Appendix 15

Greenhouse Gas and Energy Assessment

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Greenhouse Gas and Energy Assessment

Bulga Optimisation Project

December 2012

Greenhouse Gas and Energy Assessment

Bulga Optimisation Project

December 2012

Prepared by
Umwelt (Australia) Pty Limited

on behalf of
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Executive Summary

The Bulga Coal Complex (BCC) is located in the Upper Hunter Valley approximately 4 kilometres to the south-east of the Bulga village, approximately 4 kilometres to the north of the village of Broke and is approximately 12 kilometres south-west of Singleton. The BCC includes an open cut coal mine, an underground coal mine, a coal handling and preparation plant, workshop facilities and administrative buildings.

The current open cut operations are approved to operate until 2025, however, it is approaching the physical limit of the approved mining footprint. Underground mining operations are currently approved to 2031. The proposed Bulga Optimisation Project (the Project) seeks to extend the life of the open cut operations out to approximately 2035 by mining an additional approximately 200 million tonnes of run-of-mine coal from areas largely disturbed by existing open cut and underground operations. The Project will enable existing rates of production from the BCC to continue for the life of the Project, optimising utilisation of existing infrastructure at the complex.

Approval for the Project is being sought under Part 4 of the *Environmental Planning and Assessment (EP&A) Act 1979*. This report has been prepared as part of the environmental assessment process required under the EP&A Act, and it includes greenhouse gas emission projections, an evaluation of the climate change impacts and mitigation options. The scope of the following greenhouse gas environmental assessment (GHGEA) includes:

- estimating the total greenhouse gas emissions and energy use associated with the proposed Project;
- estimating greenhouse gas emissions associated with transporting coal products to domestic and international markets;
- estimating greenhouse gas emissions associated with the combustion of coal products by electricity generators and steel manufactures;
- qualifying how the Project may contribute towards climate change;
- estimating the impact of the Project's emissions on state, national and international greenhouse gas emission targets; and
- assessment of reasonable and feasible measures to minimise the greenhouse gas emissions and ensure energy use efficiency.

The GHGEA found that the Project's major operational component can be associated with the following greenhouse gas emission classes.

	Life of Mine Emissions	
	(t CO_2-e)	(%)
Scope 1	19,160,000	4.66
Scope 2	1,057,000	0.25
Scope 3	391,330,000	95.09
TOTAL	411,547,000	100.00

The proposed Project is forecast to produce approximately 871,000 t CO_2-e of Scope 1 emissions per annum, which is comparable to other Hunter Valley mining operations of similar size. The majority of Scope 1 emissions are generated by fugitive emissions and diesel combustion. The Project proponents have a direct influence over Scope 1 emissions and these emissions will be subject to management and mitigation plans. Based on the current Commonwealth *Clean Energy Act 2011*, a large proportion of Scope 1 emissions will also be subject to a carbon price.

The Project is forecast to consume approximately 196,000 GJ of electricity per annum, which will generate approximately 49,000 t CO_2-e Scope 2 emissions. The Project proponents can influence reductions in Scope 2 emissions by driving electricity reduction and efficiency initiatives.

Approximately 17,788,000 t CO_2-e Scope 3 emissions per annum are associated with the Project. The majority of Scope 3 emissions associated with the project will be generated by third parties during product transport and consumption (electricity generators and coking facilities). The proponents have no operational control over Scope 3 emissions, as they are generated by the activities of other organisations.

The Project's greenhouse gas inventory is dominated by Scope 3 emissions. Approximately 95 per cent of the Project's greenhouse gas emissions occur downstream of the Project, and are generated by third parties. Bulga Coal Management is in direct control of approximately 4.7 per cent of the greenhouse gases associated with the Project (refer to **Figure 1**).

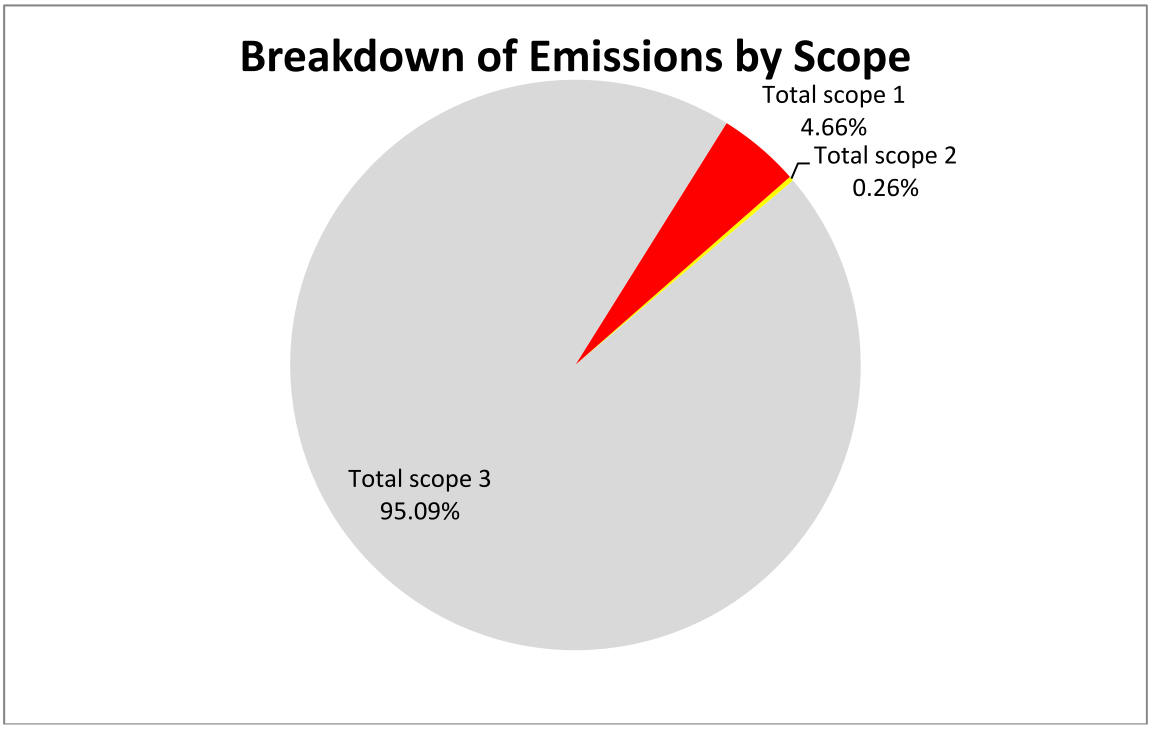

Figure 1 – Breakdown of Emissions by Scope

The GHGEA found that the Project is unlikely to impact on state and national greenhouse gas policy objectives due to the relatively small contribution the Project will make to state and national emissions on an annual basis.

The Project will contribute to global emissions, however, the extent to which global emissions and atmospheric concentrations of greenhouse gases have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions which includes all major emission sources and sinks.

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1.0 Introduction

The Bulga Coal Complex (BCC) is located in the Upper Hunter Valley approximately 4 kilometres to the south-east of the Bulga village and approximately 4 kilometres to the north of the village of Broke. The BCC is located within the Singleton Local Government Area (LGA) and is approximately 12 kilometres south-west of Singleton itself. The BCC includes an open cut coal mine, an underground coal mine, a coal handling and preparation plant, workshop facilities and administrative buildings.

The current open cut operations are approved to operate until 2025, however, it is approaching the physical limit of the approved mining footprint. Underground mining operations are currently approved to 2031. Exploration work has identified additional, open cut reserves of coal substantially within the existing BCC disturbance footprint. Bulga Coal Management (BCM), the operator of the open cut operation, is seeking approval for the Bulga Optimisation Project (the Project) to extract these additional resources. It is proposed to continue open cut operations to extract these available and mineable open cut resources.

The following Greenhouse Gas Environmental Assessment (GHGEA) evaluates the greenhouse gas and energy use implications of the proposed Project.

1.1 The Project

The Project is a proposed continuation of the existing open cut operations to enable mining to continue for approximately 22 years (approximately 10 years beyond the existing consent's expiry date) and allow approximately 200 million tonnes (Mt) of additional run of mine (ROM) of coal to be mined by open cut methods from land that is largely within the existing BCC disturbance footprint. With the estimated remaining approved resources, approximately 230 Mt of ROM coal will be recovered of the life of the Project. The Project will enable existing rates of production from the BCC to continue for the life of the Project, optimising utilisation of existing infrastructure at the complex. No change is proposed to either the maximum production rate from the open cut operations or the coal handling and preparation plant (CHPP) throughput.

The key features of the Project are summarised in **Table 1.1**:

Table 1.1 – Overview of the Project

Major Project Components	Proposed Operations
Total Production	Approximately 230 Mt ROM Coal over the life of the Project including approximately 30 Mt of existing approved ROM coal reserves.
Annual Production Limit	No changes from current approved annual limits. Up to 12.2 Mtpa ROM coal from the Bulga Surface Operations and up to 20 Mtpa ROM coal through the CHPP.
Mine Life (Production)	Approximately 22 years with further rehabilitation and closure works being carried out after the end of this period.
Operating Hours	24 hours per day, 7 days per week.
Number of Employees	Continued employment of approximately 700 full time employees, decreasing towards the end of the Project. Approximately 300 construction employees, predominately during the first 3 to 4 years of the Project.
Mining Methods	Open cut mining (including some highwall mining).

Table 1.1 – Overview of the Project (cont.)

Major Project Components	Proposed Operations
Mining Areas	Mining in three contiguous pit areas: • a western extension of the existing Bulga Pit and extraction of coal to the base of the Woodlands Hill seam (the Main Pit area); • an eastern extension of the Bulga Pit to mine the deeply dipping seems in the Wittingham Coal Measures (The East Pit area); and • deeper mining down to and including the Broonie seam series (South Pit area). A new pit area, known as the Bayswater Pit, mining shallow coal reserves will also be developed to the northeast of the former Deep Pit. This pit will ultimately be used for wet tailings storage. The Project will also develop a new box cut in the highwall for accessing existing approved underground mining areas.
Mine Infrastructure	• A new open cut mine infrastructure area (MIA). • A new underground MIA as its currently approved location will be affected by the proposed open cut mining. • Upgrades to the existing CHPP to improve throughput efficiency and increase product yield. • Changes to some Bulga Underground Operations infrastructure, including conveyor location, where it will be affected by the proposed open cut mining. • Development of new haul roads to out-of-pit emplacement areas including two new bridges over the realigned section of Broke Road. • Enlargement of ROM and product coal stockpile areas. • Construction and use of new approximately 3000 ML water storage dam (Northern Dam) as part of the mine water system. • Changes to mine and clean water diversion, management and reticulation systems. • Changes to ancillary infrastructure, including access roads and the development of construction laydown areas.
Emplacement Areas	Construction of two out-of-pit emplacement areas. The proposed Noise and Visual Bund has been designed to minimise the noise and visual impacts of the ongoing mining operations while the proposed Eastern Emplacement Area enables overburden from the eastern side of the open cut operations to be handled in a manner that minimises noise and air quality impacts to the majority of residents around the Project area. Overburden will also be emplaced in-pit.
Tailings and Rejects Strategy	Tailings will be disposed of in the Deep Pit and Bayswater Pits with tailings also potentially disposed of in the underground workings. Coarse rejects and paste thickened tailings will be co disposed with overburden.
External Coal Transport Infrastructure	No change to approved annual maximum product transported by train. Continued use of Saxonvale Rail Spur. Construction and use of a rail siding adjacent to the existing rail easement capable of parking two coal trains awaiting loading at the BCC.
Electricity Infrastructure	Realignment of sections of two 330 kV transmissions lines and other 66 kV and 11 kV powerlines and other changes to associated electricity infrastructure.
Public Roads	Realignment of sections of Broke Road and Charlton Road and the construction of haul road bridges over the realigned section of Broke Road.

Table 1.1 – Overview of the Project (cont.)

Major Project Components	Proposed Operations
Pipelines and Other Services Infrastructure	The relocation of the Broke Fordwich Private Irrigation District (PID) water pipeline, Singleton Council Broke potable water supply pipeline and other services (such as telecommunications infrastructure) which are associated with the existing public road alignments.
Resource Definition Exploration	Ongoing borehole drilling and sampling in and adjacent to mining areas to better understand the coal resource, coal quality, geological conditions and geotechnical constraints.
Rehabilitation	Rehabilitation of areas disturbed by BCC operations, infrastructure and construction.

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2.0 Assessment Framework

2.1 Objectives

The objective of this assessment is to evaluate the greenhouse gas and energy use implications of the proposed Project, in a manner that satisfies the Director General's stated environmental assessment requirements for the Project. In relation to greenhouse gas and energy, the Director General has requested that the Environmental Impact Statement (EIS) includes:

- a quantitative assessment of potential Scope 1, 2 and 3 emissions;
- a qualitative assessment of the potential impacts of these emissions on the environment; and
- an assessment of reasonable and feasible measures to minimise the greenhouse gas emissions and ensure energy use efficiency.

2.2 Scope

The scope of the GHGEA includes:

- estimating the total greenhouse gas emissions and energy use associated with the proposed Project;
- estimating greenhouse gas emissions associated with transporting coal products to domestic and international markets;
- estimating greenhouse gas emissions associated with the combustion of coal products by electricity generators and steel manufactures;
- assessing how the Project may contribute towards climate change;
- estimating the impact of the Project's emissions on state, national and international greenhouse gas emission targets; and
- assessing reasonable and feasible measures to minimise the greenhouse gas emissions and ensure energy use efficiency.

2.3 Definitions and Sources

The GHGEA assessment framework is based on the methodologies and emission factors contained in the *National Greenhouse Accounts (NGA) Factors (2011).* The assessment framework also incorporates the principles of *The Greenhouse Gas Protocol 2004*.

The NGA Factors draw on the National Greenhouse Gas and Energy Reporting System (Measurement) Determination 2008, however, the NGA Factors have a general application to the estimation of a broader range of greenhouse gas inventories (DCCEE 2011) that are more suited to environmental impact assessment.

The Greenhouse Gas Protocol (World Resources Institute/World Business Council Sustainable Development 2004) (The Protocol) provides an internationally accepted approach to greenhouse gas accounting. The Protocol provides guidance on setting reporting boundaries, defining emission sources and dealing with issues such as data quality and materiality.

The Energy Savings Action Plan described in **Section 4.2** was evaluated against the Guidelines for Energy Savings Action Plans (DEUS 2005).

Table 2.1 contains concepts and a glossary of terms relevant to this GHGEA.

Table 2.1 – Glossary of terms (The GHG Protocol 2004)

Concept	Definition
Greenhouse gases	The greenhouse gases covered by the Kyoto Protocol and referred to in this GHGEA include: • Carbon dioxide; • Methane; • Nitrous oxide; • Hydrofluorocarbons; • Perfluorocarbons; and • Sulphur hexafluoride.
Scope 1 emissions	Direct emissions occur from sources that are owned or controlled by the Project (in this case, the proponent, Bulga Coal Management) (e.g. fuel use, fugitive emissions). Scope 1 emissions are emissions over which the Project has a high level of control.
Scope 2 emissions	Indirect emissions from the generation of purchased electricity consumed by the Project. These emissions are a consequence of the activities of the Project, but are owned or controlled by another reporting entity. Scope 2 emissions can be measured easily and may be influenced through energy efficiency measures.
Scope 3 emissions	Indirect emissions are emissions that are a consequence of the activities of the Project, but occur at sources owned or controlled by another reporting entity (e.g. outsourced services). Scope 3 emissions are only estimates and may have a relatively high level of uncertainty, unreliability and variability.

2.4 Impact Assessment Methodology

Scope 1 and 2 emissions were calculated based on the methodologies and emission factors contained in the National Greenhouse Accounts (NGA) Factors 2011 (DCCEE 2011). Fugitive emissions from the open cut operation were calculated based on the modelled gas reservoir of the Project, which was calculated by BCM, using the Method 2 approach described in The NGERS Technical Guidelines 2011. Method 2 is a more robust estimation approach than the default Method 1 approach.

Scope 3 emissions associated with product transport were calculated based on emission factors contained in the National Greenhouse Gas Inventory: Analysis of Recent Trends and Greenhouse Gas Indicators (AGO 2007). Other Scope 3 emissions were calculated using methodologies and emission factors contained in the National Greenhouse Accounts (NGA) Factors 2011 (DCCEE 2011).

All methodologies and calculations have been made assuming that all operations will continue as described in **Section 1.1**.

2.5 Data Sources

The calculations in this report are based on activity data projections developed by BCM, during the mine planning process.

A detailed schedule of closure and rehabilitation activities will not be available until the latter stages of the Project. In its absence, the detailed schedule for another Xstrata operation, which is a comparatively similar sized operation, has been referred to for closure and rehabilitation data. **Table 2.2** contains the source of activity data.

Table 2.2 – Source of Activity Data Used for the Assessment

Activity Data	Source
Fugitive emissions	BCM - forecast fugitive emissions
On-site fuel consumption	BCM– forecast diesel consumption
Electricity consumption	BCM – forecast electricity consumption
Construction materials	BCM – forecast construction materials, Road Traffic Authority 2008
Product consumption	BCM – forecast mine production
Product transport	BCM – haulage distances
Closure and Rehabilitation data	Similar operation in the Hunter Valley

A detailed description of activity data and calculations are provided in **Appendices A**, **B**, **C** and **D**.

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3.0 Impact Assessment Results

A GHGEA considers the individual stages of a project as mitigation options can be developed for the construction, operation and closure stages of a project.

3.1 Construction Phase

Many construction activities are likely to occur over the duration of the Project. The GHGEA only considers the major construction activities which have been identified in **Section 1.1**, and would not normally occur as part of on-going mine operations.

Greenhouse gas estimates have been prepared for the construction of the following projects:

- the relocation of section of two 330 kV transmission lines;
- a new open cut mine infrastructure area (MIA) and relocation of underground MIA and other underground infrastructure relocated as a result of the expanded open cut pit area;
- the relocation of a section of the Broke Fordwich PID water pipeline;
- the relocation of a section of the Singleton Council Broke potable water supply pipeline;
- the realignment of sections of Broke Road;
- the realignment of sections of Charlton Road;
- the construction of a new water storage and discharge dam forming part of the BCC's mine water management system; and
- the construction of two rail sidings adjacent to the existing rail alignment.

Greenhouse gas estimates have not been prepared for the construction of the new tailings facilities, as the facilities will be developed as part of mining operations and are not expected to consume additional construction related energy or materials. Similarly, the emissions associated with the construction of new internal roads and surface water management works are largely related to diesel consumption and this is captured in mine operating emissions. Greenhouse gas estimates were also not completed for relocating the 66 kV and 11 kV transmission lines as material and energy use were considered immaterial for the scale of this project.

The greenhouse gas emission estimates for the construction phase are based on the following activities (the activities described in the following list are assumptions for the purposes of estimating greenhouse gas emissions, and should not be read as a definitive list of on-site construction activities):

- all construction activities are likely to be outsourced to 3rd parties;
- twenty seven 330 kV transmission towers will be relocated;
- approximately 9.3 kilometres of road will be constructed to re-align Broke Road;
- approximately 4 kilometres of road will be constructed to re-align Charlton Road;
- up to 5 kilometres of internal roads will be constructed;

- all electricity required for road projects is likely to be generated on-site by diesel generators;
- approximately 9.3 kilometres of the Broke Fordwich PID water pipeline will require relocating;
- approximately 9.3 kilometres of the Singleton Council Broke potable water supply pipeline will require relocating; and
- approximately 3600 metres of new rail track will be constructed.

3.1.1 Greenhouse Gas Emissions

The Project's construction related greenhouse gas emissions are summarised in **Table 3.2**. The construction of the Project is forecast to be associated with approximately 51,796 t CO_2-e Scope 3 emissions. Scope 3 emissions will be generated by third parties combusting energy and generating industrial emissions in the process of producing and transporting construction materials. Scope 3 emissions will also be generated by contractors consuming energy during the construction projects.

The breakdown of construction related emissions in **Table 3.2** demonstrate that approximately 67 per cent of forecast construction related emissions are attributable to the consumption of construction materials. The consumption of energy during construction contributes 31 per cent of construction emissions, while 2 per cent of construction emissions are attributable to the transport of construction materials (see **Table 3.2**).

3.1.2 Energy Use

The construction of the Project is forecast to require approximately 210,500 Gigajoules (GJ) of energy from diesel and grid electricity.

3.2 Operation Phase

The following assumptions were made to estimate the greenhouse gas emissions from the operation phase of the Project:

- 80 per cent of product coal is thermal quality and will be combusted by electricity generators;
- 20 per cent of product coal is coking quality and will be consumed in coking plants;
- all product coal is exported;
- all product coal is transported approximately 92 kilometres to the port of Newcastle via train; and
- all product coal is shipped an average of 9500 kilometres to either Japan or Korea.

3.2.1 Life of Mine Greenhouse Gas Emissions

The Project's life of mine (LOM) greenhouse gas emissions are summarised in **Table 3.2**. LOM forecasts are based on the Project extracting approximately 230 Mt ROM over 22 years. The LOM emissions overestimate the cumulative impacts of the proposed approval, as the Project's activity data includes approximately five years of production (approximately 30 Mt ROM Tonnes) which has already been approved under the current Development Consent (DA 41-03-99).

The Project is forecast to be associated with approximately 415,000,000 t CO_2-e of greenhouse gas emissions over 22 years of operation.

The Project is forecast to generate approximately 19,160,000 t CO_2-e Scope 1 emissions from combusting diesel and releasing fugitive emissions during its operation phase. Annual average Scope 1 emissions are forecast at approximately 871,000 t CO_2-e per annum. Annual average Scope 1 emission estimates for the Project should not be used to benchmark annual performance, as annual emissions will vary significantly due to normal variations in annual activity.

Method 2 calculations have determined that the Project could liberate up to 14,600,000 t CO_2-e from ROM coal, carbonaceous interburden and coal resources below the pit floor. Over the life of the Project, the Project could generate an equivalent fugitive emissions factor of approximately 0.063 t CO_2-e/ROM tonne, if 230 M ROM tonnes are recovered.

The Project is forecast to be associated with approximately 1,057,000 t CO_2-e Scope 2 emissions from consuming electricity during its operation phase. Annual average Scope 2 emissions are forecast at approximately 49,000 t CO_2-e per annum.

The Project is forecast to be associated with approximately 391,330,000 t CO_2-e Scope 3 emissions during its operation phase. Scope 3 emissions will be generated by third parties during product transport and consumption activities (electricity generators and coking facilities). Annual average Scope 3 emissions are forecast at approximately 17,788,000 t CO_2-e per annum.

Figure 3.1 demonstrates that the Project's greenhouse gas inventory is dominated by Scope 3 emissions. Approximately 95 per cent of the Project's greenhouse gas emissions occur downstream of the project, and are generated by third parties. BCM is in direct control of approximately 4.7 per cent of the greenhouse gases associated with the Project.

Scope 2 and 3 emissions have been included in the GHGEA to demonstrate the potential upstream and downstream impacts of the Project. All Scope 2 and 3 emissions identified in the GHGEA are attributable to, and may be reported by, other sectors.

3.2.2 Maximum Annual Greenhouse Gas Emissions

The Project is seeking approval for a maximum annual extraction rate of 12.2 M ROM Tonnes (the current approved maximum production rate). **Table 3.3** summarises the Project's annual greenhouse gas emissions at an annual extraction rate of 12.2 M ROM Tonnes. The maximum greenhouse gas emissions associated with the Project are forecast to be approximately 21,795,000 t CO_2-e per annum.

The Project is forecast to generate approximately 1,012,000 t CO_2-e Scope 1 emissions per annum at its maximum extraction rate.

The Project is forecast to be associated with approximately 55,100 t CO_2-e Scope 2 emissions per annum at its maximum extraction rate.

The Project is forecast to be associated with approximately 20,728,000 t CO_2-e Scope 3 emissions per annum at its maximum extraction rate.

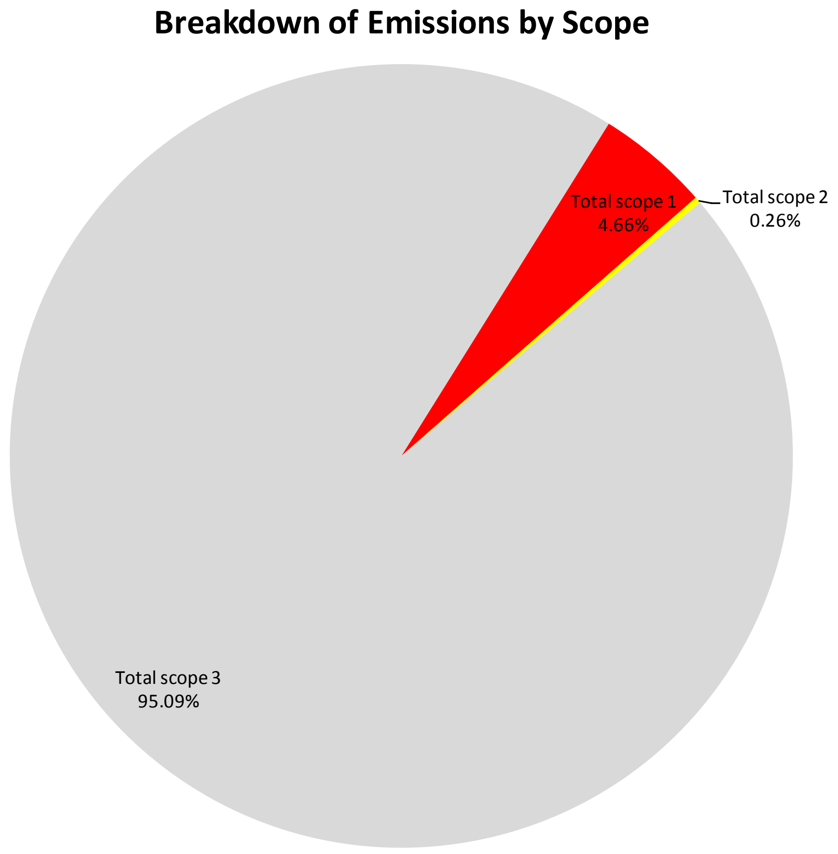

FIGURE 3.1

Breakdown of Emissions by Scope

3.2.3 Energy Use

The Project is forecast to require approximately 70,830,000 GJ of energy from diesel and grid electricity over 22 years of operation. Annual average energy consumption is forecast at approximately 3,220,000 GJ per annum. **Figure 3.2** demonstrates that energy demand decreases significantly from 2025, which is largely due to a gradual downsizing of the number of trucks operating in the pit.

The Project's electricity demand is driven by the CHPP, a dragline and electric shovels. The current conceptual mine plan only requires a dragline for the first four years of operation. **Figure 3.2** demonstrates the reduction in electricity demand once the dragline operation is complete.

The industry average energy use for open cut coal mines in Australia ranges between 430 and 660 Megajoules (MJ)/Product tonne (AGSO 2000). The current Bulga Complex open cut operation has an average energy use intensity of 448 MJ/Product Tonne, based on 2009/10–2010/11 data. The Project is forecast to produce approximately 152,000,000 product tonnes, which converts to an energy use intensity of approximately 466 MJ/Product Tonne. The forecast energy use intensity of the Project is within the normal operating range for Australian open cut coal mines.

3.3 Closure and Rehabilitation Phase

The following assumptions were made to estimate the greenhouse gas emissions from the closure phase of the Project:

- all areas not progressively rehabilitated will be rehabilitated on mine closure;
- open cut operations do not generate emissions from old workings; and
- 30 per cent of all closure costs are attributable to diesel consumption.

3.3.1 Greenhouse Gas Emissions

The Project's total closure and rehabilitation emissions are summarised in **Table 3.2**.

The Project is forecast to generate approximately 13,900 t CO_2-e Scope 1 emissions from combusting diesel during the closure phase. The closure phase is also expected to be associated with approximately 1,100 t CO_2-e Scope 3 emissions. Scope 3 emissions will be generated by third parties undertaking activities such as extracting, refining and transporting diesel.

3.3.2 Energy Use

The Project is forecast to consume approximately 200,000 GJ during the closure phase. Electricity usage during closure will be minimal; accordingly it has been assumed that all energy will be sourced from diesel.

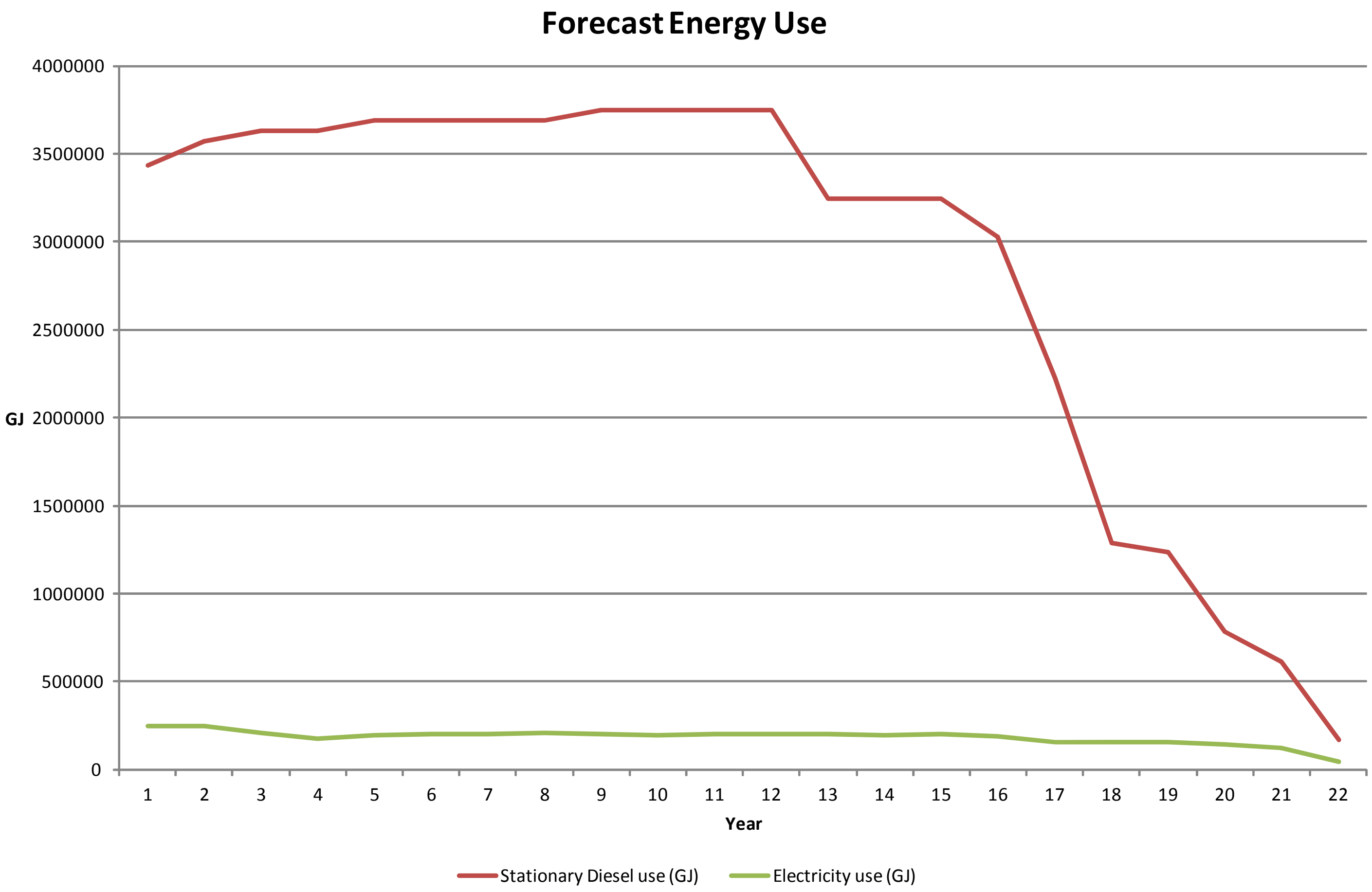

FIGURE 3.2

Forecast Energy Use for the Project

3.4 Assessment Boundary

The GHGEA assessment boundary was developed to include all significant Scope 1, 2 and 3 emissions. **Figure 3.3** demonstrates how the assessment boundary interacts with the potential emission sources under BCMs operational control and other emission sources associated with the Project.

3.5 Data Exclusions

The activities and emission sources listed in **Table 3.1** have been excluded from the GHGEA as they were considered immaterial, variable and incidental for the purposes of this report.

Petrol is rarely used by BCM's current operations. The Proposed project may only use very small volumes of petrol in operations that are incidental to the extraction of coal.

Based on annual NGERS reporting, industrial processes and waste water handling only generate a very small proportion of BCM's greenhouse gas inventory. The inclusion of these two emission sources would not significantly change the final greenhouse gas inventory (**Tables 3.2** and **3.3**).

The greenhouse gas implications of land use change were excluded from the assessment, as land use change is unlikely to be a net source of greenhouse gas emissions over the long term. The Project is expected to clear approximately 735 hectares of native woodland, 1222 hectares of native grassland and 56 hectares of rehabilitated/regenerated woodland. While the final rehabilitation plan will be developed throughout the Project, it is expected that approximately 2,500 hectares of woodland will be replanted over the life of the Project and as part of the closure process. Once the Project is complete, the potential biomass replanted should be significantly greater than the biomass cleared.

The re-alignment of Broke Road and Charlton Road will increase the travel distances and fuel consumption of vehicles utilising the roads. Forecasting the greenhouse gas implications of the road re-alignment is highly dependent on travel patterns, and classes of vehicles using the roads. Preliminary analysis found that the road re-alignment may increase greenhouse gas emissions by approximately 450 t CO_2-e per annum. The inclusion of this emission source would not significantly change the final greenhouse gas inventory (**Tables 3.2** and **3.3**).

Greenhouse gas emissions generated by waste transferred to local landfill were excluded from the analysis as the likely emissions were considered to be immaterial. The inclusion of this emission source would not significantly change the final greenhouse gas inventory (**Tables 3.2** and **3.3**).

Greenhouse gas emissions from employee travel and business travel are often excluded from greenhouse gas inventories. Given the nature of the Project, the expected emissions from business travel (i.e. flights, taxis and hire cars) will be immaterial to the final greenhouse gas inventory (**Tables 3.2** and **3.3**). Preliminary analysis of traffic data indicates that employee travel may generate approximately 5100 t CO_2-e per annum. The inclusion of employee travel would not significantly change operational Scope 3 projections.

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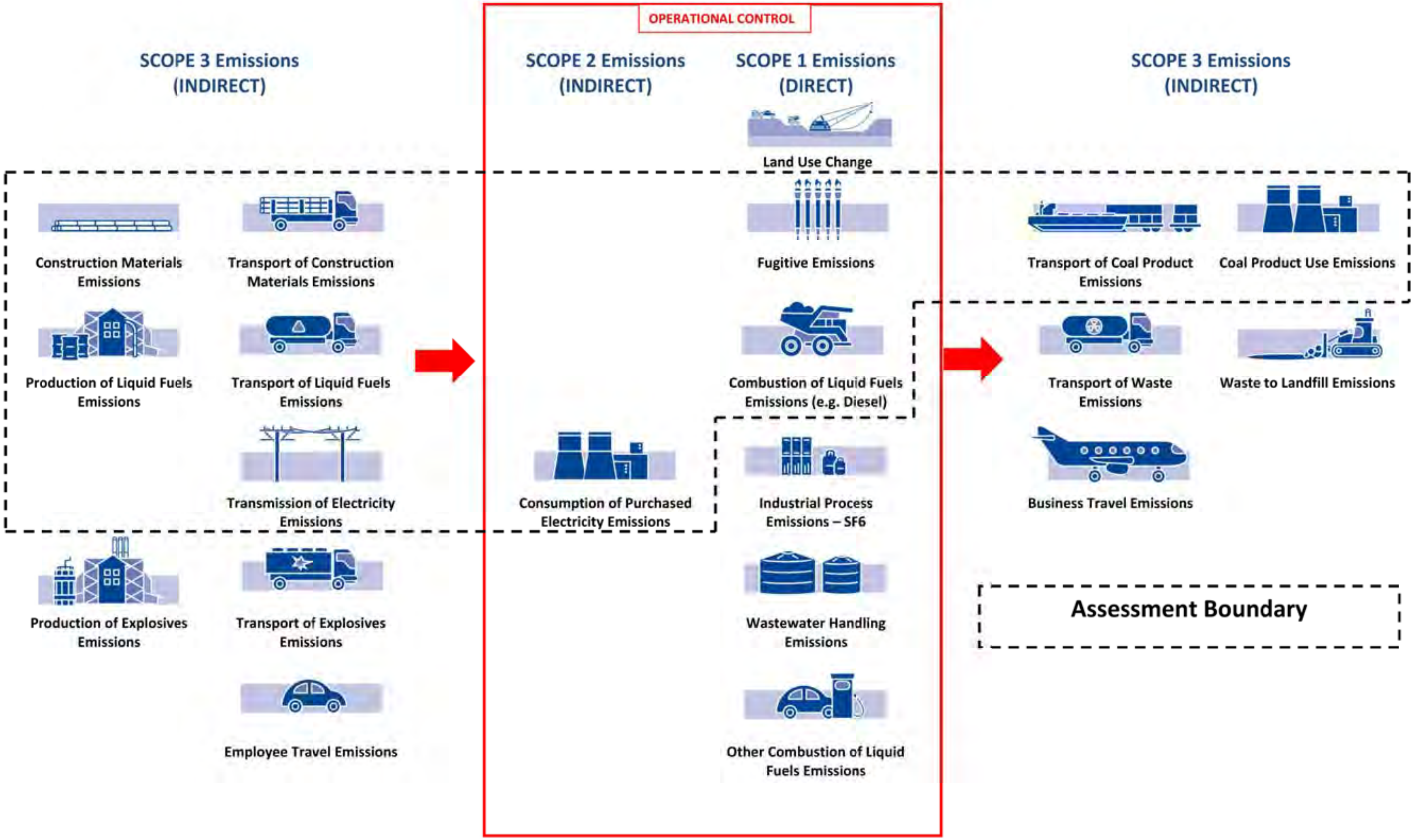

FIGURE 3.3

Greenhouse Gas Assessment Boundary

Table 3.1– Data Exclusions

Emissions Source	Scope	Description	Reason for Exclusion
Combustion of fuel for energy	Scope 1	• Small qualities of fuels such as petrol	Emissions immaterial in context of overall project emissions
Industrial processes	Scope 1	• Sulphur hexafluoride (high voltage switch gear) • Hydrofluorcarbon (commercial and industrial refrigeration)	Emissions immaterial in context of overall project emissions
Waste water handling (industrial)	Scope 1	• Methane emissions from waste water management	Emissions immaterial in context of overall project emissions
Land use, Land use change and Forestry	Scope 1	• Clearing vegetation • Mine site re-vegetation	Emissions considered to be offset by sequestration from rehabilitation plantings.
Combustion of fuel for energy	Scope 3	• Additional travel distances created by the re-alignment of Broke Road and Charlton Road	Emissions immaterial in context of overall Scope 3 emissions
Solid waste	Scope 3	• Solid waste to landfill	Emissions immaterial in context of overall Scope 3 emissions
Business travel	Scope 3	• Employees travelling for business purposes	Emissions immaterial in context of overall Scope 3 emissions
Employee travel	Scope 3	• Employees travelling between their place of residence and the Bulga site	Emissions immaterial in context of overall Scope 3 emissions

Table 3.2 – GHG Emission Summary for the Project (See Appendix A, B and D for Further Detail)

Stage	Scope	Source	Source Totals (t CO_2-e)	Scope Totals (t CO_2-e)
Construction	Scope 3 (Indirect)	Materials	34,611	51,796
		Energy Use	16,077	
		Transport of Materials	1,108	
			Total GHG Emissions for Construction	**51,796**
Life of Mine	Scope 1 (Direct)	Diesel use[1]	4,624,159	19,159,462
		Fugitive emissions	14,535,303	
	Scope 2 (Indirect)	Electricity	1,056,561	**1,056,561**
	Scope 3 (Indirect)	Product use	372,501,024	391,329,626
		Associated with energy extraction and distribution	554,497	
		Product transport	18,259,697	
		Transport of Materials (Bulk diesel)	14,408	
			Total GHG Emissions for LOM Operations	**411,545,649**
Closure and Rehabilitation	Scope 1 (Direct)	Stationary diesel use	13,884	13,884
		Transport fuel use	N/A	
	Scope 2 (Indirect)	Electricity	N/A	N/A
	Scope 3 (Indirect)	Associated with energy extraction and distribution	1,059	1,059
			Total GHG Emissions for Closure and Rehabilitation	**14,943**

[1] Includes diesel used in explosives and all on-site equipment.

Table 3.3 – Maximum Annual GHG Emission Summary for the Project (See Appendix C for Further Detail)

Stage	Scope	Source	Source Totals ($t\ CO_2$-e)	Scope Totals ($t\ CO_2$-e)
Operations	Scope 1 (Direct)	Diesel use[2]	240,885	1,011,888
		Fugitive emissions	771,003	
	Scope 2 (Indirect)	Electricity	55,042	55,042
	Scope 3 (Indirect)	Product use	19,730,954	20,727,665
		Associated with energy extraction and distribution	28,886	
		Product transport	967,825	
			Total Annual Operation	**21,794,595**

[2] Includes diesel used in explosives and all on-site equipment.

4.0 Impact Assessment Summary

The greenhouse gas emissions generated by the Project have the potential to impact the environment and the greenhouse gas reduction objectives of state, national and international governing bodies. The following section makes the distinction between environment impacts and impacts on policy objectives.

4.1 Environmental Impact

The Project's greenhouse gas emissions will have a disperse impact as they are highly mobile and are generated up and down the supply chain. Greenhouse gas emissions primarily alter the atmospheric concentration of carbon dioxide and methane. The secondary impacts of greenhouse gas emissions include; global warming, ocean acidification and carbon fertilisation of flora. The tertiary impacts of greenhouse gas emissions (i.e. climate change) may have many ramifications for the natural and built environment.

The Project's direct emissions are forecast to be approximately 871,000 t CO_2–e per annum.

To put the Project's emissions into perspective, global greenhouse gas emissions are forecast to be 46,000,000,000 t CO_2-e by 2020 (Sheehan *et al* 2008). During operation, the Project will contribute approximately 0.0019 per cent to the global emissions per annum (based on its projected Scope 1 emissions). The Scope 2 and 3 emissions associated with the Project should not be considered in a global context, as global projections only represent Scope 1 emissions (i.e. the sum of all individual emission sources).

4.2 Impact on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) define climate change as a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and persists for an extended period, typically decades or longer (IPCC 2007).

Climate change is caused by changes in the energy balance of the climate system. The energy balance of the climate system is driven by atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation (IPCC 2007). There is strong evidence to suggest that observations of global warming are directly correlated to increased concentrations of atmospheric greenhouse gases (IPCC 2007).

It would be misleading to assess the climate change impacts of the Project by simply applying a radiative forcing coefficient to the greenhouse gases generated by the Project. Carbon emitted to the atmosphere is exchanged between carbon reservoirs such as oceans and ecosystems over a wide range of timescales. It is erroneous to assume that the greenhouse gases generated by the Project will materially shift the atmospheric concentration of greenhouse gases in a linear way (IPCC 2007).

The extent to which global emissions and atmospheric concentrations of greenhouse gases have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions that includes all major emission sources and sinks.

4.3 Impact on State Policy Objectives

The new NSW State Plan (NSW 2011) has removed all references to a State based greenhouse gas reduction target. Apart from application of the relevant NSW Government guidelines for assessment, as described in previous sections, there are no NSW based objectives to assess the Project against.

4.4 Impact on National Policy Objectives

The Australian Government has committed to reduce Australia's greenhouse gas emissions by 5 per cent from 2000 levels by 2020 irrespective of what other countries do, and by up to 15 or 25 per cent depending on the scale of global action.

If Australia is able to meet the 5 per cent reduction target by 2020, the nation will be generating approximately 525 Mt CO_2-e per annum (National Greenhouse Gas Inventory 2010). In year 2020 is it anticipated that the Project will generate approximately 957,000 t CO_2-e Scope 1 emissions, if emissions are not further mitigated. This will represent approximately 0.18 per cent of Australia's national emissions by 2020. The Project's Scope 2 and 3 emissions should not be considered against national objectives, as Scope 2 and 3 emissions (which occur in Australia) will be reported by other sectors of the Australian economy.

The Project is unlikely to limit the Federal Government achieving its national greenhouse gas objectives.

4.4.1 The Clean Energy Future Policy

In 2011 the Australian Government outlined a policy framework to address climate change and move towards a 'clean energy future'. The Clean Energy Future Policy has four key elements: a carbon price; renewable energy; energy efficiency; and action on the land.

A core component of the Clean Energy Future Policy is the Clean Energy Legislative Package, which was enacted in 2012. The Clean Energy Legislative Package will generate a carbon price for large greenhouse gas emitters, by placing a carbon price on covered emissions and certain fuel uses.

The Project will be required to purchase permits/credits for Scope 1 emissions covered under the legislation. By complying with the legislation, and continuing to examine opportunities for abatement, the Project's adaptive management measures should contribute to achievement of the intended objectives of the Clean Energy Future Policy.

4.5 Impact on International Objectives

At present there is no comprehensive global agreement on greenhouse gas reduction targets that includes commitments from all major emitters such as China, India and the United States of America.

The Seventeenth Conference of the Parties (COP17) climate change negotiations in Durban, however, provides some direction for international greenhouse gas objectives. Countries agreed in Durban to begin work on a new climate change agreement that will cover all countries. The intention is to develop an agreement, including emission reduction commitments, by 2015 to come into effect from 2020. Countries also agreed that there would be a second commitment period of the Kyoto Protocol from 1 January 2013 (DCCEE 2012a).

Under the Cancun Agreements, Australia has committed to reducing its 2020 national greenhouse gas inventory by 5 per cent (based on the 2000 inventory) (DCCEE 2012b).

Australia's international objectives align with its national objectives. As discussed in **Section 4.4**, the Project is unlikely to prevent the Federal Government achieving its national/international 5 per cent greenhouse gas reduction target.

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5.0 Greenhouse Gas and Energy Management Assessment

The GHGEA is required to assess reasonable and feasible measures to minimise the Project's greenhouse gas emissions.

The term reasonable incorporates notions of costs and benefits, whereas the term feasible focuses on the more fundamental practicalities of the mitigation measures, such as engineering considerations and what is practical to build or operate (*Hunter Environment Lobby Inc v Minister for Planning* 2011).

5.1 Current Management Measures

BCM is committed to the Xstrata Coal Climate Change Policy, which specifically requires on-going consideration of greenhouse gas emissions and energy use. To assist Xstrata Coal meet its Climate Change Policy, BCM must prepare Annual Sustainability Plans and adhere to Sustainable Development Standards and Protocols.

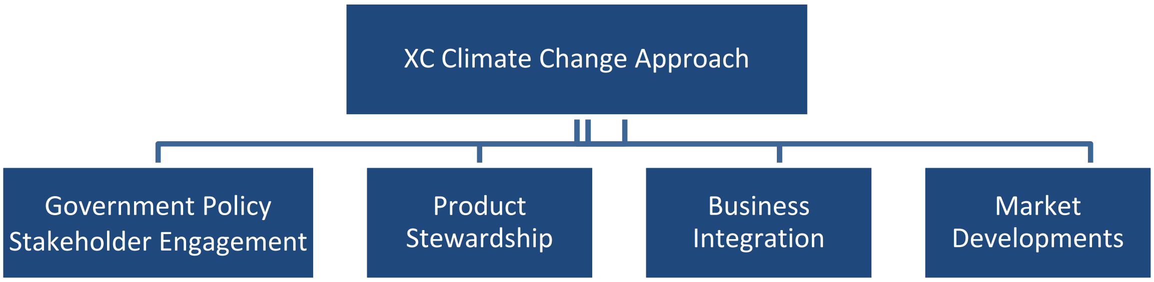
BCM has an obligation to adhere to legal requirements to manage greenhouse gas emissions and energy use. The *Energy Efficiency Opportunities Act 2006* and the *Energy and Utilities Administration Act 1987* require BCM to participate in the Energy Efficiency Opportunities (EEO) and Energy Savings Action Plan (ESAP) Programs respectively.

5.1.1 Climate Change Policy

The Xstrata Coal Climate Change Policy states (Xstrata Coal 2012):

> Xstrata Coal acknowledges that access to affordable, reliable and secure energy is fundamental to economic and social development. We understand that to meet rising global energy demand in both the developed and developing economies, a suite of energy sources (including fossil fuels) and low emission technologies will be required to meet the objectives of energy security, economic growth and sustainable environmental performance.
>
> We believe that emission reductions and increased energy efficiency associated with the production and end use consumption of fossil fuels are necessary and achievable as part of our contribution to addressing the global issue of climate change.
>
> Xstrata Coal supports the weight of scientific opinion in relation to climate change and believes action is required to avoid dangerous climate change impacts. We believe that our environment will continue to change and that this may pose social, economic and environmental risks and consequences which can only be addressed through comprehensive global action.

Our action on climate change program will focus on four key areas:



1. Government Policy & Stakeholder Engagement
   - We encourage the development of policies and regulation that are aimed at the achievement of sensible emission reduction targets at lowest possible cost as well as policies and strategies to invest in the development of an appropriate suite of low emission power generation options.
   - We work with government and key stakeholders to understand the impacts of policy and regulation on industry and support the development of a comprehensive and binding international agreement on climate change.
   - We establish respectful dialogues amongst government, NGOs and other stakeholders in key markets and countries with existing operations.
   - We demonstrate leadership on climate change issues and our actions are transparent, equitable and credible.
2. Product Stewardship
   - We contribute to the research, development, & demonstration of low emission technologies.
   - We develop strategic alliances in the area of capacity building - which will support the long term commercial application of low emission technologies.
   - We understand the full ‘lifecycle’ emissions from the exploration, mining, processing, refining, fabricating, use and disposal of our product.
   - We adapt and incorporate lifecycle analysis into our business planning, product procurement and project management processes.
   - We work with government and key stakeholders to understand and adapt to the potential physical impacts of climate change.
3. Business Integration
   - We actively manage and record our energy and emission profile.
   - We incorporate a price on carbon into our investment decisions to protect and enhance shareholder value.
   - We consider opportunities for beneficial use of coal and waste mine gas to maximise the utilisation of our resources and to assist in reduction of our energy demand.
   - We consider the abatement of fugitive emissions a priority at our operations.
4. Market Dynamics
   - We develop alliances, and collaborate with our customers, both domestic and international, in demonstrating the sustainable use of coal through new power generation technologies.
   - We understand the impact of carbon constraints on the global energy complex and monitor the impact of competition from alternative fuels and energy sources on demand for our product.

Xstrata Coal’s specific greenhouse gas mitigation measures are discussed in the following sections.

5.1.2 Energy Efficiency

BCM will mitigate Scope 1 and 2 emissions through energy efficiency initiatives. The energy efficiency of mining operations is driven by energy use and productivity. Energy efficiency is maximised when highly efficient equipment is operated at optimal capacity. BCM's mine planning process optimises operational productivity through scheduling, haul ramp design and equipment selection. In accordance with Xstrata Coal's Energy Efficiency Guideline, BCM will also participate in the Energy Efficiency Opportunities (EEO) and Energy Savings Action Plan (ESAP) Programs which assist in improving energy efficiency as outlined in the sections below.

5.1.2.1 Energy Efficiency Opportunities

Xstrata Coal's operations in Australia fall under two controlling corporations. All coal operations in NSW are part of one of those controlling corporations. Controlling corporations that use more than 0.5 petajoules (PJ) of energy per year must participate in the Energy Efficiency Opportunities Program. The controlling corporation for BCM triggers the energy use thresholds of the EEO Program and it is therefore required to undertake energy efficiency assessments and report the progress of energy efficiency projects. BCM currently complete energy efficiency assessments, undertake energy efficiency planning and assist its controlling corporation to report on the progress of nominated energy efficiency projections. As part of the implementation of the Project BCM will continue to participate in the EEO Program and undertake the following activities to improve energy use efficiency:

- develop an energy efficiency opportunities project and communication plan;
- evaluate energy use for the Project;
- identify and investigate potential energy efficiency opportunities; and
- implement, track, communicate and report on energy efficiency opportunities.

5.1.2.2 Energy Savings Action Plans (ESAPs)

BCM is listed on the Energy Savings Order and must develop ESAPs under the *Energy and Utilities Administration Act 1987*. BCM currently develops ESAPs in accordance with the Guidelines for Energy Savings Action Plans and the current process will continue and incorporate the energy use activities for the proposed Project.

BCM will continue to monitor energy use to evaluate ESAPs every four years and submit ESAP progress reports annually in accordance with legislative requirements.

5.1.2.3 Energy Efficiency and Savings Plans (EESP)

Xstrata Coal requires all mine sites to prepare an Energy Efficiency and Savings Plan (EESP) on an annual basis. The EESP consolidates the energy efficiency planning requirements of Xstrata Coal, the EEO Program and Energy Savings Action Plans. The Xstrata Coal Divisional Energy Efficiency Guideline states that EESPs should consider:

- compliance with existing regulatory requirements;
- integrating energy efficiency as 'business as usual';

- maximising productivity and minimising energy consumption;
- maximising opportunities for cost savings through energy savings; and
- efficient and effective management of equipment.

BCM will develop an EESP for the ongoing Bulga Surface Operations.

5.1.3 Greenhouse Gas Mitigation Measures Across the Bulga Coal Complex

BCM will manage the Project as part of the broader Bulga Coal Complex (BCC). BCM is currently managing greenhouse gas emissions across BCC through energy efficiency initiatives and flaring captured waste gas. BCM is about to commission an approved 9 MW Power Station, which will be fuelled by coal mine waste gas captured from Bulga's Underground Operations. BCM is also seeking approval for a further 32 MW power facility, which if approved, could develop an annual demand for up to 34 million cubic metres of coal mine waste gas across the BCC reducing future fugitive greenhouse gas emissions.

The Project has been designed to provide operational synergies with the underground operations. The Project will allow BCM to optimise the energy use efficiency of the CHPP, and may allow underground operations to reduce energy use demand through highwall mining methods. The on-site power generation facility being developed for the underground operations, could utilise drained fugitive emissions from the Project area, if the drainage process became financially reasonable.

5.1.4 Scope 3 Emissions

BCM is not in a position to mange Scope 3 emissions directly, however, Xstrata Coal manages a significant product stewardship and market development program which aims to mitigate the downstream impacts of its products.

The Xstrata Coal Climate Change Strategy supports a broad range of low-emissions technologies projects, which include:

- Committing up to $180 million over the next decade to support low-emission coal technology projects via the Australian coal industry's $1 billion COAL21 Fund. Projects supported by this fund include:
  - Callide Oxyfuel project – demonstrating carbon capture technology;
  - Otway Basin CCS project – demonstrating injection and storage of carbon dioxide; and
  - Delta-Munmorah PCC project – demonstrating carbon capture technology;
- Contributing $1 million to the $200 million Callide Oxyfuel project in Queensland;
- Committing up to $10 million to the FutureGen CCS project in the USA;
- Committing up to $10 million to the Xstrata Coal Wandoan Carbon Capture and Storage (CCS) project in Queensland;

- Launching a Low Emissions R&D Fund to support a range of climate change and energy-related projects. In the first year of the fund Xstrata Coal committed funding of over $6 million to seven projects relating to climate change or low-emissions technologies research and development. These included:
  - **Direct Injection Coal Engine project** – collaborating with Xstrata Technology, CSIRO and Man Truck and Bus AG (MAN) on developing a coal water fuel that can be directly injected into diesel engines to produce power. This project is in the early stages but has the potential to enhance energy security at remote and regional locations, and is potentially capable of utilising coal tailings from mining operations, effectively using a waste product for energy;
  - **Biochar Research project** – using coal tailings to create a biochar for soils to enhance rehabilitation performance and carbon storage, resulting in increased agricultural productivity;
  - **Chemical Looping project** – collaborating with University of Newcastle on chemical looping for combustion and gasification of coal used in power stations;
  - **Oxyfuel Technology project** – collaborating with the University of Newcastle to develop further knowledge of coal impurity and gas quality control for oxyfuel combustion technology;
  - **Membrane Research project** – collaborating with the University of Queensland to develop ceramic capillaries from current hollow fibres for air separation, to produce oxygen for use in oxyfuel power generation;
  - **Nanotechnology project** – collaborating with the University of Sydney to develop nano-structured absorbent material to use in post-combustion capture of CO2; and
  - **International Energy Centre (IEC)** – being the Foundation Corporate Member of the IEC, an innovative network of leading Australian universities and industry collaborators. The IEC has developed a Masters of Energy Studies and a number of professional development short courses.

5.2 Assessment of Potential Management Measures

BCM has incorporated a range of measures into the Project design, with the aim of minimising potential greenhouse gas emissions and improving energy efficiency. Energy efficiency was a key driver for the design of the mine plan as energy usage is a direct driver of cost as well as greenhouse gas emissions. The project design inherently minimises greenhouse gas emissions from the mining operations. Key measures included in the Project design to minimise emissions include:

- limiting the length of material haulage routes (where feasible), thus minimising transport distances and associated fuel consumption;
- selecting equipment and vehicles that have high energy efficiency ratings; and
- scheduling activities so that equipment and vehicle operation is optimised.

The following sections assess the Project's planned greenhouse gas mitigation measures against best practice greenhouse gas management.

5.2.1 Pre-draining Coal Seam Methane

Fugitive emissions arise during the coal production/extraction process whereby methane and carbon dioxide gas previously trapped within the coal is released into the atmosphere as the coal is mined. The volume and concentration of fugitive emissions vary significantly from mine to mine.

In underground coal mines, fugitive emissions are often drained from active coal seams and goaf environments (the fractured rock zone left once the coal has been extracted), to improve safety. These waste methane gases which are drained and captured are often destroyed by flaring and/or combusting as a fuel source, reducing their greenhouse gas potential. However, pre-drainage of open cut, brownfield operations is not a common practice and seams targeted for open cut extraction typically have lower gas content than deeper seams targeted for underground extraction. Gas seam contents are, however, highly variable and vary from seam to seam and from region to region.

Fugitive emissions are forecast to generate approximately 72 per cent of the Project's Scope 1 and 2 emissions. **Table 5.1** includes the greenhouse gas mitigation measures assessed for fugitive emissions.

Table 5.1 – Fugitive Emission Mitigation Options Assessed

Fugitive Emissions		
Potential Mitigation Measure	**Planned for Project**	**Reason for Inclusion/Exclusion**
1. Pre-draining and capturing coal seam methane for combustion or transfer to a third party	No	Not financially reasonable. Some aspects are not technically feasible.

BCM has modelled pre-drainage mitigation options for the Project area. The modelling prepared at the time of the EIS determined that the pre-drainage mitigation options were not feasible based on cost, technology and operational practicality.

Ideally an array of vertical holes could be used to drain the higher gas content seams (Piercefield and Mt Arthur) prior to open cut mining. However, BCM has advised that pre-drainage is not a practical mitigation measure for the Project, as the vertical wells would have to drill through significant volumes of unconsolidated material in overburden emplacement areas (average depth is 70 metres) before reaching the target coal seams. Vertical drilling through this volume of unconsolidated material is possible, but it would be extremely difficult, as drilling equipment is not designed to drill and lift loose sand and rock.

Pre-drainage gas wells for underground operations at BCC are generally operational for 3-5 years. Pre-drainage infrastructure is not logistically practical for the Project, as the progression of the mine plan would not allow gas wells and associated infrastructure to remain undisturbed on open benches for 3-5 years. In the Project environment, overburden is continuously being removed and replaced, which means vertical gas wells would have to be move regularly.

Long directional drilling, starting from a vertical position outside the overburden emplacements, could be used to overcome the issues of drilling through unconsolidated material and logistical issues, however, the required curve cannot be achieved to access the steeply dipping seams.

Pre-draining methane in the Project environment may also create safety issues if vacuum pumps are used to extract methane. Unlike an underground environment, the Project will progress horizontally and have all coal seams simultaneously exposed to high levels of oxygen. BCM has identified a concern that draining methane during the operation of the Project could create a spontaneous combustion risk, if oxygen is drawn into the working face as the extraction of methane de-pressurises the coal seam. BCM has also identified that blasting in the vicinity of pre-drainage infrastructure may also generate unnecessary safety risks.

5.2.2 Improving the Efficiency of Haul Trucks

Diesel consumption in haul trucks is forecast to generate approximately 13 per cent of the Project's combined Scope 1 and 2 emissions. **Table 5.2** includes the greenhouse gas mitigation measures assessed for improving fuel use efficiency of haul trucks.

Table 5.2 – Haul Truck Fuel Use Efficiency Options Assessed

Energy Use During Extraction		
Potential Mitigation Measure	**Planned for Project**	**Reason for Inclusion/Exclusion**
2. Limiting the length of material haulage routes	Yes	The mine planning process paid particular attention to reducing haul route distances. The mine planning process included eight iterations, which specifically focused on improving the efficiency of moving overburden. The final conceptual mine plan removes the dragline from year 4, so the pit can be re-oriented and reduce haulage distances. The final conceptual mine plan will also reduce the number of haul trucks required. Likely to be financially reasonable.
3. Optimising ramp gradients	Yes	The mine planning process focussed on minimising the need to use ramps to lift and transfer overburden. The mine plan has been designed to emplace overburden at the same height as it has been extracted. Likely to be financially reasonable.
4. Fuel efficient haul trucks	Yes	The haul truck fleet will be replaced 2-3 times during the life of the Project. Fuel use efficiency will be an important factor in selecting new haul trucks. Likely to be financially reasonable.
5. Maximising payload	Yes	Trucks will be matched with excavators to maximise payload. Trucks will also be fitted with load weights and payload efficiency is reported for all operators. Likely to be financially reasonable.
6. Increasing haul truck payload	Yes	The Project is taking delivery of some new ultra-class haul trucks. Payload is likely to increase from 240 to 350 tonne. Likely to be financially reasonable.
7. Improving rolling resistance of haul roads	Yes	Haul roads are constantly changing and it would be very expensive to pave every haul route. There are plans to improve the rolling resistance of haul roads by laying multiple sub grade layers of select material crushed to specific dimensions. Likely to be financially reasonable.
8. Reducing idling times	Yes	The Project will continuously try to improve idle times. The Project has a target of reducing idling times from 14 to 10%. Likely to be financially reasonable.

5.2.3 Improving In-Pit Fuel Use Efficiency

Diesel consumption in equipment (other than haul trucks) is forecast to generate approximately 10 per cent of the Project's combined Scope 1 and 2 emissions. **Table 5.3** includes the greenhouse gas mitigation measures assessed for improving fuel use efficiency during mining operations.

Table 5.3 – In-Pit Fuel Use Efficiency Options Assessed

Energy Use During Extraction		
Potential Mitigation Measure	**Planned for Project**	**Reason for Inclusion/Exclusion**
9. Scheduling activities so that equipment and vehicle operation is optimised	Yes	The mine planning process has scheduled activities to optimise the productivity and efficiency of equipment. Likely to be financially reasonable.
10. Alternative fuels	No	The use of biodiesel can reduce fuel use efficiency and power output. In some situations, the use of biodiesel can create technical issues. The Project is currently reviewing the feasibility of using biodiesel in open cut applications, however, it is not proposed at this time due to the above concerns.
11. Replacing trucks with conveyors	No	During the feasibility study BCM ruled out the use of conveyors based on cost and community constraints. The conveyor design required an unacceptably high discharge point, which may have created visual and dust issues. The conveyor was also not considered financially reasonable, as it would have to be moved every 12 months to keep up with the mining operation.
12. Fuel efficient equipment	Yes	The equipment will be replaced during the life of the Project. Fuel use efficiency will be an important factor in selecting new equipment. Likely to be financially reasonable.
13. Blasting strategies to improve extraction efficiency	Yes	Blasting will be undertaking using best practice. Likely to be financially reasonable.
14. Maximising resource recovery efficiency	Yes	Resource recovery will be optimised within the constraints of the Project. Likely to be financially reasonable.
15. Working machines to their upper design performance	Yes	Machines will be worked to their upper design performance. Optimising machine performance is a key performance indicator for operators. Likely to be financially reasonable.
16. Electric drills	No	Not technically practical as they lack the flexibility of diesel drills.
17. Preventing unnecessary water ingress	Yes	Desirable for many aspects of the mining operation. The Project will invest significant resources into a major water management system. Electric pumps will be prioritised for use instead of diesel.
18. Power generation fuel substitution	Yes	The on-site methane fuelled power station will substitute grid electricity. Likely to be financially reasonable.

5.2.4 Improving the Energy Efficiency of the CHPP

Electricity consumption at the CHPP is forecast to generate approximately 4 per cent of the Project's combined Scope 1 and 2 emissions. **Table 5.4** includes the greenhouse gas mitigation measures assessed for the CHPP.

Table 5.4 – CHPP Energy Use Options Assessed

Energy Use During Processing		
Potential Mitigation Measure	**Planned for Project**	**Reason for Inclusion/Exclusion**
19. Reducing reject percentage	Yes	A project is currently underway to install new flotation technology to reduce rejects by 25%. Likely to be financially reasonable.
20. Automatically shutting down CHPP when not in use	No	Not applicable. The Project should ensure the CHPP doesn't have to shut down as is expected to be constantly in use.
21. High efficiency motors	Yes	Will occur as part of on-going upgrades to the CHPP. Likely to be financially reasonable.
22. Variable Speed Drives	Yes	Will occur were appropriate as part of on-going upgrades to the CHPP. Likely to be financially reasonable.
23. Optimising motor size to load	Yes	Will occur as part of on-going upgrades to the CHPP. Likely to be financially reasonable.

The Project is planning to utilise many of the common greenhouse gas mitigation measures available for an open cut operation.

5.3 On-going Greenhouse Gas and Energy Measures

BCM will generate and evaluate many greenhouse gas management measures during a normal annual planning cycle. It is not reasonable or feasible to implement all management measures identified though the annual planning process, therefore measures will be prioritised to ensure the implementation of the most cost effective measures. To prioritise the implementation of greenhouse gas management measures, BCM will use technical review and marginal cost of abatement considerations to evaluate and prioritise all operational measures.

BCM will complete a process for prioritising reasonable and feasible greenhouse gas management measures. The steps are:

1. document greenhouse gas management options identified through the processes described in **Section 5.1.2.3** (EEAP, performance reviews, HSEC meetings);

2. identify and document options that are not technically feasible (i.e. significant technical barriers to implementation);

3. review past performance of greenhouse gas management options and make informed decisions about their ability to manage greenhouse gas emissions;

4. calculate the net present value (NPV) of implementing management options deemed technically feasible. NPV calculations would be completed over the useful life of the option and include capital expenditure, operational expenditure and forecast savings/revenue;

5. estimate the greenhouse gas savings (tCO_2-e) of implementing management options deemed technically feasible;

6. develop a marginal cost of abatement table, which contains technically feasible management options;

7. prioritise an annual management control implementation program based on cost of abatement ($/$tCO_2$-e);

8. document the outcomes of the analysis to aid future analysis and annual reporting. Documentation of outcomes will include:

   a. priority management options for implementation;

   b. potential future projects that have the potential to be feasible; and

   c. projects with an unreasonable cost of abatement.

BCM will prioritise greenhouse gas management options annually. The annual prioritisation process will assist operational planning and support a transparent process for demonstrating BCM commitment to implementing all reasonable and feasible greenhouse gas management controls.

6.0 Conclusion

The Bulga Optimisation Project is a large scale project that will produce significant energy commodities over 22 years. The Project's forecast energy use intensity is considered to fall within the normal range when compared with operations across Australia, however, given the nature and the scale of the Project, the Project is expected to generate approximately 20,217,000 t CO_2-e Scope 1 and 2 emissions.

The Project is also forecast to be associated with approximately 391,330,000 t CO_2-e Scope 3 emissions. The Project's Scope 3 emissions are beyond the operational control of BCM, and the majority of Scope 3 emissions will be generated downstream of the Project, when coal products are combusted by electricity generators and/or coking plants.

The GHGEA found that the Project is unlikely to impact national greenhouse gas policy objectives due to the relatively small annual contribution the Project will make to national emissions.

A critical aspect of the Project's justification is its ability to help meet an international demand for energy commodities. The International Energy Agency (IEA) World Energy Outlook 2012 found that coal met 45 per cent of the growth in global energy demand over the past decade. The IEA forecasts that global coal demand will grow by 1.9 per cent per year out to 2035 and will pass oil as the leading primary fuel by 2025. Given the predicted energy demand for coal, international coal consumers will continue to source coal, irrespective of Australian production.

Xstrata Coal is contributing to global solutions for climate change by addressing greenhouse gas emissions at its operations, and up and down its supply chains. Xstrata Coal has a stated commitment to addressing energy efficiency and greenhouse gas emissions and supporting the development of new technologies to reduce emissions from the consumption of coal by its customers.

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APPENDIX A

Construction Calculations

Appendix A – Construction Calculations

The greenhouse gas emissions for the construction phase of the Project are based on the following assumptions. The assumptions made for the construction related emissions are based on typical values for similar projects. The following assumptions have been used for calculation purposes only, and are not meant to describe the exact specifications of the Project.

The assumptions are:

- 622 m^3 of concrete will be required to build foundations for the transmission towers;
- each transmission tower includes 25 tonnes of steel;
- all roads will be constructed to a width of 20 metres;
- all roads will require a 230 millimetre lean concrete sub-base;
- all roads will require 75 millimetres of Asphalt AC20;
- all roads will require 50 millimetres of Asphalt AC14;
- all roads will require two 7 millimetre applications of bitumen;
- the vertical alignment of all roads will be optimised to balance cut and fill volumes;
- topsoils and other materials excavated for road construction will be utilised on-site;
- steel required for road structures (bridges, culverts) assumes concrete structures have a steel content of 120 kg/m^3;
- the recycled content of steel used in all construction projects averages 39 per cent;
- the bitumen content of asphalt averages 5 per cent;
- construction materials such as asphalt, cement and steel will be sourced within the Hunter Region and transported an average distance of 60 kilometres;
- materials will be transported via road on trucks with a payload of 33 T;

- diesel consumption for trucks transporting materials will average 55L/100 km;
- pipe relocation will require 2000 m^3 of earthworks per kilometre;
- electricity use for site based projects (MIA, Dam and Transmission lines) will require 72 kW/hr for 24 months at 8 hours per day;
- diesel use for road construction will average 240 kL/kilometre of road construction. This is a conservative assumption based on halving the diesel use estimates the RTA used for major Pacific Highway upgrades (4 lanes, divided road) (RTA 2008);
- diesel use for site based earthworks will average 1 litre per cubic metre;
- rail track will require 120 kilograms of rail steel per metre (2 rails at 60 kg/m);
- rail track will require concrete sleepers at 600 millimetre intervals;
- rail track will require 2.20 m^3 of ballast per metre;
- concrete structures required for the rail track (including sleepers) will include 100 kilograms of reinforcing steel per cubic metre;
- concrete structures required for the rail track (including sleepers) will have a concrete density of 2,400 kg/m^3;
- rail track will require 120,000 BCM of earthworks; and
- rail track earthworks will require 120,000 litres of diesel.

Construction Materials

Activity Data			Emission Factors[3]	GHG Emissions
Material Type	Usage	Unit	t CO_2-e/Unit	t CO_2-e
Steel	3,093	t	1.95	6,031
Concrete structures	16,672	m^3	0.329	5,485
Lean concrete sub-base	84,180	m^3	0.1504	12,661
Asphalt (AC20)	27,450	m^3	0.1704	4,677
Asphalt (AC14)	18,300	m^3	0.1704	3,118
Bitumen	5,124	m^3	0.515	2,639
Ballast	7,940	m^3	0	0
Total GHG emissions (t CO_2-e)				**34,611**

Energy Use during Construction

Activity Data				Emission Factors		
				Scope 1	**Scope 3**	**Full Life Cycle**
Purchased energy	Usage	Units	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Diesel	5,414	kL	208,980	69.5	5.3	74.8
Electricity	420,480	kWh	1,514	246	47	294
						t CO_2-e
Total GHG emissions (t CO_2-e)						**16,077**

Transport of Materials

Activity Data				Emission Factors		
				Scope 1	**Scope 3**	**Full Life Cycle**
Purchased energy	Usage	Units	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Diesel	383.756	kL	14,813	69.5	5.3	74.8
						t CO_2-e
Total GHG emissions (t CO_2-e)						**1,108**

[3] Emission factors sources from the University of Bath, Inventory of Carbon and Energy (ICE) v2.0, 2011.

APPENDIX B

Life of Mine Calculations

Appendix B – Life of Mine Calculations

LOM Stationary Diesel Use

Activity Data	Energy Use		Emission Factors		
			CO_2	CH_4	N_20
kL	GJ/kL	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
1,723,696	38.6	66,534,666	69.2	0.1	0.2
			t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)			4,604,199	6,653	13,307
Total GHG emissions (t CO_2-e)					**4,624,159**

LOM Fugitive Emissions

Activity Data	Energy Use		Emission Factors		
			CO_2	CH_4	N_20
ROM (t)	-	-	kg CO_2-e/ROM t	kg CO_2-e/ROM t	kg CO_2-e/ROM t
230,000,000	N/A	N/A	N/A	63.197	N/A
			t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)			N/A	14,535,303	N/A
Total GHG emissions (t CO_2-e)					**14,535,303**

LOM Electricity

Activity Data	Energy Use	Emission Factors		
		CO_2	CH_4	N_20
GJ	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
4,294,961	4,294,961	246	N/A	N/A
		t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)		1,056,561	N/A	N/A
Total GHG emissions (t CO_2-e)				**1,056,561**

LOM Product Use

Activity Data		Energy Production		Emission Factors		
				CO_2	CH_4	N_20
Product	Product (t)	GJ/Product t	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Black coal	121,233,000	27.0	3,273,291,000	88.2	0.03	0.2
Coking coal	30,682,000	30.0	920,460,000	90.0	0.02	0.2
				t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)				371,545,666	116,608	838,750
Total GHG emissions (t CO_2-e)						**372,501,024**

LOM Extraction, Production and Distribution of Energy Purchased

Activity Data		Emission Factors		
		CO_2	CH_4	N_20
Purchased energy	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Diesel	66,534,666	5.3	N/A	N/A
Electricity	4,294,961	47.0	N/A	N/A
		t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)		554,497	N/A	N/A
Total GHG emissions (t CO_2-e)				**554,497**

LOM Product Transport

Activity Data				Emission Factors		
				CO_2	CH_4	N_20
Transport mode	Product (t)	Distance (km)	Tonne km (tkm)	kg CO_2-e/tkm	kg CO_2-e/tkm	kg CO_2-e/tkm
Rail	151,915,000	92	13,976,180,000	0.0054	N/A	N/A
Ship	151,915,000	9,500	1,443,192,500,000	0.0126	N/A	N/A
				t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)				18,259,697	N/A	N/A
Total GHG emissions (t CO_2-e)						**18,259,697**

Transport of Materials (On-site Diesel)

Activity Data				Emission Factors		
				Scope 1	**Scope 3**	**Full Life Cycle**
Purchased energy	Usage	Units	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Diesel	4,990	kL	192,614	69.5	5.3	74.8
						t CO_2-e
Total GHG emissions (t CO_2-e)						**14,408**

APPENDIX C

Maximum Annual Emissions

Appendix C – Maximum Annual Emissions

Stationary Diesel Use

Activity Data	Energy Use		Emission Factors		
			CO_2	**CH_4**	**N_20**
kL	GJ/kL	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
89,792	38.6	3,465,971.2	69.2	0.1	0.2
			t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)			239,845.20	346.60	693.19
Total GHG emissions (t CO_2-e)					**240,884.99**

Fugitive Emissions

Activity Data	Energy Use		Emission Factors		
			CO_2	**CH_4**	**N_20**
ROM (t)	-	-	kg CO_2-e/ROM t	kg CO_2-e/ROM t	kg CO_2-e/ROM t
12,200,000	N/A	N/A	N/A	63.197	N/A
			t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)			N/A	771,003	N/A
Total GHG emissions (t CO_2-e)					**771,003**

Electricity

Activity Data	Energy Use	Emission Factors		
		CO_2	**CH_4**	**N_20**
GJ	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
223,748	223,748	246	N/A	N/A
		t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)		55,042.00	N/A	N/A
Total GHG emissions (t CO_2-e)				**55,042.00**

LOM Product Use

Activity Data		Energy Production		Emission Factors		
				CO_2	**CH_4**	**N_20**
Product	Product (t)	GJ/Product t	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Black coal	6,466,000	27.0	174,582,000	88.2	0.03	0.2
Coking coal	1,586,000	30.0	47,580,000	90.0	0.02	0.2
				t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)				19,680,332.40	6,189.06	44,432.40
Total GHG emissions (t CO_2-e)						**19,730,953.86**

LOM Extraction, Production and Distribution of Energy Purchased

Activity Data		Emission Factors		
		CO_2	**CH_4**	**N_20**
Purchased energy	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Diesel	3,465,971.2	5.3	N/A	N/A
Electricity	223,748	47.0	N/A	N/A
		t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)		28,885.81	N/A	N/A
Total GHG emissions (t CO_2-e)				**28,885.81**

LOM Product Transport

Activity Data				Emission Factors		
				CO_2	**CH_4**	**N_20**
Transport mode	Product (t)	Distance (km)	Tonne km (tkm)	kg CO_2-e/tkm	kg CO_2-e/tkm	kg CO_2-e/tkm
Rail	8,052,000	92	740,784,000	0.0054	N/A	N/A
Ship	8,052,000	9,500	76,494,000,000	0.0126	N/A	N/A
				t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)				967,824.63	N/A	N/A
Total GHG emissions (t CO_2-e)						**967,824.63**

APPENDIX D

Decommissioning and Closure Calculations

Appendix D – Decommissioning and Closure Calculations

The greenhouse gas emissions for the closure phase of the Project are based on closure costs of similar operations in the Hunter Valley. Diesel consumption activity data has been calculated from closure cost data, using a net diesel cost of $1.10/litre (after the Fuel Tax Credit).

Stationary Diesel Use

Activity Data	**Energy Use**		**Emission Factors**		
			CO_2	**CH_4**	**N_20**
kL	GJ/kL	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
5,175	38.6	199,755	69.2	0.1	0.2
			t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)			13,824	20	40
Total GHG emissions (t CO_2-e)					**13,884**

Extraction, Production and Distribution of Energy Purchased

Activity Data		**Emission Factors**		
		CO_2	**CH_4**	**N_20**
Purchased energy	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Diesel	199,755	5.3	N/A	N/A
Electricity	N/A	47.0	N/A	N/A
		t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)		1,059	N/A	N/A
Total GHG emissions (t CO_2-e)				**1,059**