Stature for Risk Management

Administration:

Risk Assessment Title: Subsidence
Version: 1
Region: North
Site: Mandalong
Department: ZZZZ Whole Site
Equipment / Process: HSMS
Stature Risk Assessment No.: 1001025001
Study Lifecycle State: Risk Assessment Made Effective
Potential Hazard No.: 34369
PULSE Actions Required URL:
Site Risk Assessment Ref. No. (Optional):

Executive Summary of Top 10 Risks

Background	Potential Incident	RR
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Roads Resulting in: Risk to health and safety.	16 (S)
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Electricity transmission lines Resulting in: Risk to health and safety.	14 (S)
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground communication lines Resulting in: Risk to health and safety.	13 (S)
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : fences Resulting in: Risk to health and safety.	8 (M)
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	8 (M)

Background	Potential Incident	RR
	Caused by: not considering the characteristics of a relevant surface feature : communication towers Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : faults Resulting in: Risk to health and safety.	8 (M)
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : trees Resulting in: Risk to health and safety.	6 (L)
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts Resulting in: Risk to health and safety.	6 (L)
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Identification of Geotechnical units Resulting in: Risk to health and safety.	6 (L)
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	6 (L)

Background	Potential Incident	RR
	Caused by: not considering the characteristics of all relevant topographic conditions: Steep slopes Resulting in: Risk to health and safety.	

Executive Summary of Top 10 Severities

Background	Potential Incident	MRC
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Electricity transmission lines Resulting in: Risk to health and safety.	4
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : trees Resulting in: Risk to health and safety.	3
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground communication lines Resulting in: Risk to health and safety.	3
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts Resulting in: Risk to health and safety.	3
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by:	3

Background	Potential Incident	MRC
	not considering the characteristics of all relevant geotechnical conditions: Identification of Geotechnical units Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Steep slopes Resulting in: Risk to health and safety.	3
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Roads Resulting in: Risk to health and safety.	2
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Bridges Resulting in: Risk to health and safety.	2
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : fences Resulting in: Risk to health and safety.	2
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	2

Background	Potential Incident	MRC
	Caused by: not considering the characteristics of a relevant surface feature : communication towers Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Trenching Resulting in: Risk to health and safety.	2
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : faults Resulting in: Risk to health and safety.	2
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: flood areas Resulting in: Risk to health and safety.	2

Study Approval

Approver	Approved / Rejected	Date	Comments
1. Col Macdonald [cmacdonald]	Approved	February 12, 2016	

1. Background

Mandalong is required by the Work Health Safety (Mines) Regulation 2014 to develop control measures to manage the risk to health and safety associated with subsidence

2. Objective

The following Hierarchy of Controls offers a framework for considering the effectiveness of controls. Note that the effectiveness of a control that is intended to reduce a risk decreases from top to bottom of the list. In other words, the closer the control type is to the top of the hierarchy, the more potentially effective the control.

·Eliminate the hazard or energy source (do not use the energy)
·Minimise or replace the hazard or energy source (reduce the amount of energy to a less damaging level or replace the energy with another that has less potential negative consequences)
·Control the hazard or energy using engineered devices (ex. Lock outs, chemical containers, mechanical roof support, gas monitors, etc.)
·Control the hazard or energy by using physical barriers (ex. machine guarding, fences or enclosures, etc.)
·Control the hazard or energy with procedures (ex. Isolation procedures, standard operating procedures, etc.)
·Control the hazard or energy with personal protective equipment (ex. hard hats, boots with toe caps, gloves, safety glasses, welding gear, etc.)
·Control the hazard or energy with warnings and awareness (ex. posters, labels, warning signs, verbal warnings, etc.)

To identify, assess and control the risks to health and safety associated with subsidence

3. Potential Hazards

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4a. Risk Assessment Boundary Definition

Mandalong Mine mining lease area

4b. Boundary Definition

5. Risk Assessment Methods

Risk Assessment Methods:

Workplace Risk Assessment and Control (WRAC): Yes

Fault Tree Analysis (FTA):

Safety Integrity Level Analysis to Australian Standard 61508 (SIL):

Bow Tie Analysis (BTA):

Failure Modes and Effects Analysis (FMEA):

Hazard and Operability Analysis (HAZOP):

6. Previous Risk Assessment and other documents to be used and/or referenced

Document Name	Title	Version	Referenced Document Date
Work Health and Safety Act 2011			
Work Health and Safety Regulation 2011			
Work Health and Safety (Mines) Act 2013			
Work Health and Safety (Mines) Regulation 2014			

7. Information Required for Risk Assessment

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8. Venue and Time

Date	Description	Location	Start Time	End Time	Comment
1. 05-Mar-2015	Scoping	Compliance Office	10:00 AM	2:00 PM	
2. 03-Feb-2016	Assessment	Induction Training Room	10:30 AM	12:30 PM	
3.	Review				

9. Risk Assessment Team Selection

Name	Title	Company	Industry Start Date	Yrs. of Exp.	Mobile Phone #	E-Mail Address	Pulse User No.	Role	Attendance		
									1. 05-Mar-2015	2. 03-Feb-2016	3.
Col MacDonald	Compliance manager	Centennial Mandalong	06-Dec-1977	39		col.macdonald@centennialcoal.com.au	80094	Risk Assessment Owner	P	A	
Phil Enright	Subsidence Management Coordinator	Centennial Mandalong	25-Aug-1983	33	0439 409 781	phil.enright@centennialcoal.com.au	60001		P	P	
Steve Mudford	HST Superintendent	Centennial Mandalong	09-Jan-1995	22	0457 603 043	steve.mudford@centennialcoal.com.au	80078		A	P	
Andrew Heald	Production Manager	Centennial Mandalong	05-Sep-1980	36	0439 260 877	andrew.heald@centennialcoal.com.au	80059		A	A	
Jeffrey Dunwoodie	Environmental & Community Coordinator	Centennial Mandalong	02-Dec-2002	14	0448490023	jeffrey.dunwoodie@centennialcoal.com.au	80084		A	P	
Mark Harrower	Project Surveyor	Centennial Mandalong	14-Jan-1985	32		mark.harrower@centennialcoal.com.au	80013		A	P	
Richard Lloyd	MSMW (Local Check inspector)	Centennial Mandalong	15-Jan-1979	38		richard.lloyd@centennialcoal.com.au	52061		A	P	
James Enright									A	P	

10. Scope Confirmation

Approver	Scope Confirmation	Date	Comments
1. Col Macdonald	Yes	March 05, 2015	

WRAC Analysis Worksheet

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Buildings Resulting in: Risk to health and safety.	1.1.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.1.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.1.c. Individual property subsidence management plans 1.1.d. Flood modelling assessments to determine flood risk to dwellings and access 1.1.e. Dwellings constructed post 1997 to Mine Subsidence Board (MSB) Guidelines 1.1.f. Pre Mining MSB inspections on dwellings and buildings 1.1.g. Pre mining structural inspection and assessment by qualified civil/structural engineer 1.1.h. Subsidence monitoring on dwellings conducted by Mandalong Survey 1.1.i. Subsidence design below safe, servicible and repairable criteria for buildings AS2870	**E** (D)	1 (PI)	**1 (L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Roads Resulting in:	1.2.a. Flood modelling assessments to determine flood risk to dwellings and access 1.2.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.2.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts	**A** (D)	2 (PI)	**16 (S)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	Risk to health and safety.	1.2.d. Public roads management plan developed in consultation with Lake Macquarie City Council 1.2.e. Daily inspections when road is within active subsidence zone (100m pre mining 500m post mining) 1.2.f. Weekly inspection conducted until subsidence finialised 1.2.g. Pre and post mining subsidence monitoring 1.2.h. Weekly steep slope inspection in active mining area in immediate vicinity of road where boulders could be a hazard					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : **Railways** Resulting in: Risk to health and safety.	1.3.a. Not applicable	()	0	**0**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : **Bridges** Resulting in: Risk to health and safety.	1.4.a. Flood modelling assessments to determine flood risk to dwellings and access 1.4.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.4.c. Pre and post mining subsidence monitoring 1.4.d. Pre mining structural inspection and assessment by qualified civil/structural engineer 1.4.e. Public roads management	**D** (D)	2 (PI)	**5** **(L)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
		plan developed in consultation with Lake Macquarie City Council 1.4.f. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.4.g. Weekly inspection conducted until subsidence finialised					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Water tanks Resulting in: Risk to health and safety.	1.5.a. No public water supply tanks in mining area 1.5.b. Household water tanks assessed in property subsidence management plan	**E** (D)	1 (PI)	**1** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Gas and Fuel tanks Resulting in: Risk to health and safety.	1.6.a. No commercial fuel or gas storage tanks within subsidence area	**E** (D)	1 (PI)	**1** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Water Pipe lines Resulting in: Risk to health and safety.	1.7.a. Not applicable	()	0	**0**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Electricity transmission lines Resulting in: Risk to health and safety.	1.8.a. Pre and post mining subsidence monitoring 1.8.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.8.c. Powerlines Line Management Plan developed in consultation with Ausgrid and DRE 1.8.d. Project for relocation of Transmission Line TL24 underway as agreed by Transgrid	**D** (D)	4 (PI)	**14** **(S)**	1. Develop aTransmission Line Management Plan in consultation with Transgrid and DRE. Consider inclusion of montioring arrangements.	
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : fences Resulting in: Risk to health and safety.	1.9.a. Individual property subsidence management plans 1.9.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.9.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.9.d. Elecrtic fence tester for Surveyors and Environmental Contractors provided when conducting field work	**C** (D)	2 (PI)	**8** **(M)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : air strips Resulting in: Risk to health and safety.	1.10.a. Not applicable	()	0	**0**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by:	1.11.a. No prescribed public dams under the Dam Safety Act 1973 1.11.b. Individual property subsidence management plans	**C** (D)	1 (PI)	**4** **(L)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	not considering the characteristics of a relevant surface feature : dams Resulting in: Risk to health and safety.	1.11.c. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.11.d. Pre and post mining subsidence monitoring 1.11.e. Pre Mining MSB inspections on farm dams 1.11.f. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.11.g. Subsidence monitoring on farm dams conducted by Mandalong Survey					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : communication towers Resulting in: Risk to health and safety.	1.12.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.12.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts includes identification of surface features including comms towers 1.12.c. None currently identified	**C** (D)	2 (PI)	**8 (M)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : trees Resulting in: Risk to health and safety.	1.13.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.13.b. Pre and post mining subsidence monitoring 1.13.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts	**E** (D)	3 (PI)	**6 (L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by:	1.14.a. Not applicable	()	0	**0**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	not considering the characteristics of a relevant subsurface features: Road tunnels Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Rail tunnels Resulting in: Risk to health and safety.	1.15.a. Not applicable	()	0	**0**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground communication lines Resulting in: Risk to health and safety.	1.16.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.16.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.16.c. Telstra Management Plan developed in consultation with Telstra	**C** (D)	3 (PI)	**13 (S)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground gas lines Resulting in: Risk to health and safety.	1.17.a. Not applicable	()	0	**0**		
	There is a risk to Mandalong from	1.18.a. Not applicable	()	0	**0**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground fuel tanks and lines Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground water lines Resulting in: Risk to health and safety.	1.19.a. No commercial water supply in mining area	()	0	**0**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground electricity transmission lines Resulting in: Risk to health and safety.	1.20.a. No commercial Ausgrid owned underground assets in mining area 1.20.b. Individual property subsidence management plans	**E** (D)	1 (PI)	**1** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a	1.21.a. Ground Water Management Plan identifies registered bores 1.21.b. Individual property subsidence management plans	**D** (D)	1 (PI)	**2** **(L)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	relevant subsurface features:Fresh Water Bore holes Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts Resulting in: Risk to health and safety.	1.22.a. None currently identified 1.22.b. Historical search has not identified any old workings 1.22.c. Mine Planner on site 1.22.d. Pre drilling assessment procedure which identifies presence of existing workings	**E** (D)	3 (PI)	**6** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine service bores Resulting in: Risk to health and safety.	1.23.a. None currently identified 1.23.b. Historical search has not identified any old workings 1.23.c. Mine Planner on site 1.23.d. Pre drilling assessment procedure which identifies presence of existing workings	**E** (D)	1 (PI)	**1** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Trenching Resulting in: Risk to health and safety.	1.24.a. Individual property subsidence management plans 1.24.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	**E** (D)	2 (PI)	**3** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures	1.25.a. Exploration drilling program. 1.25.b. Geologist employed at Mandalong Mine.	**C** (D)	2 (PI)	**8** **(M)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : faults Resulting in: Risk to health and safety.	1.25.c. Geological mapping of underground workings. 1.25.d. Ground magnetometer surveys to identify large geological structures. 1.25.e. Broad based aero magnetometer surveys to identify geological structures. 1.25.f. Mine planning to consider impact of geological structures on mine design.					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Dykes Resulting in: Risk to health and safety.	1.26.a. Exploration drilling program. 1.26.b. Geologist employed at Mandalong Mine. 1.26.c. Geological mapping of underground workings. 1.26.d. Ground magnetometer surveys to identify large geological structures. 1.26.e. Broad based aero magnetometer surveys to identify geological structures. 1.26.f. Mine planning to consider impact of geological structures on mine design.	**E** (D)	1 (PI)	**1 (L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Sills Resulting in: Risk to health and safety.	1.27.a. Exploration drilling program. 1.27.b. Geologist employed at Mandalong Mine. 1.27.c. Geological mapping of underground workings. 1.27.d. Ground magnetometer surveys to identify large geological structures. 1.27.e. Broad based aero magnetometer surveys to identify geological structures. 1.27.f. Mine planning to consider impact of geological structures on mine design.	**E** (D)	1 (PI)	**1 (L)**		
	There is a risk to Mandalong from	1.28.a. Exploration drilling program	**C**	1	**4**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Variations in lithology Resulting in: Risk to health and safety.	to identify defects in the Munmorah conglomerate beam used to minimise subsidence. 1.28.b. Geologist employed at Mandalong Mine. 1.28.c. Geological mapping of underground workings. 1.28.d. Mine planning to consider impact of geological structures on mine design.	(D)	(PI)	**(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam dip Resulting in: Risk to health and safety.	1.29.a. Geological mapping of underground workings. 1.29.b. No steep seam >30 degrees.	**C** (D)	1 (PI)	**4** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam roll Resulting in: Risk to health and safety.	1.30.a. Identified from in-seam drilling. 1.30.b. Geologist / geotechnical engineer employed at Mandalong Mine. 1.30.c. Geological mapping of underground workings. 1.30.d. Incorporate impacts of seam roll on subsidence predictions.	**C** (D)	1 (PI)	**4** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Depth of	1.31.a. Depth of cover is determined by exploration drilling. 1.31.b. No depth of cover is less than 160 metres. 1.31.c. No shallow workings.	**E** (D)	1 (PI)	**1** **(L)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	cover Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam thickness Resulting in: Risk to health and safety.	1.32.a. Exploration drilling program to identify seam thickness in mining areas. 1.32.b. In-seam drilling. 1.32.c. Mining equipment limits extraction thickness 3.6 - 4.8m. 1.32.d. Variations in seam thickness has minimal impacts on mine subsidence levels at Mandalong Mine.	**E** (D)	1 (PI)	**1** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrogeological conditions:Aquifers and ground water resources Resulting in: Risk to health and safety.	1.33.a. Groundwater impact assessment completed for SMP / Extraction Plan. 1.33.b. No contiguous aquifiers in the Mandalong mining area. 1.33.c. Ground Water Management Plan identifies registered bores. 1.33.d. Extensive groundwater monitoring network - 50 bores. 1.33.e. No connection between fractured zone and alluvial aquifers to date.	**D** (D)	1 (PI)	**2** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: Catchment areas Resulting in: Risk to health and safety.	1.34.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.34.b. No impacts on flow within Morans and Stockton Creek to date. 1.34.c. Bi-annual floodpath monitoring. 1.34.d. Subsidence monitoring along creek lines to assess change in grades.	**E** (D)	1 (PI)	**1** **(L)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: flood areas Resulting in: Risk to health and safety.	1.35.a. Flood modelling assessments to determine flood risk at 1 year and 100 year ARI events. 1.35.b. Flood modelling assesses impact on infrastructure and private property. 1.35.c. Include flooding assessment in PSMPs and Infrastructure Management Plans.	**D** (D)	2 (PI)	**5** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: creeks Resulting in: Risk to health and safety.	1.36.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.36.b. No impacts on flow within Morans and Stockton Creek to date. 1.36.c. Bi-annual floodpath monitoring. 1.36.d. Subsidence monitoring along creek lines to assess change in grades.	**C** (D)	1 (PI)	**4** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: dams Resulting in: Risk to health and safety.	1.37.a. No prescribed public dams under the Dam Safety Act 1973 1.37.b. Individual property subsidence management plans 1.37.c. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.37.d. Pre and post mining subsidence monitoring 1.37.e. Pre Mining MSB inspections on farm dams 1.37.f. Subsidence Management Plan/Extraction Plan to manage subsidence impacts	**E** (D)	1 (PI)	**1** **(L)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
		1.37.g. Subsidence monitoring on farm dams conducted by Mandalong Survey					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: lakes Resulting in: Risk to health and safety.	1.38.a. No lakes within the mining area.	()	0	**0**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: Rivers Resulting in: Risk to health and safety.	1.39.a. N/A	()	0	**0**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Strength and properties of Strata Resulting in: Risk to health and safety.	1.40.a. Exploration drilling program to identify defects in the Munmorah conglomerate beam used to minimise subsidence. 1.40.b. Exploration drilling program to identify seam thickness in mining areas. 1.40.c. Exploration drilling program. 1.40.d. Testing of the immediate roof and floor horizon (for strength). 1.40.e. Geotechnical subsidence consultant to review geological date from drilling program.	**E** (D)	1 (PI)	**1 (L)**		
	There is a risk to Mandalong from	1.41.a. Depth of cover is determined	**E**	1	**1**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
		by exploration drilling.	(D)	(PI)	**(L)**		
	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Overburden Resulting in: Risk to health and safety.	1.41.b. No depth of cover is less than 160 metres. 1.41.c. No shallow workings.					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Floor Resulting in: Risk to health and safety.	1.42.a. Exploration drilling program to identify seam thickness in mining areas. 1.42.b. Exploration drilling program. 1.42.c. Testing of the immediate floor horizon (for strength). 1.42.d. Geotechnical subsidence consultant to review geological date from drilling program.	**E** (D)	1 (PI)	**1 (L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Identification of Geotechnical units Resulting in: Risk to health and safety.	1.43.a. Exploration drilling program to identify seam thickness in mining areas. 1.43.b. Exploration drilling program. 1.43.c. Testing of the immediate floor horizon (for strength). 1.43.d. Geotechnical subsidence consultant to review geological date from drilling program. 1.43.e. No windblast potential. 1.43.f. No immediate massive strata in immediate mining horizon. 1.43.g. Geologist / geotechnical engineer employed at Mandalong Mine.	**E** (D)	3 (PI)	**6 (L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.44.a. N/A	()	0	**0**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	Caused by: not considering the characteristics of all relevant topographic conditions: Escarpments Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Steep slopes Resulting in: Risk to health and safety.	1.45.a. Steep Slopes Management Plan. 1.45.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts, 1.45.c. Steep slopes monitoring and inspection program. 1.45.d. Broad based mapping of steep slopes has been completed. 1.45.e. Airborne Laser Scanning of mining lease areas has been conducted to provide detail mapping	**E** (D)	3 (PI)	**6** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Plateaus Resulting in: Risk to health and safety.	1.46.a. N/A	()	0	**0**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Gorges, revines and canyons	1.47.a. N/A	()	0	**0**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant climatic conditions: rainfall Resulting in: Risk to health and safety.	1.48.a. Flood modelling assessments to determine flood risk to dwellings and access. 1.48.b. No depth of cover is less than 160 metres. 1.48.c. No direct connection between surface and underground.	**E** (D)	1 (PI)	**1** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: "not considering any conditions that may cause elevated or abnormal subsidence or the formation of sinkholes" Resulting in: Risk to health and safety.	1.49.a. No depth of cover is less than 160 metres. 1.49.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.49.c. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	**E** (D)	1 (PI)	**1** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of any previously excavated or abandoned workings that may interact with any proposed or existing mine workings Resulting in: Risk to health and safety.	1.50.a. Historical search has not identified any old workings	**E** (D)	1 (PI)	**1** **(L)**		
	There is a risk to Mandalong from ::: Less than adequate control measures	1.51.a. N/A	()	0	**0**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	to manage the risk of subsidence ::: Caused by: not considering the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the rate, method, layout, schedule and sequence of mining operations Resulting in: Risk to health and safety.	1.52.a. Systematic longwall design.	**E** (D)	1 (PI)	**1** **(L)**		

WRAC Analysis Sorted by RR

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Roads Resulting in: Risk to health and safety.	1.2.a. Flood modelling assessments to determine flood risk to dwellings and access 1.2.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.2.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.2.d. Public roads management plan developed in consultation with Lake Macquarie City Council 1.2.e. Daily inspections when road is within active subsidence zone (100m pre mining 500m post mining) 1.2.f. Weekly inspection conducted until subsidence finialised 1.2.g. Pre and post mining subsidence monitoring 1.2.h. Weekly steep slope inspection in active mining area in immediate vicinity of road where boulders could be a hazard	**A** (D)	2 (PI)	**16 (S)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Electricity transmission lines	1.8.a. Pre and post mining subsidence monitoring 1.8.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.8.c. Powerlines Line Management Plan developed in consultation with Ausgrid and DRE	**D** (D)	4 (PI)	**14 (S)**	1. Develop aTransmission Line Management Plan in consultation with Transgrid and DRE. Consider inclusion of montioring arrangements.

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.	1.8.d. Project for relocation of Transmission Line TL24 underway as agreed by Transgrid				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground communication lines Resulting in: Risk to health and safety.	1.16.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.16.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.16.c. Telstra Management Plan developed in consultation with Telstra	**C** (D)	3 (PI)	**13 (S)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : fences Resulting in: Risk to health and safety.	1.9.a. Individual property subsidence management plans 1.9.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.9.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.9.d. Elecrtic fence tester for Surveyors and Environmental Contractors provided when conducting field work	**C** (D)	2 (PI)	**8 (M)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : communication towers	1.12.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.12.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts includes identification of surface	**C** (D)	2 (PI)	**8 (M)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.	features including comms towers				
		1.12.c. None currently identified				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : faults Resulting in: Risk to health and safety.	1.25.a. Exploration drilling program.	**C** (D)	2 (PI)	**8** **(M)**	
		1.25.b. Geologist employed at Mandalong Mine.				
		1.25.c. Geological mapping of underground workings.				
		1.25.d. Ground magnetometer surveys to identify large geological structures.				
		1.25.e. Broad based aero magnetometer surveys to identify geological structures.				
		1.25.f. Mine planning to consider impact of geological structures on mine design.				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : trees Resulting in: Risk to health and safety.	1.13.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	**E** (D)	3 (PI)	**6** **(L)**	
		1.13.b. Pre and post mining subsidence monitoring				
		1.13.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts	1.22.a. None currently identified	**E** (D)	3 (PI)	**6** **(L)**	
		1.22.b. Historical search has not identified any old workings				
		1.22.c. Mine Planner on site				
		1.22.d. Pre drilling assessment procedure which identifies presence of existing workings				

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.					
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Identification of Geotechnical units Resulting in: Risk to health and safety.	1.43.a. Exploration drilling program to identify seam thickness in mining areas. 1.43.b. Exploration drilling program. 1.43.c. Testing of the immediate floor horizon (for strength). 1.43.d. Geotechnical subsidence consultant to review geological date from drilling program. 1.43.e. No windblast potential. 1.43.f. No immediate massive strata in immediate mining horizon. 1.43.g. Geologist / geotechnical engineer employed at Mandalong Mine.	**E** (D)	3 (PI)	**6 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Steep slopes Resulting in: Risk to health and safety.	1.45.a. Steep Slopes Management Plan. 1.45.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts, 1.45.c. Steep slopes monitoring and inspection program. 1.45.d. Broad based mapping of steep slopes has been completed. 1.45.e. Airborne Laser Scanning of mining lease areas has been conducted to provide detail mapping	**E** (D)	3 (PI)	**6 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.4.a. Flood modelling assessments to determine flood risk to dwellings and access	**D** (D)	2 (PI)	**5 (L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
surface subsidence	Caused by: not considering the characteristics of a relevant surface feature : **Bridges** Resulting in: Risk to health and safety.	1.4.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.4.c. Pre and post mining subsidence monitoring 1.4.d. Pre mining structural inspection and assessment by qualified civil/structural engineer 1.4.e. Public roads management plan developed in consultation with Lake Macquarie City Council 1.4.f. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.4.g. Weekly inspection conducted until subsidence finialised				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: flood areas Resulting in: Risk to health and safety.	1.35.a. Flood modelling assessments to determine flood risk at 1 year and 100 year ARI events. 1.35.b. Flood modelling assesses impact on infrastructure and private property. 1.35.c. Include flooding assessment in PSMPs and Infrastructure Management Plans.	**D** (D)	2 (PI)	**5** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : dams Resulting in:	1.11.a. No prescribed public dams under the Dam Safety Act 1973 1.11.b. Individual property subsidence management plans 1.11.c. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface	**C** (D)	1 (PI)	**4** **(L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Risk to health and safety.	subsidence 1.11.d. Pre and post mining subsidence monitoring 1.11.e. Pre Mining MSB inspections on farm dams 1.11.f. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.11.g. Subsidence monitoring on farm dams conducted by Mandalong Survey				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Variations in lithology Resulting in: Risk to health and safety.	1.28.a. Exploration drilling program to identify defects in the Munmorah conglomerate beam used to minimise subsidence. 1.28.b. Geologist employed at Mandalong Mine. 1.28.c. Geological mapping of underground workings. 1.28.d. Mine planning to consider impact of geological structures on mine design.	**C** (D)	1 (PI)	**4 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam dip Resulting in: Risk to health and safety.	1.29.a. Geological mapping of underground workings. 1.29.b. No steep seam >30 degrees.	**C** (D)	1 (PI)	**4 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.30.a. Identified from in-seam drilling. 1.30.b. Geologist / geotechnical engineer employed at Mandalong Mine.	**C** (D)	1 (PI)	**4 (L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Caused by: not considering the characteristics of all relevant geological conditions : Seam roll Resulting in: Risk to health and safety.	1.30.c. Geological mapping of underground workings. 1.30.d. Incorporate impacts of seam roll on subsidence predictions.				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: creeks Resulting in: Risk to health and safety.	1.36.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.36.b. No impacts on flow within Morans and Stockton Creek to date. 1.36.c. Bi-annual floodpath monitoring. 1.36.d. Subsidence monitoring along creek lines to assess change in grades.	**C** (D)	1 (PI)	**4** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Trenching Resulting in: Risk to health and safety.	1.24.a. Individual property subsidence management plans 1.24.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	**E** (D)	2 (PI)	**3** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Fresh Water Bore holes Resulting in: Risk to health and safety.	1.21.a. Ground Water Management Plan identifies registered bores 1.21.b. Individual property subsidence management plans	**D** (D)	1 (PI)	**2** **(L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrogeological conditions:Aquifers and ground water resources Resulting in: Risk to health and safety.	1.33.a. Groundwater impact assessment completed for SMP / Extraction Plan. 1.33.b. No contiguous aquifiers in the Mandalong mining area. 1.33.c. Ground Water Management Plan identifies registered bores. 1.33.d. Extensive groundwater monitoring network - 50 bores. 1.33.e. No connection between fractured zone and alluvial aquifers to date.	**D** (D)	1 (PI)	**2** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Buildings Resulting in: Risk to health and safety.	1.1.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.1.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.1.c. Individual property subsidence management plans 1.1.d. Flood modelling assessments to determine flood risk to dwellings and access 1.1.e. Dwellings constructed post 1997 to Mine Subsidence Board (MSB) Guidelines 1.1.f. Pre Mining MSB inspections on dwellings and buildings 1.1.g. Pre mining structural inspection and assessment by qualified civil/structural engineer 1.1.h. Subsidence monitoring on	**E** (D)	1 (PI)	**1** **(L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		dwellings conducted by Mandalong Survey				
		1.1.i. Subsidence design below safe, servicible and repairable criteria for buildings AS2870				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Water tanks Resulting in: Risk to health and safety.	1.5.a. No public water supply tanks in mining area	**E** (D)	1 (PI)	**1 (L)**	
		1.5.b. Household water tanks assessed in property subsidence management plan				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Gas and Fuel tanks Resulting in: Risk to health and safety.	1.6.a. No commercial fuel or gas storage tanks within subsidence area	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground electricity transmission lines Resulting in: Risk to health and safety.	1.20.a. No commercial Ausgrid owned underground assets in mining area	**E** (D)	1 (PI)	**1 (L)**	
		1.20.b. Individual property subsidence management plans				
1. Mining methods which intentionally cause the	There is a risk to Mandalong from	1.23.a. None currently identified	**E** (D)	1 (PI)	**1 (L)**	
		1.23.b. Historical search has not				

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine service bores Resulting in: Risk to health and safety.	identified any old workings 1.23.c. Mine Planner on site 1.23.d. Pre drilling assessment procedure which identifies presence of existing workings				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Dykes Resulting in: Risk to health and safety.	1.26.a. Exploration drilling program. 1.26.b. Geologist employed at Mandalong Mine. 1.26.c. Geological mapping of underground workings. 1.26.d. Ground magnetometer surveys to identify large geological structures. 1.26.e. Broad based aero magnetometer surveys to identify geological structures. 1.26.f. Mine planning to consider impact of geological structures on mine design.	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Sills Resulting in: Risk to health and safety.	1.27.a. Exploration drilling program. 1.27.b. Geologist employed at Mandalong Mine. 1.27.c. Geological mapping of underground workings. 1.27.d. Ground magnetometer surveys to identify large geological structures. 1.27.e. Broad based aero magnetometer surveys to identify geological structures. 1.27.f. Mine planning to consider	**E** (D)	1 (PI)	**1 (L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		impact of geological structures on mine design.				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Depth of cover Resulting in: Risk to health and safety.	1.31.a. Depth of cover is determined by exploration drilling. 1.31.b. No depth of cover is less than 160 metres. 1.31.c. No shallow workings.	**E** (D)	1 (PI)	**1** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam thickness Resulting in: Risk to health and safety.	1.32.a. Exploration drilling program to identify seam thickness in mining areas. 1.32.b. In-seam drilling. 1.32.c. Mining equipment limits extraction thickness 3.6 - 4.8m. 1.32.d. Variations in seam thickness has minimal impacts on mine subsidence levels at Mandalong Mine.	**E** (D)	1 (PI)	**1** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: Catchment areas Resulting in: Risk to health and safety.	1.34.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.34.b. No impacts on flow within Morans and Stockton Creek to date. 1.34.c. Bi-annual floodpath monitoring. 1.34.d. Subsidence monitoring along creek lines to assess change in grades.	**E** (D)	1 (PI)	**1** **(L)**	
1. Mining methods which intentionally cause the	There is a risk to Mandalong from	1.37.a. No prescribed public dams under the Dam Safety Act	**E** (D)	1 (PI)	**1** **(L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: dams Resulting in: Risk to health and safety.	1973 1.37.b. Individual property subsidence management plans 1.37.c. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.37.d. Pre and post mining subsidence monitoring 1.37.e. Pre Mining MSB inspections on farm dams 1.37.f. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.37.g. Subsidence monitoring on farm dams conducted by Mandalong Survey				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Strength and properties of Strata Resulting in: Risk to health and safety.	1.40.a. Exploration drilling program to identify defects in the Munmorah conglomerate beam used to minimise subsidence. 1.40.b. Exploration drilling program to identify seam thickness in mining areas. 1.40.c. Exploration drilling program. 1.40.d. Testing of the immediate roof and floor horizon (for strength). 1.40.e. Geotechnical subsidence consultant to review geological date from drilling program.	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to	1.41.a. Depth of cover is determined by exploration drilling.	**E** (D)	1 (PI)	**1 (L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
collapse resulting in surface subsidence	manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Overburden Resulting in: Risk to health and safety.	1.41.b. No depth of cover is less than 160 metres. 1.41.c. No shallow workings.				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Floor Resulting in: Risk to health and safety.	1.42.a. Exploration drilling program to identify seam thickness in mining areas. 1.42.b. Exploration drilling program. 1.42.c. Testing of the immediate floor horizon (for strength). 1.42.d. Geotechnical subsidence consultant to review geological date from drilling program.	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant climatic conditions: rainfall Resulting in: Risk to health and safety.	1.48.a. Flood modelling assessments to determine flood risk to dwellings and access. 1.48.b. No depth of cover is less than 160 metres. 1.48.c. No direct connection between surface and underground.	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: "not considering any conditions that may cause elevated or abnormal subsidence or the formation of sinkholes" Resulting in:	1.49.a. No depth of cover is less than 160 metres. 1.49.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.49.c. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface	**E** (D)	1 (PI)	**1 (L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Risk to health and safety.	subsidence				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of any previously excavated or abandoned workings that may interact with any proposed or existing mine workings Resulting in: Risk to health and safety.	1.50.a. Historical search has not identified any old workings	**E** (D)	1 (PI)	**1** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the rate, method, layout, schedule and sequence of mining operations Resulting in: Risk to health and safety.	1.52.a. Systematic longwall design.	**E** (D)	1 (PI)	**1** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : **Railways** Resulting in: Risk to health and safety.	1.3.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by:	1.7.a. Not applicable	()	0	**0**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	not considering the characteristics of a relevant surface feature : Water Pipe lines Resulting in: Risk to health and safety.					
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : air strips Resulting in: Risk to health and safety.	1.10.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Road tunnels Resulting in: Risk to health and safety.	1.14.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Rail tunnels Resulting in: Risk to health and safety.	1.15.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.17.a. Not applicable	()	0	**0**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Caused by: not considering the characteristics of a relevant subsurface features:Underground gas lines Resulting in: Risk to health and safety.					
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground fuel tanks and lines Resulting in: Risk to health and safety.	1.18.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground water lines Resulting in: Risk to health and safety.	1.19.a. No commercial water supply in mining area	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: lakes Resulting in: Risk to health and safety.	1.38.a. No lakes within the mining area.	()	0	**0**	
1. Mining methods which	There is a risk to Mandalong from	1.39.a. N/A	()	0	**0**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
intentionally cause the extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: Rivers Resulting in: Risk to health and safety.					
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Escarpments Resulting in: Risk to health and safety.	1.44.a. N/A	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Plateaus Resulting in: Risk to health and safety.	1.46.a. N/A	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Gorges, revines and canyons	1.47.a. N/A	()	0	**0**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.					
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings Resulting in: Risk to health and safety.	1.51.a. N/A	()	0	**0**	

WRAC Analysis Sorted by Consequence

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Electricity transmission lines Resulting in: Risk to health and safety.	1.8.a. Pre and post mining subsidence monitoring 1.8.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.8.c. Powerlines Line Management Plan developed in consultation with Ausgrid and DRE 1.8.d. Project for relocation of Transmission Line TL24 underway as agreed by Transgrid	**D** (D)	4 (PI)	**14** **(S)**	1. Develop aTransmission Line Management Plan in consultation with Transgrid and DRE. Consider inclusion of montioring arrangements.
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : trees Resulting in: Risk to health and safety.	1.13.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.13.b. Pre and post mining subsidence monitoring 1.13.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts	**E** (D)	3 (PI)	**6** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground communication lines Resulting in: Risk to health and safety.	1.16.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.16.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.16.c. Telstra Management Plan developed in consultation with Telstra	**C** (D)	3 (PI)	**13** **(S)**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts Resulting in: Risk to health and safety.	1.22.a. None currently identified 1.22.b. Historical search has not identified any old workings 1.22.c. Mine Planner on site 1.22.d. Pre drilling assessment procedure which identifies presence of existing workings	**E** (D)	3 (PI)	**6** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Identification of Geotechnical units Resulting in: Risk to health and safety.	1.43.a. Exploration drilling program to identify seam thickness in mining areas. 1.43.b. Exploration drilling program. 1.43.c. Testing of the immediate floor horizon (for strength). 1.43.d. Geotechnical subsidence consultant to review geological date from drilling program. 1.43.e. No windblast potential. 1.43.f. No immediate massive strata in immediate mining horizon. 1.43.g. Geologist / geotechnical engineer employed at Mandalong Mine.	**E** (D)	3 (PI)	**6** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Steep	1.45.a. Steep Slopes Management Plan. 1.45.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts, 1.45.c. Steep slopes monitoring and inspection program.	**E** (D)	3 (PI)	**6** **(L)**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	slopes Resulting in: Risk to health and safety.	1.45.d. Broad based mapping of steep slopes has been completed. 1.45.e. Airborne Laser Scanning of mining lease areas has been conducted to provide detail mapping				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Roads Resulting in: Risk to health and safety.	1.2.a. Flood modelling assessments to determine flood risk to dwellings and access 1.2.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.2.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.2.d. Public roads management plan developed in consultation with Lake Macquarie City Council 1.2.e. Daily inspections when road is within active subsidence zone (100m pre mining 500m post mining) 1.2.f. Weekly inspection conducted until subsidence finialised 1.2.g. Pre and post mining subsidence monitoring 1.2.h. Weekly steep slope inspection in active mining area in immediate vicinity of road where boulders could be a hazard	**A** (D)	2 (PI)	**16 (S)**	
1. Mining methods which	There is a risk to Mandalong from	1.4.a. Flood modelling	**D**	2	**5**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
intentionally cause the extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : **Bridges** Resulting in: Risk to health and safety.	assessments to determine flood risk to dwellings and access	(D)	(PI)	**(L)**	
		1.4.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
		1.4.c. Pre and post mining subsidence monitoring				
		1.4.d. Pre mining structural inspection and assessment by qualified civil/structural engineer				
		1.4.e. Public roads management plan developed in consultation with Lake Macquarie City Council				
		1.4.f. Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		1.4.g. Weekly inspection conducted until subsidence finialised				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : fences Resulting in: Risk to health and safety.	1.9.a. Individual property subsidence management plans	**C** (D)	2 (PI)	**8** **(M)**	
		1.9.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
		1.9.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		1.9.d. Elecrtic fence tester for Surveyors and Environmental Contractors provided when conducting				

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		field work				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : communication towers Resulting in: Risk to health and safety.	1.12.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.12.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts includes identification of surface features including comms towers 1.12.c. None currently identified	**C** (D)	2 (PI)	**8 (M)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Trenching Resulting in: Risk to health and safety.	1.24.a. Individual property subsidence management plans 1.24.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	**E** (D)	2 (PI)	**3 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : faults Resulting in: Risk to health and safety.	1.25.a. Exploration drilling program. 1.25.b. Geologist employed at Mandalong Mine. 1.25.c. Geological mapping of underground workings. 1.25.d. Ground magnetometer surveys to identify large geological structures. 1.25.e. Broad based aero magnetometer surveys to identify geological structures. 1.25.f. Mine planning to consider impact of geological structures on mine design.	**C** (D)	2 (PI)	**8 (M)**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: flood areas Resulting in: Risk to health and safety.	1.35.a. Flood modelling assessments to determine flood risk at 1 year and 100 year ARI events.	**D** (D)	2 (PI)	**5** **(L)**	
		1.35.b. Flood modelling assesses impact on infrastructure and private property.				
		1.35.c. Include flooding assessment in PSMPs and Infrastructure Management Plans.				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Buildings Resulting in: Risk to health and safety.	1.1.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	**E** (D)	1 (PI)	**1** **(L)**	
		1.1.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		1.1.c. Individual property subsidence management plans				
		1.1.d. Flood modelling assessments to determine flood risk to dwellings and access				
		1.1.e. Dwellings constructed post 1997 to Mine Subsidence Board (MSB) Guidelines				
		1.1.f. Pre Mining MSB inspections on dwellings and buildings				
		1.1.g. Pre mining structural inspection and assessment by qualified civil/structural engineer				
		1.1.h. Subsidence monitoring on				

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		dwellings conducted by Mandalong Survey				
		1.1.i. Subsidence design below safe, servicible and repairable criteria for buildings AS2870				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Water tanks Resulting in: Risk to health and safety.	1.5.a. No public water supply tanks in mining area	**E** (D)	1 (PI)	**1 (L)**	
		1.5.b. Household water tanks assessed in property subsidence management plan				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Gas and Fuel tanks Resulting in: Risk to health and safety.	1.6.a. No commercial fuel or gas storage tanks within subsidence area	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : dams Resulting in: Risk to health and safety.	1.11.a. No prescribed public dams under the Dam Safety Act 1973	**C** (D)	1 (PI)	**4 (L)**	
		1.11.b. Individual property subsidence management plans				
		1.11.c. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
		1.11.d. Pre and post mining subsidence monitoring				

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		1.11.e. Pre Mining MSB inspections on farm dams 1.11.f. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.11.g. Subsidence monitoring on farm dams conducted by Mandalong Survey				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground electricity transmission lines Resulting in: Risk to health and safety.	1.20.a. No commercial Ausgrid owned underground assets in mining area 1.20.b. Individual property subsidence management plans	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Fresh Water Bore holes Resulting in: Risk to health and safety.	1.21.a. Ground Water Management Plan identifies registered bores 1.21.b. Individual property subsidence management plans	**D** (D)	1 (PI)	**2 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine	1.23.a. None currently identified 1.23.b. Historical search has not identified any old workings 1.23.c. Mine Planner on site 1.23.d. Pre drilling assessment procedure which	**E** (D)	1 (PI)	**1 (L)**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	service bores Resulting in: Risk to health and safety.	identifies presence of existing workings				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Dykes Resulting in: Risk to health and safety.	1.26.a. Exploration drilling program. 1.26.b. Geologist employed at Mandalong Mine. 1.26.c. Geological mapping of underground workings. 1.26.d. Ground magnetometer surveys to identify large geological structures. 1.26.e. Broad based aero magnetometer surveys to identify geological structures. 1.26.f. Mine planning to consider impact of geological structures on mine design.	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Sills Resulting in: Risk to health and safety.	1.27.a. Exploration drilling program. 1.27.b. Geologist employed at Mandalong Mine. 1.27.c. Geological mapping of underground workings. 1.27.d. Ground magnetometer surveys to identify large geological structures. 1.27.e. Broad based aero magnetometer surveys to identify geological structures. 1.27.f. Mine planning to consider impact of geological structures on mine design.	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures	1.28.a. Exploration drilling program to identify defects in the Munmorah	**C** (D)	1 (PI)	**4 (L)**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
collapse resulting in surface subsidence	to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Variations in lithology Resulting in: Risk to health and safety.	conglomerate beam used to minimise subsidence. 1.28.b. Geologist employed at Mandalong Mine. 1.28.c. Geological mapping of underground workings. 1.28.d. Mine planning to consider impact of geological structures on mine design.				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam dip Resulting in: Risk to health and safety.	1.29.a. Geological mapping of underground workings. 1.29.b. No steep seam >30 degrees.	**C** (D)	1 (PI)	**4 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam roll Resulting in: Risk to health and safety.	1.30.a. Identified from in-seam drilling. 1.30.b. Geologist / geotechnical engineer employed at Mandalong Mine. 1.30.c. Geological mapping of underground workings. 1.30.d. Incorporate impacts of seam roll on subsidence predictions.	**C** (D)	1 (PI)	**4 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Depth of cover	1.31.a. Depth of cover is determined by exploration drilling. 1.31.b. No depth of cover is less than 160 metres. 1.31.c. No shallow workings.	**E** (D)	1 (PI)	**1 (L)**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.					
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam thickness Resulting in: Risk to health and safety.	1.32.a. Exploration drilling program to identify seam thickness in mining areas. 1.32.b. In-seam drilling. 1.32.c. Mining equipment limits extraction thickness 3.6 - 4.8m. 1.32.d. Variations in seam thickness has minimal impacts on mine subsidence levels at Mandalong Mine.	**E** (D)	1 (PI)	**1** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrogeological conditions:Aquifers and ground water resources Resulting in: Risk to health and safety.	1.33.a. Groundwater impact assessment completed for SMP / Extraction Plan. 1.33.b. No contiguous aquifiers in the Mandalong mining area. 1.33.c. Ground Water Management Plan identifies registered bores. 1.33.d. Extensive groundwater monitoring network - 50 bores. 1.33.e. No connection between fractured zone and alluvial aquifers to date.	**D** (D)	1 (PI)	**2** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions:	1.34.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.34.b. No impacts on flow within Morans and Stockton Creek to date.	**E** (D)	1 (PI)	**1** **(L)**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Catchment areas Resulting in: Risk to health and safety.	1.34.c. Bi-annual floodpath monitoring.				
		1.34.d. Subsidence monitoring along creek lines to assess change in grades.				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: creeks Resulting in: Risk to health and safety.	1.36.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
		1.36.b. No impacts on flow within Morans and Stockton Creek to date.	**C** (D)	1 (PI)	**4** **(L)**	
		1.36.c. Bi-annual floodpath monitoring.				
		1.36.d. Subsidence monitoring along creek lines to assess change in grades.				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: dams Resulting in: Risk to health and safety.	1.37.a. No prescribed public dams under the Dam Safety Act 1973				
		1.37.b. Individual property subsidence management plans				
		1.37.c. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
		1.37.d. Pre and post mining subsidence monitoring	**E** (D)	1 (PI)	**1** **(L)**	
		1.37.e. Pre Mining MSB inspections on farm dams				
		1.37.f. Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		1.37.g. Subsidence monitoring on farm dams conducted				

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		by Mandalong Survey				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Strength and properties of Strata Resulting in: Risk to health and safety.	1.40.a. Exploration drilling program to identify defects in the Munmorah conglomerate beam used to minimise subsidence. 1.40.b. Exploration drilling program to identify seam thickness in mining areas. 1.40.c. Exploration drilling program. 1.40.d. Testing of the immediate roof and floor horizon (for strength). 1.40.e. Geotechnical subsidence consultant to review geological date from drilling program.	**E** (D)	1 (PI)	**1** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Overburden Resulting in: Risk to health and safety.	1.41.a. Depth of cover is determined by exploration drilling. 1.41.b. No depth of cover is less than 160 metres. 1.41.c. No shallow workings.	**E** (D)	1 (PI)	**1** **(L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Floor Resulting in: Risk to health and safety.	1.42.a. Exploration drilling program to identify seam thickness in mining areas. 1.42.b. Exploration drilling program. 1.42.c. Testing of the immediate floor horizon (for strength). 1.42.d. Geotechnical subsidence	**E** (D)	1 (PI)	**1** **(L)**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		consultant to review geological date from drilling program.				
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant climatic conditions: rainfall Resulting in: Risk to health and safety.	1.48.a. Flood modelling assessments to determine flood risk to dwellings and access. 1.48.b. No depth of cover is less than 160 metres. 1.48.c. No direct connection between surface and underground.	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: "not considering any conditions that may cause elevated or abnormal subsidence or the formation of sinkholes" Resulting in: Risk to health and safety.	1.49.a. No depth of cover is less than 160 metres. 1.49.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.49.c. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of any previously excavated or abandoned workings that may interact with any proposed or existing mine workings Resulting in: Risk to health and safety.	1.50.a. Historical search has not identified any old workings	**E** (D)	1 (PI)	**1 (L)**	
1. Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures	1.52.a. Systematic longwall design.	**E** (D)	1 (PI)	**1 (L)**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
collapse resulting in surface subsidence	to manage the risk of subsidence ::: Caused by: not considering the rate, method, layout, schedule and sequence of mining operations Resulting in: Risk to health and safety.					
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : **Railways** Resulting in: Risk to health and safety.	1.3.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Water Pipe lines Resulting in: Risk to health and safety.	1.7.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : air strips Resulting in: Risk to health and safety.	1.10.a. Not applicable	()	0	**0**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Road tunnels Resulting in: Risk to health and safety.	1.14.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Rail tunnels Resulting in: Risk to health and safety.	1.15.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground gas lines Resulting in: Risk to health and safety.	1.17.a. Not applicable	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface	1.18.a. Not applicable	()	0	**0**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	features:Underground fuel tanks and lines Resulting in: Risk to health and safety.					
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground water lines Resulting in: Risk to health and safety.	1.19.a. No commercial water supply in mining area	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: lakes Resulting in: Risk to health and safety.	1.38.a. No lakes within the mining area.	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: Rivers Resulting in: Risk to health and safety.	1.39.a. N/A	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.44.a. N/A	()	0	**0**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
surface subsidence	Caused by: not considering the characteristics of all relevant topographic conditions: Escarpments Resulting in: Risk to health and safety.					
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Plateaus Resulting in: Risk to health and safety.	1.46.a. N/A	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Gorges, revines and canyons Resulting in: Risk to health and safety.	1.47.a. N/A	()	0	**0**	
1. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings	1.51.a. N/A	()	0	**0**	

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.					

Recommended Controls

Recommended Controls Do NOT enter additional Recommended Controls on this sheet.	Place(s) Used	Allocated To (Only one SITE person for each Recommended Control)	Required By Date	Pulse User No.	PULSE Ref. No.
1. Develop aTransmission Line Management Plan in consultation with Transgrid and DRE. Consider inclusion of montioring arrangements.	Events: 1.8	Phil Enright	15-Aug-2016	60001	34369.88447

CEY Risk Matrix Page 1

CENTENNIAL RISK MATRIX							Likelihood					
							A Certain	B Probable	C Possible	D Remote	E Improbable	Description (D)
Rating	Consequence Note: Consequence may result from a single event or may represent a cumulative impact over a period of 12 months. Use the worst case reasonable consequence if there is more than one.						Common	Has Happened within Centennial	Could Happen & has happened in non-CEY operations	Not Likely	Practically impossible	Probability (Pb)
	Financial Impact to Annual Business Plan (F)	Personal Injury (PI)	Business Interruption (BI)	Legal (L)	Reputation (R)	Environment (E)	Frequent incidents	Regular incidents	Infrequent incidents	Unlikely to occur. Very few recorded or known incidents	May occur in exceptional circumstances. Almost no recorded incidents.	Incident Frequency (IF)
							Operations – within 3 months	Operations – within 2 years	Operations – within 5 years	Operations – within 10 years	Operations – within 30 years	Operations (Op)
							Project – Every project	Project – Every 2 projects	Project – Every 5 projects	Project – Every 10 projects	Project – Every 30 projects	Project (Pr)
5. Catastrophic	>$50m	Multiple Fatalities	> 1month	Prolonged litigation, heavy fines, potential jail term	Prolonged International media attention	Long term impairment habitats/ ecosystem	25 (E)	24 (E)	21 (H)	19 (H)	15 (S)	
4. Major	$10m - $50m	Single Fatality	1 week to 1 month	Major breach/ major litigation	International media attention	Long term effects of ecosystem	23 (E)	22 (E)	18 (H)	14 (S)	10 (M)	
3. Moderate	$1m - $10m	Serious/ Disabling Injury	1 day to 1 week	Serious breach of regulation. prosecution/ fine	National media attention	Serious medium term environmental effects	20 (H)	17 (H)	13 (S)	9 (M)	6 (L)	
2. Minor	$100k - $1m	Lost Time Injury	12 hrs to 1 day	Non-compliance, breaches in regulation	Adverse local public attention	Minor effects to physical environment	16 (S)	12 (S)	8 (M)	5 (L)	3 (L)	
1. Insignificant	<$100k	First Aid Treatment Only	< 12 hrs	Low level compliance issue	Local complaints	Limited physical damage	11 (S)	7 (M)	4 (L)	2 (L)	1 (L)	

CEY Risk Matrix Page 2

Risk Rating	Risk Category		Generic Management Actions
22 to 25	E	Extreme	Immediate intervention required from senior management to eliminate or reduce this risk
17 to 21	H	High	Imperative to eliminate or reduce risk to a lower level by the introduction of control measures. Management planning required at senior levels
11 to 16	S	Significant	Corrective action required, senior management attention needed to eliminate or reduce risk
7 to 10	M	Moderate	Corrective action to be determined, management responsibility must be specified
1 to 6	L	Low	Monitor and manage by corrective action where practicable

CEY Risk Matrix Page 3

BOW TIE ANALYSIS - Control Effectiveness Matrix									
TYPE OF CONTROL	Examples	Description	Rank	Control Category	CONTROL – Impact / Status / Quality				
					A >= 80%	B 50 – 80%	C 50 / 50%	D 50 – 20%	E <= 20%
	Replace electric hand tools with compressed air alternatives in wet conditions	Eliminates a hazard by removal	1.	Elimination of hazard	100	45.0	40.0	14.0	10.0
	Replace large diameter, heavy cables with smaller ones that are easier to handle manually	Replace element with less risky alternative	2.	Substitution	85.0	40.0	35.0	13.0	8.5
	Automatic fire fighting sprinkler systems, Earth Leakage protection devices	An automatic device that operates without intervention by personnel	3.	Engineered without people	70.0	30.0	25.0	12.0	7.0
	Fire alarm that sounds & the operator then has to initiate an evacuation	A device that requires personnel to respond to a stimulus	4.	Engineered with people	50.0	20.0	14.0	10.0	5.0
	Inspection, maintenance and repair of machinery	A process carried out by personnel	5.	Procedural	20.0	15.0	10.0	6.5	2.0
	Employee made aware of dangers of large moving equipment where the operators have limited vision	Induction training programs	6.	Awareness	5.0	3.0	2.5	1.5	1.0