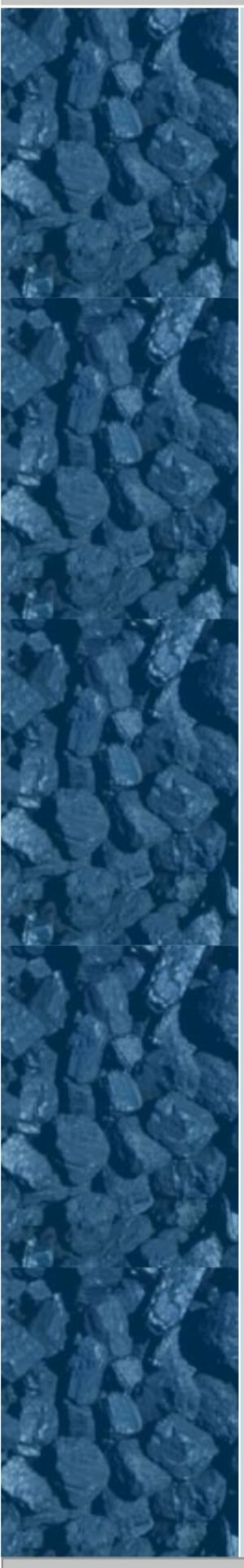
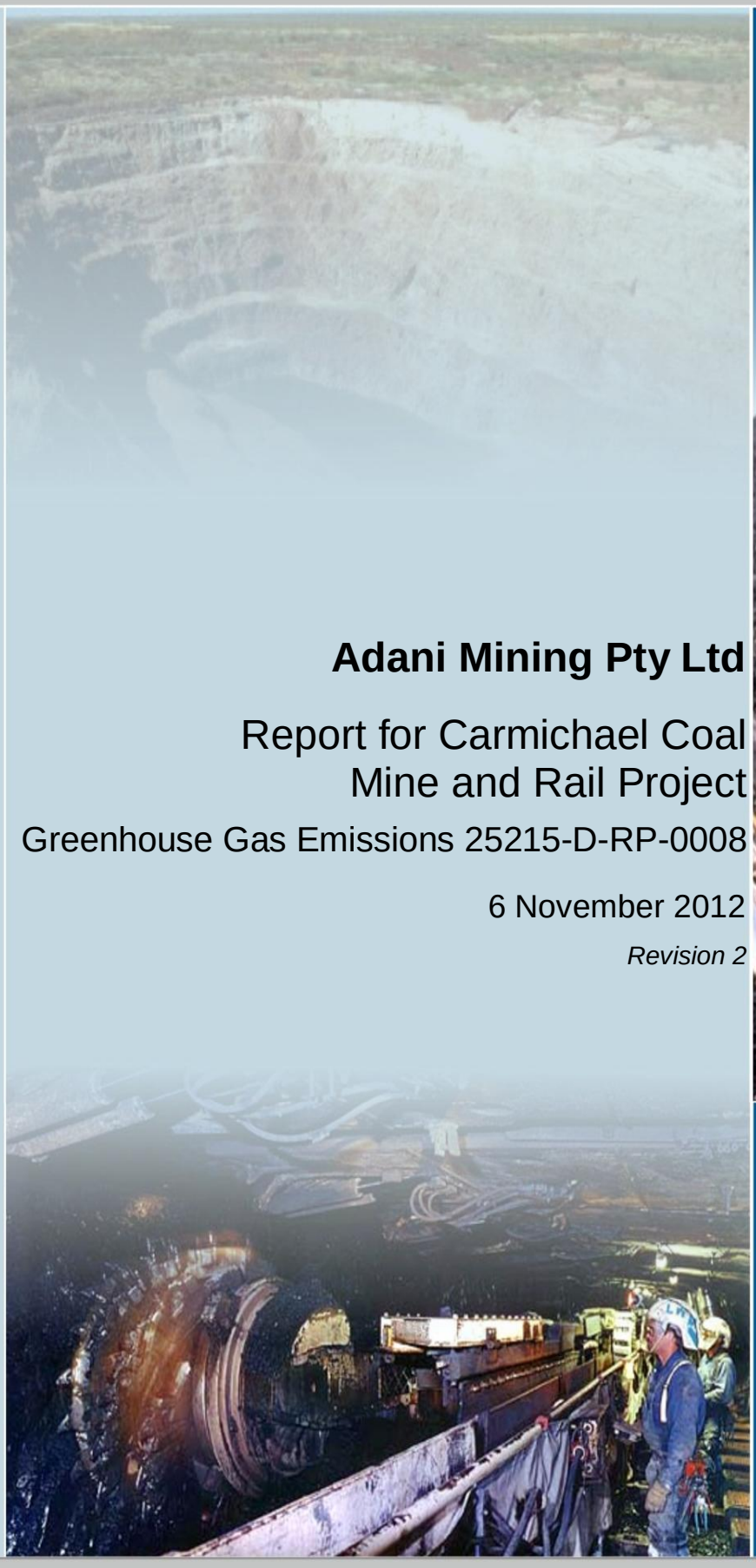
Adani Mining Pty Ltd





Adani Mining Pty Ltd

Report for Carmichael Coal Mine and Rail Project

Greenhouse Gas Emissions 25215-D-RP-0008

6 November 2012

Revision 2

This Carmichael Coal Mine and Rail Project: Mine Greenhouse Gas Emissions report ("the Report") has been prepared by GHD Pty Ltd ("GHD") on behalf of and for Adani Mining Pty Ltd ("Adani") in accordance with an agreement between GHD and Adani.

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The services undertaken by GHD in connection with preparing the Report were limited to those specifically detailed in Section 1 of the Report.

The Report is based on conditions encountered and information reviewed, including assumptions made by GHD, at the time of preparing the Report. Assumptions made by GHD are listed within Section 1.5.6 of the Report and contained through the Report.

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- *reliance on the Report by a third party, or use of this Report other than for the Purpose.*

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A Terms of Reference Cross-reference

B Greenhouse Gas Assessment Emission Factors and FullCam Setup

Abbreviation and Glossary

Project Specific Terminology	
Abbreviation	Term
the EIS	Carmichael Coal Mine and Rail Project Environmental Impact Statement - refers to the particular document that GHD is preparing to facilitate approval of the Project
the Proponent	Adani Mining Pty Ltd
the Project (Mine)	A greenfield coal mine over EPC1690 and part of EPC1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and offsite infrastructure
Generic Terminology	
Abbreviation	Term
a	annum
ANFO	ammonium nitrate fuel oil
C	carbon
CFI	Carbon Farming Initiative
CH_4	methane
CO_2	carbon dioxide
CO_2-e	Carbon dioxide equivalent emissions (emissions of other greenhouse gases are multiplied by their Global Warming Potential so that their effects can be compared to emissions of carbon dioxide)
COD	chemical oxygen demand
DCCEE	The Commonwealth Department of Climate Change and Energy Efficiency
EEO	Energy Efficiency Opportunities
EF	emission factor
Emission	The release of material into the environment (such as, dust)
FullCAM	Full Carbon Accounting Model
GHG Protocol	The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard
GIS	geographical information system
GJ	gigajoule
Greenhouse Gases	Gases that accumulate within the Earth's atmosphere (eg: primarily carbon dioxide and methane) which contribute to global climatic change/global warming (i.e. the 'greenhouse effect')

Generic Terminology	
Abbreviation	Term
GHG	Greenhouse gas
GWP	Global Warming Potential
ha	hectare
IPCC	International Panel on Climate Change
HFCs	hydrofluorocarbons
kL	kilolitres
Mitigation	Limit the intensity of impacts or prevent impacts
MWh	megawatt hour
N_2O	nitrous oxide
NCAT	National Carbon Accounting Toolbox
NGA	National Greenhouse Accounts
NGERS	National Greenhouse and Energy Reporting Scheme
p	people
PFCs	perfluorocarbons
PJ	petajoule
ROM	run of mine
SF_6	sulphur hexafluoride
t	tonne
TJ	terajoules
ToR	terms of reference

1. Introduction

1.1 Project Overview

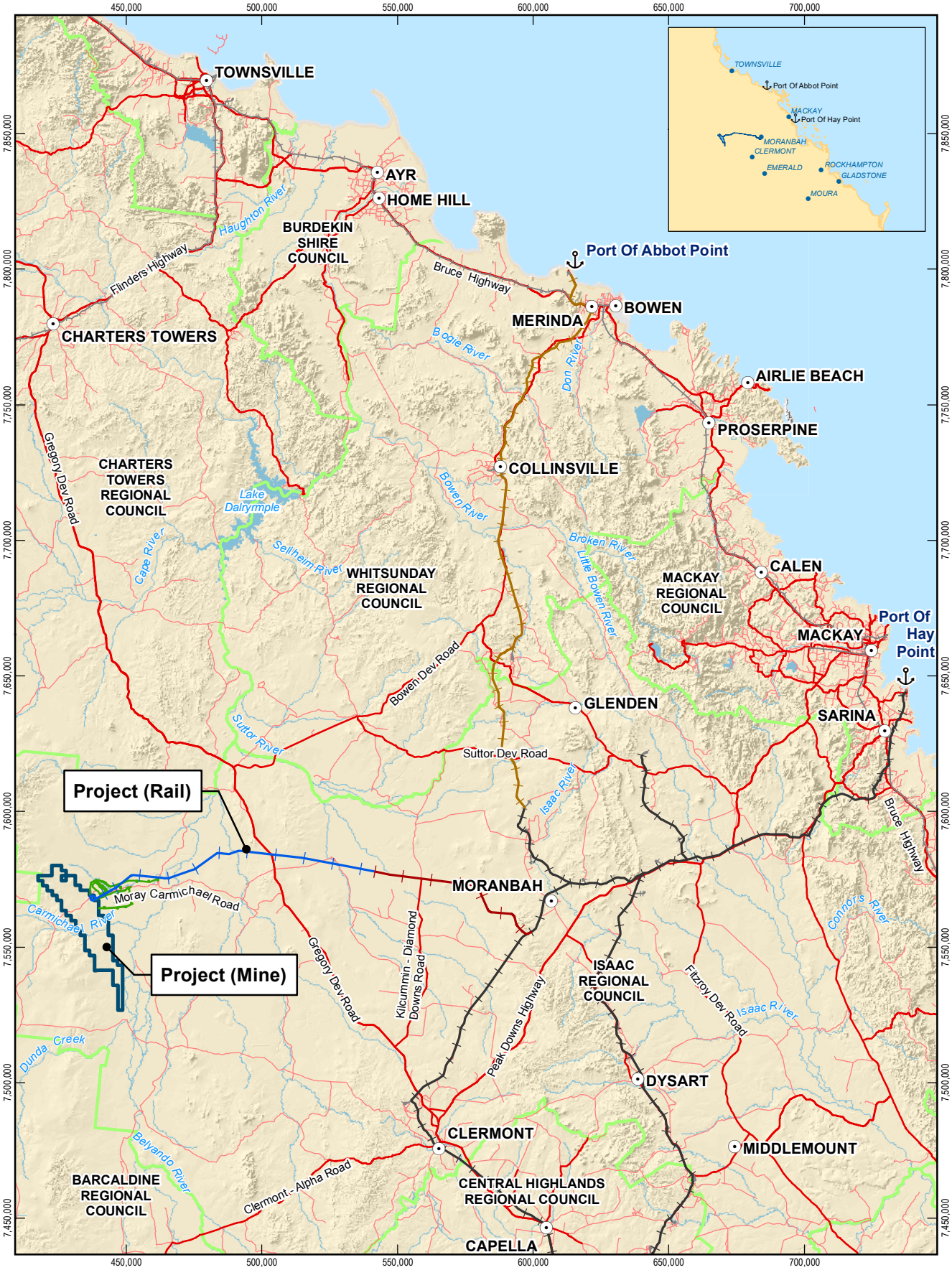
Adani Mining Pty Ltd (Adani) is proposing to develop a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the north Galilee Basin approximately 160 kilometres (km) north-west of the town of Clermont, Central Queensland. All coal will be railed via a privately owned rail line connecting to the existing QR National rail infrastructure, and shipped through coal terminal facilities at the Port of Abbot Point and the Port of Hay Point (Dudgeon Point expansion). The Carmichael Coal Mine and Rail Project (the Project) will have an operating life of approximately 90 years.

The Project is comprised of two major components:

- The Project (Mine): a greenfield coal mine over EPC1690 and the eastern portion of EPC1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including:
  - A workers accommodation village and associated facilities
  - A permanent airport site
  - Water supply infrastructure
- The Project (Rail): a greenfield rail line connecting the Mine to the existing Goonyella and Newlands rail system to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively; including:
  - Rail (west): a 120 km dual gauge portion from the Mine site running west to east to Diamond Creek
  - Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah

The Project has been declared a 'significant project' under the *State Development and Public Works Organisation Act 1971* (SDPWO Act) and as such an Environmental Impact Statement (EIS) is required for the Project. The Project is also a 'controlled action' and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project EIS has been developed with the objective of avoiding or mitigating all potential adverse impacts to environmental, social and economic values and enhancing positive impacts. Detailed descriptions of the Project are provided in Volume 2 Section 2 Project Description (Mine) and Volume 3 Section 2 Project Description (Rail). Figure 1-1 shows the Project location.



LEGEND

- Town
- Major Port
- Other Rail Network
- Goonyella System
- Newlands System
- State Road
- Local Road
- Watercourse
- Local Government Area
- Project (Rail)
- Rail (West)
- Rail (East)
- Project (Mine)
- Mine (Offsite)

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision L
Date 28-08-2012

Project Location

Figure: 1-1

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Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DERM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008); Gassman/Hyder: Mine (Offsite) (2012); DME: EPC1690 (2010), EPC1080 (2011); Adani: Alignment Opt9 Rev3 (2012). Created by: BW, JVC

1.2 Background

In 2007, the Intergovernmental Panel on Climate Change (IPCC) released its fourth assessment report which stated that evidence of warming of the climate system is now unequivocal and is very likely due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities (IPCC, 2007).

GHGs are those gases in the earth's atmosphere that trap heat, allowing the temperature of the earth to be kept at a level that is necessary to maintain life. An increase in the levels of these gases in the atmosphere results in an increase in the amount of heat being trapped, leading to warming of the earth's surface. This is commonly referred to as the enhanced greenhouse effect. The three main greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). As each of these compounds have different global warming potential (GWP), quantities of emissions of methane and nitrous oxide are standardised to carbon dioxide equivalent, (CO_2-e) by multiplying by the GWP.

At an international level, the Australian government is a signatory to the Kyoto Protocol and as such, has GHG stabilisation and reporting commitments. Australia has committed to limit national emissions to 108 per cent of 1990 emissions, during the period 2008 - 2012. International negotiations will determine what new commitment Australia signs up to after 2012.

At a National level, the government has made a commitment to Australians, separate to any commitment under the Protocol, to reduce Australia's emissions by 5 per cent below 2000 levels by 2020 and 80 per cent by 2050.

1.3 Relevant Legislation

Key legislation relevant to the Project (Mine) and potential implications includes the following:

- *Clean Energy Act 2011.* A Carbon Pricing Mechanism under the *Clean Energy Act 2011* (Cth) took effect on 1 July 2012 and established a mechanism to set a price on carbon emissions, which is commonly referred to as the Carbon Tax. The Carbon Tax applies to entities with operational control over facilities that emit in excess of 25,000 t of carbon dioxide equivalent (CO_2-e) per financial year. Liable entities are required to surrender an equivalent number of carbon units as their Scope 1 emissions. This carbon price has been initially set at $23 during the 2012-13 financial year, $24.15 during 2013-14, and $24.50 during 2014-15. From 1 July 2015 the carbon price will be determined by a market-based emissions trading scheme.
- *National Greenhouse and Energy Reporting Act 2007*. In the 2011-2012 reporting year, National Greenhouse and Energy Reporting Scheme (NGERS) applies to facilities that emit over 25,000 t CO_2-e per year or consume more than 100 TJ of energy or corporations that emit over 50,000 t CO_2-e per year or consume more than 200 TJ of energy from their combined facilities. These thresholds relate to Scope 1 and Scope 2 emissions. Based on the estimated average annual energy use during operations the Project (Mine) is likely to trigger the facility and corporation thresholds. Participation will need to be determined based on actual annual greenhouse gas emissions and energy consumption.
- *Energy Efficiency Opportunities Act 2006*. The Energy Efficiency Opportunities (EEO) program requires businesses to identify, evaluate and publicly report cost effective energy saving opportunities. Participation in EEO is mandatory for corporations that use more than 0.5 PJ of energy

per year. As the Project (Mine) operations will use more 0.5 PJ of energy per year, it will be mandatory to report this under the EEO program. Participation will need to be assessed based on actual energy consumption to determine the first year the threshold is exceeded.

- *Carbon Credits (Carbon Farming Initiative) Act 2011.* The Carbon Farming Initiative (CFI) has been developed to give farmers, forest growers and landholders the ability to generate accredited domestic offsets for access to domestic voluntary and international carbon markets. Any claims relating to 'carbon neutrality' for the Project (or part thereof) should give consideration to the purchase of offsets generated under the CFI.

1.4 Level of Assessment Required

Section 3.6 of the Project Terms of Reference (ToR) details the level of assessment required for the Project, as follows:

- Scope 1 emissions, which are greenhouse gas emissions that are released into the atmosphere as a direct result of an activity or series of activities.

  Scope 1 emissions are greenhouse gas emissions created directly by a person or business from sources that are owned or controlled by that person or business

- Scope 2 emissions, in relation to an activity or series of activities, are greenhouse gas emissions that are released into the atmosphere as a direct result of the generation of electricity, heating, cooling or steam that is consumed during the course of carrying out the activity or series of activities.

  Scope 2 emissions are greenhouse gas emissions created as a result of the generation of electricity, heating, cooling or steam that is purchased and consumed by a person or business. These are indirect emissions as they arise from sources that are not owned or controlled by the person or business who consumes the electricity.

- Scope 3 emissions are not required as part of this assessment in accordance with the TOR requirements.

Table 1-1 provides a cross-reference to the relevant sections of the ToR address herein. A detailed ToR cross-reference is included within Appendix A.

Table 1-1 Terms of Reference Cross Reference Table

Terms of Reference Requirement/Section Number	Section of this report
Section 3	
Legislative Framework with reference to *Greenhouse Gas Storage Act 2009*	GHD notes the ToR relates only to conditions for any proposed greenhouse gas injection and storage lease. As there is no greenhouse gas storage or injection associated with the Project (Mine), this is not applicable and is therefore not a requirement for this assessment

Terms of Reference Requirement/Section Number	Section of this report
Section 3.6.1 Description of Environmental Situation	
Provide an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in 'CO 2 equivalent' terms for scope 1 and scope 2 emissions.	Section 2
Describe the method by which estimates were made.	Section 1.5
Section 3.6.2 Potential Impacts and Mitigation Measures	
Description of proposed mitigation measures	Section 3
Assessment of how the measures achieve energy efficiency	Section 3
How the measures achieve best practice environment management	Section 3
Description of off-setting opportunities	Section 3
Description of the environmental management plan	Section 3
Commitments to monitor, audit and report on emissions	Section 3

1.5 Methodology

The GHG assessment was prepared in accordance with the general principles of:

- *The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard* developed by the World Resource Institute and the World Business Council for Sustainable Development (GHG Protocol).
- The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) *National Greenhouse Accounts* (NGA) Factors, July 2012
- Australia's National Carbon Accounting System (DCCEE, 2005)
- ACARP 'Guidelines for Implementation of NGER Method 2 or 3 for Open Cut Coal Mine Fugitive GHG Emissions Reporting'

These are considered to represent current good practice in Australian greenhouse gas accounting.

1.5.1 Boundary of the Assessment

The assessment included GHG emissions from the following activities:

- Electricity imported from the grid
- Fuel combustion from construction and operation of the Project (Mine)
- Fugitive GHG emissions from coal mining
- Wastewater treatment
- Vegetation removal
- Explosive uses

1.5.2 Greenhouse Gases Considered

Table 1-2 outlines the greenhouse gases considered in this assessment. The GWP for each greenhouse gas is also provided in Table 1-2. The GWPs were sourced from the NGA Factors July 2012.

Table 1-2 Greenhouse Gases and 100 year Global Warming Potentials

Greenhouse Gas	Global Warming Potential (t/CO_2-e)
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140 – 11,700
Perfluorocarbons (PFCs)	6,500 – 9,200
Sulphur hexafluoride (SF_6)	23,900

Source: NGA Factors, July 2012

1.5.3 Emission Scopes

Emissions have been separated into Scopes 1 and 2 in accordance with the GHG Protocol, as defined in Section 1.4.

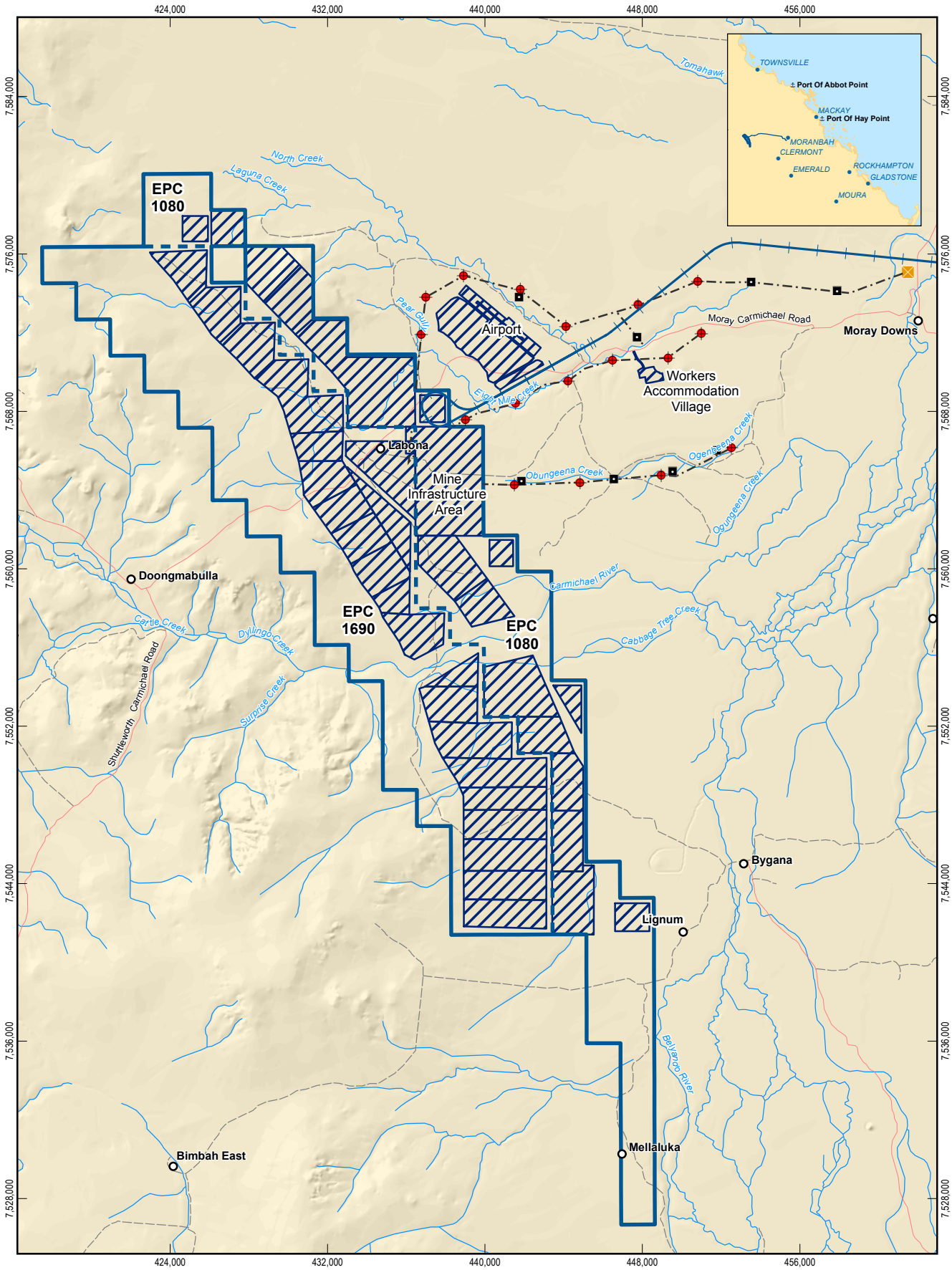
Scope 1 emissions are produced by the combustion of fuels such as diesel at the development site, and by vehicles and plant equipment which the proponent owns and/or has operational control over. Note that only the direct combustion of the fuels by equipment utilised within the proposed mining activity is considered as a Scope 1 emission. Fugitive emissions from the coal seam are also included as Scope 1 emissions. Scope 2 emissions arise from the consumption of electricity generated outside the proposed Project (mine) area, in plant equipment that is operated by the proponent. The person who pays for fuel for these vehicles should include in their Scope 1.

1.5.4 Data Collection and Calculation Procedures

Data for the GHG assessment was sourced from the Carmichael Macro-Conceptual Mining study (Runge Limited, 2011). Where data was not available, assumptions and approximations were made in order to obtain a reasonable estimate of activity levels. All assumptions are provided in Section 1.5.6.

GHG emissions due to vegetation clearing within the mine and associated off site infrastructure assessment areas were quantified using the National Carbon Accounting Toolbox (NCAT). The NCAT provides access to the Full Carbon Accounting Model (FullCAM) and supporting data. FullCAM is the method used to quantify emissions due to land clearing in Australia's land systems for the purposes of international reporting (see Appendix B for input data).

The outcomes of ecology assessment (see Volume 4 Appendix N Terrestrial Ecology Report) and geographical information system (GIS) analysis were used to quantify the types and areas of vegetation existing within the Project (Mine) (onsite and offsite) area. Three FullCAM plot files were created to model the broad scale vegetation types. Figure 1-2 shows the area of clearing based on the concept mine layout and land use planning for offsite areas.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Area of Proposed Clearing
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network

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0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision C
Date 16-10-2012

Area of Proposed Clearing

Figure: 1-2

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Data Source: DERM: Elevation (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Road, Homestead, Watercourse (2007); DME: EPC 1690 (2010)/EPC 1080 (2011); Adani: Mine Layout / Infrastructure, Alignment Opt9 Rev3 (2012); GHD: Area of proposed clearing (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

The following areas of vegetation (based on vegetation species)[1] are being cleared as part of the Project (Mine) footprint:

- Local species on duplex – woodland soil (1,619 ha)
- Mixed species environmental planting on clay – brigalow and gidgee soils (25,447 ha)
- Acacia forest and woodlands (27 ha)
- Eucalyptus open woodland (6 ha)
- Pasture grasslands (17,427 ha)

Greenhouse gas emissions due to the clearing of this vegetation were estimated by multiplying the results returned by FullCAM by 3.67 (the ratio of the mass of a carbon atom to a carbon dioxide molecule). As detailed in Section 1.5.5 calculations did not take into account sequential revegetation. It is noted that greenhouse gas emissions will be offset by progressive rehabilitation during the life of the mine and the provision of biodiversity offsets.

All energy consumption and emissions data was converted into quantities of CO_2-e. The emission values have been summed to reach an estimate of the total greenhouse gas emissions.

1.5.5 Exclusions from the Assessment

Exclusions from the assessment included:

- Leakage of hydrofluorocarbons from air conditioning units and refrigeration. These emissions were considered to be negligible compared with the emissions over the life of the Project (Mine). However, these negligible emissions will be recorded as part of the Project ongoing greenhouse reporting.
- Leakage of sulphur hexafluoride from electrical equipment. These emissions were considered to be negligible compared with the emissions over the life of the Project (Mine). However, these negligible emissions will be recorded as part of the Project ongoing greenhouse reporting.
- Sequestration of carbon dioxide from revegetation of the site. Whilst revegetation will occur onsite throughout the life of the mine, specific details regarding types of vegetation for replanting or a descriptive revegetation plan are not available at this time as such, sequestration calculations cannot be accurately undertaken. Excluding sequestration also assumes a worst case scenario for greenhouse gas emissions. Therefore this scenario is considered the most conservative representation of Project (Mine) emissions.

1.5.6 Assumptions

Assumptions used in estimating the activity levels and associated energy use and greenhouse gas emissions for the Project (Mine) are listed in Table 1-3. The assessment was based on emission factors available at the time of the assessment and future changes in emission factors were not considered.

[1] Note these areas were calculated and provided by the ecologists and totalled based on wooded and grassed areas for the purpose of the vegetation assessment.

Table 1-3 Assumptions used in the Greenhouse Gas Assessment

Parameter measured	Assumptions
Diesel (stationary energy purpose)	Average annual quantity of diesel use for operation estimated as 255,179 kL/a, which has been based on the total cost for diesel over the life of the Project (Mine), an assumed cost per litre for diesel and a total Project (Mine) life of 90 years. Emission factor (EF) sourced from DCCEE NGA Factors July 2012 Table 3.
Electricity - imported from the grid (QLD)	Average annual quantity of electricity consumption at the site estimated as 1,708,735 MWh/a based on the total cost for electricity over the life of the Project (Mine), an assumed cost per kilowatt hour for electricity and a total project life of 90 years. Using the cost provided and the production life of the Project (Mine), estimate of electricity use has been calculated as no data estimate was available for electricity consumption. EF sourced from NGA Factors July 2012 Table 5 for Queensland.
Explosives	Average annual quantity of explosives used estimated as 56,232 t (52,668 tonnes of ammonium nitrate fuel oil (ANFO) and 3,564 tonnes of ammonium nitrate emulsion). EF sourced from DCCEE NGA January 2008, Table 4 for ANFO and emulsion.
Wastewater handling	Average annual quantity of GHG emission from wastewater treatment was calculated in accordance with the DCCEE NGA Factors 2011. The emissions were based on the average workforce of 2,868 people (which includes miscellaneous contractors) and the following default factors: ◗ Chemical oxygen demand (COD) per capita per year of wastewater – 0.0585 t/person/year ◗ The quantity of COD in wastewater discharged in effluent was assumed to be zero ◗ Fraction of COD removed as sludge – 0.29 ◗ Methane emission factor for wastewater – 5.3 t CO_2-e/t ◗ Methane emission factor for sludge – 5.3 t CO_2-e/t ◗ Fraction of COD anaerobically treated in wastewater and sludge – 0.8 ◗ Methane recovered from wastewater – 0

Parameter measured	Assumptions
Fugitive emissions (open-cut mine)	Quantity of total minable coal from open-cut mine estimated as 4.2 billion tonnes (46.6 million tonnes/annum based on 90 years operational life). EF of 0.00023 sourced from ACARP 'Guidelines for Implementation of NGER Method 2 or 3 for Open Cut Coal Mine Fugitive GHG Emissions Reporting'. Based on measured average gas content provided, the coal seams are considered low gas zones and the default factor from ACARP can be applied. Low gas seams are considered those reported at or below 0.5 m^3/t. The majority of boreholes and seams have a measured gas content and order of magnitude less than the 0.5 m^3/t value, and the calculated average value of all seams is at or below 0.5 m^3/t. The determination of low gas zones has been based on information provided from the six boreholes and is assumed to be a sufficient representation of the open cut mining footprint, hence a sufficient representation of gas content conditions within the proposed mining area. Determination of low gas quantification is provided in Appendix B.
Fugitive emissions (underground mine)	Quantity of total minable coal from underground mine was provided by proponent as 0.8 billion tonnes (8.8 million tonnes per annum). Coal seam gas data was derived from the Interim Report – Supporting Data for Environmental Impact Statement for Carmichael Coal Project, prepared by Nuninuna CSG Pty Ltd (February 2011). An EF of 0.002 t CO_2-e/t coal has been calculated based on the average gas content calculated from the provided gas content data information (0.105 m^3/t). Further details on how the EF was calculated based on the provided average gas content is provided in Appendix B.

Parameter measured	Assumptions
Vegetation removal	Representative points in the mine and offsite assessment areas (latitude: -22.0531192; longitude: 146.38369984 and latitude -21.9564; longitude 146.4269984, respectively) were chosen for which climatic, geophysical and maximum aboveground biomass values were downloaded from the DCCEE server. It was assumed that data downloaded at these points were representative of conditions. In calculating existing carbon on the site no fires or management (thinning, harvesting or pruning) events in the vegetation's history were simulated. It was assumed that all carbon from the above ground vegetation, roots and soil carbon pools would be removed by the Project (Mine) and would not regrow following construction. In the absence of FullCAM categories for each vegetation community identified at the site, it was assumed that the existing FullCAM tree species groups as presented in Section 1.5.4 represent the types of vegetation existing in the area. Pasture grasslands were modelled as grasslands.

2. Scope 1 and Scope 2 Emission Inventory

The greenhouse gas emissions for the Project (Mine) were calculated based on estimated energy usage during construction and operations, fugitive emissions from coal mining and other direct emission sources, including vegetation removal, wastewater treatment and explosives usage.

The total average annual Scope 1 and Scope 2 greenhouse gas emissions for the Project (Mine) were estimated to be 2,286 kilotonnes CO_2-e per annum. Scope 1 emissions were estimated to be 782 kilotonnes CO_2-e per annum and Scope 2 emissions were estimate to be 1,504 kilotonnes CO_2-e per annum. Over the life of the Project (Mine) the Scope 1 and Scope 2 greenhouse gas emissions were estimated as 206 million tonnes CO_2-e based on a project life of 90 years, averaged over both construction and operation (refer to Appendix B for calculations).

Imported electricity from the grid was estimated to be the largest emission source for the Project (Mine), accounting for 66 per cent of emissions, with diesel consumption being the next biggest contributor at 30 per cent of emissions.

The average annual Scope 1 and Scope 2 emissions from the Project (Mine) are estimated to be approximately 2 per cent of Queensland's 2009 greenhouse gas emissions and approximately 0.6 per cent of Australia's 2009 greenhouse gas emissions (DCCEE, 2011c).

The Scope 1 and Scope 2 greenhouse gas inventory is provided in Table 2-1.

Table 2-1 Greenhouse Gas Inventory

Emissions Source	Quantity		Scope 1 Emission Factor	Scope 2 Emission Factor	Units	Scope 1 Emissions	Scope 2 Emissions	Total Emissions	Proportion of Total Inventory
	Total	Units	t CO_2-e / units	t CO_2-e / units		(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	%
Electricity - imported from the grid	1,708,735	MWh/a	0.000	0.88	MWh	0	1,503,687	1,503,687	65.8
Diesel - stationary energy purposes	255,179	kL/a	2.683	0.00	kL	684,569	0	684,569	30.0
Explosives - ANFO	52,668	t/a	0.170	0.00	t	8,954	0	8,954	0.4
Explosives - Emulsion	3,564	t/a	0.170	0.00	t	606	0	606	0.0
Wastewater handling	2,868	p	0.248	0.00	t	711	0	711	0.0
Fugitive methane - open cut mine	46,666,667	t ROM /a	0.00023	0.00	t	10,733	0	10,733	0.5
Fugitive methane - underground mine	8,888,889	t ROM /a	0.002	0.00	t	13,996	0	13,996	0.6
Vegetation removal	16,982	t C/a	3.670	0.00	t C	62,322	0	62,322	2.7
Average Annual GHG Emissions						**781,891**	**1,503,687**	**2,285,578**	**100.0**

3. Potential Impacts and Mitigation Measures

3.1 Overview

According to the Commonwealth Department of Climate Change and Energy Efficiency potential impacts to Queensland's industries, infrastructure, environment and people from greenhouse gas induced climate change include:

- Reduction of land available in the coastal zone – due to the risk of inundation from a sea level rise
- Reduction in water supply availability – due to a decrease in rainfall and an increase in evaporation rates
- Increase in extreme weather events – including severe storms, tropical cyclones, storm surge, extreme rainfall leading to flooding
- Human health impacts - Heatwaves and increases in maximum temperatures causing an increase in heat related deaths, spread of mosquito-borne diseases and human discomfort
- Loss of biodiversity – increase in sea temperature rises leading to coral bleaching of the Great Barrier Reef. Reduction in rainforest area leading to decreased habitat
- Reduced agricultural productivity – future productivity growth may be affected by climate change in the medium to long term through higher temperatures, reduced rainfall and more extreme weather events (DCCEE 2012)

It is recognised that mining construction and operations will result in the generation of greenhouse gas emissions and therefore may contribute to climate change. Therefore, Adani is committed to managing its greenhouse gas emissions to reduce the impacts identified above on the surrounding environment and its people. The following section outlines the abatement measures to avoid, mitigate and offset the greenhouse gas emissions during the construction and operation of the Project (Mine) to be implemented on site and at the corporate level.

3.2 Construction

3.2.1 Potential Greenhouse Gas Impacts

The greenhouse gas emissions from the construction of the Project (Mine) will result from fugitive emissions from construction activities and other direct emission sources, including vegetation removal, waste production, transport, manufacturing and construction of building materials and electricity. A breakdown of emissions by source is provided in Figure 3-1. These greenhouse gas emissions will be relatively low and produced over a short time period and are therefore unlikely to contribute significantly to Queensland's overall greenhouse gas emissions. However, to reduce the likely greenhouse gas emissions from the construction of the mine management and mitigation measures are outlined further below.

As construction is progressive, and information provided on diesel use (which is the most significant source of emissions during construction) does not differentiate between what is used for either construction or operation, the distinction between construction and operation emissions cannot be defined. As such, the quantities and proportion of emissions as a result of construction activities has not been separated from operational activities.

3.2.2 Planning and Commitments

An Environmental Management Plan (refer to Volume 2 Chapter 13 EMP) has been developed and will be implemented during construction. This Environmental Management Plan includes commitments aimed to avoid and reduce GHG emissions, energy costs and energy consumption for the construction of the Project (Mine).

These commitments include:

- The use of more efficient plant and vehicles
- The implementation of a traffic management plan that:
  - Reduces the number of vehicles and/or trips required for transport
  - Uses buses for transportation of large numbers of personnel to minimise number of vehicles operating
- Monitoring of fuel consumption and energy use
- Measuring and recording of greenhouse gas emissions and energy consumption in accordance with current legislative requirements
- Reporting of fuel consumption, energy use and greenhouse gas emissions to Adani senior management
- Reporting of greenhouse gas emissions and energy consumption to relevant authorities in accordance with current legislative requirements

A greenhouse gas emissions inventory has been established and assessed in this report. A more comprehensive greenhouse gas emissions inventory will be developed prior to construction that provides a greater detail on construction emissions as a tool to target potential opportunities to avoid or reduce emissions.

3.2.3 Mitigation Measures

The management of adverse impacts arising from the Project (Mine) construction has been addressed according to the hierarchy of avoidance; mitigation and offsetting of adverse impacts.

Avoidance of Impacts

Impacts of the construction of the Project (Mine) on greenhouse gas emissions have been avoided or minimised where possible through the planning and design process.

The consumption of fuel is a necessary requirement of the construction of the Project (Mine). However, a reduction in the quantity of fuel consumed will be achieved through optimisation of construction activities and logistics. Optimisation of these activities will reduce the number of vehicles and/or trips required. Adani will utilise buses for transportation of large numbers of construction personnel to minimise number of vehicles operating. Vehicle operating guidelines would also be prepared and prescribed to encourage correct and efficient operation, thus potentially reducing fuel usage and minimise maintenance requirements during the construction period. To further reduce costs and fuel usage Adani will manage charter flights so that they are fully utilised.

A small reduction in fuel consumption will be achieved through the use of more efficient plant and machinery. Newer plant and machinery models are typically more fuel efficient than the older models. The use of more recent plant and machinery will form part of a wider fuel management strategy that

incorporates Project (Mine) planning, logistics, driver education and maintenance as any fuel reduction due to more efficient models may be outweighed by poor management in other areas. Efficiently managed procurement and product supply will also reduce the overall fuel usage at the site through selecting the most appropriately sized equipment for construction operations.

Where generators are required, Adani will consider the energy efficient ratings of equipment prior to purchase. Adani will also investigate the opportunity to purchase biodiesel generators where required and correct fuel and equipment are available.

Reduction in the amount of waste generated and removed from the site for treatment and disposal will subsequently reduce the amount of transportation requirements and fuel usage. The reuse of as much waste as possible onsite will minimise vehicle movements associated with waste disposal.

Promoting the use of teleconferencing and video conferencing during construction will also be used to reduce the unnecessary travel to and from offices and associated gaseous emissions resulting from fuel combustion.

Further mitigation and offset measures are described below with the aim to overcome these constraints.

Mitigation of Impacts

The use of biodiesel would result in significant greenhouse gas mitigation. Biodiesel blends (diesel that has a percentage of the fuel replaced with biodiesel) may reduce greenhouse gas emissions due to fuel consumption; however, this is dependent on a number of factors including the origin of the biodiesel feedstock.

Opportunities for the use of biodiesel will be further examined and used where practicable on the Project (Mine). Adani will consider the purchase and use of biodiesel generators, subject to fuel availability and supply, and will consider energy efficiency ratings as part of generator selection. Gas alternatives will be considered where practicable to reduce emissions generated.

Energy Efficiency and Management

Identification of the significant energy consuming equipment and recognising opportunities to make construction of the Project (Mine) more efficient, including the application of technical efficiencies in plant and equipment as and once available, would provide more efficiency in construction operations.

For site ancillary facilities and construction camps, Adani will include a component of electricity purchases from renewable sources, such as GreenPower, and also use onsite renewables such as photovoltaics.

Site offices and accommodation buildings will be designed and constructed in accordance with the Australian BCA requirements for insulation, building materials and energy efficiency and include energy efficient lighting, energy efficient appliances (4 star and above); and the use of solar/gas hot water systems.

Site offices and accommodation will include water efficiency measures, water efficient appliances and fittings, rainwater harvesting and plumbing to toilets, grey water recycling and onsite reuse. Energy efficient pumps and equipment will also be utilised associated with water and wastewater treatment infrastructure.

3.2.4 Monitoring and Reporting

There are a number of legislative requirements for measuring, monitoring and reporting greenhouse gas emissions and energy consumption that are applicable to the construction of the Project (Mine). The liable entity for this reporting would need to be determined prior to the commencement of the construction phase. Reporting is required for exceedances of the respective thresholds of emissions and substances under the NGERs and the EEO Program. NPI reporting may also be required depending on threshold limits of emissions.

The following monitoring and reporting commitments will be implemented by Adani during the construction of the mine:

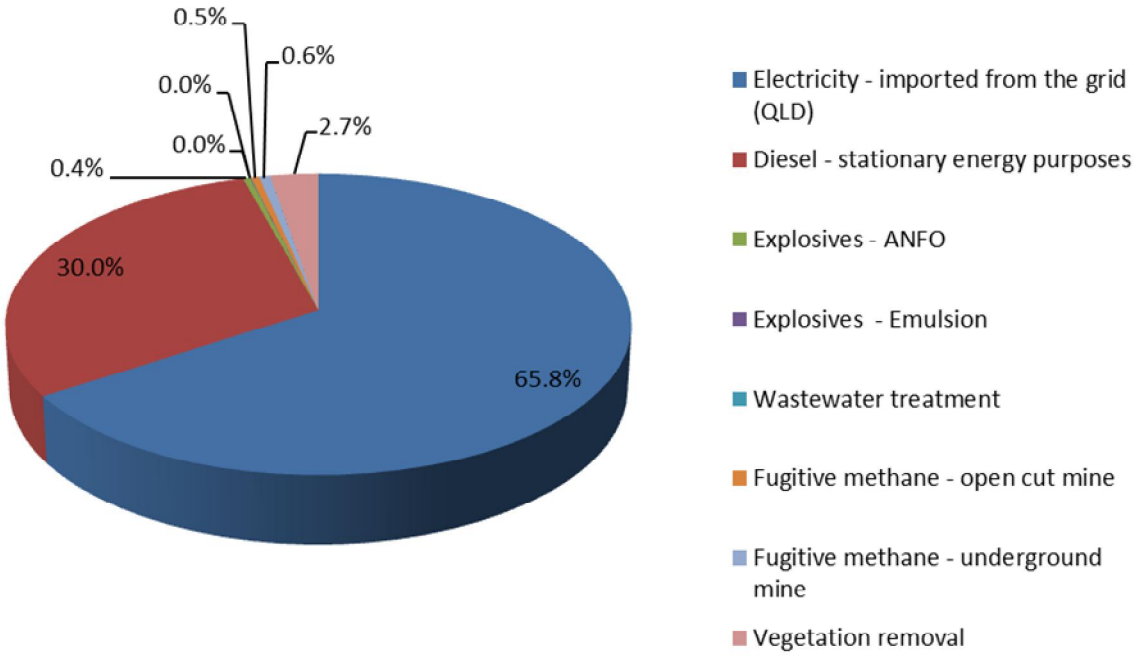
- Fuel consumption and energy use will be monitored
- Greenhouse gas emissions and energy consumption will be measured and recorded in accordance with current legislative requirements, including the NGERS, NPI and EEO program where applicable
- Fuel consumption, energy use and greenhouse gas emissions will form part of the reporting requirements to Adani senior management
- Greenhouse gas emissions and energy consumption will be reported to relevant authorities in accordance with current legislative requirements.

3.3 Operations

3.3.1 Potential Greenhouse Gas Impacts

The greenhouse gas emissions from the construction of the Project (Mine) will result from fugitive emissions from coal mining and other direct emission sources, including vegetation removal, wastewater treatment, electricity and explosives usage. Consumption of electricity from the grid will be the largest emitting source (65.8 per cent) followed by diesel consumption (30.0 per cent) (refer to Table 2-1). As indicated in Section 3.2.1, construction is progressive and various stages will overlap with operations, therefore the distinction between construction and operation emissions cannot be defined. As such, the quantities and proportion of emissions as a result of construction activities has not been separated from operational activities. A representation of the breakdown of emissions and proportion in relation to the overall contribution is provided in Figure 3-1. These greenhouse gas emissions will contribute to Queensland and Australia's overall greenhouse gas emissions over an extended period of time. To reduce the impacts from greenhouse gas emissions the operation of the Project (Mine) management and mitigation measures are outlined further below.

Figure 3-1 Breakdown of Greenhouse Gas Emissions Inventory



3.3.2 Planning and Commitments

An Environmental Management Plan (refer to Volume 2 Chapter 13 EMP) has been developed and will be implemented during operation. This Environmental Management Plan includes commitments aimed to avoid and reduce greenhouse gas emissions, energy costs and energy consumption to assist Adani to improve its operational efficiency and business productivity.

These commitments include:

- A detailed energy efficiency assessment will be conducted for the Project (Mine) on a regular basis. This review will aim to identify initiatives and available technologies, leading to implementation of processes to ensure energy efficiency opportunities are integrated into operations.
- A fuel management strategy will be developed prior to operation commencing and incorporated in the EMP, which considers Project (Mine) planning, logistics, driver education and maintenance
- Vehicle operating guidelines will be prepared and prescribed to encourage correct and efficient operation, thus potentially reducing fuel usage and minimise maintenance requirements
- Opportunities for the use of biodiesel may be further examined and used where possible on the Project (Mine)
- The procurement strategy will consider fuel efficiency, including:
  - Appropriate sizing, maintenance and selection of equipment
  - A packaging reduction program aiming to reduce the number of loads required for delivery, hence potentially less fuel consumption
  - Placement of delivered materials would also be strategically considered in order to reduce double handling, and hence the combustion of fuel through machinery usage
  - Consider the energy efficient ratings of equipment prior to purchase

  - Use of natural gas powered generators where possible
- Reduction in the amount of waste disposed to landfill will reduce the amount of transportation requirements and fuel usage
- Reuse of as much waste as possible onsite will be considered to minimise vehicle movements
- The use of continuous conveyor based mining systems will be considered to haul waste from the mine excavation to the out of pit dumps, rather than run haulage trucks back and forth to transport waste.
- The use of teleconferencing and video conferencing will be promoted also be used to reduce the unnecessary travel to and from offices and associated gaseous emissions resulting from fuel combustion.
- For site ancillary facilities and construction camps, renewable sources of electricity will be investigated, such as GreenPower, and the opportunity to use onsite renewable energy generation such as photovoltaics.
- The feasibility of generating carbon offsets at the Project site in accordance with the Carbon Farming Initiative will be investigated to off-set vegetation removal and greenhouse gas emitting activities
- The purchase of carbon offsets generated in Australia or overseas will be considered in managing potential liability under the carbon pricing mechanism.

A greenhouse gas emissions inventory has been established and assessed in this report. A comprehensive greenhouse gas emissions inventory will be developed prior to operation that provides greater detail on the operation emissions as an opportunity to identify areas for increased efficiency and hence, reduced greenhouse gas emissions.

The next steps would be to set achievable and realistic reduction targets and identify and investigate potential reduction opportunities to realise these targets. A site specific marginal abatement cost curve for identified reduction opportunities will assist Adani to prioritise these opportunities and be useful in determining what particular opportunities can be employed to reach a specific carbon reduction goal.

3.3.3 Mitigation Measures

The management of adverse impacts arising from the Project has been addressed according to the hierarchy of avoidance; mitigation and offsetting of adverse impacts.

Avoidance of Impacts

Impacts of the Project on greenhouse gas emissions have been avoided or minimised where possible through the planning and design process.

The consumption of fuel is a necessary requirement of the Project (Mine), and currently accounts for 30 per cent of the greenhouse gas emissions from the Project (Mine). However, a reduction in the quantity of fuel consumed will be achieved through optimisation of operational activities and logistics. Optimisation of these activities will reduce the number of vehicles and/or trips required. Adani will also utilise buses for transportation of large numbers of personnel to minimise number of vehicles operating. Vehicle operating guidelines will also be prepared and prescribed to encourage correct and efficient operation, thus potentially reducing fuel usage and minimise maintenance requirements. To further reduce costs and fuel usage Adani will manage charter flights so that they are fully utilised.

Reduction in the amount of waste disposed to landfill will subsequently reduce the amount of transportation requirements and fuel usage. Adani will reuse as much waste as possible onsite which will minimise offsite vehicle movements. Adani will use (where possible) continuous conveyor based mining systems to haul waste from the mine excavation to the out of pit dumps, rather than run haulage trucks back and forth to transport waste. This initiative will also reduce gaseous emissions resulting from the running of haulage trucks.

A small reduction in fuel consumption will be achieved through the use of more efficient plant and vehicles. Newer vehicle and plant models are typically more fuel efficient than the older models. The use of more recent vehicles and plant models will form part of a wider fuel management strategy that incorporates Project (Mine) planning, logistics, driver education and maintenance as any fuel reduction due to more efficient models may be outweighed by poor management in other areas.

Efficiently managed procurement and product supply will also reduce the overall fuel usage at the site. Through the appropriate sizing, maintenance and selection of equipment, equipment fuel usage will be more efficient for operations. A packaging reduction program will be implemented to reduce the number of loads required for delivery, hence potentially less fuel consumption. Placement of delivered materials will be strategically considered in order to reduce double handling, and hence the combustion of fuel through machinery usage.

Promoting the use of teleconferencing and video conferencing will also be used to reduce the unnecessary travel to and from offices and associated gaseous emissions resulting from fuel combustion.

Greenhouse gas emissions resulting from the consumption of electricity during mining operations comprise 65.8 per cent of the GHG inventory (refer to Table 2-1). The majority of electricity consumption is likely to be from operation of draglines. Although this is an essential requirement for the operation, there are a number of ways to make energy use for equipment more efficient, including regular monitoring of the electrical load of the draglines and undertaking regular calibration checks on significant energy consuming equipment, including the draglines.

Further mitigation and offset measures are described below with the aim to overcome these constraints.

Mitigation of Impacts

The most significant greenhouse gas mitigation option for fuel related emissions is likely to be the use of biodiesel. Biodiesel blends (diesel that has a percentage of the fuel replaced with biodiesel) may reduce greenhouse gas emissions due to fuel consumption; however, this is dependent on a number of factors including the origin of the biodiesel feedstock.

Energy Efficiency and Management

It is recognised that mining operations will result in the generation of greenhouse gas emissions. Through efficient and appropriate management of the operations, emissions can effectively be reduced. Identification of the significant energy consuming equipment and recognising opportunities to make this more efficient, including the application of technical efficiencies in plant and equipment as and once available, will provide more efficiency in operations.

Development and implementation of an energy efficiency review which will identify initiatives and available technologies, leading to implementation of processes to ensure energy efficiency opportunities are integrated into operations, will be undertaken. The monitoring process will enable potential energy efficient concepts to be recognised and considered through operations.

For site ancillary facilities and accommodation camps, Adani will include a component of electricity purchases from renewable sources, such as GreenPower, and also use onsite renewables such as photovoltaics.

Site offices and accommodation buildings will be designed and constructed in accordance with the Australian BCA requirements for insulation, building materials and energy efficiency. Where appliances are required in the mine village, these will be selected based on energy efficiency ratings. Site offices and accommodation will include water efficiency measures, water efficient appliances and fittings, rainwater harvesting and plumbing to toilets, grey water recycling and onsite reuse. Energy efficient pumps and equipment will also be utilised associated with water and wastewater treatment infrastructure.

Best practice environmental management in the mining industry is generally governed and directed by the site specific environmental management plan. An environmental management plan has been developed which outlines control, management and research strategies to ensure environmental conditions are considered during the operational and decommissioning phases of the mine will ensure targets and goals are achievable and best practice management is realised.

Through the environmental management plan, appropriate management will be integrated into all activities and processes and greenhouse gas emissions will be monitored. Through assessment and review, the Project (Mine) will seek continuous improvement in compliance and emissions reduction.

Commitments to energy management will be developed as part of a detailed energy efficiency assessment. Monitoring and implementation of energy efficient improvements are also required under the EEO Act. Regular energy audits and reviews of mining operations will identify possible energy efficiency improvement opportunities which will be implemented to progressively improve operations and subsequent energy efficiency.

Technology Review

The application of technical efficiencies in plant and equipment as, and once available, will provide more efficiency in operations. Due to the life of the mining operations (based on 90 years of operation), regular equipment replacement will be subject to an appropriate business case review. To be effective in improving operations at the mine, an appropriate business case will identify equipment options to be considered, including any new technologies available, expected benefits, potential risks and costs.

In order to fulfil the monitoring and implementation requirements of the EEO Act, regular improvements in mining operations energy efficiency will be required.

3.3.4 Offset Measures

The feasibility of generating carbon offsets at the Project (Mine) site in accordance with the Carbon Farming Initiative will be investigated during project planning. The feasibility study would need to consider legislative and development approval requirements in assessing whether the potential carbon offset projects comply with the additional requirements of the Carbon Farming Initiative. These options for carbon offsets will be investigated as part of rehabilitation planning.

The Project (Mine) is likely to exceed the threshold for participation in the carbon pricing mechanism. Therefore, a legislative price on the Scope 1 greenhouse gas emissions from the Project (Mine) is likely to apply. The purchase of carbon offsets generated in Australia or overseas should be considered in managing potential carbon liability under the carbon pricing mechanism.

3.3.5 Monitoring and Reporting

There are a number of legislative requirements for measuring, monitoring and reporting greenhouse gas emissions and energy consumption that are applicable to the operating phase of the Project (Mine). The liable entity for this reporting would need to be determined prior to the commencement of the construction phase.

Scope 1 and 2 emissions from the mining operations will be required to be measured or estimated as part of NGERS. The technical guidelines for NGERS outline the methods used for measuring and reporting Scope 1 and Scope 2 greenhouse gas emissions.

Measuring and monitoring Scope 1 emissions will be required as part of the carbon pricing mechanism.

Monitoring and reporting will also be mandatory under the EEO Act.

The legislative measuring and reporting requirements may be used to assist in the identification of greenhouse gas reduction opportunities and track performance throughout the mining operations.

The following monitoring and reporting commitments will be implemented by Adani during the operation of the mine:

- Fuel consumption and energy use will be monitored
- Greenhouse gas emissions and energy consumption will be measured and recorded in accordance with relevant legislative requirements including NGERS, EEO and NPI where applicable
- Regular energy audits and reviews of operations will be conducted to identify possible energy efficiency improvement opportunities
- The electrical load of the draglines will be monitored regularly to assess usage and consumption for future management
- Regular calibration checks will be conducted on significant energy consuming equipment such as the draglines, in order to check electricity measuring devices are accurate
- Fuel consumption, energy use and greenhouse gas emissions will form part of the reporting requirements to Adani senior management
- Greenhouse gas emissions and energy consumption will be reported to relevant authorities in accordance with current legislative requirements

4. Conclusion

This greenhouse gas assessment has been undertaken by GHD on behalf of Adani Mining Pty Ltd as part of the Environmental Impact Statement for the Carmichael Mine. This report has been prepared to estimate the greenhouse gas emissions associated with construction and operation of the mine, and to develop mitigation measures to minimise impacts.

The assessment was undertaken in accordance with the guidelines relevant to the Environmental Impact Statement and in line with the terms of reference. The assessment results identified:

- The average annual Scope 1 and Scope 2 greenhouse gas emissions as 2,286 kilotonnes CO_2-e per annum
- The total Scope 1 and Scope 2 emissions over the 90 year life of the Project (Mine) as 206 million tonnes CO_2-e

A number of GHG mitigation and management measures have been included in this assessment, while other measures are being considered by Adani for future implementation. These measures along with avoiding emissions where possible will reduce the total greenhouse gas emissions resulting from the Project (Mine).

The feasibility of the mitigating greenhouse gas emissions from coal seam methane, electricity consumption and diesel consumption should be investigated during mine planning.

5. References

ACARP, 2011, Guidelines for the Implementation of NGER Method 2 or 3 for Open Cut Coal Mine Fugitive GHG Emissions Reporting

Carbon Credits (Carbon Farming Initiative) Act 2011, Commonwealth Government

Clean Energy Act 2011, Commonwealth Government

Energy Efficiency Opportunities Act 2006, Commonwealth Government

International Panel on Climate Change 2007, United Nations

National Greenhouse and Energy Reporting Act 2007, Commonwealth Government

Runge Limited, 2011, Carmichael Macro-Conceptual Mining Study, Report No.: ADV-BR-10370a, May 2011

The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE), 2012, National Greenhouse Accounts (NGA) Factors

The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE), 2011b, Australian National Greenhouse Accounts: National Inventory Report 2009 Volume 1

The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE), 2011c, State and Territory Greenhouse Gas Inventories 2009

The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE), 2005, National Carbon Accounting Toolbox.

The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE), 2012. Understanding Climate Change, http://www.climatechange.gov.au/climate-change/understanding-climate-change/greenhouse-effect.aspx, Downloaded 21/02/2012World Business Council for Sustainable Development and World Resource Institute, 2005, The Greenhouse Gas Protocol - A Corporate Accounting and Reporting Standard (GHG Protocol)

Appendix A

Terms of Reference Cross-reference

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Terms of Reference Requirement/Section Number	Section of this report
Section 3.6 Greenhouse Gas Emissions	
Section 3.6.1 Description of environmental situation	
Provide an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in 'CO 2 equivalent' terms for the following categories: ◗ scope one emissions, where 'scope one emissions' means direct emissions of greenhouse gases from sources within the boundary of the facility and as a result of the facility's activities ◗ scope two emissions, where 'scope two emissions' means emissions of greenhouse gases from the production of electricity, heat or steam that the facility will consume, but that are physically produced by another facility	Section 2-1 of this report.
Briefly describe method(s) by which estimates were made.	Section 1.5 of this report.
The Department of Climate Change National Greenhouse Accounts (NGA) Factors can be used as a reference source for emission estimates and supplemented by other sources where practicable and appropriate. Coal mining projects should include estimates of coal seam methane to be released as well as emissions resulting from such activities as transportation of products and consumables and energy use by the project.	Section 1.5 and Section 1.3 of this report.
3.6.2 Potential Impacts and Mitigation Measures	
Discuss the potential for greenhouse gas abatement measures, including: ◗ a description of the proposed measures (alternatives and preferred) to avoid and/or minimise direct greenhouse gas emissions ◗ an assessment of how the preferred measures minimise emissions and achieve energy efficiency ◗ an indication of how the preferred measures for emission controls and energy consumption compare with practice in the relevant sector of industry with a view to achieving best practice environment management ◗ a description of any opportunities for further offsetting greenhouse gas emissions through indirect means including sequestration and carbon trading.	Section 3 of this report

Terms of Reference Requirement/Section Number	Section of this report
The environmental management plan in the EIS should include a specific module to address greenhouse abatement. That module should include: ◗ commitments to the abatement of greenhouse gas emissions from the project with details of the intended objectives, measures and performance standards to avoid, minimise and control emissions ◗ commitments to energy management, including undertaking periodic energy audits with a view to progressively improving energy efficiency ◗ a process for regular review of new technologies to identify opportunities to reduce emissions and use energy efficiently, consistent with best practice environmental management ◗ any voluntary initiatives such as projects undertaken as a component of the national Greenhouse Challenge Plus program, or research into reducing the lifecycle and embodied energy carbon intensity of the project's processes or products ◗ opportunities for offsetting greenhouse emissions, including, if appropriate, carbon sequestration and renewable energy uses ◗ commitments to monitor, audit and report on greenhouse emissions from all relevant activities and the success of offset measures	Section 3 and Volume 2 Section 13 Draft Environmental Management Plan for the Project (Mine)

Appendix B

Greenhouse Gas Assessment Emission Factors and FullCam Setup

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Greenhouse Gas Emission Factors

EF Calculation for underground Mine

Average gas content (Estimated September 2012)		0.105	m^3/t
Assumed gas is 100% methane Assumed ideal gas equation is appropriate Assumed standard temperature and pressure			
To determine mol/tonne:			
PV = nRT, where			
P	=	101300	Pa
V	=	0.105	m^3
R	=	8.314	J/K.mol
T	=	273	K
Therefore:			
n = PV/RT	=	4.29	
To determine grams of methane per tonne:			
n = m/MW	where m = mass (grams) Where MW = molecular mass (g/mol)		
Therefore:			
m = n*MW	=	68.69	g CH_4/t
To determine EF, need to multiply by GWP(CH4) which is 21:			
Therefore:			
m*21	=	1442	g CO_2-e/t
Conversion to tonnes	=	**0.001**	**t CO_2-e/t**

EF Determination for Open Cut Mine

The average measured gas content across all seams is 0.16 m^3/t. As this measured gas content is below 0.5 m^3/t it represents a low gas zone. Therefore the default EF value of 0.00023 has been applied for the open cut mine, in accordance with the ACARP guidelines.

The tables below indicate the measured gas content per seam, and the corresponding calculated average per seam.

Sample Number	Seam	Measured Gas Content Qm (m^3/t)
		at Sample Ash, as Measured
GM571	AB1	0.04
GM1173	AB1	0.05
GM1170	AB1	0.04
GM331	AB1	0.06
GM1171	AB2	0.04
GM563	AB3	0.08
GM1083	AB3	0.05
GM1164	AB1	0.05
GM520	AB1	0.06
GM1146	AB	0.09
GM1084	AB	0.04
GM1326	AB3	0.07
GM1329	AB	0.08
GM973	AB	0.02
GM1082	AB	0.06
GM778	AB	0.06
GM324	AB	0.04
GM937	AB	0.06
GM962	AB	0.16
GM1335	AB1	0.05
GM400	AB1	0.05
GM454	AB2	0.05
GM146	AB3	0.07
GM1479	AB	0.04
GM1471	AB	0.04
GM844	AB	0.06
GM008	AB	0.06
GM1476	AB	0.06
GM1481	AB	0.04
GM720	AB1	0.06
GM1228	AB1	0.05
GM1201	AB2	0.05

GM1490	AB3S	0.08
GM616	ABC	0.06
	Average	0.06

Sample Number	Seam	Measured Gas Content Qm (m^3/t)
		at Sample Ash, as Measured
GM822	C1	0.05
GM1087	C2	0.07
GM1086	C2	0.09
GM1165	C3	0.04
GM1080	C3	0.04
GM252	C2	0.05
GM406	C2	0.05
GM351	C3	0.06
GM1174	C3	0.08
GM271	C	0.07
GM1163	C1	0.07
GM1376	C	0.04
GM407	C1	0.28
GM983	C2	0.53
GM1486	C1	0.05
GM1126	C	0.09
GM984	C	0.05
GM984	C	0.05
	Average	0.10

Sample Number	Seam	Measured Gas Content Qm (m^3/t)
		at Sample Ash, as Measured
GM1286	D1	0.06
GM1085	D1	0.06
GM011	D2	0.06
GM394	D3	0.05
GM003	D3	0.07
GM813	D	0.06
GM018	D	0.1
GM1172	D	0.04
GM652	D	0.06
GW003	D	0.07
GM1333	D	0.05

GM274	D	0.08
GM963	D2	0.05
GM943	D2	0.03
GM086	D	0.05
GM1379	D	0.05
GM1377	D	0.07
GM664	D	0.05
GM1478	D1	0.97
GM1337	D1	0.95
GM1472	D2	1.02
GM529	D3	0.85
GM935	D	0.87
GM1482	D	0.13
GM1480	D	0.14
GM1485	D	0.13
GM1477	D	0.1
GM1487	D	0.12
GM1475	D	1.4
GM1484	D	0.11
GM1483	D	0.41
GM1434	D	0.11
GM541	D	0.09
GM1095	D2	0.1
GM1440	D3	0.11
GM944	D3	0.07
	Average	0.24

Sample Number	Seam	Measured Gas Content Qm (m^3/t)
		at Sample Ash, as Measured
GW012	E	0.07
GM785	E	0.05
GM012	E	0.05
GM417	E	1.5
GM114	E	1.01
	Average	0.54

Sample Number	Seam	Measured Gas Content Qm (m^3/t)
		at Sample Ash, as Measured
GM1166	F	0.07
GM884	F	0.07
GM1325	F	0.06

GM1081	F	0.05
GM1175	F	0.05
GM1088	F	0.05
GM377	F	0.05
GM222	F	1.11
GM1437	F	0.07
GM1424	F	0.03
GM1473	F	0.29
	Average	0.17

Mine Area - Grassland

Config: Multilayer Agricultural System

Simulation Steps: Monthly
Start Simulation: Jan, 1900
End Simulation: Dec, 2011
Output steps: every 12 (i.e. yearly)

Spatial Data
Latitude: -22.0531192
Longitude: 146.38369984

Regional Soils:
Clay – brigalow and gidgee (8)

Crop species:
Pasture (Pasture : Introduced grass)

Maximum Aboveground Biomass
50 tdm/ha(default)

Site; Crops; Soil; Initial Conditions: Defaults left

Events: No events

Area: 31284.27

Mine Area – Wooded – Environmental Planting

Config: Multilayer Forest System

Simulation Steps: Monthly
Start Simulation: Jan, 1900
End Simulation: Dec, 2011
Output steps: every 12 (i.e. yearly)

Spatial Data
Latitude: -22.0531192
Longitude: 146.38369984

Regional Soils:
Clay – brigalow and gidgee (8)

Tree species group: Mixed species environmental planting
Tree-species/Regimes: All; InitPlant; Low; 1970-on; WindrowBurn; SpotCult; NoPPWC; NoHarvest; NoPrune; NoFert; 2097

Maximum Aboveground Biomass
45 tdm/ha

Site; Crops; Trees; Initial Conditions: Defaults left

Events: No events

Mine Area – Wooded – Shrubby

Config: Multilayer Forest System

Simulation Steps: Monthly
Start Simulation: Jan, 1900
End Simulation: Dec, 2011
Output steps: every 12 (i.e. yearly)

Spatial Data
Latitude: -22.0531192
Longitude: 146.38369984

Regional Soils:
Duplex - woodland

Tree species group: Local species
Tree-species/Regimes: Local species

Maximum Aboveground Biomass
28 tdm/ha (default)

Site; Crops; Trees; Initial Conditions: Defaults left

Events: No events

Mine Area - Grassland

Config: Agricultural System

Simulation Steps: Monthly
Start Simulation: Jan, 1900
End Simulation: Dec, 2011
Output steps: every 12 (i.e. yearly)

Spatial Data
Latitude: -21.9564
Longitude: 146.4269984

Regional Soils:
Gradational

Crop species:
Pasture (Pasture : Burnt [Pasture first])

Maximum Aboveground Biomass
50 tdm/ha(default)

Site; Crops; Soil; Initial Conditions: Defaults left

Events: No events

Offsite Area – Eucalyptus open woodland

Config: Forest System

Simulation Steps: Monthly
Start Simulation: Jan, 1900
End Simulation: Dec, 2011
Output steps: every 12 (i.e. yearly)

Spatial Data
Latitude: -21.9564
Longitude: 146.42

Regional Soils:
Gradational

Tree species: Eucalyptus Open Woodland
Regimes: Eucalyptus Open Woodland clearing

Maximum Aboveground Biomass
42.2001 tdm/ha

Site; Trees; Soil; Initial Conditions: Defaults left

Events: No events

Offsite Area – Acacia Forests and Woodlands

Config: Forest System

Simulation Steps: Monthly
Start Simulation: Jan, 1900
End Simulation: Dec, 2011
Output steps: every 12 (i.e. yearly)

Spatial Data
Latitude: -21.9564
Longitude: 146.42

Regional Soils:
Gradational

Tree species: Acacia Forest and Woodland
Regimes: Acacia Forest and Woodland clearing

Maximum Aboveground Biomass
42.2001 tdm/ha (default)

Site; Trees; Soils; Initial Conditions: Defaults left

Events: No events

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Document Status

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