9.9 Atmospheric Gases (Greenhouse Gas Emissions)

9.9.1 EPA Objective

The EPA's objective with regards to greenhouse gas emissions is:

- To minimise the emissions of greenhouse gases through the application of best practice.

9.9.2 Relevant Legislation and Policy

Gases such as water vapour, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), absorb and re-emit infrared radiation from the sun warming the Earth's atmosphere and these gases are called GHG. This GHG warming is a natural phenomenon and maintains temperatures suitable to support life.

However, concentrations of GHG have increased significantly since the Industrial Revolution in the 18th century and have been linked to warming of the global climate. The Fifth Assessment Report, produced by the Intergovernmental Panel on Climate Change (IPCC, 2014), states that "Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history". The report also states that "warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia."

The United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty that aims to limit atmospheric GHG concentrations to levels below those at which unacceptable impacts would occur. Australia has signed and ratified this treaty. Australia is also a signatory to the Kyoto Protocol which is an addition to the UNFCCC treaty and has powerful and legally binding measures including emission targets for developed nations.

The National Greenhouse and Energy Reporting System (NGERS), comprising the *National Greenhouse and Energy Reporting Act 2007* (Cwlth) (NGER Act), National Greenhouse and Energy Reporting Regulations 2008 (Cwlth) (NGER Regulations) and National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Cwlth) (NGER Measurement Determination, updated annually) was introduced to provide for the reporting and dissemination of information related to GHG emissions, GHG projects, energy production and energy consumption. The NGER framework contains mandatory reporting provisions for corporations who emit over 50,000 t of CO_2-e per annum or demand over 200 terajoules (TJ) of energy; or for individual facilities where these emit over 25,000 t of CO_2-e per annum or have an energy demand of greater than 100 TJ. Information from NGERS is used in the National Greenhouse Accounts to meet Australia's GHG reporting obligations under the UNFCCC and to track progress against Australia's target under the Kyoto Protocol. The NGERS framework provides information to Australian companies on how GHG emissions should be calculated.

The government of Western Australia's view is that the regulation of greenhouse gas emissions are primarily matters for the Australian Government. The Government of Western Australia has nevertheless prepared a statement outlining the key policies it will adopt in response to climate change (Government of Western Australia, Adapting to our changing climate, October 2012). The EPA has also released a guidance statement for minimising GHG emissions (EPA, 2002a). This guidance specifically addresses the minimisation of GHG emissions from significant new or expanding operations and outlines the information the EPA will consider when assessing proposals where GHG emissions is a relevant environmental factor in an assessment. The guidance recommends that best practice is applied to maximise energy efficiency and minimise GHG emissions, comprehensive analysis is undertaken to identify and implement appropriate offsets, and that proponents undertake an ongoing program to monitor and report emissions and periodically assess opportunities to further reduce GHG emissions over time.

9.9.3 Studies and Investigations

A GHG assessment was undertaken for Yeelirrie by URS (URS 2015). The report is attached in Appendix L2. The purpose of the assessment was to provide a GHG emission forecast for the proposed Project by applying consistent international and Australian methodologies.

For the purposes of the study, the following emissions were assessed:

- Scope 1 – Direct GHG emissions. Emissions occur from sources that are owned or controlled by Cameco, such as energy consumption for electricity and steam generation and fuelling of the mine fleet.
- Scope 2 – Indirect GHG emissions. Emissions arising from the generation of purchased electricity, steam, and/or heating/cooling by third party sources. Cameco is not proposing to purchase electricity, steam, heating or cooling and therefore no Scope 2 emissions were included in the assessment.
- Scope 3 – Other indirect GHG emissions. Emissions that arise as a consequence of the upstream and downstream corporate value chain, sources used by Cameco that are owned or controlled by third parties, such as air flights and off-site transport. Scope 3 emissions were limited to those activities within Australia that were a consequence of the proposed Project's activities, specifically:
  - diesel fuel for transport of construction materials to site;
  - diesel fuel for transport of UOC to port (Adelaide and/or Darwin);
  - aviation fuel (Avtur) associated with the fly-in, fly-out workforce; and
  - hazardous waste transported off-site for disposal by licensed third parties.

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 Project infrastructure, were not included in the assessment. However, the URS report presents a discussion of the life cycle emissions associated with the mining, processing and use of uranium (Appendix L2).

The emissions generated from the following sources were used in the assessment:

- stationary energy emissions, such as from fuel burning equipment for steam and electricity generation;
- transport fuel emissions;
- emissions associated with changes to land use, such as land clearing; and
- emissions associated with chemical reactions within the tailings storage facility.

The emission factors used in this study were from the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DOE, 2014b) or, where NGER factors were not available, the National Greenhouse Accounts (NGA) Factors, 2014 were used (DOE 2014a). 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 Global Warming Potential (GWP) and the amount emitted. Land clearing emissions were estimated 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 3.1.1 of the URS Report (Appendix L2).

9.9.4 Existing Environment

The Project is located in the East Murchison region in an area which is sparsely populated. The nearest settlements are the accommodation village (14.4 km) and the Yeelirrie Homestead (16.9 km) and the Ulalla Homestead (28.8 km). The existing environment, relevant to air emissions is described in more detail in Section 9.8.

9.9.5 Potential Impacts

GHG emissions for the Project were calculated for the following phases of the Project:

- Land clearing
- Construction Phase – construction and pre-stripping;
- Operations Phase - mining and processing; and
- Decommissioning Phase.

The inventory of direct (Scope 1) GHG emissions is presented in Table 9-70 (URS, 2015).

Table 9-70: Inventory of estimated direct (Scope 1) GHG emission sources

Activity	Source	Estimated Annual Consumption (except where noted)
Land use change	Land clearing	Open pit – 726 ha over the life of the Project, with progressive rehabilitation from Year 12
		Infrastructure – 1,695 ha
Mining / light vehicle fleet	Diesel fuel	6,190 kL
Explosives	ANFO/ANE	70 t
Steam generation	Diesel fuel	26,440 kL
Electricity generation	Diesel fuel	39,260 kL
Process emissions	Absorption	CO_2-e generated from steam and electricity generation absorbed in process
TSF	Desorption	Absorbed CO_2-e is assumed, as a worst case, to be liberated from the TSF
Liquid waste	Anaerobic	24,400 kL (wastewater)
Putrescible solid waste	BOC	500 t of mixed solid wastes
Synthetic gases	Leakage	20% of capacity for mobile equipment, 35% of capacity for stationary equipment

Indirect (Scope 3) emission sources are presented in Table 9-71.

Table 9-71: Inventory of estimated indirect (Scope 3) GHG emission sources

Activity	Source	Estimated Annual Consumption (except where noted)
Materials transport	Diesel fuel	8,000 kL
Workforce transport	Avtur fuel	2,040 kg of Avtur per one way trip. 100 round trips per annum (412 t Avtur per annum)
On-site hydrocarbon scope 3 component	Grease/ lubricants	On-site oil/grease consumption of 28 tonnes

Estimated total GHG emissions for the Project are presented in Table 9-72 (URS, 2015).

Table 9-72: Estimated gross GHG emissions across the life of the Project

Emission Source	Estimated Total GHG Emissions (t CO_2-e)
Land clearing	31,380
Revegegation	-30,100
Construction Phase	316,630
Operations Phase	3,234,040
Decommissioning Phase	182,500

The predictive estimate calculated a total gross emission of approximately 3.76 x 10^6 t CO_2-e across the Project life of 22 years. When sequestration due to rehabilitation of the site is included into the calculated emissions, the net GHG emissions are estimated to be 3.73 x 10^6 t CO_2-e.

The breakdown of emissions during operations, by source are detailed in Table 9-73 (URS, 2015).

Table 9-73: Estimated annual GHG emissions during operations

Activity/Source	Scope 1	Scope 3
Steam generation	70,920	Not applicable (NA)
Electricity generation	105,330	NA
Mining and light vehicle fleet	15,590	490
Waste water treatment	370	NA
CO_2 absorption into liquor	-13,600	NA
TSF	13,600	NA
Explosives	10	NA
Waste	500	NA
Synthetic gases	620	NA
Materials transport	NA	21,590
Workforce transport	NA	80
CO_2 desorption from TSF	190	NA
Total	**193,530**	**22,160 (average)**

Diesel fuel consumption for electricity generation is the single largest source of total GHG emissions (49%) during the operations phase, followed by diesel fuel consumption for steam generation (33%) and diesel fuel use in off-site vehicles (10%).

Over the 23 year life of the proposed Project, Western Australian, Australian and global greenhouse gas emissions are predicted to rise from the current levels. The average annual greenhouse gas emissions from the proposed Project (215,690 tpa of CO_2-e) were compared against the projected future state, national and global emissions. As a proportion of these emissions, the contribution of the development to atmospheric GHG emission levels from the Project is very low. However, given the national and global importance of this issue, Cameco will investigate GHG emissions reduction initiatives throughout the life of the proposed Project.

9.9.5.1 Life Cycle Assessment

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 GHG emissions to the atmosphere. A high-level GHG emission life cycle assessment of the Project was undertaken using available literature to estimate emissions associated with uranium production, use and disposal (URS, 2015).

Studies of the nuclear fuel cycle GHG emissions have shown that the generation of nuclear electricity produces about 66 grams of CO_2-e per kWh (g CO_2-e/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. The studies undertaken by Sovacool (2008) and Lenzen (2008) highlighted the various aspects of the nuclear fuel cycle that have the greatest influence on life cycle GHG 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 GHG intensity of the electricity mix in the countries where fuel cycle activities are undertaken.

Approximately 8.49 kg of pure U_3O_8 from Yeelirrie is required to produce 1 kg of 3% U_{235} nuclear fuel-grade UO_2, sufficient to generate approximately 304 MWh of electricity. Given that 1 kg of uranium (U) is equivalent to 1.18 kg of 100% pure U_3O_8, and using the nuclear life-cycle information presented in the literature, it is estimated that 1 kg of pure U_3O_8 has the energy equivalence of approximately 9.3 kL of diesel that would generate 24.86 t of CO_2-e. Therefore, the CO_2-e saving is 24.81 t of CO_2-e per kilogram of U_3O_8 produced (URS, 2015).

9.9.6 Management

Avoid and Minimise

In term of management and reduction of GHG emissions, two main categories exist within the context of mining operations. Demand-side management relates to energy requirements throughout the site and supply-side management refers to how that energy is supplied. Cameco will minimise GHG emissions through management of both energy demand and energy supply via on-site management programs specifically designed through on-site studies. This may include the following measures:

- optimisation of the proposed mining fleet size (number of trucks versus size of trucks) in order to best meet the targets of the mine plan and optimise diesel demand;
- optimisation of the metallurgical process to reduce the electricity and steam requirements, including the capture and use of waste heat where possible, and thus reduce the site diesel demand; and
- incorporation of energy efficiency measures for the accommodation and administration facilities.

Measures to supplement energy supply:

- solar hot water systems and solar photovoltaic systems for the site administration and accommodation facilities;
- solar photovoltaic power systems for powering the remote groundwater wells and associated pumping stations; and
- consideration of biodiesel blends in the mining fleet and for the generation of on-site steam and electricity.

Cameco will continue to investigate GHG emission abatement projects throughput the life of the Project as technologies improve. The on-going monitoring, implementation and reporting of these abatement projects will be managed through a site based GHG and Energy Management Plan.

GHG emissions from the Project are as low as reasonably practicable for a Project of this scale and duration.

Rehabilitate

Disturbed areas that are no longer required for the operation of the Project will be progressively rehabilitated over the life of the mine to offset GHG emissions from clearing.

9.9.7 Commitments

Cameco commits to:

- Developing a GHG and Energy Management Plan.

9.9.8 Outcomes

Taking into account the Project design and proposed management measures to be implemented, Cameco believes that the Proposal will meet the EPA's objective with regards to Air Quality () Greenhouse Gas Emissions).