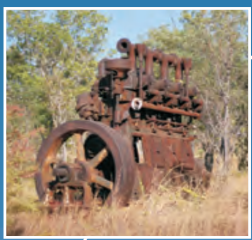

APPENDIX X

Greenhouse Gas Assessment

CLIENTS | PEOPLE | PERFORMANCE

Vista Gold Australia Pty Ltd

Mt Todd Gold Project

Greenhouse Gas Assessment

May 2013

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

This Mt Todd Gold Project Greenhouse Gas Assessment ("Report"):

1. *has been prepared by GHD Pty Ltd (GHD) for Vista Gold Australia Pty Ltd (Vista Gold);*
2. *may only be used and relied on by Vista Gold;*
3. *must not be copied to, used by, or relied on by any person other than Vista Gold without the prior written consent of GHD;*
4. *may only be used for the purpose of estimating greenhouse gas emissions from the proposed construction and operation of Mt Todd gold mine (and must not be used for any other purpose).*

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than Vista Gold arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report:

- *were limited to those specifically detailed in section 1 of this Report;*
- *did not include estimating activity data or deriving emission factors.*

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report ("Assumptions"), including (but not limited to) assumptions listed in section 3 of this report.

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on for 12 months, after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

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Executive Summary

Vista Gold Australia Pty Ltd (Vista Gold) proposes to re-establish and operate the Mt Todd Gold Mine, located 55km north of Katherine and 250km south of Darwin.

This greenhouse gas assessment has been undertaken by GHD on behalf of Vista Gold Australia Pty Ltd as part of the Draft Environmental Impact Statement for the Mt Todd Gold Project.

This report has been prepared to estimate the greenhouse gas emissions associated with construction, operations and mine closure, and to develop mitigation measures to minimise impacts.

Emissions have been separated into Scopes 1, 2 and 3 in accordance with the Greenhouse Gas Protocol (WRI et al 2004). These scopes are defined as follows:

1. Scope 1 emissions are greenhouse gas emissions created directly by a person or business from sources that are owned or controlled by that person or business.
2. Scope 2 emissions are greenhouse gas emissions created as a result of the generation of electricity, heating, cooling or steam that is purchased and consumed by a person or business. These are indirect emissions as they arise from sources that are not owned or controlled by the person or business who consumes the electricity.
3. Scope 3 emissions are greenhouse gas emissions that are generated in the wider economy as a consequence of a person's or business's activities. These are indirect emissions as they arise from sources that are not owned or controlled by that person or business but they exclude Scope 2.

The assessment was undertaken in accordance with the Northern Territory Environmental Impact Assessment Guide: Greenhouse Gas Emissions and Climate Change. The assessment results identified:

- average annual Scope 1, 2 and 3 greenhouse gas emissions is 0.50 Mt CO_2-e per annum;
- total Scope 1, 2 and 3 emissions over the project life is 10.5 Mt CO_2-e; and
- average annual greenhouse gas emissions for the Project are estimated to be approximately:
  - 2.9 percent of the Northern Territory's annual emissions;
  - 0.09 percent of Australia's annual emissions; and
  - 0.002 percent of the global annual emissions.

The feasibility of minimising greenhouse gas emissions from diesel consumption and electricity generation should be investigated during mine planning.

There are a number of legislative requirements for measuring, monitoring and reporting greenhouse gas emissions and energy consumption that are applicable to the Project. Monitoring and reporting of energy and greenhouse gas emissions will be required to comply with the *National Greenhouse and Energy Reporting Act 2007*, the *Clean Energy Act 2011* and the *Energy Efficiency Opportunities Act 2006*.

Glossary and Abbreviations

Abbreviation	Term
ANFO	Ammonium Nitrate Fuel Oil
CFI	Carbon Farming Initiative
CH_4	Methane
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent emissions (emissions of other greenhouse gases are multiplied by their Global Warming Potential so that their effects can be compared to emissions of carbon dioxide)
DCCEE	Department of Climate Change and Energy Efficiency
DEFRA	Department for Environment, Food and Region Affairs (UK)
dore	Gold in cast bars
EEO	Energy Efficiency Opportunities
EF	Emission Factor
Emission	The release of material into the environment (such as dust)
FullCAM	Full Carbon Accounting Model
GHG	Greenhouse gas
GJ	Gigajoule
Greenhouse Gases	Gases that accumulate within the earth's atmosphere (e.g.: primarily carbon dioxide and methane) which contribute to global climatic change/global warming (i.e. the 'greenhouse effect')
GWh	Gigawatt hour
GWP	Global Warming Potential
ha	Hectare
HFCs	Hydrofluorocarbons
J	Joule
kL	Kilolitre
km	Kilometre
kWh	Kilowatt hour

Abbreviation	Term
L	Litre
m	Metre
Mitigation	Limit the intensity of impacts or prevent impacts
MJ	Megajoule
MLN	Mineral Lease Number
mm	Millimetre
Mt	Million tonnes
N_2O	Nitrous oxide
NCAT	National Carbon Accounting Toolbox
NGA	National Greenhouse Accounts
NGERS	National Greenhouse and Energy Reporting Scheme
NT	Northern Territory
p	Passenger
PFCs	Perfluorocarbons
PJ	Petajoules
SF_6	Sulphur hexafluoride
t	Tonne
tdm	Tonnes of dry matter
TJ	Terajoules
Vista Gold	Vista Gold Australia Pty Ltd
XLPE	Cross-linked polyethylene

1. Introduction

1.1 Background

Vista Gold Australia Pty Ltd (Vista Gold) proposes to re-establish and operate the Mt Todd Gold Mine, located 55 kilometres (km) north of Katherine and 250km south of Darwin. The mine site is accessed via Jatbula Road, approximately 10km east of the Stuart Highway.

The Mt Todd Mine is a brownfield/disturbed site within an historical mining district. The site was most recently mined for gold in the late 1990s with operations ceasing in the early 2000s. Mining infrastructure such as pit, tailings dams, waste rock dump and remains of processing facilities remain onsite.

This report discusses the greenhouse gas (GHG) emissions associated with the construction, operation and the closure of the mine, identifies any potential impacts from GHG emissions, and documents necessary measures to manage identified potential impacts.

1.2 Level of Assessment

The assessment requirements are outlined in the Draft Environmental Impact Statement Guidelines for the Mt Todd Gold Project prepared by the NT EPA (formerly the Department of Natural Resources, Environment, The Arts and Sport (NRETAS)) in 2011). The draft guidelines refer to the *NT Environmental Impact Assessment Guide: Greenhouse Gas Emissions and Climate Change* (NRETAS 2010) for specific requirements for the GHG assessment. The GHG assessment is required to include:

- an estimate of the GHG emissions for the construction and operation phases:
  - in absolute and carbon dioxide equivalent terms;
  - identified on a gas by gas basis; and
  - by source, including on site and upstream sources.
- details of the project lifecycle GHG emissions and the greenhouse gas efficiency of the project;
- measures to minimise GHG emissions; and
- a comparison of estimated GHG emissions with NT, Australian and global annual GHG emissions.

1.3 Australian, Northern Territory and Global Greenhouse Gas Emissions

The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) estimate annual greenhouse gas emissions for Australia to fulfil reporting requirements of the United Nations Framework Convention on Climate Change and the Kyoto Protocol. A breakdown of Australia's GHG emissions by state and territory are published by the DCCEE, the latest being for 2009/10 (DCCEE, 2012).

Australia's and the Northern Territories total GHG emissions for 2009/10 were estimated as 560.8 million tonnes of carbon dioxide equivalent (Mt CO_2-e) and 14.7 Mt CO_2-e respectively. The major emission sources for the NT were agriculture (primarily the burning of savannas) and fuel combustion for stationary energy purposes.

In 2010 global GHG emissions for Annex 1 Parties to the United Nations Framework Convention on Climate Change were 23 gigatons of carbon dioxide equivalent (Gt CO_2-e) (UNFCCC, 2013).

1.4 Project Overview

This Project comprises the mining of gold ore from the existing Mt Todd Gold Mine – Batman Pit (previously mined and now in care and maintenance).

Mining will be an open-pit truck and shovel operation, using large haul trucks, hydraulic shovels and front end loaders to transport materials to the crusher, stockpiles, Run of Mine (ROM) pad and waste dump. Extracted ore, will be processed in an ore processing plant where it will be crushed, milled and then carbon in leach (CIL) leached followed by adsorption, desorption and recovery leading to gold dore (unrefined gold). Approximately 17.8 million tonnes per annum (Mtpa) of ore will be processed. Gold dore will be transported for onward secure shipment to a refinery.

Mine construction will occur over a two year period (including pre-production operations during six months in construction year 2) and employ a workforce of up to 450. Mine production is expected to occur over a further 13 year period followed by a four year closure period.

2. Legislative Framework

Key Commonwealth legislation relevant to the Project and potential implications includes the following:

- *Clean Energy Act 2011*. The Clean Energy Future legislation will introduce a carbon pricing mechanism that has a broad coverage from commencement, encompassing the stationary energy sector, transport, industrial processes, non-legacy waste and fugitive emissions. The carbon pricing mechanism will commence on 1 July 2012, with a fixed price for the first three years, after which the carbon price will transition to a fully flexible price under an emissions trading scheme, with the price determined by the market. The mine site will exceed thresholds for participation in the carbon pricing mechanism. Participation will need to be determined based on actual annual greenhouse gas emissions.
- *National Greenhouse and Energy Reporting Act 2007*. In the 2011-2012 reporting year, the National Greenhouse and Energy Reporting Scheme (NGERS) applies to facilities that emit over 25,000t CO_2-e per year or consume more than 100TJ of energy or corporations that emit over 50,000t CO_2-e per year or consume more than 200TJ of energy. These thresholds relate to Scope 1 and Scope 2 emissions. Based on the estimated energy use during operations, the Project will trigger the facility and corporation thresholds. Participation will need to be determined based on actual annual greenhouse gas emissions and energy consumption.
- *Energy Efficiency Opportunities Act 2006*. The Energy Efficiency Opportunities (EEO) program requires businesses to identify, evaluate and publicly report cost effective energy saving opportunities. Participation in EEO is mandatory for corporations that use more than 0.5PJ of energy per year. As the Project will use more than 0.5PJ of energy per year at full production levels, it will be mandatory to report this under the EEO program. Participation will need to be assessed based on actual energy consumption to determine the first year the threshold is exceeded.
- *Carbon Credits (Carbon Farming Initiative) Act 2011*. The Carbon Farming Initiative (CFI) has been developed to give farmers, forest growers and landholders the ability to generate accredited domestic offsets for access to domestic voluntary and international carbon markets. It is unlikely that the Project will be able to generate offsets at the mine site unless it can be demonstrated that rehabilitation of the mine site is additional to legislative requirements and planning approval conditions. Any claims relating to 'carbon neutrality' for the Project (or part thereof) should give consideration to the use of offsets generated under the CFI.

3. Methodology

3.1 Overview

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

- *The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard, Revised Edition,* developed by the World Resource Institute and the World Business Council for Sustainable Development (GHG Protocol);
- The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) *National Greenhouse Accounts* (NGA) Factors, July 2011 (DCCEE, 2011); and
- Australia's National Carbon Accounting System (DCCEE, 2005).

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

3.2 Boundary of the Assessment

The assessment included emissions from the following activities:

- fuel combustion from construction, operation and mine closure;
- wastewater treatment during operation and mine closure;
- vegetation removal;
- explosive use during operations;
- embodied emissions (i.e. the emissions associated with the production) of major construction materials and plant;
- embodied emissions of major consumable materials during ore processing;
- transportation of materials to site during construction and operations;
- transportation of gold dore to Darwin during operations; and
- employee transportation during construction, operation and mine closure.

3.3 Greenhouse Gases Considered

The greenhouse gases and associated Global Warming Potential (GWP) considered in this assessment are listed in Table 1. The GWPs were sourced from the NGA Factors July 2012.

Table 1 Greenhouse gases and 100 year global warming potentials

Greenhouse gas	Global warming potential [1]
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140 – 11,700
Perfluorocarbons (PFCs)	6,500 – 9,200
Sulphur hexafluoride (SF_6)	23,900

[1] GWP is a relative measure of how much heat a greenhouse gas traps in the atmosphere, eg: methane has 21 times the effect of carbon dioxide.

3.4 Emission Scopes

Emissions have been separated into Scopes 1, 2 and 3 in accordance with the GHG Protocol. These scopes are defined as follows:

1. Scope 1 emissions are greenhouse gas emissions created directly by a person or business from sources that are owned or controlled by that person or business;
2. Scope 2 emissions are greenhouse gas emissions created as a result of the generation of electricity, heating, cooling or steam that is purchased and consumed by a person or business. These are indirect emissions as they arise from sources that are not owned or controlled by the person or business who consumes the electricity; and
3. Scope 3 emissions are greenhouse gas emissions that are generated in the wider economy as a consequence of a person's or business's activities. These are indirect emissions as they arise from sources that are not owned or controlled by that person or business but they exclude Scope 2.

Scope 1 emissions are produced by the combustion of fuels such as diesel at the development site, and by vehicles and plant equipment which the proponent owns and has operational control over. Note that only the direct combustion of the fuels is considered as Scope 1 emissions.

Scope 2 emissions arise from the consumption of electricity at the development site, in plant and equipment that is owned and operated by the proponent.

Emissions arising from the extraction, processing and transportation and distribution of fuels and electricity are classified as Scope 3, since these activities are not within the operational control of the end user.

All other emissions associated with the Project are defined as Scope 3, since they are produced outside the development site, and the proponent does not have operational control of the facilities from which they originate. The proponent does not own or operate any of the vehicles that transport raw materials to the site. As such, emissions resulting from the combustion of fuels for this transportation are classified as Scope 3.

3.5 Data Collection and Calculation Procedures

Activity data used for the GHG assessment was provided by Vista Gold.

The calculation of greenhouse gas emissions for the Project was based on the methodology detailed in the *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* developed by the World Business Council for Sustainable Development and the World Resources Institute (GHG Protocol) and the relevant emission factors. The main sources of emission factors included:

- DCCEE NGA Factors July 2011; and
- SimaPro Australian and ecoinvent databases. These databases contain emission factors for scope 3 emission sources such as construction materials and transportation of materials to site.

To calculate Project emissions a spreadsheet model was specifically developed for the Project.

When data was unavailable, assumptions and approximations were made to obtain a reasonable estimate of activity levels or emission factors. All assumptions are detailed in Section 3.7.

All energy consumption and emissions data was converted into quantities of carbon dioxide equivalent. The emission values have been summed to reach an estimate of the total greenhouse gas emissions for the project.

Vegetation Clearing

Greenhouse gas emissions due to vegetation clearing were quantified using the National Carbon Accounting Toolbox (NCAT). The NCAT provides access to the Full Carbon Accounting Model (FullCAM) and supporting data (Richards and Evans, 2004). FullCAM is the method used to quantify emissions due to land clearing in Australia for the purposes of international reporting. The model estimates and predicts carbon stocks present in tree, debris and soil carbon pools and the transitions between different carbon pools in forest and agricultural systems.

In this assessment FullCAM was used to calculate the carbon stocks of mature vegetation at the Project site. It was assumed that the vegetation had reached maturity so that both the emissions from the removal of vegetation, as well as the lost sequestration potential of the vegetation, were taken into account. This is considered a conservative estimate of emissions from vegetation clearing as the current condition of the vegetation is not considered and the sequestration of carbon dioxide following site rehabilitation is not included in the assessment.

FullCAM requires information about the climatic and geophysical conditions in the area being modelled. This data was downloaded from the DCCEE Server for a specified location using FullCAM's Data Builder. A representative point at the project site (latitude: -14.141403; longitude: 132.111111) was chosen for which climatic, geophysical and maximum aboveground biomass values were downloaded. The maximum aboveground biomass is a value in FullCAM used to define a site's biomass potential. It provides an upper limit for the stock of trees and crops that can exist at a site (Richards *et al.* 2005). For the Project site the maximum aboveground biomass was 59.78 tonnes of dry matter per hectare (tdm/ha).

The FullCAM model was configured as a "Multilayer Forest System" over a period of 100 years. The initial conditions assumed that there was zero above ground vegetation at the start of the simulation. Vegetation growth was simulated as "natural regeneration" based on *Eucalyptus tintinnans*.

All FullCAM default settings were used for “Site”, “Trees” and “Soils” categories. An average year of climatic data (contained in FullCAM), based on records from 1968 – 2002, for the Project site was used. Kandosol and Tenosol soils were the available region soil types in FullCAM for the project location. Both soil types were modelled yielding the same result.

Except for the initial clearing event followed by natural regeneration, no fires, vegetation disturbances or vegetation management events (e.g. clearing, thinning, fertilising or pruning) in the vegetation’s history, were simulated. This provides a conservative calculation of carbon stocks at the site.

The mass of all carbon pools at the end of the 100 year simulation was used as the emission factor for vegetation removal.

3.6 Exclusions from the Assessment

Exclusions from the assessment included:

- electricity imported from the grid. Although the site will be able to import electricity from the grid it is assumed that electricity for the site will be supplied by the proposed gas turbine and any electricity imported from the grid during construction and operation will be negligible compared to the emissions over the life of the project;
- combustion of oils and greases in plant. These emissions were considered to be negligible compared with the emissions over the life of the project;
- emissions associated with the manufacture of minor consumables such as office supplies, cleaning products and personal protective equipment and the transportation of these consumables to site. These emissions were considered negligible compared to the overall emissions;
- miscellaneous construction materials were not included as part of this assessment as these components are considered minor, and are not considered as having considerable impact over the life of the project;
- emissions associated with the manufacture of sodium metabisulphite solution, activated carbon and lead nitrate. Emission factors for these consumables could not be identified and therefore were excluded from the assessment. It is unlikely that the exclusion of these consumables will be material to the overall emissions estimate;
- leakage of hydrofluorocarbons from air conditioning units and refrigeration. These emissions were considered to be negligible compared with the emissions over the life of the project;
- leakage of sulphur hexafluoride from electrical equipment. These emissions were considered to be negligible compared with the emissions over the life of the project;
- perfluorocarbons will not be generated or released during the project;
- scope 3 emissions from natural gas combustion (a Scope 3 emission factor is not provided for the Northern Territory in the NGA Factors July 2011 and was therefore excluded from the assessment);
- sequestration of carbon dioxide from revegetation of the site. The sequestration of carbon dioxide was excluded to provide a conservative estimate of emissions associated with vegetation removal and subsequent revegetation; and

- transportation of mine personnel by private vehicle. The majority of the mine workforce will be transported to site by bus and therefore emissions from private vehicle usage were considered to be negligible compared with the emissions over the life of the Project.

3.7 Assumptions

Assumptions used in estimating the activity levels and greenhouse gas emissions for the Project are listed in Table 2 for construction, Table 3 for operations and Table 4 for mine closure.

The assessment was based on emission factors available at the time of the assessment and future changes in emission factors were not considered.

Table 2 Construction assumptions

Parameter measured	Assumptions
Energy	
Diesel	Quantity of diesel for stationary and transport energy purposes estimated as 3,300 kL over the construction period. As per the methodology described in Section 3.5 Emission Factors (EFs) were sourced from the DCCEE NGA Factors July 2012 Tables 4 & 39 as transport EFs are greater than stationary EFs.
Materials	
Cables	Quantity estimated as 118 t based on 220,600 m of 50 mm^2 cross-linked polyethylene (XLPE) single copper core cable with a mass of 53.6 kg per 100 m. It was assumed that a 50 mm^2 cable was representative of all cables used during construction works. EF based on the mass percentage of XLPE (17%) and copper (83%) in a 50 mm^2 cable. EF for XLPE sourced from SimaPro Australian Database 2007 for polyethylene and EF for copper sourced from SimaPro Australian Database 2007.
Concrete	Quantity estimated as 24,500 t. EF sourced from the SimaPro Australian Database 2007 for concrete.
Geomembrane	Quantity estimated as 6,501 t based on 3,533,300 m^2 of geomembrane, a thickness of 2 mm and density of 0.92 t/m^3. EF sourced from SimaPro Australian Database 2007 for polyethylene.
Steel - major processing equipment	Mass of major processing equipment (crushers, mills and screens) estimated as 7,465 t. For the purpose of the assessment it was assumed that the major processing equipment was 100% steel. EF sourced from the SimaPro Australian Database 2007 for steel.
Steel - structural	Mass of structural steel estimated as 6,930 t. EF sourced from the SimaPro Australian Database 2007 for steel.

Parameter measured	Assumptions
Vegetation removal	
Vegetation removal	The area of vegetation to be removed was estimated as 575 ha as per the Flora and Vegetation Assessment (GHD 2013). A representative point at the Project site (latitude: -14.141403; longitude: 132.111111) was chosen for which climatic, geophysical and maximum aboveground biomass values were downloaded from the DCCEE server. It was assumed that data downloaded at this point was representative of conditions across the project site. In calculating existing carbon stocks on the site no fires, vegetation disturbance or vegetation management events (e.g. clearing, thinning, fertilising or pruning) in the vegetation's history were simulated. It was assumed that all carbon from the above ground vegetation, roots and soil carbon pools would be removed by the project and would not regrow following clearing. In the absence of FullCAM categories for each vegetation community identified at the site, it was assumed that the existing FullCAM tree species group "*Eucalyptus tintinnans*" represents the types of vegetation existing in the area.
Materials transportation	
Cables	It was assumed that cables will be sourced from manufacturers in Lilydale, Victoria and transported to site by road.
Concrete	It was assumed that the dry components of concrete (i.e. cement and aggregates) will be sourced from manufacturers in Darwin, Northern Territory and transported to site by road. Water for concrete will be sourced onsite. It was assumed that the dry components were 80% of the total concrete mass.
Diesel	It was assumed that diesel will be sourced from producers in Singapore, transported to Darwin by ship and transported to site by road. The density of diesel was assumed to be 0.83 t/kL.
Geomembrane	It was assumed geomembranes will be sourced from manufacturers in Malaga, Western Australia and transported to site by road.
Steel - major processing equipment	It was assumed major processing equipment will be sourced from manufacturers in South East Asia, transported to Darwin by ship and transported to site by road.
Steel - structural	It was assumed that steel will be sourced from manufacturers in Whyalla, South Australia and transported to site by road.

Parameter measured	Assumptions
Employee transportation [1]	
Employee transportation – bus	Quantity of employee transportation estimated as 13,104,000 passenger kilometres (p.km) based on 410 construction personnel being transported from the construction camp by bus (50km round trip), 7 days per week, for a two year construction period. It was assumed that the remaining 40 construction personnel would travel by light vehicles and the fuel for these light vehicles is included in the diesel quantity for construction. EF sourced from 2012 Department for Environment, Food and Region Affairs (DEFRA) guidelines for coaches.
Wastewater treatment	
Wastewater treatment - septic system	Workforce population estimated as 450 construction personnel (based on 410 construction personnel and 40 senior construction staff) and a two year construction period. EF sourced from NGA Factors July 2012 Table 44 based on anaerobic treatment of both wastewater and sludge and default factors for chemical oxygen demand per person and methane emission factors.

Table 3 Operations assumptions

Parameter measured	Assumptions
Energy	
Diesel - stationary	Quantity of diesel for stationary energy purposes estimated as 32,850 kL per annum. EF sourced from NGA Factors July 2012 Tables 3 & 39 for post 2004 vehicles.
Diesel - transport	Total diesel consumption for road registered vehicles estimated as 4 kL per annum. EF sourced from NGA Factors July 2012 Tables 4 & 39.
Natural gas	Quantity of natural gas estimated as 8.9PJ per annum. EF sourced from NGA Factors July 2011 Tables 2 (Scope 1). EF for Scope 3 emissions not provided for the Northern Territory in the NGA Factors July 2011.

[1] Unless otherwise stated:

- road transportation emissions were based on a rigid truck emission factor sourced from SimaPro Australian Database 2007;
- shipping was based on an international shipping emissions factor sourced from SimaPro Australian Database 2007; and
- distances were estimated using Google Earth Pro.

Parameter measured	Assumptions
Materials	
Sodium hydroxide	Quantity of sodium hydroxide estimated as 710 t per annum. EF sourced from the SimaPro Australian Database 2007 for sodium hydroxide.
Explosives	Quantity of explosives estimated as 3,000 t per annum. Scope 1 EF sourced from NGA Factors 2008 for heavy ANFO and Scope 3 EF sourced from the SimaPro ecoinvent v1.3 database for ammonium nitrate.
Flocculent solution	Quantity of flocculent estimated as 266 t per annum. EF sourced from the SimaPro Australian Database 2007 for flocculent.
Hydrochloric acid	Quantity of hydrochloric acid estimated as 1,441 t per annum. EF sourced from ecoinvent database version 1.3 and was based on European data for 30% hydrochloric acid in water.
Lime	Quantity of lime estimated as 16,153 t per annum. EF sourced from ecoinvent database version 1.3 and was based on European data for packed quick lime.
Sodium cyanide	Quantity of sodium cyanide estimated as 13,668 t per annum. EF sourced from ecoinvent database version 1.3 and was based on European data for sodium cyanide tablets.
Steel - ball mills grinding media	Quantity of steel for ball mill grinding media estimated as 16,901 t per annum. EF sourced from the SimaPro Australian Database 2007 for steel.
Materials transportation[2]	
Caustic soda	It was assumed that caustic soda will be sourced from manufacturers in Yarwun, Queensland and transported to site by road.
Diesel	It was assumed that diesel will be sourced from producers in Singapore, transported to Darwin by ship and transported to site by road. The density of diesel was assumed to be 0.83 t/kL.
Explosives	It was assumed that explosives will be sourced from manufacturers in Port Hedland, Western Australia and transported to site by road.
Flocculent solution	It was assumed that flocculent will be sourced from manufacturers in Yarwun, Queensland and transported to site by road.

[2] Unless otherwise stated:

- road transportation emissions were based on a rigid truck emission factor sourced from SimaPro Australian Database 2007;
- shipping was based on an international shipping emissions factor sourced from SimaPro Australian Database 2007; and
- distances were estimated using Google Earth Pro.

Parameter measured	Assumptions
Hydrochloric acid	It was assumed that hydrochloric acid will be sourced from manufacturers in Yarwun, Queensland and transported to site by road.
Lime	It was assumed that lime will be sourced from manufacturers in Mataranka, Northern Territory and transported to site by road.
Sodium cyanide	It was assumed that sodium cyanide will be sourced from manufacturers in Yarwun, Queensland and transported to site by road.
Steel - ball mills grinding media	It was assumed that grind media will be sourced from producers in China, transported to Darwin by ship and transported to site by road.
Employee transportation	
Employee transportation - bus	Quantity of employee transportation estimated as 11,234,700 p.km per annum based on 320 operation personnel being bussed from Katherine (104 km round trip) and 365 days per year. EF sourced from 2012 DEFRA guidelines for coaches.
Wastewater treatment	
Wastewater treatment - septic system	Workforce population estimated as 350 people per year (based on 320 operation personnel and 30 senior staff). EF sourced from NGA Factors July 2012 Table 44 based on anaerobic treatment of both wastewater and sludge and default factors for chemical oxygen demand per person and methane emission factors.

Table 4 Mine closure assumptions

Parameter measured	Assumptions
Diesel - stationary	Quantity of diesel for stationary energy purposes estimated as 1,200 kL based on 300 kL per annum and a closure period of four years. EF sourced from NGA Factors July 2012 Tables 3 & 39.
Employee transportation - bus	Quantity of employee transportation estimated as 4,993,200 p.km based on 30 mine closure personnel being transported from Katherine (104 km round trip) for 365 days per year and a closure period of four years. EF sourced from 2012 DEFRA guidelines for coaches.
Wastewater treatment - septic system	Workforce population estimated as 40 people per year and a closure period of four years. EF sourced from NGA Factors July 2012 Table 44 based on anaerobic treatment of both wastewater and sludge and default factors for chemical oxygen demand per person and methane emission factors.

4. Greenhouse Gas Emissions

The greenhouse gas emissions for the project were calculated based on estimated energy usage during construction, operations and mine closure, embodied emissions in major construction and operation materials, vegetation removal, wastewater treatment, explosives usage and transportation of employees to site.

Scope 1, 2 and 3 emissions for the project are summarised in Table 5. Emissions were based on the mine and processing facility operating for 19 years (2 years for construction, 13 years operation and 4 years for mine closure). Total emissions for the Project are estimated at approximately 10.5 Mt CO_2-e. Scope 1 emissions over the life of the Project were estimated to be approximately 8.2 Mt CO_2-e, and Scope 3 emissions are estimated as approximately 2.3 Mt CO_2-e. It is anticipated that emissions associated with electricity imported from the grid will be negligible compared to the total emissions as the proposed gas turbine will provide electricity for the site. Therefore Scope 2 emissions have been reported as zero.

The operational phase of the project is estimated to contribute 98.8 percent of total project emissions. The construction phase is estimate to contribute 1.1 percent of total project emissions. Emissions associated with mine closure are estimated to contribute less than 0.1 percent of total project emissions.

Table 5 Summary of GHG emissions over the project life

Project Phase	Scope 1 emissions (t CO_2-e)	Scope 2 emissions (t CO_2-e)	Scope 3 emissions (t CO_2-e)	Total GHG emissions (t CO_2-e)	Percentage of project life emissions
Construction	58,718	0	59,661	118,379	1.1%
Operations	8,184,026	0	2,231,649	10,415,675	98.8%
Mine closure	3,259	0	419	3,678	<0.1%
Total	**8,246,003**	**0**	**2,291,728**	**10,537,731**	

Assuming a total project life of 19 years, the average annual greenhouse gas emissions for the project are estimated as approximately 0.50 Mt CO_2-e per annum. Compared with the Northern Territory's 2009/10 greenhouse gas emissions of approximately 17.4 Mt CO_2-e per annum (DCCEE, 2012), the average annual emissions for the Project are estimated to be approximately 2.9 percent of the Northern Territory's annual emissions. Compared with Australia's 2009/10 greenhouse gas emissions of approximately 560.8 Mt CO_2-e per annum, the average annual emissions for the project are estimated to be approximately 0.09 percent of Australia's annual emissions. The global greenhouse emissions for Annex 1 Parties to the UNFCCC in 2010 were 23 gigatons of carbon dioxide equivalent (Gt CO_2-e) (UNFCCC, 2013). The average annual emissions for the project are estimated to be approximately 0.002 percent of the global annual emissions.

The major source of emissions during operations was estimated as energy consumption (i.e. natural gas and diesel), contributing 79.5 percent of emissions. Energy consumption was followed by embodied emissions in materials (18 percent), transportation of materials to site (2.5 percent), employee transportation (0.1%) and wastewater treatment (<0.1%). The major individual emissions sources during operations were estimated as:

- natural gas combustion (65.8%);
- diesel combustion for stationary (i.e. non-transport) purposes (13.7%);
- embodied emissions in sodium cyanide (7.5%); and
- embodied emissions in grinding media (4.6%).

These four emission sources are estimated to contribute 91.6% of total GHG emissions during operations.

A breakdown of the annual Scope 1 greenhouse gas emissions during operation by gas is provided in Table 6. Carbon dioxide was the major greenhouse gas emitted (99.7% of total carbon dioxide equivalent emissions) followed by methane (0.2%) and nitrous oxide (0.1%). As discussed in Section 3.6, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride were not considered in the assessment.

Table 6 Annual operations Scope 1 greenhouse gas emissions by gas type

Greenhouse gas	Emissions (t)		Percentage of CO_2-e emissions
	(t)	(t CO2-e)	
Carbon dioxide[1]	543,977	543,977	99.7%
Methane	52.6	1,104	0.2%
Nitrous oxide	1.7	521	0.1%
Total carbon dioxide equivalent emissions		545,602	100%

1. Carbon dioxide emissions include emissions from explosive use as these emissions could not be separated by gas type.

2. Methane emissions include emissions from wastewater treatment.

The greenhouse gas inventories for construction, operations and mine closure are provided in Appendix A.

5. Potential Mitigation Measures

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

5.1 Avoidance of Impacts

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

The consumption of diesel is a necessary requirement of the Project, and currently accounts for approximately 14 percent of the greenhouse gas emissions from the Project. However, a reduction in the quantity of fuel consumed may be achievable through optimisation of operational activities and logistics. Optimisation of these activities may reduce the number of vehicles and/or trips required. This optimisation should be undertaken during the detailed project design and planning stage.

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

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

5.2 Mitigation of Impacts

The majority of emissions for the Project are from the combustion of natural gas in a gas turbine to provide the project site with electricity. The gas fired turbine is estimated to produce 18,000 GWh of electricity over the project life. The Scope 1 greenhouse gas intensity of the onsite gas turbine is estimated to be 0.38 kg CO_2-e/kWh. Compared with the GHG intensity of grid electricity in the Northern Territory (0.67 kg CO_2-e/kWh), the onsite turbine significantly reduces emissions associated with the electricity demand for the Project site.

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

When sourced from appropriate feedstocks, the reduction in emissions is approximately equivalent to the percentage of biodiesel in the blend (for example diesel with 20 percent biodiesel will reduce greenhouse gas emissions by approximately 20 percent). Calculations to determine the reduction in GHG emissions when using biodiesel should consider the entire life cycle of the fuel.

There are a number of other factors that require consideration prior to the use of biodiesel for the Project. There is significant debate over the suitability and/or the percentage of biodiesel that can be used in vehicles and plant. Biodiesel may not be suitable for some vehicles without major modifications. Plant operators are also concerned that vehicle and plant warranties may be void if biodiesel or biodiesel blends are used in vehicles. Opportunities for the use of biodiesel may be further examined and used where possible on the Project.

5.3 Energy Efficiency

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

Development and implementation of an energy efficiency review which would identify initiatives and available technologies, leading to implementation of processes to ensure energy efficiency opportunities are integrated into operations, may be undertaken. A monitoring process like this would ensure potential energy efficient concepts are recognised and considered through operations. This is further discussed in Section 5.4.

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

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

5.4 Energy Management

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

5.5 Offsets

The feasibility of generating carbon offsets at the Project site in accordance with the Carbon Farming Initiative should be investigated during Project planning. The feasibility study would need to consider legislative and development approval requirements in assessing whether the potential carbon offset projects comply with the additionality requirements (e.g. being able to demonstrate that rehabilitation of the mine site is additional to legislative requirements and planning approval) of the Carbon Farming Initiative.

The Project will exceed the threshold for participation in the carbon pricing mechanism. Therefore, a legislative price on the Scope 1 greenhouse gas emissions from the Project will apply. Voluntarily offsetting additional greenhouse gas emissions through the purchase of carbon offsets generated in Australia or overseas should be considered when assessing the Project's liability under the carbon pricing mechanism.

5.6 Monitoring and Reporting

There are a number of legislative requirements for measuring, monitoring and reporting greenhouse gas emissions and energy consumption that are applicable to the Project for example under the *National Greenhouse and Energy Reporting Act 2007,* the *Clean Energy Act 2011* and the *Energy Efficiency Opportunities Act 2006*. The liable entity for NGERS reporting and the carbon pricing mechanism would need to be determined prior to the commencement of the construction phase. The Proponent will need to determine if it or the construction contractor(s) have operational control on the project site as defined in the *National Greenhouse and Energy Reporting Act 2007*.

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

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

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

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

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Appendix A

Greenhouse Gas Inventory

Table 7 GHG inventory for construction

Emission source category	Emission source	Value (Q)	Value Units	CO_2 Emission Factor (t CO_2 / unit)	CH_4 Emission Factor (t CO_2-e / units)	N_2O Emission Factor (t CO_2-e / units)	Scope 1 Emission Factor (t CO_2-e / units)	Scope 2 Emission Factor (t CO_2-e / units)	Scope 3 Emission Factor (t CO_2-e / units)	Total Emission Factor (t CO_2-e / units)	Total Emission Factor Units	Method	CO_2 Emissions (t CO_2)	CH_4 Emissions (t CO_2-e)	N_2O Emissions (t CO_2-e)	Scope 1 Emissions (t CO_2-e)	Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)	Total Emissions (t CO_2-e)	Proportion of Total Inventory (%)
Energy	Diesel	3,300	kL	2.67	0.00772	0.01930	2.70	0	0.20	2.90	kL	Q x EF	8,815	25	64	8,904	0	675	9,579	8.1%
Materials	Cables	118	t	0	0	0	0	0	4.97	4.97	t	Q x EF	0	0	0	0	0	587	587	0.5%
	Concrete	24,500	t	0	0	0	0	0	0.14	0.14	t	Q x EF	0	0	0	0	0	3,455	3,455	2.9%
	Geomembrane	6,501	t	0	0	0	0	0	2.18	2.18	t	Q x EF	0	0	0	0	0	14,173	14,173	12.0%
	Steel - major processing equipment	7,465	t	0	0	0	0	0	1.91	1.91	t	Q x EF	0	0	0	0	0	14,258	14,258	12.0%
	Steel - structural	6,930	t	0	0	0	0	0	1.91	1.91	t	Q x EF	0	0	0	0	0	13,236	13,236	11.2%
Vegetation removal	Vegetation removal	575	ha	86	0	0	86	0	0	86	ha	Q x EF	49,591	0	0	49,591	0	0	49,591	41.9%
Materials transportation	Cables	118	t	0	0	0	0	0	0.876	0.876	t	Q x EF	0	0	0	0	0	104	104	0.1%
	Concrete	19,600	t	0	0	0	0	0	0.071	0.071	t	Q x EF	0	0	0	0	0	1,388	1,388	1.2%
	Diesel	2,739	t	0	0	0	0	0	0.089	0.089	t	Q x EF	0	0	0	0	0	244	244	0.2%
	Geomembrane	6,501	t	0	0	0	0	0	0.921	0.921	t	Q x EF	0	0	0	0	0	5,991	5,991	5.1%
	Steel - major processing equipment	7,465	t	0	0	0	0	0	0.098	0.098	t	Q x EF	0	0	0	0	0	729	729	0.6%
	Steel - structural	6,930	t	0	0	0	0	0	0.621	0.621	t	Q x EF	0	0	0	0	0	4,304	4,304	3.6%
Employee transportation	Employee transportation - bus	14,924,000	p.km	0	0	0	0	0	0.0000347	0.0000347	p.km	Q x EF	0	0	0	0	0	518	518	0.4%
Wastewater treatment	Wastewater treatment - septic system	900	p.years	-	-	-	0.24804	0	0.0000000	0.2480400	p.year	Q x EF	-	-	-	223	0	0	223	0.2%
Total GHG emissions (construction period)													58,406	25	64	58,718	0	59,661	118,379	

Table 8 GHG inventory for operations

Emission source category	Emission source	Value (Q)	Value Units	CO_2 Emission Factor (t CO_2 / unit)	CH_4 Emission Factor (t CO_2-e / units)	N_2O Emission Factor (t CO_2-e / units)	Scope 1 Emission Factor (t CO_2-e / units)	Scope 2 Emission Factor (t CO_2-e / units)	Scope 3 Emission Factor (t CO_2-e / units)	Total Emission Factor (t CO_2-e / units)	Total Emission Factor Units	Method	CO_2 Emissions (t CO_2)	CH_4 Emissions (t CO_2-e)	N_2O Emissions (t CO_2-e)	Scope 1 Emissions (t CO_2-e)	Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)	Total Emissions (t CO_2-e)	Proportion of Total Inventory (%)
Energy	Diesel - stationary	32,850	kL	2.67	0.00386	0.00772	2.68	0	0.20	2.89	kL	Q x EF	87,746	127	254	88,127	0	6,720	94,847	13.7%
	Diesel - transport	4	kL	2.67	0.00039	0.02316	2.69	0	0.20	2.90	kL	Q x EF	11	0	0	11	0	1	12	0.0%
	Natural gas	8,900,000	GJ	0.05	0.00010	0.00003	0.05	0	0.00	0.05	GJ	Q x EF	455,680	890	267	456,837	0	0	456,837	65.8%
Materials	Sodium hydroxide	710	t	0.00	0.00000	0.00000	0.00	0	1.13	1.13	t	Q x EF	0	0	0	0	0	802	802	0.1%
	Explosives	3,000	t	-	-	-	0.18	0	8.60	8.78	t	Q x EF	-	-	-	540	0	25,800	26,340	3.8%
	Flocculent solution	266	t	0.00	0.00000	0.00000	0.00	0	1.18	1.18	t	Q x EF	0	0	0	0	0	314	314	0.0%
	Hydrochloric acid	1,441	t	0.00	0.00000	0.00000	0.00	0	0.76	0.76	t	Q x EF	0	0	0	0	0	1,091	1,091	0.2%
	Lime	16,153	t	0.00	0.00000	0.00000	0.00	0	0.75	0.75	t	Q x EF	0	0	0	0	0	12,050	12,050	1.7%
	Sodium cyanide	13,668	t	0.00	0.00000	0.00000	0.00	0	3.81	3.81	t	Q x EF	0	0	0	0	0	52,075	52,075	7.5%
	Steel - ball mills	16,901	t	0.00	0.00000	0.00000	0.00	0	1.91	1.91	t	Q x EF	0	0	0	0	0	32,281	32,281	4.6%
Materials transportation	Sodium hydroxide	710	t	0.00	0.00000	0.00000	0.00	0	0.68	0.68	t	Q x EF	0	0	0	0	0	480	480	0.1%
	Diesel	27,269	t	0.00	0.00000	0.00000	0.00	0	0.09	0.09	t	Q x EF	0	0	0	0	0	2,427	2,427	0.3%
	Explosives	3,000	t	0.00	0.00000	0.00000	0.00	0	0.53	0.53	t	Q x EF	0	0	0	0	0	1,585	1,585	0.2%
	Flocculent solution	266	t	0.00	0.00000	0.00000	0.00	0	0.68	0.68	t	Q x EF	0	0	0	0	0	180	180	0.0%
	Hydrochloric acid	1,441	t	0.00	0.00000	0.00000	0.00	0	0.68	0.68	t	Q x EF	0	0	0	0	0	974	974	0.1%
	Lime	16,153	t	0.00	0.00000	0.00000	0.00	0	0.04	0.04	t	Q x EF	0	0	0	0	0	645	645	0.1%
	Sodium cyanide	13,668	t	0.00	0.00000	0.00000	0.00	0	0.68	0.68	t	Q x EF	0	0	0	0	0	9,239	9,239	1.3%
	Steel - ball mills	16,901	t	0.00	0.00000	0.00000	0.00	0	0.10	0.10	t	Q x EF	0	0	0	0	0	1,650	1,650	0.2%
Employee transportation	Employee transportation - bus	13,315,200	p.km	0.00	0.00000	0.00000	0.00	0	0.000035	0.000035	p.km	Q x EF	0	0	0	0	0	462	462	0.1%
Wastewater treatment	Wastewater treatment - septic system	350	p	-	-	-	0.25	0	0.00	0.25	p.year	Q x EF	-	-	-	87	0	0	87	0.0%
Total GHG emissions for operation per annum													543,437	1,017	521	545,602	0	148,777	694,378	
Total GHG emissions for 15 years of operations													8,151,561	15,252	7,810	8,184,026	0	2,231,649	10,415,675	

Table 9 GHG inventory for mine closure

Emission source category	Emission source	Value		CO_2 Emission Factor	CH_4 Emission Factor	N_2O Emission Factor	Scope 1 Emission Factor	Scope 2 Emission Factor	Scope 3 Emission Factor	Total Emission Factor		Method	CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Scope 1 Emissions	Scope 2 Emissions	Scope 3 Emissions	Total Emissions	Proportion of Total Inventory
		(Q)	Units	t CO_2 / unit	t CO_2-e / units	t CO_2-e / units	t CO_2-e / units	t CO_2-e / units	t CO_2-e / units	t CO_2-e / units	Units		t CO_2	(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	%
	Diesel - stationary	1200	kL	2.67	0.00386	0.00772	2.68	0	0.20	2.89	kL	Q x EF	3,205	5	9	3,219	0	245	3,465	94.2%
	Employee transportation - bus	4993200	p.km	0.00	0.00000	0.00000	0.00	0	0.00	0.00	p.km	Q x EF	0	0	0	0	0	173	173	4.7%
	Wastewater treatment - septic system	160	p.years	-	-	-	0.25	0	0.00	0.25	p.year	Q x EF	-	-	-	40	0	0	40	1.1%
Total GHG emissions for decommissioning													3,205	5	9	3,259	0	419	3,678	

GHD

Level 5, 66 Smith Street
Darwin NT 0800
T: (08) 8982 0100 F: (08) 8981 1075 E: drwmail@ghd.com.au

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Rev No.	Author	Reviewer		Approved for Issue		
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