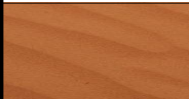


# VAM RAB Risk Assessment



# APPENDIX 3

**Dyadem Stature for Risk Management:**

**Risk Assessment Title:** VAM-RAB Demonstration Project Preliminary Environmental Risk Assessment

**Version:** 1

**Region:** North

**Site:** Mandalong

## BACKGROUND

Mandalong Mine is an underground longwall operation located in the Lake Macquarie Local Government Area (LGA) near Morisset west of the F3 Freeway. The Mine is operated by Centennial Mandalong Pty Limited (Centennial Mandalong) and is situated approximately 130 km north of Sydney. The mine supplies coal to both the domestic and export market. The current Mandalong longwall mining operations extracts coal from the West Wallarah coal seam, formed by the convergence of Wallarah and Great Northern seams. The depth and characteristics of these target seams results in the retention of methane (CH<sub>4</sub>) within the seams which is released upon extraction. Methane is a potent greenhouse gas, with around 21 times the global warming potential of carbon dioxide (CO<sub>2</sub>).

Mandalong Mine is Centennial Coal's gassiest mine and accounts for some 45% or 1.0Mt of CO<sub>2</sub> equivalents of Centennial Coals Scope 1 (direct) emissions per annum (FY2008). Mandalong Mine's GHG emissions are divided between high purity methane drainage gas (32% of emissions) and high flow rate ventilation air methane or 'VAM' (68% of emissions).

Ventilation air methane however typically has a concentration level of less than 1%, well below the lower flammability limit of 5% methane in air. Thus, the combustion characteristics of ventilation air methane are highly variable with methane concentrations never approaching the flammability limit. As such the remaining 68% of Mandalong Mines emissions are much more difficult to abate or utilise as an energy source due to the low concentration and variability of methane, impurities (dust and moisture) and high air flow.

A number of technologies to oxidise ultra low concentration methane/air mixtures are under development or are at the demonstration stage. One technology being investigated by Centennial is ventilation air methane regenerative afterburners ("VAM-RABs"). The VAM-RABs are fundamentally an oxidation vessel and a large (high thermal mass) ceramic heat exchanger that results in the oxidation of ventilation air methane. This technology has been developed and is being tested at pilot plant stage by a Newcastle based engineering company Corky's. A pre-feasibility study was undertaken on the implementation of this technology at the Mandalong Mine in late 2009.

The proposed project is seeking approval for and installation of new technology at Mandalong Mine to capture and abate approximately 10 cubic metres/second or 1/30th of the mines total ventilation air methane using VAM-RAB technology. The ventilation air methane will be collected from the mine on the surface at the fan evasee using a set back option for the initial demonstration phase. Once captured, approximately 10 cubic metres/second of ventilation air methane will then be transferred through a duct to the VAM-RAB. The VAM-RAB will be positioned near the mine ventilation fans to allow for possible later further construction of a complete set of VAM-RABs (phases 2 and 3).

The Project will be implemented in three phases. Phase one (the demonstration phase) will be the installation of a single VAM-RAB unit (one VAM-RAB pack contains up to 3 VAM-RAB units. Note that there is no heat recovery or generation component to this initial phase. Tests will be conducted over an initial eight (8) week period to verify performance of this technology. Longer-term effects such as seasonal effects, plant wear and tear etc will be considered over a further 12 months. Beyond the 14 months of experimentation, on-going operation of VAM-RAB technology at the Mandalong Mine will be considered subject to initial test results. Depending on the phase one result, phase 2 will involve the installation of an additional 17 VAM-RAB units and Phase 3 the remaining 18 units. It is proposed that successful implementation will result in the installation and operation of up to 36 VAM-RAB units (12 VAM-RAB packs) to capture and abate ventilation air methane from the Mandalong Mine (up to 300 cubic metres/second capacity) with potential heat recovery and generation potential of up to 7MW.

## 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, warning signs, 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, stickers, verbal warnings, etc.)

The Objectives of this Risk Assessment is to identify the environment and community risks associated with Phase 1 (the demonstration phase) of the Mandalong Mine VAM-RAB Project and identify areas where further information and or assessment will be required to support an Environmental Assessment for the proposed Project. This risk assessment aims to identify knowledge gaps where further information and/or assessment will be required in order for Centennial to make an informed decision regarding the environmental risks associated with the Project.

## **POTENTIAL HAZARDS/RISKS**

The potential environmental hazards/risks associated with Phase 1 (demonstration phase) of the Mandalong Mine VAM-RAB Project include:

- Air quality impacts;
- Noise impacts;
- Visual impacts;
- Ecological impacts;
- Archaeological impacts;
- Impacts on surface water;
- Increases in greenhouse gas emissions; and
- Leeching of acid sulphate soils.

## **SYSTEM BOUNDARY DEFINITION**

This Risk Assessment is a preliminary risk Assessment aimed to identify knowledge gaps and areas where further assessments will be required. The full extent of environmental risks associated with this project will not be understood until further and more detailed investigations have been undertaken. This risk assessment should be reviewed following the completion of the detailed investigations to ensure all environmental risks associated with the Project have been identified, understood and are at an acceptable level for the company.

The assessment considers 3 steps for the Project:

- 1 - Site Establishment
- 2 - Construction
- 3 - Operation

As previously stated, no site disestablishment is planned as, subject to initial test results, the plant will continue to operate. The plant will be designed to be located to allow continued operation whilst construction occurs for further plant in phases 2 and 3 (subject to further funding and approvals).

**REFERENCE MATERIAL**

<b>Document Name</b>	<b>Title</b>	<b>Version</b>	<b>Referenced Document Date</b>
Project Description	Mandalong Mine Modification - VAM Project Description and Justification	1	27-Aug-2010
Pre-Feasibility Report	Mandalong Greenhouse Abatement Facility - Prefeasibility Report - Stage 1	1	13-Oct-2009
Pre-Feasibility Report	Mandalong Greenhouse Abatement Facility - Prefeasibility Report - Stage 2	1	29-Jan-2010
Pre-Feasibility Report	Financial Aspects of the Mandalong Greenhouse Abatement Facility - Pre-feasibility Report - Stage 3	1	29-Jan-2010

## RISK ASSESSMENT PARTICIPANTS

Date	Description	Location	Start Time	End Time	Comment
1. 31-Jan-2011	Scoping	Fassifern	1:00 AM	2:30 AM	Scoping by J.Wearne
2. 01-Feb-2011	Assessment	Fassifern	9:00 AM	1:00 PM	J.Wearne and N.Alston
3. 01-Feb-2011	Review	Fassifern	1:00 PM	2:00 PM	Review by N.Alston

Name	Title	Company	Industry Start Date	Yrs. of Exp.	Mobile Phone #	E-Mail Address	Pulse User No.	Role	Attendance		
									31-Jan-2011	01-Feb-2011	01-Feb-2011
James Wearne	Environment & Community Coordinator	Centennial Coal	03-Oct-2005	5	0407207530	james.wearne@centennialcoal.com.au	100096	Facilitator	P	P	A
Neil Alston	Regional Technical Services Manager - North	Centennial Coal	02-Apr-1987	24	0408475771	neil.alston@centennialcoal.com.au	101000	Facilitator	A	P	P

Step	Potential Incident	Current Controls	L	MR C	RR	Recommended Control
1. Site Establishment	There is a risk to Mandalong from  ::: Land clearing :::	1.1.a. Mandalong Mine - Underground Mining Environmental Management Plan (May 2006)	A (D)	5 (E)	15 (S)	9. Undertake a detailed ecology assessment within the Project Application Area and identify appropriate measures to avoid mitigate or offset impacts where appropriate
	Caused by: Earthworks for site establishment  Resulting in: Loss of vegetation.	1.1.b. Report titled - The ecology in and around the Mandalong Mine surface facilities - Hunter Eco (September 2010) which includes vegetation mapping of Mandalong Mine surface facilities area.				
	There is a risk to Mandalong from  ::: Land clearing :::	1.2.a. Mandalong Mine - Underground Mining Environmental Management Plan (May 2006)	A (D)	4 (E)	10 (S)	
	Caused by: Earthworks for site establishment  Resulting in: Impacts to Endangered Ecological Communities (EECs).	1.2.b. Report titled - The ecology in and around the Mandalong Mine surface facilities - Hunter Eco (September 2010) which includes vegetation mapping of Mandalong Mine surface facilities area.				
	There is a risk to Mandalong from  ::: Land clearing :::	1.3.a. Mandalong Mine - Underground Mining Environmental Management Plan (May 2006)	A (D)	5 (E)	15 (S)	
	Caused by: Earthworks for site establishment  Resulting in: Loss of fauna habitat.	1.3.b. Report titled - The ecology in and around the Mandalong Mine surface facilities - Hunter Eco (September 2010) which includes vegetation				

Step	Potential Incident	Current Controls	L	MR C	RR	Recommended Control
		mapping of Mandalong Mine surface facilities area.				
	There is a risk to Mandalong from  ::: Land clearing :::  Caused by: Earthworks for site establishment  Resulting in: Impacts to threatened flora species.	1.4.a. Mandalong Mine - Underground Mining Environmental Management Plan (May 2006)  1.4.b. Report titled - The ecology in and around the Mandalong Mine surface facilities - Hunter Eco (September 2010) which includes threatened flora mapping of Mandalong Mine surface facilities area.	C (D)	4 (E)	18 (M)	9. Undertake a detailed ecology assessment within the Project Application Area and identify appropriate measures to avoid mitigate or offset impacts where appropriate
	There is a risk to Mandalong from  ::: Land clearing :::  Caused by: Earthworks for site establishment  Resulting in: Impacts to Archaeological sites.	1.5.a. Mandalong Mine - Underground Mining Environmental Management Plan (May 2006).  1.5.b. Archaeological survey of the Mandalong Mine surface facilities in 1997 as part of the Mandalong Mine Environmental Impact Statement (Umwelt 1997)	D (D)	4 (E)	21 (L)	1. Undertake Archaeological survey over the study area.  2. Undertake Aboriginal consultation in accordance with the Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010  3. Prepare an Aboriginal Heritage Impact Assessment for the proposed Project
	There is a risk to Mandalong from  ::: Land clearing :::  Caused by: Earthworks for site establishment	1.6.a. Noise assessment for the Mandalong Mine surface facilities site by Heggies in 2006 as part of the Statement of Environmental Effects for the Mandalong Mine gas flares.	C (D)	5 (E)	22 (L)	10. Include construction activities in detailed noise assessment for the Project

Step	Potential Incident	Current Controls	L	MR C	RR	Recommended Control
	Resulting in: Exceedances of noise criteria at site.	1.6.b. Noise limits within the Mandalong Mine development consent (DA 97/800)				8. Undertake a noise impact assessment for the proposed Project as part of the Environmental Assessment
		1.6.c. Annual attended noise monitoring around the Mandalong mine surface facilities area				
	There is a risk to Mandalong from  ::: Land clearing :::  Caused by: Earthworks for site establishment	1.7.a. Air quality assessment undertaken for the Mandalong Mine surface facilities area in 1997 as part of the Mandalong Mine Environmental Impacts Statement.	<b>C</b> (D)	5 (E)	<b>22</b> (L)	4. Undertake an air quality impact assessment for the proposed Project as part of the Environmental Assessment
	Resulting in: Exceedances of dust/air quality criteria.	1.7.b. Any fill will be sourced nearby on-site and placed using appropriate civil contractor				
	There is a risk to Mandalong from  ::: Land clearing :::  Caused by: Earthworks for site establishment	1.8.a. Mandalong Mine - Underground Mining Environmental Management Plan (May 2006).	<b>B</b> (D)	4 (E)	<b>14</b> (S)	5. Surface Water Impact Assessment to be undertaken for the proposed Project to identify any impacts and identify mitigation measures if/where required
	Resulting in: Impacts to surface waters.					
	There is a risk to Mandalong from  ::: Land clearing :::	1.9.a. European heritage assessment undertaken as part of the 1997 Mandalong Mine Environmental Impact	<b>E</b> (D)	5 (E)	<b>25</b> (L)	

Step	Potential Incident	Current Controls	L	MR C	RR	Recommended Control
	<p>Caused by: Earthworks for site establishment</p> <p>Resulting in: Impacts to European heritage sites.</p>	<p>Statement.</p> <p>1.9.b. The Australian Heritage Database</p> <p>1.9.c. The NSW Heritage Inventory</p> <p>1.9.d. Lake Macquarie Local Environmental Plan</p>				
	<p>There is a risk to Mandalong from</p> <p>::: Land clearing :::</p> <p>Caused by: Earthworks for site establishment</p> <p>Resulting in: Leeching/runoff of acid sulphate soils.</p>	<p>1.10.a. Mandalong Mine - Underground Mining Environmental Management Plan (May 2006).</p>				<p>6. Undertake soil assessment as part of Environmental Assessment for the proposed Project</p> <p>7. Implement suitable erosion and sediment controls during construction if/where required.</p>
2. Construction	<p>There is a risk to Mandalong from</p> <p>::: Construction activities :::</p> <p>Caused by: Installation of VAM-RAB facility</p> <p>Resulting in: Exceedances of noise criteria at site.</p>	<p>2.1.a. Noise assessment for the Mandalong Mine surface facilities site by Heggies in 2006 as part of the Statement of Environmental Effects for the Mandalong Mine gas flares.</p> <p>2.1.b. Noise limits within the Mandalong Mine development consent (DA 97/800)</p> <p>2.1.c. Annual attended noise monitoring around the</p>				<p>8. Undertake a noise impact assessment for the proposed Project as part of the Environmental Assessment</p>

Step	Potential Incident	Current Controls	L	MR C	RR	Recommended Control
		Mandalong mine surface facilities area				
		2.1.d. Off-site modular construction will reduce on-site construction time				
		2.1.e. Construction during daylight hours 7am-6pm Monday to Friday and 8am-1pm on Saturday. No construction to be undertaken on Sundays or public holidays.				
	There is a risk to Mandalong from ::: Construction activities :::  Caused by: Installation of VAM-RAB facility	2.2.a. Noise assessment for the Mandalong Mine surface facilities site by Heggies in 2006 as part of the Statement of Environmental Effects for the Mandalong Mine gas flares.	C (D)	5 (E)	22 (L)	11. Ensure Environmental Assessment includes all areas potentially impacted by the proposed Project
	Resulting in: Clearing outside approved areas.	2.2.b. Defined Project Area				12. Delineate no-go zones during construction activities
	There is a risk to Mandalong from ::: Construction activities :::  Caused by: Installation of VAM-RAB facility	2.3.a. Visual assessment completed in 2006 as part of the Statement of Environmental Effects for the gas flares at the Mandalong mine	C (D)	5 (E)	22 (L)	13. Undertake a visual impact assessment as part of the Project Environmental Assessment
	Resulting in: Impacts to visual amenity					

Step	Potential Incident	Current Controls	L	MR C	RR	Recommended Control
	criteria.					
3. Operation	<p>There is a risk to Mandalong from</p> <p>::: Operation activities :::</p> <p>Caused by: Operation of VAM-RAB facility</p> <p>Resulting in: Exceedances of noise criteria at site.</p>	<p>3.1.a. Noise assessment for the Mandalong Mine surface facilities site by Heggies in 2006 as part of the Statement of Environmental Effects for the Mandalong Mine gas flares.</p> <p>3.1.b. Noise limits within the Mandalong Mine development consent (DA 97/800)</p> <p>3.1.c. Annual attended noise monitoring around the Mandalong mine surface facilities area</p>	C (D)	5 (E)	22 (L)	8. Undertake a noise impact assessment for the proposed Project as part of the Environmental Assessment
	<p>There is a risk to Mandalong from</p> <p>::: Operation activities :::</p> <p>Caused by: Operation of VAM-RAB facility</p> <p>Resulting in: Exceedances of dust/air quality criteria.</p>	3.2.a. Air quality assessment undertaken for the Mandalong Mine surface facilities area in 1997 as part of the Mandalong Mine Environmental Impacts Statement.	C (D)	5 (E)	22 (L)	4. Undertake an air quality impact assessment for the proposed Project as part of the Environmental Assessment
	<p>There is a risk to Mandalong from</p> <p>::: Operation activities :::</p> <p>Caused by:</p>	3.3.a. Visual assessment completed in 2006 as part of the Statement of Environmental Effects for the gas flares at the Mandalong mine	C (D)	5 (E)	22 (L)	13. Undertake a visual impact assessment as part of the Project Environmental Assessment

Step	Potential Incident	Current Controls	L	MR C	RR	Recommended Control
	Operation of VAM-RAB facility  Resulting in: Impacts to visual amenity criteria.	3.3.b. Stack height restricted to 10.6 metres. RAB tower restricted to approximately 9.1 metres high.  3.3.c. 'Mist Green' painted surface finish excluding safety components (handrails etc). Colour to be painted mist green				
	There is a risk to Mandalong from  ::: Operation activities :::  Caused by: Operation of VAM-RAB facility  Resulting in: Increase in GHG emissions at Mandalong Mine.	3.4.a. Designed VAM burnout capability of 99.9% will result in reduced GHG emissions  3.4.b. Verification of GHG emission reduction through ENGERS reporting				14. Undertake an assessment of the Projects GHG emissions as part of the Environmental Assessment. 15. Consider life cycle analysis in GHG assessment
			<b>E</b> (D)	5 (E)	<b>25</b> (L)	

<b>Recommended Controls</b>	<b>Place(s) Used</b>	<b>Allocated To</b>	<b>Required By Date</b>
<b>Do NOT enter additional Recommended Controls on this sheet.</b>		<b>(Only one SITE person for each Recommended Control)</b>	
1. Undertake Archaeological survey over the study area.	Events: 1.5	James Wearne	30-Jun-2011
2. Undertake Aboriginal consultation in accordance with the Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010	Events: 1.5	James Wearne	30-Jun-2011
3. Prepare an Aboriginal Heritage Impact Assessment for the proposed Project	Events: 1.5	James Wearne	30-Jun-2011
4. Undertake an air quality impact assessment for the proposed Project as part of the Environmental Assessment	Events: 1.7, 3.2	James Wearne	30-Jun-2011
5. Surface Water Impact Assessment to be undertaken for the proposed Project to identify any impacts and identify mitigation measures if/where required	Events: 1.8	James Wearne	30-Jun-2011
6. Undertake soil assessment as part of Environmental Assessment for the proposed Project	Events: 1.10	James Wearne	30-Jun-2011
7. Implement suitable erosion and sediment controls during construction if/where required.	Events: 1.10	James Wearne	30-Jun-2011
8. Undertake a noise impact assessment for the proposed Project as part of the Environmental Assessment	Events: 1.6, 2.1, 3.1	James Wearne	30-Jun-2011
9. Undertake a detailed ecology assessment within the Project Application Area and identify appropriate measures to avoid mitigate or offset impacts where appropriate	Events: 1.1, 1.2, 1.3, 1.4	James Wearne	30-Jun-2011
10. Include construction activities in detailed noise assessment for the Project	Events: 1.6	James Wearne	30-Jun-2011
11. Ensure Environmental Assessment includes all areas potentially impacted by the proposed Project	Events: 2.2	James Wearne	30-Jun-2011
12. Delineate no-go zones during construction activities	Events: 2.2	James Wearne	30-Jun-2011
13. Undertake a visual impact assessment as part of the Project Environmental Assessment	Events: 2.3, 3.3	James Wearne	30-Jun-2011
14. Undertake an assessment of the Projects GHG emissions as part of the Environmental Assessment,	Events: 3.4	James Wearne	30-Jun-2011
15. Consider life cycle analysis in GHG assessment	Events: 3.4	James Wearne	30-Jun-2011

**RISK MANAGEMENT STANDARD**

**Management Standard-004**

CENTENNIAL RISK MATRIX							Likelihood					Description (D)
							A Certain	B Probable	C Possible	D Remote	E Improbable	
Rating	Consequence						Common"	Has Happened within Centennial"	"Could Happen & has happened in non-CEY operations	Not Likely	"Practically impossible	Probability (Pb)
	<b>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.</b>						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)
	Impact to Annual Business Plan (F)	Personal Injury (PI)	Business Interruption (BI)	Legal (L)	Reputation (R)	Environment (E)	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)
<b>1. Catastrophic</b>	>\$50m	Multiple Fatalities	> 1month	Prolonged litigation, heavy fines, potential jail term	Prolonged International media attention	Long term impairment habitats/ ecosystem	1 (E)	2 (E)	5 (H)	7 (H)	11 (S)	
<b>2. Major</b>	\$10m - \$50m	Single Fatality	1 week to 1 month	Major breach/ major litigation	International media attention	Long term effects of ecosystem	3 (E)	4 (E)	8 (H)	12 (S)	16 (M)	
<b>3. Moderate</b>	\$1m - \$10m	Serious/ Disabling Injury	1 day to 1 week	Serious breach of regulation. prosecution/ fine	National media attention	Serious medium term environmental effects	6 (H)	9 (H)	13 (S)	17 (M)	20 (L)	
<b>4. Minor</b>	\$100k - \$1m	Lost Time Injury	12 hrs to 1 day	Non-compliance, breaches in regulation	Adverse local public attention	Minor effects to physical environment	10 (S)	14 (S)	18 (M)	21 (L)	23 (L)	
<b>5. Insignificant</b>	<\$100k	First Aid Treatment Only	< 12 hrs	Low level compliance issue	Local complaints	Limited physical damage	15 (S)	19 (M)	22 (L)	24 (L)	25 (L)	

Risk Rating	Risk Category		Generic Management Actions
1 to 4	<b>E</b>	<b>Extreme</b>	Immediate intervention required from senior management to eliminate or reduce this risk
5 to 9	<b>H</b>	<b>High</b>	Imperative to eliminate or reduce risk to a lower level by the introduction of control measures. Management planning required at senior levels
10 to 15	<b>S</b>	<b>Significant</b>	Corrective action required, senior management attention needed to eliminate or reduce risk
16 to 19	<b>M</b>	<b>Moderate</b>	Corrective action to be determined, management responsibility must be specified
20 to 25	<b>L</b>	<b>Low</b>	Monitor and manage by corrective action where practicable

**THIS DOCUMENT IS UNCONTROLLED UNLESS VIEWED ON THE INTRANET**

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