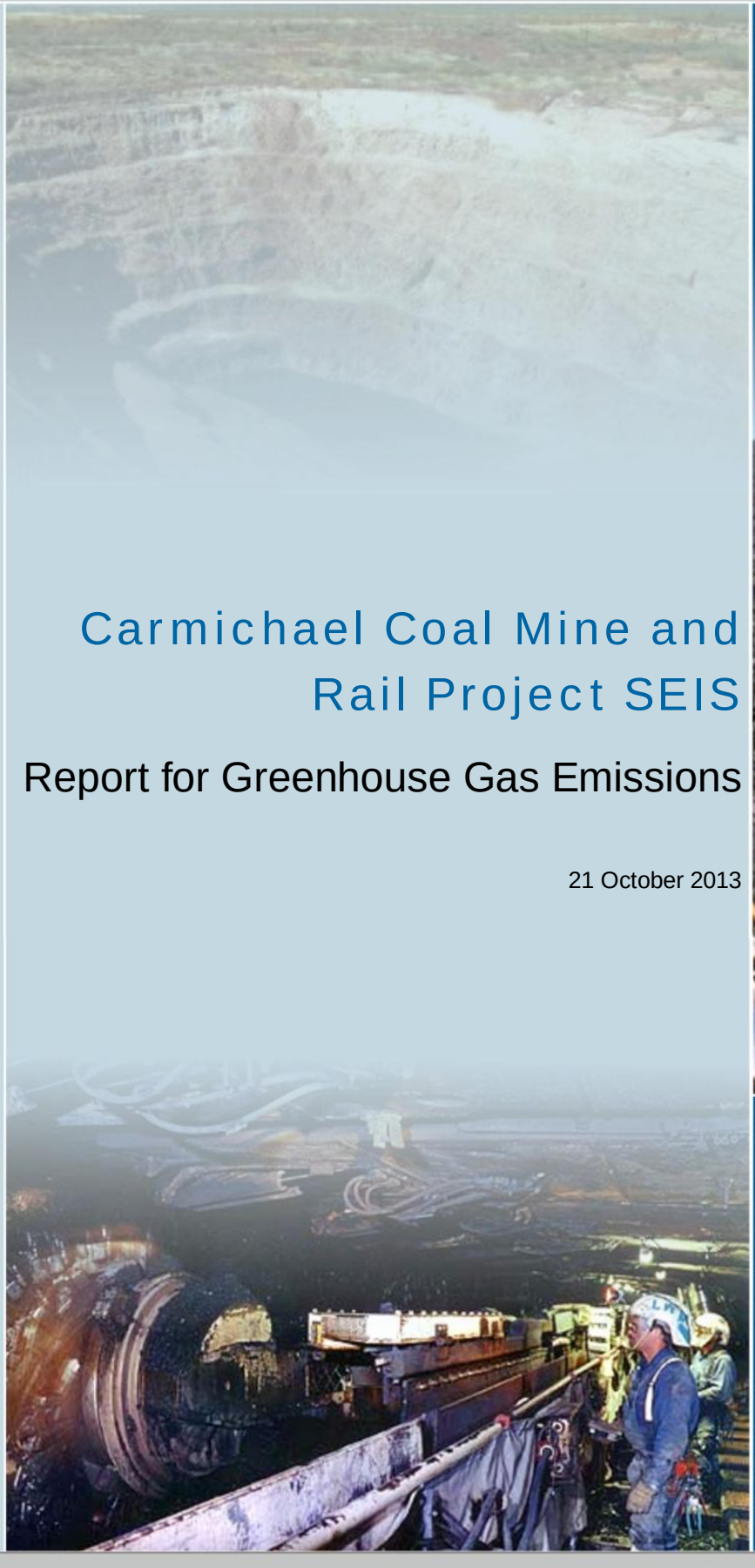
Adani Mining Pty Ltd



Carmichael Coal Mine and Rail Project SEIS

Report for Greenhouse Gas Emissions

21 October 2013

GHD

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Abbreviation and glossary

Project Specific Terminology	
Abbreviation	Term
the SEIS	Carmichael Coal Mine and Rail Project Supplementary Environmental Impact Statement
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	Commonwealth Department of Climate Change and Energy Efficiency
DIICCSRTE	Commonwealth Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education
EEO	Energy Efficiency Opportunities
EF	emission factor
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 (e.g. primarily carbon dioxide and methane) which contribute to global climatic change/global warming (i.e. the 'greenhouse effect')
GHG	Greenhouse gas
GWP	Global Warming Potential
ha	hectare
HFCs	hydrofluorocarbons
IPCC	International Panel on Climate Change
kL	kilolitres
Mtpa	million tonne per annum
MWh	megawatt hour
N_2O	nitrous oxide

Generic Terminology	
Abbreviation	Term
NCAT	National Carbon Accounting Toolbox
NGA	National Greenhouse Accounts
NGERS	National Greenhouse and Energy Reporting Scheme
NPI	National Pollutant Inventory
p	people
PFCs	perfluorocarbons
PJ	petajoule
SF_6	sulphur hexafluoride
t	tonne
TJ	terajoules
ToR	terms of reference


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1. Introduction

1.1 Project overview

Adani Mining Pty Ltd (Adani, the Proponent), commenced an Environmental Impact Statement (EIS) process for the Carmichael Coal Mine and Rail Project (the Project) in 2010. On 26 November 2010, the Queensland (Qld) Office of the Coordinator-General declared the Project a 'significant project' and the Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (referral No. 2010/5736). The Project was assessed to be a controlled action on 6 January 2011 under section 75 and section 87 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The controlling provisions for the Project include:

- World Heritage properties (sections 12 & 15A)
- National Heritage places (sections 15B & 15C)
- Wetlands (Ramsar) (sections 16 & 17B)
- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A)
- The Great Barrier Reef Marine Park (GBRMP) (sections 24B & 24C)
- Protection of water resources (sections 24D & 24E)

The Qld Government's EIS process has been accredited for the assessment under Part 8 of the EPBC Act in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland.

The Proponent prepared an EIS in accordance with the Terms of Reference (ToR) issued by the Qld Coordinator-General in May 2011 (Qld Government, 2011). The EIS process is managed under section 26(1) (a) of the *State Development and Public Works Act 1971* (SDPWO Act), which is administered by the Qld Government's Department of State Development, Infrastructure and Planning (DSDIP).

The EIS, submitted in December 2012, assessed the environmental, social and economic impacts associated with developing a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the northern Galilee Basin, approximately 160 kilometres (km) north-west of Clermont, Central Queensland, Australia. Coal from the Project will be transported by rail to the existing Goonyella and Newlands rail systems, operated by Aurizon Operations Limited (Aurizon). The coal will be exported via the Port of Hay Point and the Point of Abbot Point over the 60 year (90 years in the EIS) mine life.

Project components are as follows:

- The Project (Mine): a greenfield coal mine over EPC 1690 and the eastern portion of EPC 1080, 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, an industrial area and water supply infrastructure

- The Project (Rail): a greenfield rail line connecting to mine to the existing Goonyella and Newlands rail systems 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 running west from the Mine site 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
  - Quarries: five local quarries to extract quarry materials for construction and operational purposes

Figure 1 shows the Project location.

1.2 Report purpose

This greenhouse gas assessment has been undertaken by GHD on behalf of Adani Mining Pty Ltd as part of the Supplementary Environmental Impact Statement (SEIS) for the Project (Mine).

The assessment has been updated based on a revised mine plan description in SEIS Volume 4 Appendix B Project description. The report also responds to submissions received as part of the EIS process.

LEGEND

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

1:2,000,000 (at A4)

0 10 20 30 40 50

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision 2
Date 14-10-2013

Project Location

Figure 1

G:\41\26422\GIS\Maps\MXD\0000_Overview\41-26422_117_rev_2.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DNRM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Offsite, Quarry (2013). Created by: MS

1.3 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 concentrations in the atmosphere as a result of human activities (IPCC, 2007).

Greenhouse gases 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, quantities of emissions of methane and nitrous oxide are standardised to carbon dioxide equivalent, (CO_2-e) by multiplying each relevant greenhouse gas by its respective global warming potential.

At an international level, the Australian government is a signatory to the Kyoto Protocol and has greenhouse gas stabilisation and reporting commitments. Australia has committed to limit national emissions to 108 percent of 1990 emissions, during the period 2008 – 2012. Australia also committed to the second Kyoto period, which commenced 1 January 2013 and will operate until 2020.

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

1.4 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 (CO2-e) per financial year. Liable entities are required to surrender an equivalent number of carbon units as their Scope 1 covered emissions. The carbon price was $23 during the 2012 – 13 financial year and $24.15 during 2013 – 14. As at the date of this report a transition to an emissions trading scheme was being proposed by the Australian Government. The implications of the Carbon Pricing Mechanism on the Project (Mine) include paying a carbon price for direct covered emissions, paying an effective carbon price on certain types of fuel use, as well as incurring any pass through costs.
- *National Greenhouse and Energy Reporting Act 2007*. Under the National Greenhouse and Energy Reporting Scheme (NGERS), a controlling corporation will trigger the thresholds for a financial year if:
  - the facilities under the operational control of the members of the corporate group emit over 50,000 t CO_2-e per year or consume or produce more than 200 TJ of energy from their combined facilities; or

– a member of the corporate group has operational control of a facility that emits over 25,000 t CO_2-e per year or consumes or produces more than 100 TJ of energy per year.

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 production and 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) is a voluntary scheme that was developed to give farmers, land managers, 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.

1.5 Level of assessment required

Section 3.6 of the Project ToR details the level of assessment required for the Project, as follows:

- Scope 1 emissions, which are, in relation to a facility, greenhouse gas emissions that are released into the atmosphere as a direct result of an activity or series of activities.
- Scope 2 emissions, which are, in relation to a facility, 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 3 emissions are not required as part of this assessment in accordance with the ToR requirements.

1.6 Methodology

1.6.1 General principles

The greenhouse gas 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 Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE) National Greenhouse Accounts (NGA) Factors, July 2013

- Australia's National Carbon Accounting System (Commonwealth Department of Climate Change and Energy Efficiency (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.

1.6.2 Boundary of the assessment

The assessment included greenhouse gas emissions from the following activities:

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

1.6.3 Greenhouse gases considered

Table 1 outlines the greenhouse gases considered in this assessment. The GWP for each greenhouse gas is also provided in Table 1. The GWPs were sourced from the NGA Factors July 2013.

Table 1 Greenhouse gases and 100 year global warming potentials

Greenhouse Gas	Global Warming Potential (t/CO2-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 2013	

1.6.4 Emission scopes

Emissions have been separated into Scopes 1 and 2 in accordance with the GHG Protocol, as defined in Section 1.5.

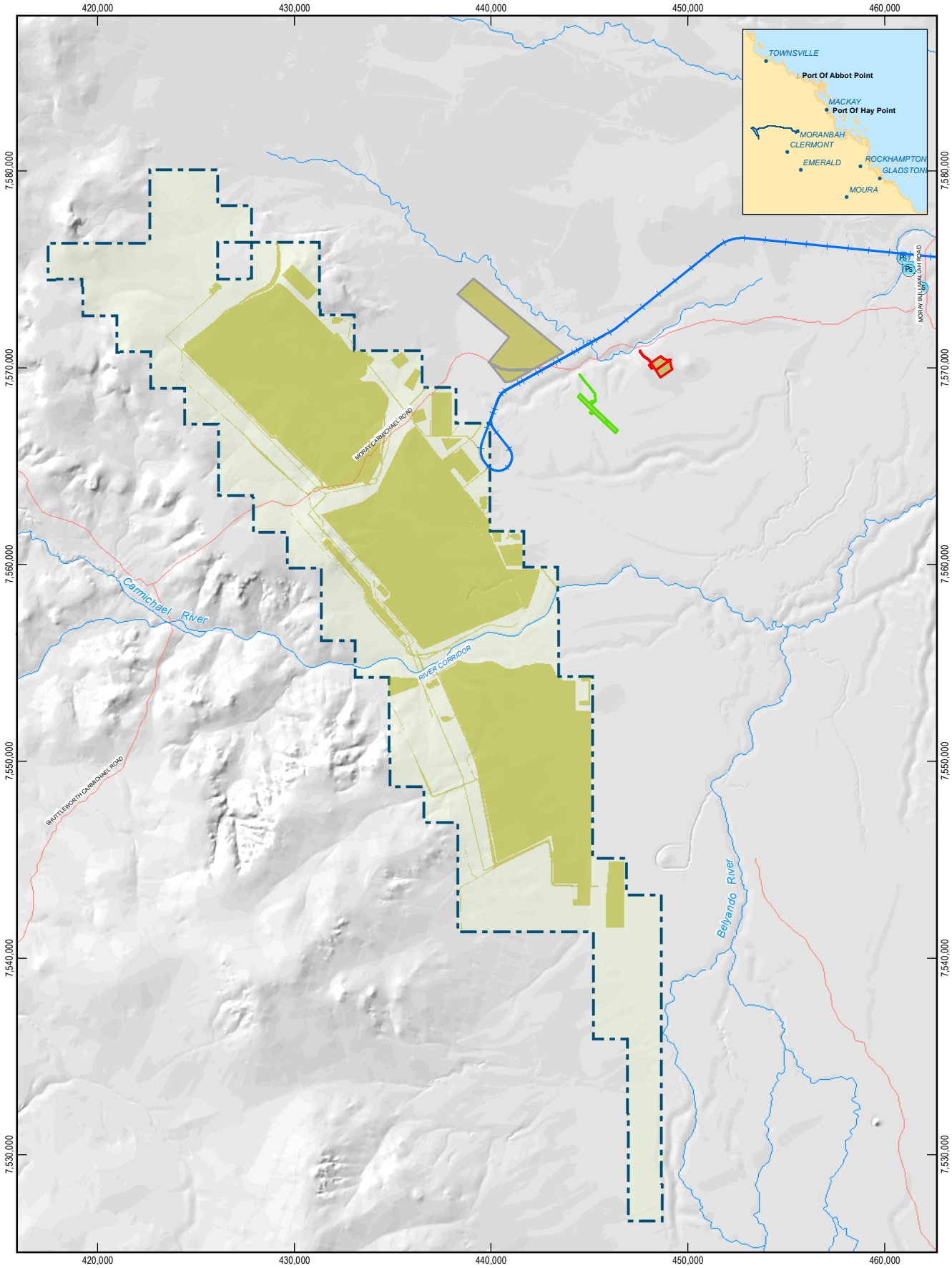
Scope 1 emissions are produced by the combustion of fuels such as diesel at the development site, and by vehicles and plant equipment which the proponent owns and/or has operational control over. Note that only the direct combustion of the fuels by equipment utilised within the proposed mining activity 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.

1.6.5 Data collection and calculation procedures

Data for the greenhouse gas assessment was sourced from the Project Description – Mine (SEIS Volume 4, Appendix B). 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 1.6.7.

Greenhouse gas 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 SEIS Volume 4 Appendix J1) 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. Figure 2 shows the area of clearing based on the concept mine layout and land use planning for offsite areas.



LEGEND

- Local Road
- River / Watercourse
- Rail (West)
- Mine (Onsite)
- Area of proposed clearing
- Mine (Offsite)
- Pump Station
- Storage Facility (Offstream)
- Airport
- Industrial Area
- Accommodation Village

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

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

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision B
Date 24-10-2013

Area of proposed clearing

Figure 2

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Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Alignment, Offsite(2013), Mine Layout / Infrastructure (2013); Created by: MS

The regional ecosystems were categorised into vegetation species listed in FullCAM. The following areas of vegetation (based on vegetation species)[1] are being cleared as part of the Project (Mine) footprint:

- Acacia forest and woodland (742 ha)
- Acacia open woodland (403 ha)
- Eucalyptus open woodland (6,027 ha)
- Eucalyptus tall open forest (2 ha)
- Eucalyptus woodland (3,632 ha)
- Non-remnant (grassland) (10,601 ha)
- Other forest and woodlands (395 ha)
- Other grassland (3 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 1.6.6 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.

1.6.6 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 over the life of the Project (Mine). However, these negligible emissions will be recorded as part of the Project's ongoing greenhouse gas 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] 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.

1.6.7 Assumptions

Assumptions used in estimating the activity levels and associated energy use and greenhouse gas emissions for the Project (Mine) are listed in Table 2. The assessment was based on emission factors available at the time of the assessment and future changes in emission factors were not considered.

Table 2 Assumptions used in the greenhouse gas assessment

Parameter measured	Assumptions
Diesel (stationary energy purpose)	The average annual quantity of diesel use for operation is estimated as 201,213 kL per annum over a 60 year mine life. Emission factor (EF) sourced from NGA Factors July 2013 Table 3.
Electricity - imported from the grid (Qld)	The average annual quantity of electricity consumption at the site is estimated as 988,640 MWh per annum over a 60 year mine life based on a peak demand of 114 MW and the Project (Mine) operating 24 hours per day and 365 days per year. Estimate includes open cut and underground mine operations, CHPP and per person at accommodation village. EF sourced from NGA Factors July 2013 Table 5 for Queensland.
Explosives	The average annual quantity of explosives used estimated as 65,737 t of ammonium nitrate fuel oil (ANFO) and 43,824 t of ammonium nitrate emulsion (heavy ANFO). Mine life is 60 years. EF sourced from NGA January 2008, Table 4 for ANFO and emulsion.
Wastewater handling	Average annual quantity of greenhouse gas emission from wastewater treatment was calculated in accordance with the NGA Factors 2013. The emissions were based on the average workforce of 2,744 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 CO2-e/t Methane emission factor for sludge – 5.3 t CO2-e/t Fraction of COD anaerobically treated in wastewater and sludge – 0.8 Methane recovered from wastewater – 0
Fugitive emissions (open-cut mine)	Quantity of total ROM coal from open-cut mine operations is estimated as 2.4 billion tonnes (43.2 million tonnes/annum based on 60 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 greenhouse gas 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 A.

Parameter measured	Assumptions
Fugitive emissions (underground mine)	Quantity of total ROM coal from underground mine operations is estimated as 0.62 billion tonnes (11.1 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 CO2-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 A.
Vegetation removal	Modelling was undertaken using FullCAM version 3.40. 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 for each vegetation type 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 1.6.5 represent the types of vegetation existing in the area. It was assumed that grasslands contained 30 t C per hectare based on Australia's Chief Scientist (2012). This is a considered a conservative approach and accounts for soil and biomass carbon.

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 1,440 kilotonnes CO_2-e per annum. Scope 1 emissions were estimated to be 621 kilotonnes CO_2-e per annum and Scope 2 emissions were estimate to be 819 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 86 million tonnes CO_2-e based on a project life of 60 years, averaged over both construction and operation (refer to Appendix A for calculations).

Imported electricity from the grid was estimated to be the largest emission source for the Project (Mine), accounting for 57 percent of emissions, with diesel consumption being the next biggest contributor at 38 percent of emissions.

The average annual Scope 1 and Scope 2 emissions from the Project (Mine) are estimated to be approximately 1 percent of Queensland's 2010/11 greenhouse gas emissions and approximately 0.3 percent of Australia's 2010/11 greenhouse gas emissions (DIICCSRTE, 2013).

The Scope 1 and Scope 2 greenhouse gas inventory is provided in Table 3.

Table 3 Greenhouse gas inventory

Emissions Source	Quantity (average per annum over 60 years)		Scope 1 Emission Factor	Scope 2 Emission Factor	Units	Scope 1 Emissions	Scope 2 Emissions	Total Emissions	Proportion of Total Inventory
	Total	Units	t CO2-e / units	t CO2-e / units		(t CO2-e)	(t CO2-e)	(t CO2-e)	%
Electricity - imported from the grid	998,640	MWh/a	0.000	0.82	MW	0	818,885	818,885	56.9%
Diesel - stationary energy purposes	201,213	kL/a	2.683	0.00	kL	539,794	0	539,794	37.5%
Explosives - ANFO	65,737	t/a	0.170	0.00	t	11,175	0	11,175	0.8%
Explosives - Heavy ANFO	43,824	t/a	0.170	0.00	t	7,450	0	7,450	0.5%
Wastewater handling	2,744	p	0.248	0.00	t	681	0	681	0.0%
Fugitive methane - open cut mine	43.2	Mt ROM /a	0.00023	0.00	t	9,936	0	9,936	0.7%
Fugitive methane - underground mine	11.1	Mt ROM /a	0.002	0.00	t	17,478	0	17,478	1.2%
Vegetation removal	9,482	t C/a	3.670	0.00	t C	34,799	0	34,799	2.4%
Average Annual greenhouse gas Emissions						621,313	818,885	1,440,198	

3. Potential impacts and mitigation measures

3.1 Overview

According to the Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) 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 Energy efficiency

The list of the identified initiatives for energy efficiency improvement and their current status are listed in Table 4. These energy efficiency opportunities have been considered throughout the detailed design of the Project (Mine) and will continue as designs are further progressed.

Table 4 Project (Mine) – potential efficiency initiatives

Initiative identified	Future actions
Active front end convertors and Invertors for grid powered mining equipment such as electric shovels (potential significant reduction in total project power usage/operating costs over LOM)	Cost/LOM implications currently under by Adani.

Initiative identified	Future actions
Variable speed drives for variable-torque-load drives (e.g. fans and centrifugal pumps) and some constant-torque-load drives (e.g. long conveyors and crushers) depending on the result of loss and saving quantification	Variable speed drives have already been applied for most of these loads mainly because of speed control requirement or for optimising the size and cost of transformers and MCCs supplying power to these loads. Cost/LOM implications to be incorporated during detailed design to increase the number of variable speed drives for the purpose of further energy efficiency improvement.
Suspended truck bodies which have minimal heavy liners with scope for fuel use reduction	Stability issues and resultant safety concerns with trucks operating on slippery clay floors
An assessment of haul road efficiency based on rolling resistance, length and grades	Report to be commissioned during detailed design to investigate, report and provide recommendation
Reduction in water requirements	Finalise tailings management plan
Fire water system with staged pressure design	To be incorporated within brief during detailed design phase
Solar grid power used in mine infrastructure area offices	To be reviewed during detailed design phase for cost vs. efficiency.
'Zoned' air-conditioning within large office spaces	Incorporate into design where practicable leading industry practice in terms of sustainability and energy efficiency
High efficient electric motors used in the project	Currently, electric motors have been specified to comply with the MEPS 2 standard efficiency level determined by AS 1359.5 in minimum. However, a comprehensive study is to be carried out in the detailed design stage to quantify payback opportunities for higher efficient motors
LED lights used for lighting	To be reviewed during detailed design phase for cost vs. efficiency.
Power factor correction used in multiple buses	A 3.5MVar capacitor bank has been already designed for the main 22kV Bus of the Mining Infrastructure Substation (East SUB) mainly because of reducing the upstream kVA load and size/cost of power transformers and 66kV OHL between the Galilee SUB and East SUB. This also significantly reduces electric losses on these upstream components. This opportunity is to be further reviewed during detailed design phase for cost vs. efficiency where more capacitor banks may be required to be installed in multiple buses and MCCs for further energy efficiency of the site power system for the staged loads
High efficient transformers used in the project	Currently, transformers have been specified to comply with minimum efficiency level determined by AS 2374. However, a comprehensive study is to be carried out in the detailed design stage to quantify payback opportunities for higher efficient transformers

3.3 Construction

3.3.1 Potential greenhouse gas impacts

The greenhouse gas emissions from the construction of the Project (Mine) will result in 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. 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, management and mitigation measures will be adopted to reduce the likely greenhouse gas emissions from the construction of the mine, as 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.

3.3.2 Planning and commitments

An Environmental Management Plan (refer to SEIS Volume 4 Appendix Q1 and Q2) has been developed and will be implemented during construction. This Environmental Management Plan includes commitments aimed to avoid and reduce greenhouse gas 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
- Engineering design of haul roads to maximise the fuel efficiency
- 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.

3.3.3 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.

The use of teleconferencing and video conferencing during construction will also be promoted 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.

3.3.4 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 controlling corporation 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. National Pollutant Inventory (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:

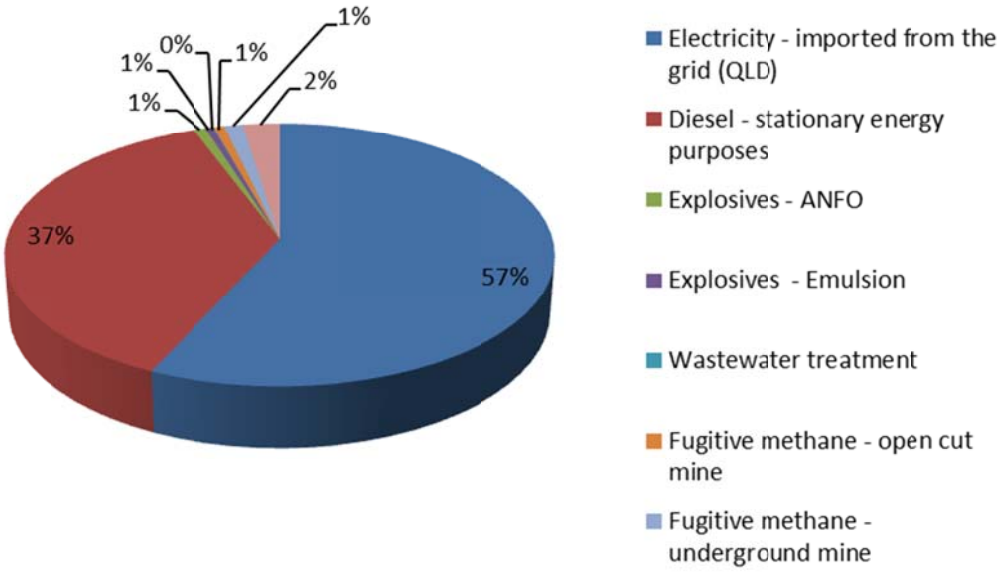
- Fuel consumption and energy use will be monitored
- Greenhouse gas emissions and energy consumption will be measured and recorded in accordance with current legislative requirements, including the NGERS, NPI and EEO program where applicable
- Fuel consumption, energy use and greenhouse gas emissions 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.

3.4 Operations

3.4.1 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 (56.9 percent) followed by diesel consumption (37.5 percent). As indicated in Section 3.3.1, 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. 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 Breakdown of greenhouse gas emissions inventory



3.4.2 Planning and commitments

An Environmental Management Plan (EMP) (refer to SEIS Volume 4 Appendix Q1 and Q2) 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
- The 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 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 Australia's 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.

3.4.3 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 (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 Project (Mine), and currently accounts for 37.5 percent 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 newer 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.

The use of teleconferencing and video conferencing will also be promoted 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 56.9 percent of the greenhouse gas inventory (refer to Figure 3). The majority of electricity consumption is likely to be from the operation of mining machinery. 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 earth moving machines and undertaking regular calibration checks on significant energy consuming equipment.

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 the implementation of processes to ensure that 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 that 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 60 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.

3.4.4 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 Australia's Carbon Pricing Mechanism. Therefore, a legislative price on the covered 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.

3.4.5 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 the covered 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
- Regular calibration checks will be conducted on significant energy consuming equipment, 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 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 1,440 kilotonnes CO_2-e per annum
- The total Scope 1 and Scope 2 emissions over the 60 year life of the Project (Mine) as 86 million tonnes CO_2-e

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

5. References

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Appendices

Appendix A – Greenhouse Gas Assessment
Emission Factors and FullCam Setup

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

Sample Number	Seam	Measured Gas Content Qm (m^3/t)
GM616	ABC	0.06
	Average	0.06

Sample Number	Seam	Measured Gas Content Qm (m3/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 (m3/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	0.10
GM1172	D	0.04
GM652	D	0.06
GW003	D	0.07
GM1333	D	0.05
GM274	D	0.08

Sample Number	Seam	Measured Gas Content Qm (m3/t)
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	0.10
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	0.10
GM1440	D3	0.11
GM944	D3	0.07
	Average	0.24

Sample Number	Seam	Measured Gas Content Qm (m3/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 (m3/t)
		at Sample Ash, as Measured
GM1166	F	0.07
GM884	F	0.07

Sample Number	Seam	Measured Gas Content Qm (m3/t)
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 – all tree species

Configuration: Forest system

Simulation Steps: Monthly

Start Simulation: Jan, 1913

End Simulation: Dec, 2013

Output steps: every 12 (i.e. yearly)

Spatial Data

Latitude: -22.053 12

Longitude: 146.383 70

IBRA: Brigalow Belt North

Soil: Duplex

Site; Crops; Trees: Defaults left with the exception of the G value. In trees tab, the G parameter for the tree yield formula was set to 10

Initial Conditions: All set to zero.

Events: Harvest 01/01/1913 – no recoverable product, Plant [species] - natural regeneration

Offsite Area – all tree species

Configuration: Forest system

Simulation Steps: Monthly

Start Simulation: Jan, 1913

End Simulation: Dec, 2013

Output steps: every 12 (i.e. yearly)

Spatial Data

Latitude: -21.9564

Longitude: 146.42

IBRA: Desert uplands

Soil: Gradational

Site; Crops; Trees: Defaults left with the exception of the G value. In trees tab, the G parameter for the tree yield formula was set to 10

Initial Conditions: All set to zero.

Events: Harvest 01/01/1913 – no recoverable product, Plant [species] - natural regeneration

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	A Maddox	J Keane	DRAFT	J Keane	DRAFT	25072013
0	A Maddox	J Keane	On file	J Keane	On file	27/07/2013
1	A Maddox	J Keane	On file	J Keane	On file	30/07/2013
2	M Goodall	J Keane		J Keane		21/10/2013

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