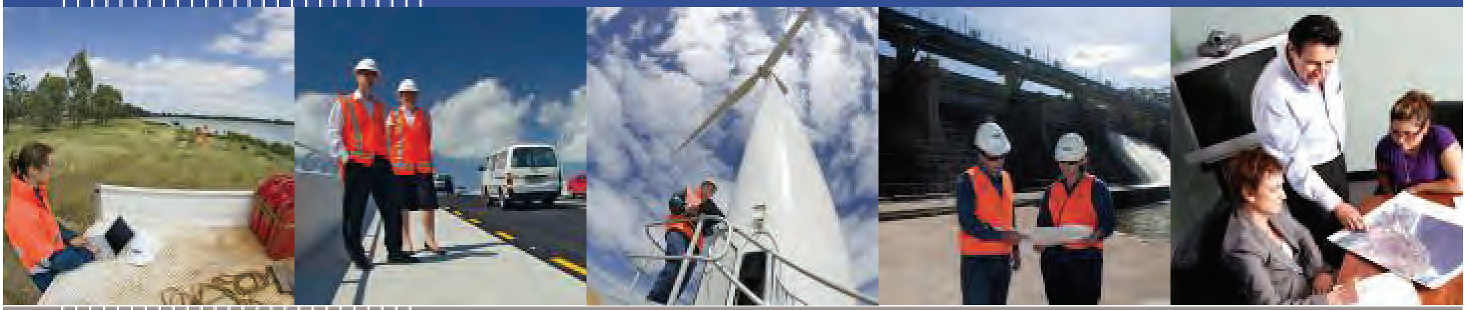


Final Report

Greenhouse Gas (GHG) Forecast for the Proposed Yeelirrie Development

FEBRUARY 2011

Prepared for

BHP Billiton Yeelirrie Development Company

42907132

URS

Project Manager:	pp [signature] .... Danie Richter Principal Environmental Scientist	**URS Australia Pty Ltd** **Level 3, 20 Terrace Road East Perth WA 6004 Australia T: 61 8 9326 0100 F: 61 8 9326 0296**	
Project Director:	[signature] .... Peter Elliott Senior Principal - Sustainability		
Author:	[signature] .... Chacko Thomas Energy Efficiency Engineer		
Reviewer:	[signature] .... Venky Narayanaswamy Principal Engineering & Technical Sustainability	Date: Reference: Status:	**February 2011** 42907132 Final

URS

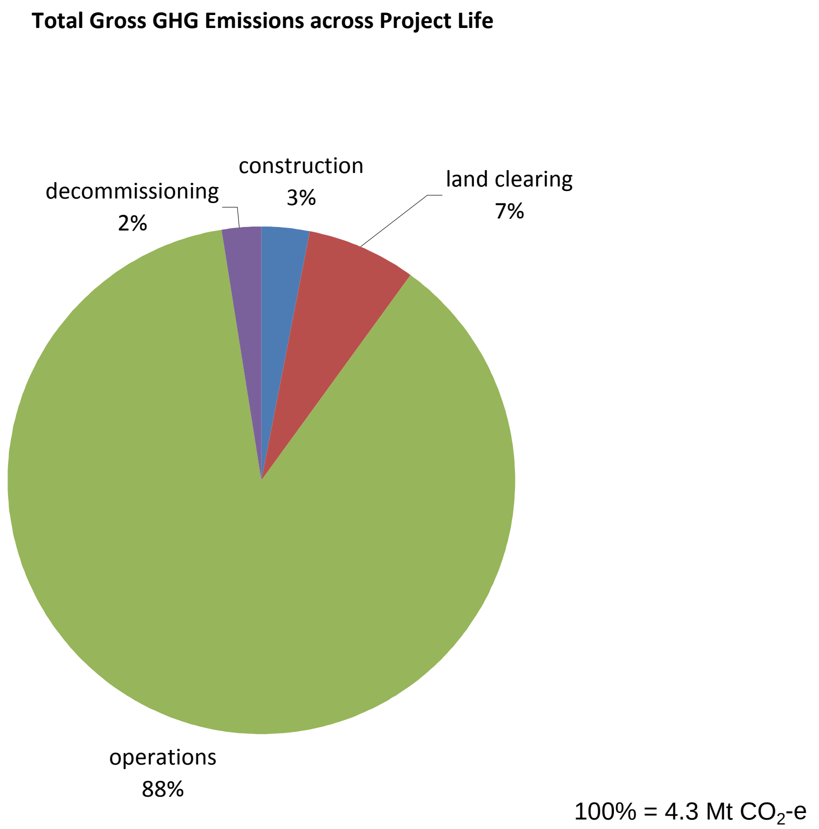
Table of Contents

Abbreviations

Benchmarking	Process used in management, in which organizations evaluate various aspects of their processes in relation to best practice, usually within their own sector
BIPV	Building Integrated Photovoltaic systems
CFCs	Chlorofluorocarbons
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalents
CSR	Corporate Social Responsibility
CVRS	Computer Vehicle and Routing Systems
DECC	Department of Environment and Climate Change
DC	Direct Current
EEO	Energy Efficiency Opportunities Act
FY	Financial Year
GCHP	Ground Coupled Heat Pump
GHG emissions	Greenhouse Gas emissions
GJ	Giga Joules (10^{12} Joules)
GSHP	Ground Source Heat Pump
GWP	Global Warming Potential
HFC's	Hydrofluorocarbons
HFE's	Hydrofluoroethers
IPCC	Intergovernmental Panel on Climate Change
KPI	Key Performance Indicator
kW	kilo Watt (10^3 watts)
kWh	kilo Watt hours
NGACs	NSW Greenhouse Abatement Certificates
NGA Factors	National Greenhouse Accounts Factors
NGERs	National Greenhouse and Energy Reporting Act
PFC's	Perflurocarbons
PV	Photovoltaic
RECs	Renewable Energy Certificates
SWIS	South West Interconnected System
UNFCCC	United Nations Framework Convention on Climate Change
UV	Ultraviolet
VSD	Variable speed drive
WBCSD	World Business Council for Sustainable Development
WNA	World Nuclear Association

Executive Summary

This greenhouse gas (GHG) emissions forecast is prepared for the proposed Yeelirrie development located in the Northern Goldfields of Western Australia. The predictive estimate calculated a total gross emission of approximately 4.3 Mt CO_2-e across the project life. The project life includes land clearing, construction, operations and decommissioning, for a period of up to 30 years. The project's mining is proposed at a rate of up to 8 Mtpa, which is estimated to produce up to 3,500 tpa of Uranium Oxide Concentrate (UOC). Figure_ES 1 shows predicted gross GHG emissions across the project life[1].



Figure_ES 1 Indicative Total Gross GHG Emissions across project life

Progressive rehabilitation is a key feature of the project, and is calculated to sequester approximately 287, 000 t CO_2-e, bringing the net emission release for the project life to a little in excess of 4 Mt CO_2-e. Table_ES 1 presents the tonnages of GHG emissions for the various project phases across the project life.

[1] 2 year construction phase, 30 year operations and 3 years decommissioning phase

Table_ES 1 Total Indicative GHG Emissions across the Project Life

Emission Source	Indicative Total GHG Emissions (t CO_2-e)
Land Clearing	273,200
Construction Phase	134,000
Operations Phase	3,794,000
Decommissioning Phase	105,000
Carbonation Process	-840,000
De-carbonation – from Tailings Residue	840,000
Re-vegetation	-287,000

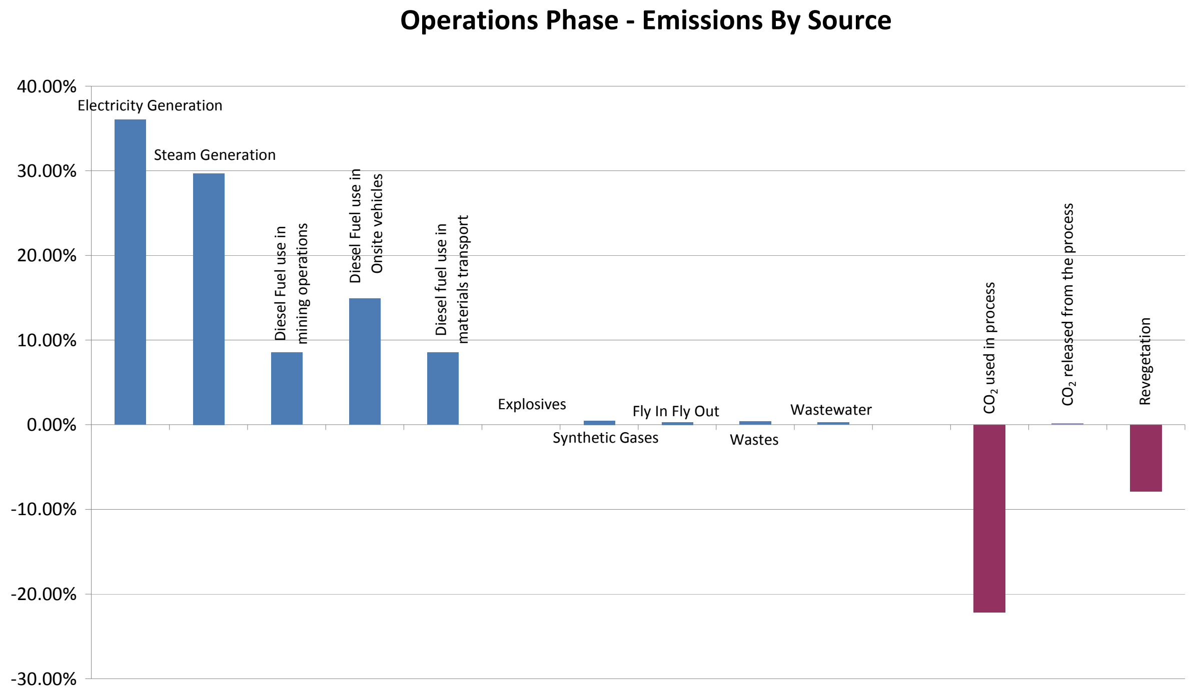
The biggest contribution of the emissions is expected to occur during the operations phase. Table_ES 2 shows the annual GHG emissions by source during the operations phase.

Table_ES 2 Annual GHG Emissions during Operations Phase

Activity/source	Annual GHG emissions (t CO_2-e per annum)	
	Scope 1	Scope 3
Steam generation	38,000	Not Applicable (NA)
Electricity generation	46,000	NA
Mining and light vehicle fleet	18,700	10,800
Carbonation process	-28,000	NA
Waste water treatment	370	NA
From Tailings Residue	28,000	NA
Explosives	12	NA
Waste	500	NA
Synthetic gases	600	NA
Materials transport	NA	10,800
Workforce transport	NA	400
CO_2 released from the metallurgical process	200	-
TOTAL	**104,382**	**22,000 (average)**

Figure_ES 2 shows the indicative total GHG emissions by source during the operations phase. At approximately 36 per cent, diesel fuel consumption for electricity generation is the single largest source of total GHG emissions during the operations phase. This is followed by diesel fuel consumption for steam generation at 30 per cent and on-site diesel fuel use at 15 per cent.

Some of the CO_2 released from the combustion of diesel for power and steam generation, will be used in the process. Approximately 28,000 t CO_2 will be used by the metallurgical process annually. However, for the purpose of the GHG emissions forecast, the CO_2 emissions sequestered through the carbonation process have not been deducted in the GHG emission inventory as it is assumed that CO_2 may be released back into the atmosphere from the TSF



100% = 126,400 t CO_2-e

Figure_ES 2 GHG Emission Sources - Operations Phase

A high-level greenhouse gas emission life cycle assessment of the Yeelirrie development was undertaken using available literature to estimate emissions associated with uranium production, use and disposal.

Approximately 9.05 kg of U_3O_8 is required to produce 1 kg of nuclear fuel-grade UO_2, sufficient to generate approximately 360,000 kWh of electricity. Given that 1 kg of Yeelirrie UOC is equivalent to 2.8 kg of U_3O_8, and using the nuclear life-cycle information presented in the literature, it is estimated that approximately 7 tonne of CO_2-e would be generated per one kilogram of Yeelirrie UOC.

Using the indicative production rates, of up to 3,500 tpa of UOC, the net greenhouse gas benefit of the expanded operation would be up to 5,900 Mt CO_2-e over the proposed 30-year life of the operation by comparison to Australia's combined cycle natural gas power generation.

The potential greenhouse gas emission impacts of the Yeelirrie development has been assessed against state, national and global greenhouse gas emission projections. A comparison of these with the project's annual GHG emission forecast is presented in Table_ES 3.

Table_ES 3 Current and Projected Australian and global greenhouse gas emissions in Mtpa of CO_2-e (excluding land use change)

Source	Unit[1]	2010	2020	2030	2040
Western Australia (DEC 2008)	Total	74	81	92	102
	%	0.17	0.16	0.14	0.12
Australia (DEC 2008)	Total	549	638	695	752
	%	0.023	0.02	0.018	0.017
Global (ABARE 2007)	Total	42,300	53,800	63,600	75,800
	%	0.0003	0.0002	0.0002	0.00017

[1]Total refers to the projected GHG emissions for the source, and % refers to the proportion of that total represented by the proposed Yeelirrie development

The data presented in Table_ES 3 show that, as a proportion of state, national and global emissions, the contribution of the development to atmospheric greenhouse gas emission levels is very low. However, given the national and global importance of this issue, BHP Billiton would investigate greenhouse gas emissions reduction initiatives throughout the life of the proposed development.

1 Introduction

1.1 Background

BHP Billiton Yeelirrie Development Company Pty Ltd proposes to develop an open pit mine and associated processing facilities at Yeelirrie in the Northern Goldfields region of Western Australia, approximately 500 km north of Kalgoorlie, 60 km west of Mount Keith, 70 km south-west of Wiluna and 110 km north-west of Leinster.

The project's average ore extraction rate would be up to 8 Mtpa. The project would produce 3,500 tpa of uranium peroxide ($UO_4.2H_2O$), more commonly referred to as uranium oxide concentrate (UOC), through the development and operation of an open pit mine and on-site metallurgical plant.

1.1.1 Mining

The Uranium mineralisation at Yeelirrie occurs as carnotite associated with calcrete and clay sediments which occurs at shallow depth centred at approximately 5.5 metres below surface with a thickness of between three and seven metres. The deposit is believed to have a strike length of nine kilometres, an average width of one kilometre and a maximum width of 1.5 kilometres. The location and extent of the mineral resource proposed for mining warrants open cut mining using truck and excavator mining equipment, with the use of some explosives where necessary. Site preparation activities will be conducted prior to, and concurrently with, the progressive mining activities across the project area. Areas to be disturbed are shown below in Figure 1-1.

1.2 Purpose and Scope

The purpose of this document is to provide a GHG emission forecast for the proposed Yeelirrie development by applying consistent international and Australian methodologies.

This section explains how the proposed development would result in additional greenhouse gas emissions.

1.2.1 Scopes and boundaries

The World Business Council for Sustainable Development (WBCSD), in partnership with the World Resources Institute, has developed the Greenhouse Gas Protocol, which subsequently defines three scopes for the estimation and assessment of greenhouse gas (GHG) emissions (WBCSD, 2004):

- Scope 1 – Direct GHG emissions. These emissions occur from sources that are owned or controlled by the company
- Scope 2 – Electricity-generated indirect GHG emissions. Emissions arising from the generation of purchased electricity, and steam, and/or heat.
- Scope 3 – Other indirect GHG emissions. Emissions that arise from as a consequence of the activities of the company, but are not owned or controlled by the company

The GHG assessment for the proposed Yeelirrie development included all identified Scope 1 emissions and no Scope 2 emissions (given that no purchase of off-site electricity would occur). Scope 3 emissions were limited to those activities within Australian that were a consequence of the proposed developments activities, specifically product transport, aviation fuel associated with the fly-in, fly-out workforce and waste deposited to landfill. Due to significant uncertainty regarding the boundaries associated with life cycle assessments, and to allow comparison of development emissions with state, federal and global GHG projections, emissions associated with the embedded energy of the materials used to construct the proposed facility were not included in the assessment. A discussion regarding the life cycle emissions associated with the mining, processing and use of uranium is presented later in this report.

1.2.2 Assessment methods

The emissions generated from the following sources were used to assess the potential greenhouse gas footprint of the proposed development:

- stationary energy emissions (i.e. from fuel burning equipment such as the steam and electricity generators)
- transport fuel emissions
- emissions associated with changes to land use (such as land clearing)
- emissions associated with oxidation reactions within the tailings storage facility (TSF).

1.2.3 Greenhouse gases

Greenhouse gases include gases such as, carbon dioxide, methane, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) that absorb and re-emit infra-red radiation (heat), which warm Earth's surface and contribute to climate change. The greenhouse effect, which is synonymous with climate change and global warming, has recently been defined as 'any change in climate over time, whether due to natural variability or as a result of human activity' (IPCC 2007).

The impact of greenhouse gas emissions on the atmosphere is the combined effect of the radiative properties of the gases (that is, their ability to absorb solar and infra-red radiation) and the time that it takes for those gases to be removed from the atmosphere by natural processes. Global Warming Potentials (GWP) are used to compare the relative effects of different gases over a particular time period and are referenced in units of carbon dioxide equivalents (CO_2-e); carbon dioxide is used as the base reference, and has a GWP of 1. Table 1-1 presents the six major groups of greenhouse gases and their GWPs, which are calculated over a 100-year time scale. GWPs reflect that an emission of 1 kg of methane has the same global warming potential as an emission of 21 kg of carbon dioxide: as such, if 1 kg of carbon dioxide is emitted together with 1 kg of methane, the total emission would be valued at 22 kg of CO_2-e.

Table 1-1 Greenhouse gas categories and indicative global warming potentials

Greenhouse gas	GWP range
Carbon dioxide	1
Methane	21
Nitrous oxide	310
Hydrofluorocarbons (HFC)	150–11,700
Hydrofluoroethers (HFE)	100–500
Perfluorocarbons (PFC)	6,500–23,900

Source: National Greenhouse Accounts Factors 2010 (DCCEE 2010)

1.2.4 Emission factors

The emission factors used in this study were sourced from the National Greenhouse and Energy Reporting Technical Guidelines (DCC 2009) or, where NGER factors were not available, the National Greenhouse Accounts (NGA) Factors, 2010 (DCCEE 2010). The NGA factors were also used to determine Scope 3 (indirect) emissions where necessary.

The emissions for the proposed development were calculated by multiplying the volume or mass of a greenhouse gas-emitting fuel or process by an emission factor, to generate a value for the likely amount of CO_2-e emitted. The CO_2-e value accounts for the various greenhouse gases emitted, taking into account their respective GWP and the amount emitted.

Land clearing emissions were predicted using the National Carbon Accounting Toolkit Full Carbon Accounting Model (FullCAM). Details regarding the inputs and assumptions associated with the use of this model are outlined in Section 4.1.2.

1.2.5 Emission sources

Greenhouse gas emissions were divided by scope as follows.

Direct (Scope 1) emission sources

Table 1-2 details the direct emission sources assessed in this study.

Table 1-2 Inventory of direct (Scope 1) GHG emissions sources

Activity	Source	Assessment basis (per annum, except where noted)
Steam generation	Diesel consumption	14,000 kL
Electricity generation	Diesel consumption	17,000 kL
Mining and light vehicle fleet	Diesel consumption	7,000 kL
Metallurgical processing emission	Oxidation reactions	No emissions, CO_2-e generated from steam and electricity generation would be used within the metallurgical process
Waste water treatment	Oxidation reactions	24,400 kL (wastewater generation)
Tailings Storage Facility (TSF)	Oxidation reactions	CO_2-e added to the metallurgical process (from steam and electricity generation) is assumed, as a worst case to be liberated from the TSF
Land use change	Land clearing	5,000 ha over the life of the project, with progressive rehabilitation from Year 6
Explosives	ANFO and emulsion	70 tonnes
Waste	Degradable organic carbon	500 tonnes of mixed solid wastes
Synthetic gases	Refrigeration leakage	20% of capacity for mobile equipment, 35% of capacity for stationary equipment

Indirect (Scope 3) emission sources

Table 1-3 details the indirect emission sources assessed in this study.

Table 1-3 Inventory of direct (Scope 3) GHG emissions sources

Activity	Source	Assessment basis (per annum, except where noted)
Materials transport	Diesel consumption	24,000 kL (peak) and 4,000 kL (average)
Workforce transport	Avtur consumption	680 kg of Avtur per one way trip, and 100 round trips per annum (136,000 kg per annum)
On-site diesel scope 3 component	Diesel consumption	The total of all on-site diesel consumption, being 38,000 kL

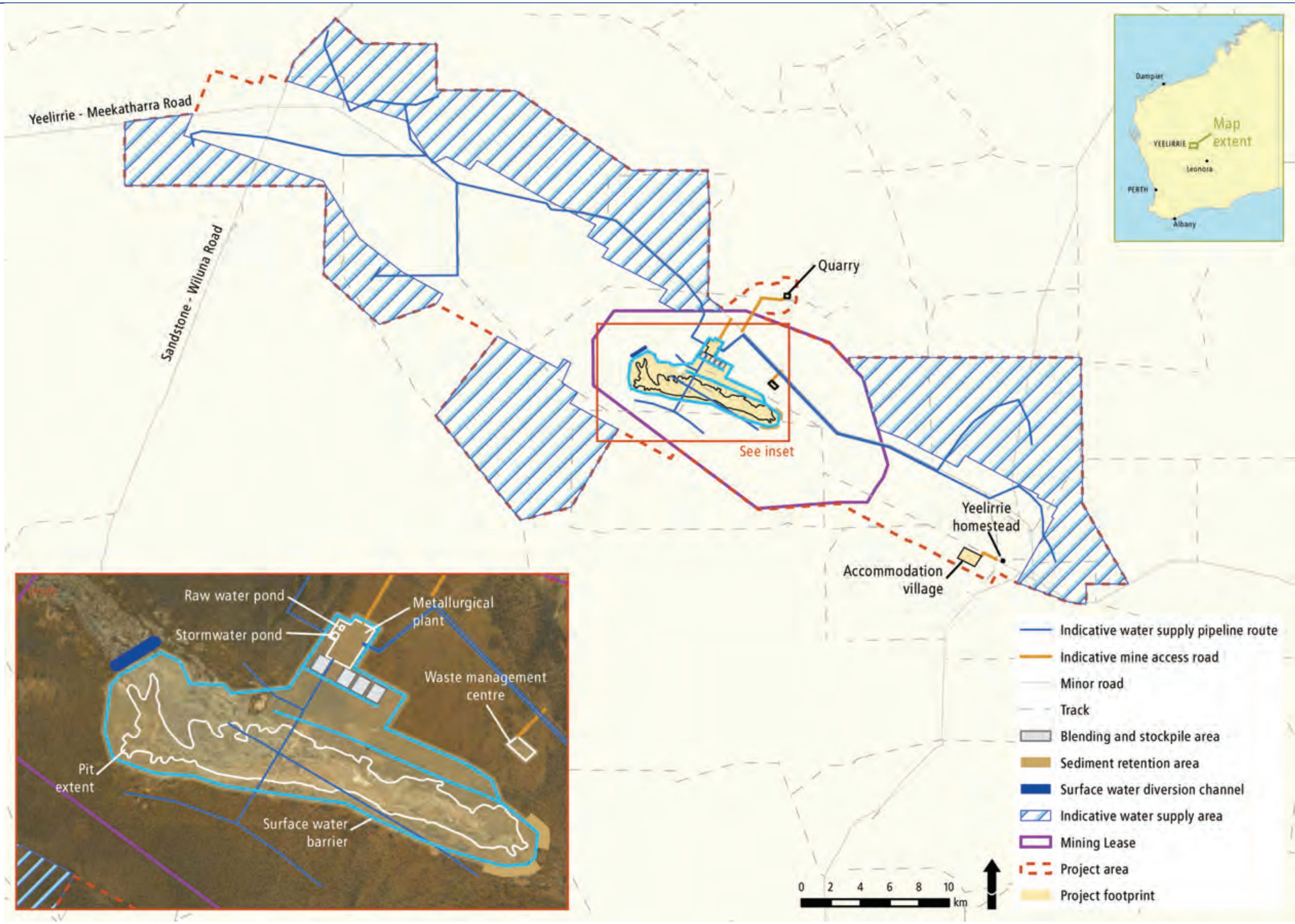


Figure 1-1 Site Layout and project footprint (area of disturbance)

Climate Change

2.1 Climate Change Predictions for Australia

Australia and the globe are experiencing rapid climate change. Since the middle of the 20th century, Australian temperatures have on average, increased by about 1°C, with an increase in the frequency of heatwaves and a decrease in the numbers of frosts and cold days. Rainfall patterns have also changed, whilst the northwest has experienced an increase in rainfall over the last 50 years, much of eastern Australia and the far southwest have experienced a decline (Chambers 2006 and DEC 2009).

2.1.1 Climate Change and Temperature

Temperatures throughout Western Australia have risen during the twentieth century (refer Figure 2-1: BoM 2011b). Overall, there is an increasing trend in annual maximum temperature. Temperatures have increased by 0.8°Celsius since 1910 and most of this warming has occurred after 1950 (0.14°Celsius increase per decade since 1950). This rise has been mainly due to warmer nights rather than hotter days. This trend of increasing average annual temperatures is set to continue in Western Australia according to climate projections that have recently been published (BoM 2011a).

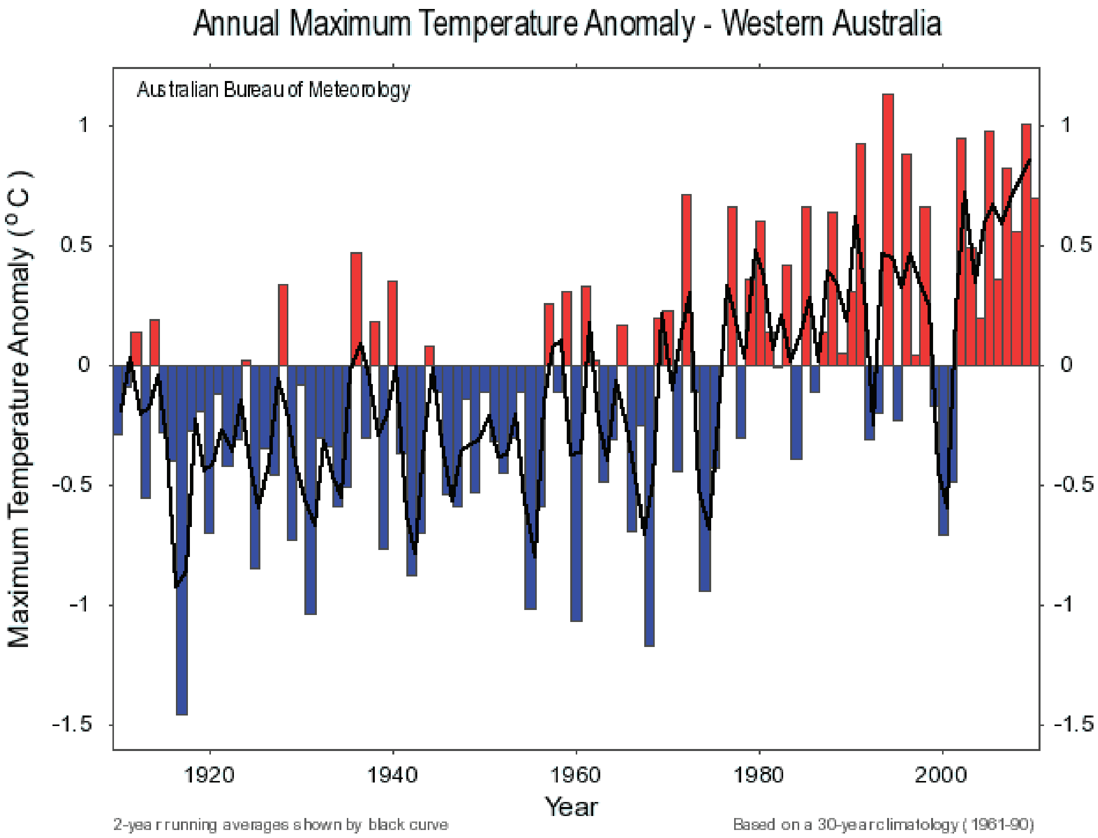


Figure 2-1 Change in Maximum Temperature

Source: (BoM 2011a) and (BoM 2011b)

2.1.2 Climate Change and Rainfall

Indian Ocean Climate Initiative (IOCI) research indicates that by 2030 rainfall may decline by as much as 20 per cent relative to the 1960-1990 level (IPCC 1990, IPCC 1995). This means that the number of winter rain days may decrease by up to 17 per cent. Conversely parts of the northwest of Western Australia have become wetter over recent decades (DEC 2009).

Figure 2-2 presents the annual total rainfall averaged for Australia since 1900 and shows a moderate increase (8.0 mm a decade) and a high year-to-year variability.

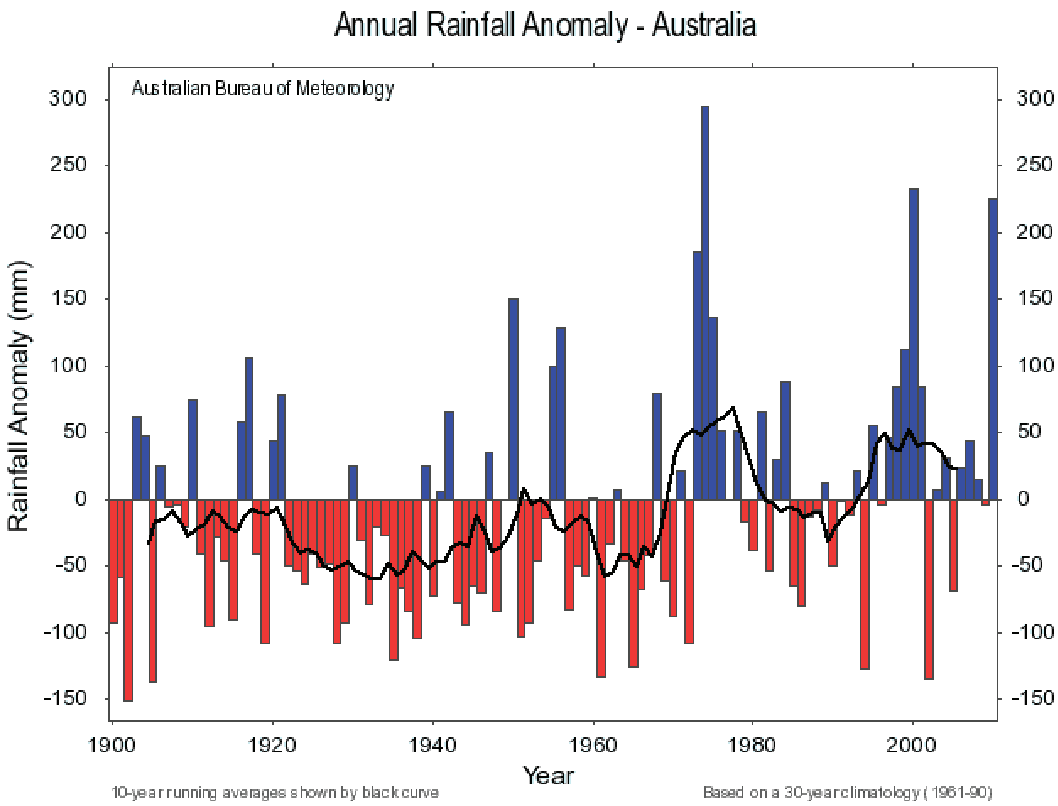


Figure 2-2 Change in Annual Rainfall

Source: (BoM 2011a) and (BoM 2011b)

2.1.3 Climate Change and Uncertainty

PMSEIC (2007) and IPCC (2007) present two scenarios for changing global CO_2 concentrations over this century (refer Figure 2-3). In the optimistic scenario, concentrations stabilise toward the end of the current century and in the challenging scenario, they continue to rise. These ‘plausible’ scenarios of future GHG concentrations are a consequence of the challenging and optimistic emissions scenarios developed by the Intergovernmental Panel on Climate Change (IPCC). Both scenarios assume no policy interventions to reduce emissions.

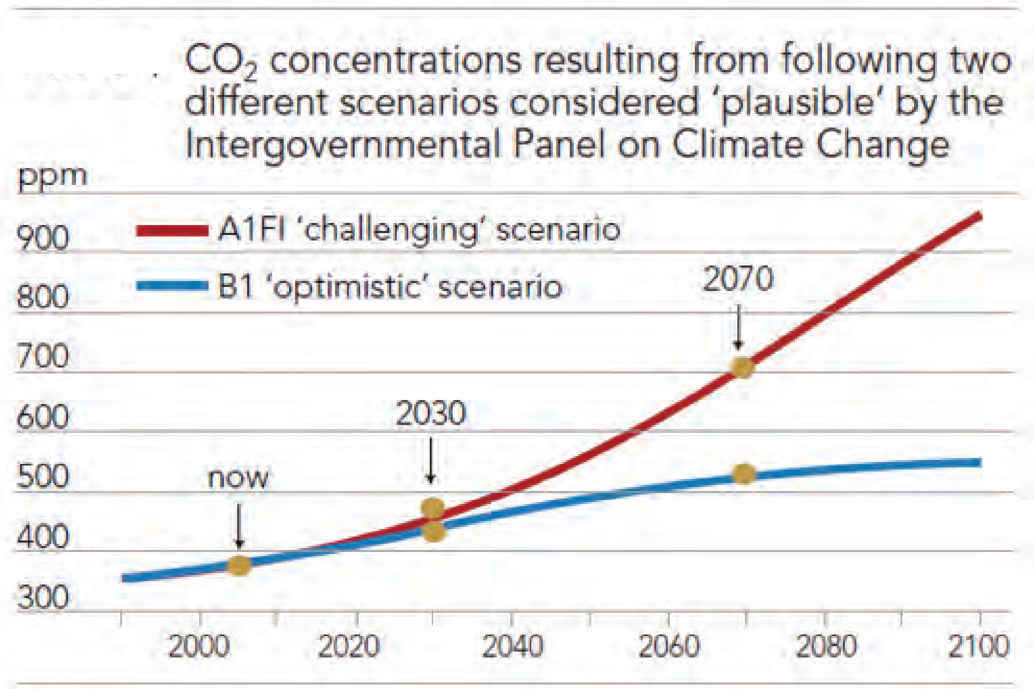


Figure 2-3 Plausible Scenarios considered by the IPCC

Source: (PMSEIC 2007), page 11

Optimistic Scenario

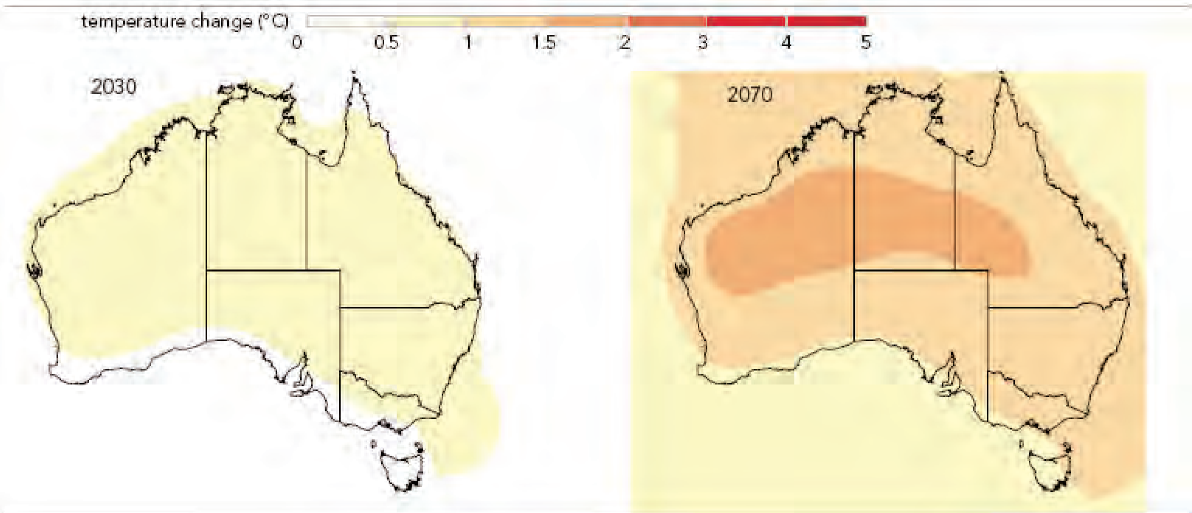


Figure 2-4 Optimistic Scenario: Annual Average Warming above 1990 levels for 2030 and 2070

Source: (PMSEIC 2007)

Under the optimistic scenario (PMSEIC 2007):

- Temperature increases of 0.5°C to 1°C by 2030 and of 0.5°C to 2°C by 2070 are projected.
- Australia warms faster over the next two decades than it has done over the previous five (at least 0.2°C per decade over the next two decades compared with about 0.1°C per decade over the last five).
- The very hottest days are forecast to increase in frequency in regionally variable amounts.

Challenging Scenario

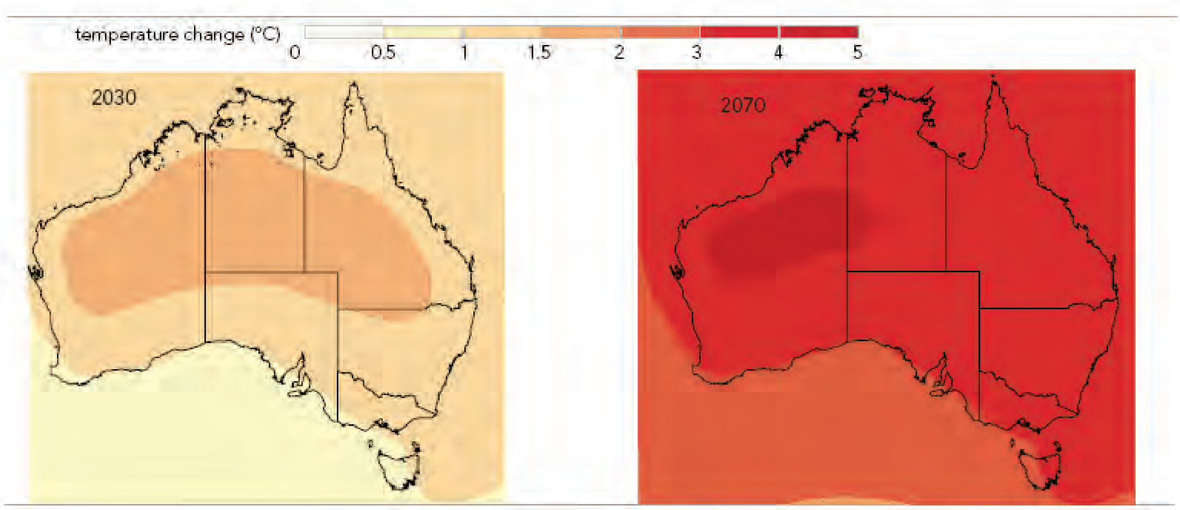


Figure 2-5 Challenging Scenario: Annual Average Warming above 1990 levels for 2030 and 2070

Source: (PMSEIC 2007)

Under the Challenging scenario (PMSEIC 2007):

- Temperature increases of 1°C to 2°C by 2030 and of 3°C to 6°C by 2070.
- Warming accelerates. Even at the lower end of the temperature range given here, Australia would warm at 0.45°C per decade.
- The very hottest days increase in frequency but with very different outcomes for different parts of Australia.
- Minimum daily temperatures are expected to also increase, translating to more frequent cold days.

The physical impacts of climate change on operations are highly uncertain. However, some of the potential impacts of climate change that may affect the project include:

- Predicted increase in temperatures associated with climate change may cause increases in electricity demand;
- Threats to mine water supply security, potentially affecting the ore processing;
- Damage to mines and associated transport infrastructure from flooding, cyclones and other extreme storm events;
- Delays and/or disruptions in construction of mine infrastructure or in production and shipping of product;

- Human health threats for mine staff from changes in working conditions or disease prevalence;
- Climate-related social dislocation and security concerns in communities around mining operations;
- Changes in surface water and groundwater interactions, with implications for acid mine drainage or movement of contaminants

Climate Change Regulation and Policy

The regulation of greenhouse gases and associated policy can be broadly divided into five areas:

- International
- National
- State
- The BHP Billiton Group
- Proposed Yeelirrie development).

This section discusses each of these elements of the policies surrounding the production and management of greenhouse gas emissions.

3.1 International Regulation

Kyoto Protocol, a binding international agreement for Australia is discussed below. All other 'talks' that were conducted subsequent to signing the protocol are non-binding and voluntary and are summarised below.

3.1.1 Kyoto Protocol

The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. As of June 2008, 182 countries have ratified the protocol. The detailed rules for the implementation of the Protocol were adopted at Conference of Parties (COP) 7 in Marrakesh in 2001, and are called the "Marrakesh Accords."

In December 2007, Australia ratified the Kyoto Protocol, which came into effect in March 2008. Under the treaty, the nation has a target of restricting greenhouse gas emissions to 108 per cent of 1990 levels during the 2008-12 commitment periods.

Bangkok Climate Change Talks

The talks in Bangkok were attended by delegates from 162 countries, tasked with reviewing the Bali Road Map[2]. This involved drawing up a work programme to craft a future international climate pact that will successfully halt the increase in global emissions within the next 10-15 years and dramatically reduce emissions by mid-century. An important outcome of the climate change talks, were that the adhoc Working Group under the Kyoto Protocol (IPCC 2007) also agreed to include forest-related activities as a means to achieve emissions reductions in the Kyoto Protocol's second commitment period.

COP 15: Copenhagen

The Copenhagen climate talks, held in December 2009, were originally conceived as the final milestone on the road to a global emissions reduction agreement. Outcomes of the Copenhagen talks were (UNFCCC 2010):

[2] Bali Road Map was a two-year process to finalizing a binding agreement in 2009 in Copenhagen. The conference encompassed meetings of several bodies, including the 13th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 13) and the 3rd Meeting of the Parties to the Kyoto Protocol (MOP 3 or CMP 3). The Bali Road Map includes the Bali Action Plan (BAP) that was adopted by Decision 1/CP.13 of the COP-13. It also includes the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP) negotiations and their 2009 deadline, the launch of the Adaptation Fund, the scope and content of the Article 9 review of the Kyoto Protocol, and as well as decisions on technology transfer and on reducing emissions from deforestation.

- Seventy-three countries have signed up to the non-binding Copenhagen Accord, the summit's outcome document.
- A commitment to keeping temperature rise below two degrees and to low emissions reduction targets;
- Advanced economies would have been bound by Kyoto's first phase in 2008-12 to curb emissions from 1990 levels, and they would have pledged to make more cuts by 2020; and
- The non-binding declaration promises short-term finance for developing countries of US$30 billion up to 2012 and US$100 billion by 2020, but it is not clear that this money will be new and additional or where it will come from.

Agreement at Copenhagen is also expected to form basis for expanded set of rules and regulations on climate issues which then becomes the replacement for Kyoto. But nations would have two years to ratify the new pact, after which it becomes enforceable by January, 2013.

COP 16: Cancun

The United Nations Climate Change conference was held in Cancun, Mexico from 29 November. Outcomes of the Cancun Climate Change talks include:

- Talks focused on the adoption of voluntary commitments and little or no elaboration on deadlines or mechanisms to regarding the second period of commitments of the Kyoto Protocol.
- The agreed upon level of an overall increase of 2°C remains the same as what came out of the "Copenhagen Accord"
- The agreement includes a "Green Climate Fund," proposed to be worth $100 billion a year by 2020, would assist poorer countries in financing emission reductions and adaptation initiatives. Although the creation of a global fund was approved, specifics on committed resources and their distribution are yet to be confirmed.

3.1.2 Implications for Australia by ratifying the Kyoto Protocol

Australia has recently committed to a reduction target of sixty per cent of GHG emissions by 2050 relative to 2000. The European Union committed to a reduction target of twenty per cent from 1990 levels by 2020 and 30 per cent of 1990 levels by 2030 provided that other developed countries commit to comparable emission reductions, and to 60-80 per cent reductions by 2050. The United States of America (USA) is yet to commit to either short- or long-term targets, although recent legislative initiatives suggest that it may soon have long-term targets in place. California has legislated for a reduction to 1990 levels by 2020 and 80 per cent reduction below 1990 levels, by 2050.

Australia is obliged to meet its Kyoto commitments in the first period (2008–2012). International negotiations are currently being held to discuss what targets need to be set for the second phase, post 2012.

3.2 National Regulation

3.2.1 Carbon Pollution Reduction Scheme

On 27 April 2010 the then Prime Minister Kevin Rudd announced that the Government has decided to delay the implementation of the Carbon Pollution Reduction Scheme (CPRS).[3].

The former Prime Minister announced that the Australian Government will not introduce the CPRS until after the end of the current commitment period of the Kyoto Protocol (which ends in 2012) and only when there is greater clarity on the actions of other major economies including the US, China and India.

3.2.2 National Greenhouse and Energy Reporting Scheme (NGERS)

The *National Greenhouse and Energy Reporting Act 2007* (NGER 2007) establishes a national framework for corporations to report greenhouse gas emissions and energy consumption and production from 1 July 2008. The Act makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds listed below (DCC 2009):

- Corporate Level – 125 kt CO_2-e or 500 TJ (during FY08-09), reducing to 50 kt CO_2-e or 200 TJ (during FY10-11)
- Facility Level – 25 kt CO_2-e or 100 TJ

The NGER Act has been designed to provide robust data, which will serve as the foundation for an Australian Emissions Trading Scheme. BHP Billiton has been submitting its annual NGER reports, and for this year, the annual NGER report is due by 31st October 2011.

3.2.3 Energy Efficiency Opportunities (EEO)

The Energy Efficiency Opportunities Act 2006 was developed to improve the method of identifying and evaluating energy efficiency opportunities. Participation in the EEO regulation is mandatory for corporations that use more than 0.5 petajoules (PJ) of energy per year. This regulation requires reporting organisations to submit five year plans that set out proposals for assessing their energy usage and to identify, evaluate and report on cost effective energy savings opportunities.

BHP Billiton is currently registered with EEO regulation and has used an internal program referred to as the Energy Excellence (EEx) program to meet the intent and key requirements of EEO legislation. The overall objective of the EEx program is to identify initiatives and implement processes that ensure energy efficiency and energy source substitution opportunities are integrated into the business. EEx provides a framework for sites to evaluate energy savings opportunities in a manner consistent with EEO while retaining the flexibility to develop projects that can be fully integrated into the individual operations and business culture.

3.2.4 National Carbon Offset Standard

The National Carbon Offset Standard (the Standard) is intended to apply to voluntary abatement activity that occurs beyond that imposed by the CPRS. It came into effect on 1 July 2010. The standard provides guidance to businesses that wish to become carbon neutral or develop carbon

[3] http://www.theage.com.au/business/rudd-delays-carbon-scheme-until-2012-20100427-tp29.html

neutral products. This is done through the purchase and retirement of carbon offsets that are beyond those achieved by the CPRS but contribute to Australia's national emissions reduction targets.

3.2.5 Carbon Farming Imitative

The 'Carbon Farming Initiative' (CFI) would set up a new trading scheme that enables farmers, foresters, indigenous communities and conservation groups to carry out various practices and land-uses that reduce pollution from the farm or sequester carbon in the landscape. Draft legislation and methodology guidelines were released on 4 January 2011, the Australian government is working toward scheme commencement on 1 July 2011.

Within the CFI, it is proposed that two types of credits will be issued - Kyoto and non-Kyoto CFI credits[4]. Potential eligible abatement activities include[5];

- Reforestation and revegetation;
- Reduced methane emissions from livestock;
- Reduced fertiliser emissions;
- Manure management;
- Reduced emissions or increased sequestration in agricultural soils (soil carbon);
- Savanna fire management;
- Avoided deforestation;
- Burning of stubble/crop residue;
- Reduced emissions from rice cultivation; and
- Reduced emissions from landfill waste deposited before 1 July 2011.

3.3 State Regulation

3.3.1 Environmental Protection Authority (EPA) Guidance Notes

WA EPA Guidance Statement No.12, "Minimising Greenhouse Gas Emissions", (EPA 2002) addresses the minimisation of GHG emissions from significant, new or expanding operations and requires proponents to clearly indicate, in their environmental review documentation the following:

- GHG emissions inventory and benchmarking;
- Measures to minimise annual GHG emissions and over the life of the project;
- Carbon sequestration opportunities, such as bio-sequestration, geo-sequestration, chemical, soil uptake and reuse; and
- Benefits of reduced GHG emissions on a National or Global scale;

The Guidance Statement also suggests that proponents address/commit to:

- applying best practice to maximise energy efficiency and minimise GHG emissions;
- undertaking comprehensive analysis to identify and implement appropriate offsets; and

[4] "Kyoto" CFI credits would be issued for abatement that is recognised under Australia's Kyoto Protocol target. Credits for abatement that occurs prior to the end of the first Kyoto Protocol commitment period (2008-2012) could be exchanged for Kyoto Protocol units held by the Government – either Assigned Amount Units or Emissions Reduction Units – and could be exported to other Kyoto Protocol registries.

[5] http://www.nailsma.org.au/nailsma/projects/downloads/Carbon-Farming-Consultation-Paper.pdf

- undertaking ongoing programmes to monitor and report emissions and periodically assess opportunities to further reduce GHG emissions over time.

The WA EPA is currently in the process of updating Guidance Statement No. 12

3.4 BHP Billiton Position

In June 2007, the BHP Billiton Group released its Climate Change Position statement (BHP Billiton 2009b). The statement aims to:

- Understand GHG emissions from the full life cycle of the products the BHP Billiton Group produces;
- Improve the management of energy and GHG emissions across the BHP Billiton Group businesses;
- Commit US$300 million over five years to support the development of low emissions technology, energy excellence projects within the company and encourage emissions abatement by employees and local communities;
- Use technical capacity and experience of the BHP Billiton Group to assist governments and other stakeholders to design effective and equitable climate change policies, including market-based mechanisms such as emissions trading.

3.5 Yeelirrie Project Position

3.5.1 Sustainability in Design

BHP Billiton used sustainability design criteria to screen and identify opportunities where sustainability performance might be improved during the detailed design phase. The process of screening was a collaborative one, engineering design team provided innovative design solutions to combat GHG emissions and other environmental issues.

In undertaking the review of the design criteria, BHP Billiton focused on the following four sustainability goals:

- Minimise wastes, emissions and discharges to protect the quality of the surrounding environment during construction, operations and closure.
- Use resources (economic, raw materials, etc.) efficiently in the design, construction and operation of the project.
- Use water efficiently; maintain the quality of available water & protect the beneficial use of water during mining and post closure.
- Optimise the reduction in the greenhouse footprint of the mining, processing and transport operations through energy efficiency measures and the use of renewable energy.

GHG Emissions Forecast

4.1 GHG Emissions

4.1.1 Emission Sources

Emission sources and activity data description that underpin the GHG inventory are given in Table 4-1. Table 4-1 has been derived from Table 1-2 and Table 1-3 in Section 1.2.5 through regular consultation with the Yeelirrie project design engineers.

Table 4-1 Emission Sources and Data Description

Emission Activity	Description and Remarks
Fuel consumption for Power and Steam Generation	Annual electricity consumption is estimated at 72,000 MWh (BHP Billiton 2010) and 0.12 tonne of steam is consumed per tonne of ore processed (BHP Billiton 2009a)
Fleet fuel consumption	Annual diesel fuel consumption in the mining fleet as supplied by BHP Billiton (BHP Billiton 2010)
Land use change	Total land disturbance area for the Yeelirrie project is assumed to be 5,000 ha (refer Figure 1-1)
Emissions from chemical processes	▪ Waste water treatment; ▪ Oxidation reactions within the metallurgical process; and ▪ Tailings Storage Facility (TSF) - there is a risk that some or all of the 'sequestered' CO_2 may be released over time, if the pH of the tailings residue decreases to ≤ 5, or if the soluble carbonates and bicarbonates disintegrate to form more stable salts and carbon dioxide
Synthetic Gases	▪ Refrigerant gases used in air-conditioning both for buildings and mobile equipment. Assumptions made: - R 134a is the refrigerant gas used in both mobile equipment and buildings; - Operating emission factor (% of capacity/year) is 20% for mobile equipment and 35% for medium and large commercial refrigeration units (IPCC 2006). ▪ Mobile equipment numbers taken from

Emission Activity	Description and Remarks
	Copy of Yeelirrie trip planning & commodity estimates. ▪ Only low and medium voltage switchgears to be used. Consequently, SF_6 emissions have not been included in the GHG emissions inventory.
Fly In Fly Out	▪ 100 round trips per year. Aircraft consumes approximately 680 kg of Avtur per one way trip, and 100 round trips per annum (136 tonnes per annum). Flying time to Yeelirrie is assumed to be 2 hours per leg.
Explosives	▪ 70 tonnes of emulsions per annum are to be used as explosives
CO_2 used in process	▪ Based on the mass balance provided, 3.55 t/hour of CO_2 will be consumed in the process (BHP Billiton 2009a).
Waste	▪ Inert, recyclable and putrescible waste generated as a result of operations. For detailed lists of waste types and generation rates, refer Table 3.21 (BHP Billiton 2010)
Revegetation	▪ Progressive revegetation will begin from year 6 of operations

The major features of the proposed open pit are summarised in Table 4-2.

Table 4-2 Features of the Open Pit development

Features	Proposed Yeelirrie Development
Nominal mine life (years)	30
Mining rate (Mtpa)	Up to 8

4.1.2 GHG Emissions from Land Use Change

Full Carbon Accounting Modelling (FullCAM) is a model developed, named by the National Carbon Accounting System, Department of Climate Change, Australian Government, Canberra. The FullCAM is an integration of biomass, decomposition, soil carbon models and accounting tools to provide a single model capable of carbon accounting in transitional (e.g. afforestation, reforestation and deforestation) and mixed (e.g. agro forestry) systems. The FullCAM model can be run in point, estate (a mix of areas by age by activity types) and a spatial mode which will integrate information drawn from the remotely sensed land-cover-change program, productivity and climate surfaces and other ancillary data to perform the various accounting routines capable of meeting the various reporting requirements of the UN Framework Convention on Climate Change, and more specifically, the Kyoto Protocol. When calculating emissions from land use change in the proposed Yeelirrie development, a FullCAM model was typically run. This model provides an indication of the carbon stocks contained within the soil, above and below ground vegetation and debris in a mature (not regrowth) ecosystem. The FullCAM run for the site at Yeelirrie used the default vegetation type "Acacia Forest and Woodland". The values in Table 4-3 and Table 4-4 give an indication of carbon stocks for and the emissions caused if vegetation were cleared. The carbon stocks at this site are relatively low due to the generally low net primary productivity of the environment.

The following technical criteria were used in deriving the GHG emissions from land use change.

1. The carbon dioxide equivalent is the GHG emissions caused if vegetation was cleared and allowed to decay or burn. This is derived by multiplying the amount of carbon estimated by the FullCAM model by 3.67 (a standard multiplying factor).
2. Soil carbon is the largest component as the site has been assessed to be predominantly shrub land or grassland. If topsoil is to be cleared, then the soil carbon component should be considered an emission; if the topsoil is to remain in place, then the soil carbon pool would not be altered significantly by clearing vegetation.

The FullCAM plot for Yeelirrie includes above and below-ground vegetation and has included the carbon mass of above and below ground tree components with the expectation that roots are removed during clearing the below ground component.

There are some limitations associated with this site and the FullCAM model that have been taken into consideration whilst estimating GHG emissions due to vegetative clearing:

- FullCAM is inherently conservative in estimating carbon pools for most vegetation types (i.e. it tends to underestimate carbon stocks, anecdotally in some cases up to 30 per cent).
- FullCAM has been designed to model forested areas; it is less accurate for modelling of grasslands, savannahs, agricultural land etc.
- The definition of 'forest' for the purpose of the model is vegetation at least 2m high and with at least 20 per cent canopy cover. The photos of the Yeelirrie site (provided in the botanical report) suggest that much of the area does not meet this definition.
- The model assumes there are trees in the landscape (based on an "acacia forest/woodland") which contain more carbon than much of the actual landscape shown in the botanical report photos.

These values are applicable to the areas containing trees but are likely to be a slight overestimate in non-forest areas. As such, applying these values across the whole site could be a conservative approach to estimating emissions from land use change.

Table 4-3 FullCAM estimate of GHG emissions due to clearing of 'Acacia Forest and Woodland'

Carbon pool	Carbon mass (t C/ha)	Carbon dioxide equivalent (t CO_2-e/ha)
Soil	9.3	34.1
Debris	0.1	0.4
Above ground tree components	4.2	15.4
Below ground tree components	1.3	4.8
Total	**14.9**	**54.7**

Simulation for Saltbush (Atriplex)

The default vegetation type; *Chenopod Shrub, Samphire Shrub and Forbland* was used to run the simulation. Note that for this simulation, "tree components" refers to these vegetations.

Table 4-4 FullCAM estimate of GHG emissions due to clearing of 'Chenopod and Samphire shrub and Forbland'

Carbon pool	Carbon mass (t C/ha)	Carbon dioxide equivalent (t CO_2-e/ha)
Soil	9.1	33.4
Debris	1.9	7.0
Above ground tree components	3.8	13.9
Below ground tree components	3.6	13.2
Total	**18.4**	**67.5**

The following assumptions were made relating to the modelling in FullCAM and environmental conditions of the site. Terms used in the FullCAM model are in *italics*:

- Site location (which determines default environmental conditions) was Latitude -27.288706 and Longitude 120.10454.
- Used the default values for soil, rainfall, temperature and tree growth parameters.
- The model did not have any specific *soil data* for this location (this is often the case for regions where forestry is not a common land use). Therefore a (unspecified) default soil type was used.
- Used the Plot Type; Multilayer mixed (forest and agricultural) system.
- Simulated conditions under Agriculture plantation weed species prior to 'planting' (this reflects conditions under a grassland environment similar to that at the Yeelirrie site).
- 'Planted' a Mixed Species Environmental Planting of Acacia Forest and Woodland
- Simulated growth for 600 years (including an 18 year run-in). This was the point at which carbon pools were deemed to have 'stabilised' and best represents a native ecosystem in a natural (undisturbed) state.
- FullCAM output is on a per-hectare basis, values have been provided for 1 hectare.
- The whole site area is covered by Acacia Forest and Woodland, as defined in FullCAM.

4.2 GHG Emissions from Yeelirrie Project

GHG emissions for the project have taken into account the project life emissions during the following phases:

- Construction Phase;

- Operations Phase - mining and processing; and
- Decommissioning Phase.

Assumptions

The following assumptions were made in estimating the annual and life of project GHG emissions:

- Indicative figures for the consumption of and generation of energy, waste, transportation, etc. taken from Project Description (BHP Billiton 2010);
- Metallurgical plant throughput is up to 1.2 Mtpa;
- Life of the mine is 30 years, whilst, the life of the plant is 30 years; Total land clearing is assumed to be 5,000 ha (refer Figure 1-1);
- Diesel fuel consumption as per the project trip planning study estimates (Yeelirrie_Trip Planning & Commodity Estimates_Base Case_v6.0_17Mar 10.xls);
- Construction phase has been assumed to last for 2 years;
- Hydrofluorocarbons will be used in the heating, ventilation and air conditioning systems;
- Sulphur hexafluoride is not likely to be used for electrical switch gear;
- Mine dewatering has the capacity to wither vegetation in and around the project site. However, it is assumed that BHP Billiton will take adequate measures to reduce vegetative loss in surrounding areas;
- Progressive revegetation has been assumed to begin in year 6 of operations;
- 70 tonnes of Ammonium Nitrate Fuel Oil (ANFO) and emulsions per annum will be used as explosives; and
- Embedded energy and greenhouse gas emissions of materials used has not been taken into consideration into the emissions inventory.

4.2.2 Total Gross Project GHG Emissions for the Entire Project Life

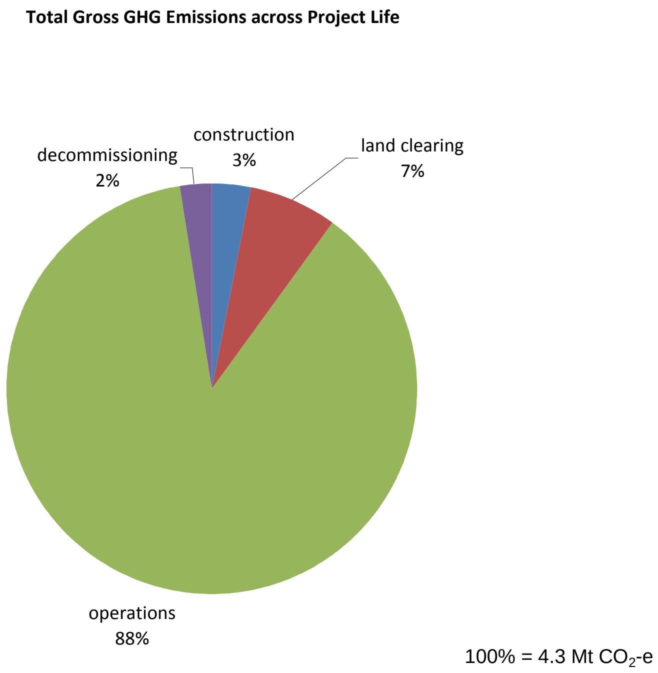


Figure 4-1 Indicative Total Gross GHG Emissions across project life

Figure 4-1 shows the total indicative GHG emissions across the project life. Total gross (excluding GHG emissions sequestered through revegetation) project GHG emissions are approximately 4.3 Mt CO_2-e, of which approximately 88 per cent is accounted for in the operations phase. A one off release of GHG emissions (7 per cent) associated with land clearing (5,000 ha) has been included.

Mining Operations

Table 4-5 shows the total indicative gross GHG emissions across the project life. Total project GHG emissions are approximately 4.3 Mt CO_2-e[6].

Table 4-5 Total Indicative GHG Emissions across the life of project

Emission Source	Indicative Total GHG Emissions (t CO_2-e)
Land Clearing	273,200
Construction Phase	134,000
Operations Phase	3,794,000
Decommissioning Phase	105,000
Carbonation Process	-840,000
De-carbonation – from Tailings Residue	840,000
Re-vegetation	-287,000

[6] CO_2 sequestered in the carbonation process has not been included in the net emissions.

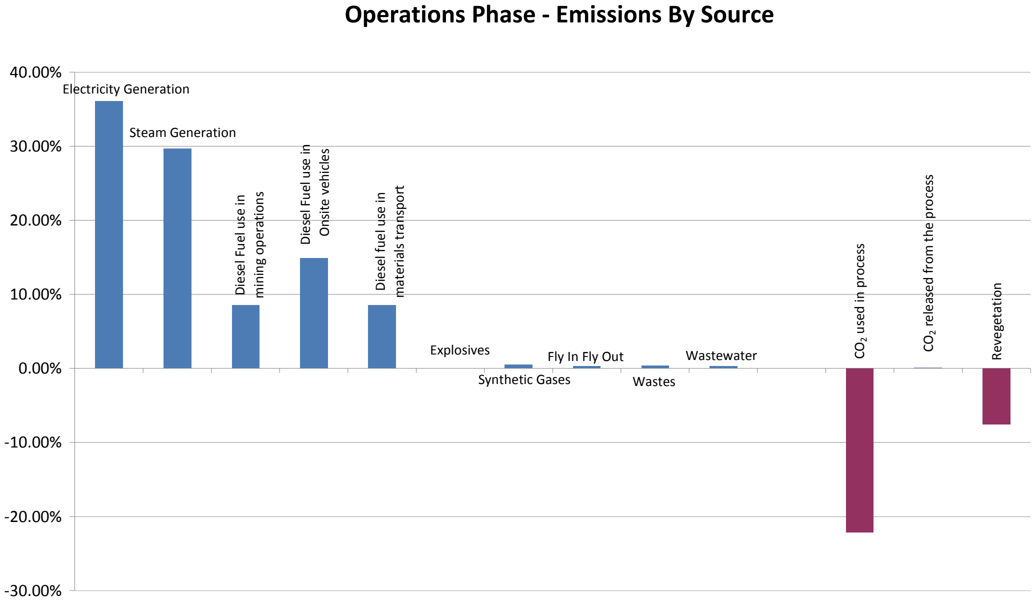
Table 4-5 provides the indicative GHG emissions across the project life. The progressive rehabilitation of the site is estimated to result in sequestering approximately 287,000 t CO_2-e.

4.2.3 GHG Emissions by Source during Operations Phase

Table 4-6 shows predicted annual GHG emissions by source during the operations phase.

Table 4-6 Predicted Annual GHG Emissions during Operations Phase

Activity/source	Annual GHG emissions (t CO_2-e per annum)	
	Scope 1	Scope 3
Steam generation	38,000	Not Applicable (NA)
Electricity generation	46,000	NA
Mining and light vehicle fleet	18,700	10,800
Metallurgical processing emissions	-28,000	NA
Waste water treatment	370	NA
Tailings Storage Facility (TSF)	28,000	NA
Explosives	12	NA
Waste	500	NA
Synthetic gases	600	NA
Materials transport	NA	10,800
Workforce transport	NA	400
CO_2 released from the metallurgical process	200	-
TOTAL	**104,382**	**22,000 (average)**



100% = 126,400 t CO_2-e

Figure 4-2 Indicative GHG Emission Sources - Operations Phase

Figure 4-2 shows the indicative total GHG emissions by source during the operations phase. At approximately 36 per cent, diesel fuel consumption for electricity generation is the single largest source of total GHG emissions during the operations phase, followed by diesel fuel consumption for steam generation at 30 per cent. This is followed by diesel fuel use in on-site vehicles (15 percent).

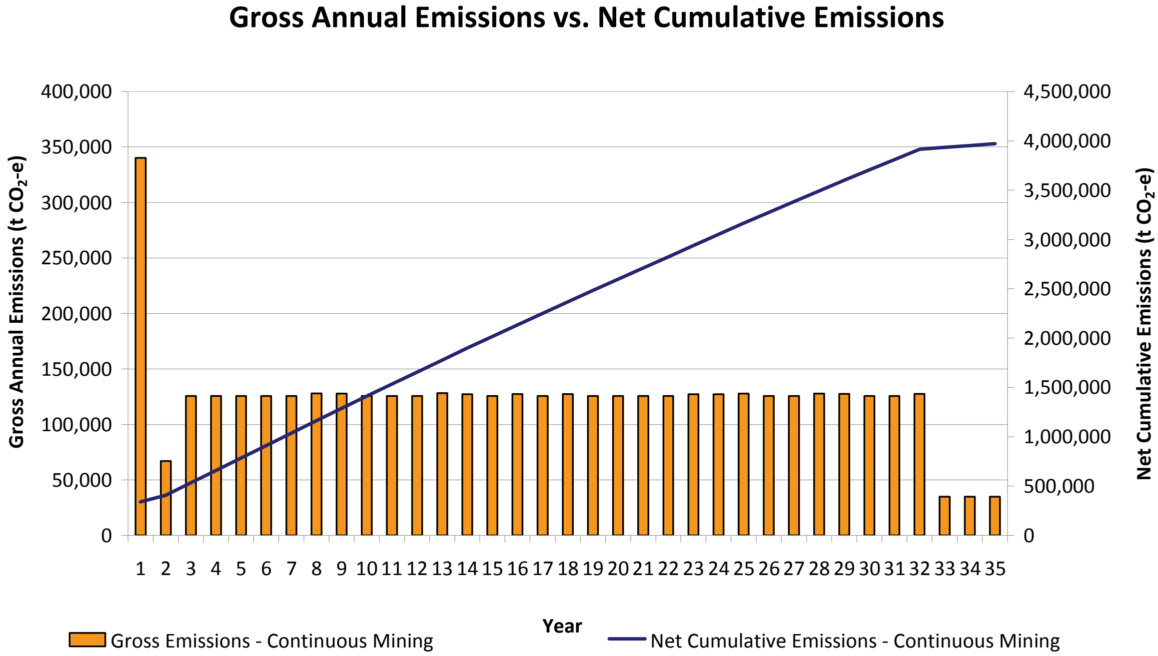


Figure 4-3 Indicative Total Annual GHG Emissions vs. Cumulative Emissions across the Project Life

Figure 4-3 shows the indicative total annual GHG emissions versus the cumulative GHG emissions across the project life. From the figure, it is evident that land clearing emits approximately two times the annual GHG emissions during the operating phase.

Net cumulative GHG emissions for the entire project life are approximately 4 Mt CO_2-e when including the CO_2 sequestered due to progressive rehabilitation of the site, but not the CO_2 that is re-used in the process. Reasons for this are described in Section 4.3.

4.3 GHG emissions from tailings residue storage

Approximately 28,000 tonnes CO_2 per annum have been estimated to be accumulated and stored in the TSF as sodium carbonates and sodium bicarbonates. This is from the reuse of exhaust emissions in the metallurgical plant that originate from the electricity and steam generators. For the whole of project life, it is estimated that approximately 840,000 tonnes CO_2 may potentially be released from the TSF.

4.4 Life Cycle Greenhouse Gas Emissions

The extraction of uranium by BHP Billiton at its Yeelirrie mine site is the first step in a long and complex process to provide nuclear generated energy. The end-product of uranium mining may be CO_2-free nuclear power but the extraction and conversion of the ore consist of activities that generate and emit CO_2 to the atmosphere.

4.4.1 Potential Life Cycle Emission Benefits

All manufactured products cause environmental degradation in some way, whether from their manufacturing, use or disposal. Life Cycle Assessment (LCA) is a method to analyse resource issues across the life cycle of a product and can systematically identify key areas to improve environmental and economic performance.

Studies of nuclear fuel life cycle greenhouse gas emissions have shown that the generation of nuclear electricity produces about 66 g of CO_2-e per kWh of electricity generation (Sovacool 2008; Lenzen 2008). This emissions intensity is about 10 to 15 times less than that of other fossil fuel electricity generation and at the higher end of the range of renewable electricity generation emission intensities.

An extensive analysis of the life cycle greenhouse gas emissions of electricity-generating technologies has been undertaken (Sovacool 2008; Lenzen 2008). These studies highlighted the various aspects of the nuclear fuel cycle that have the greatest influence on life cycle greenhouse gas emissions. Specifically these are:

- the grade of the uranium ore mined
- the method of enrichment
- the conversion rate of the nuclear fuel cycle (i.e. the amount of fuel recycling)
- the source (fossil, renewable or nuclear) of electricity used for the enrichment phase and the overall greenhouse gas intensity of the electricity mix in the countries where fuel cycle activities are undertaken.

Sovacool (2008) undertook a literature review of 19 previous nuclear life cycle emission analyses from more than 60 nuclear power stations. The results of this study are presented in Table 4-7.

Table 4-7 Emissions intensity of the nuclear fuel cycle (Sovacool 2008)

Emissions	Emissions intensity (g CO_2-e per kWh of generated electricity)					
	Front-end[1]	Construction[2]	Operation[3]	Back-end[4]	Decommissioning[5]	Total
Minimum	0.58	0.27	0.1	0.4	0.01	1.36
Maximum	118	35	40	40.75	54.5	288.25
Mean	25.09	8.2	11.58	9.2	12.01	66.08

[1] Front-end – Mining, milling, conversion, enrichment, fuel fabrication, and transport.
[2] Construction – All materials and energy inputs for building the power station.
[3] Operation – All energy needs for maintenance, cooling and fuel cycles and back-up generators.
[4] Back-end – Fuel processing, conditioning, reprocessing, interim and permanent storage.
[5] Decommissioning – Deconstruction of the facility and land reclamation.

Sovacool analysed more than one hundred lifecycle studies of nuclear plants around the world. Sovacool found that estimates of total lifecycle carbon emissions ranged from 1.4 grams of carbon dioxide equivalent per kilowatt-hour (g CO_2-e/kWh) of electricity produced, up to 288 g CO_2-e/kWh. Sovacool believes the mean of 66 g CO_2-e/kWh to be a reasonable approximation.

According to Sovacool's analysis, nuclear power, at 66 g CO_2-e/kWh emissions (Sovacool 2008), is well below scrubbed coal-fired plants, which nominally emit 960 g CO_2-e/kWh, and natural gas-fired plants, which nominally emit 443 g CO_2-e/kWh.

A similar study undertaken by Lenzen (2008) on behalf of the Australian Government concluded that the greenhouse gas intensity of nuclear power was around 60 g CO_2-e per kWh of generated electricity (ranging between 10–130 g CO_2-e per kWh) for light water reactors, and around 66 g CO_2-e per kWh (ranging between 10–120 g CO_2-e per kWh) for heavy water reactors. The greenhouse gas intensity of nuclear power is lower than any fossil-fuelled power technology.

The results of the above-mentioned nuclear fuel life cycle emissions analysis are compared to other forms of electricity-generation technologies in Table 4-8, which shows both international greenhouse gas intensities and those in an Australian context (study ranges within brackets).

Table 4-8 Greenhouse gas emissions intensity of electricity generation technologies

Electricity technology	Greenhouse gas intensity (g CO_2-e/kWh)	
	International	Australian
Off-shore wind[1]	9	n.a.
On-shore wind[1]	10	21 (13−40)
Biogas[1]	11	n.a.
Hydroelectric (run-of-river)[1]	13	15 (6.5−44)
Solar thermal[1]	13	n.a.
Biomass[1]	28	n.a.
Solar PV[2]	32	106 (53−217)
Geothermal[1]	38	n.a.
Nuclear[3]	66	65 (10−130)
Natural gas (combined cycle)[4]	443	577 (491−655)
Natural gas (open cycle)	n.a.	751 (627−891)
Fuel cell[4]	664	n.a.
Diesel[4]	778	n.a.
Heavy oil[4]	778	n.a.
Black coal (supercritical)[4]	n.a.	863 (774−1046)
Black coal (new subcritical)[4]	n.a.	941 (843−1,171)
Black coal (scrubbed)[4]	960	n.a.
Black coal (unscrubbed)[4]	1,050	n.a.
Brown coal (new subcritical)[4]	n.a.	1,175 (1,011−1,506)

[1] Sourced from Pehnt 2006.
[2] Sourced from Fthenakis and Kim 2008.
[3] Sourced from Sovacool 2008.
[4] Sourced from Gagnon et al 2002.

It can be seen from the data in Table 4-8 that the nuclear fuel cycle emits less greenhouse gas than any fossil fuel technology, and emissions are similar to, though at the upper range of, the renewable electricity generation technologies.

4 GHG Emissions Forecast

A high-level greenhouse gas emission life cycle assessment of the Yeelirrie development was undertaken using available literature to estimate emissions associated with uranium production, use and disposal.

Approximately 9.05 kg of U_3O_8 is required to produce 1 kg of nuclear fuel-grade UO_2, sufficient to generate approximately 360,000 kWh of electricity. Given that 1 kg of Yeelirrie UOC is equivalent to 2.8 kg of U_3O_8, and using the nuclear life-cycle information presented in the literature, it is estimated that approximately 7 tonne of CO_2-e would be generated per one kilogram of Yeelirrie UOC.

Using the indicative production rates, of up to 3,500 tpa of UOC, the net greenhouse gas benefit of the expanded operation would be up to 5,900 Mt CO_2-e over the proposed 30-year life of the operation by comparison to Australia's combined cycle natural gas power generation.

Comparison with Global, National and State GHG Emissions

A comparison of the annual GHG emission forecast from the Yeelirrie development against the current and projected future state, national and international annual GHG emissions is discussed below.

5.1 Current and Projected GHG Emissions

Over the 30 year life of the proposed Yeelirrie development, Western Australian, Australian and global greenhouse gas emissions are predicted to rise from the current levels described in Table 5-1 (ABARE 2007, DEC 2008). The annual greenhouse gas emissions from the proposed Yeelirrie development (126,400 tpa of CO_2-e) were compared against the projected future state, national and global emissions.

Table 5-1 Current and Projected Australian and global greenhouse gas emissions in Mtpa of CO2-e (excluding land use change)

Source	Unit[1]	2010	2020	2030	2040
Western Australia (DEC 2008)	Total	74	81	92	102
	%	0.17	0.16	0.14	0.12
Australia (DEC 2008)	Total	549	638	695	752
	%	0.023	0.02	0.018	0.017
Global (ABARE 2007)	Total	42,300	53,800	63,600	75,800
	%	0.0003	0.0002	0.0002	0.00017

[1]Total refers to the projected GHG emissions for the source, and % refers to the proportion of that total represented by the proposed Yeelirrie development

The data presented in Table 5-1 show that, as a proportion of state, national and global emissions, the contribution of the development to atmospheric greenhouse gas emission levels is very low. However, given the national and global importance of this issue, BHP Billiton would investigate greenhouse gas emissions reduction initiatives throughout the life of the proposed development.

5.2 Conclusions

This assessment has identified and quantified the characteristics of likely greenhouse gas sources, assessed them in the context of state, national and global greenhouse gas emission projections and provided a summary of potential emission reduction opportunities that may be investigated into the future. The assessment has followed accepted practice for undertaking such GHG forecast and the findings are presented as estimates due to the inherent uncertainties associated with undertaking such predictive assessments.

The predictive estimate calculated a total gross emission of approximately 4.3 Mt CO_2-e across the project life. The project life includes land clearing, construction, operations and decommissioning, for a period of up to 30 years. When including into the calculated emissions, sequestration due to rehabilitation of the site, the net GHG emissions are estimated to be 4.0 Mt CO_2-e.

Whilst these emissions are very low on a state, national and global scale, BHP Billiton would investigate greenhouse gas emission abatement projects throughout the life of the proposed development as technologies improve. These projects will broadly be categorised into those that reduce energy demand, and those that provide a cleaner energy supply. The on-going monitoring, implementation, and reporting of these abatement projects would be managed through a site based Greenhouse Gas and Energy Management Plan.

References

ABARE 2007. *Technology: Towards a Low Emission Future*, Australian Bureau of Agricultural and Resource Economics, ABARE Research Report No. 07.16, Canberra, September 2007, ISBN 1920925996, pp. 1-149.

BHP Billiton 2009a, *Yeelirrie Project Design Criteria: Option 4A. YEE24000-PR-DC-00-0006 Rev C*, prepared for BHP Billiton Yeelirrie Development Company Pty Ltd August 2009.

BHP Billiton 2009b, *BHP Billiton Climate Change Position Statement*, website: http://www.bhpbilliton.com/bbContentRepository/docs/SustainableDevelopment/policiesAndKeyDocuments/ClimateChange.pdf, accessed on 20 January 2011.

BHP Billiton 2010, *Chapter 3: Project Description, YEE88300-EN-ST-0003*, prepared for BHP Billiton Yeelirrie Development Company Pty Ltd, September 2010.

BoM 2011a. *Australian climate variability & change – Trend Maps*, website: http://reg.bom.gov.au/cgi-bin/climate/change/trendmaps.cgi accessed on 21 January 2011.

BoM 2011b. *Australian climate variability & change* – Time series graphs, website: http://reg.bom.gov.au/cgi-bin/climate/change/timeseries.cgi?graph=tmax&area=aus&season=0112&ave_yr=7 http://reg.bom.gov.au/cgi-bin/climate/change/trendmaps.cgiaccessed on 21 January 2011.

Chambers, L.E. 2006. *Associations between climate change and natural systems in Australia*. Bulletin of the American Meteorological Society, Vol. 87, Issue No. 2, pp. 201-206.

DCC 2009. *National greenhouse and energy reporting system measurement: Technical guidelines for the estimation of greenhouse gas emissions by facilities in Australia*. Department of Climate Change, Australian Government, Canberra, June 2009, website: http://www.climatechange.gov.au/government/initiatives/national-greenhouse-energy-reporting/~/media/publications/greenhouse-report/nger-measurement-technical-2009.ashx accessed on 21 January 2011, pp. 1-375.

DCCEE 2010. *National Greenhouse Accounts (NGA) Factors*, published by the Department of Climate Change and Energy Efficiency, Commonwealth of Australia, Canberra, July 2010, pp. 1-74.

DEC 2008. *Assessment of Greenhouse Gas Abatement Potential and Cost in Key Sectors of the Western Australian Economy*, December 2008, Government of Western Australia, Report Prepared by the NOUS Group and SKM, pp.1-249.

DEC 2009. *Factsheet 6, Evidence of Changing Climate, Climate Change and Biodiversity*, October 2009, Perth, Government of Western Australia, website: http://www.dec.wa.gov.au/content/view/5174/1927/lang,en/ accessed on 21 January 2011.

EPA 2002. *Guidance for the Assessment of Environmental Factors No. 12: Guidance for Minimising Greenhouse Gas Emissions*, Government of Western Australia, Perth.

Fthenakis, V and Kim, H 2008. *Emissions from Photovoltaic Life Cycles*. Environmental Science and Technology, Vol. 42, 2008, pp. 2168-2174.

Gagnon, L., Belanger, C., Uchiyama, Y 2002. Lifecycle assessment of electricity generation options: The status of research in year 2001. Energy Policy, Vol. 30, 2002, pp. 1267-1278.

Garnaut R 2008. *Chapter 3: Emissions in the Platinum Age, the Garnaut Climate Change Review, Final report*, Cambridge University Press, ISBN. 9780521744447, Canberra and Melbourne, 30

6 References

September 2008, website: http://www.garnautreview.org.au/pdf/Garnaut_prelims.pdf accessed on 21 January 2011.

Greenhouse and Energy Taskforce 2006. *A Cleaner Energy Future: Strategies to Reduce Greenhouse Gas Emissions from the Western Australian Stationary Energy Sector*, a Report prepared for the Government of Western Australia, Perth, December 2006, pp. 1-38.

IPCC 1990. *Climate Change: The IPCC Scientific Assessment*, WMO & UNEP, Cambridge University Press, Cambridge, 1990.

IPCC 1995. *Intergovernmental Panel on Climate Change Second Assessment Report*, Climate Change 1995, website: http://www.ipcc.ch/pdf/climate-changes-1995/ipcc-2nd-assessment/2nd-assessment-en.pdf accessed on 21 January 2011.

IPCC 2006. *Guidelines for National Greenhouse Gas Inventories, Volume 3, Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances*, *Table 7.9 Estimates for Charge, Lifetime, and Emission Factors for Refrigeration and Air-conditioning Systems*, page 52 of 71, 2007.

IPCC 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment, Report of the Intergovernmental Panel on Climate Change 2007, eds ML Parry, OF Canziani, JP Palutikof, PJ van der Linden & CE Hanson, Cambridge University Press, Cambridge, UK.

Lenzen, M. 2008 *Life cycle energy and greenhouse gas emissions of nuclear energy: A review*. Energy Conversion and Management, Vol. 49, pp. 2178-2199.

NGER 2007. *National Greenhouse and Energy Reporting (NGER) Act*, Department of Climate Change, Australian Government, Canberra, 2007.

Pehnt, M 2006. *Dynamic lifecycle assessment of renewable energy technologies*. Renewable Energy Vol. 31, 2006, pp. 55 – 71.

PMSEIC 2007. *Climate Change in Australia: Regional Impacts and Adaptation – Managing the Risk for Australia*, Report Prepared for the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) Independent Working Group, Canberra, June 2007, pp. 1-63.

Sovacool, Benjamin K 2008. *Valuing the greenhouse gas emissions from nuclear power: A critical survey*, Energy Policy, Vol. 36, 2008, pp. 2940-2953.

UNFCCC 2010. *Outcome of the work of the adhoc working group on Long-term Cooperative Action under the Convention*, COP 15 Report on 15 Decision Outcomes, March 2010.

WNA 2010. *The Nuclear Fuel Cycle, Public Information Series,* World Nuclear Association, August 2010.

WRI and WBCSD 2004. *The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard*, Revised Edition, March 2004, pp. 1-116.

7 Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of BHP Billiton and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated July 2009.

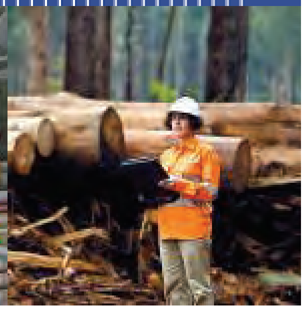
The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared during April 2009-January 2011 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.







URS Australia Pty Ltd
Level 3, 20 Terrace Road
East Perth WA 6004
Australia
T: 61 8 9326 0100
F: 61 8 9326 0296

www.ap.urscorp.com