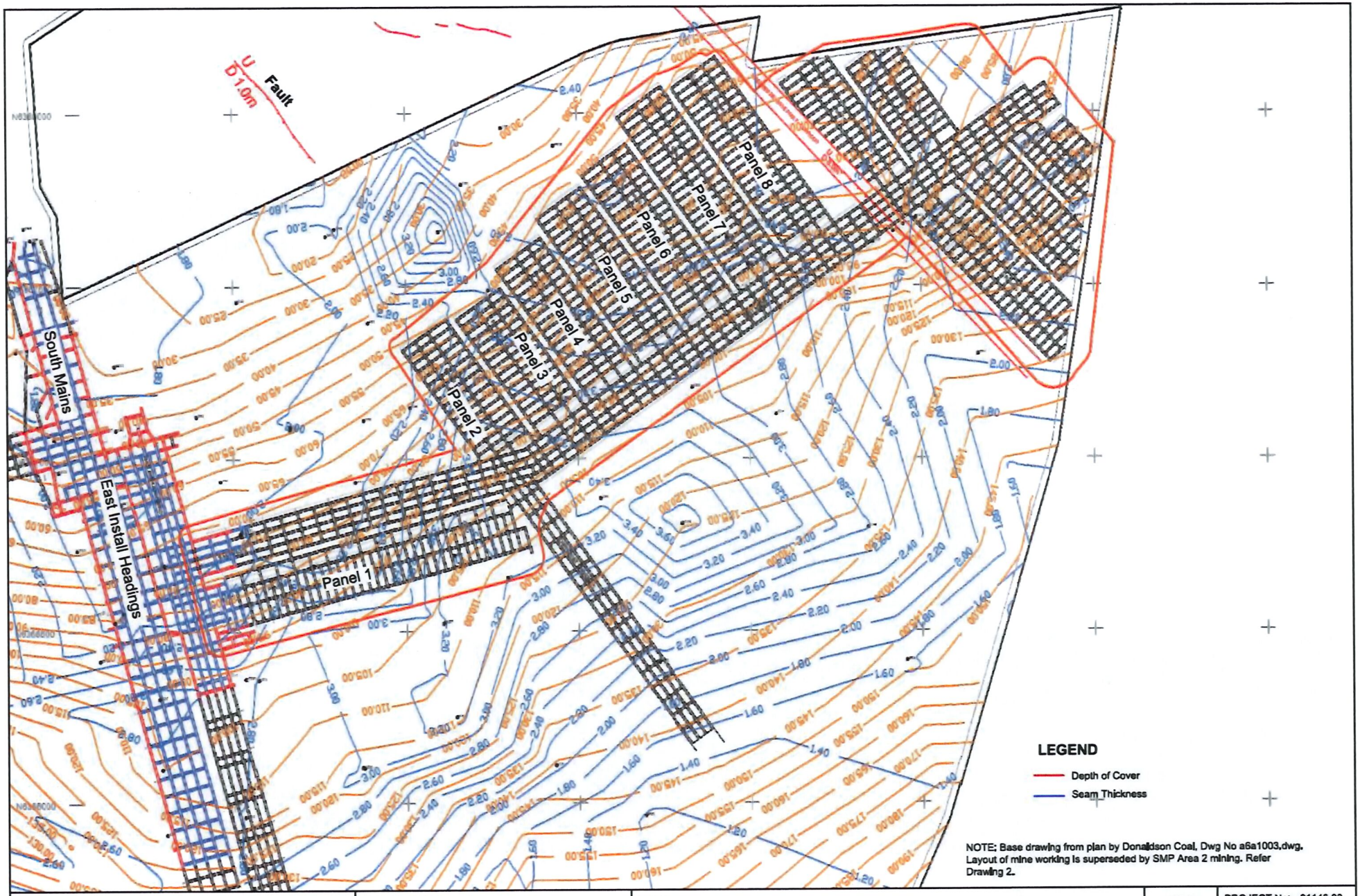
LEGEND

- Underground Mine Workings
- SMP Area 1 Boundary
- SMP Area 2 Boundary
- Property Boundary

0 100 200 300 400 500 750 1000 1500m

1:15,000 @ A3

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: F & F Properties	TITLE: **Layout of Workings on Aerial Image** **Mine Subsidence Assessment** **Lot 1131, DP1057179, Black Hill Road, Black Hill**	PROJECT No: 91148.00
	OFFICE: Newcastle / DRAWN BY: PLH		DRAWING No: 1
	SCALE: 1:15,000 / DATE: 06.09.2017		REVISION: 0



Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: F & F Properties	
OFFICE: Newcastle	DRAWN BY: PLH
SCALE: 1:10,00	DATE: 06.09.2017

TITLE:
Depth of Cover
Mine Subsidence Assessment
Lot 1131, DP1057179, Black Hill [illegible], Black Hill

PROJECT No:	91148.00
DRAWING No:	2
REVISION:	0

Appendix C

Table 4: Predicted subsidence parameters and final observed subsidence parameters reproduced from the "Abel Mine Subsidence Management Plan End of year Report 2014" (Ref 8)
Figure 1.2 - Mine Geology by R. W. CORKERY & CO. PTY. LIMITED

Survey / Monitoring Line	Survey / Monitoring Description	Pre – Mining Survey	Survey / Inspection / Monitoring Dates	Post – Mining
TransGrid Transmission Towers	*Subsidence survey*	28/03/2012	*As detailed in Management Plan*	Same date as Panel surveys
	Visual inspection		Daily Surveys	
	Photographic monitoring	28/03/2012		

Table 4 – Comparison of Subsidence Monitoring Results to SMP Predictions

PANEL 1 (W = 120 m; T = 2.35 - 3.0m)			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	0.95 - 1.25m	0.72 - 1.228m	Measured subsidence < predictions
Tensile Strain	10 - 18 mm/m	4 - 12 mm/m (18 mm/m)	Measured tensile strains < predictions.
Compressive Strain	13 - 23 mm/m	5 - 14 mm/m	Measured compressive strains < predictions
Tilt	22 - 40 mm/m	22 - 46 mm/m	Measured tilts < predictions. One exceedance of 15%.
Other		Cracked Joint to Hunter Water Pipeline Repaired 11kv Power Line	All necessary repairs have been carried out.

PANEL 2 (W= 150m ; T = 2.5 m)			
< 75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.30 - 1.38m	0.977 - 1.041 m	Measured subsidence < predictions
Tensile Strain	18 - 31 mm/m	4 - 6 mm/m (5 mm/m)	Measured tensile strains < predictions
Compressive Strain	23 - 40 mm/m	4 - 7 mm/m	Measured compressive strains < predictions
Tilt	40 - 67 mm/m	22 - 32 mm/m	Measured tilts < predictions
Other			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.20 - 1.32m	0.94 - 0.966m	Measured subsidence < predictions
Tensile Strain	13 - 20 mm/m	9 mm/m (15 mm/m)	Measured tensile strains < predictions
Compressive Strain	17 - 25 mm/m	6 mm/m	Measured compressive strains < predictions
Tilt	30 - 45 mm/m	27 mm/m	Measured tilts < predictions
Other			

PANEL 3 (W=160.5 m; T = 2.5 m)			
< 75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.33 - 1.34 m	1.003 m	Measured subsidence < predictions
Tensile Strain	19 - 31 mm/m	8 - 9 mm/m (26 mm/m)	Measured tensile strains < predictions
Compressive Strain	24 - 40 mm/m	5 - 7 mm/m	Measured compressive strains < predictions
Tilt	42 - 67 mm/m	28 - 39 mm/m	Measured tilts < predictions
Other			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.26 - 1.27 m	0.884 - 0.982 m	Measured subsidence < predictions
Tensile Strain	14 - 21mm/m	8 mm/m (10 mm/m)	Measured tensile strains < predictions
Compressive Strain	18 - 27 mm/m	4 mm/m	Measured compressive strains < predictions
Tilt	33 - 49 mm/m	30 mm/m	Measured tilts < predictions
Other			

PANEL 4 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.27-1.29m	1.065m	Measured subsidence < predictions
Tensile Strain	19 - 31 mm/m	6 - 10 mm/m (37.5 mm/m)	Measured tensile strains < predictions with 1 exceedance of 20% at clay cap.
Compressive Strain	24 - 40 mm/m	6 - 18 mm/m	Measured compressive strains < predictions
Tilt	42 - 67 mm/m	36 - 60 mm/m	Measured tilts < predictions
Other			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.29 - 1.32m	1.054 m	Measured subsidence < predictions
Tensile Strain	14 - 21mm/m	5 mm/m	Measured tensile strains < predictions
Compressive Strain	18 - 27 mm/m	5 mm/m	Measured compressive strains < predictions
Tilt	42 - 67 mm/m	25 - 36 mm/m	Measured tilts < predictions
Other			

PANEL 5 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.27-1.43	1.154m	Measured subsidence < predictions
Tensile Strain	14 - 15 mm/m	10 mm/m	Measured tensile strains < predictions
Compressive Strain	15 - 19 mm/m	4 mm/m	Measured compressive strains < predictions
Tilt	41 - 46 mm/m	68 mm/m	Measured tilts < predictions with 1 minor exceedance
Other			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.42 - 1.43m	1.002 m	Measured subsidence < predictions
Tensile Strain	11 - 15 mm/m	2 mm/m	Measured tensile strains < predictions
Compressive Strain	15 - 18 mm/m	13 mm/m	Measured compressive strains < predictions
Tilt	38 - 46 mm/m	29.8 mm/m	Measured tilts < predictions
Other			

PANEL 6 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.21 - 1.32m	1.215m	Measured subsidence < predictions
Tensile Strain	14 mm/m	8 mm/m	Measured tensile strains < predictions
Compressive Strain	17 - 18 mm/m	21 mm/m	Measured compressive strains < predictions with 1 minor exceedance
Tilt	39 - 41 mm/m	89.6 mm/m	Measured tilts < predictions with 1 minor exceedance
Other			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.32 - 1.42m	1.066 m	Measured subsidence < predictions
Tensile Strain	11 - 14mm/m	9 mm/m	Measured tensile strains < predictions
Compressive Strain	14 - 17 mm/m	7 mm/m	Measured compressive strains < predictions
Tilt	38 - 41 mm/m	30 mm/m	Measured tilts < predictions
Other			

PANEL 7 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.27 - 1.32m	0.771m	Measured subsidence < predictions
Tensile Strain	11 - 14 mm/m	5 mm/m	Measured tensile strains < predictions
Compressive Strain	14 - 18 mm/m	2 mm/m	Measured compressive strains < predictions
Tilt	41 mm/m	12 mm/m	Measured tilts < predictions
Other			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.32 - 1.43m	1.336 m	Measured subsidence < predictions
Tensile Strain	11 - 15mm/m	23 mm/m	Measured tensile strains < predictions with 1 minor exceedance
Compressive Strain	14 - 18 mm/m	36 mm/m	Measured compressive strains < predictions with 1 minor exceedance
Tilt	41 mm/m	42.5 mm/m	Measured tilts < predictions with 1 minor exceedance
Other			

PANEL 8 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	< 1.32m	0.830m	Measured subsidence < predictions
Tensile Strain	14 - 15 mm/m	2 mm/m	Measured tensile strains < predictions
Compressive Strain	17 - 19 mm/m	3 mm/m	Measured compressive strains < predictions
Tilt	42 mm/m	11.4 mm/m	Measured tilts < predictions
Other			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.25 - 1.32m	0.845 m	Measured subsidence < predictions
Tensile Strain	10 - 14mm/m	11 mm/m	Measured tensile strains < predictions with 1 minor exceedance
Compressive Strain	13 - 17 mm/m	6 mm/m	Measured compressive strains < predictions with 1 minor exceedance
Tilt	41 mm/m	33.8 mm/m	Measured tilts < predictions
Other			

PANEL 15 (W= 160.5 m; T = 2.5 m)			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.17 - 1.23m	1.164m	Measured subsidence < predictions
Tensile Strain	7 - 12mm/m	15 mm/m	Measured tensile strains < predictions
Compressive Strain	9 - 15 mm/m	13 mm/m	Measured compressive strains < predictions
Tilt	19 - 32 mm/m	49 mm/m	Measured tilts < predictions with 2 minor exceedance
Other			

PANEL 20 (W= 128 m; T = 2.7 m)			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	150 mm	62 mm	Measured subsidence < predictions
Tensile Strain	2 mm/m	1 mm/m	Measured tensile strains < predictions
Compressive Strain	2 mm/m	2 mm/m	Measured compressive strains < predictions
Tilt	3 mm/m	2.5 mm/m	Measured tilts < predictions
Other			

PANEL 21 (W= 212 m; T = 2.7 m)			
125m Cover	Predicted	Final Measured	Comment
Subsidence	150 mm	96 mm	Measured subsidence < predictions
Tensile Strain	2 mm/m	1 mm/m	Measured tensile strains < predictions
Compressive Strain	2 mm/m	1 mm/m	Measured compressive strains < predictions
Tilt	3 mm/m	2.1 mm/m	Measured tilts < predictions
Other			

TAILGATE HEADINGS (W= 80.5 m; T = 2.8 m)			
<110mCover	Predicted	Final Measured	Comment
Subsidence	0.88 – 0.99m	0.250m	Measured subsidence < predictions
Tensile Strain	8 - 9mm/m	2 mm/m	Measured tensile strains < predictions
Compressive Strain	8 - 9 mm/m	2 mm/m	Measured compressive strains < predictions
Tilt	18 - 33 mm/m	7 mm/m	Measured tilts < predictions
Other			

EAST INSTALL HEADINGS (W= 105m; T = 2.7 m)			
100m Cover	Predicted	Final Measured	Comment
Subsidence	0.9m	1.286m	Measured subsidence > predictions
Tensile Strain	13 – 19 mm/m	12 mm/m	Measured tensile strains < predictions
Compressive Strain	16 - 24 mm/m	9 mm/m	Measured compressive strains < predictions
Tilt	24 - 35 mm/m	44 mm/m	Measured tilts > predictions
Other			

EAST MAINS HEADINGS (W= 125m; T = 2.7 m)			
100m Cover	Predicted	Final Measured	Comment
Subsidence	1.59m	1.408m	Measured subsidence < predictions
Tensile Strain	10 - 16 mm/m	11 mm/m	Measured tensile strains < predictions
Compressive Strain	13 - 20 mm/m	15 mm/m	Measured compressive strains < predictions
Tilt	49 mm/m	48.6 mm/m	Measured tilts < predictions
Other			

Panel 19A (W= 227.9m; T = 2.6 m)			
100m Cover	Predicted	Final Measured	Comment
Subsidence	1.42m	1.261m	Measured subsidence < predictions
Tensile Strain	8 - 14 mm/m	3 - 12 mm/m	Measured tensile strains < predictions
Compressive Strain	11 - 18 mm/m	4 - 13 mm/m	Measured compressive strains < predictions
Tilt	40 mm/m	29 - 48 mm/m	Measured tilts < predictions with only a minor exceedance
Other			

PANEL 22 (W= 180.3 m; T = 2.8 m)			
125m Cover	Predicted	Final Measured	Comment
Subsidence	150 mm	44 mm	Measured subsidence < predictions
Tensile Strain	2 mm/m	1 mm/m	Measured tensile strains < predictions
Compressive Strain	2 mm/m	1 mm/m	Measured compressive strains < predictions
Other			

PANEL 23 (W= 215 m; T = 2.5 m)			
<130m Cover	Predicted	Final Measured	Comment
Subsidence	1.30m	0.983m	Measured subsidence < predictions
Tensile Strain	30 mm/m	13 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	13 mm/m	Measured compressive strains < predictions
Other			

PANEL 24 (W= 220 m; T = 2.5 m)			
<130m Cover	Predicted	Final Measured	Comment
Subsidence	1.30m	1.061m	Measured subsidence < predictions
Tensile Strain	30 mm/m	7 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	9 mm/m	Measured compressive strains < predictions
Other			

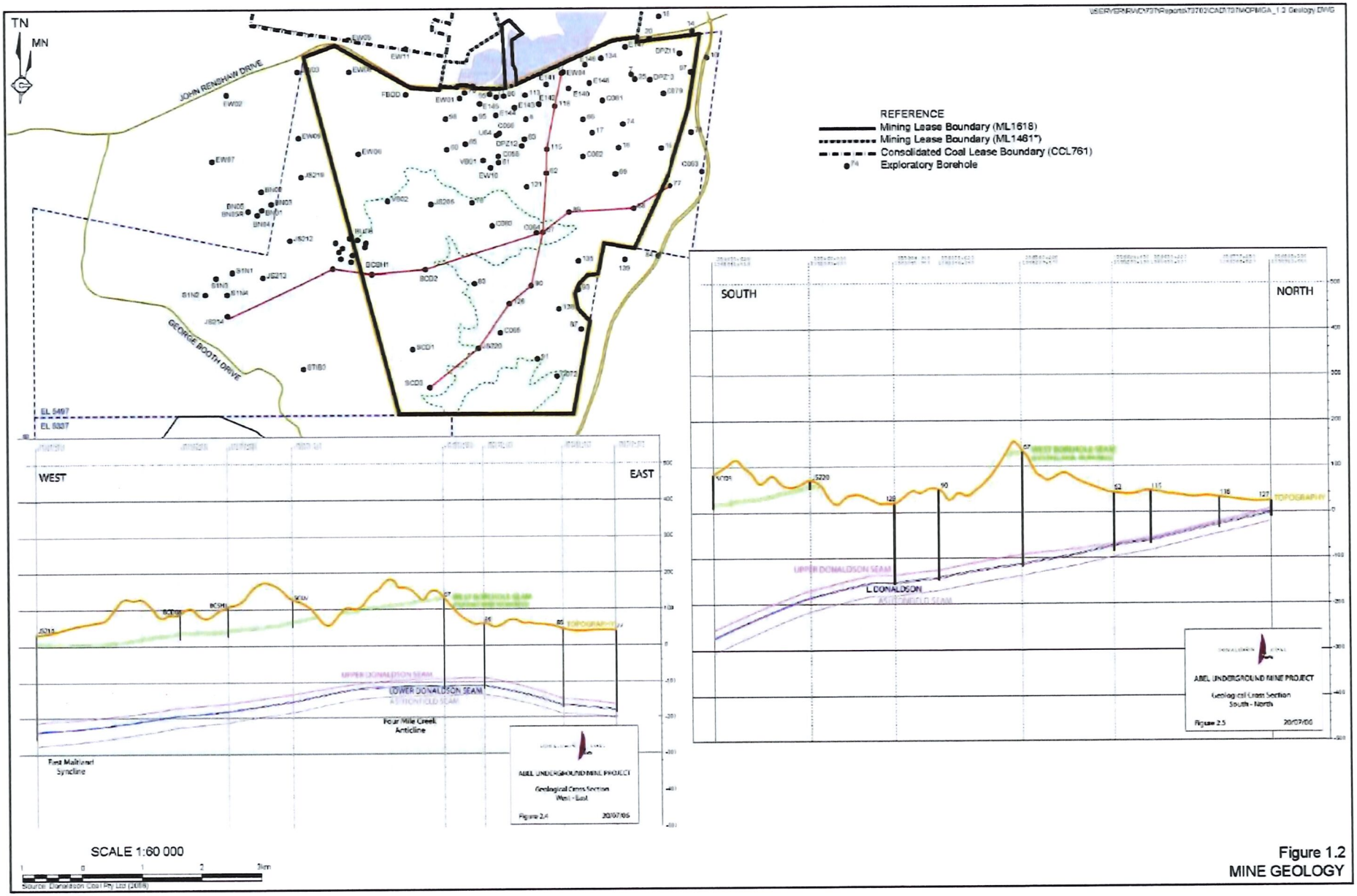


Figure 1.2
MINE GEOLOGY