Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Chapter 26

Climate change and greenhouse gas

26 Climate change and greenhouse gas

This chapter assesses the potential impacts of climate change on the project and adaptation measures that have been incorporated into the design of the project. Greenhouse gas emissions generated by the construction and operation of the project are also assessed within this chapter. Detailed greenhouse gas calculations and climate change projections are provided in Appendix X (Technical working paper: Climate change and greenhouse gas calculations).

The Secretary's environmental assessment requirements relating to climate change and greenhouse gas emissions, and where in the environmental impact statement these have been addressed, are detailed in Table 26-1.

Avoiding or minimising impacts has been a key consideration throughout the design and development process for the Beaches Link and Gore Hill Freeway Connection project. A conservative approach has generally been used in the assessments, with potential impacts presented before implementation of environmental management measures. The environmental management measures proposed to minimise the potential impacts in relation to adaptation for climate change risk and greenhouse gas emissions are included in Section 26.1.5 and Section 26.2.5 respectively.

Table 26-1 Secretary's environmental assessment requirements – climate change risk

Secretary's requirement	Where addressed in EIS
Climate change risk	
1. The Proponent must assess the risk and vulnerability of the project to climate change in accordance with the current guidelines.	This chapter and **Appendix X** (Technical working paper: Climate change and greenhouse gas calculations), present a climate change risk assessment for the project in accordance with current guidelines as listed in **Section 26.1.1**.
2. The Proponent must quantify specific climate change risks with reference to either the NSW Government's climate projections at 10 km resolution (or lesser resolution if 10 km projections are not available) or equivalent projection tool (such as the Climate Futures Tool from CSIRO and BoM (attenuated for project region)) and incorporate specific adaptation actions in the design.	Climate change risks to the project are identified in **Section 26.1.4**, and **Appendix X** (Technical working paper: Climate change and greenhouse gas calculations), with reference to current climate change projections presented in **Section 26.1.3**.

26.1 Climate change risk assessment

This section outlines the legislation, policies and climate change projections relevant to the project, assesses the risks of climate change to the project and outlines adaptations to manage those risks.

26.1.1 Legislative and policy framework

The climate change risk assessment has been conducted in line with the following relevant standards and current guidelines:

- *National Climate Resilience and Adaptation Strategy* (Department of the Environment and Energy, 2015)
- *NSW Climate Change Policy Framework* (Office of Environment and Heritage (OEH), 2016a)

- *Environmental Sustainability Strategy 2019-2023* (Roads and Maritime Services, 2019)
- Australian Standard *AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk-based approach* (Standards Australia, 2013)
- Australian and New Zealand Standard *AS/NZ ISO 31000:2009 Risk management – Principles and guidelines* (Australian and New Zealand Standard, 2009)
- *Climate Change Impacts and Risk Management – A Guide for Business and Government* (Australian Government, 2006)
- *Technical Guide for Climate Change Adaptation for the State Road Network* (Roads and Maritime Services, 2015e)
- *Guideline for Climate Change Adaptation, Revision 2.1* (Australian Green Infrastructure Council, 2011)
- *Climate Risk Assessment Guideline* (Transport for NSW, 2019b).

26.1.2 Assessment methodology

The methodology for the climate change risk assessment was based on the Australian Standard *AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach*. This standard follows the International Standard *ISO 31000:2009, Risk management – Principles and guidelines* (adopted in Australian and New Zealand as AS/NZ ISO 31000:2009), which provides a set of internationally endorsed principles and guidance on how organisations can integrate decisions about risks and responses into its existing management and decision-making processes. The methodology was also guided by the draft *Technical Guide for Climate Change Adaptation for the State Road Network* (Roads and Maritime Services, 2015e).

While adhering to the above guidance documents, the following key steps were carried out to complete the climate change risk assessment:

- Determination of the climate change context, including greenhouse gas emissions scenarios and projections, data on climate variables and past meteorological record
- Identification of the climate risks and assess the likelihood and consequence of each risk
- Identification of adaptation responses.

To assist with the determination of the climate change context as well as the identification of climate change risks and the likelihood of such risks, a multidisciplinary risk workshop was held with members of the project team (ie members of the design and environmental assessment teams) early in the design phase. The preliminary risks identified at the workshop were then formalised in a risk register and thorough risk descriptions, including cause, impact/consequence and current and proposed future treatment were identified.

A climate change risk update was subsequently carried out based on the design that forms the basis of this environmental impact statement. The update identified treatments that had been incorporated into the design since the initial climate change risk workshop, risk treatments to be implemented or investigated in future design stages, and some updates to risk ratings.

A hazard-receiver pathway model has been applied to identify and analyse risks to the project with respect to climate change. Climate or climate influenced attributes with potential to influence the project were identified (hazards), along with the component of the project, user or surrounding environment that would be impacted by the hazard (receivers).

The appropriate risk rating level was identified by:

- Determining the likelihood of each risk occurring
- Determining the consequences of each risk occurring
- Considering what is already inherent in the design, and the business as usual controls expected to be applied through design, construction, maintenance and operation

- Determining the residual risk, incorporating the above factors.

The risk assessment matrix in Appendix X (Technical working paper: Climate change and greenhouse gas calculations) was applied to determine risk ratings for the identified hazards and receivers.

26.1.3 Climate change projections

Climate change projections used for the climate change risk assessment are summarised below in Table 26-2.

The projections were developed for three periods, broadly reflecting the operating timeframes of different elements of the project:

- Year 2030: assets and systems with short operating timeframes, such as communications and other electronic systems, landscaping and road surfaces
- Year 2050: assets and systems with long operating timeframes, such as drainage structures and barriers/rails
- Year 2090: 'permanent' assets, which would become fixed and ongoing features of project, such as tunnel civil structures (including rock bolts), bridges, embankment culverts (and other inaccessible drainage), and buildings.

Projections were derived from the Intergovernmental Panel on Climate Change's Fifth Assessment Report (AR5) (IPCC, 2013) which are incorporated into the Climate Futures Tool by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Department of Agriculture, Water and Environment. Projections are provided for a number of emissions and pathway scenarios for a range of climate parameters. The projections are based on the 'worst-case' scenario (Representative Concentration Pathways 8.5), which reflects the highest emissions projected for the time period.

Table 26-2 Summary of climate change projections – Sydney region

Climate variable	Baseline (1986 - 2005)	2030	2050	2090
Temperature				
Mean minimum temperatures (°C) – annual	14.4	15.5	16.3	18.4
Mean maximum temperatures (°C) – annual	22.4	24.3	24.4	26.5
Days over 35°C – annual	3.5	5.6	5.9	11.3
Rainfall				
Mean precipitation (mm) – annual	1238	1206	1151	1049
Extreme rainfall events – max 1-day rainfall	Projected to increase 2 – 22%			
Extreme rainfall events – 20-year return level of max. 1-day rainfall	Projected to increase 5 – 42%			
Evapotranspiration				
Annual change in potential evapotranspiration (% change)	375 mm (1961-1990)	4.2	No data	14.3
Fire regimes				
The number of days where the fire danger rating is 'severe' or 'extreme'	0.9	1.3	No data	2.1

Climate variable	Baseline (1986 - 2005)	2030	2050	2090
Severe wind				
Average maximum daily wind speed (% change)	120 km/h	-0.2 to 1.9	1.8 to 3.2	0.3 to 5.7
Sea conditions				
Sea level rise (m)	0	0.14	No data	0.66
Sea surface temperature (°C)	Varies	1.0	No data	3.1
Atmospheric CO_2				
Atmospheric CO_2 concentration	401 ppm	No data	No data	940 ppm (2100)

Note: "No data" is where projections are not available for the time period; "Varies" is where data varies both within the year and range identified.

26.1.4 Climate change risk evaluation

Climate change risks with a medium or high rating (based on the design presented in this environmental impact statement), prior to the implementation of further treatment measures, are summarised in Table 26-3 (ie 'initial rating'). These 'initial ratings' assume the incorporation of business as usual design, construction and operational controls. Treatment methods have been identified and are proposed for those 'initial ratings', based on the current design, or are proposed to be carried out as part of future investigations during further design development.

The 'final rating' (ie post-treatment), incorporating further additional treatment options and investigations, is also presented in Table 26-3.

Low risks identified during the assessment were not considered to require any additional risk treatment, as these risks are considered tolerable. As such, risks classified as 'low' or 'negligible' have not been included in the table below.

In summary, the assessment of climate change risks identified no extreme or high initial risk ratings, and only four medium risk ratings. These medium risks are anticipated in respect to rainfall and surface flooding, bushfires (particularly in the area adjoining to Wakehurst Parkway), and sea level rise. Two of these medium risks, for rainfall and surface flooding and sea level rise, drop to a final risk rating of low when incorporating further additional treatment or investigations.

Table 26-3 Climate change risk assessment

Risk ID	Hazard Category	Description	Initial Rating	Measures incorporated into the current design and business as usual practice	Proposed further treatment or investigation	Final Rating
38	Rainfall and surface flooding	Potential for key project elements (ie tunnel portals, motorway facilities and motorway control centre) to be flooded in extreme rainfall/stormwater events, resulting in operational failure.	Medium	Facilities have been designed to be immune in the probable maximum flood.	Further flood modelling for detailed design would continue to use sea level rise projections and rainfall projections.	Low
18	Bushfires	Damage to road infrastructure especially along Wakehurst Parkway from bushfires where bushland surrounds the project.	Medium	Standard asset protection zones around buildings.	No additional measures.	Medium
22	Bushfires	An increased likelihood in the occurrence of bushfires which may increase the potential for injuries and/or fatalities to pedestrians and cyclists along Wakehurst Parkway. An increased patronage is anticipated as a result of improved access facilitated by the project.	Medium	Variable message signs incorporated into the design at Wakehurst Parkway.	No additional measures.	Medium
26	Sea level rise	Potential for key project elements (ie tunnel portals, motorway facilities and motorway control centre) to be flooded as a result of sea level rise, resulting in operational failure.	Low	Key project elements are designed above probable maximum flood and above future projected sea levels.	Further flood modelling in detailed design would continue to use sea level rise projections and rainfall projections.	Low

26.1.5 Adaptation for climate change

Table 26-4 lists the actions that would be carried out during further design development to mitigate the effects of climate change.

Table 26-4 Environmental management measures – climate change risks

Ref	Phase	Risks	Environmental management measure	Location
CC1	Design	Climate change risks and flood modelling projections	The following actions will be carried out during further design development to ensure climate change is adequately addressed: a) Flood modelling will continue to use sea level rise projections and future climate change rainfall projections b) The extent of scour protection will be refined c) Sensitivity testing for future climate change will be carried out in the detailed design of drainage channels and culverts. Increased capacity will be provided where feasible and reasonable.	BL/GHF

Beaches Link = BL, Gore Hill Freeway = GHF

26.2 Greenhouse gas

Atmospheric greenhouse gases absorb and re-radiate heat from the sun, trapping heat in the lower atmosphere and influencing global temperatures. This is known as the greenhouse effect and is linked to climate change.

The emission of greenhouse gases into the atmosphere occurs as a result of both natural processes (eg bushfires) and human activities (eg burning of fossil fuels to generate electricity).

This section outlines the legislation and policies relevant to the project, and the greenhouse gas emissions and potential impacts caused by the construction and operation of the project.

26.2.1 Legislative and policy framework

This assessment was prepared according to the principles and objectives outlined in the following legislation and policies:

- *Kyoto Protocol to the United Nations Framework Convention on Climate Change* (the Kyoto Protocol) (UNFCCC, 1998)
- *Doha Amendment to the Kyoto Protocol* (UNFCCC, 2012)
- *Paris Agreement* (UNFCCC, 2015)
- *National Greenhouse and Energy Reporting Act 2007* (Cwlth)
- *Direct Action Plan* (Australian Government, 2014)
- *NSW Climate Change Policy Framework* (OEH, 2016a)
- *Environmental Sustainability Strategy 2019-2023* (Roads and Maritime Services, 2019).

26.2.2 Assessment methodology

The methodology for this greenhouse gas and energy assessment is based on the following tools and protocols:

- *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (World Resources Institute & World Council for Sustainable Business Development (WRI & WBCSD), 2004)
- *Greenhouse Gas Assessment Workbook for Road Projects* (the TAGG Workbook) (Transport Authorities Greenhouse Group (TAGG), 2013)
- *Infrastructure Sustainability Materials Calculator* (Infrastructure Sustainability Council of Australia, 2016b)
- *Tools for Roadside Air Quality* (Roads and Maritime Services, 2012).

Greenhouse gas emissions are reported as kilotonnes of carbon dioxide equivalent (kt CO_2-e).

Emissions are categorised into three different scopes in accordance with the Greenhouse Gas Protocol.

The three greenhouse gas scopes are:

- Scope 1 emissions – direct emissions generated by the project, eg emissions generated by the use of diesel fuel in project construction plant, equipment or vehicles
- Scope 2 emissions – indirect emissions from the consumption of purchased electricity for project equipment or operation of the project
- Scope 3 emissions – all other indirect emissions (not included in Scope 2) generated as a consequence of the project, eg emissions associated with the mining, production and transport of materials used in construction.

26.2.3 Assessment of potential construction impacts

The primary sources of construction greenhouse gas emissions and the indicative Scope 1, 2 and 3 emissions for the project are presented in Table 26-5 and Figure 26-1.

The construction stage of the project is expected to generate about 724 kt CO_2-e of greenhouse gas emissions. As shown in Figure 26-1, about 38 per cent of emissions are expected to be contributed from terrestrial electricity consumption, and about 42 per cent by construction materials.

The estimated construction stage emissions represent about 0.6 per cent of NSW emissions and about 0.13 per cent of Australia's national emissions in 2018. Due to the indirect nature of Scope 3 emissions, a proportion of these emissions may be generated interstate or internationally. While these percentage contributions are small within the NSW and national contexts, measures have been outlined in Section 26.2.5 to further minimise greenhouse gas emissions during the construction of the project.

Table 26-5 Indicative construction phase greenhouse gas emissions by scope

Emission source	Emissions (kt CO_2-e)			
	Scope 1	Scope 2	Scope 3	Total
Diesel combustion (plant and equipment)	23.9	-	1.2	25.1
Diesel combustion (generators for marine construction)	4.5	-	0.2	4.7
Diesel combustion (transport of materials to terrestrial temporary construction support sites)	-	-	9.6	9.6
Diesel combustion (transport of waste and spoil from terrestrial and harbour temporary construction support sites)	-	-	98.6	98.6

Emission source	Emissions (kt CO_2-e)			
	Scope 1	Scope 2	Scope 3	Total
Vegetation removal	2.9	-	-	2.9
Electricity consumption (terrestrial)	-	249.5	27.7	277.2
Construction materials	-	-	305.6	305.6
Total	31.3	249.5	442.9	723.7

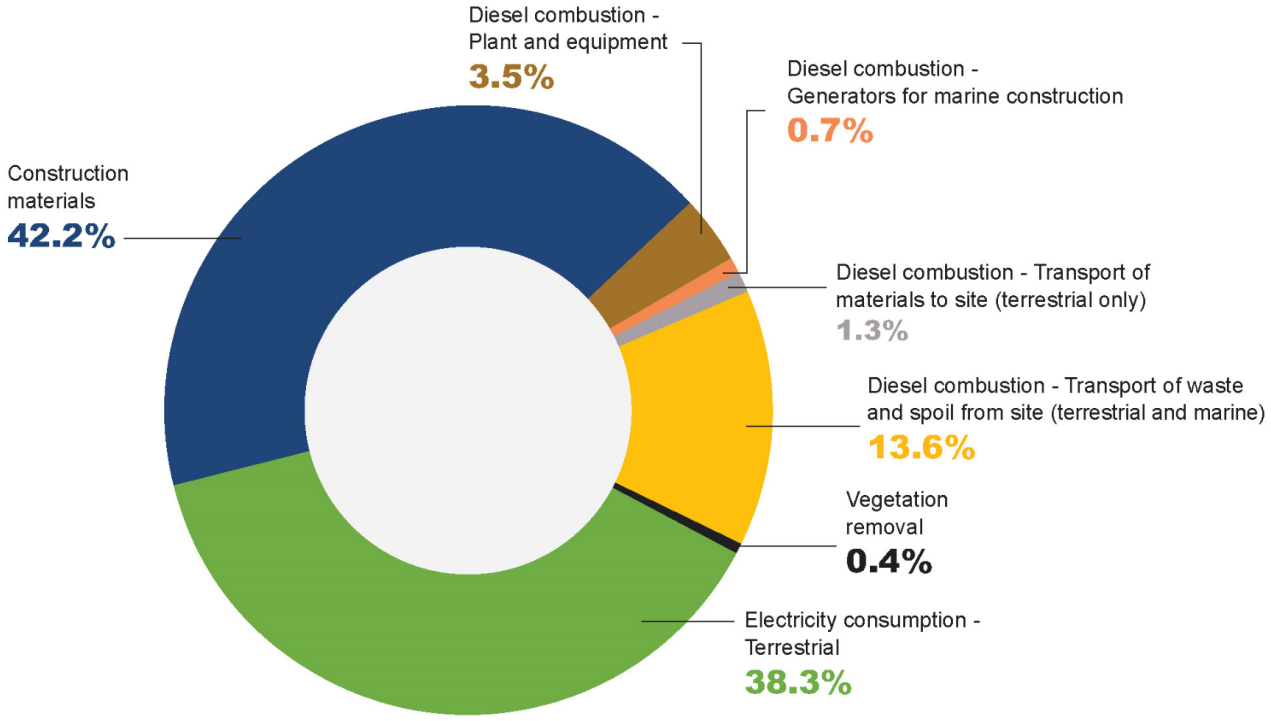

Figure 26-1 Estimated greenhouse gas emissions by source for construction

26.2.4 Assessment of potential operational impacts

The primary sources of operational greenhouse gas emissions and the indicative Scope 1, 2 and 3 emissions for the project are presented in Table 26-6. Emissions estimates are provided for operational scenarios in 2027 (opening) and 2037 (10 years after opening).

Electricity

Operational greenhouse gas emissions would be associated with the electricity consumption required to power operational infrastructure and facilities, including:

- Tunnel ventilation
- Surface and tunnel lighting
- Motorway control centre
- Wastewater treatment plant
- Substations.

Operational electricity consumption is projected to increase over time, due to the projected increase in traffic volumes using the roads, increasing tunnel ventilation requirements.

Maintenance

Greenhouse gas emissions generated from the maintenance of road infrastructure would be relatively small in comparison with other operational sources. Emissions would result from the use of diesel fuel maintenance vehicles and equipment, and are embedded in the construction materials used for maintenance activities.

Traffic

Operational greenhouse gas emissions would be associated with fuel consumed by vehicles using the road network. Greenhouse gas emissions are also projected to increase as traffic numbers across the road network grow. However, the expected reduction in congestion as a result of the project and expected improvements in fuel efficiency and increases in electric vehicles, are projected to result in improvements to the overall efficiency of emissions. The project would increase the number of road links across the network, but would result in fewer vehicle stop and start movements, less congestion and a greater average vehicle speed, which would further increase the efficiency of vehicles and assist in reducing emissions. Table 26-6 outlines the difference, with and without the project, between operational greenhouse gas emissions associated with traffic.

Emission estimates

The estimated operational emissions would represent about 0.03 and 0.04 per cent of projected NSW emissions in 2027 and 2037 respectively, and 0.01 per cent of Australia's projected national emissions in both 2027 and 2037. While these percentage contributions are small within the NSW and national contexts, the environmental management measures outlined in Section 26.2.5 would be implemented to further minimise greenhouse emissions during the operation of the project.

Table 26-6 Indicative operational phase greenhouse gas emissions by scope

Source	Emissions (kt CO_2-e)			
	Scope 1	Scope 2	Scope 3	Total
2027				
Operational electricity	-	27.9	3.1	31.0
Maintenance	0.3	-	0.3	0.6
Traffic (difference between existing levels and levels with the project)	-	-	13.7	13.7
Total	0.3	27.9	17.1	45.3
2037				
Operational electricity	-	29.2	3.2	32.4
Maintenance	0.3	-	0.3	0.6
Traffic (difference between existing levels and levels with the project)	-	-	19.5	19.5
Total	0.3	29.2	24.1	52.5

26.2.5 Environmental management measures

Environmental management measures relating to greenhouse gas emissions are outlined in Table 26-7.

Table 26-7 Environmental management measures – greenhouse gas

Ref.	Phase	Risks	Environmental management measure	Location
GHG1	Design	Energy efficiency	Energy efficiency will be considered during further design development with energy efficient systems installed where reasonable and practicable.	BL/GHF
GHG2	Construction	Emission of greenhouse gases during construction	Greenhouse gas emissions will be managed and minimised as part of the Sustainability Management Plan and will be implemented to assist in achieving 'Design' and 'As Built' ratings of Excellent under the Infrastructure Sustainability Council of Australia rating scheme (Version 1.2).	BL/GHF

Beaches Link = BL, Gore Hill Freeway = GHF