# The Northern Road Upgrade Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

NSW Environmental Impact Statement / Commonwealth Draft Environmental Impact Statement

## Appendix Q – Technical working paper: Greenhouse gas assessment and Climate change risk assessment

June 2017

# The Northern Road Upgrade – Mersey Road to Glenmore Parkway

Prepared for Roads and Maritime Services by Jacobs Australia

## Greenhouse Gas Assessment

Final

15 May 2017

# The Northern Road Upgrade (Mersey Road to Glenmore Parkway)

Project No: IA086100
Document Title: Greenhouse Gas Assessment
Document No.: D0
Revision: V9
Date: 15 May 2017
Client Name: NSW Roads and Maritime Services
Project Manager: Kelly Thomas
Author: James Moore
File Name: \\Jacobs.com\SYDProjects\NBIF\Projects\IA086100\Technical\EIS Editorial Review April 17\appendices\Appendix Q - GHG Assessment and CCRA\IA086100-RP-EN-0125_Greenhouse Gas Assessment_DOv9_15052017_FINAL.docx

Jacobs Australia Pty Limited

710 Hunter Street
Newcastle West NSW 2302 Australia
PO Box 2147 Dangar NSW 2309 Australia
T +61 2 4979 2600
F +61 2 4979 2666
www.jacobs.com



## Document history and status

| Revision | Date | Description | By | Review | Approved |
|---|---|---|---|---|---|
| D0v0 | 20/05/2016 | Initial Draft for internal peer review | J Moore | M Davies | 23/05/2016 |
| D0v1 | 23/05/2016 | Initial Draft issued for NSW Roads and Maritime Services review | J Moore | D Williams | 26/05/2016 |
| D0v2 | 04/05/2016 | Final Draft for issue | J Moore | D Williams | 21/06/2016 |
| D0v3 | 19/07/2016 | Final | J Moore | D Williams | 19/07/2016 |
| D0v4 | 16/09/16 | Final updated for design changes | J Moore | D Williams | 16/09/2016 |
| D0v5 | 23/09/16 | Final with comments from RMS addressed | J Moore | D Williams | 23/09/2016 |
| D0v6 | 11/11/2016 | Final draft in response to RMS review comments and updated project description | J Moore | D Williams | 11/11/2016 |
| D0v7 | 20/02/2017 | Final draft | J Moore | D Williams | 20/02/2017 |
| D0v8 | 10/03/2017 | Final | J Moore | D Williams | 10/03/2017 |
| D0v9 | 15/05//2017 | Final – updated project description | J Moore | D Williams | 15/05//2017 |

## Contents

# 1. Introduction

## 1.1 Project background

Roads and Maritime is seeking approval to upgrade 16km of The Northern Road between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park (the project). The project generally comprises the following key features:

- A six-lane divided road between Mersey Road, Bringelly and Bradley Street, Glenmore Park (two general traffic lanes and a kerbside bus lane in each direction). The wide central median would allow for an additional travel lane in each direction in the future, if required
- An eight-lane divided road between Bradley Street, Glenmore Park and about 100 m south of Glenmore Parkway, Glenmore Park (three general traffic lanes and a kerbside bus lane in each direction separated by a median)
- About eight kilometres of new road between Mersey Road, Bringelly and just south of the existing Elizabeth Drive, Luddenham, to realign the section of The Northern Road that currently bisects the Western Sydney Airport site and to bypasses Luddenham
- About eight kilometres of upgraded and widened road between the existing Elizabeth Drive, Luddenham and about 100 m south of Glenmore Parkway, Glenmore Park
- Closure of the existing The Northern Road through the Western Sydney Airport site
- Tie-in works with the following projects:
  - The Northern Road Upgrade, between Peter Brock Drive, Oran Park and Mersey Road, Bringelly (to the south)
  - The Northern Road Upgrade, between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith (to the north)
- New intersections including:
  - A traffic light intersection connecting the existing The Northern Road at the southern boundary of the Western Sydney Airport, incorporating a dedicated u-turn facility on the western side
  - A traffic light intersection for service vehicles accessing the Western Sydney Airport, incorporating 160 m of new road connecting to the planned airport boundary
  - A traffic light intersection connecting the realigned The Northern Road with the existing The Northern Road (west of the new alignment) south of Luddenham
  - A 'give way' controlled intersection (that is, no traffic lights) connecting the realigned The Northern Road with Eaton Road (east of the new alignment, left in, left out only)
  - A four-way traffic light intersection formed from the realigned Elizabeth Drive, the realigned The Northern Road and the existing The Northern Road, north of Luddenham
  - A traffic light intersection at the Defence Establishment Orchard Hills entrance, incorporating a u-turn facility
- New traffic lights at four existing intersections:
  - Littlefields Road, Luddenham
  - Kings Hill Road, Mulgoa
  - Chain-O-Ponds Road, Mulgoa
  - Bradley Street, Glenmore Park incorporating a u-turn facility
- Modified intersection arrangements at:
  - Dwyer Road, Bringelly (left in, left out only)
  - Existing Elizabeth Drive, Luddenham (left out only)

- Gates Road, Luddenham (left in only)
- Longview Road, Luddenham (left in, left out only)
- Grover Crescent south, Mulgoa (left in only)
- Grover Crescent north, Mulgoa (left out only)

- Dedicated u-turn facilities at:
  - The existing The Northern Road at Luddenham, south-west of Elizabeth Drive
  - The existing Elizabeth Drive, Luddenham around 800 m east of The Northern Road
  - Chain-O-Ponds Road, Mulgoa
- Twin bridges over Adams Road, Luddenham
- Local road changes and upgrades, including:
  - Closure of Vicar Park Lane, east of the realigned The Northern Road, Luddenham
  - Eaton Road cul-de-sac, west of the realigned The Northern Road, Luddenham
  - Eaton Road cul-de-sac, east of the realigned The Northern Road, Luddenham
  - Elizabeth Drive cul-de-sac, about 300 m east of The Northern Road with a connection to the realigned Elizabeth Drive, Luddenham
  - Extension of Littlefields Road, east of The Northern Road, Mulgoa
  - A new roundabout on the Littlefields Road extension, Mulgoa
  - A new service road between the Littlefields Road roundabout and Gates Road, including a 'give way' controlled intersection (that is, no traffic lights) at Gates Road, Luddenham
  - Extension of Vineyard Road, Mulgoa between Longview Road and Kings Hill Road
  - A new roundabout on the Vineyard Road extension at Kings Hill Road, Mulgoa
- A new shared path on the western side of The Northern Road and footpaths on the eastern side of The Northern Road
- A new shared path on the western side of The Northern Road and footpaths on the eastern side of The Northern Road where required
- The upgrading of drainage infrastructure
- Operational ancillary facilities including:
  - Heavy vehicle inspection bays for both northbound and southbound traffic, adjacent to Grover Crescent, Mulgoa and Longview Road, Mulgoa respectively
  - An incident response facility on the south-western corner of the proposed four-way traffic light intersection at Elizabeth Drive, Luddenham
- New traffic management facilities including variable message signs (VMS)
- Roadside furniture and street lighting
- The relocation of utilities and services
- Changes to property access along The Northern Road (generally left in, left out only)
- Establishment and use of temporary ancillary facilities and access tracks during construction
- Property adjustments as required
- Clearance of undetonated explosive ordinance (UXO) within the Defence Establishment Orchard Hills as required.

The project assessed in this EIS does not include surveys, test drilling, test excavations, geotechnical investigations or other tests, surveys, sampling or investigation for the purposes of the design or assessment of the project.

The upgrade of The Northern Road is part of the Western Sydney Infrastructure Plan (WSIP). The WSIP involves major road and transport linkages that will capitalise on the economic gains from developing the Western Sydney Airport site at Badgerys Creek whilst boosting the local economy and liveability of western Sydney.

Jacobs Group (Australia) Pty Ltd (Jacobs) was commissioned by Roads and Maritime Services (Roads and Maritime) to undertake an assessment of the potential environmental impacts of the project, and prepare an Environmental Impact Statement (EIS) is accordance with the *Environmental Planning and Assessment Act 1979* (EP&A Act) that adequately addresses the *Secretary's Environmental Assessment Requirements* (SEARS) issued 9 March 2016 and the Commonwealth EIS Guidelines issued 5 August 2016. This document presents the results of the greenhouse gas (GHG) assessment for the project.

## 1.2 Location of project area

The Northern Road is about 45 km west of the Sydney central business district and traverses the local government areas of Penrith in the north and Liverpool in the south.

The Northern Road is a key north–south road between Narellan and Richmond, connecting the North West and South West Priority Growth Areas. The corridor intersects with a number of regional motorway, arterial and collector roads such as (north to south) Richmond Road, Great Western Highway, M4 Motorway, Elizabeth Drive, Bringelly Road, and Camden Valley Way.

South of Glenmore Parkway, the project area is surrounded by rural residential zoned land as well as pastures and grasslands. Land to the east of The Northern Road in this section is occupied by the Commonwealth Defence Establishment Orchard Hills. Further south, The Northern Road passes through the village of Luddenham (including a small number of residential and commercial properties), before continuing through agricultural grasslands to its junction with Mersey Road (the northern extent of The Northern Road Upgrade between Peter Brock Drive, Oran Park and Mersey Road, Bringelly).

A seven kilometre section of the existing The Northern Road alignment bisects the Western Sydney Airport site south-east of the Luddenham town centre. The location of the project is shown on Figure 1-1.

## 1.3 Aim and scope of assessment

The purpose of this report is to provide an assessment of potential GHG and Climate Change impacts associated with the construction and operational phases of the project. This report is intended to support the EIS being prepared to assess the overall environmental impacts associated with the project.

In achieving this purpose, the main objectives of this assessment were to:

- Identify relevant emissions sources/activities and undertake a construction energy and GHG assessment using Carbon Gauge
- Assess qualitatively operational energy and GHG emissions and provide recommendations for reducing GHG emissions.

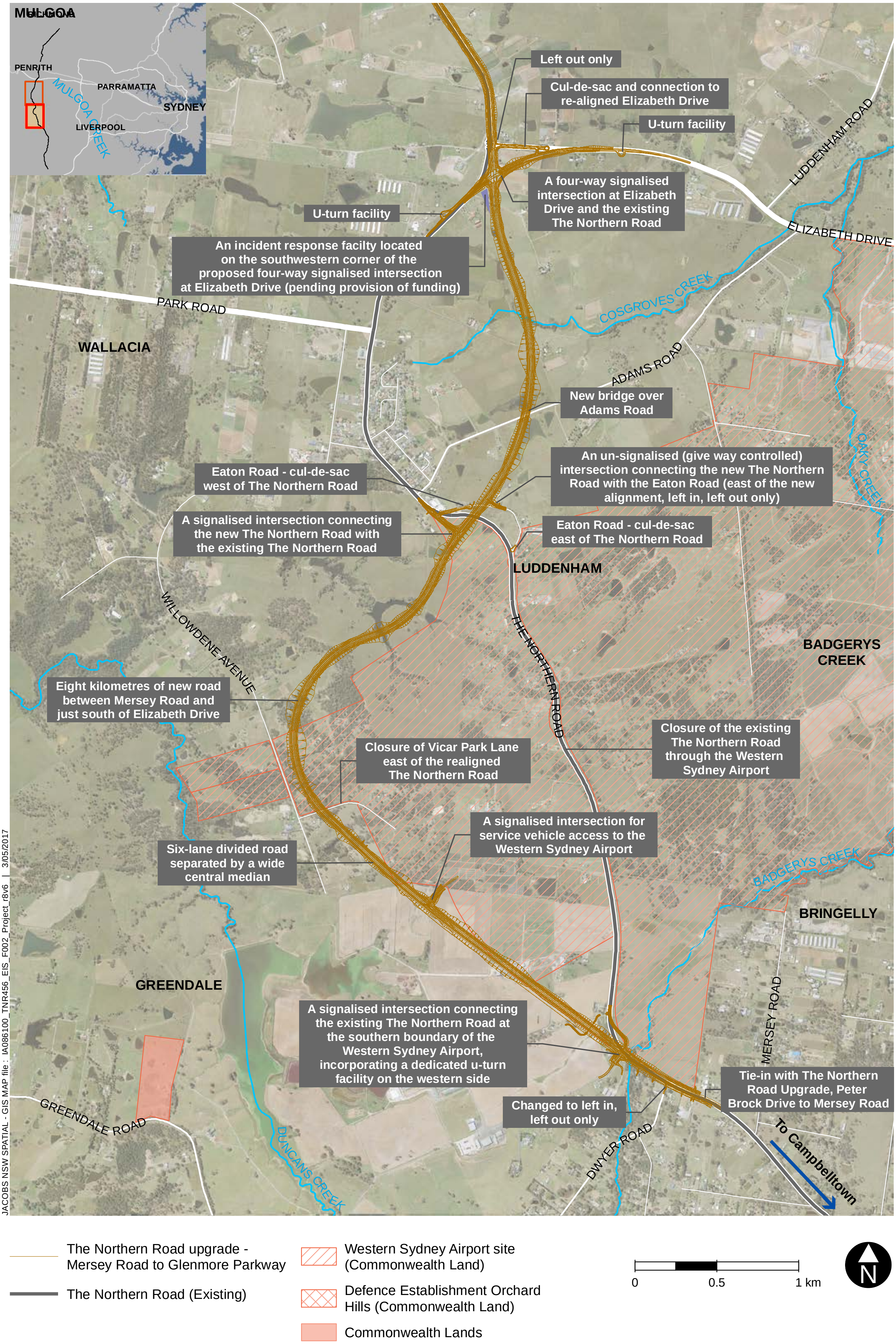
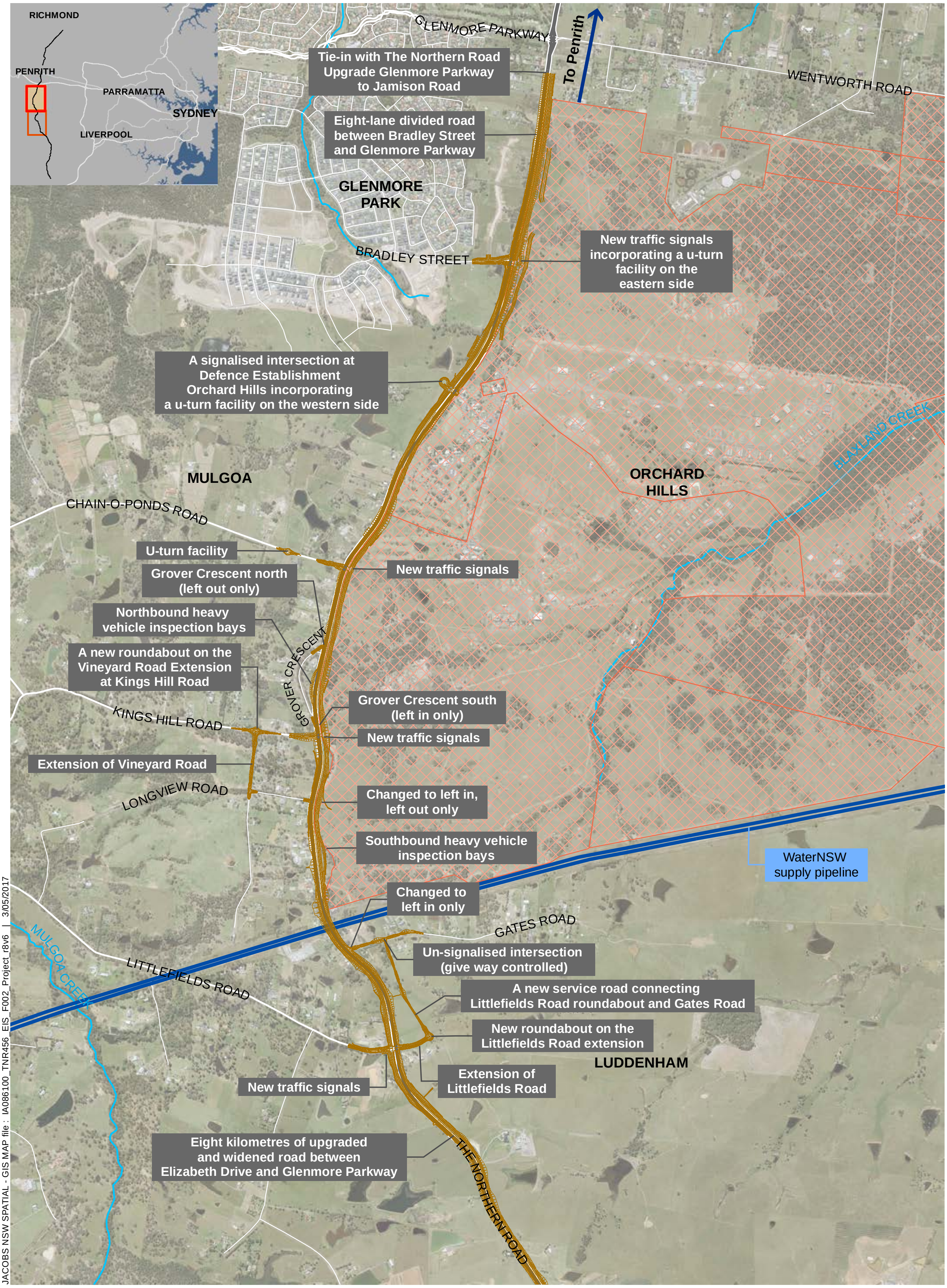



**Figure 1-1** | Overview of the project




The Northern Road upgrade - Mersey Road to Glenmore Parkway

The Northern Road (Existing)

WaterNSW supply pipelines

Western Sydney Airport site (Commonwealth Land)

Defence Establishment Orchard Hills (Commonwealth Land)

Commonwealth Lands

0 0.5 1 km

N

**Figure 1-1** | Overview of the project

# 2. Methodology

This section of the report describes the methods applied in this study to assess potential GHG impacts during construction and operational phases of the project.

## 2.1 Greenhouse gas accounting

Greenhouse gases is a collective term for a range of gases that are known to trap radiation in the upper atmosphere, where they have the potential to contribute to the greenhouse effect (global warming). Creating an inventory of the likely GHG emissions associated with a project has the benefit of determining the scale of the emissions and providing a baseline from which to develop and deliver GHG reduction options. GHGs include:

- Carbon dioxide ($CO_2$) – by far the most abundant, primarily released during fuel combustion
- Methane ($CH_4$) – from the anaerobic decomposition of carbon based material (including enteric fermentation and waste disposal in landfills)
- Nitrous oxide ($N_2O$) – from industrial activity, fertiliser use and production
- Hydrofluorocarbons (HFCs) – commonly used as refrigerant gases in cooling systems
- Perfluorocarbons (PFCs) – used in a range of applications including solvents, medical treatments and insulators
- Sulphur hexafluoride ($SF_6$) – used as a cover gas in magnesium smelting and as an insulator in heavy duty switch gear.

It is common practice to aggregate the emissions of these gases to the equivalent emission of carbon dioxide. This provides a simple figure for comparison of emissions against targets. Aggregation is based on the potential of each gas to contribute to global warming relative to carbon dioxide and is known as the global warming potential (GWP). The resulting number is expressed as carbon dioxide *equivalents* (or $CO_2e$).

The GHG inventory in this document is calculated in accordance with the principles of the GHG Protocol (GHG Protocol)[1]. The GHG emissions that form the inventory can be split into three categories known as 'Scopes'. Scopes 1, 2 and 3 are defined by the GHG Protocol and can be summarised as follows:

- **Scope 1** – Direct emissions from sources that are owned or operated by a reporting organisation (*examples – combustion of diesel in company owned vehicles or used in on-site generators*)
- **Scope 2** – Indirect emissions associated with the import of energy from another source (*examples – importation of electricity or heat*)
- **Scope 3** – Other indirect emissions (other than Scope 2 energy imports) which are a direct result of the operations of the organisation but from sources not owned or operated by them (*examples include business travel (by air or rail) and product usage*).

The initial action for a GHG inventory is to determine the sources of GHG emissions assess their likely significance and set a provisional boundary for the study.

[1] The Greenhouse Gas Protocol is collaboration between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The Protocol provides guidance on the calculation and reporting of carbon footprints.

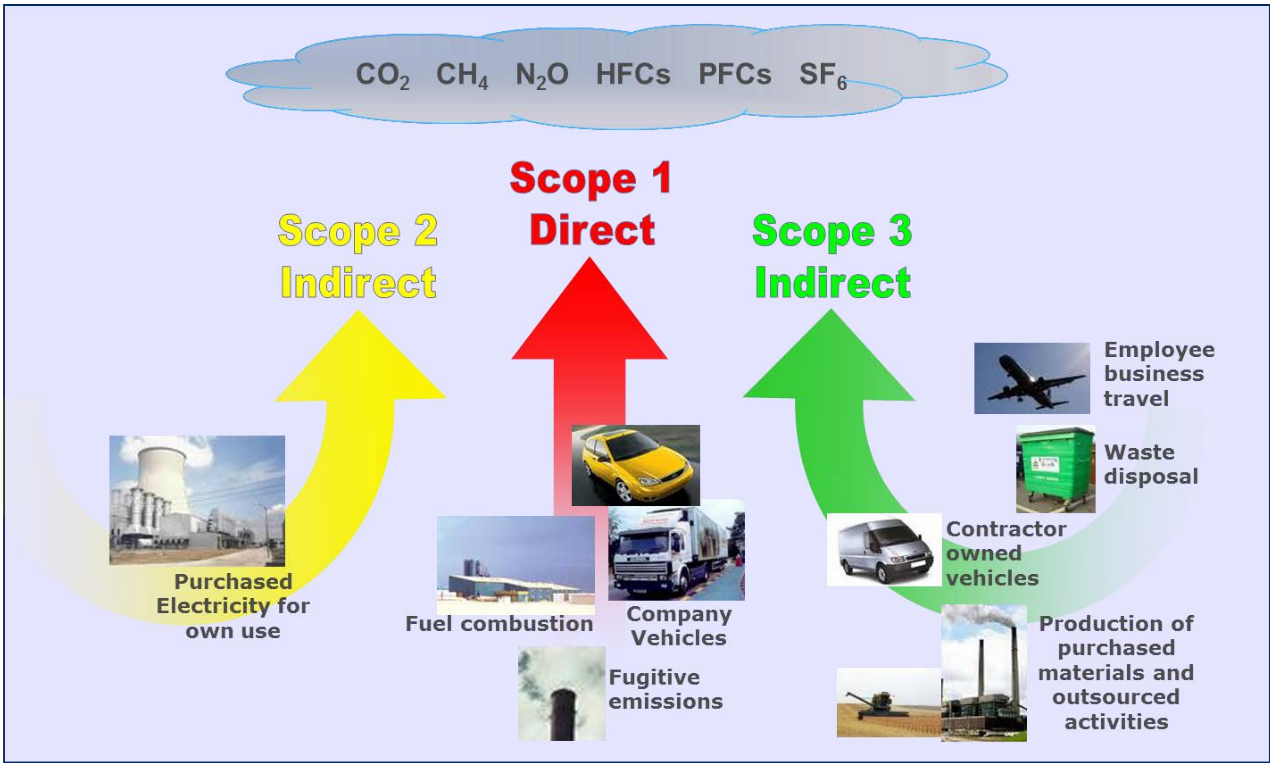



Figure 2-1 Sources of Greenhouse Gases - *Adapted from World Business Council for Sustainable Development – Greenhouse Gas Protocol*

The results of this study are presented in terms of the above-listed 'Scopes' to help understand the direct and indirect impacts of the project.

The GHG Protocol (and similar reporting schemes) dictates that reporting Scope 1 and 2 sources is mandatory, whilst reporting Scope 3 sources is optional. Reporting *significant* Scope 3 sources is recommended. Within this inventory, we have made an assessment of all (Scopes 1, 2 and 3) sources of GHG deemed significant to the implementation of the project.

## 2.2 Carbon Gauge

The tool used for the assessment of construction, and limited operational impacts was 'Carbon Gauge' – a tool which automates many of the calculations, assumptions and default GHG emissions factors presented in the *Greenhouse Gas Assessment Workbook for Road Projects,* Developed by the Transport Authorities Greenhouse Group.

This tool provides a framework for assessing the GHG emissions associated with road construction projects through the completion of a materiality assessment, and then provision of standard carbon emissions factors for activities typically undertaken. This allows the user to build a GHG profile through input of standard data on the length and area of pavement, road features included and cost of construction, amongst other, accessible data. Carbon Gauge has been used to determine the GHG emissions associated with construction, and some elements of the operation of the project (power for intersections and fuel / materials used in maintenance activities).

## 2.3 Tools for Roadside Air Quality (TRAQ)

TRAQ is a tool for modelling emissions from vehicles using roads, using input data on traffic numbers and type, average traffic speeds, numbers of lanes and standard emissions factors for road going vehicles. As well as standard air quality parameters (such as carbon monoxide, nitrous oxides and particulate matter) the tool also projects emissions of GHG. TRAQ was used to determine emissions associated with current and future operational road use, both with and without the project.

# 3. Existing environment

It is assumed for the base case GHG assessment that, as per other supporting studies, the 'do minimum' case is the realignment of The Northern Road to bypass Luddenham, and to avoid the area earmarked for the Western Sydney Airport, with no upgrades to the number of carriageways in each direction (i.e. remaining as single carriageways). This is taken as the representation of the existing environment for the purposes of GHG assessment.

With forecast growth in traffic numbers, traffic modelling suggests that this configuration would result in greater congestion, slowing average speeds and reducing the amount of traffic that can pass per unit time. This is shown in Table 3-1.

Table 3-1: Traffic numbers (both directions) for 'do minimum' case – year of opening (2021) and future year (2031).

| Operating scenario | Traffic / day |
|---|---|
| 2021 'do minimum' | 188,598 |
| 2031 'do minimum' | 183,400 |

Greenhouse gas emissions, modelled using TRAQ, take account of:

- The expected mix of road users (vehicle types)
- Traffic numbers
- Length of road
- Traffic average and peak speeds
- Road gradient.

The projections for 2021 and 2031 for the 'do minimum' scenario are presented in Table 3-2.

Table 3-2: Greenhouse Gas Emissions for 'do minimum' case – year of opening (2021) and future year (2031).

| Operating scenario | Total Emissions ($tCO_2e$) |
|---|---|
| 2021 'do minimum' | **20,756** |
| 2031 'do minimum' | **27,158** |

As can be seen in Table 3-1, although traffic numbers are projected to decrease as a result of congestion; GHG emissions are projected to increase. This is due to much slower speeds, greater congestion during peak periods and, therefore, lower efficiency of travel. The effective rate of carbon emissions for an average vehicle traversing sections of The Northern Road under the 'do minimum' case are shown in Table 3-3, which demonstrates this drop in fuel efficiency (and therefore greater emissions rate).

Table 3-3: Greenhouse Gas Emissions Efficiency for 'do minimum' case – year of opening (2021) and future year (2031).

| | The Northern Road Upgrade, Mersey Road to Eaton Road | The Northern Road Upgrade, Eaton Road to Littlefields Road | The Northern Road Upgrade, Littlefields Road to Glenmore Parkway |
|---|---|---|---|
| Greenhouse Gas Emissions 2021 $kgCO_2e$ / vehicle | 0.33 | 0.36 | 0.27 |
| Greenhouse Gas Emissions 2031 $kgCO_2e$ / vehicle | 0.68 | 0.53 | 0.29 |

# 4. Policy Setting

## 4.1 Kyoto Protocol and COP21

On 3 December 2007, the former Australian Prime Minister, Kevin Rudd, signed the instrument of ratification of the Kyoto Protocol. Australia has met its Kyoto Protocol target of limiting emissions to 108 per cent of 1990 levels, on average, over the Kyoto period 2008–2012. Over the five reporting years in the Kyoto period (2008 to 2012), Australia’s net emissions averaged 104 per cent of the base year level (DoE 2014). As such, Australia has committed to meeting its Kyoto Protocol long term target, and has set a target to reduce GHG emissions by 60 per cent on 2000 levels by 2050.

Additionally, as a medium target the Government has committed to reduce Australia’s carbon pollution to 25 per cent below 2000 levels by 2020 if the world agrees to an ambitious global deal to stabilise levels of GHGs in the atmosphere at 450 parts per million $CO_2$ equivalent or lower. This will maximise Australia’s contribution to an ambitious outcome in international negotiations. If the world is unable to reach agreement on a 450 parts per million target; Australia will still reduce its emissions by between 5 and 15 per cent below 2000 levels.

Following the 2015 Paris Climate Conference (COP21), international agreements were made to:

- Keep global warming well below 2.0 degrees Celsius, with an aspirational goal of 1.5 degrees Celsius
- From 2018, countries are to submit revised emission reduction targets every 5 years, with the first being effective from 2020, and goals set to 2050
- Define a pathway to improve transparency and disclosure of emissions
- Make provisions for financing the commitments beyond 2020.

It is yet to be determined how Australia will deliver these commitments in detail.

## 4.2 National Greenhouse and Energy Reporting Act 2007

The Federal Government uses the National Greenhouse Gas and Energy Reporting (NGER) legislation for the measurement, reporting and verification of Australian GHG emissions. This legislation is used for a range of purposes, including being used for international GHG reporting purposes. Corporations which meet the thresholds for reporting under NGER must register and report their GHG emissions.

Under the NGER Act, constitutional corporations in Australia which exceed thresholds for GHG emissions or energy production or consumption are required to measure and report data to the Clean Energy Regulator on an annual basis. The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* identifies a number of methodologies to account for GHGs from specific sources relevant to the project. This includes emissions of GHGs from direct fuel combustion (fuels for transport energy purposes), emissions associated with consumption of power from direct combustion of fuel (e.g. diesel generators used during construction), and from consumption of electricity from the grid.

## 4.3 Emissions Reduction Fund (ERF)

Previous legislation passed by the Australian Government to reduce carbon emissions was the *Clean Energy Act 2011*. This legislation established an Emissions Trading Scheme (ETS) or carbon price. Under this ETS, approximately 370 companies were required to purchase a permit for every tonne of carbon equivalent they emit.

The *Clean Energy Legislation (Carbon Tax Repeal) Act 2014* repealed the *Clean Energy Act 2011*. This abolished the carbon pricing mechanism from 1 July 2014, and is replaced with the Australian Government’s Direct Action Plan, which aims to focus on sourcing low cost emission reductions. The Direct Action Plan includes an Emissions Reduction Fund (ERF); legislation to implement the ERF came into effect on 13

December 2014, and is now considered to be the centrepiece of the Australian Government's policy suite to reduce emissions.

Emissions reduction and sequestration methodologies are available under the ERF which could provide the project with the opportunity to earn carbon credits as a result of emissions reduction activities.

## 4.4 NSW Long Term Transport Master Plan

The NSW Long Term Transport Master Plan includes commitments from the NSW State Government regarding “air quality, efficiency of energy use and reducing GHG emissions”. Commitments include: Development of an electric vehicles road map;

- Consider the air quality of transport projects
- Restructure motor vehicle registration charges.

Specifically this last point involves incentivising uptake of lower emissions vehicles through provision of lower registration charges for such vehicles.

## 4.5 Roads and Maritime policy

The *Roads and Maritime Environmental Sustainability Strategy 2015-19* outlines sustainability objectives in nine key focus areas. These areas focus on priority environmental issues that it has the opportunity to address through its actions, including:

- Climate change resilience
- Air quality
- Energy and carbon management
- Sustainable procurement
- Resource use and waste management
- Pollution control
- Biodiversity
- Heritage
- Liveable communities.

With respect to Energy and Carbon Management, an objective has been set to ‘Minimise energy use and reduce GHG emissions without compromising the delivery of services to our customers’. Delivered through the energy hierarchy, this includes performance metrics such as:

- Energy use by Roads and Maritime in buildings and in operation of the road network
- Energy ratings for larger offices
- Total GHG emissions
- Proportion of energy sourced from renewable sources.

Performance against these metrics is reported annually by Roads and Maritime.

# 5. Potential impacts

The project involves the upgrade and realignment of existing road to allow a greater number of vehicles to travel with greater efficiency. The potential impacts associated with this activity include GHG emissions associated with the construction of the upgrade and realignment, and the change in GHG emissions associated with its operation, both in absolute and relative terms.

The activity data and resulting emissions associated with construction and operation of the project are described in the following sections.

## 5.1 Construction

Greenhouse gas emissions from the following activities were modelled to identify the potential impacts as a result of construction of the project:

- Plant and Equipment Fuel (construction, earthworks)
- Embedded emissions in materials used in pavement (road, bicycle path, footpath and median)
- Embedded emissions in materials used in structures
- Embedded emissions in materials used in drainage.

Impacts associated with fuel consumption for vegetation removal were not included as they do not trip the materiality threshold within Carbon Gauge (clearance at 44.3Ha (443,000m$^2$) is less than 60% of the total pavement area (801,985m$^2$ for asphalt alone)). Greenhouse gas emissions associated with the loss of the vegetation itself is included.

For each of these areas, Carbon Gauge was used to determine the potential impacts, using standard emissions factors for road construction activities, referencing a relevant unit of activity. The activity data is presented in **Table 5-1**.

Table 5-1: Activity Data – Construction Greenhouse Gas Assessment

| Activity | Totals |
|---|---|
| Estimated Value | $519 Million |
| Construction Duration (Months) | 30 |
| Plant Equipment Fuel | 100% Diesel |
| Concrete Footpaths | 20,865 m$^2$ |
| Bike Path – concrete | 48,435 m$^2$ |
| Median and traffic island infill | 8,870 m$^2$ |
| Full Depth Asphalt * | 801,985 m$^2$ |
| Bridges – Precast Concrete | (1) 0.04 km long, 49m wide, (2) 0.078 km long, 50m wide |
| Median Kerb, Type 2 | 39.087 km |
| Median Kerb, Type 5 | 8.813 km |
| Small <450 RCP | 23.885 km |
| Medium 450 - 750 RCP | 14.871 km |
| Large 750 - 1200 RCP ** | 11.105 km |
| Strip and respread topsoil | 126,916 m$^3$ |
| Cut to spoil | 136,630 m$^3$ |
| Cut to fill | 904,694 m$^3$ |
| Import and place filling | 461,491 m$^3$ |
| Vegetation Clearance | 44.3 Ha (26.1 Ha classified as ‘Open Forest’ and 18.2 Ha classified as ‘Grassland’) |

* Note includes a range of asphalt types broadly classified in Carbon Gauge as ‘Full Depth Asphalt’

** Note includes some drains larger than this, but Carbon Gauge has a maximum size of 1200 x 600.

The GHG emissions associated with the activity data presented Table 5-1 are presented in Table 5-2 and Figure 5-1.

Table 5-2: Greenhouse Gas Emissions by Scope and Activity – Construction

| | Scope 1 ($tCO_2e$) | Scope 2 ($tCO_2e$) | Scope 3 ($tCO_2e$) | Total ($tCO_2e$) |
|---|---|---|---|---|
| Fuel Combustion – site vehicles | 785 | | 61 | **846** |
| Fuel Combustion – Plant & Equipment | 27,780 | | 2,125 | **29,905** |
| Fuel Combustion – Demolition and Earthworks | 8,626 | | 659 | **9,285** |
| | | | | |
| Material Usage – Aggregate | | | 4,656 | **4,656** |
| Material Usage – Concrete | | | 5,242 | **5,242** |
| Material Usage – Cement | | | 3,670 | **3,670** |
| Material Usage – Steel | | | 3,208 | **3,208** |
| Material Usage – Bitumen | | | 16,269 | **16,269** |
| | | | | |
| Vegetation Removal | 15,874 | | | 15,874 |
| Total | **53,065** | | **35,890** | **88,955** |

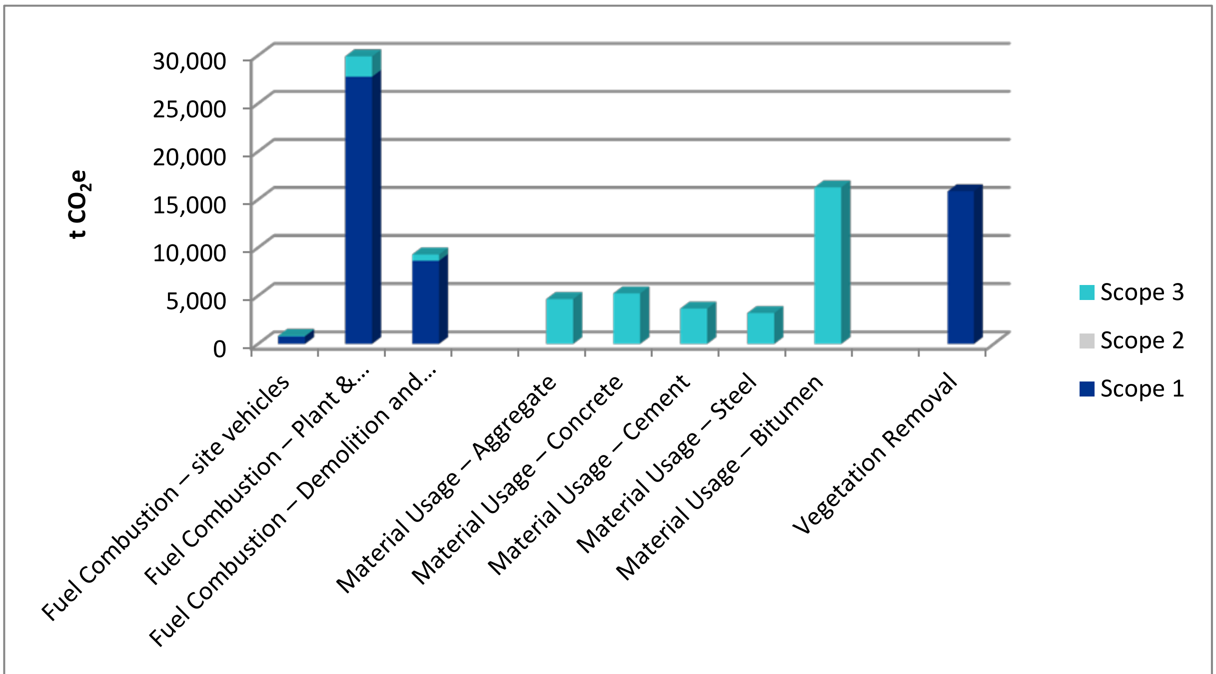



Figure 5-1 Greenhouse Gas Emissions by Scope and Activity – Construction Greenhouse Gas Assessment

Table 5-2 and Figure 5-1 show that the construction of the project is expected to generate approximately 89 ktCO2e. Of this, the greatest proportion if related to the combustion of fuel for on-site construction plant and equipment. The use of bitumen as part of the asphalting process is the second largest contributor, followed by vegetation removal.

## 5.2 Operation and maintenance

Greenhouse gas emissions from the following activities were modelled as part of the operation of the project over a period of 50 years:

- Electricity consumption for powering intersections

- Fuel and material consumption for maintenance activities
- Fuel consumption from road traffic using the project.

Carbon Gauge was used to project emissions relating to energy consumption for operation of intersections and fuels / materials usage in undertaking maintenance activities.

Table 5-3: Carbon Gauge Activity Data – Operation Greenhouse Gas Assessment

| Activity | Totals |
|---|---|
| Street Lighting | Full Lighting on 11.5km, 20% lighting on 4.5km |
| Major Urban Intersections – Divided road | 7 (Number) |
| Arterial road with Divided road (Full diamond Interchange) | 1 (Number) |

TRAQ was used to determine emissions associated with road traffic. TRAQ models were run for two 'do minimum' scenarios and two 'with project' scenarios – 2021 (year of opening) and 2031 (future year). These 'with project' scenarios correspond to the same periods as the 'do minimum' scenarios to facilitate direct comparison.

The project would allow for a greater number of vehicles to use the upgraded road – with fewer stop / starts, less congestion and a greater average speed. Expected vehicle numbers are presented in Table 5-4 alongside vehicle numbers for the 'do minimum' scenario:

Table: 5-4 Traffic numbers (both directions) for 'do minimum' and 'with project' cases – year of opening (2021) and future year (2031).

| Operating scenario | Traffic / day |
|---|---|
| 'do minimum' 2021 | 188,598 |
| 'with project' 2021 | 214,312 |
| 'do minimum' 2031 | 183,400 |
| 'with project' 2031 | 322,449 |

Table 5-4 shows that traffic volumes for the project are expected to be higher than the 2021 'do minimum' scenario, with slight increases forecast for year of opening (2021), and substantial increases in the future year (2031). The project allows for an almost doubling of traffic numbers over the 10 year period post opening.

Table 5-5 presents the GHG emissions associated with these traffic numbers, including both 'do minimum' and 'with project' results. These results are calculated from data on traffic speeds, gradients and traffic mix types, as well as the numbers of vehicles.

Table 5-5 Greenhouse Gas Emissions for 'do minimum' and 'with project' cases – year of opening (2021) and future year (2031).

| Operating scenario | Greenhouse Gas Emissions $tCO_2e/y$ |
|---|---|
| 'do minimum' 2021 | **20,756** |
| 'with project' 2021 | **23,430** |
| 'do minimum' 2031 | **27,158** |
| 'with project' 2031 | **33,168** |

Table 5-5 shows that a small increase in GHG emissions from the 'do 'minimum scenario' is expected on year of opening (2021), and a large increase in GHG emissions is expected from the future year 'do minimum' scenario (2031). This is directly associated with the substantial increase in traffic numbers using the project. The greatest increase is related to the 2031 ‘with project’ scenario, and is directly related to the large increase in traffic using the project over the other scenarios.

Table 5-6 shows the GHG efficiency of vehicles using the project compared to the ‘do minimum’ scenario. The annual GHG projections are divided by the number of vehicles using the project in the representative year.

Table 5-6: Greenhouse Gas Emissions Efficiency for ‘do minimum’ and ‘with project’ cases – year of opening (2021) and future year (2031).

| | The Northern Road Upgrade, Mersey Road to Eaton Road | The Northern Road Upgrade, Eaton Road to Littlefields Road | The Northern Road Upgrade, Littlefields Road to Glenmore Parkway |
|---|---|---|---|
| ‘do minimum’ Greenhouse Gas Emissions 2021 $kgCO_2e$ / vehicle | 0.33 | 0.36 | 0.27 |
| ‘with project’ Greenhouse Gas Emissions 2021 $kgCO_2e$ / vehicle | 0.39 | 0.35 | 0.25 |
| ‘do minimum’ Greenhouse Gas Emissions 2031 $kgCO_2e$ / vehicle | 0.68 | 0.53 | 0.29 |
| ‘with project’ Greenhouse Gas Emissions 2031 $kgCO_2e$ / vehicle | 0.33 | 0.33 | 0.25 |

Table 5-6 shows that under the ‘do minimum’ scenario, the GHG efficiency, derived from fuel efficiency, is expected to drop on all sections. Between Mersey Road and Littlefields Road, this is expected to drop substantially as a result of increased congestion.

Under the ‘with project’ scenario, GHG efficiency is projected to stay relatively similar to the ‘do minimum’ scenario at year of opening, both in 2021 and 2031. This represents traffic which is able to flow freely, greatly improving fuel efficiency.

Table 5-7 and Figure 5-2 present the emissions associated with operation of the project over a 50 year timeframe. Emissions from road traffic have been assumed to be a linear interpolation between results for 2021 and 2031, with the remaining years of operation assumed to be constant at the 2031 level. In reality, it is likely that a wide range of other factors, such as fuel efficiency of vehicles, ongoing development of the region and environmental pressures would substantially affect this assumption.

Table 5-7: Emissions Data – Operational Greenhouse Gas Assessment (50 years)

| | Mersey Road to Glenmore Parkway ($tCO_2e$) |
|---|---|
| Operation – Intersections | **12,699** |
| Operation – Street Lighting | **14,748** |
| Operation – Maintenance | **25,578** |
| Operation – Road Traffic | **1,735,836** |
| **Total** | **1,788,861** |

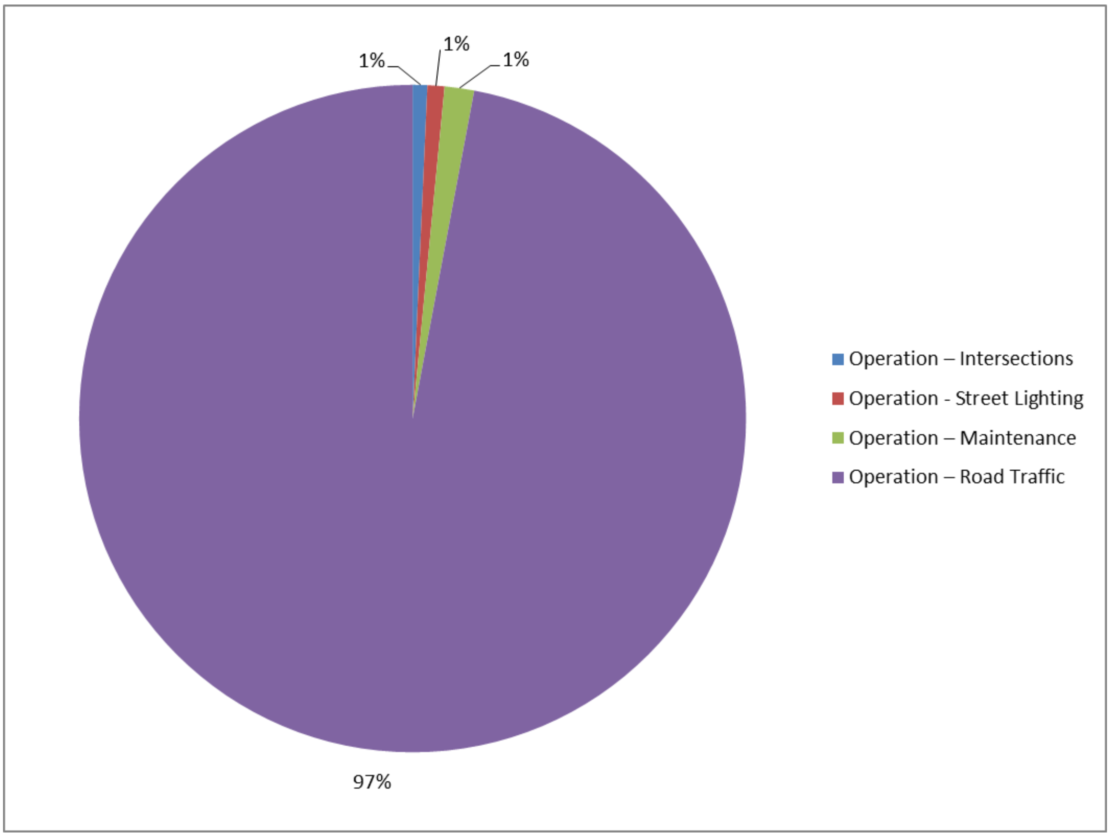



Figure 5-2: Greenhouse Gas Emissions by Source – Operation Greenhouse Gas Assessment

Road traffic usage of the project is, as expected, the greatest contributor to the operational GHG inventory, forming 97 per cent of emissions. The total emissions from road traffic of the 'with project' over 50 years post year of opening are 1,736 kt$CO_2$e, which compares to 1,326 kt$CO_2$e for the 'do minimum' scenario. This is as a result of the greater number of vehicles moving through the road network in comparison to the 'do minimum' scenario. A summary of the operation emissions projection (50 Years) by GHG scope is presented in Table 5-8.

Table 5-8: Emissions Data – Operational Greenhouse Gas Assessment (50 years) by Scope

| | Scope 1 | Scope 2 | Scope 3 | Total |
|---|---|---|---|---|
| Operation – Intersections | | 12,699 | | **12,699** |
| Operation – Street Lighting | | 14,748 | | **14,748** |
| Operation – Maintenance | 19,129 | | 6,449 | **25,578** |
| Operation – Road Traffic | 1,735,836 | | | **1,735,836** |
| **Total** | **1,754,965** | **27,447** | **6,449** | **1,788,861** |

## 5.3 Summary

A summary of the emissions from construction and operation of the project is presented in Table 5-9, Figure 5-3 and Figure 5-4.

Table 5-9: Greenhouse Gas Emissions by Scope and Activity – Construction and Operation Summary

| | Scope 1 | Scope 2 | Scope 3 | Total |
|---|---|---|---|---|
| Construction – Fuel Combustion | 37,191 | | 2,845 | **40,036** |
| Construction – Material Usage | | | 33,045 | **33,045** |

| | Scope 1 | Scope 2 | Scope 3 | Total |
|---|---|---|---|---|
| Construction – Vegetation Removal | 15,874 | | | **15,874** |
| *Construction – Subtotal* | *53,065* | | *35,890* | ***88,955*** |
| Operation – Intersections | | 12,699 | | **12,699** |
| Operation – Street Lighting | | 14,748 | | **14,748** |
| Operation – Maintenance | 19,129 | | 6,449 | **25,578** |
| Operation – Road Traffic | 1,735,836 | | | **1,735,836** |
| *Operation - Subtotal* | *1,754,965* | *27,447* | *6,449* | **1,788,861** |
| **Total – Construction and Operation (50 years)** | **1,808,030** | **27,447** | **42,339** | **1,877,816** |

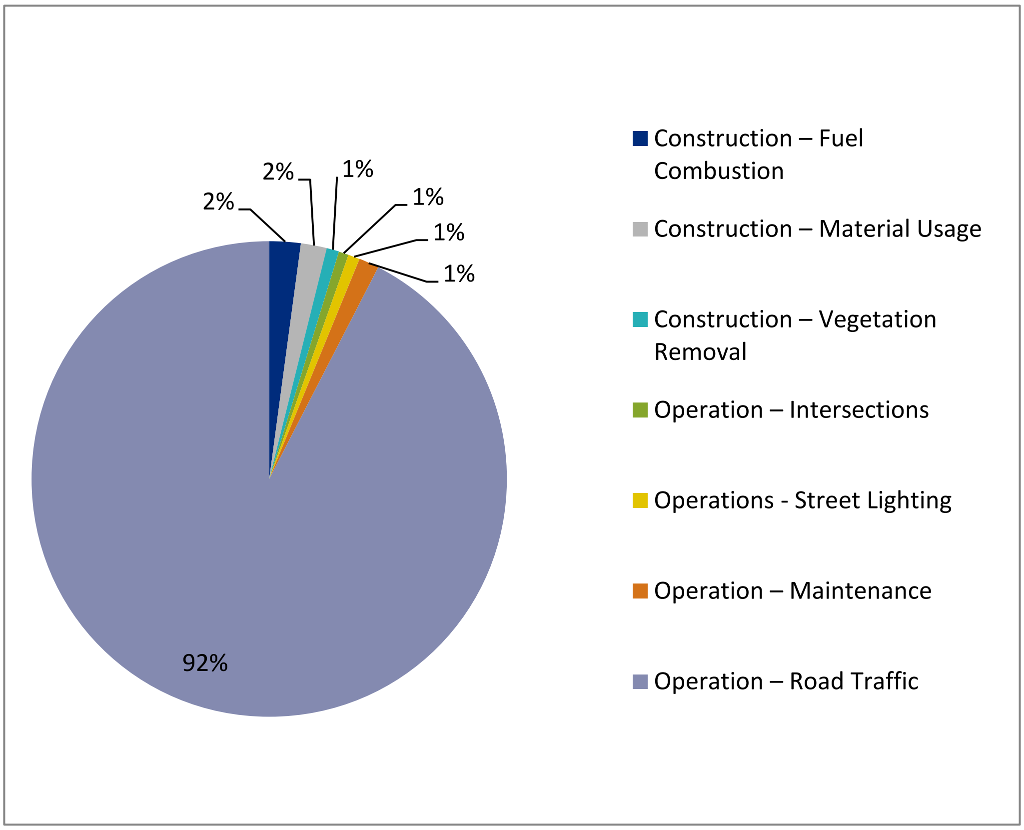



Figure 5-3: Greenhouse Gas Emissions –Construction and Operations Summary

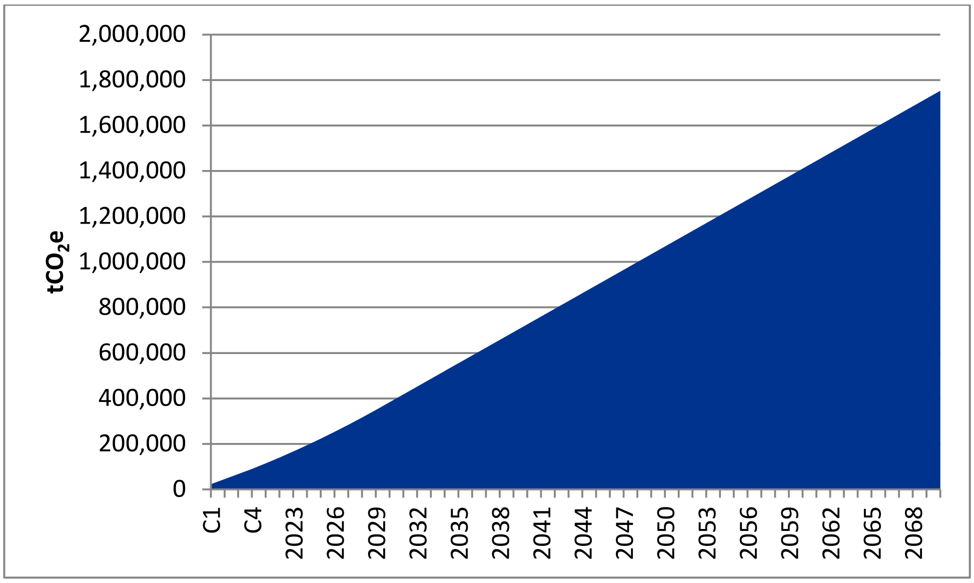



Figure 5-4: Greenhouse Gas Emissions – Cumulative Construction and Operations Profile

Construction emissions of 89kt$CO_2$e are split over approximately 4 years of construction (22kt$CO_2$e / year). This represents 0.016 per cent of the NSW state emissions (2012/13 emissions[2] of 141.8 million tonnes $CO_2$e).

[2] http://www.climatechange.environment.nsw.gov.au/About-climate-change-in-NSW/NSW-emissions

# 6. Safeguards and management measures

## 6.1 Expected environmental outcomes

Road traffic emissions for the project dominate the combined construction and operational GHG inventory when assessed over a 50 year period. Further, road traffic emissions are forecast to grow substantially from the current level due to land use changes, the Western Sydney Airport. However, due to improvements in road layout and widening, the efficiency of cars traversing the project area is forecast to improve.

This, as well as analysis of the benefits of fuel efficiency as presented in Table 5-5 suggests that efforts during design and construction to support the free flow of traffic along the project is likely to have life cycle benefits gained during operation. This is supported by the project in efforts to:

- Widen the existing road to reduce congestion
- Reduce the extent to which the road changes grade
- Limit the number of intersections and turning lanes at which traffic needs to stop and start
- Support free flowing intersections with other major roads (such as the M12).

Additional measures for consideration during the design process include:

- Use of LED and low energy equipment for signals and signage
- Consideration of options for installation of renewable energy generation (small scale wind or solar photovoltaics) to power electronic equipment.

Construction management measures are commonly applied within the industry to lessen the GHG impact (and improve energy efficiency) of construction. Construction GHG management measures to be considered in later stages of design include:

- Identify recycled materials (such as recycled aggregates in road pavement and surfacing; steel with recycled content) for use in construction or operation of the project where they are cost, quality and performance competitive
- Use of modern diesel engine equipment, to ensure highest fuel efficiency ratings
- Specification of the use of biofuels, or biofuel blends in construction plant and equipment
- Provision of clear guidance to construction staff on equipment start up and shut down procedures to ensure that they are not left idling when not in use
- Review of cut and fill balances for earthworks to ensure material is transported the least possible distances
- Review of local options for import and export of fill materials as needed to reduce excess fuel used during transport
- Specification and certification of steel from recycled sources where suitable for offsetting virgin steel
- Specification of materials with low embodied energy / embodied GHG content, such as:
  - Replacement of Portland cement in concrete mixes with low carbon alternatives such as fly-ash
  - Use of warm mix asphalt versus hot mix
- Resource and Waste Management Plan (RWMP) would be prepared to maximise re-use and recycling of construction and demolition waste.

## 6.2 Expected effectiveness

Roads and Maritime have experience in managing potential greenhouse gas impacts as a result of road developments of similar scale and scope to this project. A construction environment management plan (CEMP) would be prepared as part of the project, and this would detail those greenhouse gas mitigation measures to be implemented through construction stages. Audits and reporting of the effectiveness of environmental management measures is generally carried out to show compliance with management plans and other relevant approvals and would be outlined in detail in the CEMP prepared for the project.

## 6.3 Residual impacts

The project, by its nature, would result in the generation of GHG emissions particularly from road traffic usage. As such, regardless of the implementation of the management measures above, the project would result in residual GHG impacts.

Residual impacts from construction include:

- Impacts associated with the loss of carbon sink through removal of vegetation for construction of the project. Areas cleared for site compounds, and those associated with embankments are likely to be revegetated where appropriate. However, areas of removed vegetation that will be paved as part of the project will remain unvegetated. Whilst the removal of the carbon sink represents a one-off emissions event, there will also be a small ongoing loss of carbon sink as the removed vegetation will not be able to sequester carbon. This impact is relatively minor as the removed vegetation is mature forest and grassland, both of which have lower sequestration potential (than younger forest, or recently converted grassland).

Post construction – residual impacts will include:

- Road traffic usage – the emissions of greenhouse gases from road vehicles using the project. It could reasonably be expected that the energy efficiency (and emissions intensity) of road traffic will improve over the life of the project, and as such the forecast emissions forecast will be lower than projected. This source of emissions will however likely remain by far the largest and most substantial for the project;
- Electricity consumption – ongoing emissions associated with the generation of electricity to power signals and signs within the project. It should be noted that within the assessment that these emissions are based on emissions rates for current power generation. Future power generation is likely to be lower in emissions intensity, and as such the forecasts may be lower than expected;
- Minor impacts associated with maintenance activities.