REPORT

CHINA FIRST PROJECT GREENHOUSE AND CLIMATE RISK ASSESSMENT

Waratah Coal

Job No: 3015f

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A PEL Company

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
°C	degrees Celsius
ABS	Australian Bureau of Statistics
ACARP	Australian Coal Association Research Program
AGSO	Australian Geological Survey Organisation
ANFO	Ammonium nitrate fuel oil
APSDA	Abbot Point State Development Area
CCC	Clean Coal Council
CCS	carbon capture and storage
CDM	Clean Development Mechanism
CH_4	Methane
CMAF	Coal Mining Abatement Fund
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
COP	Conference of Parties
CPRS	Carbon Pollution Reduction Scheme
CSJP	Coal Sector Jobs Package
CMATSP	Coal Mining Abatement Technology Support Package
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCC	Department of Climate Change (now Department of Climate Change and Energy Efficiency)
DCCEE	Department of Climate Change and Energy Efficiency
EEO	Energy Efficiency Opportunity
EIT	economies in transition
EPA	Environmental Protection Agency
EPC	Exploration Permit Coal
ETS	Emission Trading Scheme
GCM	general circulation models
GJ	gigajoules
GWP	global warming potential
HFCs	hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
KEI	key emissions indicators
km	kilometre
kt CO_2-e	kilotonnes of carbon dioxide equivalent
kWh	kilowatt hours
LPA	Liberal Party Australia
MRET	Mandatory Renewable Energy Target
Mt CO_2-e	megatonnes of carbon dioxide equivalent
Mtpa	million tonnes per annum
MWh	megawatt hours
N_2O	Nitrous oxide
NCOS	National Carbon Offset Standard
NGA	National greenhouse accounts
NGER Act	National Greenhouse and Energy Reporting Act
NGER	National Greenhouse and Energy Reporting System
NLECI	National Low Emissions Coal Initiative
OECD	Organisation for Economic Co-Operation and Development
PFCs	Perfluorocarbons

Abbreviation	Meaning
PJ	petajoule
ppm	parts per million
QGS	Queensland Gas Scheme
RFI	radiative force index
ROM	run of mine coal
SF_6	sulfur hexafluoride
t	tonnes
t CO_2-e	tonnes of carbon dioxide equivalent
t ROM	tonnes of run of mine (coal)
TJ	terajoules

LIST OF TERMINOLOGIES

Term	Meaning
Carbon dioxide equivalent (CO_2-e)	The key greenhouse gases are carbon dioxide, methane and nitrous oxide. To simplify the accounting of GHGs, the unit of a carbon dioxide equivalent or CO_2-e is used. This ensures that the global warming potential of each gas is accounted for. Carbon dioxide has a global warming potential of 1, methane has a global warming potential of 21, and nitrous oxide has a global warming potential of 310.
Climate change	Any long-term significant change in the 'average weather' that a given region experiences. Average weather may include average temperature, precipitation and wind patterns. It involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years.
Climate variability	Deviations of climate statistics over a given period of time (such as a specific month, season or year) from the long-term climate statistics relating to the corresponding calendar period.
Environmental impact statement (EIS)	The information document prepared by the proponent when undertaking an environmental impact assessment. It is prepared in accordance with terms of reference prepared or approved by government. EIS is the term used by the Environment Protection and Biodiversity Conservation Act 1999 and the Environmental Protection Act 1994, and it is defined in Part 4 of the State Development and Public Works Organisation Act 1971.
Greenhouse gas	The gases present in the earth's atmosphere which reduce the loss of heat into space and therefore contribute to global temperatures through the greenhouse effect.
Scope 1 emissions	Scope 1 greenhouse gas (GHG) emissions are produced from sources within the reporting boundary and arise from: combustion of fuels to generate heat and energy; on-site transport; and fugitive (intentional or unintentional) releases of GHGs from pipes and joints.
Scope 2 emissions	Scope 2 GHG emissions arise from purchased electricity, heat and steam. These emissions are generated outside of the project boundary.
Scope 3 emissions	Scope 3 GHG emissions are related to the activities of the reporting entity but arising from sources beyond the reporting boundary – for example, extraction, processing and transport of purchased fuels to the project site.
Terms of Reference	As defined by Part 4 of the *State Development and Public Works Organisation Act 1971*.

EXECUTIVE SUMMARY

The primary objectives of the study are to estimate the greenhouse gas emissions resulting from the development and operation of the China First Project, which includes the mine, railway and coal terminal, and to identify appropriate measures to manage greenhouse gas emissions. The assessment was based on the mine producing 56 Mtpa ROM and 40 Mtpa saleable coal. However, the rail assessment was based on 400 Mtpa coal to be transported from the Galilee basin to the Port of Abbot Point.

To meet the requirements of the *Terms of Reference*, the following tasks formed the scope of work:

- review and identify relevant international, federal and state greenhouse gas policies;
- estimate the anticipated scope 1 and scope 2 greenhouse gas emissions associated with the project in a suitable format for external and internal reporting and review;
- assess residual and cumulative impacts of greenhouse gases arising from the project with respect to identified issues, taking into account implemented mitigation measures and relevant assessment framework;
- benchmark the energy and emissions intensity of the project against existing Australian coal mines; and
- identify and describe measures to avoid, reduce, mitigate and manage greenhouse gases associated with the project, and describe how these measures would be implemented, monitored and audited.

Scope 1 and scope 2 emissions from the mine, railway and coal terminal have been estimated using the following recognised Australian and international methodologies:

- the World Resources Institute/World Business Council for Sustainable Development *Greenhouse Gas Protocol*;
- *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines 2009*; and
- the Australian Government Department of Climate Change *National Greenhouse Accounts (NGA) Factors 2009*.

A summary of the emissions estimated for the China First Project is provided in Table E1. Based on the estimated emissions, and a review of relevant greenhouse gas legislation, it is expected that the China First Project:

- will exceed the thresholds for participation in the *National Greenhouse and Energy Reporting* (NGER) *System*, meaning Waratah Coal will have to annually report greenhouse gas emissions and energy consumption/production from the mine, railway and coal terminal;
- will exceed the threshold for participation in the *Energy Efficiency Opportunities* (EEO) *Program*, meaning Waratah Coal will have to assess the project's energy efficiency and identify energy efficiency opportunities with a payback period of less than four years, and publicly report the results;
- is expected be a direct participant in the emissions trading scheme outlined in the *Carbon Price Mechanism* as it is currently proposed, meaning that Waratah Coal will have to annually report its emissions (as per NGER) and hold emission permits, obtained through auction or allocation from the government, at the end of each reporting period equivalent to the amount reported; and

- should not be financially penalised for emitting greenhouse gas emissions under the Australian Liberal Party's *Direct Action Plan.*

The China First Mine is predicted to consume more energy (electricity and diesel) per tonne of product coal than the median of existing Australian coal mines. This may be due to electricity consumption estimates being based on the typically conservative preliminary design. The estimated greenhouse gas emission rates approximate the average for existing Australian coal mines that have open cut and underground operations.

Greenhouse gas emissions from the China First Project can most effectively be managed through:

- the identification of major sources of greenhouse gas emissions through ongoing measurement, monitoring;
- improvements in energy efficiency;
- switching to less emissions intensive fuels; and
- offsetting emissions by investing in third party projects that reduce greenhouse gas emissions below a demonstrated baseline.

The China First Project can most effectively reduce its annual emissions through improvements in energy efficiency. It is recommended that ongoing internal measurement and monitoring of emissions, in addition to mandatory reporting under NGER and the EEO Program, be performed to identify sources with the greatest potential for emissions reductions.

Attributing the potential impacts associated with climate change to a single source of greenhouse gas emissions is problematic. The potential impacts associated with greenhouse gas emissions from the China First Project will be in proportion with its contribution to global greenhouse emissions. The total emissions from the China First Project are insignificant in comparison with Australian emissions, and according to the Australian government, Australia's total emission inventory in 2006 represents approximately 1.5% of global greenhouse emissions. Therefore the potential impacts associated with climate change directly attributable to China First Project can be expected to be negligible. The cumulative impacts associated with the project have not been assessed, as the impacts associated with greenhouse gas emissions are not localised to the source of emissions.

Table E1: Summary of Projected Greenhouse Gas Emissions

Project Phase	Total Scope 1 Emissions	Total Scope 2 Emissions	Total Scope 1 and 2 Emissions	Units
Total mine construction emissions	14,217,468	1,160,104	15,377,573	t CO_2-e
Total mine annual operation emissions	1,096,053	1,208,442	2,304,495	t CO_2-e/a
Total rail construction emissions	517,995	-	517,995	t CO_2-e
Total rail annual operation emissions	2,763,552	155,928	2,919,480	t CO_2-e/a
Total port construction emissions	34,026	-	34,026	**t CO_2-e**
Total port annual operation emissions	-	265,078	265,078	**t CO_2-e/a**
Project total construction emissions	**14,769,489**	**1,160,104**	**15,929,593**	**t CO_2-e**
Project total annual operation emissions	**3,859,605**	**1,629,448**	**5,489,053**	**t CO_2-e/a**

For clarity figures have been presented in non scientific notation, data should be considered to have 3 significant figures.

1 INTRODUCTION

1.1 Project Description

Waratah Coal proposes to mine 1.4 billion tonnes of raw coal from its existing tenements, EPC 1040 and EPC 1079. The mine development involves the construction of four 9 Mtpa underground long-wall coal mines, two 10 million tonnes per annum (Mtpa) open cut pits, two coal preparation plants with raw washing capacity of 28 Mtpa.

The annual Run-of-Mine (ROM) coal production will be 56 Mtpa to produce 40 Mtpa of saleable export product coal. At this scale of operation, the capital expense of constructing the required rail and port infrastructure is economically viable over the life of the project.

Processed coal will be transported by a new 447 km railway system from the Galilee Basin to the existing Port of Abbot Point. The railway component includes a state of the art, heavy haul, standard gauge railway to support 25,000 tonne train units. The final railway easement is expected to be approximately 100 m wide and will be confirmed at detailed design.

The Port of Abbot is undergoing an extensive expansion program to facilitate coal export to the growing world market. The China First Project will be integrated within the planned expansion strategies to further consolidate the operability of the Port of Abbot Point as a state of the art export facility.

The auxiliary facilities for the project include the provision of new power supply infrastructure, water supply and wastewater treatment facilities, fire fighting and first aid infrastructure, machinery maintenance centre, accommodation and an airport. The construction period for the project is estimated to last 36 months.

1.2 Objectives of Study

The primary objectives of the study are to estimate the greenhouse gas emissions resulting from the development and operation of the China First Project, which includes the mine, railway and coal terminal, and to identify appropriate measures to manage greenhouse gas emissions.

To meet the requirements of the *Terms of Reference*, the following tasks formed the scope of work:

- review and identify relevant international, federal and state greenhouse gas policies;
- estimate the anticipated scope 1 and scope 2 greenhouse gas emissions associated with the project in a suitable format for external and internal reporting and review;
- assess residual and cumulative impacts of greenhouse gases arising from the project with respect to identified issues, taking into account implemented mitigation measures and relevant assessment framework;
- benchmark the energy and emissions intensity of the project against existing Australian coal mines; and
- identify and describe measures to avoid, reduce, mitigate and manage greenhouse gases associated with the project, and describe how these measures would be implemented, monitored and audited.

2 LEGISLATIVE CONTEXT OF THE ASSESSMENT

This section identifies the key international, federal and state government policies and laws regulating greenhouse gas emissions, and the prescribed methods and factors for estimating greenhouse gas emissions.

2.1 International Framework

2.1.1 Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is a panel established in 1988 by the World Meteorological Organisation and the United Nations Environment Programme, to provide independent scientific advice on climate change. The panel was asked to prepare, based on available scientific information, a report on all aspects relevant to climate change and its impacts and to formulate realistic response strategies. This first assessment report of the IPCC served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC) (IPCC, 2004).

The IPCC also produce a variety of guidance documents and recommended methodologies for greenhouse emissions inventories, including:

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories; and
- Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000).

Since the UNFCCC entered into force in 1994, the IPCC remains the pivotal source for scientific and technical information relevant to climate change and greenhouse emissions.

The IPCC operates under the following mandate: *"to provide the decision-makers and others interested in climate change with an objective source of information about climate change. The IPCC does not conduct any research nor does it monitor climate-related data or parameters. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature produced worldwide, relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they need to deal objectively with policy relevant scientific, technical and socio economic factors. They should be of high scientific and technical standards, and aim to reflect a range of views, expertise and wide geographical coverage"* (IPCC, 2009).

The stated aims of the IPCC are to assess scientific information relevant to:

- human-induced climate change;
- the impacts of human-induced climate change; and
- options for adaptation and mitigation.

The IPCC released its fourth assessment report in 2007. IPCC reports are widely cited in climate change debates and policies, and are generally regarded as authoritative.

2.1.2 United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource, the stability of which can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The convention enjoys near universal membership, with 172 countries (parties) having ratified the contained treaty, the Kyoto Protocol – see 2.1.3. Australia ratified the Kyoto Protocol in December 2007.

Under the UNFCCC, governments:

- gather and share information on greenhouse gas emissions, national policies and best practices;
- launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and
- cooperate in preparing for adaptation to the impacts of climate change.

2.1.3 Kyoto Protocol

The Kyoto Protocol entered into force on 16 February 2005.

The Kyoto Protocol builds upon the UNFCCC by committing to individual, legally binding targets to limit or reduce their greenhouse gas emissions. Annex I Parties are countries that were members of the Organisation for Economic Co-operation and Development (OECD) in 1992, plus countries with economies in transition (the EIT Parties), such as Russia. The greenhouse gases included in the Kyoto Protocol are:

- carbon dioxide (CO_2);
- methane (CH_4);
- nitrous oxide (N_2O);
- hydrofluorocarbons (HFCs);
- perfluorocarbons (PFCs); and
- sulfur hexafluoride (SF_6).

The emission reduction targets are calculated based on a party's domestic emission greenhouse inventories (which include the sectors land use change and forestry clearing, transportation, stationary energy, etc). Domestic inventories require approval by the Kyoto Enforcement Branch. The Kyoto Protocol requires developed countries to meet national targets for greenhouse gas emissions over a five year period between 2008 and 2012.

To achieve their targets, Annex I Parties must put in place *domestic policies and measures.* The Kyoto Protocol provides an indicative list of policies and measures that might help mitigate climate change and promote sustainable development.

Under the Kyoto Protocol, developed countries can use a number of flexible mechanisms to assist in meeting their targets. These market mechanisms include:

- Joint Implementation (JI) – where developed countries invest in greenhouse gas emission reduction projects in other developed countries; and
- the Clean Development Mechanism (CDM) – where developed countries invest in greenhouse gas emission reduction projects in developing countries.

Annex I countries that fail to meet their emissions reduction targets during the 2008-2012 period may be liable for a 30 percent penalty (additional to the level of exceedance). Countries would have to make up the exceedance plus penalty in the post-2012 commitment period.

2.1.4 International Agreement Post-Kyoto

An international framework for mitigating the impacts of climate change past the Kyoto period was discussed at the 15th United Nations Conference of Parties (COP), Copenhagen, in December 2009. It concluded with an agreement that the global temperature rise should be capped through significant emission reductions by all countries, however no legally binding agreement was ratified. The *Copenhagen Accord* was drafted and supported by the majority countries, and outlined the following (UNFCCC, 2009):

- the global temperature increase should be held below 2°C;
- emissions targets for developed countries and actions to reduce emissions by developing countries should be specified;
- an international framework for measurement, reporting and verification of greenhouse gas emissions; and
- financial assistance for developing countries to reduce emissions and adapt to climate change.

Nations went to Copenhagen with national emission reduction targets, both unconditional and dependent on global emission reduction commitments. Australia's commitments are outlined in the draft *Carbon Pollution Reduction Scheme* legislation (Section 2.2.4). It is clear that the *Copenhagen Accord* is not legally binding to the extent of the Kyoto Protocol and the specification of national emissions reduction commitments for the period 2012-2020 will be subject to further negotiation.

2.2 Australian Context

2.2.1 Australia's Greenhouse Gas Inventory

Australia's greenhouse gas emissions increased by 9.3% between 1990 and 2007 (refer to Table 2.1). The largest increase was in the energy sector, with emissions increasing by 42.5% between 1990 and 2007. Emissions from the China First Project would fall under the energy sector.

The relatively small change in total emissions from 1990 to 2007 is largely due to a significant reduction in greenhouse emissions associated with land use change, which has decreased by over 57% between 1990 and 2007 (DCC, 2009a). Under current Kyoto accounting provisions, these emissions include:

- afforestation and reforestation (establishment or re-establishment of forests) since 1990; and
- deforestation – the deliberate human induced removal of forest cover and replacement with other uses.

Since 1990, there has been a significant reduction in deforestation within Australia and annual associated release of stored carbon combined with an increase in forestry projects. In addition there has been an increase in forest planting, increasing the amount of carbon dioxide sequestered from the atmosphere.

Table 2.1: Australian Greenhouse Emissions 1990 and 2007 Kyoto Baseline by Sector

Sector	Emissions (Mt CO_{2-e})		Percentage change
	1990	2007	1990 to 2007
Energy	286.4	408.2	42.5%
Industrial Processes	24.1	30.3	25.7%
Agriculture	86.8	88.1	1.5%
Waste	18.8	14.6	-22.5%
Land Use, Land Use Change and Forestry [a]	130.1	56.0	-57.0%
Australia's Net Emissions	546.3	597.2	9.3%

Source: *Australia's National Greenhouse Accounts: National Greenhouse Gas Inventory Accounting for the Kyoto Target*, Department of Climate Change, Commonwealth of Australia, May 2009

[a] Strictly speaking, the net credits from land use change and forestry should only enter the account during the first commitment period (2008 to 2012). However, the 1990 and 2007 values are indicated for reference, and included in totals.

2.2.2 Australia and the Kyoto Protocol

Australia submitted its 'instrument of ratification' on 12 December 2007. Ratification came into force for Australia on 11 March 2008 following a mandatory 90 day waiting period.

Under the protocol, developed countries are legally required to take domestic action to reduce greenhouse emissions. Each developed country's target was negotiated and agreed internationally. Australia's national target is to achieve an average of 108% of 1990 emissions for the five years of the first commitment period (2008-2012). Any new sources that begin emitting during this period will contribute to Australia's Kyoto target.

The National Greenhouse Gas Inventory 2007 from the Australian Government Department of Climate Change (DCC), now the Department of Climate Change and Energy Efficiency (DCCEE), shows that 2007 emissions were 109.3% above 1990 baseline (refer to Table 2.1). The DCCEE is projecting that emissions will reduce to an average of 583 Mt CO_2-e per annum over 2008-12. This is 107 per cent of 1990 levels, meaning that Australia is expected to meet its Kyoto obligations (DCCEE, 2009a).

The Kyoto Protocol requires Australia to implement a range of monitoring and reporting commitments. Specifically, Australia will be required to report its annual greenhouse emissions every year during the 2008 to 2012 commitment period. Australia's greenhouse emissions reporting framework is discussed below.

2.2.3 The National Greenhouse and Energy Reporting Act (NGER Act)

Federal parliament passed the *National Greenhouse and Energy Reporting Act 2007* (NGER Act) in September 2007. The NGER Act establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production.

The NGER Act is one of a number of legislative instruments related to greenhouse reporting, which together form the National Greenhouse and Energy Reporting (NGER) System, as follows:

- *National Greenhouse and Energy Reporting Regulations 2008*;
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008* and *National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2009*; and

- the proposed *External Audit Legislative Instrument*, which is not yet in force (at 10 August 2010).

The NGER Act is seen as an important first step in the establishment of a domestic emissions trading scheme. This intention is explicitly stated in the objectives for the NGER Act, as follows:

- establish a baseline of emissions for participants in a future Australian emissions trading scheme;
- inform the Australian public;
- meet international reporting obligations; and
- assist policy formulation of all Australian governments while avoiding duplication of similar reporting requirements.

Corporate and facility reporting thresholds for greenhouse gas emissions and energy consumption or energy production can be seen in Table 2.2. Based on the findings of this study, annual greenhouse gas emissions from the China First Project will exceed the NGER corporate threshold (refer to Section 4 for emission estimates). Therefore, Waratah Coal will be required to report greenhouse gas emissions and energy consumption/production from the mine, railway and coal terminal.

Table 2.2: NGER Reporting Thresholds

Year	Corporate Threshold		Facility Threshold	
	GHG Emissions (kt CO_2-e)	Energy Usage (TJ)	GHG Emissions (kt CO_2-e)	Energy Usage (TJ)
2008-2009	125	500	25	100
2009-2010	87.5	350		
2010-2011	50	200		

2.2.4 Energy Efficiency Opportunities Program

The Energy Efficiency Opportunities (EEO) Program is designed to improve the energy efficiency of large businesses. Participation is mandatory for corporations that use more than 0.5 PJ of energy. Participating corporations must assess their energy efficiency, and energy efficiency opportunities with a payback period less than four years, and publicly report the results.

Based on expected electricity and diesel usage, the China First Project will exceed the EEO participation threshold of 0.5 PJ (refer to Appendix E for a summary of total energy usage).

2.2.5 Proposed Legislation - The Carbon Price Mechanism

On 10 July 2011, the Australian Government released its *Clean Energy Plan*, which incorporates a Carbon Pricing Mechanism. Under this proposed policy, from 1 July 2012, the eligible industries in Australia will be required to pay for every tonne of carbon pollution released to the atmosphere (Australian Government, 2011a). This mechanism is expected to replace the Carbon Pollution Reduction Scheme (CPRS) put forward by the Australian Government in 2008.

The CPRS was intended to be the principal mechanism used to reduce Australia's greenhouse gas emissions for the Kyoto period, and beyond. The centrepiece of the CPRS was a "cap and trade" emissions trading scheme to constrain greenhouse gas emissions and establish a price for greenhouse gas emissions in Australia. On 27 April 2010 the Australian Government announced the deferral of the CPRS implementation date.

Although the framework of the proposed carbon mechanism resembles that proposed in the Green and White Papers (DCC, 2008a and DCC, 2008b) for the CPRS, the carbon price mechanism involves the following distinguishing features:

- The carbon price mechanism will consist of two distinct stages. For the first three years, a fixed price stage will operate with the price of all carbon permits set by the government. The carbon price will start at $23 AUD per tonne and rise by 2.5% a year, resulting in a carbon price of $24.15 AUD per tonne in 2013-14 and $25.40 AUD per tonne in 2014-15 (Australian Government, 2011a). During this fixed price period, businesses will be able to acquire as many permits at the set price as required to meet their obligations.
- Subsequent to this three year period, a flexible cap and trade emissions trading scheme will commence (refer to Section **Error! Reference source not found.**).
- During the fixed price stage, *eligible* Australian carbon credit units (ACCUs) produced from Australian projects under the Carbon Farming Initiative (CFI), will be accepted as currency as an alternative of purchasing Australian Permits. The CFI will produce carbon credits eligible for local and international compliance (e.g., Emission Trading Scheme - ETS) and voluntary markets (e.g., National Carbon Offset Standard - NCOS) (Carbon Neutral, 2011). Only 5 % of liable entities' obligation may be met by surrendering eligible ACCUs during the fixed price stage. However, Australia's carbon price will not be linked to international carbon markets during the fixed price period.
- The *Clean Energy Plan* is expected to cut pollution by a minimum of 5% below 2000 levels *by 2020 and by 80% below 2000 lev*els *by 2050.*
- Before the flexible price period, the Government will set annual caps on pollution for the first *five years which w*ill be extended each year to assist businesses planning their strategy for compliance.

As proposed in the CPRS, the threshold for facilities will be identical to that employed for NGER reporting (i.e., 25,000 kt CO_2-e/year or more - excluding emissions from transport fuels and some synthetic greenhouse gases) and will be used to identify whether a facility will be covered by the carbon pricing mechanism. This threshold is expected to be triggered by Waratah Coal.

2.2.5.1 Emissions Trading

Subsequent to the fixed price stage, a variable price as part of a "cap and trade" system will be implemented where the carbon price will be set by the market. The number of permits issued by the Government each year will be capped. In cap and trade schemes, an aggregate cap is enforced. Organisations within the cap are able to trade emission permits to meet their permitting liabilities. International carbon markets and land abatement programs will also be available to acquire permits for compliance. During the flexible price period, an unlimited amount of eligible ACCUs can be surrendered for compliance, as opposed to the 5% limit set for the fixed price period.

Carbon permits can enter the market either by auction or by administrative allocation. Companies will have an economic incentive to pay for permits if their internal costs of abatement are higher than the price of permits, and to directly reduce their emissions if their internal costs of abatement are lower than the price of permits. In theory, companies that own permits would be willing to sell them if the revenue received from selling permits exceeds the profits from using them.

These market incentives are designed to encourage the cheapest abatement to occur first.

The carbon price mechanism will cover the same emissions as proposed under the CPRS, with the exception of the definite exclusion of agricultural carbon emissions. Approximately 60% of Australia's carbon pollution is expected to be covered by the carbon price, which encompasses the following emission sources:

- stationary energy production (e.g., natural gas, coal, petroleum fuels, electricity);
- some business transport;
- industrial processes (e.g., cement or aluminium production);
- fugitive emissions (other than from decommissioned coal mines); and
- emissions from non-legacy waste.

The scheme will have broad economic ramifications beyond large emitters with direct obligations. Households are likely to experience increased costs associated with carbon intensive goods and services such as electricity, gas and food. However, a significant portion of the scheme is devoted to measures to ease the transition to carbon-constrained economy and assistance from the Australian Government will be provided to approximately 8 million households.

2.2.5.2 Support Measures

The government will provide a range of support measures to industry, businesses and households to allow them to adapt to a carbon constrained economy. The assistance measures relevant to the coal mines are the *Coal Sector Jobs Package* (CSJP) and the *Technology Support Package* (CMATSP) (Australian Government, 2011a).

The *Coal Sector Jobs Package* will provide assistance for coal mines with high fugitive emissions (i.e. emissions of methane and carbon dioxide released when the coal is mined). Mines with a fugitive emissions intensity of greater than 0.1 t CO_2-e per tonne of saleable coal will be eligible for assistance for up to 80% of the liability for purchasing permits for fugitive emissions above the 0.1 t CO_2-e per tonne of saleable coal threshold. However, the package will not assist new mines or expansions of production in existing mines and the carbon price will provide incentives for expanded coal production to be sourced from lower-emissions coal seams (Australian Government, 2011a).

CMATSP is a $70 million fund over six years available to coal mining operators for capital grants on a co-contribution basis for greenhouse gas abatement projects. Additional support for the coal sector is also available to China First Project through the Department of Resources, Energy and Tourism, such as the *National Low Emissions Coal Initiative* (NLECI). The initiative was established by the Australian Government in 2008 to accelerate the development and deployment of technologies to reduce emissions from coal use (Australian Government, 2011c).

2.2.5.3 The China First Project and the Carbon Price Mechanism

Waratah Coal will be a direct participant in the carbon price mechanism as it is currently proposed since Waratah Coal is part of the stationary energy sector and the project is expected to emit over 25 kt CO_2-e (scope 1) on an annual basis (refer to Table 4.1) (Australian Government, 2011b). This will mean Waratah Coal must report their emissions and hold emission permits at the end of each period equivalent to the amount reported. As detailed in Section 2.2.5.1, Waratah Coal may obtain permits through allocation from the government, or purchasing them from an auction. As the cost of permits fluctuates, it may be more economically viable to pursue costly emission mitigation and avoidance measures than to obtain permits for all emissions. The extent of emissions reductions will ultimately be determined by market forces.

The carbon price is expected to have a relatively minor impact on coal mines that emit small volumes of fugitive emissions. A carbon price of approximately $1.40 AUD per tonne of coal produced is estimated for low-fugitive-emissions coal mines in comparison to a carbon price of approximately $7.40 to $25 AUD per tonne of coal produced for average-to-high-fugitive-emissions coal mines (Australian Government, 2011a).

2.2.6 Proposed Legislation - The Coalition's Direct Action Plan

On December 1 2009, a new Opposition Leader was elected by the Liberal Party. Under the new leadership, the Opposition is seeking to defeat the proposed emissions trading scheme. The policy currently put forward by the Opposition is the Direct Action Plan (LPA, 2010). This policy remains in force after the announcement made by the Australian Government in regards to the carbon tax on 10 July 2011 (LPA, 2011).

The centrepiece of this policy is the replenishment of soil carbons – a large CO_2 abatement through bio-sequestration (currently soil carbons are not recognised under the Kyoto Protocol, however future global agreements on CO_2 reductions may include them).

The policy will also introduce an Emissions Reduction Fund to facilitate 140 million tonnes of CO_2 abatement per annum by 2020. The fund is intended to aid projects that will:

- reduce CO_2 emissions;
- not result in price increases for consumers;
- deliver additional practical environmental benefits;
- protect Australian jobs; and
- would not proceed without fund assistance.

A particular target of the policy is the nation's oldest and most inefficient power generation facilities, which will have the ability to use the fund to introduce programs to increase efficiency, or switch to less carbon intensive fuels.

The *Direct Action Plan* is essentially a 'baseline and credit' approach, where:

- if businesses reduce their emissions below their baseline they have the opportunity to offer the abatement for sale to the government; and
- while no penalties are proposed for businesses that remain at their baseline levels of emissions, financial penalties are proposed for those businesses that emit more than their baseline levels.

The Coalition claims that the *Direct Action Plan* will match the 5% emission reductions outlined in the draft CPRS legislation (LPA, 2010) (now deferred); however no emission reduction target is specified.

2.2.6.1 The China First Project and the Direct Action Plan

The proposed policy should not impose penalties on Waratah Coal. The policy states that, "provision will be made to ensure penalties will not apply to new entrants or business expansion at 'best practice'." While the policy does not go into further detail on how best practice would be assessed, it is expected that this will involve consideration of the emission intensity of the business.

The *Direct Action Plan* may therefore provide options for Waratah Coal to reduce the emission intensity of their operations, if significant abatement opportunities arise that Waratah Coal would not pursue without the fund's contribution. The policy as it is currently proposed should not place a financial burden on Waratah Coal, or any further effort on top of the current NGER system.

2.2.7 Australian Context Post-Kyoto

Currently an unconditional emission reduction target of 5% below 2000 levels by 2020 is supported by both major political parties. This was part of Australia's submission to the United Nations COP in Copenhagen. Other conditional targets included in the submission are 15% below 2000 levels and 25% below 2000 levels. These targets would require a global agreement that has developed countries contributing comparably to Australia. However, at present, Australia has no legally binding emission reduction target after the Kyoto period, which ends in 2012. The targets pledged in the *Copenhagen Accord* and anchored with the *Cancún Agreements* will nonetheless be treated as serious political commitments, and will likely form the basis of targets agreed to under a replacement of the Kyoto Protocol.

2.3 Queensland Greenhouse Policy

2.3.1 ClimateQ

The Queensland Government's climate change mitigation strategy is presented in: *ClimateQ: toward a greener Queensland* (2008). It is a consolidation and update to previous Qld Government strategies - *ClimateSmart 2050* and the *ClimateSmart Adaptation Plan 2007-12*.

ClimateQ outlines a commitment to reduce Queensland's greenhouse gas emissions by 60% by 2050, in line with the Australian Government's target.

2.3.2 Clean Coal Technology Special Agreement Act 2007

Due to the importance of the coal industry to Queensland's economy, the Queensland Government has outlined its commitment to accelerate investments to develop and demonstrate carbon capture and storage (CCS) technologies with the *Clean Coal Technology Special Agreement Act 2007*. The Act established the Clean Coal Council (CCC), who are charged with administrating a $900 million fund consisting of $300 million from the Qld Government and $600 million from a voluntary fund from the coal industry.

Projects using funds administrated by the CCC are:

- *ZeroGen Project* - a commercial-scale Integrated Gasification Combined Cycle plant that is CCS ready;
- *Callide Oxyfuel Project* - a study of combusting coal in the presence of oxygen and exhaust gas, as opposed to air, producing a concentrated CO_2 exhaust stream suitable for carbon capture and storage; and
- *Carbon Geostorage Initiative* - which identifies, characterises and evaluates geological sites that have the potential for long-term, safe and secure storage of CO_2 emissions.

ClimateQ places restrictions on any new coal-fired power station in Queensland. To be commissioned they must use world's best practice low emission technology, and be CCS ready with retrofitting mandatory within five years of CCS being proven on a commercial scale.

3 COLLATING GREENHOUSE EMISSIONS

3.1 Estimating Methods

Greenhouse gas emissions have been estimated based upon the methods outlined in the following documents:

- the World Resources Institute/World Business Council for Sustainable Development *Greenhouse Gas Protocol*;
- *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines 2009*; and
- the Australian Government Department of Climate Change *National Greenhouse Accounts (NGA) Factors 2009*.

3.1.1 The Greenhouse Gas Protocol

The Greenhouse Gas Protocol establishes an international standard for accounting and reporting of greenhouse gas emissions. The Greenhouse Gas Protocol has been adopted by the International Standard Organisation, endorsed by greenhouse gas initiatives (such as the Carbon Disclosure Project) and is compatible with existing greenhouse gas trading schemes.

Three 'scopes' of emissions (scope 1, scope 2 and scope 3) are defined for greenhouse gas accounting and reporting purposes. This terminology has been adopted in Australian greenhouse reporting and measurement methods and has been employed in this assessment. The 'scope' of an emission is relative to the reporting entity, indirect scope 2 and scope 3 emissions will be reportable as direct scope 1 emissions from another facility.

1) Scope 1: Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions are defined as those emissions that occur from sources that are owned or controlled by the reporting entity. Direct greenhouse gas emissions are those emissions that are principally the result of the following types of activities undertaken by an entity (WRI, 2003):

- generation of electricity, heat or steam, where emissions result from the combustion of fuel in stationary sources;
- physical or chemical processing, where most of these emissions result from manufacture or processing of chemicals and materials, e.g., the manufacture of cement, aluminium, etc;
- transportation of materials, products, waste and employees, where emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources, e.g., trucks, trains, ships, aeroplanes, buses and cars; and.
- fugitive emissions, where emissions result from intentional or unintentional releases, e.g., methane emissions from coal mines and venting; equipment leaks from joints, seals, packing, and gaskets; HFC emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport.

With respect to the China First Project, the major sources of scope 1 emissions are fugitive methane emissions from coal mining and the combustion of fossil fuels for mining equipment. The China First Project will only have direct control of scope 1 emissions, which include activities under the operation control of Waratah Coal.

2) Scope 2: Energy Product Use Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that accounts for greenhouse gas emissions from the generation of purchased energy products (principally, electricity, steam/heat and reduction materials used for smelting) by the entity.

Scope 2 in relation to the China First Project covers purchased electricity defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity. Scope 2 emissions physically occur at the facility where electricity is generated. Entities report the emissions from the generation of purchased electricity that is consumed in its owned or controlled equipment or operations as scope 2.

3) Scope 3: Other Indirect Greenhouse Gas Emissions

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of scope 3 activities provided in the Greenhouse Gas Protocol are the use of sold products, the extraction and production of purchased materials and transportation of purchased fuels.

Scope 3 emissions associated with the China First Project have not been estimated, in accordance with the requirements of *Section 3.6: Greenhouse gas abatement and emissions* of the Terms of Reference.

3.1.2 National Greenhouse and Energy Reporting Technical Guidelines 2009

The National Greenhouse and Energy Reporting Determination 2008 commenced on 1 July 2008 and is made under subsection 10 (3) of the *National Greenhouse and Energy Reporting Act 2007*. It provides for the measurement of the following arising from the operation of facilities:

- greenhouse gas emissions;
- the production of energy; and
- the consumption of energy.

The determination deals with scope 1 and scope 2 emissions. The methods are presented as tiers with higher tiers producing less uncertain results but requiring more data to employ. In the determination there are 4 categories of scope 1 emissions (in brackets the code for the IPCC classification):

- fuel combustion (UNFCCC Category 1.A);
- fugitive emissions from fuels, which deals with emissions released from the extraction, production, flaring of fuel, processing and distribution of fossil fuels (UNFCCC Category 1.B);
- industrial processes emissions (UNFCCC Category 2); and
- waste emissions (UNFCCC Category 6).

Where possible, PAEHolmes have employed methods consistent with those described in the Determination, which covers scope 1 emissions.

3.1.3 National Greenhouse Accounts Factors

The National Greenhouse Accounts (NGA) Factors provides emission factors which have a general application to a broader range of greenhouse emission inventories. The NGA replaces the Australian Greenhouse Office Factors and Methods Workbook. The default emission factors listed in NGA Factors have been derived by the Department of Climate Change using the Australian Greenhouse Emissions Information System and determined simultaneously with the production of Australia's NGA. This document has been used to supplement the estimation of scope 2 based on Australia's NGA.

3.2 Greenhouse Emission Sources

This greenhouse gas assessment considers the scope 1 and scope 2 greenhouse gas emissions associated with the project during construction and operation, as provided in Table 3.1.

Table 3.1: Greenhouse Gas Emission Sources during Project Operation

Project Section	Scope 1 Emissions	Scope 2 Emissions
Mine - Construction	Fuel consumption: - Mining equipment - Auxiliary vehicles - Transport	Electricity
	Fugitive methane release from mined coal	
	Spontaneous combustion of mined coal	
	Slow oxidation from mined coal	
	Wastewater treatment	
	Blasting	
	Vegetation clearing	
Mine - Operation	Fuel consumption: - Mining equipment - Auxiliary vehicles - Transport	Electricity
	Fugitive methane release from mined coal	
	Spontaneous combustion of mined coal	
	Slow oxidation from mined coal	
	Wastewater treatment	
	Blasting	
Railway - Construction	Fuel consumption: - Mining equipment - Auxiliary vehicles	-
	Vegetation Clearing	
Railway - Operation	Fuel consumption - Locomotives	Electricity
Coal terminal - Construction	Fuel consumption	-
	Vegetation clearing	
Coal terminal - Operation	Fuel consumption - vehicles	Electricity

3.3 Estimation Methodologies

3.3.1 Mine

3.3.1.1 Construction – Land Clearing

Greenhouse gas emissions from the clearing of vegetation were estimated using the following equation:

Scope 1:

$$E_{CO_2-e} = \frac{A \times EF_{S1}}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from land clearing	(t CO_2-e)
A	=	Estimated area cleared	(ha)
EF_{S1}	=	Greenhouse gas scope 1 emission factor for land clearing	(t CO_2-e/ha)

The following parameters were used in the equation:

- EF_{S1} = 165 t CO_2-e/ha; and
- A = 83,114 ha cleared.

For the purposes of this assessment, some assumptions have been made to obtain approximate emission factors for the vegetation clearance component of the Project. One important assumption is that 50% of the biomass in an area is carbon. In reality, this value differs between each species in the range of 40-50% (AGO, 2000). 50% has been used as a conservative assumption.

The general biomass densities that have been used by the Australian Greenhouse Office for land clearing inventory purposes will be used in this assessment. Of the three forest classes provided in Table 2.5 of '*Synthesis of Allometrics, Review of Root Biomass and Design of Future Woody Biomass Sampling Strategies*' (AGO, 2000), Open Forest has been deemed the most appropriate for this assessment. The biomass density presented (90 t biomass/ha) corresponds to an emission factor of 165 t CO_2-e/ha (assuming that all carbon oxidises to CO_2 and that 50% of the biomass is carbon).

The area assumed to be cleared for the Project is EPC 1040 (744.34 km^2) and EPC 1079 (86.8 km^2).

3.3.1.2 Construction – Ramp-up Emissions

As project-specific activity data were not available for the construction (or ramp up) stage of the project, the construction stages of other projects of similar type and scale were assessed in order to approximate the project's construction emissions. This assessment determined that for similar coal mine projects, the typical construction stage lasts about two years, with the first year having about 30% of the average annual operational emissions, and the second year having about 65% of the average annual operational emissions.

These ratios have therefore been applied to the average annual operational emissions outlined in Sections 3.3.1.3 to 3.3.1.10.

3.3.1.3 Operations - Diesel Combustion for Transport Energy

Greenhouse gas emissions from fuel combustion for vehicles were estimated using the following equation:

Scope 1:

$$E_{CO_2-e} = \frac{Q \times EF_{S1}}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from diesel combustion	(tCO_2-e/annum)
Q_i	=	Estimated combustion of diesel	(GJ/annum)
EF_{S1}	=	Greenhouse gas scope 1 emission factor for fuel i combustion	(kg CO_2-e/GJ)

The following parameters were used in the equation:

- estimated annual diesel consumption of
  - 4,094,847 GJ/a for mining equipment, based on fuel consumption data (kL/a) provided by Waratah Coal and an energy content of 38.6 GJ/kL for diesel, sourced from *Table 4*: *Fuel combustion emission factors - fuels used for transport energy purposes*, DCC National Greenhouse Accounts (NGA) Factors, June 2009
  - 279,155 GJ/a for auxiliary vehicles, based on information provided by Waratah Coal (refer to Appendix 0)
  - 75,654 GJ/a for transport vehicles, based on information provided by Waratah Coal (refer to Appendix A.2); and
- scope 1 emissions factors, sourced from *Table 4*: *Fuel combustion emission factors - fuels used for transport energy purposes*, DCC National Greenhouse Accounts (NGA) Factors, June 2009, of
  - 69.2 $kgCO_2$-e/GJ for CO_2;
  - 0.2 $kgCO_2$-e/GJ for CH_4; and
  - 0.5 $kgCO_2$-e/GJ for N_2O.

3.3.1.4 Operations - Explosives

Greenhouse gas emissions from explosives were estimated using the following equation:

$$E_{CO_2-e} = EU \times EF_{S1}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from explosives	(t CO_{2-e}/annum)
EU	=	Estimated explosive usage on-site	(t/annum)
EF	=	Greenhouse gas emission factor for explosives	(t CO_{2-e}/t)

The following parameters were used in the equation:

- estimated explosive use of 46,500 t/a, as provided by Xenith Consulting; and

- scope 1 emission factor of 0.18 t CO_{2-e}/t explosive for heavy explosives, sourced from *Table 4: Industrial Processes emission factors for Heavy ANFO and normal ANFO explosive use,* DCC National Greenhouse Accounts (NGA) Factors, January 2008 (Note: emission factors for explosive usage are not presented in NGA Factors, June 2009).

3.3.1.5 Operations - Fugitive Methane emissions

Greenhouse gas emissions from fugitive methane emissions were estimated using the following equation:

$$E_{CO_2-e} = RomCoal \times EF_{S1}$$

where:

E_{CO2-e}	=	Fugitive methane emissions	(t CO_{2-e}/annum)
RomCoal	=	Run of Mine Coal extracted	(t/annum)
EF	=	Greenhouse gas emission factor for fugitive methane emissions	(t CO_{2-e}/t ROM coal)

The following parameters were used in the equation:

- estimated ROM coal extracted from
  - Open Cut Mines 1 and 2 of 20,000,000 t/a, as provided by Waratah Coal, and
  - Underground Mines 1 to 4 of 36,000,000 t/a , as provided by Waratah Coal;
- scope 1 emission factor for underground extraction of coal for 'non-gassy' mines of 0.008 t CO_2-e/t ROM, sourced from *Table 6: Emission factors for the extraction of coal (fugitive) - Underground,* DCC National Greenhouse Accounts (NGA) Factors, June 2009; and
- scope 1 emission factor for open cut extraction of coal in Queensland mines of 0.017 t CO_2-e/t ROM, sourced from *Table 8: Emission factors for the production of coal (fugitive) - Open cut*, DCC National Greenhouse Accounts (NGA) Factors, June 2009.

The emission factor for 'non-gassy', as opposed to 'gassy', underground mines was chosen. 'Gassy' mines are defined as those with greater than 0.1% methane in the mine's return ventilation, according to *Appendix B: Definitions and interpretations*, NGER (Measurement) Technical Guidelines, June 2009. This definition cannot be applied to the underground mines at the China First Project until they are operational.

Therefore, the classification of the underground mines as 'non-gassy' was based on:

- the Australian Coal Association Research Program (ACARP) defining underground mines as having low gas rating if the gas content of the coal is less than 3 m^3/tonne (ACARP, 2001); and
- results from 22 gas samples conducted for the B, C, DL and DU seams within the China First Project footprint (provided in 0), which recorded
  - gas contents at sample ash ranging from 0.03 to 0.21 m^3/tonne, and
  - 18 of the 22 samples having no detectable methane.

The classification of the underground mines as 'non-gassy' can be confirmed once the mine is operational.

3.3.1.6 Operations - Slow Oxidation

Coal subject to the atmosphere is subject to slow oxidation at ambient temperatures, as opposed to fast oxidation, which occurs when coal is combusted at high temperatures (Energy

Strategies, 2000). This results in emissions of carbon dioxide. Greenhouse gas emissions from slow oxidation were estimated using the following equation:

$$E_{CO_2-e} = \frac{PSC \times EF_{S1}}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from slow oxidation	(t CO_{2-e}/annum)
PSC	=	Estimated production of saleable coal	(t/annum)
EF	=	Emission factor for slow oxidation	(kg CO_{2-e}/tonne coal)

The following parameters were used in the equation:

- the estimated production of saleable coal of 40 Mtpa, as provided by Waratah Coal; and
- scope 1 emission factor for slow oxidation of coal of 0.125 kg CO_{2-e}/t coal, sourced from *Projection of Fugitive Greenhouse Gas Emissions to 2020* (Energy Strategies, 2000).

The greenhouse gas emission factor published in this report is actually 0.5 kg CO_{2-e} per tonne of saleable coal production. However, the Energy Strategies report states that the emission factor overestimates emissions from slow oxidation by a factor of four or more. Consequently, the emission factor was divided by four for use in the greenhouse gas assessment.

There are no emission factors for slow oxidation published in the NGA Factors or NGER (Measurement) Technical Guidelines, and emissions associated with slow oxidation are not included in the National Greenhouse Gas Inventory due to the high level of uncertainty associated with emission estimates (Energy Strategies, 2000). However, as slow oxidation has been identified as a potential source of greenhouse gas emissions (Energy Strategies, 2000; ACARP, 2001) it has been included in this assessment for completeness, in accordance with the general requirements of NGER reporting.

3.3.1.7 Operations - Spontaneous Combustion

Coal is also subject to spontaneous combustion if the rate of heat generated during slow oxidation is greater than rate of heat removed, resulting in emissions of carbon dioxide and a small amounts of methane (Energy Strategies, 2000). Greenhouse gas emissions from spontaneous combustion were estimated using the following equation:

$$E_{CO_2-e} = \frac{PSC \times EF_{S1}}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from spontaneous combustion	(t CO_{2-e}/annum)
PSC	=	Estimated production of saleable coal	(t/annum)
EF	=	Emission factor for spontaneous combustion	(kg CO_{2-e}/tonne coal)

The following parameters were used in the equation:

- the estimated production of saleable coal of 40,000,000 t/a, as provided by Waratah Coal; and
- scope 1 emission factor for spontaneous combustion of coal of 3 kg CO_{2-e}/t coal, as sourced from *Projection of Fugitive Greenhouse Gas Emissions to 2020* (Energy Strategies, 2000).

The greenhouse gas emission factor published in this report is actually 12 kg CO_{2-e} per tonne of saleable coal production. However, the Energy Strategies report states that the emission factor overestimates emissions from spontaneous combustion by a factor of four or more. Consequently, the emission factor was divided by four for use in the greenhouse gas assessment.

As with slow oxidation, emission factors for spontaneous combustion are not published in the NGA Factors or NGER (Measurement) Technical Guidelines, however, as spontaneous combustion has been identified as a potential source of greenhouse gas emissions (Energy Strategies, 2000; ACARP, 2001) it has been included in this assessment for completeness, in accordance with the general requirements of NGER reporting.

3.3.1.8 Operations - Electricity Usage

Greenhouse gas emissions from electricity usage were estimated using the following equation:

Scope 2:

$$E_{CO_2-e} = \frac{Q \times EF_{S1}}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from electricity usage	(tCO_2-e/annum)
Q	=	Estimated electricity usage	(kWh/annum)
EF_{S2}	=	Scope 2 emission factor for electricity usage in Queensland	($kgCO_2$-e/kWh)

The following parameters were used in the equation:

- estimated annual electricity consumption for the mine of 1,357,800 MWh/annum, based electricity consumption of 155 MW, as provided by Waratah Coal, assumed to occur at this rate for 100% of the year; and
- scope 2 emission factor for electricity purchased from the Queensland grid of 0.89 kg CO_2-e/MWh, sourced from *Table 5: Indirect (scope 2) emission factors for consumption of purchased electricity from the grid*, DCC National Greenhouse Accounts (NGA) Factors, June 2009.

3.3.1.9 Operations - Plane Flights

There will be daily plane travel from Brisbane to an airstrip, proposed to be constructed at the China First Mine. Alternatively, commercial airlines will be used for air travel, with planes landing at an upgraded airstrip at the township of Alpha. Should commercial airlines be used, Waratah Coal will have not have any responsibility for ongoing reporting of greenhouse gas emissions (under NGER) from plane flights.

For the purposes of this assessment, it has been assumed that the air travel will not use commercial airlines, instead, planes have been assumed to be under the operational control of Waratah Coal, and the emissions associated with the planes have been considered as scope 1 emissions. As such, emissions associated with plane travel were calculated using the following equation:

$$E_{CO_2-e} = Distance \times Passengers \times RFI \times EF$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from fuel combustion in planes	(tCO_2-e/annum)
Distance	=	Total distance travelled per year	(km/annum)
Passengers	=	Total number of passengers travelling	(passengers)
RFI	=	Radiative forcing index	(-)
EF	=	Emission factor for plane flights	(tCO_2-e/km/passenger)

The following parameters were used in the equation:

- the total distance travelled per annum, based on an estimated flight distance from Brisbane to the Galilee Coal Mine of 1000 km, sourced from *GoogleMaps*, and four one-way flights per day, sourced from *Section 8.5: Airport*, Screening Study of the Australia China First Power coal Project;
- the number of passenger travelling per flight, based on a 100 seat plane and an assumed capacity of 50% per flight;
- a radiative forcing index (RFI) of 2.7, which takes into account the warming potential of greenhouse gases emitted at altitude, sourced from *Calculating Your Greenhouse Gas Emissions from Flights*, Victorian Environmental Protection Agency (EPA), 2009; and
- an emission factor of 0.00012 t CO_2-e/km/passenger, sourced from *Calculating Your Greenhouse Gas Emissions from Flights*, Victorian Environmental Protection Agency (EPA), 2009, for medium haul flights with distance 500 km to 1600 km.

3.3.1.10 Note that the breakdown of CO_2, CH_4 or N_2O emissions from plane flights is unknown, so emissions are only presented as CO_2-e.Operations - Wastewater Treatment

Emissions from onsite wastewater treatment were assessed in accordance with using the methodology presented in Part 5.3 of the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines, June 2009. As the wastewater is treated using aerobic digestion, greenhouse gas emissions are negligible in the context of this assessment.

3.3.2 Railway

3.3.2.1 Construction – Land Clearing

Greenhouse gas emissions from land clearing for the railway were estimated using the same methodology outlined in Section 3.3.1.1.

As project-specific data was not available for this stage of the project, the construction stages of other rail projects of similar type and scale were assessed in order to approximate the Project's construction emissions. This process determined key activity data on a per km of rail basis.

The area cleared per km of rail was estimated as 0.66 ha (Connell Hatch, 2009). Therefore the estimated area cleared for the Project was 291 ha.

3.3.2.2 Construction – Diesel Combustion for Stationary Energy

As project-specific data was not available for this stage of the project, the construction stages of other rail projects of similar type and scale were assessed in order to approximate the Project's construction emissions. This process determined key activity data on a per km of rail basis, including the amount of diesel combusted in stationary engines to provide power to construction camps and other purposes, 12,956 L/km (Connell Hatch, 2009).

Greenhouse gas emissions from fuel combustion for vehicles were estimated using the following equation:

Scope 1:

$$E_{CO_2-e} = \frac{Q \times EF_{S1}}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from diesel combustion	(tCO_2-e)
Q_i	=	Estimated combustion of diesel	(GJ)
EF_{S1}	=	Greenhouse gas scope 1 emission factor for fuel i combustion	(kg CO_2-e/GJ)

The following parameters were used in the equation:

- estimated diesel consumption of
  - 443,695 GJ; and
- scope 1 emissions factors, sourced from *Table 3*: *Fuel combustion emission factors – liquid fuels and certain petroleum based products for stationary energy purposes*, DCC National Greenhouse Accounts (NGA) Factors, June 2009, of
  - 69.2 $kgCO_2$-e/GJ for CO_2;
  - 0.1 $kgCO_2$-e/GJ for CH_4; and
  - 0.2 $kgCO_2$-e/GJ for N_2O.

3.3.2.3 Construction – Diesel Combustion for Transport Energy

Greenhouse gas emissions from diesel combustion for the railway were estimated using the same methodology outlined in Section 3.3.1.3.

As project-specific data was not available for this stage of the project, the construction stages of other rail projects of similar type and scale were assessed in order to approximate the Project's construction emissions. This process determined key activity data on a per km of rail basis.

The amount of diesel combusted for transport energy purposes per km of rail was estimated as 183.45 kL/km (Connell Hatch, 2009). Therefore the estimated amount of diesel combusted for transport purposes during the construction of the rail line was 6,282,403 GJ.

3.3.2.4 Operations - Diesel Combustion

Greenhouse gas emissions from diesel combustion for the railway were estimated using the same methodology outlined in Section 3.3.1.3.

Total diesel consumption was estimated to be 39,535,790 GJ/annum for the railway, estimated based on fuel consumption rates of diesel locomotives, as provided Waratah Coal.

3.3.2.5 Operations - Electricity Usage

Scope 2 emissions from electricity usage for the railway were estimated using the same methodology outlined in Section 3.3.1.8.

Estimated annual electricity consumption for the railway was 175,200 MWh/annum, based on electricity consumption of 20 MW, as provided by Waratah Coal, is assumed to occur at this rate for 100% of the year.

3.3.3 Coal Terminal

3.3.3.1 Construction – Diesel Combustion for Transport Energy

Greenhouse gas emissions from diesel combustion for the coal terminal were estimated using the same methodology outlined in Section 3.3.1.3.

As project-specific data was not available for this stage of the project, the construction stages of other cargo handling projects of similar type and scale were assessed in order to approximate the Project's construction emissions. The most appropriate facility was the Abbot Point Multi Cargo Facility (NQ Bulk Ports, 2010). This process determined key activity data that could form the basis of this assessment.

The amount of diesel combusted for transport energy purposes per tonne of coal throughput was estimated as 39.4 kL/t throughput (NQ Bulk Ports, 2010). Therefore the estimated amount of diesel combusted for transport purposes during the construction of the coal terminal was 3,165,277 GJ.

3.3.3.2 Construction – Material Movement

Greenhouse gas emissions from material movement were estimated using the following equation:

Scope 1:

$$E_{CO_2-e} = \frac{Q \times EF_{S1}}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from material movement	(tCO_2-e)
Q	=	Estimated material movement	(t.km)
EF_{S1}	=	Greenhouse gas scope 1 emission factor for material movement	(kg CO_2-e/t.km)

As project-specific data was not available for this stage of the project, the construction stages of other the Abbot Point Multi Cargo Facility was assessed in order to approximate the Project's construction emissions. This process determined key activity data that could form the basis of this assessment.

This includes an approximation of material movement – 2,749,728 t.km per tonne of coal throughput (NQ Bulk Ports, 2010). The material movement for the construction of the coal terminal has therefore been estimated as 109,989,120 t.km. The emission factor used was 0.2277 kg CO_2-e/t.km (NQ Bulk Ports, 2010).

3.3.3.3 Construction – Land Clearing

Greenhouse gas emissions from land clearing for the coal terminal were estimated using the same methodology outlined in Section 3.3.1.1.

As project-specific data was not available for this stage of the project, the construction stages of the Abbot Point Multi Cargo Facility was assessed in order to approximate the Project's construction emissions. This process determined key activity data that could form the basis of this assessment.

The area cleared per tonne of throughput was estimated as 0.52 ha (NQ Bulk Ports, 2010). Therefore the estimated area cleared for the Project was 21 ha. As the projects are in the same region, the location-specific vegetation clearing emission factor used for the Abbot Point Multi Cargo Facility EIS has been used in this assessment, 227 t CO_2-e/ha (NQ Bulk Ports).

3.3.3.4 Operations - Electricity Usage

Scope 2 emissions from electricity usage for the railway were estimated using the same methodology outlined in Section 3.3.1.8.

Estimated annual electricity consumption for the coal terminal was 297,840 MWh/annum, based electricity consumption of 34 MW, as provided by Waratah Coal, assumed to occur at this rate for 100% of the year.

No emissions from diesel combustion have been considered for the coal terminal. The following coal handling activities will occur at the coal terminal:

- unloading of coal trains;
- stacking/reclaiming of coal stockpiles;
- conveying of coal to ship loader; and
- loading to ships.

Equipment for all of these activities is to be powered by electricity. As such, the only source of diesel combustion is expected to be passenger vehicle use, the emissions from which will be insignificant in comparison with scope 2 emissions associated with electricity consumption.

4 FORECASTED GREENHOUSE EMISSION ESTIMATES FOR THE CHINA FIRST PROJECT

Based on the methodologies presented in Section 3.3, scope 1 and 2 greenhouse gas emissions for the China First Project are estimated to be approximately 15,929 kt CO_2-e for the construction of the coal terminal, rail and construction and ramp-up of the mine. Scope 1 emissions make up the majority of this total (93%), with scope 2 contributing 7%.

Operational scope 1 and 2 greenhouse gas emissions are estimated to be approximately 5,489 kt CO_2-e per annum, with scope 1 and 2 emissions contributing approximately 70% and 30% of total emissions respectively. These figures represent annual emissions for the mine, railway and coal terminal, based on maximum projected coal production of 40 Mt saleable coal per annum and throughput on the railway of 400 Mt per annum. The rail is the most significant source of emissions, contributing 53% of total emissions, with the mine and coal terminal contributing 42% and 5% respectively.

The bulk of the annual scope 1 greenhouse gas emissions are associated with rail diesel consumption emissions released (72%). The remainder is predominately associated with diesel consumption from mining equipment, fugitive methane emissions from underground and open-cut mines, as well as spontaneous combustion. The majority of total scope 1 emissions are CO_2 emissions (83%) and CH_4 emissions (16.5%), with N_2O emissions representing the remainder (note that the breakdown of CO_2, CH_4 or N_2O emissions from plane flights is not known, and so emissions from plane flights are attributed only to total CO_2-e emissions).

Of the scope 2 emissions, 74% are associated with electricity consumption for activities within the mine boundary, with the remainder comprising of electricity consumption for the coal terminal (16%) and railway (10%).

The calculated construction and annual emissions for the mine, rail and coal terminal are presented in Table 4.1 to Table 4.6, while a summary of all emissions is presented in Table 4.7.

Table 4.1: Construction GHG Emissions Summary (Mine)

Source	Greenhouse Gas	Emission Factor	EF Units	Construction Emissions Year 1	Construction Emissions Year 2	Total Emissions	Units
Auxiliary vehicles	CO_2	69.2	kg CO_2-e/GJ	5,988	12,556	18,545	t CO_2-e
	CH_4	0.2	kg CO_2-e/GJ	17	36	54	t CO_2-e
	N_2O	0.5	kg CO_2-e/GJ	43	91	134	t CO_2-e
	Total CO_2-e	**69.9**	**kg CO_2-e/GJ**	**6,049**	**12,683**	**18,732**	**t CO_2-e**
	Percentage of total scope 1 emissions					**0.13%**	
Blasting	CO_2	0.18	t CO_2-e/t	2,595	5,441	8,035	t CO_2-e
	Total CO_2-e	**0.18**	**t CO_2-e/t**	**2,595**	**5,441**	**8,035**	**t CO_2-e**
	Percentage of total scope 1 emissions					**0.06%**	
Fuel consumption - mining equipment	CO_2	69.2	kg CO_2-e/GJ	87,843	184,186	272,029	t CO_2-e
	CH_4	0.2	kg CO_2-e/GJ	254	532	786	t CO_2-e
	N_2O	0.5	kg CO_2-e/GJ	635	1,331	1,966	t CO_2-e
	Total CO_2-e	**69.9**	**kg CO_2-e/GJ**	**88,731**	**186,049**	**274,781**	**t CO_2-e**
	Percentage of total scope 1 emissions					**1.93%**	
Fugitive methane from open cut mines	CH_4	0.017	t CO_2-e/t ROM	105,400	221,000	326,400	t CO_2-e
	total CO_2-e	**0.017**	**t CO_2-e/t ROM**	**105,400**	**221,000**	**326,400**	**t CO_2-e**
	Percentage of total scope 1 emissions					**2.30%**	
Fugitive methane from underground mines	CH_4	0.008	t CO_2-e/t ROM	89,280	187,200	276,480	t CO_2-e
	Total CO_2-e	**0.008**	**t CO_2-e/t ROM**	**89,280**	**187,200**	**276,480**	**t CO_2-e**
	Percentage of total scope 1 emissions					**1.94%**	
Plane	**Total CO_2-e**	**0.00032**	**t CO_2-e/km/pass**	**7,332**	**15,374**	**22,706**	**t CO_2-e**
	Percentage of total scope 1 emissions					**0.16%**	
Slow oxidation	CO_2	0.000125	t CO_2-e/t coal	1,550	3,250	4,800	t CO_2-e
	Total CO_2-e	**0.000125**	**t CO_2-e/t coal**	**1,550**	**3,250**	**4,800**	**t CO_2-e**
	Percentage of total scope 1 emissions					**0.03%**	

Source	Greenhouse Gas	Emission Factor	EF Units	Construction Emissions Year 1	Construction Emissions Year 2	Total Emissions	Units
Spontaneous combustion	CO_2	0.003	t CO_2-e/t coal	37,200	78,000	115,200	t CO_2-e
	Total CO_2-e	**0.003**	**t CO_2-e/t coal**	**37,200**	**78,000**	**115,200**	**t CO_2-e**
	Percentage of total scope 1 emissions					**0.81%**	
Transport vehicles	CO_2	69.2	kg CO_2-e/GJ	1,623	3,403	5,026	t CO_2
	CH_4	0.2	kg CO_2-e/GJ	5	10	15	t CO_2
	N_2O	0.5	kg CO_2-e/GJ	12	25	36	t CO_2
	Total CO_2-e	**69.9**	**kg CO_2-e/GJ**	**1,639**	**3,437**	**5,077**	**t CO_2**
	Percentage of total scope 1 emissions					**0.04%**	
Land Clearing	CO_2	165	t CO_2-e/ha	4,251,281	8,913,977	13,165,258	t CO_2-e
	Percentage of total scope 1 emissions					**92.60%**	
Scope 2 - mine electricity consumption	Scope 2 CO_2-e	0.89	t CO_2-e/MWh	374,617	785,487	1,160,104	t CO_2-e
Total CO_2				4,388,080	9,200,813	13,588,892	t CO_2
Total CH_4				194,956	408,778	603,734	t CO_2
Total N_2O				690	1,446	2,136	t CO_2
Total Scope 1 CO_2-e				**4,591,058**	**9,626,411**	**14,217,468**	**t CO_2**
Total Scope 2 CO_2-e				**374,617**	**785,487**	**1,160,104**	**t CO_2**
TOTAL GREENHOUSE GAS EMISSIONS				**4,965,675**	**10,411,898**	**15,377,573**	**t CO_2-e**

For clarity figures have been presented in non scientific notation, data should be considered to have 3 significant figures.

Table 4.2: Operational GHG Emissions Summary (Mine)

Source	Activity data	Units	Greenhouse Gas	Emission Factor	EF Units	Emissions	Units
Auxiliary vehicles	279,155	GJ fuel/a	CO_2	69.2	kg CO_2-e/GJ	19,318	t CO_2-e/a
			CH_4	0.2	kg CO_2-e/GJ	56	t CO_2-e/a
			N_2O	0.5	kg CO_2-e/GJ	140	t CO_2-e/a
			Total CO_2-e	**69.9**	**kg CO_2-e/GJ**	**19,513**	**t CO_2-e/a**
			Percentage of total scope 1 emissions			**1.78%**	
Blasting	46,500	t explosive/a	CO_2	0.18	t CO_2-e/t	8,370	t CO_2-e/a
			CH_4	-		-	
			N_2O	-		-	
			Total CO_2-e	**0.18**	**t CO_2-e/t**	**8,370**	**t CO_2-e/a**
			Percentage of total scope 1 emissions			**0.76%**	
Fuel consumption - mining equipment	4,094,847	GJ fuel/a	CO_2	69.2	kg CO_2-e/GJ	283,363	t CO_2-e/a
			CH_4	0.2	kg CO_2-e/GJ	819	t CO_2-e/a
			N_2O	0.5	kg CO_2-e/GJ	2,047	t CO_2-e/a
			Total CO_2-e	**69.9**	**kg CO_2-e/GJ**	**286,230**	**t CO_2-e/a**
			Percentage of total scope 1 emissions			**26.11%**	
Fugitive methane from open cut mines	20,000,000	t ROM/a	CO_2	-		-	
			CH_4	0.017	t CO_2-e/t ROM	340,000	t CO_2-e/a
			N_2O	-		-	
			total CO_2-e	**0.017**	**t CO_2-e/t ROM**	**340,000**	**t CO_2-e/a**
			Percentage of total scope 1 emissions			**31.02%**	
Fugitive methane from underground mines	36,000,000	t coal/a	CO_2	-			t CO_2-e/a
			CH_4	0.008	t CO_2-e/t ROM	288,000	t CO_2-e/a
			N_2O	-		-	
			Total CO_2-e	**0.008**	**t CO_2-e/t ROM**	**288,000**	**t CO_2-e/a**
			Percentage of total scope 1 emissions			**26.28%**	

Source	Activity data	Units	Greenhouse Gas	Emission Factor	EF Units	Emissions	Units
Plane	73,000,000	pass-km/a	CO_2	-		-	
			Total CO_2-e	**0.00032**	**t CO_2-e/km/pass**	**23,652**	**t CO_2-e/a**
			Percentage of total scope 1 emissions			**2.16%**	
Slow oxidation	40,000,000	t coal/a	CO_2	0.000125	t CO_2-e/t coal	5,000	t CO_2-e/a
			CH_4	-		-	
			N_2O	-		-	
			Total CO_2-e	**0.000125**	**t CO_2-e/t coal**	**5,000**	**t CO_2-e/a**
			Percentage of total scope 1 emissions			**0.46%**	
Spontaneous combustion	40,000,000	t coal/a	CO_2	0.003	t CO_2-e/t coal	120,000	t CO_2-e/a
			CH_4	-		-	
			N_2O	-		-	
			Total CO_2-e	**0.003**	**t CO_2-e/t coal**	**120,000**	**t CO_2-e/a**
			Percentage of total scope 1 emissions			**10.95%**	
Transport vehicles	75,654	GJ fuel/a	CO_2	69.2	kg CO_2-e/GJ	5,235	t CO_2-e/a
			CH_4	0.2	kg CO_2-e/GJ	15	t CO_2-e/a
			N_2O	0.5	kg CO_2-e/GJ	38	t CO_2-e/a
			Total CO_2-e	**69.9**	**kg CO_2-e/GJ**	**5,288**	**t CO_2-e/a**
			Percentage of total scope 1 emissions			**0.48%**	
Scope 2 - mine electricity consumption	1,357,800	MWh/a	Scope 2 CO_2-e	0.89	t CO_2-e/MWh	1,208,442	t CO_2-e/a
Total CO_2						441,286	t CO_2-e/a
Total CH_4						628,890	t CO_2-e/a
Total N_2O						2,225	t CO_2-e/a
Total Scope 1 CO_2-e						**1,096,053**	**t CO_2-e/a**
Total Scope 2 CO_2-e						**1,208,442**	**t CO_2-e/a**
TOTAL GREENHOUSE GAS EMISSIONS						**2,304,495**	**t CO_2-e/a**

For clarity figures have been presented in non scientific notation, data should be considered to have 3 significant figures.

Table 4.3: Construction GHG Emissions Summary (Rail)

Source	Activity Data	Units	Greenhouse Gas	Emission Factor	EF Units	Emissions	Units
Diesel consumption for transport purposes	6,282,403	GJ	CO_2	69.2	kg CO_2-e/GJ	434,742	t CO_2-e
			CH_4	0.2	kg CO_2-e/GJ	1,256	t CO_2-e
			N_2O	0.5	kg CO_2-e/GJ	3,141	t CO_2-e
			Total CO_2-e	**69.9**	**kg CO_2-e/GJ**	**439,140**	**t CO_2-e**
			Percentage of total Scope 1 emissions			**85%**	
Diesel consumption for stationary energy purposes	443,695	GJ	CO_2	69.2	kg CO_2-e/GJ	30,704	t CO_2-e
			CH_4	0.1	kg CO_2-e/GJ	44	t CO_2-e
			N_2O	0.2	kg CO_2-e/GJ	89	t CO_2-e
			Total CO_2-e	**69.5**	**kg CO_2-e/GJ**	**30,837**	**t CO_2-e**
			Percentage of total Scope 1 emissions			**6%**	
Vegetation clearing	291	ha	CO_2	165	t CO_2-e/ha	48,019	t CO_2-e
			Total CO_2-e	**165**	**t CO_2-e/ha**	**48,019**	**t CO_2-e**
			Percentage of total Scope 1 emissions			**9%**	
Total CO_2						513,465	t CO_2-e
Total CH_4						1,301	
Total N_2O						3,230	t CO_2-e
Total Scope 1 CO_2-e						**517,995**	**t CO_2-e**
TOTAL GREENHOUSE GAS EMISSIONS						**517,995**	**t CO_2-e**

For clarity figures have been presented in non scientific notation, data should be considered to have 3 significant figures.

Table 4.4: Operational GHG Emissions Summary (Rail)

Source	Activity data	Units	Greenhouse Gas	Emission Factor	EF Units	Emissions	Units
Rail Diesel Consumption	39,535,790	GJ/a	CO_2	69.2	kg CO_2-e/GJ	2,735,877	t CO_2-e/a
			CH_4	0.2	kg CO_2-e/GJ	7,907	t CO_2-e/a
			N_2O	0.5	kg CO_2-e/GJ	19,768	t CO_2-e/a
			Total CO_2-e	**69.9**	**kg CO_2-e/GJ**	**2,763,552**	**t CO_2-e/a**
			Percentage of total Scope 1 emissions			**100%**	
Scope 2 – Rail Electricity Consumption	175,200	MWh/a	Scope 2 CO_2-e	0.89	t CO_2-e/MWh	155,928	t CO_2-e/a
Total CO_2						2,735,877	t CO_2-e/a
Total CH_4						7,907	
Total N_2O						19,768	t CO_2-e/a
Total Scope 1 CO_2-e						**2,763,552**	**t CO_2-e/a**
Total Scope 2 CO_2-e						**155,928**	**t CO_2-e/a**
TOTAL GREENHOUSE GAS EMISSIONS						**2,919,480**	**t CO_2-e/a**

For clarity figures have been presented in non scientific notation, data should be considered to have 3 significant figures.

Table 4.5: Construction GHG Emissions Summary (Coal Terminal)

Source	Activity Data	Units	Greenhouse Gas	Emission Factor	EF Units	Emissions	Units
Diesel consumption for on-site earthworks and construction	60,900	GJ	Total CO_2-e	69.9	kg CO_2-e/GJ	4,260	t CO_2-e
			Percentage of total Scope 1 emissions			**12.5%**	
Diesel consumption for transport of construction material	109,989,120	t.km	Total CO_2-e	0.2277	kg CO_2-e/t.km	25,045	t CO_2-e
			Percentage of total Scope 1 emissions			**73.6%**	
Vegetation clearing	21	ha	Total CO_2-e	227	t CO_2-e/ha	4,722	t CO_2-e
			Percentage of total Scope 1 emissions			**13.9%**	
Total Scope 1 CO_2-e						**34,026**	**t CO_2-e**
TOTAL GREENHOUSE GAS EMISSIONS						**34,026**	**t CO_2-e**

For clarity figures have been presented in non scientific notation, data should be considered to have 3 significant figures.

Table 4.6: Operational GHG Emissions Summary (Coal Terminal)

Source	Activity data	Units	Greenhouse Gas	Emission Factor	EF Units	Emissions	Units
Scope 2 - coal terminal electricity consumption	297,840	MWh/a	Scope 2 CO_2-e	0.89	t CO_2-e/MWh	265,078	t CO_2-e/a
Total CO_2						N/A	t CO_2-e/a
Total CH_4						N/A	t CO_2-e/a
Total N_2O						N/A	t CO_2-e/a
Total Scope 1 CO_2-e						N/A	t CO_2-e/a
Total Scope 2 CO_2-e						**265,078**	**t CO_2-e/a**
TOTAL GREENHOUSE GAS EMISSIONS						**265,078**	**t CO_2-e/a**

For clarity figures have been presented in non scientific notation, data should be considered to have 3 significant figures.

Table 4.7: Summary of Project GHG Emissions

Project Phase	Total Scope 1 Emissions	Total Scope 2 Emissions	Total Scope 1 and 2 Emissions	Units
Total mine construction emissions	14,217,468	1,160,104	15,377,573	t CO_2-e
Total mine annual operation emissions	1,096,053	1,208,442	2,304,495	t CO_2-e/a
Total rail construction emissions	517,995	-	517,995	t CO_2-e
Total rail annual operation emissions	2,763,552	155,928	2,919,480	t CO_2-e/a
Total port construction emissions	34,026	-	34,026	**t CO_2-e**
Total port annual operation emissions	-	265,078	265,078	**t CO_2-e/a**
Project total construction emissions	**14,769,489**	**1,160,104**	**15,929,593**	**t CO_2-e**
Project total annual operation emissions	**3,859,605**	**1,629,448**	**5,489,053**	**t CO_2-e/a**

5 IMPACT OF GREENHOUSE GAS EMISSIONS FROM THE CHINA FIRST PROJECT

According to the IPPC, global surface temperature has increased 0.74 ± 0.18ºC during the 100 years ending 2005, and that: *"most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations"* (IPCC, 2007a). "Very likely" is defined in as greater than 90% probability of occurrence (IPCC, 2007a).

Predictions of climate change specific to the China First Project region are presented in Appendix C, based on climate change modelling sourced from the CSIRO and Queensland Government. Predictions show that temperature is expected to increase under a variety of global greenhouse gas emissions scenarios developed by the IPCC. For other climate parameters, such as rainfall, there is great uncertainty for future trends, with models predicting both increases and decreases.

The most recent and authoritative work in predicting the future impacts that global greenhouse gas emissions and climate change will have on the Australian environment and economy is the Garnaut Climate Change Review (Garnaut, 2008). The Garnaut Review builds on the climate change modelling undertaken by the CSIRO, and global greenhouse gas emissions scenarios developed by the IPCC. It also builds on previous attempts to quantify the social and economic impacts of climate change in particular, the Stern Review on the Economics of Climate Change, which was prepared for the British Government and released in October 2006 (Stern, 2006). The impacts associated with climate change predicted by the Garnaut Review are detailed in Appendix D.

Attributing the potential impacts associated with climate change to a single source of greenhouse gas emissions is problematic. The potential impacts associated with greenhouse gas emissions from the China First Project will be in proportion with its contribution to global greenhouse emissions. The total emissions from the China First Project are insignificant in comparison with Australian emissions, as can be seen in Table 5.1, and according to the Australian government, Australia's total emission inventory in 2006 represents approximately 1.5% of global greenhouse emissions. Therefore the potential impacts associated with climate change directly attributable to China First Project can be expected to be negligible.

Implementing abatement measures (refer to Section 7) could reduce direct greenhouse gas emissions from the China First Project. However, given that the potential impacts from the project are negligible, the residual impacts after implementing the abatement measures will also be negligible.

Impacts associated with greenhouse gas emissions are not localised to the source of the emissions. As such, it is not relevant to assess the cumulative impacts of greenhouse gas emissions from the China First Project and existing and proposed projects in the region.

Table 5.1: Estimates of Greenhouse Emissions

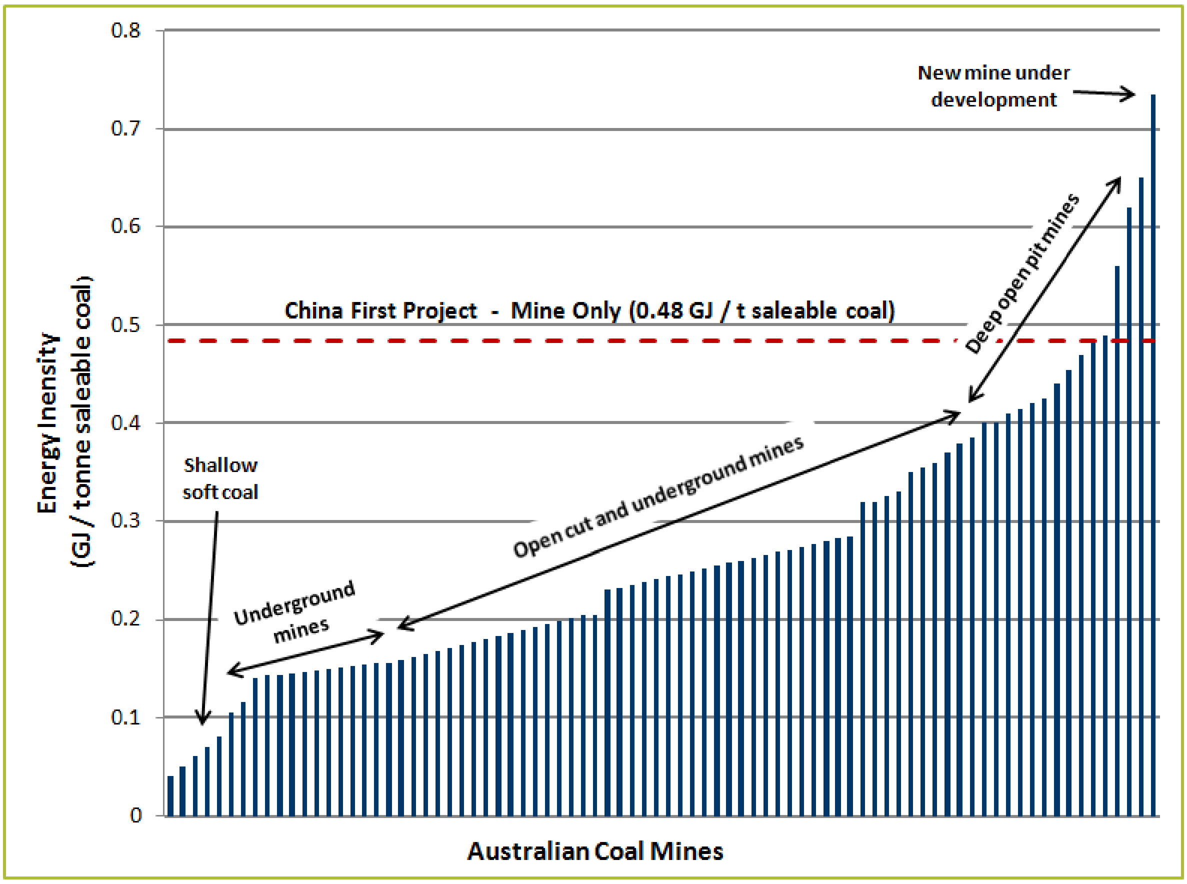
Geographic coverage	Source coverage	Timescale	Emission Mt CO_2-e	China First Project % of Source	Reference
Global	Consumption of fossil fuels	Since industrialisation 1750 to 1994	865,000	0.0006%	IPPC (2007b) Figure 7.3 converted from Carbon unit basis to CO_2 basis. Error stated greater than ±20%
Global	CO_2 emission increase 2004 to 2005	2005	733	0.75%	IPPC (2007b) From tabulated data presented in Table 7.1 on the basis of an additional 733 Mt/a. Data converted from Carbon unit basis to CO_2 basis.
Australia	Total including landuse change	2007	597.2	0.92%	DCC (2009a) Taken from the DCC National Greenhouse Gas Inventory 2006
Australia	Kyoto target	2008 -2012	596.8	0.92%	DCC (2009a) Based on 1990 net emissions multiplied by 108% Australia's Kyoto emissions target
Australia	Energy sector	2007	408.2	1.35%	DCC (2009a) Energy sector includes stationary energy, transport and fugitive emissions
Australia	Fugitive emissions from fuel	2007	37.7	14.6%	DCC (2009a) Emissions from coal mining, handling and decommissioned mines; and oil and natural gas production, processing and distribution
Queensland	Total GHG emissions	2007	181.6	3%	DCC (2009b) Emissions including landuse change
China First Project	Scope 1 and 2 emissions	Estimated annual	5.5	100%	Section 4

6 BENCHMARKING

The energy and greenhouse gas emissions intensity of the China First Project have been benchmarked against existing Australian coal mines, using the methodology employed by the Australian Geological Survey Organisation (AGSO, 1999). A full breakdown of the energy and greenhouse gas emissions intensities is provided in Appendix E.

6.1 Energy Intensity

The estimated energy intensity of the China First Project is 1.6 GJ/t saleable coal. This value includes diesel and electricity consumed by the railway and at the coal terminal. However, as transport of product coal was not included in the AGSO study the estimated energy intensity for the mine only - 0.48 GJ/t saleable coal – has been compared with the energy intensity of existing Australian coal mines, as presented in Figure 6.1. As can be seen, the energy intensity of the China First Mine is at the high end in comparison with existing mines. This may be due to electricity consumption estimates (as provided by Waratah Coal) being based on preliminary design estimates which are typically conservative.



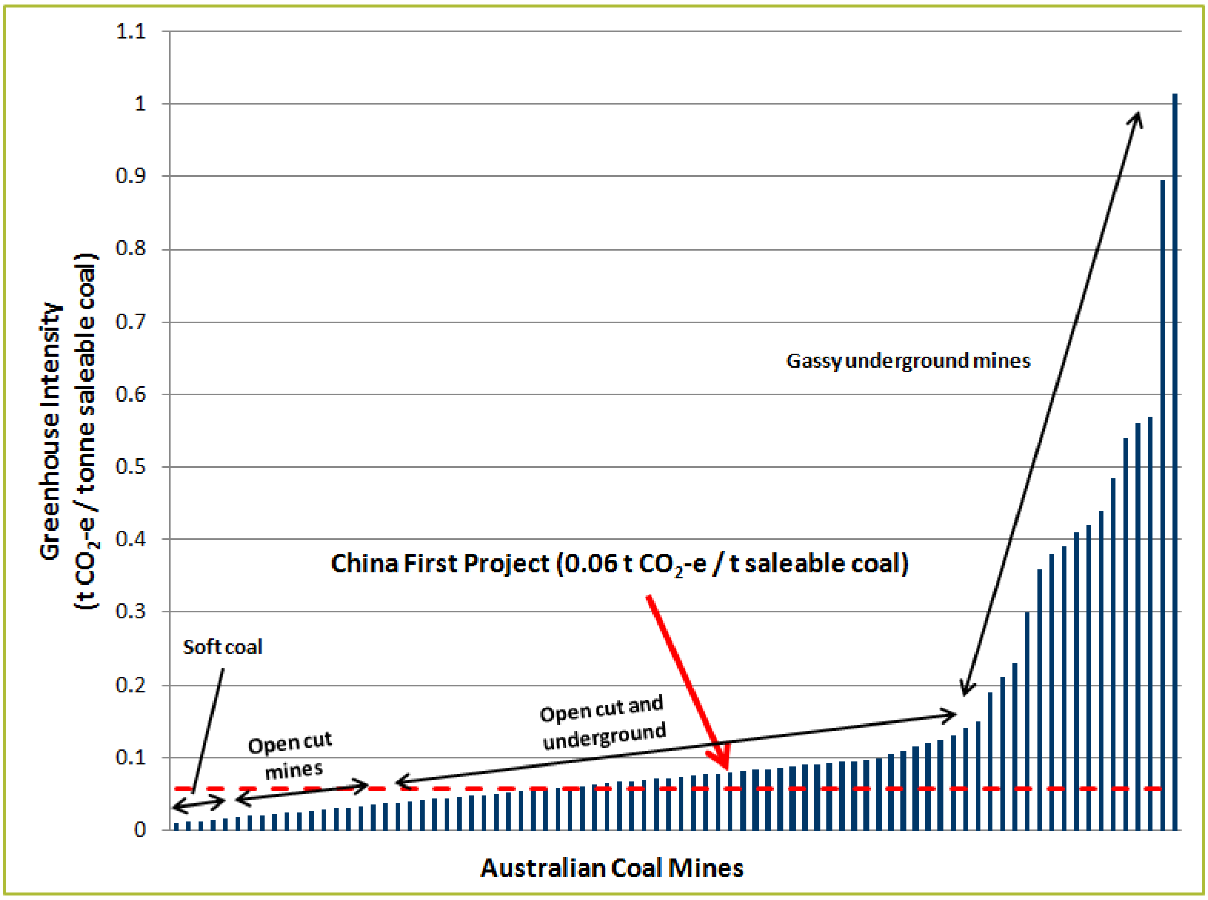
Source: **Graph reproduced from *Figure 3: Typical Benchmarking Result for Energy Intensity,* AGSO, 1999**
Note: **Includes electricity and diesel usage for the mine only**

Figure 6.1: Energy Intensity of the China First Project in Comparison with Australian Coal Mines

6.2 Greenhouse Gas Emissions Intensity

The estimated greenhouse gas emissions intensity of the China First Project is approximately 0.137 t CO_2-e/t saleable coal, including emissions associated with the railway and coal terminal. The estimated emissions intensity of the project is comparable with the average emissions intensity of existing Australian coal mines (AGSO, 1999). This can be seen in Figure 6.2..

The emissions intensity of the China First Project Mine, excluding the railway and coal, is estimated to be 0.06 t CO_2-e/t saleable coal, which is equivalent to existing mines that have open cut and underground operations, and is significantly less than “gassy underground mines”. This can be seen in Figure 6.2.



Source: Graph reproduced from *Figure 17: Typical Benchmarking Result for Greenhouse Intensity,* AGSO, 1999

Figure 6.2: Greenhouse Gas Intensity of the China First Project in Comparison with Australian Coal Mines

7 ABATEMENT ACTIONS

Greenhouse gas emissions from the China First Project can be most effectively managed through:

- the identification of major sources of greenhouse gas emissions through ongoing measurement, monitoring;
- improvements in energy efficiency;
- switching to less emissions intensive fuels; and
- offsetting emissions.

In addition, opportunities to convert any methane in the ventilation air to carbon dioxide should be investigated, however based on currently available information, it is not expected that the underground mines of the China First Project will be significant methane emitters.

7.1 Emissions Measurement

Ongoing GHG emissions measurement is the first step towards effective mitigation. Measuring emissions indicates which sources have the greatest potential for emission reductions.

7.1.1 Mandatory Reporting

Annual reporting of greenhouse gas emissions from the China First Project will be mandatory under NGER. Emissions reportable under NGER are at high level, and will be attributed to total fuel and electricity consumption and total fugitive methane emissions.

NGER reporting will likely underpin any national greenhouse gas emissions strategies. Annual emissions reported for NGER will show Waratah Coal's liability under the Carbon Price Mechanism, and indicate whether Waratah Coal will be financially penalised or rewarded under the Liberal Party's *Direct Action Plan*.

7.1.2 In-house Reporting

To target specific emission sources, the *Australian Coal Association Research Program* (ACARP) recommends that emissions be measured at the activity or equipment type level (ACARP, 2001). This includes setting 'key emissions indicators' (KEIs), to compare the emissions intensity of similar activities. KEIs recommended to be monitored for the China First Project include:

- t CO_2-e / tonne of coal moved - for material movement equipment (draglines, haul trucks, bulldozers etc); and
- t CO_2-e / tonne of ROM coal processed – for processing facilities.

Based on the results of monitoring KEIs, energy efficiency improvements (as detailed in Section 7.2) can be made to specific equipment or process areas to achieve the maximum reductions in greenhouse gas emissions.

7.2 Energy Efficiency

Ongoing improvements in energy efficiency will achieve the greatest emissions reductions for non-gassy coal mines (ACARP, 2001). As detailed in Section 2.2.4, it is expected that the Waratah Coal will be a participant in the Energy Efficiency Opportunities Program, and will be required to conduct ongoing assessments of energy efficiency, and energy efficiency opportunities.

Areas where energy efficiency improvements can be made, as identified by ACARP, and their priority in terms of potential greenhouse gas emission reductions can be seen in Table 7.1.

Table 7.1: Energy Efficiency Strategies

Classification	Details	Priority Open Cut	Priority Underground
Energy management	Annual energy audits	High	High
	Implementation of an energy management program	High	High
Energy projects	Implement a computerised energy management system to measure and monitor energy usage	High	High
	Bathhouse hot water systems with high efficiency, such as using gas heating as opposed to electric	High	High
	High efficiency electric motors for all equipment	High	High
	Ventilation systems – use air compressors with high efficiency (e.g. with variable speed drives)	N/A	High
	Minimising diesel fuel usage by haulage vehicles by minimising haul distances and optimising haul schedule to reduce idling time	Medium	Medium
	Minimise requirement of lighting systems	Medium	Medium
	Optimisation of face shovel and dragline performance to minimise rehandle	High	N/A
Mining process	Blast management to ensure that rehandle is minimised	High	Low

Adapted from *Table 11: Energy efficiency strategies for the coal mining industry*, ACARP, 2001.

7.3 Switching to Less Emissions Intensive Fuels

Scope 2 emissions associated with electricity consumption are the largest source of total scope 1 and 2 emissions for the China First Project. It is expected that the emission intensity of the Queensland electricity grid will decrease, and that the associated emissions for the China First Project will decrease accordingly. The decrease will be due to:

- the *Queensland Gas Scheme* – which prescribes that Queensland electricity retailers source a percentage (currently 13% with the option to increase to 18%) of their electricity from gas-fired generators; and
- the *Mandatory Renewable Energy Target* – which is designed to deliver 20% renewable energy in Australia's electricity supply by 2020.

Scope 2 emissions can also be reduced by generating a proportion of the mine's electricity requirements onsite, by utilising the following:

- solar cells, particularly for mine lighting and administration buildings; and
- waste streams, such as ventilation air.

In addition, it is recommended that replacing diesel with less emissions-intensive fuels be investigated, such as:

- using biodiesel in mining and transport vehicles; and
- using gas-based fuels in some vehicles.

7.4 Fugitive Methane Mitigation

Destruction of methane vented from the China First Project's underground mines, by converting it to carbon dioxide will reduce underground fugitive emissions by a factor of 21 (as the global warming potential (GWP) of methane is 21 times greater than carbon dioxide).

Methane mitigation is identified by ACARP as having the greatest potential for greenhouse gas emission reductions for gassy underground mines. Based on gas composition sampling it is not expected that the China First Project's underground mines will produce significant methane emissions (refer to Section 3.3.1.5). Determining whether the destruction of methane will be a beneficial emissions mitigation method will be best assessed when the underground mines are operational, and actual methane emission rates are known.

7.5 Third Party Offsets

The China First Project can offset its emissions by investing in third party projects that reduce greenhouse gas emissions below a demonstrated baseline. Examples of projects that reduce emissions are:

- forestry projects that reduce emissions by
  - sequestering carbon through reforestation or afforestation,
  - prevent deforestation, or
  - increase the carbon contained in soils through soil management;
- renewable energy, such as wind farms, geothermal or solar; and
- destruction of methane produced from landfills, wastewater treatment plants etc.

8 CONCLUSION

Greenhouse gas emission sources from the China First Project have been identified for the mine, railway and coal terminal. Annual greenhouse gas emissions have been estimated using applicable and recognised methodologies for reporting. Emission estimates have been based on the mine operating at full capacity, where 56 Mt ROM and 40 Mt saleable coal is produced from the mine per annum and transported via the railway to the coal terminal.

It is expected that the China First Project will generate scope 1 and 2 greenhouse gas emissions of approximately 15,929 kt CO_2-e for the construction of the coal terminal, rail and construction and ramp-up of the mine. Scope 1 emissions make up the majority of this total (93%), with scope 2 contributing 7%.

Operational emissions are expected to be approximately 5,489 kt CO_2-e per annum. 30% of total emissions are scope 2 emissions, estimated using the emission factor for electricity purchased from the Queensland grid. The remaining 70% are scope 1 emissions, which are direct emissions associated with activities under the operational control of Waratah Coal. The single largest source of scope 1 emissions is associated with rail diesel consumption emissions released (72%). The remainder is predominately associated with diesel consumption from mining equipment, fugitive methane emissions from underground and open-cut mines, as well as spontaneous combustion.

The expected annual scope 1 and 2 emissions from the China First Project represent approximately 0.92% of Australia's total greenhouse gas emissions in 2007, and a very small proportion of global greenhouse gas emissions. The impact of the greenhouse gas emissions from the project on global climate change will be in proportion with its contribution to global emissions. The cumulative impacts associated with the project have not been assessed, as the impacts associated with greenhouse gas emissions are not localised to the source of emissions.

The emissions intensity of the China First Project, for the mine only, is 0.06 tCO2-e/t saleable coal, which is approximately equivalent to the average emissions intensity of existing Australian coal mines that have both open cut and underground operations, and is less than the Average emissions intensity of all coal mines (0.079 t CO_2-e/t saleable coal). The emissions intensity inclusive of the mine, railway and coal terminal is 0.137 t CO_2-e/t saleable coal.

Greenhouse gas emissions from the China First Project will have to be annually reported under the requirements of National Greenhouse and Energy Reporting (NGER) System, and the Waratah Coal will be a direct participant in the Carbon Price Mechanism as it is currently proposed. It is also expected that Waratah Coal will have to assess the energy efficiency of the China First Project, and identify measures to improve energy efficiency, under the Energy Efficiency Opportunities (EEO) Program.

The China First Project can most effectively reduce its annual emissions through improvements in energy efficiency. It is recommended that ongoing internal measurement and monitoring of emissions, in addition to mandatory reporting under NGER and the EEO Program, be performed to identify sources with the greatest potential for emissions reductions. Greenhouse gas emissions can also be offset through investment in third party projects that reduce emissions below a demonstrated baseline, for example, through forestry and renewable energy projects.

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Appendix A

Diesel Consumption

A.1 AUXILLIARY VEHICLES

Diesel consumption for auxiliary vehicles was estimated using the following equation:

$$Q_j = \frac{No.Vehicles_j \times OpHrs_j \times EngSize_j \times Loadfactor_j \times 0.0036}{\eta_j}$$

where:

Q_j	=	Estimated combustion by vehicle type *j*	(GJ)
No.Vehicles	=	Number of vehicle type *j*	(-)
$OpHrs_j$	=	Total operating hours of vehicle type *j*	(hours)
$EngSize_j$	=	Engine size of vehicle type *j*	(kW)
$Loadfactor_j$	=	Loadfactor of vehicle type *j*	(%)
η_j	=	Efficiency of engine for vehicle type *j*	(%)
0.0036	=	Conversion from kWh to GJ	(kWh/GJ)

A summary of the parameters used in the equation, as provided by Waratah Coal, is presented in Table A. 9.1.

Table A. 9.1: Diesel Consumption for Auxiliary Vehicles

Vehicle type	Number of vehicles	Load factor %	Engine Size (kW)	η %	Operational hours	Diesel Consumption (GJ)
Diesel fork truck	30	50	110	28%	4,380	93,263
Crawler type bulldozer	8	55	630	31%	4,380	140,996
Atocrane	5	100	205	36%	4,380	44,895
					Total	***279,155***

Engine efficiencies and typical load factors for industrial vehicles were adapted from Appendix B.2 *Industrial Vehicles*, NPI EET Manual for Combustion Engines v3.0, June 2008.

Engine sizes provided by Waratah Coal.

Operational hours based on 12 hours operation per day for 365 days per year, as provided by Waratah Coal.

A.2 TRANSPORT VEHICLES

Diesel consumption for transport vehicles was estimated using the following equation:

$$Q_j = \frac{No.Vehicles_j \times Distance_j \times FuelCons_j \times EnergyDensity}{1000}$$

where:

Q_j	=	Estimated combustion by vehicle class *j*	(GJ)
No.Vehicles	=	Number of vehicle type *j*	(-)
$Distance_j$	=	Total distance travelled by vehicle class *j*	(km)
$FuelCons_j$	=	Average fuel consumption of vehicle class *j*	(l/km)
EnergyDensity	=	Energy content per volumetric unit of fuel	(GJ/kL)

A summary of the parameters used in the equation, as provided by Waratah Coal, is presented in Table A. 9.2.

Table A. 9.2: Diesel Consumption for Transport

Vehicle type	Number of vehicles	Distance (km)	Fuel Cons. (L/km)	Energy Density (GJ/kL)	Diesel Cons. (GJ)
Heavy duty truck - 50t	15	7300	0.546	38.6	2,308
Heavy duty truck - 20t	30	146000	0.286	38.6	48,353
Coach	15	18250	0.292	38.6	3,085
Autodumper	8	146000	0.286	38.6	12,894
Wagon	12	87600	0.125	38.6	5,072
Off-road vehicle	15	36500	0.125	38.6	2,642
Car	15	18250	0.123	38.6	1,300
				Total	***75,654***

Number of vehicles and kilometres travelled by vehicle type provided by Waratah Coal.

Fuel usage was taken from the Australian Bureau of Statistics Survey of Motor Vehicle Use, 12 Months ending 31 October 2007, after classification by PAEHolmes to match ABS vehicle types.

Diesel energy content of 38.6 GJ/kL sourced from *Table 4*: *Fuel combustion emission factors - fuels used for transport energy purposes*, DCC National Greenhouse Accounts (NGA) Factors, June 2009.

Appendix B

Gas Composition Samples

Table B.1: Summary of Gas Yields and Compositions from Five Core Holes within the China First Project Footprint

Borehole Number	GeoGAS Sample Number	Seam	Depth from (m)	Depth to (m)	Measured Gas Content Qm (m^3/t)	Desorption Rate @ Sample Ash		Density	Gas Composition Results					
					at Sample Ash	GeoGAS DRI	IDR30 (m^3/t)	Sample ARD (g/cc)	H_2S Detected	$CH_4/(CH_4+CO_2)$	CH_4% Air Free	CO_2 % Air Free	N_2% Air Free	Inert Gas Flushed (Yes/No)
WAR3114c	WR0001	C	256.39	257.03	0.11	14	0.02	1.31	No	0.00	0.0	100.0	0.0	Yes
WAR3114c	WR0002	DU	270.85	271.53	0.12	12	0.01	1.32	No	0.16	15.5	84.5	0.0	Yes
WAR3114c	WR0003	DL	282.48	283.18	0.03	6	0.01	1.46	No	N/A	N/A	N/A	N/A	No
WAR3114c	WR0004	DL	283.18	283.85	0.06	5	0.01	1.29	No	0.00	0.0	100.0	0.0	Yes
WAR3114c	WR0005	DL	283.85	284.60	0.06	6	0.01	1.32	No	0.00	0.0	100.0	0.0	Yes
WAR3013c	WR0006	B	192.32	193.10	0.12	17	0.04	1.38	No	0.84	83.6	16.4	0.0	Yes
WAR3013c	WR0007	B	193.10	193.74	0.10	19	0.04	1.47	No	0.88	88.2	11.8	0.0	Yes
WAR3013c	WR0008	B	193.74	194.51	0.10	13	0.03	1.41	No	0.76	76.3	23.7	0.0	Yes
WAR3013c	WR0009	DU	284.91	285.56	0.10	16	0.06	1.30	No	0.00	0.0	100.0	0.0	Yes
WAR3013c	WR0010	DU	285.56	285.98	0.15	19	0.09	1.27	No	0.00	0.0	100.0	0.0	Yes
WAR3013c	WR0011	DL	297.33	297.87	0.12	17	0.08	1.29	No	0.00	0.0	100.0	0.0	Yes
WAR3013c	WR0012	DL	297.87	298.60	0.06	7	0.02	1.35	No	0.00	0.0	100.0	0.0	Yes
WAR3013c	WR0013	DL	298.60	299.23	0.04	3	0.00	1.31	No	0.00	0.0	100.0	0.0	Yes
WAR3310c	WR0014	DL	224.11	224.60	0.05	6	0.00	1.55	No	0.00	0.0	100.0	0.0	Yes
WAR3310c	WR0015	DL	224.66	225.33	0.04	4	0.00	1.29	No	0.00	0.0	100.0	0.0	Yes
WAR3310c	WR0016	DL	225.35	226.21	0.10	20	0.00	1.34	No	0.00	0.0	100.0	0.0	Yes
WAR3308c	WR0017	DU	201.59	202.26	0.15	18	0.05	1.29	No	0.00	0.0	100.0	0.0	Yes
WAR3308c	WR0018	DL	214.21	214.91	0.08	6	0.04	1.32	No	0.00	0.0	100.0	0.0	Yes
WAR3308c	WR0019	DL	214.91	215.60	0.06	9	0.02	1.29	No	N/A	N/A	N/A	N/A	No
WAR3302c	WR0020	DL	199.91	200.60	0.21	0	0.02	1.32	No	0.00	0.0	100.0	0.0	Yes
WAR3302c	WR0021	DL	200.60	201.15	0.19	0	0.02	1.38	No	0.00	0.0	100.0	0.0	Yes
WAR3302c	WR0022	DL	201.15	201.90	0.14	0	0.01	1.33	No	0.00	0.0	100.0	0.0	Yes

Data provided by, Waratah Coal

Appendix C

Climate Change Predictions

Projected climate change for Australia is presented in *Climate Change in Australia* (CSIRO & BoM, 2007). Annual average projections are for 2030, 2050 and 2070, are based on the following emissions scenarios presented in the IPCC's *Special Report on Emissions Scenarios* 2001:

- B1 – low emissions scenario that assumes a rapid shift to less fossil fuel intensive industries;
- A1B – medium emissions scenario that assumes a balance of energy sources; and
- A1FI – high emissions scenario that assumes strong economic growth based on continued fossil fuel dependence.

The *Climate Change in Australia* report details climate projections for three Queensland cities – Brisbane, Cairns and St George. Projected changes are reported to vary little with respect to emissions scenarios up to 2030, and so only results for scenario A1B (medium) are presented.

After 2030, climate change projections are increasingly dependent on the level of emissions, so both low and high emissions scenarios are used for 2050 and 2070.

C.1 INTERPRETING CLIMATE CHANGE PROJECTIONS

In *Climate Change in Australia*, annual or seasonal average changes in temperature, mean precipitation, humidity, radiation, wind speed, potential evaporation and sea surface temperature, projections are provided in a probabilistic form, with 10^{th}, 50^{th}, and 90^{th} percentiles provided. It is important to note that the site-specific probability distribution represents the range of model results. It is still a leap of faith to assume that the range of model results gives a representation of the expected change of the real world to a specific emission scenario. The real world may end up with different climate changes than any of these models have predicted, or the future climate changes may truly be within the bounds of these models' predictions.

Uncertainties in model predictions lie in how the models simulate the complicated physical and chemical processes of earth systems. Some of the processes are straight forward, but others may be complex systems with potential feedback mechanisms; some changes may be gradual and some others may be abrupt changes (such as the possible route changes of ocean currents). Processes may be known to scientists and hence incorporated into the existing climate models and others may remain unidentified by scientific communities. Because of the complexity of earth systems in response to increases in greenhouse gases contents in atmosphere and the uncertainties of model predictions, it is important to treat the predictions with caution.

Climate change models generally predict mean temperature changes in the most consistent way, in other words, the range of model predictions are narrow. For most other climate variables such as rainfall, relative humidity, solar radiation, the predicted changes vary wildly among models. For example, in *Climate Change in Australia*, predicted mean temperature changes for 2030 A1B are all positive, with less than 1 degree of uncertainties; in comparison, the predicted changes for rainfall, relative humidity, and solar radiation range from positive to negative, with mean model predictions near zero for the 2030 A1B scenario. Due to the large variations in the model predictions in these climate variables, the best estimate of the change is the ensemble average or multi-model mean. The upper and lower bounds of model predictions should not be taken as the bounds of climate changes in the future real world.

Rainfall is one of the most important climate variables for the Project. But, it is hard for climate models to predict it any certainty. Cumulative rainfall is influenced by many different scales of weather systems, from the small-scale systems such localised thunderstorms, tropical cyclones, to large-scale frontal systems. Global climate change models (general circulation models – GCM) are mostly run at a coarse resolution, say 250 km, and this resolution is not fine enough to resolve small scale rainfall systems such as thunderstorms and tropical cyclones. Rainfall tends to vary locally, and is impacted by local terrains, distance to the coastal, etc. Current global climate change models cannot resolve such fine geographic changes. Many other climate variables suffer similar constraints. For example, solar radiation is associated with cloud cover, which is related to predicted rainfall and other climate variables such as relative humidity.

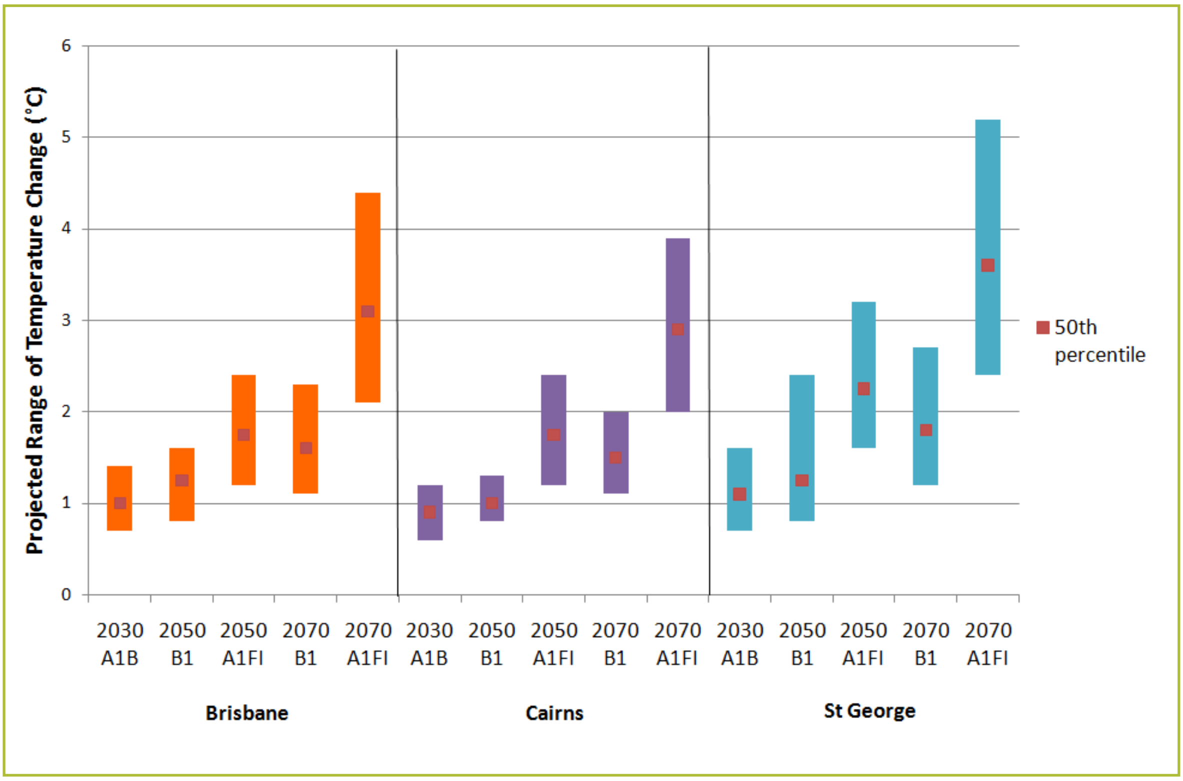
Many climate variables, such as climate extremes, have not been presented in *Climate Change in Australia* in a probabilistic manner; the uncertainties in predicting them are even greater. For these climate variables, the scientific understanding of the topic may be such that a qualitative assessment was all that was warranted.

Trends and ranges of climate change projections are location specific. Hence, predictions for the three locations in Queensland, Brisbane, Cairns, and St George may not be applicable to the China First Project region for all climatic parameters. Brisbane and Cairns are both coastal areas, while the Project is located approximately 500 km inland. St George is inland Australia, but it is far south of the Project area. Climate change projections by the Queensland Government, derived from downscaled runs of the CSIRO's climate change modellings, provide more region-specific predictions for temperature, rainfall and evaporation.

C.2 TEMPERATURE

Increased concentrations of greenhouse gases in the earth's atmosphere directly impact temperature change. Therefore projected temperature change is the climatic parameter that can be most accurately modelled.

Projected annual average temperature changes for Brisbane, Cairns and St George show similar upward trends for low, medium and high emissions scenarios (Figure C.1). It is reasonable to suggest annual average temperatures for the China First Project region will follow similar upward trends.



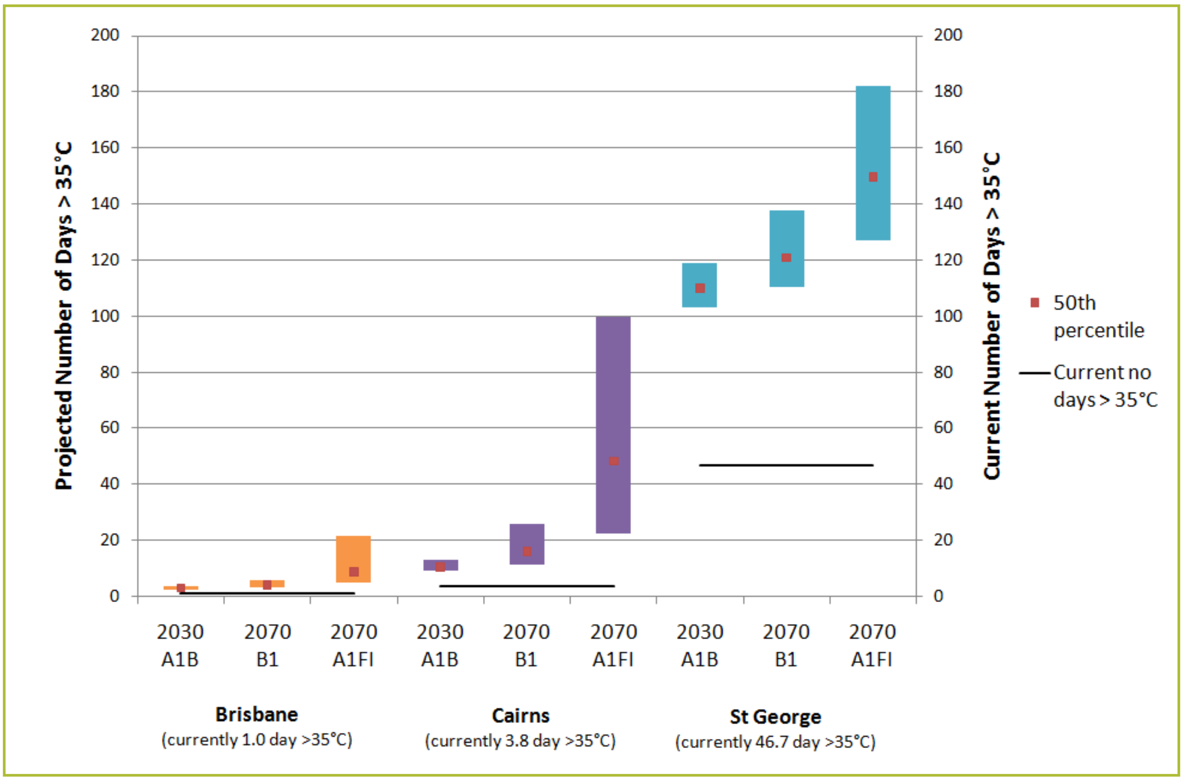
Values adapted from *Climate Change in Australia – Technical Report 2007*

Bars represent range from 10th percentile to 90th percentile

Figure C.1: Projected annual average temperature change for Brisbane, Cairns and St George relative to 1990 baseline

C.3 NUMBER OF DAYS > 35°C

The projected number of days greater than 35°C gives an indication of future climate extremes. Figure C.2 shows the number of days greater than 35°C is expected to increase in Brisbane, Cairns and St George; however the absolute number of days and the projected range varies significantly between cities. It can be assumed that under the various emissions scenarios, the future number of days greater than 35°C will increase in the China First Project region. Further detail for the Project region is provided in Table C.1, sourced from the Queensland Government.



Values adapted from *Climate Change in Australia – Technical Report 2007*

Bars represent range from 10th percentile to 90th percentile

Values for 2050 not available

Figure C.2: Projected annual average number of days > 35°C for Brisbane, Cairns and St George relative to 1990 baseline

C.4 RAINFALL

Best estimate (50th percentile) model projections indicate that rainfall is expected to decrease at Brisbane, Cairns and St George, however the range of uncertainty is great for all model scenarios at all cities, and shows that rainfall could either increase or decrease.

As detailed in Section C.1, rainfall predictions are location specific, so using the trends for Brisbane, Cairns and St George to predict rainfall for the China First Project region would be misleading. More regional specific rainfall predictions, sourced from the Queensland Government, are shown in Table C.1.

Values adapted from *Climate Change in Australia – Technical Report 2007*

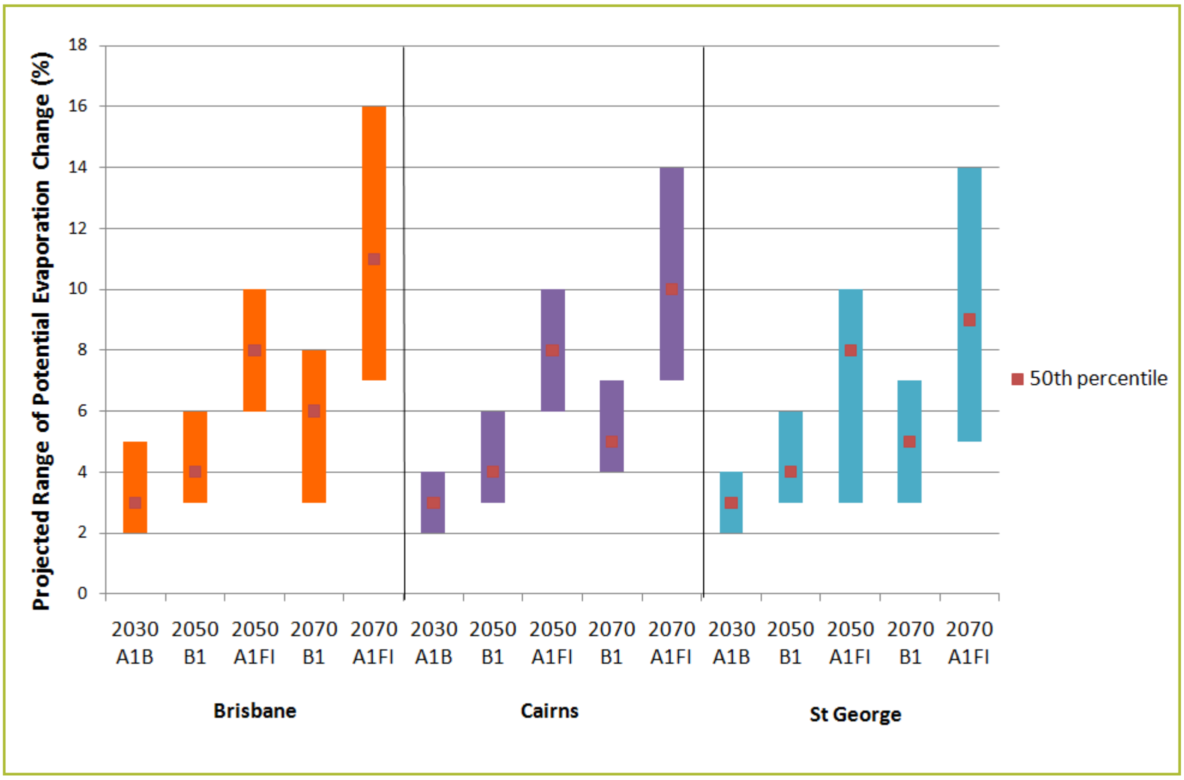
Bars represent range from 10th percentile to 90th percentile

Figure C.3: Projected annual average rainfall change for Brisbane, Cairns and St George relative to 1990 baseline

C.5 POTENTIAL EVAPORATION

Potential evaporation for Brisbane, Cairns and St George is projected to increase under all emissions scenarios, however the range of uncertainty is large, especially for a high emissions scenario (A1FI) at 2070.

Regional specific potential evaporation projections, sourced from the Queensland Government, are provided in Table C.1.



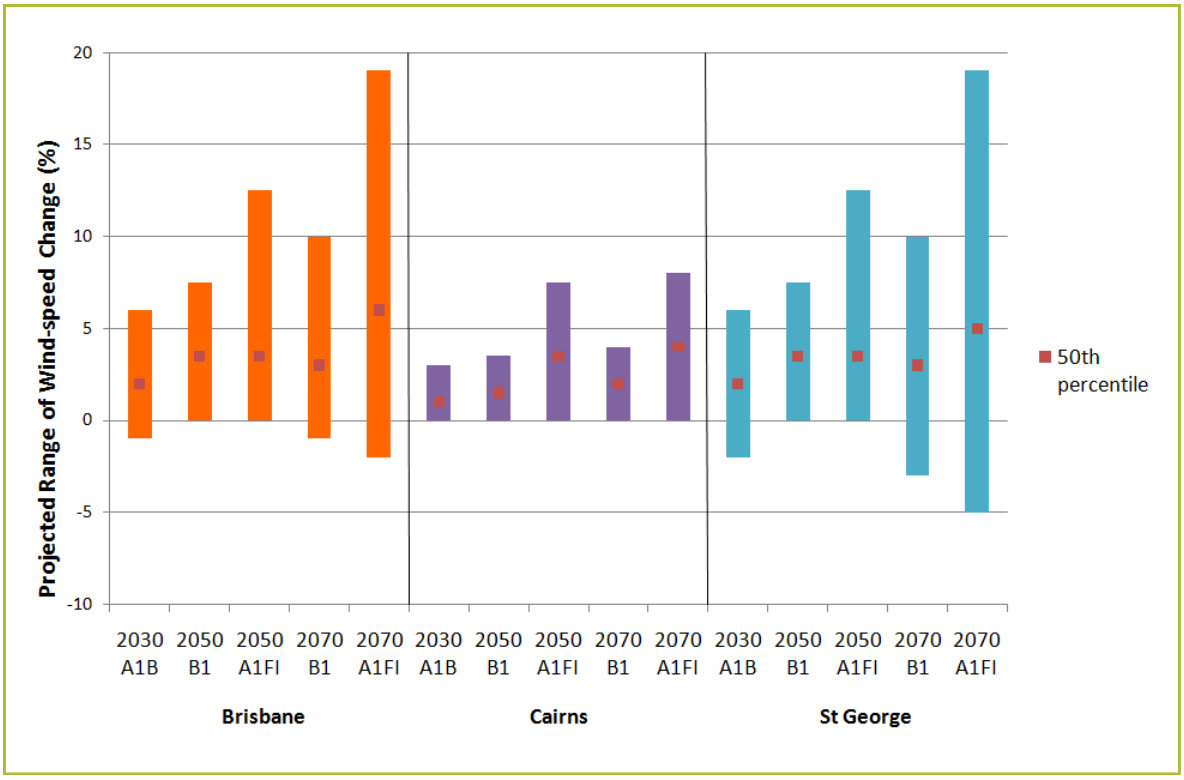
Values adapted from *Climate Change in Australia – Technical Report 2007*

Bars represent range from 10th percentile to 90th percentile

Figure C.4: Projected annual average wind-speed change for Brisbane, Cairns and St George relative to 1990 baseline

C.6 WIND-SPEED

Best estimate (50th percentile) model projections indicate that wind-speed is expected to increase at Brisbane, Cairns and St George. The range of uncertainty is great for all model scenarios at all cities; however the probability of increasing wind-speed is greater than decreasing wind-speed. It is reasonable to assume that annual average wind-speed at the China First Project region will increase. However as wind-speed is location specific, the projected change should not be taken from the ranges presented in Figure C.5.



Values adapted from *Climate Change in Australia – Technical Report 2007*

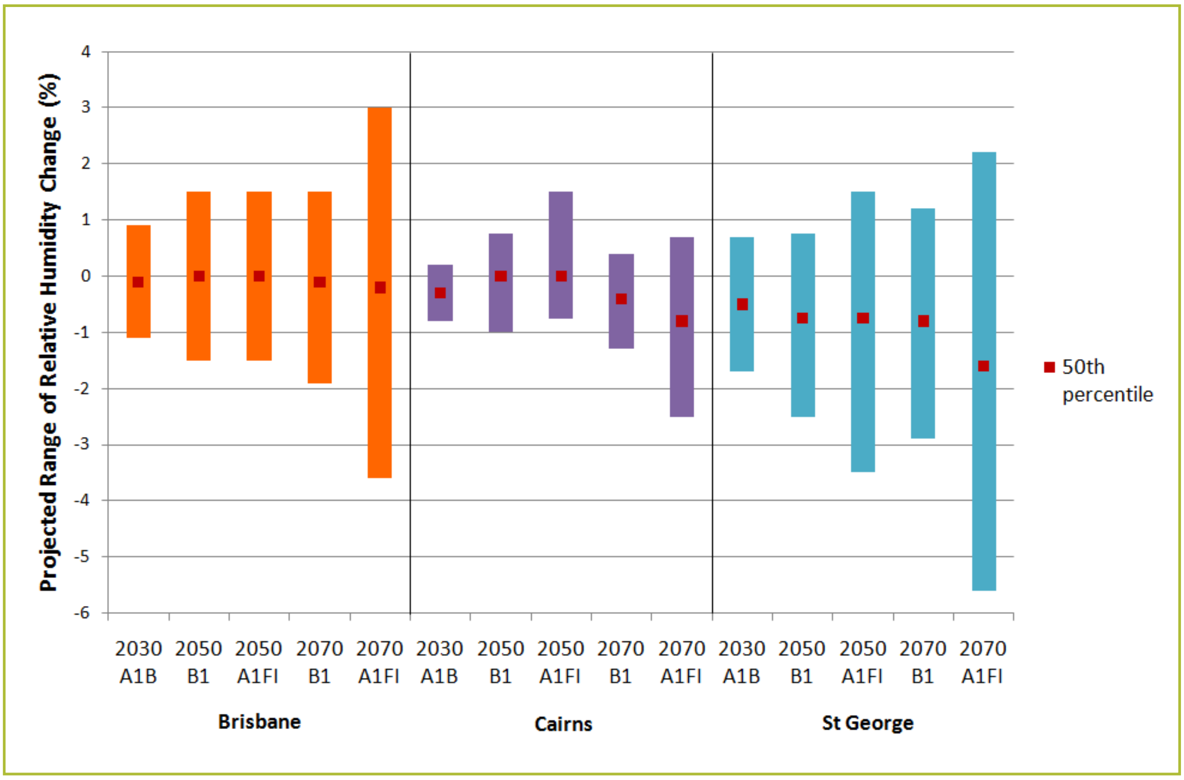
Bars represent range from 10th percentile to 90th percentile

Figure C.5: Projected annual average wind-speed change for Brisbane, Cairns and St George relative to 1990 baseline

C.7 RELATIVE HUMIDITY

Best estimate (50th percentile) model projections indicate that relative humidity is expected to slightly decrease at Brisbane, Cairns and St George, however the range of uncertainty at all cities shows that the relative humidity could either increase or decrease.

As relative humidity is location specific, it would be misleading to predict the relative humidity for the China First Project region using the trends for Brisbane, Cairns and St George.



Values adapted from *Climate Change in Australia – Technical Report 2007*

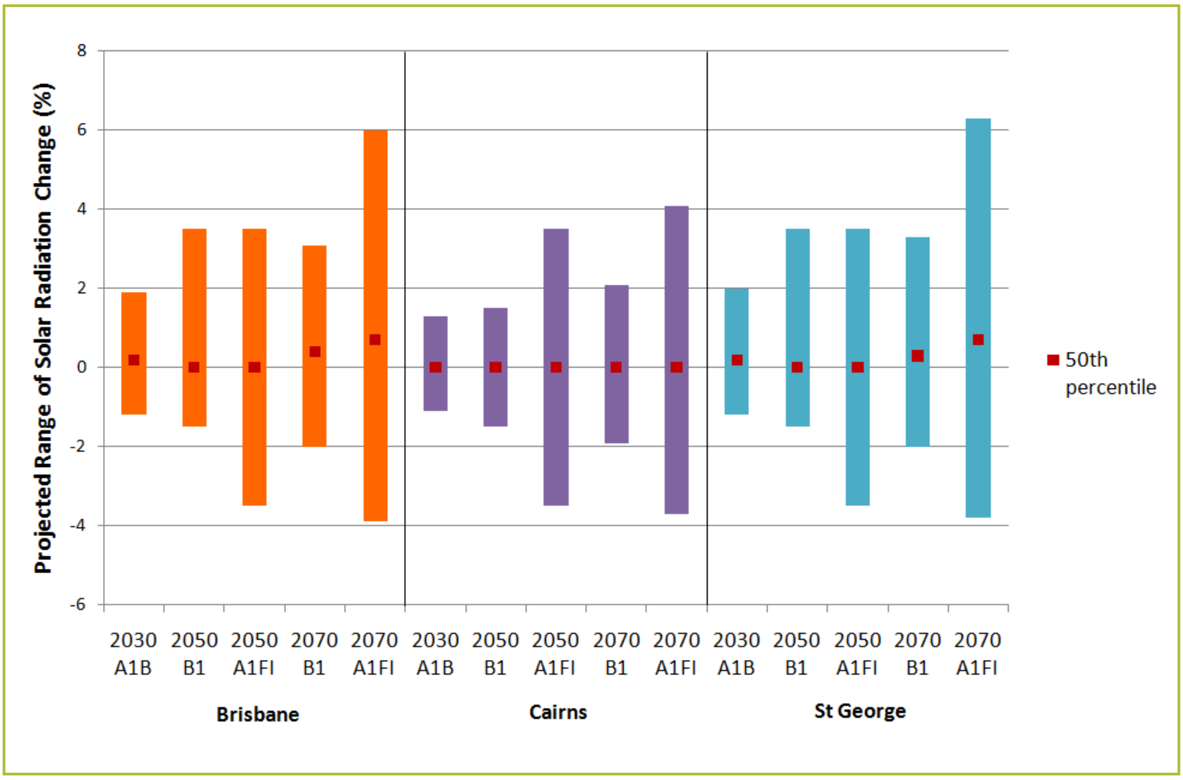
Bars represent range from 10th percentile to 90th percentile

Figure C.6: Projected annual average relative humidity change for Brisbane, Cairns and St George relative to 1990 baseline

C.8 SOLAR RADIATION

Best estimate (50th percentile) model projections indicate that solar radiation is expected to slightly increase or remain the same at Brisbane, Cairns and St George. The ranges of uncertainty for the model scenarios show solar radiation at all cities could either increase or decrease with almost equal probability.

As solar radiation is location specific, it would be misleading to predict the relative humidity for the China First Project region using the trends for Brisbane, Cairns and St George.



Values adapted from *Climate Change in Australia – Technical Report 2007*

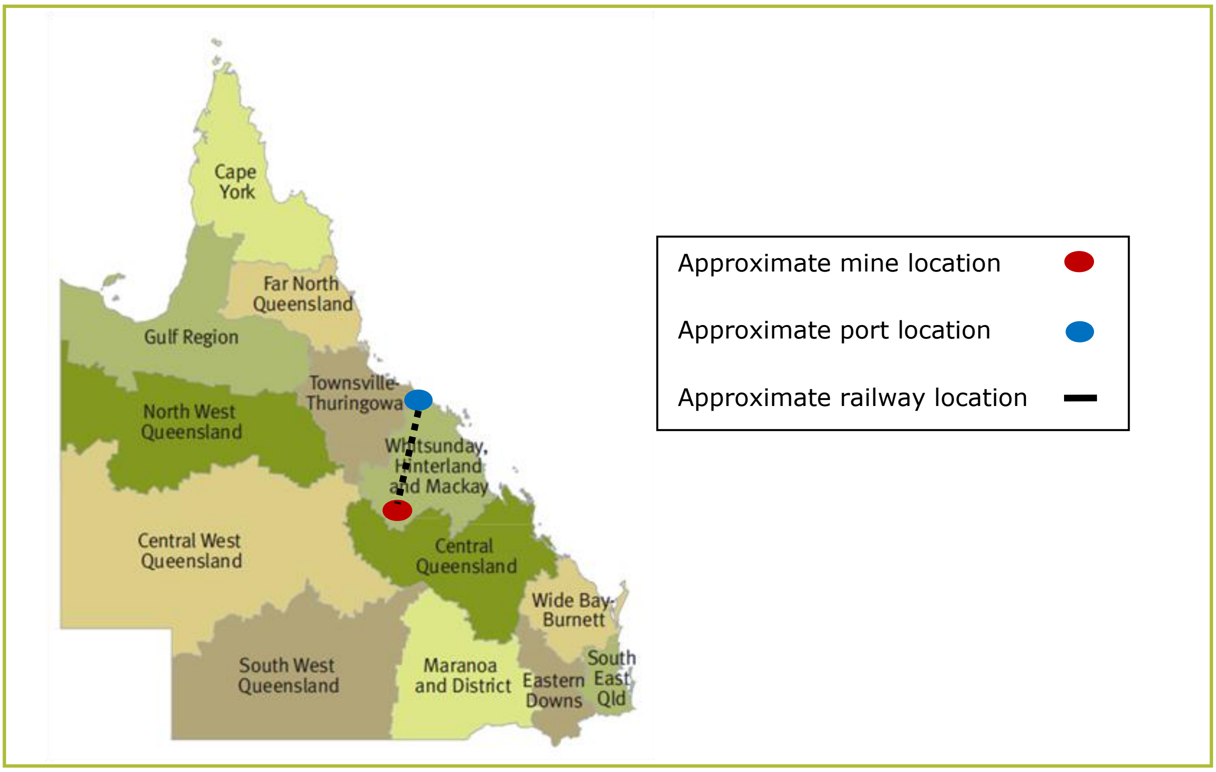
Bars represent range from 10th percentile to 90th percentile

Figure C.7: Projected annual average solar radiation change for Brisbane, Cairns and St George relative to 1990 baseline

C.9 QUEENSLAND GOVERNMENT PREDICTIONS

The Queensland Government has built on the modelling conducted for the *Climate Change in Australia* report, providing climate change projections for Queensland regions.

Table C.1 presents a summary of the predicted impacts of climate change by 2070, under a high emissions scenario (A1FI) best estimate (50th percentile) projection, sourced from *ClimateQ: Towards a Greener Queensland*.



Source: Figure taken from Qld Government, 2009, *ClimateQ: Towards a Greener Queensland* (Chapter 5: *Climate Change Impacts on Queensland's Regions)*

Figure C.8: Regions used for Queensland climate change projections and the approximate location of the China First Project

Table C.1: Qld Government's Climate Change Predictions

	Queensland Average	Whitsunday, Hinterland and Mackay	Central Queensland	Central West Queensland	Eastern Downs	Far North Queensland	Gulf Region
Temperature							
Change previous decade	0.4	0.3°C	0.5°C	0.7°C	0.5°C	0.1°C	0.2°C
Predicted change by 2070	4.4	4.2°C	4.5°C	5.2°C	4.5°C	3.9°C	4.4°C
Predicted no. days above 35°C (% change)	437%	1200%	400%	150%	300%	800%	200%
Rainfall							
Change in last decade in comparison with previous 30years[a]	-8	-14%	-14%	-9%	-12%	-2%	3%
Predicted change (% change)[b]	-4.3	-35-17%	-35 to 17%	-37 to 22%	-32 to 16%	-26 to 22%	-26 to 24%
Evaporation							
Predicted change (% change)	10.5	7-15%	7-15%	3-14%	7-15%	7-15%	7-14%

[a]This is generally consistent with natural variability experienced over the last 110 years, which makes it difficult to detect any influence of climate change at this stage

[b]The 'best estimate' of projected rainfall change shows a decrease under all emissions scenarios

Source: Qld Government, 2009, *ClimateQ: Towards a Greener Queensland* (Chapter 5: *Climate Change Impacts on Queensland's Regions)*

	Maranoa and District	North West Queensland	South East Queensland	South West Queensland	Townsville Thuringowa	Cape York	Wide Bay Burnett
Temperature							
Change previous decade	0.5°C	0.4°C	0.4°C	0.8°C	0.2°C	-0.1°C	0.4°C
Predicted change by 2070	5°C	4.9°C	4°C	5.2°C	4.2°C	3.7°C	4.1°C
Predicted no. days above 35°C (% change)	200-300%	150%	300-600%	150-200%	200-1000%	200-300%	300-1200 %
Rainfall							
Change in last decade in comparison with previous 30years[a]	-8%	-2%	-16%	-16%	-4%	0%	-12%
Predicted change (% change)[b]	-34 to 17%	-31 to 24%	-30 to 17%	-38 to 20%	-32 to 19%	-21 to 24%	-33 to 16%
Evaporation							
Predicted change (% change)	6-15%	6-14%	6-16%	3-15%	7-15%	7-14%	7-16%

[a]This is generally consistent with natural variability experienced over the last 110 years, which makes it difficult to detect any influence of climate change at this stage

[b]The 'best estimate' of projected rainfall change shows a decrease under all emissions scenarios

Source: Qld Government, 2009, *ClimateQ: Towards a Greener Queensland* (Chapter 5: *Climate Change Impacts on Queensland's Regions)*

Appendix D

Garnaut Review Predictions

The most recent and authoritative work in predicting the future impacts that global greenhouse gas emissions will have on Australian climate patterns and the Australian economy is the Garnaut Climate Change Review (Garnaut, 2008). The Garnaut review builds on previous attempts to quantify the social and economic impacts of climate change; in particular, the Stern Review on the Economics of Climate Change, which was prepared for the British Government and released in October 2006 (Stern, 2006).

The Garnaut review found that actual emissions between 2000 and 2005 were higher than those projected by the IPCC's emissions scenarios. An updated emissions scenario was developed based on the most recent projections of the International Energy Agency.

Predicted climate change impacts and emission trajectories identified by the Garnaut Review are divided into three global emission scenarios, no mitigation, 550 ppm stabilisation and 450 ppm stabilisation with overshoot.

- ***No mitigation***

  No action to mitigate climate change. Emissions continue to increase throughout the 21st century, leading to an accelerating rate of increase in atmospheric concentrations of greenhouse gases. Greenhouse gas concentrations reach 1,565 ppm CO_2-e, more than 3.5 times higher than pre-industrial concentrations by 2100.

- ***550 ppm stabilisation***

  Emissions peak and decline steadily, so that atmospheric concentrations stop rising in 2060 and stabilise around 550 ppm CO_2-e (one third the concentration reached in the no mitigation scenario).

- ***450 ppm stabilisation with overshoot***

  Emissions are reduced immediately and decline more sharply than in the 550 ppm case. Atmospheric concentrations overshoot to 530 ppm CO_2-e mid-century and decline toward stabilisation at 450 ppm CO_2-e early in the 22nd century.

The Garnaut review details Australian emission trajectories for each of the three global emission scenarios, in the context of Australia playing a fair and proportionate part in an effective global agreement to constrain greenhouse emissions. The trajectories give an indication of the greenhouse emission cuts required to achieve the 550 ppm and 450 ppm CO_2-e stabilisation goals, so they can be related to potential impacts predicted by the Garnaut review.

Forecasted climate change impacts identified by Garnaut Review for the global emission scenarios are summarised in Table D.1.

Table D.1: Summary of Forecast Impacts from the Garnaut Climate Change Review

Aspect	Location	Year	Predicted impact No mitigation	450 ppm	550 ppm	Notes	Reference
Sea level rise	Global	2100	29 to 59 cm rapid changes in ice flow could add another 10 to 20cm to the upper range	Not specifically determined	Not specifically determined	Based on IPCC estimations for SRES scenario A1F1 similar to no mitigation case	Chapter 4 p93
Ocean acidity	Global	NA	Increasing ocean acidity proportionate to increased atmospheric carbon dioxide concentrations, consequences for aquatic life, increased impact in colder waters			This is directly related to CO_2 concentration in atmosphere	Chapter 4 p80
Cyclones and storms	Global	NA	Increased intensity			Not based on a specific scenario	Chapter 5 p117
		NA	Frequency same or decreased			Not based on a specific scenario	
Bushfires	Australia	2013	5 to 25% increase in number of days with extreme fire weather	Not specifically determined	Not specifically determined	Based on 0.4°C increase	Chapter 5 Table 5.4 p118
		2034	15 to 65% increase in number of days with extreme fire weather	Not specifically determined	Not specifically determined	Based on 1°C increase	
		2067	100 to 300% increase in number of days with extreme fire weather	Not specifically determined	Not specifically determined	Based on 2.9°C increase	
Heatwaves	Brisbane	2008	0.9 days over 35°C	Not specifically determined	Not specifically determined	Increase over 1990 baseline	Chapter 5 Table 5.3 p117
		2030	1.7 days over 35°C	Not specifically determined	Not specifically determined		
		2070	8 days over 35°C	Not specifically determined	Not specifically determined		
		2100	21 days over 35°C	Not specifically determined	Not specifically determined		
Agriculture	Australia	NA	Crop production affected by changes in average rainfall and temperature. Livestock affected by quantity and quality of pastures. Severe weather events (bushfire, flooding) reduce production. Increased temperature alters occurrence of pests and disease. Potential for carbon fertilisation if not crop growth is not restricted by temperature and rainfall.			Not based on specific scenario	Chapter 6 p129

Aspect	Location	Year	Predicted impact No mitigation	450 ppm	550 ppm	Notes	Reference
Dryland cropping - wheat	Dalby, Queensland	2030	8.2% cumulative yield change	1.6% cumulative yield change	4.8% cumulative yield change	Percentage cumulative yield change from 1990	Chapter 6 Table 6.5 p132
		2100	-18.5% cumulative yield change	-3.7% cumulative yield change	-1.0% cumulative yield change	Based on median probability of rainfall, relative humidity, temperature	
Dryland cropping - wheat	Emerald, Queensland	2030	7.2% cumulative yield change	1.8% cumulative yield change	4.4% cumulative yield change	Percentage cumulative yield change from 1990	Chapter 6 Table 6.5 p132
		2100	-10.1% cumulative yield change	-2.5% cumulative yield change	0% cumulative yield change	Based on median probability of rainfall, relative humidity, temperature	
Irrigated agriculture	Murray Darling	2030	12% decline in economic value of production	3% decline in economic value of production	3% decline in economic value of production	Based on median probability of rainfall, relative humidity, temperature	Chapter 6 Table 6.4 p130
		2050	49% decline in economic value of production	6% decline in economic value of production	6% decline in economic value of production	Based on median probability of rainfall, relative humidity, temperature	
		2100	92% decline in economic value of production	6% decline in economic value of production	20% decline in economic value of production	Based on median probability of rainfall, relative humidity, temperature	
Water supply infrastructure	Australia	2100	34% increase in cost of supplying water	4% increase in cost of supplying water	5% increase in cost of supplying water	Based on median probability	Chapter 6 Table 6.3
Coastal buildings	Queensland	2030	Medium magnitude of net impact	Medium magnitude of net impact	Medium magnitude of net impact	Based on median probability of rainfall, relative humidity, temperature	Chapter 6 Table 6.8
	Queensland	2100	Extreme magnitude of net impact	Medium magnitude of net impact	Medium magnitude of net impact		
Temperature related deaths	Queensland	2100	Over 4000 additional heat-related deaths relative to no climate change	Fewer deaths relative to no climate change	Fewer than 80 additional heat-related deaths relative to no climate change	Based on median probability	Chapter 6 Table 6.3 p128
Geopolitical stability in Asia-Pacific	Asia Pacific	2100	Displacement of people from South East Asian cities (sea rise)	Less displacement (lower sea rise)	Less displacement (lower sea rise)	Based on median probability	Chapter 6 Table 6.3 p128
Ecosystems	Global	NA	Loss of biodiversity in high altitudes, wet tropics, coastal freshwater wetlands, coral reefs increasing with higher impact scenarios			Impact is specific to each ecosystem	Chapter 6 p142
International trade	Global	NA	Affected economies (China, India, Indonesia) reducing demand for Australian goods			not based on a specific scenario	Chapter 6 p145

(Garnaut, 2008)

Appendix E

Breakdown of Energy Usage

Table E.1: Summary of forecast energy usage for the China First Project

Production		Energy content of Product coal	Energy delivered in product	Emissions Source	Energy source	Usage	Units	Energy content	Total energy in Primary	% of Energy delivered	Emissions t CO2-e / a	GJ / t ROM	GJ / t Product	GJ / GJ	t CO2-e / t Product	t CO2-e / GJ delivered
Mt ROM	Mt Product	MJ / kg	GJ / a					GJ	GJ							
56	**40**	**26.64**	**1,065,600,000**	Auxilliary vehicles	Diesel	279,155	GJ/a	1	279,155	1.62%	19,401	0.0050	0.00698	0.0003	0.0005	0.00002
				Blasting	Explosive	46,500	t/a	2.316	107,694	0.62%	8,370	0.0019	0.00269	0.0001	0.0002	0.00001
				Fuel consumption - mining equipment	Diesel	4,094,847	GJ/a	1	4,094,847	23.70%	284,592	0.0731	0.10237	0.0038	0.0071	0.00027
				Fugitive methane from open cut mines		20,000,000					340,000	-	-	-	0.0085	0.00032
				Fugitive methane from underground mines		36,000,000					288,000	-	-	-	0.0072	0.00027
				Plane		73,000,000					23,652	-	-	-	0.0006	0.00002
				Slow oxidation		40,000,000					5,000	-	-	-	0.0001	0.00000
				Spontaneous combustion		40,000,000					120,000	-	-	-	0.0030	0.00011
				Transport vehicles	Diesel	75,654	GJ/a	1	75,654	0.44%	5,258	0.0014	0.00189	0.0001	0.0001	0.00000
				Railway - diesel consumption	Diesel	3,953,579	GJ/a	1	3,953,579	22.88%	274,774	0.0706	0.09884	0.0037	0.0069	0.00026
				Scope 2 - mine electricity consumption	Electricity	1,357,800	MWh/a	3.6	4,888,080	28.29%	1,208,442	0.0873	0.12220	0.0046	0.0302	0.00113
				Scope 2 - railway electricity consumption	Electricity	175,200	MWh/a	3.6	630,720	3.65%	155,928	0.0113	0.01577	0.0006	0.0039	0.00015
				Scope 3 - coal terminal electricity consumption	Electricity	297,840	MWh/a	3.6	3,249,164	18.80%	265,078	0.0580	0.08123	0.0030	0.0066	0.00025
								TOTAL	**17,278,893**	**100%**	**2,998,494**	**0.309**	**0.432**	**0.016**	**0.075**	**0.003**
								TOTAL MINE ONLY	**9,445,430**		**2,302,715**	**0.169**	**0.236**	**0.009**	**0.058**	**0.002**

This table does not include energy usage during construction, and it assumes 40 Mtpa product coal to be transported via the rail.

Electricity use converted to primary energy usage is based on thermal efficiency of Australian power stations of 33% (AGSO, 1999)

For clarity figures have been presented in non scientific notation, data should to considered to have 3 significant figures.

Energy content of explosives is assumed to be derived solely from fuel oil content, which was assumed to be 6% by weight.