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TABLES

18. GREENHOUSE GAS EMISSIONS

This section assesses Section 3.6 of the TOR. The potential greenhouse impacts of the Project have been identified and mitigation measures proposed.

18.1. Regulatory framework

There are a number of Commonwealth legislation and policy items aimed at identifying and reducing Australia's greenhouse gas emissions. Those relevant to the water industry include the following:

- the *Energy Efficiency Opportunities Act 2006* (EEO Act) requires large energy-users to identify, evaluate and publicly report cost effective energy savings opportunities; and
- the *National Greenhouse and Energy Reporting Act 2007* (NGER Act) establishes a single, national system for reporting greenhouse gas emissions, abatement actions, and energy consumption and production by corporations.

The Queensland Government introduced the Smart Energy Savings Program (SESP) through the *Clean Energy Act 2008*. The program requires participating businesses to undertake an energy audit, develop an Energy Savings Plan and publish their actions for each relevant site.

SunWater is committed to the efficient use of all energy sources to minimise total energy consumption and to reduce the amount of greenhouse gas emissions produced during the construction and operation of water storage facilities and the delivery of water services. SunWater has implemented an Energy Management Standard across all levels and functions of the organisation to:

- conduct energy assessments of SunWater facilities to identify opportunities to improve energy efficiency and to reduce greenhouse gas emissions;
- provide education and training to increase the level of energy management skills and competencies of SunWater staff;
- develop consistent data capture and reporting processes; and
- communicate SunWater performance on energy management.

18.2. Methodology

The estimation of Greenhouse Gas (GHG) emissions from the Project were determined through the adoption of emission factors published by the Department of Climate Change and Energy Efficiency (DCCEE) in the National Greenhouse Accounts (NGA) Factors Workbook (DCCEE, 2010).

For ease of calculation and reporting, sources of GHG emissions were separated into construction and operational phases.

18.2.1. Emissions classification

The sources of GHG emissions have been separated into different 'Scope' areas, based on the NGA (2009) workbook emission classification. This classification and the potential sources of GHG emissions from the Project are outlined in Table 18-1.

Table 18-1 Project emissions classification

Scope	Construction	Operational
Scope 1 – direct emissions, per unit of activity at the point of emissions release.	▪ Land use change ▪ Fuel combustion on site	
Scope 2 – indirect emissions from the combustion of purchased electricity consumed on-site.		▪ Electricity consumption
Scope 3 – emissions generated by external operators that arise from an organisation's activities but are not from sources owned or controlled by that organisation.	▪ Haulage of materials ▪ Embodied energy of materials	

18.2.2. Emission factors

Landuse change is a significant contributor to the emissions from dam construction due to the clearing of vegetation and the subsequent release of carbon from the decaying vegetation. The IPCC Guidelines for National Greenhouse Inventories have been used to derive appropriate emission factors. These guidelines derive emission rates for methane and carbon dioxide based on existing landuse type and corresponding carbon content. These emissions occur through the decay of inundated biomass and soil organic matter. The Project area is considered to correspond to the classification of warm, temperate and dry climate. There are two broad land classifications for the water storage, specifically grassland and woodland with a dry matter content of 6.1 t/Ha and 60 t/ha respectively. The corresponding emission factors are shown in Table 18-2.

The other emissions factors were derived from The National Greenhouse Account (NGA) Factors (DCC, 2010) in conjunction with the VicRoads Sustainability Toolkit V2. The derived emissions are shown Table 18-2.

Table 18-2 Greenhouse emission factors used for emission estimation for construction and operation

	Scope 1	Scope 2	Scope 3	Source
Inundation	5.2 kg CO_2-e/ha/day 0.44 kg CH_4/ha/day	-	-	IPCC (2006)
Land clearing – Grassland	10.5 t CO_2-e /ha	-	-	IPCC (2006)
Land clearing- Woodland	103.4 t CO_2-e /ha	-	-	IPCC (2006)
Diesel usage	2.7 t CO_2-e / kL		0.2046 t CO_2-e /kL	DCCEE (2010)
Electricity usage	-	0.89 t CO_2-e /MWh	-	DCCEE (2010)
Pipeline	-	-	266 t CO_2-e/km	CS (2010)
Concrete	-	-	0.258 t CO_2-e/m^3	VICROADS Sustainability Toolkit

18.3. Potential impacts

18.3.1. Dam and surrounds

18.3.1.1. Construction

The Project involves both permanent inundation to FSL (water storage) and temporary inundation (flood margin). All tree and shrub vegetation within the water storage will be cleared, except in the riparian zone of the Dawson River and tributaries which will be cleared to within 1.5 m of the FSL and clearly marked to this line. However, it is assumed that this vegetation left in place will eventually die due to inundation, although it may take some time to die, depending on the rate of filling of the dam. The proposed total area to be cleared, at FSL is 13,508 ha. Based on field assessment, it is estimated that the vegetation within the water storage is 77% grassland and 23% woodland. An area of 217 ha will also be cleared for the construction area. It is assumed the construction area is 87% grassland and 13% woodland.

The estimated GHG emissions from dam construction due to diesel use and land clearing are summarised in Table 18-3.

Table 18-3 GHG emissions (tonnes CO_2-e) resulting during construction.

Emission Source	Value	Units	Emissions
Diesel for dam construction	5,000	kL	13,500
Clearing for construction	217	ha	4,853
Clearing for water storage	13,508	ha	430,716
Total			**449,069**

18.3.1.2. Inundation

The new dam will result in the permanent inundation or clearing of vegetation. Simply, once inundated or cleared, the vegetation no longer has the ability to absorb CO_2 and through decomposition, produces gases such as methane. Therefore, land-use change is considered a source of GHG emissions.

It is proposed that the tree and shrub vegetation within the water storage will be cleared except where there is significant vegetation near FSL. This machinery requirement for the clearing of vegetation is also likely to incur additional GHG emissions. This consumption of diesel is included in the construction energy consumption.

The figures outlined in Table 18-4 show that a maximum of approximately 30,194 t CO_2-e over a 10-year period will potentially be emitted through inundation.

Table 18-4 GHG emissions (tonnes CO_2-e) resulting from inundation

Emission Source	Value	Units	Emissions
Inundation (CO_2)	13,508	ha	25,638
Inundation (CH_4)	13,508	ha	4,556
Total			**30,194**

18.3.2. Pipeline

18.3.2.1. Construction

The estimated GHG emissions during pipeline construction due to diesel storage and land clearing are summarised in Table 18-5. Along the proposed pipeline route, it is anticipated that a further 390 ha will require clearing. Based on field assessment, it is estimated the vegetation in the pipeline route is 77% grassland and 23% woodland.

Table 18-5 GHG emissions (tonnes CO_2-e) resulting from pipeline construction

Emission Source	Value	Units	Emissions
Diesel for pipeline construction	4 790	kL	12,935
Clearing for pipeline	390	ha	12,432
Total			**25,367**

18.3.2.2. Site facilities

For the construction site, it is anticipated that additional ablution facilities will be required. This will also be the case for the pipeline construction. Septic tanks are likely to be required. Whilst some of the sewage will be disposed in the town's sewerage network, there will be some minor GHG emissions from the remainder of the sewage that requires disposal.

18.3.3. Operational emissions

Once construction is complete, the major source of GHG emissions will occur from the ongoing electricity consumption by the pump stations. Other motors include the outlet works and small machinery that will be used to maintain the dam, which are minor sources. On the pipeline the route is traversed by vehicle at least monthly. These other sources of GHG are considered to be minor and have not been estimated for this assessment. The estimated annual GHG emissions resulting from the operation of the pump stations is 71,645 t CO_2-e.

Table 18-6 Annual GHG emissions (tonnes CO_2-e) resulting from pump stations

Emission Source	Value	Units	Emissions
Pump Station 1	11.2	GWh/yr	9,968
Pump Station 2	25.2	GWh/yr	22,428
Pump Station 3	23.8	GWh/yr	21,182
Pump Station 4	20.3	GWh/yr	18,067
Total			**71,645**

18.3.4. Upstream emissions

The potential major sources of other GHG emissions identified are as follows:

- Emissions associated with haulage of construction materials; and
- Embodied energy associated with the production of construction materials.

It is expected that the majority of pre-constructed materials for the dam and pipeline will be transported by truck from Brisbane. It is estimated that this transport of materials will require on average for the pipe construction of 14 trips / day and for the dam construction four trips / day for the dam construction site. This amount of haulage will result in approximately 10,000 kL of diesel being consumed. The resultant GHG emissions are estimated to be 27,000 t CO_2-e.

Other construction materials are mostly likely to be sourced and transported from local providers, for example aggregate transported from local quarries. It is not possible to identify these routes at this stage and are therefore are not estimated; however, in comparison to other sources these will be relatively minor.

The embodied energy of the transported construction materials encompasses the total energy required to manufacture the materials and transport to site. The largest amount of materials required for construction is the MSCL pipe. The embodied energy estimates associated with these materials is detailed in Table 18-7.

Table 18-7 GHG emissions associated with the embodied energy of major construction materials

Component	**Quantity**	**tCO_2-e**
Concrete	31,200 m^3	8,050
Pipe	261 km	69,160
Haulage	10,000 kL	27,000
Diesel	19,790 kL	4,049
Total		**108,259**

18.4. Mitigation measures

18.4.1. Construction

The following management measures are proposed to minimise greenhouse gas emissions during construction of the Project:

- as far as reasonably possible, construction materials will be sourced from within or close to the Project area to reduce fuel use from transport of materials;
- maximum re- use of cleared material;
- construction equipment will be maintained in good working to maximise fuel efficiency of equipment;
- appropriately sized equipment will be used for construction activities;
- waste from construction will be minimised; and
- greenhouse reduction initiatives will be undertaken at construction camps and construction sites.

18.4.2. Operation

Best practice in managing energy efficiency and GHG emissions for new developments can be achieved through:

- Estimating annual energy consumption and greenhouse gas emissions;
- Estimating direct greenhouse gas emissions; and
- Identifying and evaluating opportunities to reduce greenhouse gas emissions (EPA Victoria, 2002).

The Project's operational annual energy consumption energy and greenhouse gas emissions during are presented in Section 18.3.3. Energy consumption and GHG emissions during operation are predominantly associated with electricity consumption at each of the four pump stations. The pipeline design has been designed to minimise pumping requirements (reducing energy consumption and greenhouse gas emissions) through the use of gravity of flows and minimising pressure head losses within the pipeline. The following energy efficiency opportunities have been identified to further minimise greenhouse gas emissions during operation of the Project:

- Installation of high efficiency pumps to reduce energy consumption; and
- Implementation of effective leakage management systems to minimise operational losses.

SunWater will assess the feasibility of these opportunities during the detailed design phase by:

- Determining the cost of implementing these energy efficiency measures;
- Estimating the potential energy and GHG emissions savings on an annual basis;
- Estimating the annual payback period on each of these energy efficiency measures.

There may be opportunities to develop a forestry sequestration program on the properties surrounding the dam or related to any vegetation offset required for the Project. Revegetation of some areas outside the inundation zone is proposed be carried out in accordance with current land use as appropriate. This practice has the potential to reduce GHG.

SunWater is required to estimate and report annual greenhouse gas emissions under the National Greenhouse and Energy Reporting System. The development of consistent data capture and reporting processes will assist with the ongoing management of SunWater's greenhouse and energy management programs.

The continued implementation of SunWater Energy Management Standards will minimise greenhouse gas emissions from the Project by:

- identifying opportunities to improve energy efficiency for operation of the Project and to reduce greenhouse gas emissions; and
- providing education and training to increase the level of energy management skills and competencies of SunWater staff.

The Project is physically closer than other water supply options for mining operations. The greenhouse gas and energy intensity associated with pumping water will be lower than these other water supply options because of the shorter transport distance and lower pressure drop through the Pipeline.

18.5. Summary

The overall potential GHG emissions resulting from the Project are summarised below:

- Construction
  - Diesel consumption 26,435 t CO_2-e
  - Land clearing 448,001 t CO_2-e

- Inundation (over 10 years) 30,194 t CO_2-e
- Embodied energy of materials & Haulage 108,259 t CO_2-e

- Operational
  - Annual electricity consumption 71,645 t CO2-e

The cumulative total potential GHG emissions due to the construction of the dam and pipeline are approximately 612,889 tCO_2-e and 71,645 tCO_2-e per year for the operational phase. Note that it is assumed that emissions due to inundation occur over a 10-year period after the dam is complete. The largest contributor to GHG emissions is land use change.

The construction program will be designed to maximise energy efficiency and minimise greenhouse gas emissions from the works by incorporating a range of management measures. The continued implementation of SunWater's Energy Management Standard will minimise greenhouse gas emissions from the operation of the Project.