



ABEL MINE

Subsidence Management Plan

TransGrid Towers Management Plan

SMP AREA 2

December 2012

Document Control

Description

Document No.	Abel SMP Area 2
Title	TransGrid Towers Management Plan SMP Area 2
General Description	To ensure the safety and serviceability of the TransGrid 330kV overhead powerline & tower numbers 29B & 28B that may be affected by the mining of Panels 19 & 19A 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
APPROVED	Tony Sutherland	Position Technical Services Manager – Donaldson Underground Operations	Signed	Date
APPROVED	Bruce Fraser	Position Mains Manager – Northern Region	Signed	Date

Revisions

Version #	Date	Description	By	Checked	Approved	
					Name	Signed
2	14.12.12	Tower movement direction updated				
3	18.12.12	Tower movement direction updated				

The nominated Coordinator for this document is	Technical Services Manager
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1 INTRODUCTION

1.1 Background

The TransGrid, West Wallsend to Tomago, 330kV Transmission line, was installed in the early 1980's across the Ironbark Subsidence District area.

There are two towers (29B to 28B) within the current Subsidence Management Plan (SMP) Area 2 at the Abel Mine. The towers suspend a total of 6 electricity transmission conductors, which form a double, 330 kV circuit to the aluminium smelter at Tomago. The towers were constructed in 1982/1983 with reinforced concrete cruciform footings, in anticipation of mine subsidence impacts from multi seam mining proposed at the time by R W Miller.

Subsidence predictions have been developed for the towers by Ditton Geotechnical Services (DGS).

A risk assessment was conducted by Donaldson and facilitated by HMS Consultants in January 2011 to determine the risks and impacts of pillar extraction on the surface infrastructure.

The effects of maximum reasonable subsidence were assessed and the outcomes incorporated in the mitigation strategy.

This Management Plan utilises the risk assessment and the work of the subsidence consultants and outlines the consultation, investigations, monitoring, and actions to be performed prior, during and following the extraction of the pillar panels.

1.2 Scope

The management plan relates to those activities involved with managing the possible impacts of subsidence on the 330kv TransGrid transmission line during and after the mining period until final subsidence has been realised. This plan is limited to the management of the effects of possible subsidence on transmission towers 29B & 28B that lie within the Abel SMP Area 2, caused by pillar extraction of Panels 19 & 19A.

<u>SMP Reference</u>	<u>TransGrid Number</u>
29B	82TL29D / 95TL29D
28B	82TL28D / 95TL28D

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1.3 Objective

The objective of the management plan is to ensure the safety and serviceability of the transmission towers that may be affected by the mining of the pillar extraction panels in the SMP Area 2 and gather information to aid future planning in regard to further mining beneath transmission towers.

1.4 Stakeholder Consultation

Donaldson has developed this plan in consultation with TransGrid and the Department of Trade and Investment, Regional Infrastructure and Services.

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: <ul style="list-style-type: none">• Background information• Identified risks• Subsidence Monitoring and Control Plan• Public Safety Management Plan• Individual Property, feature and infrastructure TARP's
TransGrid Towers Management Plan – SMP Area 2

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Photos 1 & 2 – Typical “cruciform footing” at base of towers

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2 SUBSIDENCE MANAGEMENT

2.1 Site Characteristics

The towers are galvanised, bolted steel frame structures approximately 45m high. The base of the towers are 9m by 9m square with four legs encased in a 1 m wide x 2 m deep 'cruciform' shaped footing and are partially buried (see **Photos 1 and 2** for existing tower conditions).

The mine scheduling indicates that towers 29B and 28B will be subsided by Panels 19 and 19A. (refer **Appendix A**).

2.2 Predicted Subsidence Impacts

Detailed descriptions and predictions of the worst-case transient and final subsidence related movements at TransGrid Tower 29B are provided in the report 'Subsidence Contour Predictions and Impact Assessment for the Proposed Total Pillar Extraction Panels 19 and 19A in SMP Area 2 (refer **Appendix B**).

2.2.1 Towers above the Proposed pillar panels

The two towers within the proposed limits of the pillar extraction panels are likely to be subjected to a maximum subsidence of 1.53m at the tower centres. Transient tilts above the pillar extraction panels are estimated to range from 17 to 40 mm/m for the possible range of retreat rates. Transient tensile and compressive strains are expected to range from 7 to 18 mm/m.

Final tower tilts will range between 2mm/m and 27mm/m. Horizontal displacements are estimated to range between 20mm and 270mm.

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A summary of the subsidence prediction results for each tower are presented in **Tables 1 & 2**.

Table 1 - Transient* Subsidence Impact Parameter Development at the Transgrid Towers

Tower #	Final Tower Subsidence S_{max} (m)	Maximum Tilt T_{max} (mm/m)		Maximum Horizontal Displacement HD_{max} (mm)		Initial Tower Movement Direction (grid bearing(°))	Maximum Tensile Strain^ $+E_{max}$ (mm/m)		Maximum Compressive Strain^ $-E_{max}$ (mm/m)	
Face Retreat Rate:		30 m/wk	<10 m/wk	30 m/wk	<10 m/wk		30 m/wk	<10 m/wk	30 m/wk	<10 m/wk
29B	1.53	11	28	110	280	054	3	5	3	5
28B	0.001	0	0	20	026	026	0	0	0	0

* - Refers to subsidence movements directly associated with the retreating extraction face.

^ - Maximum strains refer to major principal strains. Minor principle strains = 0.25 x major principle strains.

Table 2 - Final* Subsidence Impact Parameter Development at the Transgrid Towers

Tower #	Final Tower Subsidence S_{max} (m)	Tilt T_{max} (mm/m)	Horizontal Displacement HD_{max} (mm)	Final Tower Movement Direction grid bearing (°)	Total Tower Rotation# (°)	Major Principle Strain E_{max} (mm/m)	Minor^ Principle Strain e_{max} (mm/m)
29B	1.53	1	10	144	90	-1	-0.5
28B	0.001	0	40	341	-45	1.2	0.3

* - Refers to subsidence movements after mining of panel has stopped.

- Clockwise rotation is positive.

^ - minor principle strains = 0.25 x major principle strains.

Italics - Far-field displacements and strains are Upper 95%CL values.

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3 RISKS

Risks to the towers and transmission lines from mine subsidence include, but may not be limited to:

- a) Increased or decreased tensions in the various spans which could cause tower or conductor failure due to tilting and horizontal movement of the towers.
- b) Buckling of the tower or induced stresses in tower members lessening the tower's ability to carry the normal transmission line loads due to differential movements of tower legs. (Only towers without cruciform).
- c) Reduction of clearance between line conductors and tower which could place line at risk of tripping under extreme conditions due to tilting.

4 CONTROLS

4.1 Subsidence Monitoring Program

Monitoring of the towers will be undertaken using both conventional surveys and continuous monitoring. Monitoring will be conducted as per the Abel Surface Subsidence Monitoring programme that will be approved by the Principal Subsidence Engineer at the Department of Trade and Investment Regional Infrastructure and Services (DTIRIS) NSW. As a minimum surveys will be conducted at least once a week to determine tilt and strain along with daily visual inspections while in the active area.

4.2 Conventional Surveys

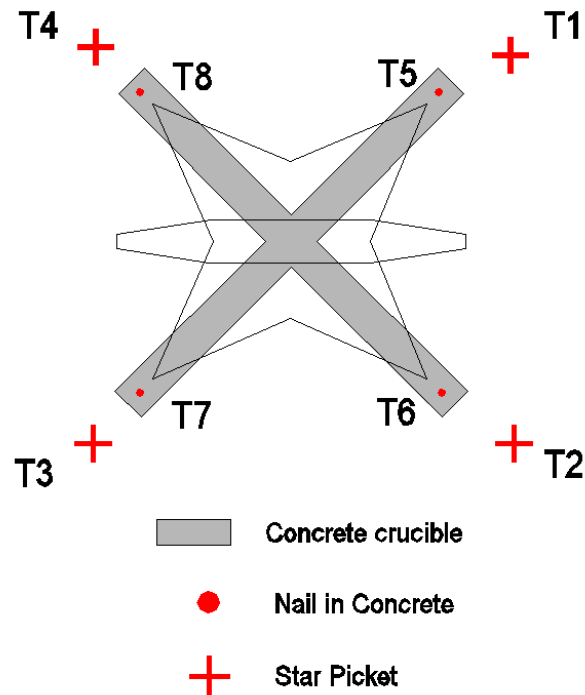
Stable marks will be established on each leg of each of the towers and on the ground adjacent to each leg. Survey will be by precision level and measurements by steel band to provide information for tilt and strain calculations. Horizontal movement and "earthwire peak" will be monitored using Total Station by traversing in from a stable baseline outside of the predicted area of influence.

See **Figure 1** for proposed monitoring point locations.

The face position will also be recorded at the time of each survey.

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Figure 1
Proposed Monitoring Point Locations



4.3 Continuous Monitoring

- A Biaxial Monopod Tilt meter and data-recorder will be attached to each tower prior to the area being influenced by mining induced subsidence.
- Data will be received back to the mine site via GSM phone link.
- Data will be processed using “Argus” Web-Based Monitoring and access made available to all stakeholders.

In the event that a tilt meter is not operational, additional conventional surveys will be considered until the tilt meter is operational.

4.4 Subsidence Inspections

Subsidence inspections will be carried out daily by mine staff while the Towers are located in the active mining zone. The inspections will be carried out to assess impact on the surface. Observed impacts on the surface may indicate an impact on the transmission towers. The “Subsidence Inspection Checklist” will be used for this task. (**Appendix C**).

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4.4.1 Scope of Inspections

Donaldson

The inspections will cover the “Active Mining Zone”, 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
- Damage to towers, crossarms and conductors
- Reduced ground clearances of conductors
- Tilting of towers, increased/decreased tension in conductors
- Bent tower members

TransGrid

During the active influence of mining on Transmission Towers, TransGrid will arrange routine 2nd daily (or at an increased frequency when necessary) inspections of the affected Towers by a TransGrid Patrolman.

4.4.2 Powerline Safety Issues Identified During Inspections

If any powerline safety issue is identified during inspections the Donaldson Coal shall:

- Immediately notify TransGrid of the findings.
- Immediately notify the Abel Technical Services Manager of the findings.

4.4.3 Remediation of Powerline Safety Issues

If any public safety issue is identified during inspections or other public safety issue is identified during assessment of monitoring or inspection results Donaldson Coal shall:

- Immediately contact TransGrid and advise the identified impact
- Arrange for TransGrid to effect immediate repairs if necessary
- Liaise with Mine Management and Mine Subsidence Board to arrange long term repairs.

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4.5 Monitoring Results

If any routine monitoring results are higher than the prediction for subsidence at that location, Donaldson Coal will notify TransGrid.

If requested by TransGrid, Donaldson Coal will have the subsidence impact on the Tower likely to be affected by the change reassessed and the results of these studies, provided to TransGrid.

TransGrid will use any reforecast to determine if any ameliorative action is required or whether to increase inspections on the Tower.

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

4.6 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 $\pm 1\text{mm}$ 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 TransGrid 330kV Transmission Towers the following protocols are to be implemented as detailed in **Appendix E**.

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6 RESPONSIBILITIES

It is the responsibility of Abel Mine to comply with the Project Approval conditions, mining lease conditions, SMP and Clause 88 Approval Conditions, other licences and approvals and the general legislation that applies to its operations. There are a number of government departments that are responsible for assessing and monitoring the compliance of the Mine with these requirements. **Appendix 1** details the responsibilities of the Mine with respect to the development of a PSMP for a landowner.

6.1 Abel Technical Services Manager

- 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 TransGrid and the Mine Subsidence Board of the issue.
- Arrange for TransGrid and the Mine Subsidence Board to inspect and to effect immediate repairs if necessary.
- Liaise with TransGrid and the Mine Subsidence Board to arrange long term repairs.

6.2 Registered Mining Surveyor

- Ensure the TARPS are followed.
- Review and assess subsidence results and inspection checklists.
- Ensure the Weekly Status Report is completed and forwarded to all stakeholders.
- 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 surface cracking or plug failure.
- Ensure that all data, records and reports arising from the provisions of this plan are maintained and archived.
- Liaise with Stakeholders or land owners as necessary.
- Coordinate the surface inspection monitoring program.
- Ensure that surface inspections are carried out in accordance with this plan.
- Manage any surface repairs due to subsidence.
- Bring to the attention of the Technical Services Manager any identified safety issue or impacts that require notification to DTIRIS.

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6.3 TransGrid

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

6.4 Surface Inspection Personnel

- Conduct the subsidence inspection within the required subsidence zone to the standard required in the subsidence inspection checklist form.
- Take actions to remediate any public safety issue identified during inspections.
- Where inspections identify a hazard to the public or infrastructure notify the Registered Mining Surveyor.

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

All survey results will be emailed as an Excel Spreadsheet to TransGrid. If any unexpected movements outside the predicted range occur on the towers, TransGrid will be informed immediately by phone.

A Weekly Status Report will be forwarded to TransGrid.

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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

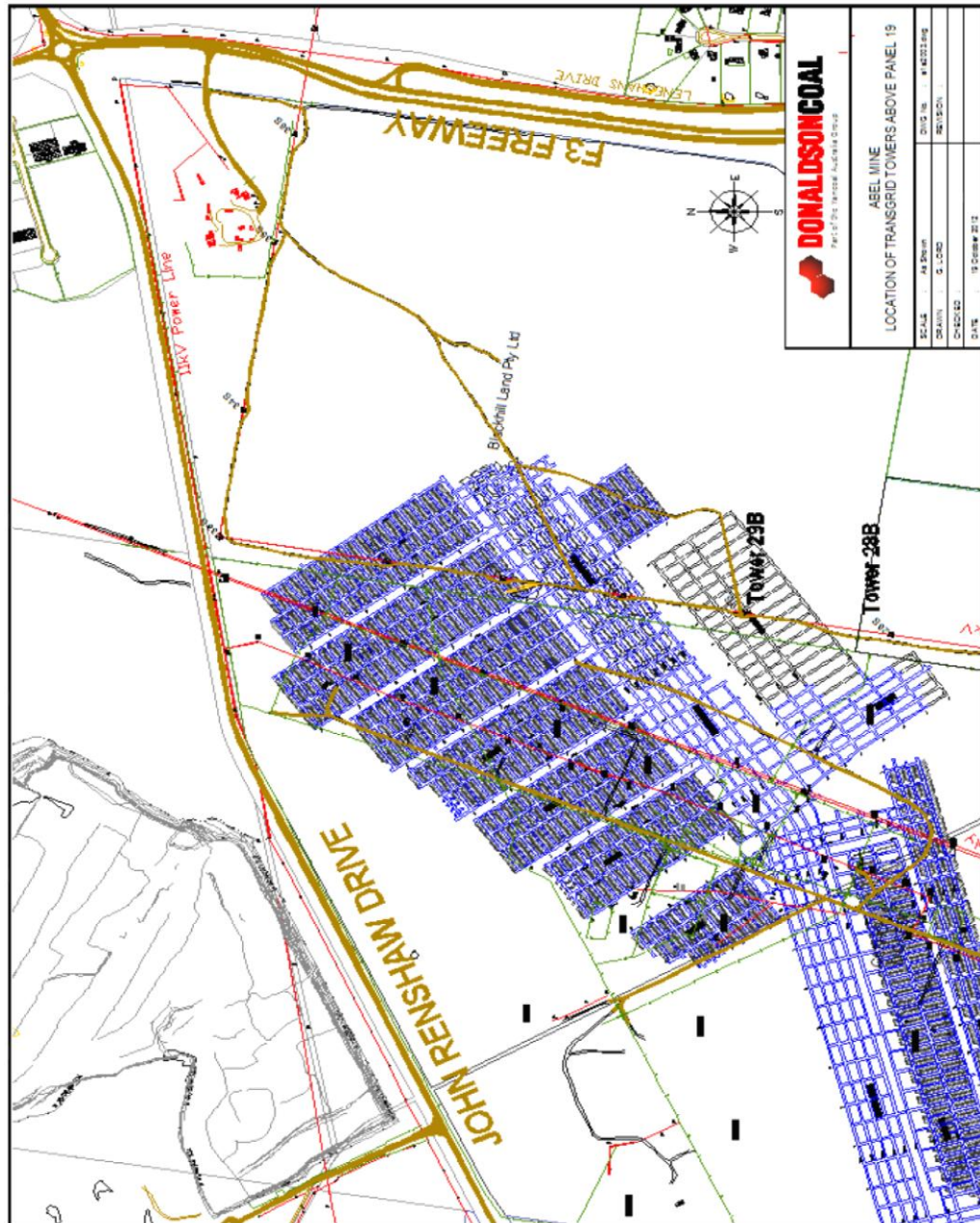
If any Stakeholder deems it necessary to consult with other Stakeholders, a meeting shall be convened to review these concerns and determine appropriate action.

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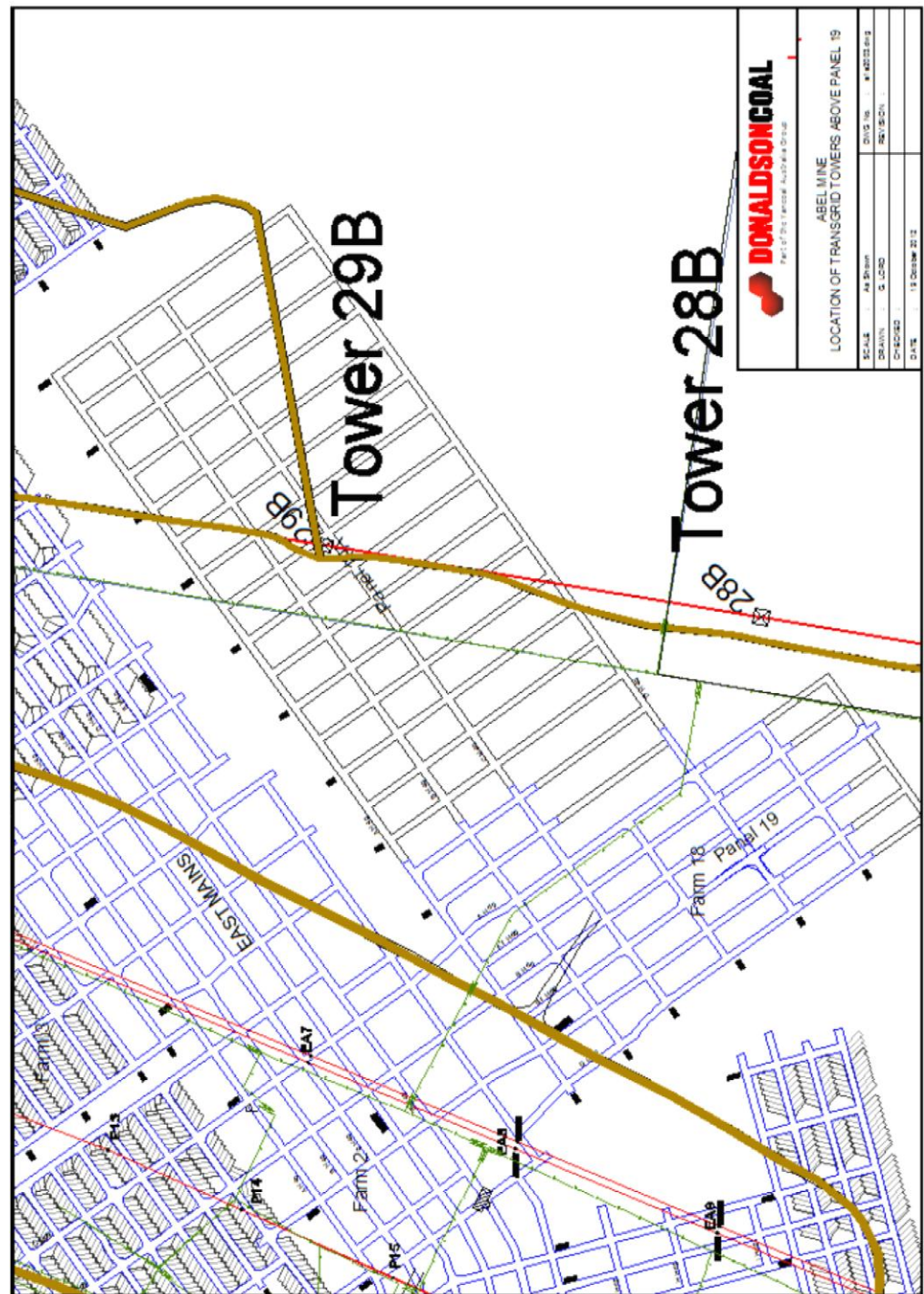
APPENDIX A

LOCATION PLAN

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APPENDIX B

REPORT ON SUBSIDENCE IMPACT PREDICTIONS

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APPENDIX C

INSPECTION CHECKLIST

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APPENDIX C - INSPECTION CHECKLIST

SUBSIDENCE INSPECTION CHECKLIST – POWERLINE		
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		
Damage to towers, crossarms and conductors. Eg leaning towers, bending of tower members, increased sag in conductors, reduced ground clearance		
Other		

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APPENDIX D

CONTACT LIST

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Appendix D

KEY CONTACTS

Organisation	Contact Person	Phone Number
Donaldson Coal	Tony Sutherland – Technical Services Manager	02 4015 1105 0407 239 820
Donaldson Coal	Matthew Wright – Registered Mining Surveyor	0488 206 172
TransGrid	Bruce Fraser – Mains Manager – Northern Region	02 4967 8670 or 0417 481 480
TransGrid Emergency Hotline		1800 027 253
Mine Subsidence Board	Paul Gray - Area Supervisor	(02) 4908 4356

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APPENDIX E

TARPS

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Appendix E

Table 2: Trigger Action Response Plan – Transgrid Towers

Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Subsidence Monitoring – Subsidence	Trigger	Subsidence results within predicted range Tower 29B – 1.53 m Tower 28B – 0.001m	Subsidence results greater than but less than 15% above predictions	Subsidence results are greater than 15% above predictions
	Notification	Monitoring results forwarded to TransGrid as scheduled in Management Plan	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to monitor at specified frequency	Inspection by TransGrid and Donaldson TransGrid and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	Inspection with TransGrid and Donaldson TransGrid 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 TransGrid, appropriate consultant and PSE	Review mine plan in consultation with TransGrid, appropriate consultant and PSE

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Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Subsidence Monitoring – Tilt	Trigger	Results within predicted range Tower 29B – 28 mm/m Tower 28B – 16 mm/m	Results greater than but less than 15% above predictions	Results are greater than 15% above predictions
	Notification	Monitoring results forwarded to TransGrid as scheduled in Management Plan	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to monitor at specified frequency	Inspection with TransGrid and Donaldson TransGrid and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	Inspection with TransGrid and Donaldson TransGrid 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 TransGrid, appropriate consultant and PSE	Review mine plan in consultation with TransGrid, appropriate consultant and PSE

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Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Subsidence Monitoring – Strain	Trigger	Results within predicted range Tower 29B – 5 mm/m Tower 28B – 0mm/m	Results greater than but less than 15% above predictions	Results are greater than 15% above predictions
	Notification	Monitoring results forwarded to TransGrid as scheduled in Management Plan	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to monitor at specified frequency	Inspection with TransGrid and Donaldson TransGrid and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	Inspection with TransGrid and Donaldson TransGrid 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 TransGrid, appropriate consultant and PSE	Review mine plan in consultation with TransGrid, appropriate consultant and PSE

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Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Subsidence Monitoring – Horizontal Displacement	Trigger	Results within predicted range Tower 29B – 280 mm/m Tower 28B – 158 mm/m	Results greater than but less than 15% above predictions	Results are greater than 15% above predictions
	Notification	Monitoring results forwarded to TransGrid as scheduled in Management Plan	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to monitor at specified frequency	Inspection with TransGrid and Donaldson TransGrid and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	Inspection with TransGrid and Donaldson TransGrid 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 TransGrid, appropriate consultant and PSE	Review mine plan in consultation with TransGrid, appropriate consultant and PSE

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Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Visual Inspection	Trigger	Ground cracking, step changes, surface humps within predicted range	Ground cracking, step changes, surface humps up to 25% above predicted range. Any noticeable damage to tower structure, cross arms and/or conductors	Ground cracking, step changes, surface humps more than 25% above predicted range. Any increase in damage level to tower structure, cross arms and/or conductors
	Notification	Monitoring results forwarded to TransGrid as scheduled in Management Plan	Notify TransGrid, Principal Subsidence Engineer (PSE) DTIRIS and Mine Subsidence Board	Notify TransGrid, Principal Subsidence Engineer (PSE) DTIRIS and Mine Subsidence Board
	Action / Response	Continue to inspect at specified frequency Maintain warning signs Monitor cracks over following 12 months.	Maintain warning signs and erect additional signs in immediate area. Inspection with TransGrid and Donaldson. TransGrid 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	Maintain warning signs and erect additional signs in immediate area including NO ROAD signs if required. Inspection with TransGrid and Donaldson TransGrid and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE
	Mitigation / Remediation	Repair (see Public Safety Management Plan for detail)	Repair cracks (see Public Safety Management Plan for detail). Suspension of mining activities in vicinity of TransGrid assets (if required) Repairs to TransGrid assets (if required) Review mine plan in consultation with TransGrid, appropriate consultant and PSE	Repair cracks (see Public Safety Management Plan for detail) Suspension of mining activities in vicinity of TransGrid assets (if required) Repairs to TransGrid assets Review mine plan in consultation with TransGrid, appropriate consultant and PSE

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Monitoring Method	Trigger / Response	Results within predicted / acceptable range	Irregular result	Increased irregular result
Tiltmeter Continuous Monitoring	Trigger	Results within predicted range Tower 29B – 28 mm/m Tower 28B – 16 mm/m	Results greater than but less than 15% above predictions	Subsidence results are greater than 15% above predictions
	Notification	Monitoring results forwarded to TransGrid as scheduled in Management Plan	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS	Notify TransGrid and Principal Subsidence Engineer (PSE) DTIRIS
	Action / Response	Continue to monitor at specified frequency	Inspection with TransGrid and Donaldson TransGrid and Donaldson meeting to review predictions and data. Obtain opinion from appropriate consultant, review monitoring program and consult with PSE	Inspection with TransGrid and Donaldson TransGrid 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 TransGrid, appropriate consultant and PSE	Review mine plan in consultation with TransGrid, appropriate consultant and PSE

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