APPENDIX 10

Greenhouse and Energy Profile

Mackas Sand

Greenhouse Gas and Energy Assessment of Sand Extraction Operations from Lot 218 DP 1044608 and Lot 220 DP 1049608, Salt Ash

April 2009

Umwelt
Environmental Consultants

Greenhouse Gas and Energy Assessment of Sand Extraction Operations from Lot 218 DP 1044608 and Lot 220 DP 1049608, Salt Ash

Prepared by

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on behalf of

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Executive Summary

Mackas Sand Pty Limited (Mackas Sand) proposes to extract industrial grade and construction sand resources from two sites at Stockton Bight, New South Wales (NSW). The extraction operations will be conducted on behalf of the Worimi Local Aboriginal Land Council (Worimi LALC) (the Project). The project includes the construction of unsealed access roads on private land adjacent to each site. The respective sites are known as Lot 218 and Lot 220. The extraction of up to 2,000,000 tonnes per annum (2 Mtpa) of sand is predicted from the combined operations. A maximum of 1,000,000 tonnes per annum (1 Mtpa) will be extracted from either site.

The proposed sand extraction operations at each site will involve: preparation of the site; extraction of sand with front-end loaders, screening sand, washing sand if a suitable source of water is obtained, transport operations, and site rehabilitation. Sand extraction operations from Lot 220 are expected to take 10 to 20 years to complete. There is potential for the extraction of sand from Lot 218 to continue indefinitely, due to natural replenishment processes. A 10 year timeframe, therefore, has been used for this assessment.

This Greenhouse Gas and Energy Assessment (GHGEA) has been prepared as part of the Environmental Assessment (EA), prepared in accordance with Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project will require the approval of the NSW Minister for Planning.

The Full Life Cycle Analysis emissions estimate (with no statistical consideration of variables) for the Project is 89,226.4 t CO_2-e. The total mean yearly emissions from the Project are 8,922.64 t CO_2-e. The main sources of emissions from the Project are estimated to be from the offsite transport of sand products. These Scope 3 emissions are considered to be outside the parameters of the Project and the direct influence of Mackas Sand.

The largest source of emissions onsite are Scope 1 fugitive emissions produced by sand extraction equipment. The Scope 1 fugitive emissions produced by the transport of sand onsite and the indirect Scope 2 emissions generated from electricity consumption are estimated to be approximately 989.51 (t CO_2-e) per year.

The Scope 1, Scope 2 and Scope 3 emissions generated from sand extraction activities at Lot 218 and Lot 220 will contribute an estimated 0.000221 per cent to international yearly GHG emissions (based on 2004 modelling).

Mackas Sand greenhouse gas and energy management focus will be directed at an efficient use of fuel and energy use on site. Mackas Sand proposes to exercise the following mitigation activities for both management and operational activities:

- ongoing assessment of energy use to identify potential areas of increased efficiency; and
- ongoing assessment of operational practices and activities to identify potential areas of increased efficiency; and
- assessment of onsite fugitive emissions for potential areas of reduction and implement where possible.

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1.0 Sand Extraction

1.1 Description of Proposed Resource Extraction

Mackas Sand Pty Limited (Mackas Sand) proposes to extract industrial grade and construction sand resources from two sites at Stockton Bight, New South Wales (NSW). The extraction operations will be conducted on behalf of the Worimi Local Aboriginal Land Council (Worimi LALC) (the Project). The project includes the construction of unsealed access roads on private land adjacent to each site. The respective sites are known as Lot 218 and Lot 220. The extraction of up to 2,000,000 tonnes per annum (2 Mtpa) of sand is predicted from the combined operations. A maximum of 1,000,000 tonnes per annum (1 Mtpa) will be extracted from either site.

The proposed sand extraction operations at each site will involve: preparation of the site; extraction of sand with front-end loaders, screening sand, washing sand if a suitable source of water is obtained, transport operations, and site rehabilitation. Sand extraction operations from Lot 220 are expected to take 10 to 20 years to extract the estimated 9.6 million tonne resource. There is potential for the extraction of sand from Lot 218 to continue indefinitely, due to natural replenishment processes. At a maximum extraction rate of 1 million tonnes per year, it would take approximately 10 years to extract the sand resource from Lot 220 and therefore the scenario of maximum extraction over a 10 year timeframe has been used for this assessment.

Some extracted sand will be processed through either vibrating screens or a wash plant located at Lot 220 prior to being transported off site. Up to four front-end loaders will extract sand from the proposed operational area at Lot 218. It is estimated that approximately 1.4 Mtpa of sand migrates into this area each year. The operations on Lot 218 could therefore potentially continue indefinitely.

This Greenhouse Gas and Energy Assessment (GHGEA) has been prepared as part of the Environmental Assessment (EA) prepared for the Project in accordance with Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project will require the approval of the NSW Minister for Planning.

1.2 Resource and Operational Framework

1.2.1 Resource Extraction (Sand Mining) and Construction

Lot 218 Operations

Sand extraction at Lot 218 will occur progressively with up to four Volvo 180F front-end loaders or similar working along a 150 metre wide operational area. Approximately 50 per cent of sand from Lot 218 will be loaded directly onto trucks and transported or blended with other products without any processing. The remaining sand will be processed through 14 millimetre vibrating screens prior to being loaded onto trucks.

Typically, extracted sand will be transported by 33 tonne trucks with a 'truck and dog' arrangement. Volvo A40 six-wheel articulated haulers or similar may be used to transport sand within the operational area, as required. As stated, it is anticipated that up to 1,000,000 tonnes of sand will be extracted from Lot 218 each year.

Lot 220 Operations

Sand extraction at Lot 220 will occur in two areas. Sand extraction from Extraction Area 1 will begin with the construction of an access road into the lot through the dune in the northern section of the site. Sand extraction will continue behind the dune. A wash plant and other facilities will be established in Extraction Area 1 once a suitable area has been established and a suitable source of water is obtained. Development of Extraction Area 2 will commence when suitable access can be made from Extraction Area 1. Approximately 10 to 20 per cent of sand from Lot 220 will be loaded directly onto trucks and transported or blended with other products without any processing. The remaining sand will be processed through 14 millimetre vibrating screens or a wash plant prior to be loaded onto trucks.

Typically, extracted sand will be transported by 33 tonne trucks with a ‘truck and dog’ arrangement. Volvo A40 six-wheel articulated haulers or similar will be used to transport sand within the site, as required. As stated, it is anticipated that up to 1,000,000 tonnes of sand will be extracted from Lot 220 each year.

A truck weighbridge will be installed near the entrance to the site. The following buildings will also be constructed at the site:

- amenities room equipped with toilet and shower facilities. This building will be portable and will be moved to remain in reasonable proximity to the extraction operations;
- lunch room equipped with seating, kitchen facilities and air-conditioning. This building will also be portable and will be moved to remain in reasonable proximity to the extraction operations; and
- office equipped with office facilities and air conditioning. This building will be located adjacent to the truck weighbridge. A concrete hardstand area providing parking for three cars will be created adjacent to this building.

1.2.2 Resource Extraction Infrastructure

1.2.2.1 Volvo Wheel Loader

As stated, up to 4 Volvo Wheel Loaders (Model L180F) will be used at both sites. The product specifications are as follows (Volvo, 2007a). The 12-litre engine with Volvo Advanced Combustion Technology (V-ACT) is designed to maximise fuel efficiency and produce low emissions. The Volvo D12D LA E3 engine has the following fuel consumption rates (expressed in litres per hour (L/hr):

- Low 17 L/hr;
- Medium 21 L/hr; and
- High 34 L/hr.

According to the Volvo product specifications documentation (Volvo, 2007a), the wheel loaders are renowned for their low fuel consumption. The V-ACT engines are turbocharged and considered high-performance. The V-ACT engine uses advanced fuel injection and electronic engine control systems, making efficient use fuel. The internal exhaust gas recirculation system (I-EGR) is designed to reduce the emission of NOx by lowering peak combustion temperatures (Volvo, 2007a).

1.2.2.2 Volvo Articulated Hauler

The Volvo Articulated Hauler (Model A40E) will be used for the transport of product onsite. The Model A40E has a 40 tonne capacity. The engine utilises Volvo Advanced Combustion Technology, V-ACT (Volvo, 2007b). The Volvo D16E AAE3 engine has the following fuel consumption rates (expressed in L/hr):

- Low 19-26 L/hr;
- Medium 26-34 L/hr; and
- High 34-48 L/hr.

The Articulated Hauler uses the same V-ACT engine as indicated in **Section 1.2.2.1** (Volvo, 2007b).

1.2.3 Resource Processing

Approximately 50 per cent of sand from Lot 218 and up to 90 per cent from Lot 220 will be screened prior to being loaded onto trucks. A Turbo Chieftain 2100 vibrating screen will be used at each site to process this sand. Approximately 50 per cent of sand extracted from Lot 220 will be processed through a wash plant that will be constructed at Lot 220 once a suitable source of water is obtained. A typical configuration for the proposed washplant, as applicable to energy consumption, will utilise the following processes:

- a front-end loader will load extracted sand from a feed stockpile into the feed hopper which will supply the sand to a sand slurrying box via a conveyor;
- the sand slurrying box will be used to break up and wet the sand prior to feeding it through a trash screen of approximately 1.5 by 3.0 metres in size;
- sand will pass through the trash screen before entering the constant density tank. Oversize particles from the trash screen will be conveyed to a ground hopper and discarded. The separation process on the trash screen will be assisted by sprays;
- the constant density tank will be used to separate silt and clay particles up to 100 microns in diameter from the sand and provide a constant density feed to a cyclone separator;
- the constant density tank will be constructed so that it constantly overflows to one of two settlement ponds that will be constructed adjacent to the wash plant; and
- processed sand will finally be pumped through a cyclone (centrifugal separator) prior to being placed in stockpiles. Dirty water from the cyclone will be returned to the constant density tank.

1.2.4 Resource Transport

As stated, extracted sand from the area will be supplied to Sydney and Newcastle markets. The majority (estimated at 60 per cent) of the resource will be transported by truck (33 tonne capacity) to Newcastle. An estimated 40 per cent of the resource will be transported by truck (33 tonne capacity) to Sydney. The resource is not transported by other means.

It is estimated that a maximum of approximately 3,100 tonnes of sand will be produced in a day at either site. The sand extracted on Lot 220 will require the use of a Volvo Articulated

Hauler (Model A40E) to move the sand from the extraction area to the processing plant. The Volvo A40E has a 40 tonne capacity.

It is estimated that a maximum of eight laden 40 tonne capacity truck movements could occur per hour at Lot 218 and at Lot 220.

2.0 Assessment Framework and Objectives

2.1 Assessment Methodology and Factors

The Project GHGEA framework and objectives are in direct accordance with the *National Greenhouse and Energy Reporting System* (NGERS) (DCCb, 2008) and methodology established in the *National Greenhouse and Energy Report (Measurement) Technical Guidelines 2008 v1.0* (NGERS: TG) (DCCc, 2008). Additionally, the *National Greenhouse and Energy Reporting (Measurement) Determination* (the Determination) was made under subsection 10 (3) of the NGER Act and provides methods, and criteria for the estimation of greenhouse gas emissions; the production of energy; and the consumption of energy. Also applied is the United Nations Framework Convention on Climate Change (UNFCCC) reporting categories, as adopted and implemented by the Department of Climate Change (DCC) (DCCc, 2008).

In accordance with NGERS: TG (DCCc, 2008), this GHGEA is based on Method 1: the National Greenhouse Accounts default method, for the estimation of emissions. Method 1 provides a class of estimation procedures derived directly from the methodologies used by the DCC for the preparation of the National Greenhouse Accounts. The use of methodologies from the National Greenhouse Accounts also anchors Method 1 within the international guidelines adopted by the UNFCCC. Method 1 specifies the use of designated emission factors (EF) in the estimation of emissions. The EF are national average factors determined by the DCC using the Australian Greenhouse Emissions Information Systems (AGEIS) (DCCd, 2008).

The NGERS: TG (DCCc, 2008) default EF includes the effects of oxidation. The oxidation factor (OF) reflects the fact that 100 per cent of the carbon is not actually combusted, in general, as often there is a small unburnt residual (for example, soot). Default OF are taken from the *National Inventory Report* 2005 *Revised* (DCCe, 2008) for Australia and are used in conjunction with facility-specific EF in the absence of any facility-specific information on actual levels of oxidation (DCCc, 2008). The GHGEA takes the following structure (refer to **Table 2.1**).

Table 2.1 – Project GHGEA Framework and Outline

Mackas Sand GHGEA Framework	
1	An **assessment** of the respective sources of energy consumption and greenhouse gas emissions at Mackas Sand in accordance with nationally and internationally recognised assessment guidelines.
2	**Calculation** of energy consumption and greenhouse gas emissions from sand extraction operations and production by using nationally and internationally recognised methodology.
3	**Summary** and management/mitigation measure for the Project.

2.1.1 Specific Methodology

Estimations have been made using site and equipment data provided by Mackas Sand and referring to the specific assumptions, methodology, algorithms, precedence outlined in the following documents and legislation:

- Department of Climate Change *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines, 2008 v1.0 (NGERS: TG)* (DCCc, 2008)*;*

- *National Greenhouse Energy Reporting Act, 2007* (NGER Act)*;*

- Department of Climate Change *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2006: Energy (Fugitive Fuel Emissions)* (DCCa, 2006);

- Department of Climate Change *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2006: Energy (Stationary Sources)* (DCCf, 2007)*;*

- Department of Climate Change *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2006: Industrial Processes)* (DCCg, 2007)*;*

- *Report of the Independent Hearing and Assessment Panel for the Anvil Hill Sand Project: Greenhouse Gas Addendum Report to the Director-General,* Department of Planning, May 2007 (Anvil Hill IHAP) (Anvil Hill IHAP, 2007); and

- World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI) Greenhouse Gas Protocol 2004 (GHG Protocol) (WBC, 2004).

As stated in **Section 1.1**, it is estimated that extraction of Lot 218 has the potential to continue indefinitely while extraction operations from Lot 220 are expected to take 10 to 20 years from the commencement of operations to complete. For this assessment, an emissions period of 10 years at full production has been assumed.

2.2 Assessment Scope

2.2.1 Definitions

The emissions and energy consumption from Mackas Sand operations and the estimated emissions from the transport of the industrial grade sand resource have been assessed. A This GHGEA assesses a modified full life cycle of the Project. A description of the Project's modified full life cycle GHGEA parameters is outlined in **Table 2.2**. These parameters are defined by the NGERS: TG (DCCc, 2008), which outlines three scopes of emission categories for a project (refer to **Table 2.2**).

Table 2.2 – Project GHGEA Emissions Categories

Project GHGEA Emissions Categories	
Scope 1	Covers *direct emissions* from the combustion of fuels (for example, diesel) and industrial processes within the boundary of the mining operational.
Scope 2	Covers *indirect emissions* from the extraction operation's estimated consumption of purchased electricity that is produced by another organisation.
Scope 3	Includes the *indirect emissions* as a result of the transport of the industrial sand to market. These activities are not from sources owned or controlled by the organisation and involve the offsite transportation of the product.

The *National Greenhouse and Energy Reporting Act 2007* (the NGER Act) defines a **Greenhouse Gas** (GHG) as those indicated below. The NGER Act also specifies that GHG will be measured in carbon dioxide equivalents (CO_2-e). This methodology is applied to this GHGEA:

- carbon dioxide;
- methane;
- nitrous oxide;
- sulphur hexafluoride;
- a hydrofluorocarbon of kind specified in regulations; and
- a perfluorocarbon of a kind specified in regulations.

The **Global Warming Potential** (GWP) of a GHG is an index representing the combined effect of the differing multiplications of GHG remaining in the atmosphere and the relative effectiveness in absorbing outgoing infrared radiation. The GWP index is agreed internationally under the UNFCCC and the Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol) (United Nations, 1998).

2.2.2 Assumptions and Exclusions

The GHGEA assumes that the aggregate energy demand, electricity consumption and fuel consumption data, provided by Mackas Sand is accurate and representative. The year 2009 is considered the commencement date of the Project. This GHGEA makes the following exclusions:

- disposal of waste generated;
- disposal (end of life) of products sold;
- employee business travel;
- employees commuting to and from work;
- extraction, production and transport of other purchased materials and goods; and
- outsourced activities.

3.0 Technical Methodology and Results

The NGER Act and the Determination sets the technical methodology framework by the following specific principles: transparency, comparability, accuracy, and completeness. The Project's emissions profile is estimated as follows (refer to **Table 3.1**). As far as possible, the GHGEA will comply with the stated principles.

Table 3.1 – GHGEA Emissions Profile for the Project

GHGEA Emissions Profile for the Project	
Scope 1	• Diesel consumption. • Fugitive emissions (sand extraction). • Fugitive emissions (sand processing).
Scope 2	• Electricity consumption.
Scope 3	• Resource transport (local). • Resource transport (regional).

It is recognised that these GHG calculations are complex and have the potential to be imprecise.

3.1 Fugitive Emissions

3.1.1 Scope 1 Fugitive Emissions

Scope 1 Fugitive Emissions are those that are produced from activities within the parameters of the Project. Emissions from the Project will arise from the combustion of fuel during sand extraction operations and transport. Where EF are related to energy throughput, the energy content of fuel is expressed in terms of gross calorific value (GCV).

3.1.1.1 Onsite Fuel Combustion (Equipment)

Onsite Fuel Combustion Sources

Onsite fuel combustion from the onsite transport of product and onsite operations (sand extraction, onsite transport and processing) are included in the estimated operational data provided by Mackas Sand (refer to **Attachment 1**). GHG emissions from mobile and operational sources consist of gaseous products of engine fuel combustion (exhaust emissions) and gas leakage from vehicle (fugitive emissions). These emissions comprise CO_2 emissions due to the oxidation of fuel carbon content during fuel combustion: CH_4, N_2O, NOx, CO, SO_2 and non-methane volatile organic compounds (NMVOCs) emission.

The CO_2 emissions from the combustion of transport fuels are calculated by *Tier 1* methods by multiplying the fuel consumption for each type of mobile engine by a country-specific or default CO_2 emissions factor (in g/MJ) and an oxidation factor. This assigns the total carbon content of the fuel to CO_2 emissions and solid products, even though under actual engine operating conditions a portion of the carbon in fuel is released as CH_4, CO and NMVOCs. All emissions factors relating to energy consumption are given in terms of (GCV) (DCCc, 2008).

Onsite Fuel Combustion Calculation

The following formula is provided in the NGERS: TG (DCCc, 2008) to estimate GHG emissions from the combustion of each type of fuel listed. The projected diesel consumption estimate for the Project has not been calculated at the time of this GHGEA. Estimates for fugitive emissions produced by equipment onsite therefore incorporate equipment fuel consumption estimates.

The emissions are generally expressed in tonnes of CO_2 per GJ and the GWP of the relatively small quantities of CH_4 and N_2O emitted. All emissions factors incorporate the relevant oxidation factors. No increase in fuel use is currently predicted. No transport factors are provided for vehicles not registered for road use in the NGERS: TG. Stationary energy factors for individual fuel types are the recommended use in these cases. The results are presented in **Table 3.2**. Note the combustion of liquid fuels produces emissions of carbon dioxide, methane and nitrous oxide.

As stated in **Section 1.2.2**, the Volvo 180F and the Volvo A40E will combust diesel onsite. The estimated use is based on the following parameters. Medium engine activity is assumed.

Volvo L180F — **21L/hr** (Volvo, 2008a) based on an estimated *1000 operational hours* per year for one vehicle (21,000L/annum = **21 kL/annum**). If there are up to four vehicles operating at both sites at any one time, then the total will be **21kL x 8 (vehicles) = 168 kL/annum**; and

Volvo A40E — **26L/hr** (Volvo, 2008b) based on an estimated *3,300 operational hours* per year for Lot 220 (total = 85,800L/annum = **85.8kL/annum**).

Turbo Chieftan 2100 — **5L/hr** (estimate by Mackas Sand) to process **150 tonnes per hour**. Estimates are for the operation of the screens at Lot 220 and Lot 218.).

As indicated in **Section 1.2.3**, up to 400,000 tonnes of sand will be processed through a Turbo Chieftan 2100 vibrating screen at Lot 220 and 500,000 tonnes will be processed this way at Lot 218. An estimated total of 900,000 tonnes/annum will therefore be processed through this plant.

Based on an estimated *6,000 operational hours* per year for Lot 220 and Lot 218 (total = 30,000L/annum = **30kL/annum**).

Combined total = **283.8 kL/annum**.

The GHG emissions from diesel combustion were estimated using the following equation.

$$E_{ij} = Q_i \times EC_i \times EF_{ijoxec}/1000$$

where:

E_{ij} emissions of greenhouse gases from diesel combustion (t $CO_{2\text{-}e}$/annum);

Q_i quantity of diesel combusted onsite for transport purposes (as stated above, however, vehicles not registered for road use *should refer to stationary energy* EF (kL/annum); and

EC_i energy content factor of fuel type (i) measured as energy content GJ/kL for *stationary energy purposes;*

EF_{oxij} the emission factor for each gas type released from the operation of the facility during the year (which includes the effect of an oxidation factor) measured in kg/$CO_{2\text{-}e}$/GJ of fuel type (j) for *stationary energy purposes*.

Table 3.2 – Calculation of Emissions from Onsite Fuel Combustion (Equipment)

Period	**Formula**		**Calculation**
2009	Onsite Fuel Combustion (t CO_2-e)	= Q_i x EC_i x EF_{ijoxec}/1000	= 283.8 x 38.6 x 69.5/1000
			= 761.35
2011	Onsite Fuel Combustion (t CO_2-e)	= Q_i x EC_i x EF_{ijoxec}/1000	= 283.8 x 38.6 x 69.5/1000
			= 761.35
2013	Onsite Fuel Combustion (t CO_2-e)	= Q_i x EC_i x EF_{ijoxec}/1000	= 283.8 x 38.6 x 69.5/1000
			= 761.35
2015	Onsite Fuel Combustion (t CO_2-e)	= Q_i x EC_i x EF_{ijoxec}/1000	= 283.8 x 38.6 x 69.5/1000
			= 761.35
2017	Onsite Fuel Combustion (t CO_2-e)	= Q_i x EC_i x EF_{ijoxec}/1000	= 283.8 x 38.6 x 69.5/1000
			= 761.35
2019	Onsite Fuel Combustion (t CO_2-e)	= Q_i x EC_i x EF_{ijoxec}/1000	= 283.8 x 38.6 x 69.5/1000
			= 761.35
		Mean	= 761.35/$CO_{2\text{-}e}$
		Life of Extraction (Years)	= 10
		Subtotal	= 10 x 761.35
		Total Emissions from Onsite Fuel Combustion (Equipment)	**= 7,613.5 $tCO_{2\text{-}e}$**

For the estimated 10-year period, the total emissions from onsite equipment fuel combustion is estimated at 7,613.5 t CO_2-e based on an annual mean consumption of 283.8 kL of diesel (based on operational hour estimates). The mean yearly onsite emissions are calculated as 761.35 t CO_2-e.

3.1.1.2 Onsite Fuel Combustion (Truck)

Onsite Fuel Combustion Sources (Truck)

As stated in **Section 3.1.1.2**, onsite fuel combustion from the onsite transport of product and onsite operations (sand extraction and transport for processing) are included in the estimated operational data provided by Mackas Sand (refer to **Attachment 1**).

Onsite Fuel Combustion Calculation (Truck)

An estimation of emissions for the transport of sand products by road onsite at Lot 218 is provided with reference to industry studies. As stated, the projected diesel consumption estimate for the Project has not been calculated at the time of this GHGEA. Estimates for fugitive emissions produced by trucks onsite therefore incorporate a freight weight and distance formula.

The transport of sand one-way is the basis of this calculation as the sand will be transported one-way only and the formula has a freight-weight base. The NGERS: TG formula is also based on the quantity of diesel fuel used to transport the extracted resource. The formula used in the Mackas Sand GHGEA is assumed transferable from the research papers *Food Miles in Australia: a Comparison of Emissions from Road and Rail Transport* (Gaballa & Cranley, 2008) and *Comparison of Greenhouse Gas Emissions by Australian Intermodal Rail and Road Transport* (Affleck, 2002).

Fuel consumption data (as required by NGERS: TG formulae) was replaced by factoring an Energy Intensity estimate (in GJ/NTK (net tonne kilometre). This equates to the energy cost of moving one tonne of freight one kilometre. The following equation using an average Energy Intensity for Australian road truck was included to calculate GHG emissions estimates for sand product when transported by road truck. The results are provided in **Table 3.3**:

$$E_{Road} = (FW \times D \times EI_{Road}) \times EF$$

where:

E_{Road} GHG emissions from road truck transport (t CO_2-e);

FW is the freight weight (tonnes) (the Model A40E has a 40 tonne capacity);

D is transport distance by road (one-way trip is 2 kilometres);

EI_{Road} is the Energy Intensity of road freight operations (in GJ/Tkm)
Road Freight Intensity is 0.72 MJ/Tkm = 0.00072 GJ/Tkm; and

EF is the diesel fuel Emission Factor, in tonnes CO_2-equivalent (CO_2-e) emissions per GJ of fuel energy consumed. Diesel Emissions Factor is 0.0699 t CO_2-e/GJ.

The EI constant for road freight was sourced from a comparative study of intermodal and road freight by Affleck Consulting (Affleck, 2002). This constant provides an average figure for the fuel energy required to move 1 tonne of freight a distance of 1 kilometre: averaging payloads, road truck capacity lengths and engine efficiencies. To transport the extracted sand one-way onsite at Lot 218, based on a truck capacity of 40 tonnes will require an estimated 25,000 trips per year.

Table 3.3 – Calculation of Emissions from Onsite Fuel Combustion (Truck)

Period	**Formula**		**Calculation**
One Trip	Onsite Fuel Emissions (t CO_2-e) (Truck)	= (FW x D x EI_{Road}) x EF	= (40 x 2 x 0.00072) x 0.0699
			= 0.0040 tCO_{2-e}
2009	Onsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 25,000 x 0.0040
			= 100
2011	Onsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 25,000 x 0.0040
			= 100
2013	Onsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 25,000 x 0.0040
			= 100

Table 3.3 – Calculation of Emissions from Onsite Fuel Combustion (Truck) (cont)

Period	Formula		Calculation
2015	Onsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x $CO_{2\text{-}e}$ (1 x Trip)	= 25,000 x 0.0040
			= 100
2017	Onsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x $CO_{2\text{-}e}$ (1 x Trip)	= 25,000 x 0.0040
			= 100
2019	Onsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x $CO_{2\text{-}e}$ (1 x Trip)	= 25,000 x 0.0040
			= 100
		Mean	= 100 $tCO_{2\text{-}e}$
		Life of Extraction (Years)	= 10
		Subtotal	= 10 x 100
		Total Emissions from Onsite Fuel Combustion (Truck)	**= 1000 $tCO_{2\text{-}e}$**

The estimated GHG emissions for the transport of sand within the parameters of Lot 218 are 1000 t CO_2-e for a period of 10 years. As stated, the laden one-way road trip is an estimated distance of 2 kilometres. The annual mean emission estimate for onsite road transport of product is 100 t CO_2-e. The estimated emissions for the one-way trip are 0.0040 t CO_2-e.

3.1.2 Scope 3 Fugitive Emissions

3.1.2.1 Scope 3 Fugitive Emissions Parameters

Scope 3 fugitive emissions are those that occur outside of the parameters of the Project. The World Business Council for Sustainable Development and the World Resources Institute *Greenhouse Gas Protocol 2004* (WRI, 2004) specifically acknowledges the importance of the avoidance of double-counting of GHG emissions. On an international scale, double-counting needs to be avoided when compiling national inventories under the Kyoto Protocol.

There are considerable speculative and assumption-based scientific and practical implications from such assessment of Scope 3 and indirect emissions. With the stated exclusions (refer to **Section 2.2.2**.), the GHGEA includes an assessment of Scope 3 fugitive emissions for context and consideration of ESD principles only. These emissions are produced outside the parameters and direct influence of the Project. The following Scope 3 emissions are assessed:

- *Offsite Fuel Combustion*: the transport of product sand to local and regional markets (road truck with 33 tonne capacity).

No assessment of the emissions produced or the energy consumption in the end use of the sand resource is provided.

3.1.2.2 Offsite Fuel Combustion

Transport by Road to Sydney and Newcastle Markets

An estimation of emissions for the transport of sand products by road offsite to Sydney and Newcastle is provided with reference to industry studies. The transport of sand one-way is the basis of this calculation. The formula is based on emissions generated by transporting the freight to market. No assumption of the direction or potential freight of a return trip is made in this GHGEA (Anvil Hill IHAP, 2007) as there is a high potential that a back load will be transported on the return trip. The NGERS: TG formula is also based on the quantity of diesel fuel used to transport the extracted resource. The formula used in the Mackas Sand GHGEA is assumed transferable from the research papers *Food Miles in Australia: a Comparison of Emissions from Road and Rail Transport* (Gaballa & Cranley, 2008) and *Comparison of Greenhouse Gas Emissions by Australian Intermodal Rail and Road Transport* (Affleck, 2002).

Fuel consumption data (as required by NGERS: TG formulae) was replaced by factoring an Energy Intensity estimate (in GJ/NTK (net tonne kilometre). This equates to the energy cost of moving one tonne of freight one kilometre. The following equation using an average Energy Intensity for Australian road truck was included to calculate GHG emissions estimates for sand product when transported by road truck. The results are provided in **Tables 3.4** and **3.5**:

$$E_{Road} = (FW \times D \times EI_{Road}) \times EF$$

where:

E_{Road} GHG emissions from road truck transport (t CO_2-e);

FW is the freight weight (tonnes) (an estimated *40 per cent of the resource will be transported to Sydney*; and an estimated *60 per cent of the resource will be transported to Newcastle*);

D is transport distance by road (one-way trip to Newcastle *is estimated at 25 kilometres*; and one-way trip to *Sydney is estimated at 160 kilometres*);

EI_{Road} is the Energy Intensity of road freight operations (in GJ/Tkm)
Road Freight Intensity is 0.72 MJ/Tkm = 0.00072 GJ/Tkm; and

EF is the diesel fuel Emission Factor, in tonnes CO_2-equivalent (CO_2-e) emissions per GJ of fuel energy consumed. Diesel Emissions Factor is 0.0699 t CO_2-e/GJ.

The EI constant for road freight was sourced from a comparative study of intermodal and road freight by Affleck Consulting (Affleck, 2002). This constant provides an average figure for the fuel energy required to move 1 tonne of freight a distance of 1 kilometre: averaging payloads, road truck capacity lengths and engine efficiencies. To transport the extracted sand one-way to Newcastle and Sydney markets, based on a truck capacity of 33-tonnes will require an estimated **36,363 trips** and **24,242 trips** per year respectively. The calculations are based on the framework that one truck type will be used for transporting the entire annual load to market.

Table 3.4 – Calculation of Fugitive Emissions from Road Transport
(Newcastle – 1,200,000 tonnes/annum)

Period	Formula		Calculation
One Trip	Offsite Fuel Emissions (t CO_2-e) (Truck)	= (FW x D x EI_{Road}) x EF	= (33 x 25 x 0.00072) x 0.0699
			= 0.0415 $tCO_{2\text{-}e}$
2009	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x $CO_{2\text{-}e}$ (1 x Trip)	= 36,363 x 0.0415
			= 1,509

Table 3.4 – Calculation of Fugitive Emissions from Road Transport (Newcastle – 1,200,000 tonnes/annum) (cont)

Period	Formula		Calculation
2011	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 36,363 x 0.0415
			= 1,509
2013	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 36,363 x 0.0415
			= 1,509
2015	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 36,363 x 0.0415
			= 1,509
2017	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 36,363 x 0.0415
			= 1,509
2019	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 36,363 x 0.0415
			= 1,509
		Mean	= 1,509 tCO_{2-e}
		Life of Extraction (Years)	= 10
		Subtotal	= 10 x 1,509
		Total Fugitive Emissions from Road Transport to Newcastle	**= 15,090 t CO_{2-e}**

The estimated GHG emissions for the transport of sand outside the parameters of the sites are 15,090 t CO_2-e for the life of the Project. As stated, the laden one-way road trip is an estimated distance of 25 kilometres to Newcastle. The annual mean emission estimate for offsite road transport of product is to Newcastle is 1,509 t CO_2-e. The estimated emissions for the one-way trip are 0.0415 t CO_2-e.

Table 3.5 – Calculation of Fugitive Emissions from Road Transport (Sydney – 800,000 tonnes/annum)

Period	Formula		Calculation
One Trip	Offsite Fuel Emissions (t CO_2-e) (Truck)	= (FW x D x $EI_{\mathbf{Road}}$) x EF	= (33 x 160 x 0.00072) x 0.0699
			= 0.265 tCO_{2-e}
2009	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 24,242 x 0.265
			= 6,424.13
2011	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 24,242 x 0.265
			= 6,424.13
2013	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 24,242 x 0.265
			= 6,424.13
2015	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 24,242 x 0.265
			= 6,424.13
2017	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 24,242 x 0.265
			= 6,424.13
2019	Offsite Fuel Emissions (t CO_2-e) (Truck)	= # Trips x CO_{2-e} (1 x Trip)	= 24,242 x 0.265
			= 6,424.13
		Mean	= 6,424.13 tCO_{2-e}
		Life of Extraction (Years)	= 10
		Subtotal	= 10 x 6,424.13
		Total Fugitive Emissions from Road Transport to Sydney	**= 64,241.3 t CO_{2-e}**

The estimated GHG emissions for the transport of sand outside the parameters of the sites are 64,241.3 t CO_2-e for the life of the Project. As stated, the laden one-way road trip is an estimated distance of 160 kilometres to Sydney. The annual mean emission estimate for offsite road transport of product is to Sydney is 6,424.13 t CO_2-e. The estimated emissions for the one-way trip are 0.265 t CO_2-e.

The total Scope 3 fugitive fuel combustion emissions for offsite transport of the product to both Sydney and Newcastle are estimated as 79,331.3 t CO_2-e over a 10 year period.

3.2 Stationery Emissions

3.2.1 Scope 2 Emissions

3.2.1.1 Emissions from the Consumption of Electricity

Consumption of Electricity Source

Stationery source (*indirect*) emissions are those that are physically produced by another organisation, most particularly in the form of electricity. The methodology and EF used to estimate annual emissions of GHG from stationery sources within the energy sector covers fuels including: coal, coke, brown sand briquettes and coke oven gas, petroleum products, natural gas, and town gas. The estimate of electricity consumption has been provided by Mackas Sand and is based on the framework of current operations. As such, the electricity consumption for the Project is a general estimate only. The following operational and administrative activities are predicted to consume electricity onsite:

Sand wash plant at Lot 220, including:

- washplant conveyor (120 tonnes/hour);
- washplant screen (120 tonnes/hour);
- washplant pump x 2 (120 tonnes/hour);
- administration building (with air conditioner); and
- amenities building.

Consumption of Electricity Calculation

The following formula is listed in NGERS: TG to estimate GHG emissions from the combustion of coal to produce electricity. Indirect emissions factors for the consumption of purchased electricity are provided by State because electricity flows between states are constrained by the capacity of the interstate inter-connectors and in some cases there are no interconnections. The factors estimate emissions of CO_2, CH_4 and N_2O expressed together as CO_2-e. All emissions factors incorporate the relevant oxidation factors. The GHG emissions in tonnes of CO_2-e attributable to the quantity of electricity used may be calculated with the following equation. The results are detailed in **Table 3.6**.

$E_{(t\ CO2\text{-}e)} = Q \times EF/1000$

where:

Q is the electricity consumed by the reporting organisation expressed in kWh;

EF is the emission factor expressed in kg $C0_2$-e/kWh; and

EF for NSW (Full-cycle) is 1.068 (Anvil Hill IHAP, 2007).

Electricity consumption from the proposed Project has been estimated by Mackas Sand as approximately 10,000 kWh per month (120,000 kWh/annum). As is it a projected estimate only, and based on the framework from current and larger operations, it may feasibly be considered an overestimate. This estimate is, however, taken as generally representative of electricity consumption for the Project.

Table 3.6 – Calculation of Stationary Source Emissions

Period	Formula		Calculation
2009	Stationary Source Emissions (t CO_2-e)	= Q x EF/1000	= 120,000 x 1.068/1000
			= 128.16
2011	Stationary Source Emissions (t CO_2-e)	= Q x EF/1000	= 120,000 x 1.068/1000
			= 128.16
2013	Stationary Source Emissions (t CO_2-e)	= Q x EF/1000	= 120,000 x 1.068/1000
			= 128.16
2015	Stationary Source Emissions (t CO_2-e)	= Q x EF/1000	= 120,000 x 1.068/1000
			= 128.16
2017	Stationary Source Emissions (t CO_2-e)	= Q x EF/1000	= 120,000 x 1.068/1000
			= 128.16
2019	Stationary Source Emissions (t CO_2-e)	= Q x EF/1000	= 120,000 x 1.068/1000
			= 128.16
		Mean	= 128.16 t CO_2-e/kWh
		Life of Remaining Production (Years)	= 10
		Total for Project (Estimate)	= 10 x 128.16
		Total Stationary Source Emissions	**= 1,281.6 t CO_2-e/kWh**

The estimated yearly mean emissions from electricity consumption of the Project will be 128.16 t $C0_2$-e/kWh. This calculation is based on an estimated projection of 120,000 kWh per annum. The total emissions from electricity consumption for the Project are estimated as 1,281.6 t $C0_2$-e/kWh. As previously stated, the predicted monthly electricity consumption by the Project is it an estimate only. As it is understood that Mackas Sand has based this estimate on the framework from current and larger operations, the emissions estimate may feasibly be considered an overestimate.

3.3 Greenhouse Gas Impact Assessment

With direct reference to the Anvil Hill IHAP (Anvil Hill IHAP, 2007), the Mackas Sand GHGEA also incorporates an address of the principles of Ecologically Sustainable Development

(ESD), and in particular, the principle of intergenerational equity and the precautionary principle from the downstream GHG emissions from the project.

The precautionary principle requires that the Project's cumulative effects (including downstream emissions) must be assessed, and that the impacts of end uses of sand products be assessed despite any scientific uncertainty about the extent of impact. In this context, the contribution of the Project to national and international GHG emissions are included.

3.3.1 National Emissions Contribution

An assessment of the GHG emissions produced by the proposed Project as a percentage of national emissions is provided, based on the following equation. The results are presented in **Table 3.7**.

$$PC_i = ECC/T_i \times 100$$

where:

PC_i estimated percentage contribution from the Project to national emission estimates (%);

ECC estimated emissions of GHG from the Project (t CO_2-e/annum);

T estimated emissions of GHG on a national scale (t CO_2-e/annum).

National GHG emission under for Australia: *Total UNFCCC Carbon Dioxide Equivalent Emissions, 2006, UNFCCC Accounting within the National Greenhouse Accounts Online Reporting Framework (*AGEIS, 2008) is 549, 852,000 tonnes of CO_2-e. The total Mackas Sand emissions were calculated in **Table 3.7** as 89,226.4 t CO_2-e.

Table 3.7 – Calculation of Percentage Contribution to National Emissions

Period	**Formula**		**Calculation**
2009	Percentage Contribution (%)	= $ECC/T_i \times 100$	= 89,226.4/549,852,000 x 100
			= 0.016 % /annum
			= 0.016 % /annum **(based on 2004 modelling)**

The sand extraction activities at Lot 218 and Lot 220, will contribute an estimated 0.016 per cent to national yearly GHG emissions (based on 2004 modelling).

3.3.2 International Emissions Contribution

An assessment of the GHG emissions produced by the Project as a percentage of international GHG emissions is provided. The percentage contribution to international GHG emissions was estimated using the following equation. The results are presented in **Table 3.8**.

$PC_i = ECC/T_i \times 100$

where:

PC_i estimated percentage contribution from the Project to global emission estimates (%);

ECC estimated emissions of GHG from the Project (t CO_2-e/annum);

T estimated emissions of GHG on a global scale (t CO_2-e/annum).

International GHG emission estimates during 2004 were **40,335,714,286 t CO_2-e**. At the time of this calculation, it was estimated that Australia produced 1.4 per cent of total global emissions. The global GHG emission estimate is sourced from *Economic Impact of Climate Change Policy: the role of technology and economic instruments* (ABARE, 2006).

The total emissions from the Project have been estimated and presented in **Table 3.8** as **89,226.4 t CO_2-e.**

Table 3.8 – Calculation of Percentage Contribution to International Emissions

Period	Formula		Calculation
2009	Percentage Contribution (%)	= $ECC/T_i \times 100$	= 89,226.4/40,335,714,286 x 100
			= 0.000221
			= 0.000221 % **(based on 2004 modelling)**

The sand extraction activities will contribute an estimated 0.000221 per cent to international yearly GHG emissions (based on 2004 modelling). No forecast is made with this assessment.

4.0 Summary

A summary of GHG emission sources and quantities from the Project are presented in **Table 4.1**. The estimates are presented in order of mean yearly emissions and total emissions for the extraction of up to 1 Mpta from Lot 218 and Lot 220, or a total of 2 Mtpa from the combined operations.

Table 4.1 – Summary of Estimated GHG Emissions from the Project

Emission Source	Emission Type	Emission Scope	Mean Yearly Emission (t CO_2-e)	Total Project Emission (t CO_2-e)
Onsite Fuel Combustion (Equipment)	Fugitive	Scope 1	761.35	7,613.5
Onsite Fuel Combustion (Truck)	Fugitive	Scope 1	100	1000
Electricity Consumption	Stationery	Scope 2	128.16	1,281.6
Offsite Transport Combustion	Fugitive	Scope 3	7,933.13	79,331.3
		Scope 1 and Scope 2 TOTAL	**989.51**	**9,895.1**
		TOTAL	**8,922.64**	**89,226.4**

The modified full life cycle analysis emissions estimate (with no statistical consideration of variables) for the Project is 89,226.4 t CO_2-e. The total mean yearly emissions from the Project is 8,922.64 t CO_2-e. The main sources of emissions from the Project are estimated to be from the offsite transport of sand products. These Scope 3 emissions are considered to be outside the parameters of the Project and the direct influence of Mackas Sand.

The largest source of emissions onsite are Scope 1 fugitive emissions produced by sand extraction equipment. The Scope 1 fugitive emissions produced by the transport of sand onsite and the indirect Scope 2 emissions generated from electricity consumption are estimated to be approximately 989.51 (t CO_2-e) per year.

5.0 Management and Mitigation

Mackas Sand greenhouse gas and energy management focus will be directed at an efficient use of fuel and energy use on site. Mackas Sand will exercise the following mitigation activities for both management and operational activities:

- assessment of energy use to identify areas of reduction and increased efficiency and implement where possible;
- assessment of operational practices and activities to potential for a more efficient use of resources and implement where possible; and
- assessment of onsite fugitive emissions for potential areas of reduction and implement where possible.

Some of the opportunities for improving energy efficiency and reducing GHG emissions from the Project include the following:

- review energy efficiency in plant and equipment operation, consideration to be given to the life cycle costs advantages obtained by using energy efficient components (for example, high efficiency conveyors, screens, external lighting, and efficient air conditioning systems);
- review operational initiatives such as turning off idling plant equipment;
- review control and temperature settings for air conditioning units in site facilities;
- implement the potential energy efficiency opportunities in water pumping systems (for example, variable speed drive pumps); and
- review changes in power consumption with installation of new equipment and install power factor correction equipment to suit.

6.0 References

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ATTACHMENT 1

GHG Data

Attachment 1 - GHG Data

Project Component Lot 220	**Operational Hours**	**Operational Kilometres**	**Diesel Consumption**	**Electricity Consumption**	**Notes**
Haul Truck (40 tonne capacity)	3,300	20,000			
FEL (10 tonne bucket)	1,000	8,000			
Washplant - converyor (120 tonnes per hour)	4,200	n/a			Wash plant operates 24/7
Washplant - screen (120 tonnes per hour)	4,200	n/a			Screen size 1.5 x 3 metres
Washplant - Pump x 2 (120 tonnes per hour)	4,200	n/a			
Vibrating screen (150 tonnes per hour)	2,700	n/a			
Project Component Lot 218					
FEL (10 tonne bucket)	1,000				
Vibrating screens (150 tonnes per hour)	3,400	n/a			
Road Truck (on-site) (33-tonne capacity)	30,300	121200			
Project Component - Off Site					
Road Truck (33-tonne capacity) - Sydney destination 320 km round trip 40%		7,600,000			
Road Truck (33-tonne capacity) - Newcastle Destination 50 km round trip 60%		1,800,000			