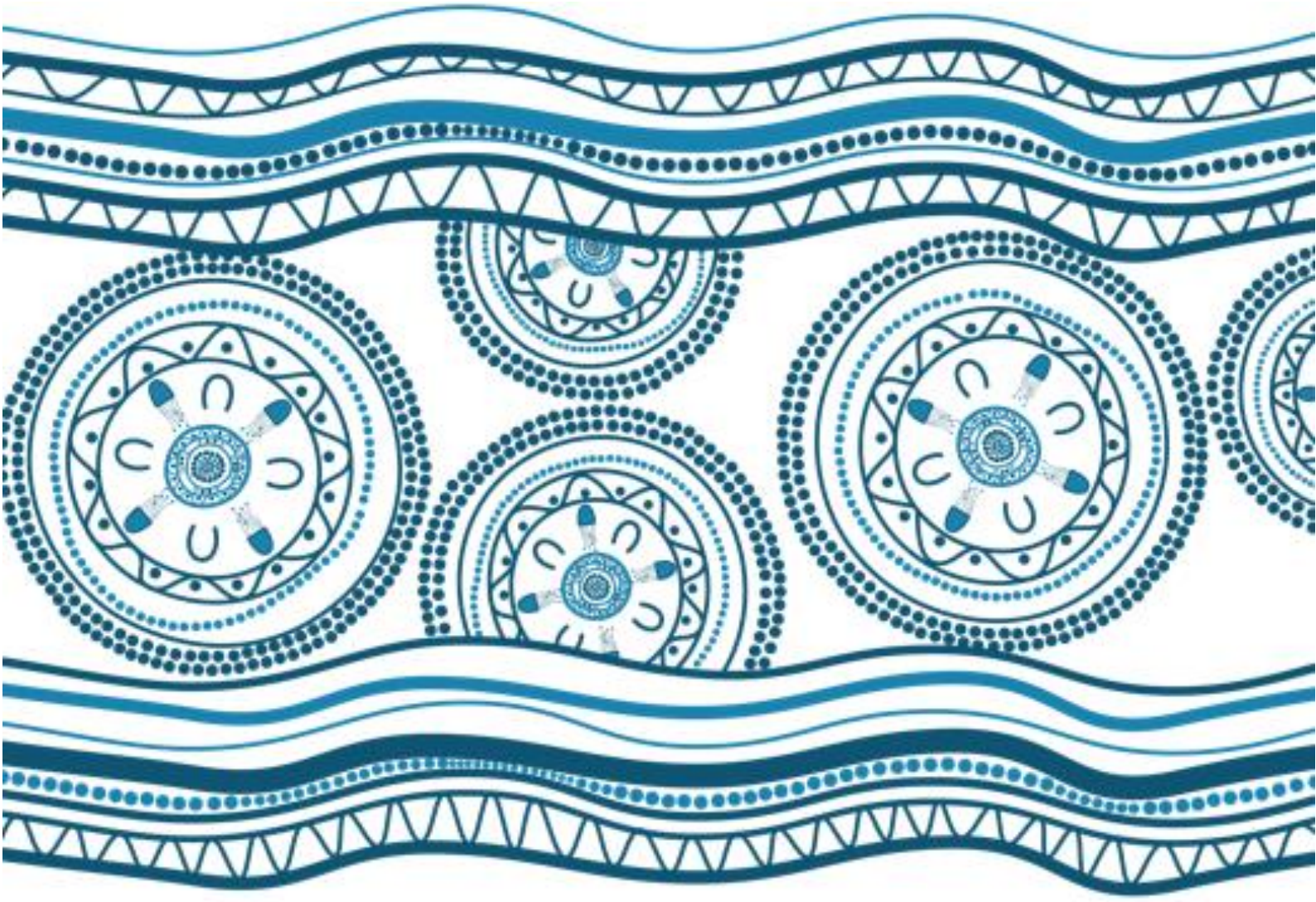
Chapter 21

Greenhouse gas



BLANK PAGE

21 Greenhouse gas

This chapter presents an assessment of the impacts of the project on greenhouse gas emissions and identifies mitigation and management measures to minimise and reduce these impacts.

The assessment presented in this chapter is based on detailed greenhouse gas calculations that have been prepared in accordance with relevant policies and guidelines (refer to section 21.1.1). The greenhouse gas calculator is included in Appendix W (Greenhouse Gas Calculations), and the key findings are summarised in this chapter.

21.1 Assessment methodology

The method used to undertake the greenhouse gas assessment involved:

- Identifying best practice guidelines for greenhouse gas emission calculations
- Defining the emission boundary
- Categorising emissions sources for the project
- Gathering information and data inputs, outlining any assumptions that were made
- Quantifying greenhouse gas emissions for construction and operation of the project
- Recommending mitigation measures to help reduce greenhouse gas emissions.

The process for quantifying greenhouse gas emissions involved using best practice guidelines to calculate total emissions (in metric tonnes of carbon dioxide equivalent (tCO_2-e)) for different emissions sources that were deemed to fall within the project emissions boundary. These calculations were based on the project description, best available information on material volumes and usages, assumptions based on consultant experience and expertise, and published energy content and emission factors. An example of this is the diesel used to power ferry operations. Diesel consumption rates were provided by experienced consultants, the vessel movements were based on details in the project description, the distance was calculated from project data, and the breakdown of diesel into its constituent energy content and emission factors were based on published values in the Department of Industry, Science, Energy and Resources National Greenhouse Accounts Factors 2019. A summary of all assumptions and calculations used to determine greenhouse gas emissions for different emission sources can be found in Appendix W (Greenhouse Gas Calculations).

21.1.1 Policy framework

In line with best practice guidelines, the following policies and guidelines were referred to when undertaking the greenhouse gas assessment:

- *National Greenhouse and Energy Reporting Act 2007* (Cth)
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Cth)
- IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006)
- Greenhouse Gas Assessment Workbook for Road Projects (Transport Authorities Greenhouse Group, 2013)
- Australian Standard ISO 14064.1:2006 Greenhouse Gas Part 1: Specification with guidance at the organisational level for quantification and reporting of greenhouse gas emissions and removals (Standards Australia, 2006).

The need to minimise greenhouse gas emissions associated with construction and operation of projects is consistent with the following NSW Government and Transport for NSW policies:

- Transport for NSW Environmental Climate Change Strategy 2019-2023 (Transport for NSW, 2019d)
- Sustainability Policy (Transport for NSW, 2020g)
- NSW Climate Change Policy Framework (NSW Office of Environment and Heritage, 2016)
- NSW Climate Change Net Zero Plan Stage 1: 2020 – 2030 (NSW Department of Planning, Industry and Environment, 2020f).

21.2 Greenhouse gas emissions

Scientists have determined that the earth's surface temperature is increasing, and that human influence in the form of greenhouse gas emissions, are the most likely cause of this temperature change. The changing climate has had observable impacts on human and natural systems and land and ocean ecosystems (Intergovernmental Panel on Climate Change, IPCC, 2018).

All infrastructure projects have the potential to generate greenhouse gas emissions. As such, an assessment can be carried out in line with regulatory and best practice requirements to help identify the type and scale of emissions generated. This can form a baseline from which risks and opportunities can be identified to reduce greenhouse gas emissions.

21.2.1 Defining greenhouse gases

Greenhouse gas is a collective term. It describes a range of gases that absorb or reradiate outgoing infrared radiation reflected from the Earth's surface that influence the global temperatures. This is known as the greenhouse effect. A change in the mix of greenhouse gases can result in a cooling or heating of the current global temperatures. Human activities, including the combustion of carbon-based fuels, have and continue to increase the concentration of greenhouse gases in the atmosphere. This leads to greater absorption of infra-red radiation and an increase in atmospheric temperature.

The most abundant greenhouse gases are:

- Water vapour (H_2O)
- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Ozone (O_3)
- Chlorofluorocarbons (CFCs)
- Hydrofluorocarbons (HCFs), including Hydrochlorofluorocarbons (HCFCs).

In addition, the following greenhouse gases are also considered under global climate change agreements:

- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6).

21.2.2 Quantifying GHG emissions

To help differentiate between greenhouse gas emission sources, emissions are typically classified into the following scopes. This also helps define ownership and the ability to control and influence different emissions sources.

- **Scope 1** 'direct' emissions include all direct greenhouse gas emissions from sources that are within the projects control boundary (eg combustion of fuels onsite, refrigerants).
- **Scope 2** 'indirect' emissions relate to energy produced outside the projects control boundary but are used in the project. This includes purchased electricity (from the grid), heat, cooling, and steam.
- **Scope 3** 'indirect' emissions are all emissions that occur as a result of the activities of the project, but occur from sources outside the projects control boundary. This includes upstream or downstream activities (eg emissions associated with the extraction and production of materials and the transportation of materials to site).

21.2.3 Emission boundary

The emission boundary for this assessment relates to the greenhouse gas emissions generated during the construction of the project and operation of the ferry service within the project areas at La Perouse, Kurnell and the ferry swept path (refer to Figure 1-2 in Chapter 1 (Introduction)). The emission boundary needs to appropriately account for the emissions of the project and include emissions under the direct control or ownership of the project, as well as emissions that are a

consequence of the activities of the project but outside its direct ownership or control. These emissions are generated both up and down stream during the construction and operation phases. The emission boundary has been determined based on a variety of factors including:

- Geographical boundary
- Experience with similar projects
- Relevance of emissions based on the following criteria:
  - Are emission sources likely to be large relative to the area's stationary energy, fuel, and electricity emissions (Scope 3)
  - The contribution of the emissions source to the overall risk exposure
  - Are emissions deemed relevant by stakeholders
  - The potential to control and influence the reduction of emissions for a particular source
- The availability of information.

Generally, exclusions were made based on its very minor or minor contribution to the overall emission budget and the limited information available for these emissions, and the emission source being outside the geographical boundary of the project. A summary of the established emission boundary, highlighting inclusions and exclusions, are detailed in Table 21-1 below. Maintenance of the project has been excluded from the assessment as it could not be quantified at the time of carrying out the assessment.

Table 21-1: Greenhouse gas reporting boundary

	Included		Excluded	
	Construction	**Operation**	**Construction**	**Operation**
SCOPE 1 (direct emissions)	• Fuel for machinery and equipment • Fuel for marine vessels used during construction • Refrigerant leakage in site offices.	• Fuel for ferry operation • Fuel use associated with berthing and refuelling • Other fuels (eg generators) • Refrigerant leakage onboard the ferries.	• Refrigerant usage in site offices • Fuel used for plant and equipment (eg generators).	• Refrigerant usage in fridges onboard etc. • Air conditioning on board • Maintenance.
SCOPE 2 (indirect energy	• Site offices.	• Electricity use at the wharves.	• Electricity consumed at Transport for NSW offices outside the project area.	• Electricity consumed at Transport for NSW offices outside the project area.
SCOPE 3 (all other indirect emissions)	• Workforce travel to and from site • Construction materials • Materials and waste transportation emissions • Emissions from waste degradation.	• Materials and waste transport emissions • Staff vehicle emissions • Emissions from waste degradation.	• Electrical cables, coils etc. • Black and grey water disposal and treatment • Vegetation clearing (minimised onsite).	• Potable water • Sewage disposal • Emissions related to the provision of food and beverage on board • Transportation of fuel to refuelling stations • Maintenance and materials • Cleaning.

21.2.4 Inputs – information and data

A variety of inputs were used to calculate the greenhouse gas emissions associated with the project. These included project and design specific information (eg material types and quantities) and published data relating to emission factors and material densities. Below is a list of primary sources of information that were used during the assessment:

- Construction methodology (refer to Chapter 5 (Project description))
- Project description and associated design information (refer to Chapter 5 (Project description))
- Assumptions from project team, existing ferry operations, and similar projects
- National Greenhouse Gas Factors: Australian National Greenhouse Accounts (Australian Government, Department of the Environment and Energy (DoEE), 2019). Since the preparation of this assessment, the 2020 National Greenhouse Gas Factors Account were issued. The assessment has not been adjusted to take into account these factors.
- Carbon Estimate & Reporting Tool Version 2.1 (Transport for NSW, 2019a)
- Inventory of Carbon & Energy Version 2.0 (University of Bath, 2011).

Where information gaps were present, assumptions were made so that calculations could be completed. For full transparency, these assumptions are detailed within the greenhouse gas calculations included in Appendix W (Greenhouse Gas Calculations).

21.3 Assessment of potential impacts

This section provides a summary of the major sources and quantities of emissions during construction and operation of the project.

21.3.1 Calculation summary

Emissions were calculated using the information presented in Chapter 5 (Project description) (ie construction period of 13 months and a design life of 50 years) and the greenhouse gas calculator (refer to Appendix W (Greenhouse Gas Calculations)).

During construction, Scope 3 emissions account for the largest source due to the embodied energy of the materials used during construction. During operations, Scope 1 emissions dominate, largely due to the consumption of diesel (which largely emits CO_2, CH_4 and N_2O) (Australian Government, DoEE, 2019) to fuel the ferries.

Table 21-2 summarises the total greenhouse gas emissions associated with the three emissions scopes. Section 21.1.1 and section 21.3.3 provide the breakdown of calculated greenhouse gas emissions during construction and operation.

Table 21-2: Estimated greenhouse gas emissions (tCO_2-e) over the project's life

Stage	tCO_2-e			
	Scope 1 (direct emissions)	Scope 2 (indirect energy emissions)	Scope 3 (all other indirect emissions)	Total
Construction	240	26	4,527	4,793
Operation	5,451*	443	275	6,169
			Total	**10,962**

** this can also be presented as 13.1g CO2/km/passenger based on a ferry capacity of 250 passengers*

21.3.2 Assessment of construction impacts

The major sources of greenhouse gas emissions is presented in Table 21-3.

Table 21-3: Greenhouse gas emissions during construction

	Inclusions	Key assumptions	Total emissions (tCO_2-e)
SCOPE 1 (direct emissions)	• Stationary fuel – marine vessels	• Marine vessel (tugs, barges, work punts) movements during construction • Barges and tugs are fuelled by diesel, consume an average of 10L/hr and 150L/hr respectively, and operate for four hours per movement • 20 days worked each month, 13-month construction period	240
SCOPE 2 (indirect energy emissions)	• Construction site office energy use	• Two site offices each with an area of 400m^2 (20m x 20m) • Air-conditioned opened plan office uses 37 kWh/m2/year.	26
SCOPE 3 (all other indirect emissions)	• Primary materials used in construction • Transport to and from site (site workers) • Transport of materials to site • Transport emissions from waste • Waste degradation	• Embodied energy of some materials based on estimations of material strength and densities • Transport of materials by diesel floats and unleaded vehicles • Deliveries as per the construction traffic movements summarised in Chapter 5 (Project description) • Waste transport emissions are associated with transport to Port Botany Transfer Station – Veolia or Breen Recycling Facility. • A workforce of 45 people who drive unleaded fuelled vehicles an average of 10km per day (roundtrip) with an average fuel consumption of 10.8L/100 km • Six-tonne skip disposed per site per week (construction and demolition waste) • 120L general waste bin collected per site per week • Emission from waste degradations based National Greenhouse Gas Factors (DoEE, 2019)	4,527
		Total	**4,793**

Figure 21-1 examines each scope emission in more detail. The results indicate that the major emission sources are the embodied carbon associated with the materials used for infrastructure (90 per cent).

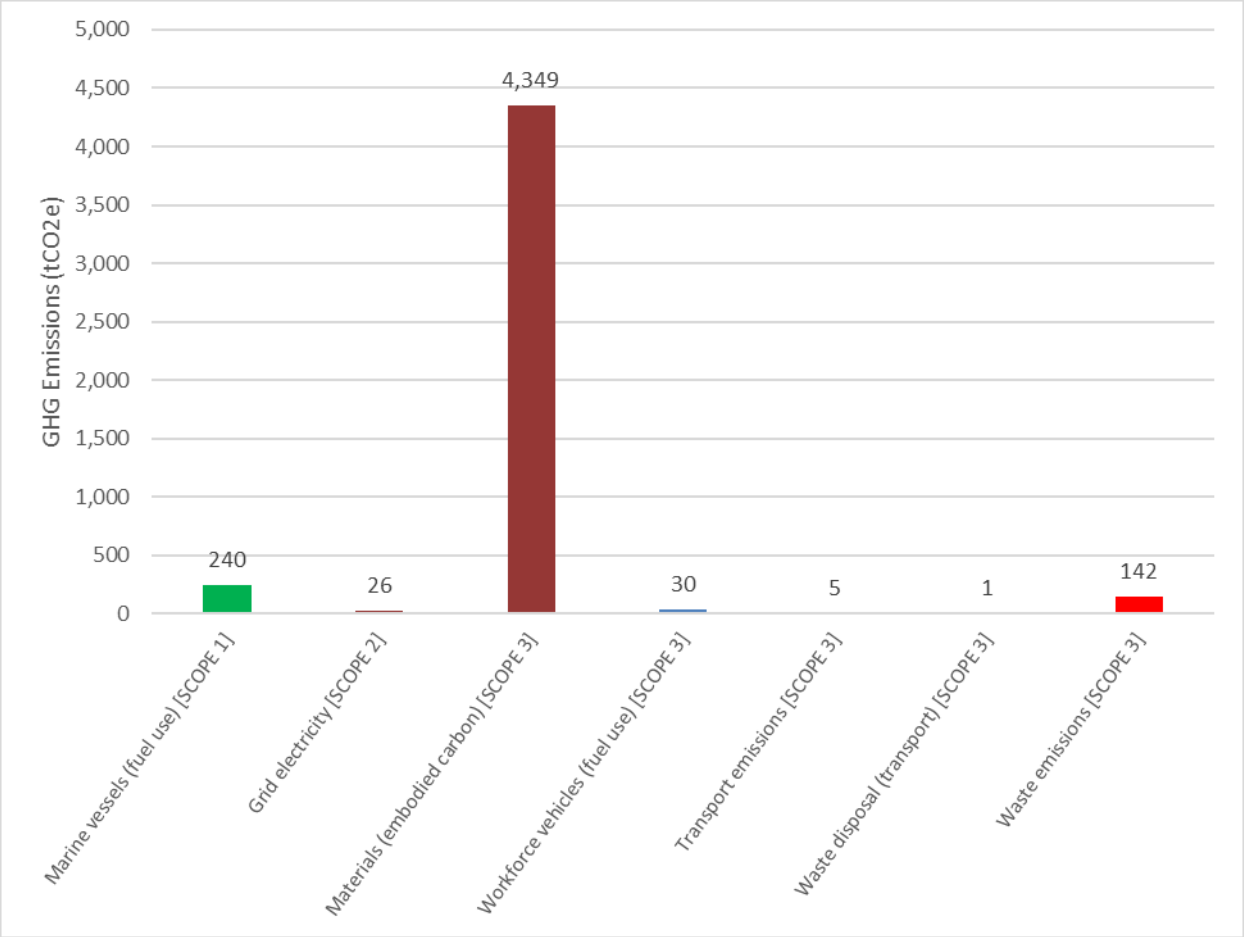


Figure 21-1: Greenhouse gas emissions during construction

21.3.3 Assessment of operation impacts

Operational greenhouse gas emissions calculations were based on a variety of inputs including information provided in the project description, best available assumptions based on consultant experience and expertise, knowledge of similar projects, and published energy content and emission factors. The major sources of greenhouse gas emissions associated with each scope during the operation of the project are presented in Table 21-4.

Table 21-4: Greenhouse gas emissions during operation

	Inclusions	Key assumptions	Total emissions (tCO_2-e)
SCOPE 1 (direct emissions)	• Ferry services - Diesel fuel use	• Ferry services operate three return trips per hour and operating for 12 hours a day, 365 days a year • 36 vessel movements per day at 2.5 km per trip, for 12 hours a day, 365 days a year • Diesel consumed by ferries at 1.149L/km • Design life of 50 years • Ferry capacity of 250 passengers.	5,451 OR 13.1g/CO_2/km/ passenger
SCOPE 2 (indirect energy emissions)	• Wharf services such as ticket machines, timetables, closed circuit TV (CCTV) and lighting.	• 15kWh/day required for each wharf • Grid electricity emission factors are the same over the design life of the project • Design life of 50 years.	443

	Inclusions	Key assumptions	Total emissions (tCO_2-e)
SCOPE 3 (all other indirect emissions)	• Transport to and from site (staff) • Transport emissions from waste (landfill and recycling) • Waste degradation emissions	• A workforce of four people who drive unleaded fuelled vehicles an average of 10 km per day (roundtrip) with an average fuel consumption of 10.8L/100 km • Transport of municipal waste to landfill to Port Botany Transfer Station – Veolia or Breen Recycling Facility. • 2 x 120L general waste and recycling bins per wharf disposed of daily. • Emission from waste degradation based on National Greenhouse Gas Factors (DoEE, 2019). • Design life of 50 years.	275
		Total	**6,169**

Figure 21-2 shows each scope emission in more detail. The results indicate that the major emission sources are associated with transport fuels used for ferry services (88 per cent).

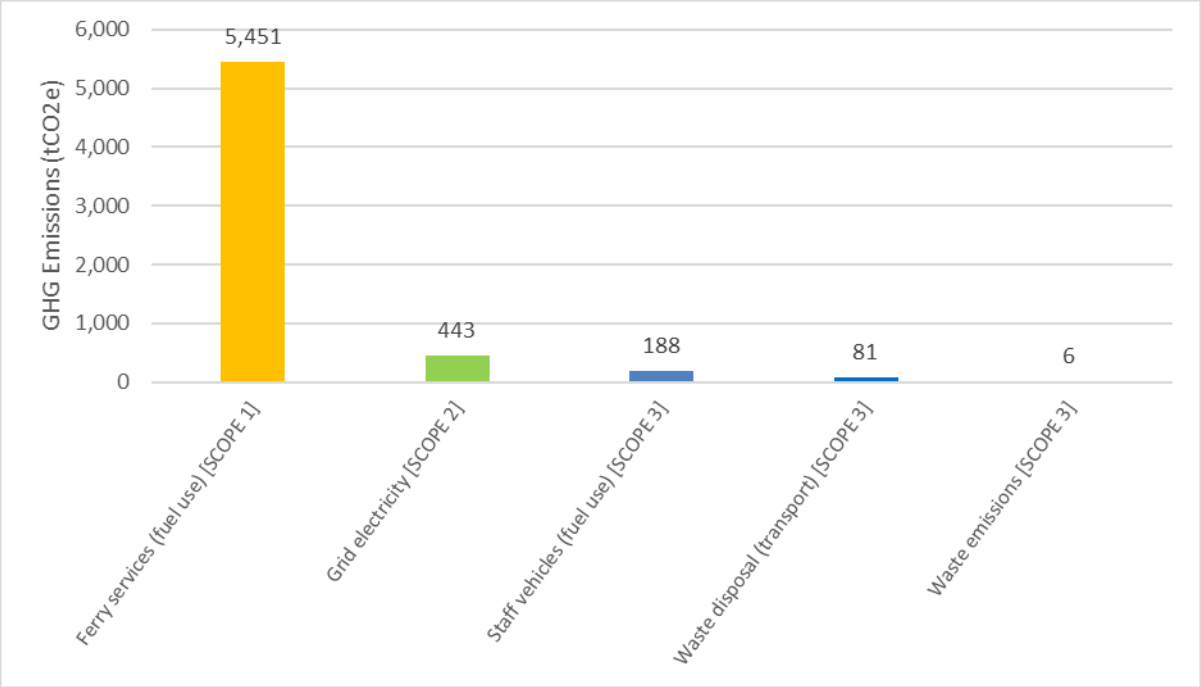


Figure 21-2: Greenhouse gas emissions during operation

It should be noted that the public transport provision provided by the new ferry service between La Perouse and Kurnell may result in a shift in mode of transport away from the heavy reliance on cars to access the National Park and surrounding areas. The expected reduction to the number of kilometres travelled on the road and via the public transport network will reduce vehicle emissions and improve other externalities such as air quality and pollution. Although this is not captured in the greenhouse gas emission calculations above, it should be recognised for its role in offsetting emissions at a broader scale.

21.4 Environmental management measures

The opportunities to reduce greenhouse gas emissions during construction are mostly achieved by selecting materials with less embodied carbon. Once operational, the ferry fuel use is the largest greenhouse gas emitting activity. Operating and maintaining ferry vessels which are the most fuel efficient would be the best mitigation. The wharves are designed to cater for a variety of vessel sizes, this supports the use for current and future vessels types and services (including a future electric ferry). The following management measures would be implemented to reduce greenhouse gas emissions.

Table 21-5: Environmental management measures for reducing greenhouse gas emissions

Impact	ID	Environmental management measure	Responsibility	Timing
Greenhouse gas emissions	GG1	The wharf design will include materials that have low embodied carbon, are durable (to reduce maintenance), and/ or are highly efficient such as LED lighting.	Transport for NSW	Detailed design
Embodied carbon in construction materials	GG2	Where practicable and feasible, construction materials will be managed to: a. Maximise onsite materials reuse b. Reuse recycled aggregates c. Manage waste to maximise recycling and minimise the percentage sent to landfill d. Incorporate fly ash in concrete e. Procure prefabricated materials to eliminate offcuts onsite f. Reduce use of reinforcement bar/steel.	Transport for NSW Contractor	Detailed design and construction
Greenhouse gas emissions	GG3	The ferry vessels will be operated and maintained in accordance with the Transport for NSW operational management system to ensure optimal operational conditions to minimise fuel use.	Transport for NSW	Operation