REPORT

Review of Greenhouse Gas Assessment

Gunns Pulp Mill

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PACIFIC AIR & ENVIRONMENT

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1 INTRODUCTION

This report has been prepared for the proposed Gunns pulp mill in Tasmania, addressing greenhouse gas emissions from the proposed project. This assessment differs from the original greenhouse gas assessment performed by GHD due to the following factors:

- Inclusion of all scope 3 greenhouse gas emission (i.e. indirect, downstream emissions) estimates;
- A more complete coverage of all greenhouse gas emission sources from the proposed project in line with approved methodologies prescribed by the Australian Government Department of the Environment & Heritage and with the International Council of Forest and Paper Associations (ICFPA) for determining greenhouse gas emissions; and
- Updated activity data supplied by Gunns Limited for the proposed pulp mill.

2 GREENHOUSE GAS EMISSIONS ASSESSMENT FRAMEWORK

2.1 Methodologies

This report is based upon the methodologies outlined in the following documents:

- The World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) *Greenhouse Gas Protocol* (GHG Protocol); and
- The Australian Greenhouse Office (AGO) *Factors and Methods Workbook* (AGO Workbook).

Each of the GHG Protocol and the AGO Workbook contains a methodology for assessing and calculating GHG emissions. The GHG Protocol has been adopted broadly within the internationally community. This is reflected in the AGO Workbook which largely adopts the methodology presented in the GHG Protocol.

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

Furthermore, the guidance document developed by the International Council of Forest and Paper Associations for estimating greenhouse gas emissions from pulp and paper mills has been used to estimate emissions of greenhouse gases from the proposed Bell Bay Pulp Mill. The calculation tools are called *Calculation Tools for Estimating Greenhouse Gas Emissions from Pulp and Paper Mills* (NCASI, 2005). The tools were developed to assist pulp and paper mills compile greenhouse gas inventories. Moreover, the tools are consistent with protocols issued by the Intergovernmental Panel on Climate Change (IPCC) and the WRI/WBCSD GHG Protocol.

2.1.1 The GHG Protocol

Under the GHG Protocol, the establishment of operational boundaries involves identifying emissions associated with an entity's operations, categorising them as direct or indirect emissions, and identifying the scope of accounting and reporting for indirect emissions.

Three "Scopes" of emissions (Scope 1, Scope 2, and Scope 3) are defined for GHG accounting and reporting purposes. Scopes 1 and 2 have been carefully defined to ensure that two or more entities will not account for emissions in the same Scope.

(a) Scope 1: Direct GHG Emissions

Direct GHG emissions are defined as those emissions that occur from sources that are owned or controlled by the entity. Direct GHG emissions are those emissions that are principally the result of the following types of activities undertaken by an entity:

- Generation of electricity, heat or steam. These emissions result from combustion of fuels in stationary sources, e.g. boilers, furnaces, turbines;
- Physical or chemical processing. Most of these emissions result from the manufacture or processing of chemicals and materials, e.g.: the manufacture of cement, aluminium, ammonia, or waste processing;
- Transportation of materials, products, waste, and employees. These emissions result from the combustion of fuels in entity owned/operated mobile combustion sources, e.g.: trucks, trains, ships, aeroplanes, buses, and cars; and
- Fugitive emissions. These emissions result from intentional or unintentional releases, e.g., equipment leaks from joints, seals, packing, and gaskets; methane emissions from coal mines and venting; HFC (hydrofluorocarbon) emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport.

(b) Scope 2: Electricity indirect GHG emissions

Scope 2 emissions are a category of indirect emissions that accounts for GHG emissions from the generation of purchased electricity consumed by the entity.

Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary by the entity. Scope 2 emissions physically occur at the facility where electricity is generated. Entities report the emissions from the generation of purchased electricity that is consumed in their owned and operated equipment or operations as Scope 2.

(c) Scope 3: Other indirect GHG emissions

Under the GHG Protocol, Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions.

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

The GHG Protocol provides that reporting Scope 3 emissions is optional. If an organisation believes that Scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with Scope 1 and 2. However, the GHG Protocol notes that reporting Scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or projects difficult because reporting is voluntary. Double counting needs to be avoided when compiling national (country) inventories under the Kyoto Protocol. The GHG protocol also recognises that compliance regimes are more likely to focus on "point of release" of emissions (i.e. direct emissions) and indirect emissions from the use of electricity.

2.1.2 AGO Workbook

The Department of the Environment and Heritage (DEH) released the AGO Workbook in December 2005. The AGO Workbook provides current GHG emission factors for Australian organisations to estimate their emissions and abatement.

The emission factors presented in the December 2005 edition of the AGO workbook have been harmonised with the international reporting framework of the GHG Protocol.

Scope of Emissions to be assessed/calculated

Participants in many AGO programmes are required to report both direct and indirect GHG emissions.

"Direct Emissions" are defined by the AGO Workbook as:

Direct emissions are produced from sources within the boundary of an organisation and as a result of that organisation's activities. These emissions mainly arise from the following activities:

- generation of energy, heat, steam and electricity, including carbon dioxide and products of incomplete combustion (methane and nitrous oxide);
- manufacturing processes, which produce emissions (for example, cement, aluminium and ammonia production);
- transportation of materials, products, waste and people; for example, use of vehicles owned and operated by the reporting organisation;

- fugitive emissions: intentional or unintentional GHG releases (such as methane emissions from coal mines, natural gas leaks from joints and seals); and

- on-site waste management, such as emissions from company-owned and operated landfill sites.

For example, a company with a car fleet would report greenhouse gas emissions from the combustion of petrol in those motor vehicles as direct emissions. Similarly, a mining company would report methane escaping from a coal seam during mining (fugitive emissions) as direct emissions and a cement manufacturer would report carbon dioxide released during cement production as direct emissions.

Emission factors for calculating direct emissions are generally expressed in the form of a quantity of a given GHG emitted per unit of energy (kg CO_{2-e}/GJ), fuel (t CH_4/t coal) or a similar measure. Emission factors are used to calculate GHG emissions by multiplying the factor (e.g. kg CO_2/GJ energy in petrol) by activity data (e.g. kilolitres x energy density of petrol used).

"Indirect Emissions" are defined in the AGO Workbook as:

Indirect emissions are emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation. The most important category of indirect emissions is from the consumption of electricity. Other examples of indirect emissions from an organisation's activities include upstream emissions generated in the extraction and production of fossil fuels, downstream emissions from transport of an organisation's product to customers, and emissions from contracted or outsourced activities. The appropriate emissions factor for these activities depends on the parts of upstream production and downstream use considered in calculating emissions associated with the activity.

As discussed, to achieve harmonisation with the international reporting framework, the AGO Workbook adopts the emissions categories of the GHG Protocol and provides that the scope of emissions that are reported by an entity under the AGO Workbook is determined by whether the activity is within the entity's boundary (direct – Scope 1) or outside it (indirect – Scope 2 and Scope 3).

The AGO Workbook provides that Scope 3 emissions can include:

- Disposal of waste generated (e.g. if the waste is transported outside the organisation and disposed of);
- Use of products manufactured and sold;
- Disposal (end of life) of products sold;
- Employee business travel (in vehicles or aircraft not owned or operated by the reporting organisation)

- Employees commuting to and from work;
- Extraction, production and transport of purchased fuels consumed;
- Extraction, production and transport of other purchased materials or goods;
- Purchase of electricity that is sold to an end user (reported by electricity retailer);
- Generation of electricity that is sold to an end user (reported by electricity retailer);
- Generation of electricity that is consumed in a transport and distribution system (reported by end user);
- Out-sourced activities; and
- Transportation of products, materials and waste.

2.1.3 Calculation Tools for Estimating Greenhouse Gas Emissions from Pulp and Paper Mills

Responding to the need for improved methods for estimating greenhouse gas (GHG) emissions from pulp and paper mills, in 2001 the International Council of Forest and Paper Associations (ICFPA), which includes the Australian Paper Industry Council, agreed to develop international tools to:

- enable harmonised collection of credible, transparent, and comparable data worldwide;
- address the forest products industry's unique attributes; and
- establish a framework that will assist in implementing a variety of programs that might make use of carbon inventory data.

To accomplish this, the ICFPA Climate Change Working Group retained the research institute National Council for Air and Stream Improvement, Inc. (NCASI) to review existing GHG protocols and assist the industry in developing calculation tools for estimating GHG emissions. The results of that effort have been used to prepare this report.

The calculation tools were developed to help achieve the following outcomes:

- ensure credible and transparent emission estimates for GHGs of potential significance to pulp and paper mills i.e. fossil-CO_2, CH_4 (methane) and N_2O (nitrous oxide);
- provide companies with methods that are tailored to the conditions likely to be encountered at pulp and paper mills and are easily implemented;
- minimise the potential for inappropriate mill-to-mill, company-to-company, and international comparisons of GHG emissions;
- facilitate the tracking of improvements at individual sites or companies;
- facilitate carbon trading; and
- be as consistent as possible with recognised international and national protocols.

The Calculation Tools for Estimating GHG Emissions from Pulp and Paper Mills were compiled to be consistent with the GHG Protocol.

Therefore, GHG emission estimates contained in this report are as outlined in the Calculation Tools for Estimating GHG Emissions from Pulp and Paper Mills (NCASI, 2005) and the AGO Workbook (DEH, 2005).

3 GHG EMISSION SOURCES

Scope 1 and scope 2 emissions are based on a projected maximum production rate of pulp of 1,100,000 ADt[a] per annum from the proposed pulp mill. Transportation emission estimates considered in this assessment as scope 3 emissions are based on a production mix scheme where the production at the start is equivalent to 820,000 ADt per annum and increases to 1,100,000 tonnes per annum.

Greenhouse gas emission sources from the proposed facility are shown in Table 3.1.

Table 3.1: Greenhouse Gas Emission Sources from the Proposed Pulp Mill

Scope 1 Emissions	Scope 2 Emissions	Scope 3 Emissions
■ Emissions from make-up $CaCO_3$ ■ Emissions from make-up Na_2CO_3 ■ Emissions from the natural gas fired lime kiln, recovery boiler and NCG incinerator ■ Emissions from stationary combustion of biomass ■ Emissions from wastewater treatment	■ Generation of electricity	■ Transportation of products ■ Transportation of materials ■ Transportation of chemicals ■ Emissions from the extraction (and processing and transport) of natural gas ■ Emissions from the extraction (and processing and transport) of diesel ■ Resource delivery by rail ■ Transportation of waste ■ Transportation of boiler fuel ■ Light vehicle transportation ■ Production of burnt lime

The pulp mill will not use greenhouse gases such as CFCs, (chlorofluorocarbons) HCFCs (hydrochlorofluorocarbons), CCl_4 (carbon tetrachloride), CH_3CCl_3 (trichloroethane) and CH_3Br (methylbromide) and hence emissions of these substances are expected to be zero.

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[a] Air Dried tonnes

3.1 Greenhouse Gas Emissions from Stationary Fossil Fuel Combustion

Carbon dioxide emissions from stationary fossil fuel combustion represent the bulk of Scope 1 greenhouse gas emissions for most pulp and paper mills (NCASI, 2005). Emissions of CO_{2-e} are estimated from the carbon content of, or emission factors for, all fossil fuels being burned.

It is proposed that natural gas will be combusted in the lime kiln, recovery boiler (during start-up and shut-down) and the Non-Condensable Gases (NCG) incinerator at the proposed Bell Bay Pulp Mill. Greenhouse gas emissions from natural gas combustion arise due to direct emissions (scope 1) from the release of CO_2 and CH_4 from the combustion of natural gas, and from indirect emissions due to the fuel extraction (scope 3).

Scope 1 emissions from natural gas combustion are estimated using emission factors supplied in the *Calculation Tools for Estimating GHG Emissions from Pulp and Paper Mills* (NCASI, 2005). Estimated emissions are provided in Table 3.2, Table 3.3 and Table 3.4 for the Lime Kiln, Recovery Boiler (burning natural gas during start-up and shut-down) and the NCG incinerator respectively.

Table 3.2: Scope 1 Emissions from Natural Gas Combustion in the Lime Kiln

Substance	Heat Required[a] (MWh/annum)	Rate of Natural Gas Consumption[b] (GJ/annum)	Scope 1 Emission Factor [c] (kg/GJ)	Emissions (t/annum)
CO_2	442,490	1,625,473	55.9	90,864
CH_4	442,490	1,625,473	0.0027	4.39
			Total Estimated CO_{2-e} Emissions	**90,956**

[a] Source: Table 4-b, Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS

[b] Derived as follows:

442,490 [MWh/annum] x 3.6 [GJ/MWh]/0.98 = 1,625,473 [GJ/annum] (assuming 98% combustion efficiency)

[c] *Calculation Tools for Estimating GHG Emissions from Pulp and Paper Mills* (NCASI, 2005) (based on a lower heat value of natural gas)

Table 3.3: Scope 1 Emissions from Natural Gas Combustion in the Recovery Boiler (During Start-up and Shut-Down)

Substance	Heat Required[a] (MWh/annum)	Rate of Natural Gas Consumption[b] (GJ/annum)	Scope 1 Emission Factor [c] (kg/GJ)	Emissions (t/annum)
CO_2	53,265	195,667	55.9	10,938
CH_4	53,265	195,667	0.0027	0.53
			Total Estimated CO_{2-e} Emissions	**10,949**

[a] Source: Table 4-b, Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS

[b] Derived as follows:

53,265 [MWh/annum] x 3.6 [GJ/MWh]/0.98 = 195,667 [GJ/annum] (assuming 98% combustion efficiency)

[c] *Calculation Tools for Estimating GHG Emissions from Pulp and Paper Mills* (NCASI, 2005) (based on a lower heat value of natural gas)

Table 3.4: Scope 1 Emissions from Natural Gas Combustion in the NCG Incinerator

Substance	Heat Required[a] (MWh/annum)	Rate of Natural Gas Consumption[b] (GJ/annum)	Scope 1 Emission Factor[c] (kg/GJ)	Emissions (t/annum)
CO_2	6,470	23,767	55.9	1,329
CH_4	6,470	23,767	0.0027	0.064
		Total Estimated CO_{2-e} Emissions		**1,330**

[a] Source: Table 4-b, Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS

[b] Derived as follows:

6,470 [MWh/annum] x 3.6 [GJ/MWh]/0.98 = 23,767 [GJ/annum] (assuming 98% combustion efficiency)

[c] *Calculation Tools for Estimating GHG Emissions from Pulp and Paper Mills* (NCASI, 2005) (based on a lower heat value of natural gas)

Scope 3 emissions from natural gas combustion are estimated using emission factors sourced from the AGO workbook. As there are no Scope 3 emission factors available for natural gas fuel extraction for Tasmania, emission factors for South Australia have been used to estimate greenhouse gas emissions due to natural gas fuel extraction. Estimated emissions are presented in Table 3.5, Table 3.6 and Table 3.7 for the Lime Kiln, Recovery Boiler (burning natural gas during start-up and shut-down) and the NCG incinerator respectively.

Table 3.5: Scope 3 Emissions from Natural Gas Fuel Extraction used in the Lime Kiln

Substance	Rate of Natural Gas Consumption[a] (GJ/annum)	Scope 3 Emission Factor[b] (kg/GJ)	Emissions (t/annum)
CO_{2-e}	1,625,473	19.4	31,534

[a] Derived from Table 4-b, Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS

[b] Table 2, AGO Factors and Methods Workbook, DEH (2005), Scope 3 emission factor for South Australia natural gas fuel extraction.

Table 3.6: Scope 3 Emissions from Natural Gas Fuel Extraction used in the Recovery Boiler (During Start-Up and Shut-Down)

Substance	Rate of Natural Gas Consumption[a] (GJ/annum)	Scope 3 Emission Factor[b] (kg/GJ)	Emissions (t/annum)
CO_{2-e}	195,667	19.4	3,796

[a] Derived from Table 4-b, Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS

[b] Table 2, AGO Factors and Methods Workbook, DEH (2005), Scope 3 emission factor for South Australia natural gas fuel extraction

Table 3.7: Scope 3 Emissions from Natural Gas Fuel Extraction used in the NCG Incinerator

Substance	Rate of Natural Gas Consumption[a] (GJ/annum)	Scope 3 Emission Factor [b] (kg/GJ)	Emissions (t/annum)
CO_{2-e}	23,767	19.4	461

[a] Derived from Table 4-b, Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS

[b] Table 2, AGO Factors and Methods Workbook, DEH (2005), Scope 3 emission factor for South Australia natural gas fuel extraction

3.2 Carbon Dioxide Emissions from Make-Up Chemicals

3.2.1 Make-Up Chemicals Produced at the Mill Site

Although losses of sodium and calcium from the recovery system are usually made up using non-carbonate chemicals, small amounts of $CaCO_3$ and Na_sCO_3 are sometimes used. The carbon contained in these chemicals is of fossil origin. In the calculation tools designed for greenhouse gas emissions estimation for pulp and paper mills it is assumed that the carbon in these make-up chemicals escapes as CO_2 from the lime kiln or recovery furnace. These emissions are estimated by assuming all of the carbon in $CaCO_3$ and Na_2CO_3 used in the recovery and causticising are released to atmosphere (NCASI, 2005).

It is important to note that calcium make-up is required because of losses from the causticising area, most of which are in the form of calcium carbonate. This lost material is usually landfilled, thereby sequestering the carbon contained in the calcium carbonate. Because the default method in these calculation tools does not consider this loss of carbon from the system, the estimated CO_2 emissions from the make-up calcium carbonate will be higher than actual emissions (NCASI, 2005).

The conversion factors for estimating fossil-CO_2 releases from the use of carbonate-based make-up chemicals in the pulp mill are shown are:

- Pulp mill make-up $CaCO_3$: 440 kg CO_2/t $CaCO_3$
- Pulp mill make up Na_2CO_3: 415 kg CO_2/t $CaCO_3$

Estimated greenhouse gas emissions from make-up chemicals are provided in Table 3.8.

Table 3.8: Estimated Emissions of Greenhouse Gases from Make-Up Chemicals

Substance	Amount used [a] (tonnes/annum)	Emission Factor [b] (kg CO2/t chemical)	CO_2 Emissions (t CO2/annum)
$CaCO_3$	24,750	440	10,890
Na_2CO_3	388	415	161
		TOTAL CO_2 Emissions:	**11,051**

[a] Table 3-28, Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS

[b] Table 7, NCAIS, 2005

3.2.2 Make-Up Chemicals Produced Off-Site

Burnt lime is used in the pulp making process. Carbon dioxide emissions from producing lime are estimated assuming that lime is produced using a coal fired rotary kiln. Emissions of carbon dioxide are estimated using a technique from USEPA AP42 *Chapter 11.17 Lime Manufacturing* (USEPA, 1998). The published CO_2 emission factor for production of lime using a rotary lime kiln fired with coal is:

- 1,600 kg CO_2/tonne of lime produced.

The amount of burnt lime used is equal to 6,875 tonnes per annum. Therefore, scope 3 greenhouse gas emissions from the production of burnt lime are equal to 10,800 tonnes CO_{2-e} per annum.

3.3 Emissions from Stationary Combustion of Biomass Fuels

3.3.1 Climate-Neutral GHG Emissions from Burning Biomass Fuels

Energy-rich biomass – derived from wood chips, bark, sawdust, and pulping liquors recovered from the harvesting and manufacturing processes – is formed when atmospheric carbon dioxide is sequestered by trees during growth and transformed into organic carbon substances. When these biomass fuels are burned, the CO_2 emitted during the manufacturing and combustion processes is the atmospheric carbon dioxide that was sequestered during growth of the tree; hence, there is no net contribution to the atmospheric CO_2 level. This carbon cycle is a closed loop. New tree growth keeps absorbing atmospheric carbon dioxide and maintains the cycle (NCASI, 2005).

Any increases or decreases in the amount of carbon sequestered by the forests are accounted for in the comprehensive forest accounting system. This is the approach generally prescribed for national inventories by the United Nations Framework Convention on Climate Change. Most international protocols, including that of the Intergovernmental Panel on Climate Change (IPCC), have adopted the convention set out by the United Nations. The IPCC has stated that emissions from biomass do not add to atmospheric concentrations of carbon dioxide (NACSI, 2005).

Therefore, in keeping with well-established practices, the greenhouse gas emission estimates should not include emission estimates of CO_2 from the combustion of biomass. Some national reporting schemes, however, require that these climate-neutral emissions be estimated and reported as "supporting information."

IPCC provides the following list of biomass fuels (IPCC 1997a, b):

- wood and wood waste (although biogas from wood waste and other biomass is not specifically listed by IPCC, it clearly falls within the general definition of biomass)
- charcoal
- dung
- agricultural residues and wastes

- municipal and industrial wastes (where the organic material is biological in origin) (this would include wastewater treatment sludges from pulp and paper mills)
- bagasse
- bio-alcohol
- black liquor
- landfill gas
- sludge gas

CO_2 emissions from peat burning are usually considered to be greenhouse gases and they are included in the emissions from fossil fuel burning.

3.3.2 Methane and Nitrous Oxide Emissions from Burning Biomass Fuels

Although CO_2 from biomass burning is almost universally excluded from GHG inventories, CH_4 and N_2O from biomass burning are sometimes included.

Unfortunately, there are few data on CH_4 and N_2O emissions from biomass boilers and recovery furnaces. Available emission factors vary considerably, reflecting the many different types and ages of boilers tested, operating conditions, control equipment and fuel characteristics. Consequently, the recommended emission factors to use are the median emission factors from the *Calculation Tools for Estimating Greenhouse Gas Emissions from Pulp and Paper Mills* (NCASI, 2005). The median emission factors for methane and nitrous oxide from emissions from biomass combustion are as follows:

- Methane emission factor: 12 kg CH_4/TJ
- Nitrous oxide emission factor: 4 kg N_2O/TJ

The power boiler proposed for the Bell Bay Pulp Mill Project will combust a maximum of 4,563,000 GJ per annum of biomass fuel. This is equivalent to 4,563 TJ per annum of biomass. Furthermore, nitrous oxide emissions from the power boiler were estimated by Poyry Forest Industry as 1.0 g N_2O per second (Poyry Forest Industry, 2006) as the most appropriate average emission rate. This equates to an emission estimate of 30,240 kg N_2O per annum (based on a 350 day per year, 24 hour per day operational scenario) or an emission factor of 6.6 kg N_2O per TJ. As this value is higher than that given in the NCASI methodology, it has been used in this assessment in order to provide a conservative estimate. GHG emissions from stationary combustion of biomass that need to be accounted for are outlined in Table 3.9.

Table 3.9: Estimated Emissions of Greenhouse Gases from Biomass Combustion

GHG Substance	Fuel Burn Rate [a] (TJ/annum)	Emission Factor[b] (kg/TJ)	Global Warming Potential	Emissions (t/annum)
CH_4	4,563	12	21	54.8
N_2O	4,563	15.2	310	30.2
CO_{2-e}				**10,524**

[a] Table 2.1, Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS

[b] Table 8, Calculation Tools for Estimating Greenhouse Gas Emissions from Pulp and Paper Mills (NCASI, 2005)

3.4 Emissions Attributable to Exports of Electricity

Generating electricity by burning fossil fuels produces greenhouse gases. The combustion of biomass at the proposed Bell Bay Pulp Mill will produce a surplus of electricity. The additional electricity not required by the facility will be exported to the national electricity grid. As mentioned previously, combustion of biomass is carbon neutral. Therefore, electricity generated from the combustion of biomass does not generate greenhouse gases, as defined. Electricity in Australia is produced from a mixture of black and brown coal, natural gas, oil, hydro and other power stations. The additional electricity exported to the national electricity grid will displace power generated from at least some of these sources.

The proposed Bell Bay Pulp Mill will generate an excess of 62 MW of electricity that will be exported to the national grid (Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS). Based on an annual operating period of 8,400 hours per annum (350 days per annum, 24 hours per day), this equates to 1,874,880 GJ per annum of energy exported to the national grid.

The amount of greenhouse gas emissions reduction is dependent on the source of the power displaced by the additional electricity. In this analysis, the fraction of electricity displaced from each power source is assumed to be proportional to the fraction of total electricity provided from each power source.

Greenhouse gas emission reductions are estimated using the following equation:

$$E_{CO_{2\text{-}e}} = \sum_i EF_{CO2\text{-}e,i} \times FB_i$$

where:

$E_{CO2\text{-}e}$	=	Emissions of greenhouse gases displaced from the exportation of surplus energy	(kg $CO_{2\text{-}e}$/annum)
$EF_{CO2\text{-}e}$	=	Full fuel cycle greenhouse gas emission factor for fuel type i	(kg $CO_{2\text{-}e}$/GJ)
FB_i	=	Amount of fuel burn displaced (for fuel type i)	(GJ/annum)

where:

$$FB_i = PE \times \frac{1}{Eff_i} \times p$$

PE	=	Power exported to the national grid	(GJ/a)
Eff_i	=	Efficiency of power generation for fuel type i	(%)
p	=	Proportion of electricity on national grid supplied by fuel type i	(%)

The amount of greenhouse gas emissions displaced by the surplus electricity generated at the Bell Bay Pulp Mill is outlined in Table 3.10.

Table 3.10: Greenhouse Gas Emissions Potentially Displaced from Surplus Electricity Generated by the Bell Bay Pulp Mill

Fuel Source	Heating Value[a]	Efficiency of power generation (%)	Proportion of electricity generation[b] (%)	Amount of fuel burn displaced	Emission factor[a] (kg CO_{2-e}/GJ)	Emissions Displaced (t CO_{2-e}/a)
Black Coal	27 GJ/t	36%	55%	106,089 t/a	97	277,847
Brown Coal	10 GJ/t	36%	22%	114,576 t/a	94.6	108,389
Natural Gas	38.8 MJ/m³	70%	14%	9,664,330 m³/a	71.2	26,698
Oil	37.3 GJ/kL	36%	1%	1,396 kL/a	77.5	4,036
Hydro	NA	NA	7%	NA	NA	0
Other	NA	NA	1%	NA	NA	0
Total			**100%**			**416,970**

[a] AGO Factors and Methods Workbook, DEH (2005)

[b] ABARE (2005) Australian Energy: National and State Projections 2019-2020

[c] NA: Not Applicable

[d] An example calculation is provided for black coal as follows:

$$1{,}874{,}880\,\frac{\text{GJ}}{\text{annum}}\times\frac{1}{36\%}\times\frac{1\,\text{tonne}}{27\,\text{GJ}}\times 55\% = 106{,}089\,\frac{\text{tonne}}{\text{annum}}$$

$$106{,}089\,\frac{\text{tonne}}{\text{annum}}\times 27\,\frac{\text{GJ}}{\text{tonne}}\times 97\,\frac{\text{kg CO}_{2\text{-e}}}{\text{GJ}}\times\frac{\text{tonne}}{1000\,\text{kg}} = 277{,}847\,\frac{\text{tonne CO}_{2\text{-e}}}{\text{annum}}$$

In this assessment, greenhouse gas offsets from electricity production have been included in Scope 2 emissions.

We have assumed that it will displace electricity from other sources in proportion to their existing contributions, and this is probably conservative.

3.5 Emissions from Wastewater Treatment

Most existing GHG protocols address waste treatment plant emissions only from anaerobic treatment and digestion processes. Therefore, the calculation tools for greenhouse gas emission estimation were developed assuming that emissions from other types of wastewater and sludge treatment processes are negligible. Although aerobic and facultative treatment systems may have zones with depleted dissolved oxygen, methane generation rates in aerated stabilisation basins, activated sludge systems, and their associated retention ponds would be expected to be much lower than those estimated for anaerobic systems. In any event, due to a lack of data, emissions from aerobic and facultative treatment operations are seldom estimated. IPCC, for instance, recommends a default assumption that a methane conversion factor of zero be used for aerobic systems (NCASI, 2005). Carbon dioxide emissions from aerobic systems contain biomass carbon, which is not included in greenhouse inventory totals. Therefore, only methane emissions need to be considered.

The proposed effluent treatment plant comprises a modern primary and secondary effluent treatment facility (Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS) consisting of:

- Primary clarification with a 3 to 4 hour retention time;
- Aerated equalisation basis with approximately 10 to 12 hours retention time;

- Aerated selector membrane bioreactor (MBR);
- Anaerobic chlorate removal selector with a 2 hour retention time; and
- Aerated activated sludge treatment process.

The wastewater treatment process is largely an aerobic process. However, a fraction of the effluent stream will be treated under anaerobic conditions. Emissions from anaerobic wastewater treatment are estimated using a technique from the *Calculation Tools for Estimating Greenhouse Gas Emissions from Pulp and Paper Mills* (NCASI, 2005) as follows:

$$E_{CO_{2\text{-}e}} = (BOD \times EF_{CH4}) \times GWP_{CH4}$$

where:

$E_{CO2\text{-}e}$	=	Emissions of greenhouse gases from wastewater treatment	(kg $CO_{2\text{-}e}$/annum)
BOD	=	Mass of BOD (biological oxygen demand) in wastewater treated under anaerobic conditions	(kg/year)
EF_{CH4}	=	Emission factor for methane generation	(kg CH_4/kg BOD)
GWP_{CH4}	=	Global warming potential for methane (= 21)	(kg $CO_{2\text{-}e}$/kg CH_4)

Poyry Forest Industry supplied an estimate of 10% of influent BOD treated under anaerobic conditions with the designed system (pers comm Kotajarvi, T, Poyry Forest Industry, 13 December, 2006). Annual BOD load to the wastewater treatment system is estimated at 49,145 kg per day or 17,194,800 kg per annum (based on a 350 day per year operating scenario) (Table 3-31, Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS). Therefore, emissions of greenhouse gases from the wastewater treatment system are as presented in Table 3.11.

Table 3.11: Estimated Emissions from Anaerobic Wastewater Treatment

BOD Load[a] (kg BOD/year)	BOD Treated under Anaerobic Conditions[b] (%)	Emission Factor[c] (kg CH_4/kg BOD)	Methane emissions (kg/year)	Emissions (t $CO_{2\text{-}e}$/a)
17,194,800	10%	0.6	1,031,688	21,665

[a] Based on 49,128 kg BOD per day and a 350 day per year operating scenario (Table 3-31 Draft EIS, Volume 6 - A7 Pre-Engineering Report for IIS)

[b] Source: pers comm Kotajarvi, T, 13 December, 2006

[c] Page 46, Calculation Tools for Estimating Greenhouse Gas Emissions from Pulp and Paper Mills (NCASI, 2005)

3.6 Emissions from Transportation

3.6.1 Resource Delivery by Rail

This section addresses the greenhouse gas emissions from trains transporting logs. Under the rail scenario, Gunns propose to operate two trains for the purpose of transporting logs from state-wide wood resource zones to the proposed pulp mill. One train will haul wood resources in the southern region from the Plenty and Bridgewater railheads and the other train will operate in the north west of the state, from Wiltshire and South Burnie railheads. It is expected that each train will contain approximately 50 carriages (page 99, GHD Pulp Mill Transport and Traffic Impact Assessment).

It is estimated that one train will arrive at the pulp mill each day, either from the south or north west. The increase in rail transport is set out in Table 3.12.

Table 3.12: Distance Travelled by Rail Delivering Resource [a]

	Startup (2008-2009)		Snapshot 1 (2013-2015)		Snapshot 2 (2019–2021)	
	Anticipated	Plantation	Anticipated	Plantation	Anticipated	Plantation
Rail Transport (Million tkm)[b]	2.293	2.203	5.723	6.890	5.886	5.858

[a] Source: Table 26, Section 6.13, GHD Pulp Mill Transport and Traffic Impact Assessment

[b] tonne-kilometres

Freight rail energy efficiency varies depending on the source of the data from 3 tkm/MJ to 5 tkm/MJ. Therefore, an average energy efficiency of 4.12 tkm/MJ has been used to estimate the energy consumption by trains delivering resource to the pulp mill.

The trains use diesel fuel, therefore, greenhouse gas emissions are estimated using the methodology outlined in the AGO Workbook for transportation emissions. Diesel fuel greenhouse gas emissions include direct combustion emissions and indirect emissions from fuel extraction and processing. Estimated emissions are outlined in Table 3.13. However, it is noted that the trains are not owned and operated by Gunns Limited. Therefore, all greenhouse gas emissions from rail transport are categorised as Scope 3 emissions.

Table 3.13: Estimated Greenhouse Gas Emissions from Resource Delivery from Rail

	Startup (2008/2009)		Snapshot 1 (2013-2015)		Snapshot 2 (2019 - 2021)	
	Anticipated	Plantation	Anticipated	Plantation	Anticipated	Plantation
Total Rail (Mtkm/annum)	2.293	2.203	5.723	6.89	5.886	5.858
Energy Consumption (MJ/annum) [a]	556,553	534,709	1,389,078	1,672,330	1,428,641	1,421,845
Total Emissions [b,c] (t CO_{2-e}/annum)	**45.25**	**43.47**	**112.9**	**136.0**	**116.1**	**115.6**

[a] Based on an average energy efficiency for rail transport of 4.12 tkm/MJ

[b] Scope 1 emission factor = 70.5 kg CO_{2-e}/MJ (Table 2, AGO Workbook)

[c] Scope 3 emission factor = 7.8 kg CO_{2-e}/MJ (Table 2, AGO Workbook)

3.6.2 Resource Delivery by Road

This section addresses the greenhouse gas emissions from trucks transporting logs. The movement of log freight on Tasmania's road network leads to greenhouse gas emissions. Estimated greenhouse gas emissions are presented for two scenarios: a rail scenario (assuming rail is being used to transport resource to the pulp mill), and a no rail scenario (under this scenario trucks are used to transport resource to the pulp mill). The movement of log freight on Tasmania's road network **as a**

result of the pulp mill has been sourced from the Traffic Impact Assessment (page 72, Traffic Impact Assessment, Gunns Pulp Mill, GHD, 2006).

Emissions of greenhouse gases are estimated for combustion emissions and emissions attributable to extracting and processing the required amount of diesel fuel. The methodology used to estimate emissions is sourced from the AGO workbook.

Trucks used to transport resource are owned by a third party. Therefore all greenhouse gas emissions are categorised as indirect, scope 3 emissions.

Rail Scenario

Estimated transport by log trucks on Tasmania's road network for the rail scenario are provided in Table 3.14 for each scenario.

Table 3.14: Transportation Changes due to the Proposed Pulp Mill (Rail Scenario)

	Startup (2008/2009)			Snapshot 1 (2013-2015)			Snapshot 2 (2019 - 2021)		
	Control	Anticipated	Plantation	Control	Anticipated	Plantation	Control	Anticipated	Plantation
NE [a] (Mtkm/a)	17.0976	17.0976	17.0976	17.7744	17.7744	17.7744	20.4672	20.4672	20.4672
NW [a] (Mtkm/a)	4.3032	4.3032	4.3032	7.572	5.3688	7.0512	6.9672	6.192	8.3184
South [a] (Mtkm/a)	12.504348	10.654891	10.654891	11.016	8.3472	10.98	12.9192	10.428	12.516
Total Road (Mtkm/a) [a]	33.905148	32.055691	32.055691	36.3624	31.4904	35.8056	40.3536	37.0872	41.3016
Difference		-1.849457	-1.849457		-4.872	-0.5568		-3.2664	0.948

[a] Source: Appendix D, Vehicles Kilometres Travelled – Revised Data, Expert Witness Statement – Keith Midson, January 2007, Gunns Ltd Bell Bay Pulp Mill Project, GHD, 2007

As shown in Table 3.14 the rail option will generally reduce truck movements on Tasmania's road network. The difference in greenhouse gas emissions from the changed traffic scenario is presented in Table 3.15.

Table 3.15: Estimated Greenhouse Gas Emission Change due to Proposed Pulp Mill (Rail Scenario)

	Startup (2008/2009)		Snapshot 1 (2013-2015)		Snapshot 2 (2019 - 2021)	
	Anticipated	Plantation	Anticipated	Plantation	Anticipated	Plantation
NE	0	0	0	0	0	0
NW	0	0	-2.2032	-0.5208	-0.7752	1.3512
South	-1.849457	-1.849457	-2.6688	-0.036	-2.4912	-0.4032
Total Road (Mtkm)	-1.849457	-1.849457	-4.872	-0.5568	-3.2664	0.948
Fuel consumption (L) [a]	-1,002,406	-1,002,406	-2,640,624	-301,786	-1,770,389	513,816
Emissions (t CO_{2-e}/annum) [b]	-3,007	-3,007	-7,922	-905	-5,311	1,541

[a] Fuel consumption is estimated based on a fuel efficiency of 0.542 L/km for heavy trucks sourced from Table 4, AGO Workbook

[b] Full fuel cycle emission factor for diesel combustion – 3.0 CO_{2-e}/kL (Table 3, AGO workbook)

No Rail Scenario

Estimated transport by log trucks on Tasmania's road network for the no rail scenario is provided in Table 3.14 for each scenario.

Table 3.16: Transportation Changes due to the Proposed Pulp Mill (No Rail Scenario)

	Startup (2008/2009)			Snapshot 1 (2013-2015)			Snapshot 2 (2019 - 2021)		
	Control	Anticipated	Plantation	Control	Anticipated	Plantation	Control	Anticipated	Plantation
NE [a] (Mtkm/a)	17.0976	17.0976	17.0976	17.7744	17.7744	17.7744	20.4672	20.4672	20.4672
NW [a] (Mtkm/a)	4.3032	4.3032	4.3032	7.572	10.3872	19.3416	6.9672	11.9928	14.7384
South [a] (Mtkm/a)	12.504348	15.241291	15.241291	11.016	14.7744	12.4704	12.9192	16.3992	17.6328
Total Road (Mtkm/a) [a]	33.905148	36.642091	36.642091	36.3624	42.936	49.5864	40.3536	48.8592	52.8384
Difference		2.736943	2.736943		6.5736	13.224		8.5056	12.4848

[a] Source: Appendix D, Vehicles Kilometres Travelled – Revised Data, Expert Witness Statement – Keith Midson, January 2007, Gunns Ltd Bell Bay Pulp Mill Project, GHD, 2007

Under the no rail scenario, estimated traffic of log trucks increases. The estimated difference in greenhouse gas emissions from the road transport of resource to the proposed pulp mill is provided in Table 3.17

Table 3.17: Estimated Greenhouse Gas Emission Change due to Proposed Pulp Mill (Rail Scenario)

	Startup (2008/2009)		Snapshot 1 (2013-2015)		Snapshot 2 (2019 - 2021)	
	Anticipated	Plantation	Anticipated	Plantation	Anticipated	Plantation
NE	0	0	0	0	0	0
NW	0	0	2.8152	11.7696	5.0256	7.7712
South	2.736943	2.736943	3.7584	1.4544	3.48	4.7136
Total Road (Mtkm)	2.736943	2.736943	6.5736	13.224	8.5056	12.4848
Fuel consumption (L) [a]	1,483,423	1,483,423	3,562,891	7,167,408	4,610,035	6,766,762
Emissions (t CO_{2-e}/annum) [b]	4,450	4,450	10,689	21,502	13,830	20,300

[a] Fuel consumption is estimated based on a fuel efficiency of 0.542 L/km for heavy trucks sourced from Table 4, AGO Workbook

[b] Full fuel cycle emission factor for diesel combustion – 3.0 CO_{2-e}/kL (Table 3, AGO workbook)

3.6.3 Waste Disposal

Trucks will be used by Gunns to dispose of waste to a landfill. The landfill will be owned and operated by Gunns (constructed as part of this project). The landfill is located 1.5 km from the proposed pulp mill and waste generation rates will require 20 round truck trips per day, assuming a 10 tonne truck capacity (i.e. waste generation rates are estimated at 200 tonnes per day).

Greenhouse gas emissions are estimated using the methodology outlined in the AGO Workbook for transportation emissions. Diesel fuel greenhouse gas emissions include direct combustion emissions and indirect emissions from fuel extraction and processing. Estimated greenhouse gas emissions are outlined in Table 3.18. It is noted that transportation of waste is subcontracted to a third party. Therefore, all greenhouse gas emissions from the transportation of waste are considered to be indirect emissions and are categorised as scope 3 emissions.

Table 3.18: Estimated Emissions from Transportation of Waste Disposal

Distance from Proposed Pulp Mill (km)[a]	Distance of Return Trip (km)[a]	Estimated trucks per day (trucks/d)[a]	Total No of Kms travelled per year (km/year)	Fuel Efficiency (L/km)[b]	Fuel consumption conversion (L/year)	Total Emissions (t CO_{2-e}/a)[c]
1.5	3	20	21900	0.283	6197.7	18.6

[a] Source: GHD Greenhouse gas assessment, Draft EIS

[b] Table 4, AGO Workbook, fuel consumption rate for medium diesel fuelled truck

[c] Scope 1 emission factor = 2.7 t CO_{2-e}/kL (Table 3, AGO Workbook); Scope 3 emission factor = 0.3 t CO_{2-e}/kL (Table 3, AGO Workbook)

3.6.4 Chemical Delivery

The ongoing operation for the pulp mill requires a range of chemical inputs that will need to be transported by sea or road to the subject site.

Chemicals that require ship freight delivery are outlined in Table 3.19.

Table 3.19: Chemicals that require Shipping Delivery

Chemical	Amount Required (tonnes/annum)	Transport Origin
Salt	50,066	Ship from Western Australia or South Australia to Pulp Mill berth
Caustic soda	5,000 [a]	Ship to Bell Bay port, trucked to site. Assume chemical is sourced from New South Wales
Sulphuric acid	23,238	Ship to Bell Bay, trucked to site. Assume chemical is sourced from New South Wales
Hydrochloric acid	200	Ship to Bell Bay, trucked to site. Assume chemical is sourced from New South Wales
Sulphate	14,151	Ship to Bell Bay, trucked to site. Assume chemical is sourced from New South Wales
Peroxide	2,200	Ship to Bell Bay, trucked to site. Assume chemical is sourced from New South Wales
Magnesium sulphate	250	Ship to Bell Bay, trucked to site. Assume chemical is sourced from New South Wales

[a] This amount of caustic soda required to be transported to the site assumes the operation of an integrated chemical plant on-site which will reduce the amount of caustic soda transported to the site

The shipping distance from South Australia to Bell Bay is approximately 775 nautical miles (1,436 km) and the shipping distance from Port Kembla, NSW to Bell Bay is approximately 469 nautical miles (870 km) (Source: http://www.distances.com/). Caustic soda, sulphuric acid, hydrochloric acid, sulphate, peroxide and magnesium sulphate are assumed to be shipped via chemical tanker. Typical carrying capacities for chemical tankers are between 3,500 and 6,000 tonnes (e.g. Tina Jakopsen, Bro Nora). An average carrying capacity of 4,750 tonnes has been used in this assessment. It is assumed that salt is shipped using o-class cargo ships with an average capacity of 65,000 m^3.

Estimated greenhouse gas emissions from the shipping delivery chemicals are outlined in Table 3.20.

Table 3.20: Estimated Greenhouse Gas Emissions from Transportation of Chemicals via Ships

Chemical	Amount Required (tonnes/a)	EDY [a]	Shipping Origin	Distance (nautical miles/trip)	Total Shipping [b] (Mtkm/a)	FE [c] (tkm/MJ)	EC[d] (GJ/a)	EF [e] (kg CO_{2e}/GJ)	Emissions (t CO_{2-e}/a)
Caustic soda	5000	1.053	Port Kembla	469	8.69	4.16	2,089	82	171
Salt	50066	0.670	Port Pirie	775	85.6	4.16	20,809	82	1,706
Sulphuric acid	23238	4.89	Port Kembla	469	40.4	4.16	9,709	82	796
Hydrochloric acid	200	0.042	Port Kembla	469	0.348	4.16	84	82	7
Sulphate	14151	2.98	Port Kembla	469	24.6	4.16	5,913	82	485
Peroxide	2200	0.463	Port Kembla	469	3.82	4.16	919	82	75
Magnesium sulphate	250	0.0526	Port Kembla	469	0.435	4.16	104	82	9
Total Emissions (t CO_{2-e}/annum)									**3,249**

[a] EDY: Estimated equivalent ship deliveries per annum

[b] Total shipping estimated based on shipping distance (return trip) and dead weight tonnage of ships (4750 tonnes for chemical tanker and 45000 tonnes for cargo ship)

[c] FE: Estimated fuel efficiency

[d] EC: Estimated energy consumption

[e] EF: Emission factor for heavy fuel oil combustion, Table 3, AGO Workbook

Estimated emissions from chemicals delivered via road transport are provided in Table 3.21. Emissions from chemical delivery are categorised as Scope 3 emissions (indirect) as the transportation vehicles are not owned by Gunns.

Table 3.21: Estimated Greenhouse Gas Emissions from Road Transport of Chemicals

Chemical	Origin	Number of Trucks per annum[a]	Trucks per day[a]	No of kms travelled per return trip[a] (km/trip)	Total No of kms travelled per year (km/year)	Fuel consumption[b] (L/year)	Emissions[c] (t CO_{2-e}/a)
Export Deliveries from Mill							
Sodium chlorate	From site to Bell Bay Port	2400	10	15.2	36,480	10,324	31.0
Oxygen	From site to Bell Bay Port	2450	10.21	15.2	37,240	10,539	31.6
Hydrogen peroxide	From site to Bell Bay Port	600	2.50	15.2	9,120	2,581	7.74
Nitrogen	From site to Bell Bay Port	700	2.92	15.2	10,640	3,011	9.03
Major Deliveries							
Sulphuric acid	Shipped to Bell Bay, trucked to site	1186	4.94	15.2	18,027.2	5,102	15.3
Hydrochloric acid	Shipped to Bell Bay, trucked to site	31	0.13	15.2	471.2	133	0.400
Sulphate	Shipped to Bell Bay, trucked to site	708	2.95	15.2	10,761.6	3,046	9.14
Peroxide	Shipped to Bell Bay,	740	3.08	15.2	11,248	3183	9.55

	trucked to site						
Sand	Truck from Scottsdale	150	0.63	164.6	24,690	6987	21.0
Limestone	Truck from Railton	750	3.13	220	165,000	46,695	140.1
Burnt lime	Truck from Railton	229	0.95	220	50,380	14,258	42.8
Magnesium sulphate	Shipped to Bell Bay, trucked to site	13	0.054	15.2	197.6	55.9	0.168
Urea	Truck from Bell Bay	78	0.33	15.2	1,185.6	336	1.01
Aluminium sulphate	Truck from Bell Bay	55	0.23	15.2	836	237	0.710
Baling wire	Truck from Bell Bay	67	0.28	15.2	1,018.4	288	0.865
Minor Deliveries							
Defoamer	Truck from Bell Bay	28	0.12	15.2	425.6	120	0.361
Talc	Truck from Bell Bay	28	0.12	15.2	425.6	120	0.361
Phosphoric acid	Truck from Bell Bay	15	0.063	15.2	228	64.5	0.194
Sulphamic acid	Truck from Bell Bay	1	0.0042	15.2	15.2	4.30	0.0129
Sodium carbonate	Truck from Bell Bay	19	0.079	15.2	288.8	81.7	0.245
Flocculation aids	Truck from Bell Bay	7	0.029	15.2	106.4	30.1	0.090
Filtering aids	Truck from Bell Bay	10	0.042	15.2	152	43.0	0.129
Boiler water and steam chemicals	Truck from Bell Bay	1	0.0042	15.2	15.2	4.30	0.0129
Miscellaneous	Truck from Bell Bay	1	0.0042	15.2	15.2	4.30	0.0129
						Total Emissions (t CO_{2-e}/annum)	**322**

[a] Source: Table 5, Expert Witness Statement – Keith Midson, January 2007, Gunns Ltd Bell Bay Pulp Mill Project, GHD, 2007

[b] Estimated based on a fuel efficiency of 0.283 L/km provided for medium trucks by AGO (Source: Table 4, AGO workbook)

[c] Based on the full fuel cycle emission factor of 3.0 t CO_{2-2}/kL from Table 3, AGO workbook

3.6.5 Boiler Fuel Delivery

It is proposed that waste woodchip residue be utilised for fuel for the proposed pulp mill's boiler operation. Waste woodchip residue is to be sourced from existing timber resource zones (as a by-product of harvesting), as well as a number of timber mills in the northeast region. Trucks to be used for transportation of boiler fuel are operated by a third party. Therefore, emissions from combustion and fuel extraction are categorised as scope 3 emissions. Emissions were estimated using the technique for diesel transportation outlined in the AGO workbook. Estimated emissions are presented in Table 3.22 and Table 3.23.

Table 3.22: Estimated Greenhouse Gas Emissions from Boiler Fuel Delivery from Mill Residue

Wood Residue Origin	Forest Catchment Origin	Distance from Proposed Pulp Mill[a] (km)	Estimated Trucks per day[a]	Approaching Mill from Direction	No of trucks per year	No of kms travelled per return trip (km/trip)	Fuel Consumption [b] (L/a)	Emissions[c] (t CO2-e/a)
N/A	WK	70	0.22	South	52.8	140	4006	12
N/A	DM	20	0.54	North	129.6	40	2810	8
N/A	DM	20	2.01	North	482.4	40	10458	31
N/A	DM	20	2.83	North	679.2	40	14725	44
N/A	WK	70	2.32	South	556.8	140	42250	127
N/A	DM	20	1.49	North	357.6	40	7753	23
N/A	BL	160	2.14	South	513.6	320	89079	267
N/A	LL	110	0.64	South	153.6	220	18315	55
N/A	BL	160	1.49	South	357.6	320	62022	186
N/A	BL	160	1.09	South	261.6	320	45372	136
N/A	BL	160	0.37	South	88.8	320	15401	46
N/A	BL	160	2.23	South	535.2	320	92825	278
N/A	BL	160	1.18	South	283.2	320	49118	147
N/A	BL	160	0.06	South	14.4	320	2498	7
N/A	BL	160	0.54	South	129.6	320	22478	67
N/A	BL	160	0.07	South	16.8	320	2914	9
N/A	LZ	160	0.29	South	69.6	320	12071	36
N/A	M7	130	1.09	South	261.6	260	36865	111
N/A	NG	60	0.68	South	163.2	120	10615	32
N/A	NG	60	0.62	South	148.8	120	9678	29
Mill Residue Total			**21.9**		**5256**			**1,654**

[a] Distances are calculated from the region centroid to the pulp mill. Source: Appendix C, Boiler Fuel Data – Revised Data, Expert Witness Statement – Keith Midson, January 2007, Gunns Ltd Bell Bay Pulp Mill Project, GHD, 2007

[b] Estimated based on a fuel efficiency of 0.542 L/km provided for heavy trucks by AGO (Source: Table 4, AGO workbook)

[c] Based on the full fuel cycle emission factor of 3.0 t CO_{2-2}/kL from Table 3, AGO workbook

Table 3.23: Estimated Greenhouse Gas Emissions from Boiler Fuel Delivery from Northeast Resource Catchment Zones

Wood Residue Origin	Forest Catchment Origin	Distance from Proposed Pulp Mill[a] (km)	Estimated Trucks per day[a]	Approaching Mill from Direction	No of trucks per year	No of kms travelled per return trip (km/trip)	Fuel Consumption [b] (L/a)	Emissions[c] (t CO2-e/a)
Blessington	BL	160	2.63	South	631.2	320	109475	328
Campbell Town	CB	210	2.63	North	631.2	420	143686	431
Dismal	DM	20	2.63	South	631.2	40	13684	41
Devonport	DT	160	2.63	South	631.2	320	109475	328
Fingal	FG	320	2.63	South	631.2	640	218951	657
Highlands	HI	350	2.63	South	631.2	700	239477	718
Lilydale	LL	110	2.63	South	631.2	220	75264	226
Liffey	LZ	160	2.63	South	631.2	320	109475	328
Merged Block 7	M7	130	2.63	South	631.2	260	88949	267
Merged Block 8	M8	270	2.63	North	631.2	540	184740	554
Meander	MQ	220	2.63	South	631.2	440	150529	452
Rosevale	RV	100	2.63	South	631.2	200	68422	205
Snake Bank	SN	230	2.63	North	631.2	460	157371	472
Sheffield	SQ	190	2.63	South	631.2	380	130002	390
Scottsdale	SZ	250	2.63	South	631.2	500	171055	513
Targa	TR	44	2.63		631.2	88	30106	90
Winkleigh	WK	74	2.63		631.2	148	50632	152
Resource Zone Total			**44.71**		**10,730**			**6,154**

[a] Distances are calculated from the region centroid to the pulp mill. Source: Appendix C, Boiler Fuel Data – Revised Data, Expert Witness Statement – Keith Midson, January 2007, Gunns Ltd Bell Bay Pulp Mill Project, GHD, 2007

[b] Estimated based on a fuel efficiency of 0.542 L/km provided for heavy trucks by AGO (Source: Table 4, AGO workbook)

[c] Based on the full fuel cycle emission factor of 3.0 t CO_{2-2}/kL from Table 3, AGO workbook

3.6.6 Light Vehicles

Emissions from light vehicles used by employees to travel to and from the site were estimated based on a technique outlined in the AGO workbook. Light vehicles used by employees are not owned by Gunns Limited. Therefore, under the AGO workbook, emissions are categorised as scope 3 emissions. Estimated emissions from light vehicles are presented in Table 3.24.

Table 3.24: Estimated Emissions of Greenhouse Gases from Light Vehicles

Vehicle Origin	Activity (vehicles/day)	Distance (km/one way trip)	Distance travelled (km/year)	Fuel efficiency (L/km)	Fuel consumption (L/year)	Emissions (t CO_{2-e}/a)
Launceston	165	35	4,215,750	0.107	451,085	1,249.5
George Town	110	10	803,000	0.107	85,921	238.0

[a] Table 4, AGO Workbook, fuel consumption rate for passenger petrol fuelled cars

[b] Scope 1 emission factor = 2.5 t CO_{2-e}/kL (Table 3, AGO Workbook); Scope 3 emission factor = 0.77 t CO_{2-e}/kL (Table 3, AGO Workbook)

3.6.7 Final Product Delivery

The transportation of pulp to overseas customers will generate emissions of greenhouse gases. The Australian Greenhouse Office classifies greenhouse gas emissions from final product delivery as scope 3 emissions. Estimated emissions are based on the following activity data:

- Cargo ship dead weight tonnage (DWT) of 45,000 tonnes (equivalent to o-class cargo ships (e.g. Star Osakana));
- Freight shipping energy efficiency is equal to 4.16 tkm/MJ
- The distance pulp is shipped is equal to 5000 nautical miles (i.e. 18,530 km per return trip). (For example, Bell Bay to Kaohsiung, Taiwan = 4,779 nautical miles, Bell Bay to Tokyo = 4,842 nautical miles, Bell Bay to Hong Kong = 5,008 nautical miles. Source: www.distances.com)
- Ships are assumed to burn heavy fuel oil

A one-way trip is assumed in estimating scope 3 greenhouse gas emissions as it is probable that the ships will carry a load of another product once the pulp product is delivered. Emissions from the transportation of other products are not considered within the boundary of the proposed pulp mill's greenhouse gas assessment.

Estimated greenhouse gases from the transportation of the final product are outlined in Table 3.25.

Table 3.25: Estimated Greenhouse Gas Emissions from Transportation of Final Product

	Startup (2008-2009)		Snapshot 1 (2013-2015)		Snapshot 2 (2019-2021)	
	Anticipated	Plantation	Anticipated	Plantation	Anticipated	Plantation
Mass of pulp produced (t/a)	615,000	615,000	913,562	913,562	962,516	962,516
Number of pulp ships required per annum	14	14	20	20	21	21
Total Shipping[a] (Mtkm/a)	5,837	5,837	8,339	8,339	8,755	8,755
Energy Consumption (TJ)[b]	1,403	1,403	2,004	2,004	2,105	2,105
Emissions [c] (t CO_{2-e}/a)	115,055.3	115,055.3	164,364.7	164,364.7	172,582.9	172,582.9

[a] Based on an o-class cargo ship with a dead weight tonnage of 45,000 tonnes and a shipping distance of 5000 nautical miles (9265 km) for a one way trip

[b] Based on a freight shipping energy efficiency of 4.16 tkm/MJ

[c] Full fuel cycle emission factor for heavy fuel oil = 82.0 kg CO_{2-e}/GJ

Ships currently export Gunns Limited wood chips from Tasmania to the Asia Pacific region. The downstream effect of producing pulp from existing wood chips and managed plantations in Tasmania is that Gunns Limited wood chip exports will be reduced. Emissions from the reduction of shipping movements are considered to be scope 3 emissions under the methodology outlined in the AGO workbook. Once the proposed mill is operating, shipping traffic of wood chips from Gunns Limited will be reduced as this resource will be used to produce pulp at the proposed facility. Furthermore, wood chip cargo ships always return empty, as carrying another product would contaminate the load due to the wood chips.

Estimated greenhouse gas emissions due to shipping of Gunns Limited woodchip to the Asia Pacific region are outlined in Table 3.26.

Table 3.26: Estimated Greenhouse Gas Emissions from Shipping Wood Chips from Tasmania

	Startup (2008-2009)		Snapshot 1 (2013-2015)		Snapshot 2 (2019-2021)	
	Anticipated	Plantation	Anticipated	Plantation	Anticipated	Plantation
Mass of wood chip consumed by the proposed pulp mill (t/a)	2,340,690	2,340,690	3,366,476	3,366,476	3,482,383	3,482,383
Number of pulp ships required per annum	52	52	75	75	77	77
Total Shipping[a] (Mtkm/a)	43,360	43,360	62,539	62,539	64,206	64,206
Energy Consumption (TJ)[b]	10423	10423	15033	15033	15434	15434
Emissions [c] (t CO_{2-e}/a)	854,696	854,696	1,232,735	1,232,735	1,265,608	1,265,608

[a] Based on an o-class cargo ship with a dead weight tonnage of 45,000 tonnes and a shipping distance of 10000 nautical miles (18530 km) for a return trip (wood chip ships return empty)

[b] Based on a freight shipping energy efficiency of 4.16 tkm/MJ

[c] Full fuel cycle emission factor for heavy fuel oil = 82.0 kg CO_{2-e}/GJ

Other indirect emissions could be expected from changes in transportation of wood chips and pulp, dictated by the world market. However, changes in transportation routes required for Kraft pulp and wood chips by the world market are outside the scope for Gunns Limited to assess in terms of greenhouse gas emissions. Only emissions associated with the transportation of Gunns Limited product is included in the assessment.

Therefore, indirect greenhouse gas emissions from transportation of Gunns Limited pulp and the reduction in Gunns Limited wood chip exports from Tasmania are presented in Table 3.27.

Table 3.27: Estimated Indirect Greenhouse Gas Emissions from Transportation of Final Product and Wood Chips

	Startup (2008/2009)		Snapshot 1 (2013-2015)		Snapshot 2 (2019 - 2021)	
	Anticipated	Plantation	Anticipated	Plantation	Anticipated	Plantation
Emissions ($t\ CO_{2-e}/a$)	-739,641	-739,641	-1,068,370	-1,068,370	-1,093,025	-1,093,025

3.7 Emissions Summary

In this section, a summary of greenhouse gas emissions is presented for the proposed pulp mill. Scope 1 and scope 2 emissions from the proposed mill are presented separately from scope 3 emissions. This has been done because the GHG Protocol recognises that compliance regimes are more likely to focus on the "point of release" of emissions (i.e. direct emissions) and indirect emissions from the use of electricity, rather than on scope 3 emissions.

3.7.1 Scope 1 and Scope 2 Greenhouse Gas Emissions

Estimated Scope 1 and Scope 2 greenhouse gas emissions from the proposed pulp mill are presented in Table 3.28. Emission estimates for scope 1 and scope 2 emissions are based on production on 1,100,000 ADt of pulp per annum.

Table 3.28: Estimated Scope 1 and Scope 2 Greenhouse Gas Emissions

	Emissions ($t\ CO_{2-e}$/annum)		
Emission Source	Scope 1	Scope 2	Total
Power boiler	10,524		10,524
Make-up chemicals	11,051		11,051
Lime kiln	90,956		90,956
Recovery boiler	10,949		10,949
NCG Incinerator	1,330		1,330
Electricity exports		-416,970	-416,970
Wastewater	21,665		21,665
Transportation - Resource delivery by rail			-
Transportation - Waste disposal	-		-
Transportation - Final product delivery			-
Transportation - International Wood Chip Exports			-

Transportation - Resource delivery by road			-
Transportation - Chemical delivery			-
Transportation - Boiler fuel delivery			-
Transportation - Light vehicles			-
Total Emissions	**146,476**	**-416,970**	**-270,494**

3.7.2 Scope 3 Emissions Greenhouse Gas Emissions

Estimated scope 3 greenhouse gas emissions for the proposed pulp mill under the resource delivery by rail scenario are presented in Table 3.29.

Table 3.29: Estimated Scope 3 Emissions under the Resource Delivery Option by Rail Scenario

	Emissions (t CO_{2-e}/annum)					
	Start up (2008-2009)		Snapshot 1 (2013-2015		Snapshot 2 (2019-2021)	
Emission Source	**Anticipated Strategy**	**Plantation Strategy**	**Anticipated Strategy**	**Plantation Strategy**	**Anticipated Strategy**	**Plantation Strategy**
Power boiler						
Make-up chemicals						
Lime kiln	31,534	31,534	31,534	31,534	31,534	31,534
Recovery boiler	3,796	3,796	3,796	3,796	3,796	3,796
NCG Incinerator	461	461	461	461	461	461
Electricity exports						
Wastewater						
Production of burnt lime	10,800	10,800	10,800	10,800	10,800	10,800
Transportation - Resource delivery by rail	45	43	113	136	116	116
Transportation - Waste disposal	19	19	19	19	19	19
Transportation - Final product delivery	115,055	115,055	164,365	164,365	172,583	172,583
Transportation - International Wood Chip Exports	-854,696	-854,696	-1,232,735	-1,232,735	-1,265,608	-1,265,608
Transportation - Resource delivery by road	-3,007	-3,007	-7,922	-905	-5,311	1,541
Transportation - Chemical delivery	3,571	3,571	3,571	3,571	3,571	3,571
Transportation - Boiler fuel delivery	7,808	7,808	7,808	7,808	7,808	7,808
Transportation - Light vehicles	1,488	1,488	1,488	1,488	1,488	1,488
Total Emissions	**-683,127**	**-683,129**	**-1,016,703**	**-1,009,664**	**-1,038,744**	**-1,031,892**

Estimated scope 3 greenhouse gas emissions for the proposed pulp mill under the resource delivery by road truck scenario are presented in Table 3.30.

Table 3.30: Estimated Scope 3 Emissions under the Resource Delivery Option by Road Truck Scenario

Emission Source	Emissions (t CO_{2-e}/annum)					
	Start up (2008-2009)		Snapshot 1 (2013-2015		Snapshot 2 (2019-2021)	
	Anticipated Strategy	Plantation Strategy	Anticipated Strategy	Plantation Strategy	Anticipated Strategy	Plantation Strategy
Power boiler						
Make-up chemicals						
Lime kiln	31,534	31,534	31,534	31,534	31,534	31,534
Recovery boiler	3,796	3,796	3,796	3,796	3,796	3,796
NCG Incinerator	461	461	461	461	461	461
Electricity exports	-	-	-	-	-	-
Wastewater	-	-	-	-	-	-
Production of burnt lime	10,800	10,800	10,800	10,800	10,800	10,800
Transportation - Resource delivery by rail	-	-	-	-	-	-
Transportation - Waste disposal	19	19	19	19	19	19
Transportation - Final product delivery	115,055	115,055	164,365	164,365	172,583	172,583
Transportation - International Wood Chip Exports	-854,696	-854,696	-1,232,735	-1,232,735	-1,265,608	-1,265,608
Transportation - Resource delivery by road	4,450	4,450	10,689	21,502	13,830	20,300
Transportation - Chemical delivery	3,571	3,571	3,571	3,571	3,571	3,571
Transportation - Boiler fuel delivery	7,808	7,808	7,808	7,808	7,808	7,808
Transportation - Light vehicles	1,488	1,488	1,488	1,488	1,488	1,488
Total Emissions	**-675,715**	**-675,715**	**-998,205**	**-987,392**	**-1,019,719**	**-1,013,249**

The average scope 3 emissions of greenhouse gases from the proposed pulp mill are presented in Table 3.31.

Table 3.31: Average Scope 3 Greenhouse Gas Emissions from the Proposed Pulp Mill

Emission Source	Emissions (t CO_{2-e}/annum)	
	Rail Scenario	No Rail Scenario
Power boiler	-	-
Make-up chemicals	-	-
Lime kiln	31,534	31,534
Recovery boiler	3,796	3,796
NCG Incinerator	461	461
Electricity exports	-	-
Wastewater	-	-
Production of burnt lime	10,800	10,800
Transportation - Resource delivery by rail	95	-
Transportation - Waste disposal	19	19
Transportation - Final product delivery	150,668	150,668
Transportation - International wood chip exports	-1,117,680	-1,117,680
Transportation - Resource delivery by road	-3,102	12,537
Transportation - Chemical delivery	3,571	3,571
Transportation - Boiler fuel delivery	7,808	7,808
Transportation - Light vehicles	1,488	1,488
Total Emissions	**-910,543**	**-894,999**

4 CONCLUSION

The greenhouse gas assessment shows that the operation of the proposed pulp mill will reduce Gunns Limited net greenhouse gas emissions. Estimated scope 1 and scope 2 emissions are presented in Table 4.1 and average scope 3 emissions are presented in Table 4.2.

Table 4.1: Estimated Scope 1 and Scope 2 Greenhouse Gas Emissions

	Emissions (t CO_{2-e}/annum)		
Emission Source	**Scope 1**	**Scope 2**	**Total**
Power boiler	10,524		10,524
Make-up chemicals	11,051		11,051
Lime kiln	90,956		90,956
Recovery boiler	10,949		10,949
NCG Incinerator	1,330		1,330
Electricity exports		-416,970	-416,970
Wastewater	21,665		21,665
Transportation - Resource delivery by rail			-
Transportation - Waste disposal	-		-
Transportation - Final product delivery			-
Transportation - International Wood Chip Exports			-
Transportation - Resource delivery by road			-
Transportation - Chemical delivery			-
Transportation - Boiler fuel delivery			-
Transportation - Light vehicles			-
Total Emissions	**146,476**	**-416,970**	**-270,494**

Table 4.2: Average Scope 3 Greenhouse Gas Emissions from the Proposed Pulp Mill

	Emissions (t CO_{2-e}/annum)	
Emission Source	**Rail Scenario**	**No Rail Scenario**
Power boiler	-	-
Make-up chemicals	-	-
Lime kiln	31,534	31,534
Recovery boiler	3,796	3,796
NCG Incinerator	461	461
Electricity exports	-	-
Wastewater	-	-
Production of burnt lime	10,800	10,800
Transportation - Resource delivery by rail	95	-
Transportation - Waste disposal	19	19
Transportation - Final product delivery	150,668	150,668
Transportation - International wood chip exports	-1,117,680	-1,117,680
Transportation - Resource delivery by road	-3,102	12,537
Transportation - Chemical delivery	3,571	3,571
Transportation - Boiler fuel delivery	7,808	7,808
Transportation - Light vehicles	1,488	1,488
Total Emissions	**-910,543**	**-894,999**

The reduction in Gunns Limited greenhouse gas emissions is therefore:

- -270,494 tonnes CO_{2-e} per annum for scope 1 and scope 2 emissions; and
- -900,000 tonnes (approximately) CO_{2-e} per annum for scope 3 emissions.

It is also noted that scope 1 and scope 2 emission estimates are based on a production value of 1,100,000 ADt of pulp per year, whereas, estimated scope 3 emissions are based on actual production volumes (which are less than 1,100,00 ADt). This has further reduced the estimated reduction in scope 3 greenhouse gas emissions and provides for a conservative assessment.

The main causes for the reduction in greenhouse gas emissions are as follows:

- The pulp mill will produce excess electricity from combined heat and power systems that are fuelled by biomass. Biomass combustion is carbon neutral as the biomass sequesters atmospheric carbon, which is released when these biomass fuels are burned. Sustainable management of resources will ensure that the cycle is carbon neutral. The bulk of electricity displaced by the proposed pulp mill will be fossil-fuel based; and
- At present, Gunns Limited exports woodchips to the Asia Pacific region in cargo ships. The wood chips are used to produce pulp abroad. A maximum resource volume of 3,482,400 tonnes of wood produces approximately 962,500 ADt of pulp. The proposed pulp mill will reduce the amount of shipping traffic required for Gunns Limited products. This significantly reduces indirect greenhouse emissions from Gunns Limited operations.

Scope 3 greenhouse gas emissions that are not accounted for in this assessment include:

- Greenhouse gas emissions from the production of all chemicals transported to site;
- Greenhouse gas emissions from world pulp production adjusting to the changes in demand and supply, which will include the operations of this mill; and
- The life cycle of products from the mill.

There are too many unknown variables to assess greenhouse gas emissions from the above-mentioned sources. Furthermore, the emission sources are not owned or operated by Gunns Limited and as such are outside Gunns's ability to reduce or manage these emissions.

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