9 November 2016

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Centennial Mandalong Pty Ltd
12 Kerry Anderson Drive
Mandalong
NSW 2264

Attention: Iain Hornshaw

Dear Iain

SSD-5144 MOD 4
Longwall Panel 22-23 Extension Modification (Mod 4)
Greenhouse Gas Assessment

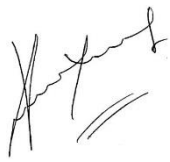
SLR Consulting has been commissioned by Centennial Mandalong Pty Limited (Centennial Mandalong) to prepare a Greenhouse Gas (GHG) assessment for the extensions to longwall panels 22 and 23, located within the approved Project Application Area of SSD-5144.

A GHG assessment for the Mandalong Southern Extension Project (Extension Project) was completed by BDM Resources in 2012 (BDM 2012). Further, a GHG assessment for the Mandalong Tonnage Increase Modification (Mod 3) was submitted as part of the Statement of Environmental Effects (SEE) in September 2016.

The current GHG assessment aims to quantify the life of mine (LOM) GHG emissions due to secondary extraction of extended longwall panels 22 and 23 (Mod 4). The methodology, results and conclusions of the GHG assessment are attached.

We trust this letter provides you with the information required, however if you should have any questions or require further information, please do not hesitate to contact the undersigned.

Yours sincerely



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1 Background

Mandalong Mine is an existing underground longwall coal mining operation producing thermal coal that is supplied to domestic and export markets. It is located approximately 35 kilometres south-west of Newcastle near Morisset in New South Wales. Mandalong Mine is 100 percent owned and operated by Centennial Mandalong, a subsidiary of Centennial Coal Company Limited. Centennial Coal Company Limited is a wholly owned subsidiary of Banpu Public Company Limited.

Mandalong Mine operates under Development Consent SSD-5144 which was granted on 12 October 2015 by the NSW Planning Assessment Commission under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), and provided for extension of the mining area with a production limit of 6 million tonnes per annum of thermal coal from the West Wallarah and Wallarah-Great Northern Seams.

The currently approved Mandalong Mine comprises the underground workings and surface infrastructure of the following:

- The Mandalong Mine Access Site, encompassing underground workings and associated surface infrastructure near Morisset.
- Delivery of run-of-mine coal from the underground workings to the Cooranbong Entry Site. The Cooranbong Entry Site coal handling and processing facilities are approved under the Northern Coal Logistic Project (SSD-5145).
- Delivery of run-of-mine coal from the underground workings to the Delta Entry Site, located near Wyee at the Vales Point Rail Unloader Facility. The coal handling facility is approved under DA35-2-2004.
- Mandalong South Surface Site (MSSS), which is yet to be constructed, encompassing ventilation shafts, ventilation fans and underground delivery boreholes located approximately 6 kilometres south-west of the Mandalong Mine Access Site.

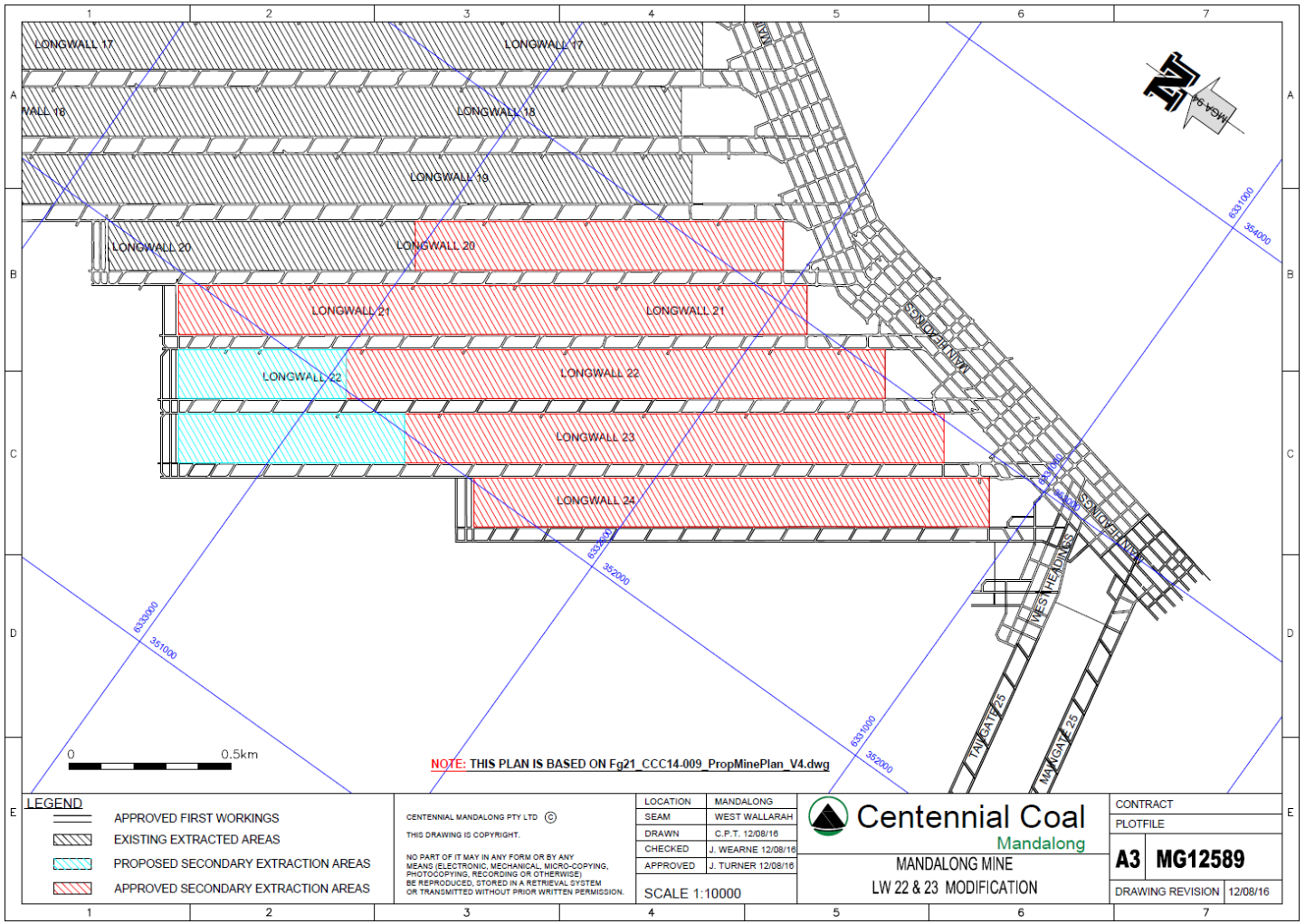
An igneous sill exists to the west of approved longwall panels 22 to 24. Due to historic uncertainty associated with the extent of the igneous sill, longwall panels 22 to 24 were shortened as a conservative measure to mitigate the sill's impact on the mine's production. In recent times, through ongoing geological exploration and the successful extraction of adjacent longwall panels below the igneous sill, its extent and condition has become better understood. This has resulted in the proposed extension of longwall panels 22 and 23 within the Project Application Area of SSD-5144. **Figure 1** illustrates the proposed extension of longwall mining within these two panels.

Centennial Mandalong has prepared a Statement of Environmental Effects (SEE) to support an application seeking to modify Development Consent SSD-5144 under Part 4 of the EP&A Act. The modification is seeking to undertake the secondary extraction of longwall panels 22 and 23 within the Project Application Area of SSD-5144 as illustrated on **Figure 1**.

Outlined below are the primary components of the Mandalong Longwall Panel 22 to 23 Modification:

- Extension of Longwall 22 from 1,630 metres (m) to 2212 m. This yields an additional 617,381 tonnes (t) beyond the 1,793,842 t already approved.
- Extension of Longwall 23 from 1,631 m to 2,392 m. This yields an additional 799,933 t beyond the 1,799,425 t already approved.

Figure 1 Mandalong Mine – Proposed extensions to Longwall 22 and 23



2 Legislative Framework

State Significant Development (SSD) Consent SSD-5144 was granted on 12 October 2015 by the NSW Planning Assessment Commission under Part 4 Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Centennial Mandalong is now proposing to modify its Development Consent SSD 5144 for the Mandalong Longwall Panel 22 to 23 Modification. SSD consents may be modified under Section 96 of the EP&A Act provided that the development as modified will be substantially the same development as the development for which consent was originally granted.

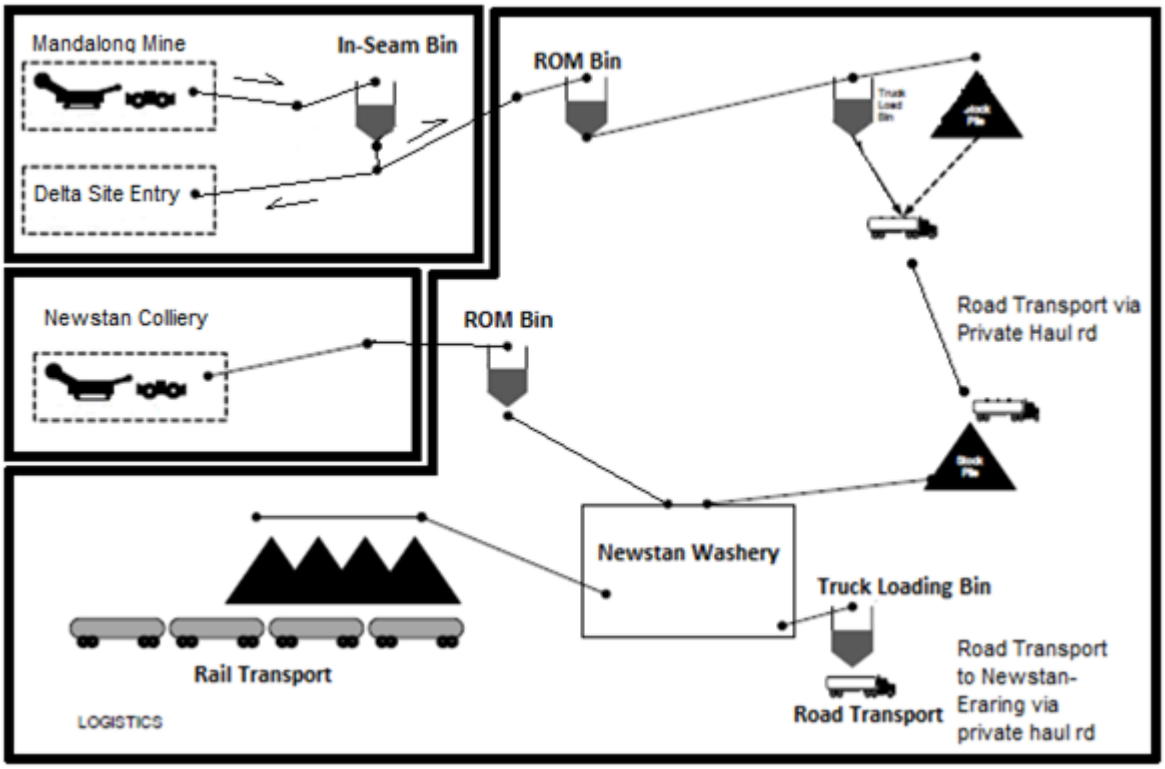
It is considered the proposed modifications to the Mandalong Southern Extension Project SSD-5144 development consent are substantially the same development as the development for which consent was originally granted being an underground longwall coal mine. The proposed modification will provide additional coal resources given the improved understanding regarding the extent and condition associated with the igneous sill. As such, it is considered the modification can be modified pursuant to Section 96(2) of the EP&A Act.

3 Project Boundary

The boundaries between the Northern Coal Logistics Project (SSD-5145), Mandalong Southern Extension Project (SSD-5144) and Mandalong Coal Delivery System (DA 35-2-2004) are presented in **Figure 2**. The same Project boundaries as the previous GHG assessment (BDM 2012) have been adopted for this Project.

For comprehensiveness, this report includes an assessment of scope 3 emissions, including combustion of the product coal by the end user.

Figure 2 GHG inventory boundaries between the three concurrent northern Centennial projects (BDM 2012)



4 GHG Emission Sources

The GHG emissions associated with the Project have been assessed in terms of direct (Scope 1) emission potential, indirect (Scope 2) emission potential and significant upstream/downstream (Scope 3) emission potential.

A summary of the potential Project GHG emission sources considered in this assessment is provided in **Table 1**.

It is noted that a number of scope 1 emission sources have not been included in the GHG emission calculations due to their contribution being less than 1% of total Project emissions. Specifically, emissions from SF_6 leakage, oils and grease consumption (not combusted), LPG consumption and waste to landfill are considered to be negligible compared to the total Scope 1 and Scope 2 GHG emissions from the Project.

Table 1 Summary of Potential Project Greenhouse Gas Emissions

Project Component	Direct Emissions	Indirect Emissions	
	Scope 1	**Scope 2**	**Scope 3**
Fugitive Emissions	Emissions from the release of coal seam methane and carbon dioxide as a result of extraction activities.	N/A	N/A
Diesel	Emissions from the combustion of diesel at the Project in both mobile and fixed plant and equipment	N/A	N/A
Electricity	N/A	Emissions associated with the consumption of generated and purchased electricity at the mine.	N/A
Coal Combustion	N/A	N/A	Emissions from the combustion of coal from the Project.

N/A = Not applicable

5 Activity Data

The activity data used for the GHG emissions calculations for this Project are shown in **Table 2**.

As shown in **Table 2** the Longwall 22 and 23 extensions will result in an additional 1.4 Mt of coal being extracted from Mandalong Mine over the life of the mine. The GHG emissions associated with extracting this additional resource have therefore been compared to the total life of mine GHG emissions, rather than the Mine's annual GHG emissions. It is also noted that the proposed extraction of this additional 1.4 Mt is proposed to be achieved within the existing approved mine life and annual extraction rate. The estimated incremental GHG emissions associated with the Longwall 22 and 23 extensions therefore should be regarded as a component of the total life of mine GHG emissions presented in this report (which are based on 6.5 Mtpa being extracted over 25 years).

Table 2 Project Activity Data

Activity Data	Quantity	Units
Maximum annual coal production	6.5	Mtpa
Project commences	2016	-
Project ceases	2040	-
Years of Project operation	25	years
Drainage Gas		
Maximum pre-drainage gas flow of CH_4	800	L/sec
Maximum pre-drainage gas flow of CO_2	33	L/sec
Mandalong Ventilation Air		
Maximum flow rate of mine ventilation air (MVA)	500	m^3/sec
Average ventilation CH_4 concentration (VAM)	0.46	%
Average ventilation CO_2 concentration	0.019	%
Cooranbong Ventilation Air		
Cooranbong maximum ventilation flow rate	75	m^3/sec
Concentration of CH_4 in Cooranbong ventilation flow	0.09	%
Concentration of CO_2 in Cooranbong ventilation flow	0.05	%
Electricity		
Internal power needs (average demand)[1]	131,911,000	kWh pa
Diesel		
Maximum annual underground diesel usage [1]	1,066	kL
Longwall Panels 22 & 23		
Additional Coal Production - Longwall Panels 22 & 23	1.41731	Mt (over life of mine)
Additional Electricity[2]	28,762,970	kWh (over life of mine)
Additional Diesel[2]	232	kL (over life of mine)

Note:
[1] Scaled up based on the usage provided for production of 6 Mtpa coal
[2] Estimated based on the usage provided for production of 6 Mtpa coal

6 Emission Factors

The emission factors for the Scope 1, 2 and 3 emissions are presented below and are sourced from the *National Greenhouse Accounts Factors* published by the Australian Government's Department of the Environment (DEE 2016 b).

Table 3 A Summary of Emission Factors used for the Calculation of GHG Impacts (DEE 2016 b)

Scope 1				
Emission Source	**Energy Content (GJ/m^3)**	**Emission Factor (kg CO2-e/GJ)**		
		CO_2	**CH_4**	**N_2O**
Combustion of diesel oil for stationary energy purposes	38.6	69.9[a]	0.1	0.2
Combustion of diesel oil for transport energy purposes (post-2004 vehicles)	38.6	69.9[a]	0.01	0.6
Scope 2				
Emission Source	**Emission Factor (kg CO_2-e/kWh)**			
Consumption of purchased electricity	0.84[b]			
Scope 3				
Emission Source	**Energy Content (GJ/m^3)**	**Emission Factor (kg CO2-e/GJ)**		
		CO_2	**CH_4**	**N_2O**
Total coal combusted - Bituminous coal	27	90[c]	0.03	0.2
Other Factors				
Description	**Units**	**Value**		
		CO_2	**CH_4**	
Greenhouse gas GWPs	(t CO_2-e/t CO_2)	1	25	
Volume to mass conversion	(m^3 [STP] to t)[d]	1.861×10^{-3}	6.784×10^{-4}	
Oxidation factor for flaring	-	0.98	-	

[a] The CO_2 emission factor for diesel combustion for stationary energy purposes changed from 69.2 (NGA Factors 2012) to 69.9 kg CO_2-e/GJ (NGA Factors 2016)

[b] The emission factor for electricity usage in NSW changed from 0.88 (NGA Factors 2012) to 0.84 kg CO_2-e/GJ (NGA Factors 2016);

[c] The CO_2 emission factor for bituminous coal combustion changed from 88.2 (NGA Factors 2012) to 90 kg CO_2-e/kWh (NGA Factors 2016)

[d] All gas values are stated at Standard Temperature and Pressure (STP) of 288.15 K and 101.325 kPa (NGER (Measurement) Determination 2008, page 71)

7 GHG Emissions

7.1 Scope 1 Emissions

Scope 1 emissions refer to the "direct emissions" that occur as a result of the Project. The Scope 1 emissions from this Project are:

- Fugitive emissions from drainage gas;
- Fugitive emissions from Ventilation Air Methane (VAM); and
- Emissions from combustion of diesel.

7.1.1 Fugitive Emissions from Drainage Gas

Scope 1 fugitive emissions from the extraction of coal from underground mines are determined using Method 4 - Extraction of coal, Division 3.2.2 Subdivision 3.2.2.2 Section 3.6 of the NGER technical guidelines (DEE 2016 a).

The annual pre-drainage gas emission rate will not increase as a result of the proposed extensions to longwall panels 22 and 23 as the in-situ seam gas pressures will remain unchanged and the gas generation rate is independent of production rates. The pre-drainage maximum gas flow rate used in the calculations of 833 L/s (96% CH_4 and 4% CO_2) is therefore unchanged from the previous assessment (BDM 2012). The calculated annual and life of mine (LOM) Scope 1 fugitive emissions from drainage gas are shown in **Table 4**. The associated contribution of the Longwall 22 and 23 extensions to the total LOM emissions is shown in the shaded cells.

Table 4 Calculated Fugitive Emissions from Drainage Gas – Scope 1

Source	Mandalong Tonnage Increase Modification 3 (6.5 Mtpa)		Associated Longwall 22 & 23 Extension (1.4 Mt)
	Annual GHG Emissions (tonnes CO_2-e per annum)	LOM GHG Emissions (25 years) (tonnes CO_2-e)	(tonnes CO_2-e)
Emissions from drainage gas	429,837[1]	10,745,925[1]	93,721

[1]Source: Centennial 2016

7.1.2 Fugitive Emissions from Mine Ventilation Air

The Project comprises three sites, the existing Mandalong Mine and Cooranbong sites, and the proposed southern extension surface site. All three sites will be connected via an underground ventilation network as illustrated in **Figure 2**. Ventilation fans are currently located at Cooranbong and Mandalong Mine and will be installed at the proposed southern surface site. The Cooranbong fan does not draw in air from new mine workings and subsequently has a lower methane concentration and contribution to Project emissions.

For a production rate of 6 Mtpa (Extension Project), the maximum ventilation air flow rate was reported to be 500 m^3/sec (0.46% CH_4 and 0.019% CO_2) for Mandalong Mine and 75 m^3/sec for Cooranbong (0.09% CH_4 and 0.05% CO_2). To provide a conservative estimate of the GHG emissions due to Longwall 22 and 23 extensions, these air flow rates have been scaled accordingly. The GHG emissions due to the Mandalong Tonnage Increase Modification 3 (6.5 Mtpa) are sourced from the SEE prepared for Mod 3 (Centennial 2016). The resulting calculated annual and LOM Scope 1 fugitive emissions from mine ventilation air are shown in **Table 5**. The associated contribution of the Longwall 22 and 23 extensions to the total LOM emissions is shown in the shaded cells.

Table 5 Calculated Fugitive Emissions from Mine Ventilation Air – Scope 1

Source	Mandalong Tonnage Increase Modification 3 (6.5 Mtpa)		Associated Longwall 22 & 23 Extension (1.4 Mt)
	Annual GHG Emissions (tonnes CO_2-e per annum)	LOM Emissions (25 years) (tonnes CO_2-e)	(tonnes CO_2-e)
Emissions from mine ventilation	1,385,486[1]	34,367,150[1]	300,951

[1]Source: Centennial 2016

7.1.3 Diesel Combustion Emissions

Scope 1 emissions from the use of diesel fuel in mobile and fixed plant and equipment were estimated using Method 1 - Emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum based oils or greases, Division 2.4.2 Section 2.41 of the NGER technical guidelines (DEE 2016 a). The energy content of diesel fuel was taken to be 38.6 GJ/kL and the relevant Scope 1 emission factors are shown in **Table 3**.

Diesel consumption is linked to production. To assess the incremental contribution of the proposed Project, the maximum diesel consumption rate for the production of 6 Mtpa (984 kL) was scaled accordingly to give 1,066 kL for 6.5 Mtpa and 252 kL for the Longwall 22 & 23 Extension (1.4 Mtpa). The resulting calculated annual and LOM Scope 1 emissions from diesel consumption are shown in **Table 6**. The associated contribution of the Longwall 22 and 23 extensions to the total LOM emissions is shown in the shaded cells.

Table 6 Calculated Emissions from Diesel Combustion – Scope 1

Source	Mandalong Tonnage Increase Modification 3 (6.5 Mtpa)		Associated Longwall 22 & 23 Extension (1.4 Mt)
	Annual GHG Emissions (tonnes CO_2-e per annum)	LOM Emissions (25 years) (tonnes CO_2-e)	(tonnes CO_2-e)
Emissions from diesel combustion	2,889[1]	72,214[1]	630

[1] Adjusted from Centennial (2016) to account for the updated NGA Emission Factor as discussed in **Section 6**.

7.2 Scope 2 Emissions

Scope 2 emissions refer to indirect emissions associated with the generation of imported electricity. Scope 2 GHG emissions as defined by NGERS were estimated using Method 1 – purchase of electricity from main electricity grid in a State or Territory, Chapter 7, section 7.2 of the NGER technical guidelines (DEE 2016 a).

State emission factors are used because electricity flows between states are significantly constrained by the capacity of the inter-state interconnectors and in some cases there are no interconnections.

Electricity consumption at Centennial Mandalong is associated with conveyors and current ventilation requirements, as well as bath house operations etc. It has therefore been assumed that the contribution of the proposed longwall panels 22 and 23 extensions to the total LOM emissions will be proportional to the 1.4 Mt extracted. The annual and LOM Scope 2 emissions from electricity consumption are shown in **Table 7** and the associated contribution of the Longwall 22 and 23 extensions to the total LOM emissions is shown in the shaded cells.

Table 7 Calculated Emissions from Electricity Consumption – Scope 2

Source	Mandalong Tonnage Increase Modification 3 (6.5 Mtpa)		Associated Longwall 22 & 23 Extension (1.4 Mt)
	Annual GHG Emissions (tonnes CO_2-e per annum)	LOM Emissions (25 years) (tonnes CO_2-e)	(tonnes CO_2-e)
Emissions from electricity consumption	110,805[1]	2,770,131[1]	24,161

[1] Adjusted from Centennial (2016) to account for the updated NGA Emission Factor as discussed in **Section 6**.

7.3 Scope 3 Emissions

Scope 3 emissions for the Mandalong Mine are primarily associated with combustion of the product coal by the end user. Other sources of Scope 3 GHG emissions, such as product transport and employee travel, total less than 5% and are considered negligible in comparison to the total Scope 3 emissions.

Scope 3 emissions as a result of combustion of the product coal have been calculated using Method 1 - Emissions of carbon dioxide, methane and nitrous oxide from solid fuels, Division 2.2.2, Section 2.4 of the NGER technical guidelines (DEE 2016 a). The annual and LOM Scope 3 emissions from the combustion of bituminous coal are shown in **Table 8**. The associated contribution of the Longwall 22 and 23 extensions to the total LOM emissions is shown in the shaded cells.

Table 8 Calculated Emissions from coal combustion – Scope 3

Source	Mandalong Tonnage Increase Modification 3 (6.5 Mtpa)		Associated Longwall 22 & 23 Extension (1.4 Mt)
	Annual GHG Emissions (tonnes CO_2-e per annum)	LOM Emissions (25 years) (tonnes CO_2-e)	(tonnes CO_2-e)
Emissions from coal combustion	15,835,365[1]	395,884,125[1]	3,452,875

[1] Adjusted from Centennial (2016) to account for the updated NGA Emission Factor as discussed in **Section 6**.

7.4 Summary of Emissions

A summary of the estimated annual and LOM Scope 1, 2 and 3 emissions are shown in **Table 9**. It is noted that the emissions associated with the Longwall 22 and 23 extensions represent the contribution of the extraction of this additional resource to the LOM emissions which are based on the maximum production rate of 6.5 Mtpa and the full 25 year life of the mine. The 1.4 Mt coal proposed to be extracted as part of the Longwall 22 and 23 extensions will be achieved within this current approved annual extracted rate and mine life.

Table 9 Summary of Scope 1, 2 and 3 Emissions from the Project

Source	Mandalong Tonnage Increase Modification 3 (6.5 Mtpa)		Associated Longwall 22 & 23 Extension (1.4 Mt)
	Annual GHG Emissions (tonnes CO_2-e per annum)	LOM Emissions (25 years) (tonnes CO_2-e)	(tonnes CO_2-e)
Scope 1			
Emissions from drainage gas	429,837	10,745,925	93,721
Emissions from mine ventilation	1,385,486	34,637,150	300,951
Emissions from diesel combustion	2,889	72,214	630
Scope 2			
Emissions from electricity consumption	110,805	2,770,131	24,161
Scope 3			
Emissions from coal combustion	15,835,365	395,884,125	3,452,875
TOTAL – Scope 1	**1,818,212**	**45,455,289**	**395,302**
TOTAL – Scope 1 & 2	**1,929,017**	**48,225,420**	**419,463**

7.5 Comparison with National and State GHG Emissions

Emissions of GHG in NSW were reported to be 130.1 Mt in 2014, (DEE 2016c) which was approximately 25% of the total Australian GHG emissions of 523.1 Mt (DEE 2016c). A comparison of the emissions estimated for Mandalong Mine with NSW and Australia emission totals is presented in **Table 10**. As shown in **Table 9**, the contribution of Longwall 22 and 23 extensions to the total LOM emissions is minimal, at less than 1%.

Table 10 Comparison of Modified Project GHG Emissions with State and National Totals 2014

Emission Scope	Estimated Emissions (tCO_2-e/annum)	Percentage of NSW 2014 GHG Emission Total	Percentage of Australian 2014 GHG Emission Total
Scope 1	1,818,212	0.001%	0.0003%
Scope 1 and 2	1,929,017	0.001%	0.0004%

8 References

- BDM 2012, Mandalong Southern Extension Project (MLS) Greenhouse Gas Report for EIS, BDM Resources 12/12/2012.
- Centennial 2016, Statement of Environmental Effects, Mandalong Mine – State Significant Development 5144 – Modification 3, September 2016.
- DEE 2016a, National Greenhouse and Energy Reporting Scheme Measurement, *Technical Guidelines for the estimation of emissions by facilities in Australia*, Australian Government's Department of the Environment and Energy, August 2016.
- DEE 2016b, *National Greenhouse Accounts Factors* published by the Australian Government's Department of the Environment and Energy, August 2016.
- DEE 2016c, National Inventory Report 2014 (revised) - Volume 1, The Australian Government Submission to the United Nations Framework Convention on Climate Change, Australian National Greenhouse Accounts, Department of the Environment and Energy, August 2016