18.0 GREENHOUSE GAS EMISSIONS

18.1 INTRODUCTION

Greenhouse gases (GHG's) are atmospheric gases which reduce the loss of heat from the earth into space. While these gases are naturally present in the atmosphere, significant additional amounts are released when fossil fuel based products (like coal, natural gas, and petrol) are burned. Because of the gases ability to capture energy, increased levels mean more heat is captured, resulting in an increase in global surface temperatures (through the 'enhanced' greenhouse effect). The impacts of this temperature increase are accepted to include a rise in sea levels, increase in frequency and intensity of severe weather events (flood, drought, etc) and changes in rainfall patterns.

The built environment and infrastructure are responsible for these emissions when trees are cleared for access (removal of carbon sink) and where liquid fossil fuels are used to transport materials and equipment for construction and operation. Energy (as both fuel and electricity generated from fossil fuels) is also consumed in the manufacture and production of the materials used, and can be considered to be 'embedded' in the final product.

By recognising these links and accounting for them in the development phase; many of these contributions can be significantly reduced or eliminated through better planning and design decisions.

In addition to the direct net impact of the development on, and contribution to greenhouse emissions, there are also potential impacts of climate change on the development. Adaptation and mitigation measures can be selected to manage the changes in environment and stakeholder expectations to determine the success of the development in the medium to long term.

The greenhouse gas footprint of the substation was assessed based on vehicle movement and construction materials data provided by the client and a serries of assumptions regarding travel distance and load capacity.

18.2 ADAPTATION PLANNING

With regard to the changing physical and political environment (as discussed in Sections 6.2.1 and 6.2.2) there are a number of considerations in the planning of the project which can help to control any exposure. A brief summary of these issues is provided in the below table.

As with any risk management strategies, hazards don't necessarily need to be eliminated, but controlled to within acceptable risk tolerances.

TABLE 18-1 CLIMATE CHANGE RISK AND ADAPTATION SUMMARY

RISK	IMPACT	DESIGN RESPONSE
Flash Flooding	Inundation and high velocity water movements, erosion, access restrictions and material damage.	Any grading of land, drainage system and bunding to take risk into account. Rate and nature of degradation of materials. Material selection and maintenance schedule to consider. Access to repairs/ maintenance may be impeded due to weather events. Insurance premiums / excess may increase with more frequent severe weather events.
Severe Storms & Tropical cyclones	High wind loading, lightning strike and flash flooding. Cyclones may become more intense and move further South more often, impacting the study area.	Design to account for wind loading as necessary (AS/NZS 1170.2:2002 – Structural design actions – Wind actions). Proper grounding of structure. Drainage design to account for severe short term events (as per above).
Temperature Rise	Cyclones may become more intense and move further South more often, impacting the study area.	Specifications for materials should account for these issues. Rate and nature of degradation of materials and potential increase in maintenance schedule to be considered.
	Increased bushfire risk and season, destruction of plant as well as overheating of lines, transformers etc.	Firebreaks to be maintained and appropriately sized for conditions and level of acceptable risk.
	Network congestion from increased peak loads associated with air-conditioning use etc. Decrease efficiency transmission and generation facilities.	Design and capacity of the substation to include sufficient redundant capacity to account for potential future inefficiencies.
Changing Rainfall Patterns	Changes to ground conditions (wetting and drying cycles) leading to impacts on footings and foundation materials.	Material specifications should account for such potential stresses. Maintenance and testing systems and frequency should be developed with regard to acceptable level of risk.
Legislative response to CC	Distribution patterns for electricity are likely to be effected by both CPRS and MRET, favouring renewable and lower intensity capacity.	Substation capacity should account for potential future renewable generation sources, such as biogas from the Tong park Piggery etc.

18.3 GREENHOUSE GAS FOOTPRINT

Typically Greenhouse Gas (GHG) emissions reporting involves categorisation of the emissions into three 'Scopes' or types of emissions. This helps to delineate emissions with regard to the source and level of control.

These 'Scopes' may be defined as follows:

- Scope 1 emissions are direct, controllable emissions that come from sources owned and controlled by the company (such as fuel-use by vehicles or natural gas consumed on site);
- Scope 2 emissions are indirect emissions that come from the generation of purchased electricity; and

- Scope 3 emissions are a consequence of the activities which are not in the direct ownership or control of the company, but are a result of their use of third party goods and services. Items such as domestic flights, taxis or emissions from the production of consumables such as paper all fit under this category.

Scope 3 emissions are generally reported voluntarily and separately from a company's other emissions, as they will form part of the 'primary' (scope 1 and 2) emissions of another entity. A preliminary desktop audit has summarised the major project elements as follows:

TABLE 18-2 GREENHOUSE GAS (GHG) SOURCES BY SCOPE

SCOPE 1	SCOPE 2	SCOPE 3
Tree clearing for site preparation. Fuel used in company owned heavy vehicles for site works. Fuel used in company owned light vehicles (for staff transport, delivery of materials etc). Any fuel used for on site generation (industrial lighting etc).	Grid Electricity used in temporary site office.	Domestic flights for staff and management to and from site. Other project consumables (paper etc). Wastes generated as a result of the project. Energy / Emissions embedded in construction materials. Third party site works and vehicle movements.

18.4 VEGETATION CLEARING

The proposed substation development site includes some vegetative cover which will be cleared for construction. While this will be partially replaced by site planting, there is expected to be some net loss of vegetative-carbon sink due to the substation development. No modelling is currently available for estimation of the scale of the lost sink. Refer to Section 10 (Flora and Fauna) for more details.

18.5 MATERIALS FOR CONSTRUCTION

With National Greenhouse and Energy Reporting System (NGERS) now in place, information on the embedded energy and GHG intensity of many common construction materials will be readily available for such reviews. The following has been calculated based on inputs provided by the client and assumptions based on transport-industry standards and averages, and emission factors available produced by VIC Roads as part of the Greenhouse Gas Calculator model (Feb 2008).

TABLE 18-3 GREENHOUSE GAS EMISSION ASSOCIATED WITH CONSTRUCTION MATERIALS

MATERIAL	AMOUNT	UNIT	EMBEDDED ENERGY T CO2-E/UNIT OF FINAL PRODUCT	EMISSIONS T CO2-E
Substation				
Concrete (assume 15% cement mix)	900	m^3	0.25752	232
Reinforcement (assumed steel, non recycled source)	400	Tonnes	2.65	1,060
Clean Fill	1,000	Tonnes	0.0015	2
Total				1,293

18.6 HEAVY VEHICLE FUEL USE

Heavy vehicles (trucks, pilling rig, excavators and crane etc) will be used to transport materials to and from the site. It has been estimated that in the region of 320 round trips will be made to and from the site to deliver materials and equipment, and to remove site wastes:

- 9 Low loader deliveries for bulk earthworks machinery (Bulldozers, Excavators and Drotts) and 9 trips for collection;
- 10 Semi-trailer deliveries for site cranes (plus 10 trips for collection)
- 20 Semi trailer deliveries for reinforcement steel;
- 5 Semi trailer deliveries for other materials and civil construction machinery;
- 5 Semi trailer deliveries for Excavators/Bobcats;
- 100 Concrete Truck deliveries;
- 35 Semi-trailer deliveries for prefabricated structures and plant equipment; and
- 50 Deliveries of materials for site finishing (turf, rock etc).

It has been assumed that all suppliers and materials will be provided from the Toowoomba area (approx 120 km away) with an average travel distance (return trip) of 240 km. This results in a total heavy vehicle travel distance of 60,720 km for the substation. The Australian Bureau of Statistics (ABS, 2008) estimate Articulated trucks to consume in the region of 54.6 L of diesel per 100km travelled, and 28.6 L / 100 km for rigid trucks. In total around 23.8 kL of diesel has been calculated for this use.

In addition to the above, some equipment will be used at the site for civil and construction works:

- 3 Bulldozers for 3 Months;
- 3 Excavators for 3 Months;
- 3 Drotts for 3 Months;
- 10 Cranes for 3 Months; and
- 5 Bobcats for 3 Months.

Assuming the site operates for 8 hours per day 5 days per week, 12,480 machine hours are accrued. According to "Spon's Civil Engineering and Highway Works Price Book" (2005) heavy machinery for site works use in the region of 38 L diesel per hour with 80% capacity usage (leaving around 30L/hour being used). Small bobcats where assumed to use half this amount. The National Greenhouse Accounts (NGA) Factors (June 2009) indicate 2.7 tonnes of $CO_2{}^{-eq}$ per kL of diesel fuel. Based on these values; the substation would contribute 918 tonnes of GHG.

18.7 LIGHT VEHICLE FUEL USE

Private vehicles usage are estimated to vary over the project schedule. Site staff will be going to and from the site daily from the Toowoomba area (approximately 120 km away). The following figures have therefore been assumed:

- 12 site vehicles making daily trips over 12 month construction schedule; and
- Testing and commissioning (12 vans and small trucks) for final 3 months.

Using an average return trip distance of 240 km, a total of 3,900 return trips and a total distance of just under 1 million km are estimated to be travelled. ABS (2008) estimate passenger vehicles use 11.1 L of petrol per 100km travelled. The testing vehicles where assumed to be light commercial vehicles at 12.5 L diesel per 100 km's. In total around 106.5 kL of fuel is expected to be consumed based on the above assumptions. Approximately 254 tonnes of greenhouse gas are contributed to the footprint from this source.

It should be noted that this number is highly dependent on driver behaviour, location and site conditions, and would need to be closely monitored (through the use of fuel cards, etc) to ensure the appropriate reporting thresholds are observed.

18.8 ELECTRICITY FOR TEMPORARY SITE AMENITIES

No temporary site amenities have been indicated. It is assumed all staff will be Chinchilla based.

18.9 EMISSIONS SUMMARY

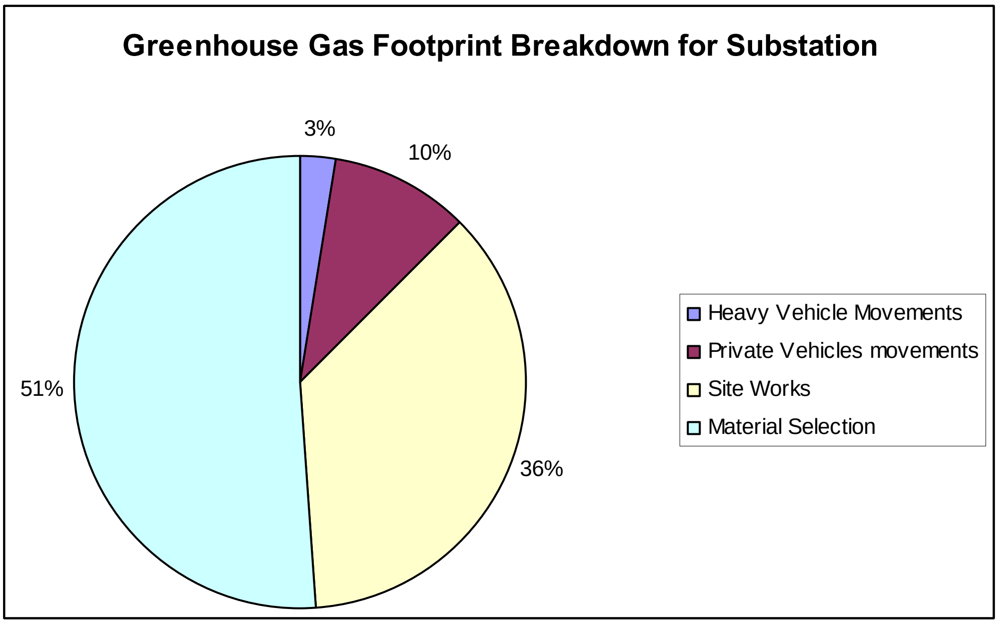
The following table summarises the calculated GHG emissions according to the Scopes that categorises them. While Scope 3; or indirect auxiliary emissions is the largest emissions group, Scope 1 or direct emissions is only slightly less.

TABLE 18-4 EMISSIONS SUMMARY

	SCOPE 1 (T CO2-E)	SCOPE 2 (T CO2-E)	SCOPE 3 (T CO2-E)
Loss of Carbon Sink	unknown		
Energy Embedded in Construction Materials			1,293
Heavy Vehicles - Deliveries			64
Heavy Vehicles – Site Works	918		
Light Vehicles for Staff Transport	254		
Totals	1,172 t CO_2^{-e}	0 t CO_2^{-e}	1,357 t CO_2^{-e}

This is reinforced by the below chart, which illustrate the division of Scope 1 and 3 emission sources in almost equal proportions. It is therefore evident that the greatest reduction in emissions could be achieved by selection of materials with greater recycled content and which are locally sourced as well as back loading of materials where possible and proper planning for efficient and well-organised site works.

FIGURE 18.1 EMISSIONS BREAK-DOWN PIE CHART FOR SUBSTATION



18.10 POTENTIAL IMPACTS

Australia's 2007 Greenhouse Gas Inventory for Kyoto reporting estimates emissions from the construction sector to be 1,755,940 tonnes, which excluded 'embedded' energy in materials consumed. The equivalent emissions for this project would account for around 0.07% of this total.

18.11 MITIGATION MEASURES

In addition to being impacted by the climate, the process of development, construction and operation will also evolve emissions which may contribute to anthropogenic climate change.

Management strategies can be put into place to minimise these emissions to the minimum necessary.

Site Preparation

- Consider clearing minimisation when selecting transmission line route and substation location; and
- Offset of significant trees removed during construction and operation.

Material Selection & Transport

- Selection of locally sourced materials and labour to reduce transport emissions;
- Selection of long wearing and robust materials to minimise lifecycle emissions;
- Selection of materials with recycled content, and which are in turn recyclable;
- Using standard dimensions to make use of unused product and reuse following disassembly easier;
- Take advantage of back-loading for materials transport where feasible to do so; and
- Use of certified sustainable timbers if available.

Efficient Plant and Equipment

- Appropriate maintenance intervals for equipment and vehicles; and
- Proper sulphur hexafluoride (SF_6) storage, leakage detection and recovery capacity.

Auxiliary Emissions

- Coordination of staff travel to minimise return trips;
- Specify GHG monitoring and reporting for all sub-contractors (also important for NGERS reporting); and
- Segregation and recycling of construction wastes.