



Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Appendix B – Operational traffic modelling technical report

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GLOSSARY OF TERMS AND ACRONYMS

Term / Acronym	Definition
Beaches Link	Component of the project which includes twin tolled motorway tunnels connecting the Warringah Freeway and the Western Harbour Tunnel at Cammeray and the Gore Hill Freeway at Artarmon to the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Killarney Heights, and an upgrade of Wakehurst Parkway.
CBD	Central Business District
'Do minimum'	An operational traffic model scenario that does not include the proposed project infrastructure.
'Do something'	An operational traffic model scenario that includes the proposed project infrastructure with NorthConnex, WestConnex, Beaches Link and Gore Hill Freeway Connection and Warringah Freeway Upgrade projects but without Western Harbour Tunnel, Sydney Gateway and M6 Motorway (Stage 1) projects. Also includes Sydney Metro City & Southwest and Northern Beaches Hospital road upgrade project. Also referred to as the 'project only' scenario.
'Do something cumulative'	An operational traffic model scenario that includes the proposed project infrastructure with NorthConnex, WestConnex, Western Harbour Tunnel and Warringah Freeway Upgrade, Beaches Link and Gore Hill Freeway Connection, Sydney Gateway and M6 Motorway projects 2, 3. Also includes Sydney Metro City & Southwest and Northern Beaches Hospital road upgrade project. Also referred to as the 'cumulative projects' scenario.
DPIE	New South Wales Department of Planning, Industry and Environment
Gore Hill Freeway Connection	Component of the project which includes the connection and integration works along the existing Gore Hill Freeway at Artarmon.
Hr	Hour
Km	Kilometres
LoS	Level of service
Project	Beaches Link and Gore Hill Freeway project (subject to this preferred infrastructure report)
PTPM	Public Transport Planning Model
SCATS	Sydney Coordinated Adaptive Traffic System
Sec	Seconds
SMPM	Sydney Motorway Planning Model
Strategic road network	The higher-order roads in the network that primarily serve a movement function connecting cities, ports, airports and other places of importance. The strategic road network is usually comprised of motorways and arterial roads generally used for long-distance travel.
Transport for NSW	Transport for New South Wales
Unreleased trips (or demand)	Traffic demand that goes unserved during the peak period.
Veh	Vehicles

GLOSSARY OF TERMS AND ACRONYMS

Term / Acronym	Definition
VHT	Vehicle hours travelled
VISSIM	Name of the software package used for operational traffic modelling.
VKT	Vehicle kilometres travelled
Warringah Freeway Upgrade	Part of the Western Harbour Tunnel and Warringah Freeway Upgrade project – upgrade of the Warringah Freeway beginning immediately north of the Sydney Harbour Bridge through to Willoughby Road, Crows Nest.
Western Harbour Tunnel	Part of the Western Harbour Tunnel and Warringah Freeway Upgrade project – tunnel between the Rozelle interchange, Rozelle and the Warringah Freeway, North Sydney.
Western Harbour Tunnel and Beaches Link program	Program of works that considers the Western Harbour Tunnel and Warringah Freeway Upgrade project, and the Beaches Link and Gore Hill Freeway Connection project.

1. INTRODUCTION

1.1. Background

The Beaches Link and Gore Hill Freeway Connection project would, by providing a new underground motorway bypass of the Military Road/Spit Road (A8) and Warringah Road (A38)/Eastern Valley Way corridors, substantially improve journey times and trip reliability for millions of freight vehicles, public transport users and other road users who rely on these transport links each year. The environmental impact statement indicates that some intersections in the vicinity of the project's surface connections would experience localised delays during operation. However, it also identifies that the substantial broader network benefits of the project would offset localised delays for the majority of road users; benefits and impacts are illustrated holistically throughout the environmental impact statement (in particular Appendix F (Technical working paper: Traffic and transport) and Chapter 9 (Operational traffic) of the environmental impact statement) by network speeds and corridor travel times. While there may be some localised intersection impacts in some instances, in many cases intersections in the network are expected to experience improved performance. In any one journey, it is likely that a customer would travel through several intersections, not just one, and this reinforces the need to consider traffic performance holistically (ie through network metrics and corridor travel times) rather than in isolation.

Following exhibition of the environmental impact statement in December 2020, GTA now Stantec was engaged by Transport for NSW to carry out additional operational traffic modelling analysis and assessment to address concerns raised by the NSW Department of Planning, Industry and Environment regarding the assessment of localised road network performance within the project study areas – Warringah Freeway and surrounds, Gore Hill Freeway and Artarmon, Balgowlah and surrounds and Frenchs Forest and surrounds.

This technical report has been prepared to inform the preferred infrastructure report in response to the Department of Planning, Industry and Environment's concerns by providing additional clarity on the environmental impact statement operational traffic modelling outcomes or identifying potential further opportunities to improve localised operational traffic performance outcomes. Details on the operational traffic modelling approach for the various study areas has been provided in Section 2 of this report while Section 3 and Section 4 presents the road performance outcomes for the respective project 2037 ('Do something') and cumulative projects 2037 ('Do something cumulative') scenarios.

1.2. Department of Planning, Infrastructure and Environment traffic and transport comments

As part of the Department of Planning, Industry and Environment environmental impact statement review, the Department of Planning, Industry and Environment requested Transport for NSW to carry out additional analysis and provide additional information to confirm any potential impacts to individual intersections due to the delivery of the project, and on how any impacts would be managed:

"Identify local road intersections impacted by traffic changes as a result of the operation of the project; consider and assess the impact of those changes and identify measures to mitigate the impacts."

To address this requirement, additional review and assessment of the environmental impact statement operational traffic models has been carried out, including additional modelling (where considered

necessary) to further refine the operational traffic models and/or provide further clarity on the modelling outcomes, including potential localised intersection performance benefits/impacts as a result of the project.

Table 1.1 outlines the specific items which have been considered in this technical report to address the Department of Planning, Industry and Environment’s concerns and to inform the preferred infrastructure report.

Table 1.1: Summary of Department of Planning, Industry and Environment traffic and transport preferred infrastructure report requirements

Item	Description
1	Detailed assessment of potential impacts from the project on the local road network.
2	Demonstrate that the project would achieve no worsening of average delays at the critical locations listed in Item 3 and identify any additional mitigation works required.
3	Further information and localised traffic impact assessment, including traffic signal optimisation and traffic modelling, and consideration of mitigation to address impacts to non-project traffic is required to be assessed during peak traffic periods for the following locations: <ul style="list-style-type: none"> • Warringah Freeway and surrounds study area <ul style="list-style-type: none"> ○ Amherst Street: West Street to Miller Street ○ Ernest Street: Merlin Street to Miller Street ○ Miller Street: Falcon Street to Pacific Highway ○ Brook Street: Merrenburn Avenue to Chandos Street • Gore Hill Freeway and Artarmon study area <ul style="list-style-type: none"> ○ Reserve Road: Barton Road to Dickson Avenue • Balgowlah and surrounds study area <ul style="list-style-type: none"> ○ Sydney Road: Frenchs Forest Road to Wanganella Street • Frenchs Forest and surrounds study area <ul style="list-style-type: none"> ○ Frenchs Forest Road East: Warringah Road to Wakehurst Parkway ○ Frenchs Forest Road West: Wakehurst Parkway to Gladys Avenue ○ Warringah Road: Hilmer Street to Frenchs Forest Road.
4	For the Reserve Road and Sydney Road locations identified in Item 3, provide clarification on the high reported average delays (ie “>100” second average delay) for the 2037 ‘Do something’ and 2037 ‘Do something cumulative’ scenarios.

1.3. Operational traffic modelling objectives

The objectives of the operational traffic modelling assessment to inform the preferred infrastructure report in response to the Department of Planning, Industry and Environment comments are outlined as follows:

- To provide further evidence that the environmental impact statement operational traffic modelling demonstrates that the traffic performance of the Beaches Link and Gore Hill Freeway Connection project is acceptable in the project 2037 (‘Do something’) and cumulative projects 2037 (‘Do something cumulative’) scenarios – ie no worse than the future year scenario without the project (‘Do minimum’)
- To present the road network performance outcomes of refined operational traffic modelling as it relates to providing additional mitigation measures to inform the preferred infrastructure report.

Section 2.2 of this report outlines the operational traffic modelling approach in detail for each of the study areas, noting that a tailored approach was required for each study area in order to address the comments and requirements of Department of Planning, Industry and Environment.

1.4. Purpose of this report

The purpose of this operational traffic modelling report is to:

- Provide an understanding of the comments and requirements raised by Department of Planning, Industry and Environment on the environmental impact statement operational traffic modelling assessment for the Warringah Freeway and surrounds, Gore Hill Freeway and Artarmon, Balgowlah and surrounds and Frenchs Forest and surrounds study areas
- Outline the traffic analysis and modelling approach to address the Department of Planning, Industry and Environment comments and requirements for each of the relevant model study areas
- Document the findings of the operational traffic modelling review and assessment for the purposes of the preferred infrastructure report.

1.5. Report structure

The remaining sections of this report are structured as follows:

- **Section 2 – Assessment Methodology**
 - Provides an outline of the overall assessment approach and modelling approach for each of the study areas
- **Section 3 – Future Road Performance with the Project**
 - Provides a detailed assessment of road network performance for the respective project 2037 (or 'Do something') scenarios
- **Section 4 – Cumulative Operational Impacts Assessment**
 - Provides a detailed assessment of road network performance for the respective cumulative projects 2037 (or 'Do something cumulative') scenarios
- **Section 5 – Summary**
 - Provides a summary of key findings and outcomes from the assessment for each of the study areas.

2. ASSESSMENT METHODOLOGY

2.1. Overall assessment approach

The environmental impact statement operational traffic modelling assessment was carried out using the VISSIM software package to inform the road network performance benefits/impacts of the project in localised areas. Individual operational traffic models were developed for each study area – ie Warringah Freeway and surrounds, Gore Hill Freeway and Artarmon, Balgowlah and surrounds, and Frenchs Forest and surrounds. The Sydney Motorway Planning Model (SMPM) was used to inform the strategic transport benefits/impacts of the project, as well as inform forecast traffic growth and distribution in the future year operational traffic modelling.

The operational traffic model study areas and scenarios considered in this preferred infrastructure report are consistent with the environmental impact statement modelling. An outline of the model scenarios is as follows noting that Section 9.2.2 of Chapter 9 (Operational traffic and transport) of the environmental impact statement provides further detail on the projects included in these scenarios:

- Without the project ('Do minimum') – includes approved, under construction and/or recently opened projects such as NorthConnex, WestConnex, Sydney Metro City & Southwest and Northern Beaches Hospital transport upgrade project
- With the project ('Do something') – as per 'Do minimum' plus Beaches Link and Gore Hill Freeway Connection and Warringah Freeway Upgrade projects
- With the project and other planned or proposed projects ('Do something cumulative') – as per 'Do something' plus Western Harbour Tunnel, Sydney Gateway and M6 Motorway projects.

Having consideration to the Department of Planning, Industry and Environment traffic and transport requirements (refer Section 1.2), a tailored approach to each of the relevant operational traffic model study areas has been developed to address the concerns raised. Ultimately, the approach(es) sought to either:

1. Demonstrate that the model results presented in the environmental impact statement are appropriate and are substantiated by further evidence (e.g. additional model outputs and supplementary performance metrics illustrate the performance benefits of the project on the local road network and intersections); or
2. Refine assumptions in the operational traffic models with respect to road network conditions and operation to reflect additional potential mitigations. Any additional assumed mitigations have been documented where relevant.

The review of environmental impact statement operational traffic modelling outcomes indicated that the Department of Planning, Industry and Environment's concerns were generally consistent for both 2027 and 2037 horizon years, with 2037 issues being of larger magnitude due to the additional assumed traffic demand growth. Due to this, the 2037 horizon year models are the focus of this assessment. Table 2.1 provides an overview of the 2037 future year scenarios reviewed for the purposes of the preferred infrastructure report, noting that the environmental impact statement did not indicate any potential localised impacts for the models excluded from this additional analysis.

Table 2.1: Preferred infrastructure report model scenarios

Model study area	2037 'Do something'		2037 'Do something cumulative'	
	Morning peak	Evening peak	Morning peak	Evening peak
Warringah Freeway and surrounds	✓	✓	✓	✓
Gore Hill Freeway and Artarmon	x	✓	x	✓
Balgowlah and surrounds	x	✓	x	✓
Frenchs Forest and surrounds	✓	✓	✓	✓

Further to the above, the operational traffic modelling assessment presented in the environmental impact statement adopted an overarching strategy to optimise the performance of the broader road network/corridor, rather than a detailed review of individual intersection performance. Thus, while intersection performance metrics may not necessarily demonstrate improvements on an isolated basis, the focus was on ensuring that the typical customer experience over a broader journey would not be compromised after the project was introduced.

For the Gore Hill Freeway and Artarmon, and Balgowlah and surrounds areas, the information provided in this preferred infrastructure report is additional, detailed metrics extracted from the operational traffic modelling carried out for and presented in the environmental impact statement. No additional operational traffic modelling has been undertaken for these areas.

For the Warringah Freeway and surrounds, and Frenchs Forest and surrounds areas, additional operational traffic modelling has been carried out to further refine the modelling outcomes presented in the environmental impact statement. For these areas network optimisation through improved operation and coordination of traffic signals has been considered, and potential measures to further mitigate residual traffic performance impacts have also been explored.

Section 2.2 of this report outlines in more detail the approach for each model study area, including the selection of specific peaks for some study area models. This is followed by the supporting analysis and modelling outcomes in Section 3 ('Do something' scenarios) and Section 4 ('Do something cumulative' scenarios).

2.2. Operational traffic modelling approach

2.2.1. Warringah Freeway and surrounds

In the Warringah Freeway and surrounds area, the environmental impact statement illustrated that although the project would generally improve network performance for roads within and around North Sydney, it would not resolve localised performance issues at several intersections. It is also noted that options to further improve traffic performance at intersections throughout the area have previously been investigated. However, these alternative options would result in further impacts on other customers or in other areas and consequently create net disbenefits. The proposed works are therefore considered to provide an equitable outcome from the perspective of maintaining a balanced and integrated transport network through the constrained urban environment of North Sydney, with further refinements to movement and place outcomes within the North Sydney CBD being delivered by works associated with the North Sydney Integrated Transport Program (NSITP/North Sydney Program).

The operational traffic modelling outcomes presented in the environmental impact statement indicated that the 'Do something' and 'Do something cumulative' scenarios resulted in potential impacts to intersections on local road corridors in some locations. As such, further assessment was requested by the Department of Planning, Industry and Environment for the following road corridors to determine if localised intersection performance impacts presented in the environmental impact statement could be mitigated when taking into consideration further traffic signal optimisation and other mitigations:

- Amherst Street between West Street and Miller Street (Local road corridor)
- Ernest Street between Merlin Street and Miller Street (Regional road corridor)
- Miller Street between Falcon Street and Pacific Highway (Regional road corridor)
- Brook Street between Merrenburn Avenue and Chandos Street (Regional road corridor).

Assessment scenarios

The Warringah Freeway and surrounds VISSIM model scenarios that have been reviewed as part of this technical report are as follows:

- 2037 'Do something' – morning and evening peaks
- 2037 'Do something cumulative' – morning and evening peaks.

It is noted that the 2037 'Do minimum' scenario presented in the environmental impact statement was used as the baseline for this assessment.

Approach

An outline of the adopted modelling approach for the Warringah Freeway and surrounds study area is as follows:

1. Obtain the relevant Warringah Freeway and surrounds study area environmental impact statement VISSIM models and confirm that the models are consistent with the environmental impact statement reporting
2. Review model operation and performance to better understand the operational performance and constraints of local intersections with a focus on the critical intersections along the Amherst Street, Ernest Street, Miller Street and Brook Street corridors
3. Identify and test further opportunities for traffic signal optimisation to better reflect typical road network management practices without adversely impacting the broader network in the 2037 'Do something' and 2037 'Do something cumulative' model scenarios
4. Review both the environmental impact statement and signal optimised models and results to determine the appropriate model scenarios to present and inform the preferred infrastructure report.

Signal optimisation assumptions

A review of the 2037 'Do something' and 2037 'Do something cumulative' models and results (in particular intersection performance) was carried out to understand potential pinchpoints on the network and help identify where further improvements could be gained. Signal optimisation strategies (e.g. phase time redistribution, signal coordination and changes to phasing arrangements) were adopted to extract the full capability and capacity of the network from an operational perspective.

Thorough investigation of signal optimisation strategies in each of the model scenarios was determined to be sufficient to ensure that the Warringah Freeway and surrounds model network could suitably accommodate the expected level of traffic demand, thus demonstrating that the project traffic performance in the 2037 'Do something' and 2037 'Do something cumulative' scenarios would be generally comparable or improved when compared to the 2037 'Do Minimum' scenario, whilst also preserving the network / corridor performance benefits presented in the environmental impact statement.

A description of the signal optimisation techniques adopted for each model is provided in Annexure A noting that the optimisation of signals maintained the integrity of operational requirements and assumptions (e.g. sufficient crossing times for pedestrians or signal sequencing). It is noted that these assumptions refer to 'signal optimisation within the model environment' and there would be opportunities for additional improvements when the system is built through the application of real time traffic network management via systems such as the Sydney Coordinated Adaptive Traffic System (SCATS). The system would also be subject to future optimisation to consider other travel modes such as pedestrians and cyclists.

Following the testing and comparison of model results, the signal optimised models for all scenarios were considered acceptable to take forward and inform the preferred infrastructure report. The model results and outcomes following application of these optimisation strategies are provided in Section 3.2 and Section 4.2 of this report for the 2037 'Do something' and 2037 'Do something cumulative' scenarios, respectively.

2.2.2. Gore Hill Freeway and Artarmon

The operational traffic modelling outcomes presented in the environmental impact statement indicated that the Gore Hill Freeway and Artarmon 2037 'Do something' and 2037 'Do something cumulative' scenarios could potentially result in impacts to intersections on the Reserve Road corridor during the evening peak, as some of these intersections were reported as operating with ">100 second" intersection delays in the environmental impact statement. For the purpose of the environmental impact statement the presentation of intersection average delay was "capped" at >100 seconds to address the practical limitations of strategic traffic forecasting and downstream microsimulation modelling in instances where forecast peak hour demand exceeds practical capacity. These limitations can result in the absolute value of delay simulated in microsimulation being distorted and potentially unrealistic.

Further investigation and information from the environmental impact statement modelling was requested by the Department of Planning, Industry and Environment to demonstrate that the project would not adversely impact on the Reserve Road corridor between Barton Road and Dickson Avenue (Local road corridor) compared to the 'Do minimum' scenario. In particular, the "uncapped" intersection performance metrics have been extracted and presented to demonstrate the relative benefit/impact of the project – ie confirming if intersection performance is anticipated to improve or deteriorate as a result of the project, rather than presenting conditions both with and without the project as ">100 seconds".

Assessment scenarios

The Gore Hill Freeway and Artarmon VISSIM model scenarios that have been reviewed as part of this preferred infrastructure report are as follows:

- 2037 'Do something' – evening peak only
- 2037 'Do something cumulative' – evening peak only.

It is noted that the 2037 'Do minimum' scenario presented in the environmental impact statement was used as the baseline for this assessment.

Approach

An outline of the adopted modelling approach for the Gore Hill Freeway and Artarmon study area is as follows:

1. Obtain the relevant Gore Hill Freeway and Artarmon study area environmental impact statement VISSIM models and confirm that the models are consistent with the environmental impact statement reporting

2. Review model operation and performance to better understand the operational performance of local intersections with a focus on the critical intersections along the Reserve Road corridor
3. Through an assessment of both model results and operation, determine whether the project impacts are considered acceptable in the environmental impact statement
4. Carry out sensitivity testing to understand whether further performance benefits could be attained through network and signal optimisation strategies.

Sensitivity testing

Referring to Item 4 of the abovementioned approach for the Gore Hill Freeway and Artarmon study area, sensitivity testing of the 2037 'Do something cumulative' evening peak model was carried out to investigate whether further optimisation of signal timings (phase time redistribution) at the Reserve Road / Gore Hill Freeway interchange and the Reserve Road / Dickson Avenue intersection could result in improved local area performance without impacting the broader network. It should be noted that the purpose of the sensitivity tests does not override or negate the environmental impact statement operational traffic modelling results for the Gore Hill Freeway and Artarmon study area. Rather, the sensitivity testing has been carried out to inform and understand the potential scope and benefits of further works that may amplify project benefits in this area.

The outcomes of the sensitivity testing showed that localised traffic performance improvements on Reserve Road (reduction in average delays and increase in traffic throughput) could potentially be gained through signal optimisation alone. However, the sensitivity testing also highlighted the operational complexity of the Gore Hill Freeway and Artarmon study area network, whereby increased throughput at the Reserve Road interchange caused broader (or downstream) impacts on the road network – in this instance at the Pacific Highway / Longueville Road and Epping Road / Longueville Road intersections. This negated some of the benefits achieved in the local area, thus resulting in limited or no change to the overall performance of the network.

As such, for the purposes of the preferred infrastructure report, the environmental impact statement models are considered appropriate - and referred to - to demonstrate that the project benefits and impacts on the local road network area in the Gore Hill Freeway and Artarmon study area. Most notably, the future road network performance with the project in the 2037 'Do something' and 'Do something cumulative' scenarios can be expected to operate at a comparable (or better) level than the future year scenario without the project (ie 2037 'Do minimum' scenario) – as discussed in Section 3.3 (2037 'Do something' scenario) and Section 4.3 (2037 'Do something cumulative' scenario) of this report.

2.2.3. Balgowlah and surrounds

For the Balgowlah and surrounds area, the environmental impact statement indicated that the operation of the project would facilitate additional traffic travelling through the corridor within the Balgowlah and surrounds area at greatly reduced levels of delay, and would benefit both regional and local trips. This would result in improved travel times on key routes through the area as a result of the project. However, the operational traffic modelling outcomes presented in the environmental impact statement indicated that the 2037 'Do something' and 2037 'Do something cumulative' scenarios could result in impacts to intersections on the Sydney Road corridor during the evening peak, as some of these intersections were reported as operating with ">100 second" intersection delays in the environmental impact statement. Similar to the Gore Hill Freeway and Artarmon study area, for the purpose of the environmental impact statement the presentation of intersection average delay was "capped" at >100 seconds to address traffic forecasting and modelling limitations.

As such, further information was requested by the Department of Planning, Industry and Environment to demonstrate that the project would not adversely impact the Sydney Road corridor between Frenchs

Forest Road and Wanganella Street (State road corridor) compared to a future year scenario without the project (ie 'Do minimum'), including presenting the uncapped intersection performance metrics to demonstrate the relative benefit/impact of the project.

Assessment scenarios

The Balgowlah and surrounds VISSIM model scenarios that have been reviewed as part of this preferred infrastructure report are as follows:

- 2037 'Do something' – evening peak only
- 2037 'Do something cumulative' – evening peak only.

It is noted that the 2037 'Do minimum' scenario presented in the environmental impact statement was used as the baseline for this assessment.

Approach

An outline of the adopted modelling approach for the Balgowlah and surrounds study area is as follows:

1. Review and analyse the Balgowlah and surrounds study area environmental impact statement model results in detail
2. Review model operation and performance to better understand the operational performance of local intersections with a focus on the critical intersections along the Sydney Road corridor
3. Through an assessment of both model results and operation, determine whether the project impacts are considered acceptable in the environmental impact statement
4. Carry out sensitivity testing to understand whether further performance benefits could be attained through network and signal optimisation strategies.

Sensitivity testing

Referring to Item 4 of the abovementioned approach for the Balgowlah and surrounds study area, sensitivity testing of the 2037 'Do minimum', 2037 'Do something' and 2037 'Do something cumulative' evening peak scenario was carried out to investigate whether further optimisation of signal timings at the critical Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection would result in improved local area performance without impacting the broader network. In addition, sensitivity testing of potential capacity improvements at the Frenchs Forest Road / Sydney Road roundabout was carried out. An overview of the two sensitivity tests is as follows:

- Sensitivity Test 1: Update signal settings of the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection to better accommodate forecast demands for the 2037 'Do minimum', 2037 'Do something' and 2037 'Do something cumulative' scenarios
- Sensitivity Test 2: Identify and test the effects of potential capacity increases at the Frenchs Forest Road / Sydney Road roundabout in the 2037 'Do something' and 2037 'Do something cumulative' scenarios.

It should be noted that the purpose of the sensitivity tests does not override or negate the environmental impact statement operational traffic modelling results for the Balgowlah and surrounds study area. Rather, the sensitivity testing has been carried out to inform and understand the potential scope and benefits of further works that may amplify project benefits in this area.

The outcomes of the first sensitivity test generally indicate that the refined signal arrangements at the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection would provide some improvements to each of the 2037 'Do minimum', 2037 'Do something' and 2037 'Do something cumulative' scenarios when compared to Beaches Link and Gore Hill Freeway environmental impact statement models from a network and intersection performance perspective. However, residual impacts

at downstream / upstream road sections and intersections would offset and limit any potential net performance benefits.

The second sensitivity test assumed an increase in the capacity at the Frenchs Forest Road / Sydney Road roundabout. The outcomes of this test indicated that mitigation works at this intersection would likely result in improved operating performance along the broader Sydney Road corridor by allowing both the Frenchs Forest Road / Sydney Road and Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersections to operate more efficiently.

Notwithstanding the performance improvements that could potentially be gained through further signal optimisation and infrastructure solutions, it was considered that the environmental impact statement models are suitable to inform the preferred infrastructure report for the Balgowlah and surrounds study area. It is important to note that opportunities to further improve network and intersection performance within the Balgowlah and surrounds area (and specifically for the Sydney Road corridor) would continue to be investigated by relevant divisions of Transport for NSW and other relevant stakeholders.

2.2.4. Frenchs Forest and surrounds

For the Frenchs Forest and surrounds area, the environmental impact assessment strategic modelling indicated that road users would benefit from substantial travel time savings on the broader network due to the strategic benefits provided by the Beaches Link and Gore Hill Freeway Connection project. However, the changes to traffic patterns associated with the project could result in increased localised delays on the existing road network between Forest Way and Wakehurst Parkway and reduced travel speeds through the area during the busiest peak traffic periods.

The operational traffic modelling outcomes presented in the environmental impact statement indicated that the Frenchs Forest and surrounds 2037 'Do something' and 2037 'Do something cumulative' scenarios could result in localised impacts to intersections on the Frenchs Forest Road East, Frenchs Forest Road West and Warringah Road corridors.

Consequently, further analysis for the following locations was requested by the Department of Planning, Industry and Environment:

- Frenchs Forest Road East: Warringah Road to Wakehurst Parkway (Local road corridor)
- Frenchs Forest Road West: Wakehurst Parkway to Gladys Avenue (Local road corridor)
- Warringah Road: Hilmer Street to Frenchs Forest Road (State road corridor).

The operational traffic modelling investigation and analysis has been carried out with the aim of reducing the impacts on key movements through and within the Frenchs Forest and surrounds study area.

Assessment scenarios

The Frenchs Forest and surrounds VISSIM model scenarios that have been reviewed as part of this preferred infrastructure report are as follows:

- 2037 'Do something' – morning and evening peaks
- 2037 'Do something cumulative' – morning and evening peaks.

It is noted that the 2037 'Do minimum' scenario presented in the environmental impact statement was used as the baseline for this assessment.

Approach

An outline of the adopted modelling approach for the Frenchs Forest and surrounds study area is as follows:

1. Review and analyse the Frenchs Forest and surrounds study area environmental impact statement model results in detail
2. Review the Frenchs Forest and surrounds environmental impact statement model inputs, assumptions, operation and performance to better understand the operational performance of local intersections
3. Consider the effects of the likely increase in public transport (bus) provision servicing the Frenchs Forest and surrounds study area and other demand management measures on private vehicle demand. It is important to note that the environmental impact statement demand modelling assumed no material change to public transport provisions to and from the Northern Beaches (ie no express bus services via the Beaches Link nor improvements to existing surface routes). In this sense, the environmental impact statement modelling is conservative as it assumes a relatively high private vehicle mode share / low public transport share. The introduction of express bus services via the Beaches Link and other public transport network enhancements and demand management initiatives would increase public transport demand and consequently reduce private vehicle demand
4. Additional operational traffic modelling of the Frenchs Forest and surrounds study area models to reflect a reduction in private vehicle demand in the 2037 'Do something' and 2037 'Do something cumulative' model scenarios (refer 'additional operational traffic modelling' section for further details)
5. Through an assessment of the environmental impact statement model results and sensitivity testing, determine the appropriate scenario(s) to inform the preferred infrastructure report.

Additional operational traffic modelling

Referring to Item 4 of the abovementioned approach for the Frenchs Forest and surrounds study area, additional operational traffic modelling of the 2037 'Do something' and 2037 'Do something cumulative' morning and evening peak models was carried out to consider an increase in public transport (bus) provision servicing the Frenchs Forest and surrounds study area and demand management initiatives in the area.

The additional operational traffic modelling was carried out adopting a strategic view of traffic demand and network supply (capacity) in the Frenchs Forest and surrounds study area. This considers the following elements:

- Outputs from SMPM have been used to inform the future year demand input into the Frenchs Forest and surrounds operational traffic models. The SMPM is a macroscopic traffic assignment model with limited ability to reflect detailed operational constraints on the road network which may affect traffic distribution and assignment. As such, this limitation at the strategic modelling level may at times reassign existing or new traffic to an area of a network that has perceived strategic capacity (or supply) improvements – typically referred to as 'induced demand'. Given the known existing and expected future capacity/operational constraints within the Frenchs Forest study area, the expected level of 'induced demand' forecast for the 'Do something' and 'Do something cumulative' model scenarios should be minimal, or at least not to the level as forecast by the SMPM strategic modelling
- As noted above, new future bus routes servicing the Frenchs Forest and surrounds area, as well as the implementation of broader transport strategies (e.g. Future Transport Strategy 2056, Northern Beaches Hospital Precinct Structure Plan), which promote and would provide complementary initiatives to encourage a higher shift to other sustainable modes of transport, (away from private vehicle or car trips).

Having consideration to the above, the review of the Frenchs Forest and surrounds operational traffic models presented in this report assumes that total traffic demand forecast in the 2037 'Do minimum' scenario could provide a more reasonable vision/target of future private vehicle demand levels in the Frenchs Forest study area. As such, traffic demand in the 2037 'Do something' and 2037 'Do something

'cumulative' scenarios has been scaled to match the 2037 'Do minimum' scenario in the respective morning and evening peaks. This approach preserves the project's forecast effects on traffic patterns within and through the Frenchs Forest and surrounds network. It is noted that no physical changes to the Reference Design scope presented in the environmental impact statement were considered in the preferred infrastructure report assessment.

The outcomes of this additional operational traffic modelling have been used to inform the preferred infrastructure report and are presented in Section 3.5 and Section 4.5 of this report for the 'Do something' and 'Do something cumulative' scenarios, respectively.

3. FUTURE ROAD PERFORMANCE WITH THE PROJECT

3.1. Overview

This section provides a summary of future road network performance under future year 2037 model scenarios with the Beaches Link and Gore Hill Freeway Connection project ('Do something'). This assessment is based on a comparison against the 2037 'Do minimum' scenario for the following performance measures (consistent with the environmental impact statement):

- Network performance metrics
- Intersection performance based on intersection Level of Service
- General traffic and bus travel times for key corridors.

Additional supplementary performance measures have been presented, where necessary, to further demonstrate the performance of the 2037 'Do something' scenarios in comparison to the 2037 'Do minimum' scenario.

It is noted that the environmental impact statement models and results for the Gore Hill Freeway and Artarmon and Balgowlah and surrounds study areas are considered appropriate to inform the preferred infrastructure report and as such no further modelling was required for the respective 2037 'Do something' scenarios. However, further detail and commentary has been provided for these study areas on the relevant performance metrics to contextualise the project benefits and impacts.

The 2037 'Do something' model results presented for the Warringah Freeway and surrounds and Frenchs Forest and surrounds study areas have been reviewed and refined as part of the preferred infrastructure report, as discussed in previous sections.

3.2. Warringah Freeway and surrounds

Intersection performance at key intersections on local road corridors is one indicator of operating performance. However, preserving the overall corridor and network performance is of primary importance to Transport for NSW, particularly for the Warringah Freeway and surrounds study area.

As such, in addition to intersection performance metrics, the full suite of performance metrics have been reviewed as part of the modelling process and presented in the following sections in order to enable consideration of the broader road network and corridor performance for users, not just individual intersection performance. These model performance metrics represent the refined 2037 'Do something' model outcomes based on the adopted approach outlined in Section 2.2.1 and compared against the benchmark 2037 'Do minimum' scenario which is unchanged from the environmental impact statement.

FUTURE ROAD PERFORMANCE WITH THE PROJECT

3.2.1. Network performance

The network performance metrics in the Warringah Freeway and surrounds study area for the 2037 'Do minimum' and refined 2037 'Do something' scenarios are presented in Table 3.1 and Table 3.2 for the morning and evening peaks, respectively.

Table 3.1: Modelled 'Do something' morning peak (6am to 9am) network performance – Warringah Freeway and surrounds study area

Network Measure	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles		
Total traffic demand (veh)	112,432	114,989
Total VKT through network	350,650	385,754
Total VHT through network	10,158	10,869
Total number of stops	746,104	672,526
Average vehicle statistics		
Average vehicle trip length through the network (km)	3.5	3.7
Average vehicle trip time through the network (hours)	0:06:01	0:06:12
Average number of stops per trip	7.4	6.4
Average trip speed (km/hr)	34.5	35.5
Unreleased traffic		
Total unreleased trips	11,269	9,834
% demand unreleased	10.0%	8.6%

Table 3.2: Modelled 'Do something' evening peak (3pm to 6pm) network performance – Warringah Freeway and surrounds study area

Network Measure	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles		
Total traffic demand (veh)	118,121	120,706
Total VKT through network	348,965	387,823
Total VHT through network	12,368	10,997
Total number of stops	980,319	454,848
Average vehicle statistics		
Average vehicle trip length through the network (km)	3.2	3.5
Average vehicle trip time through the network (hours)	0:06:51	0:06:00
Average number of stops per trip	9.0	4.1
Average trip speed (km/hr)	28.2	35.3
Unreleased traffic		

FUTURE ROAD PERFORMANCE WITH THE PROJECT

Network Measure	2037 'Do minimum'	2037 'Do something'
Total unreleased trips	9,800	10,880
% demand unreleased	8.3%	9.0%

A summary of the key network performance outcomes under the refined 2037 'Do something' morning and evening peak models compared to the 2037 'Do minimum' scenario is as follows:

- Consistent with the environmental impact statement results presented, the refined 2037 'Do something' scenario in the morning peak shows improved overall network performance compared to the 2037 'Do minimum' scenario, noting the following key metrics:
 - Total number of stops is expected to improve by approximately 10 per cent
 - Average vehicle trip time through the network remains comparable at approximately 6 minutes
 - Average trip speed is expected to increase by approximately 1 km/hr (approximately 3 per cent improvement)
 - Total number of unreleased trips at the end of the morning peak is expected to decrease from 10 per cent to 9 per cent of the total demand.
- In the evening peak, road network performance under the refined 2037 'Do something' scenario is also improved overall compared to the 2037 'Do minimum' scenario, noting the following key metrics:
 - Total number of stops is expected to improve by approximately 50 per cent
 - Average vehicle trip time through the network is expected to decrease by approximately 1 minute
 - Average trip speed is expected to increase by approximately 7 km/hr (approximately 25 per cent improvement)
 - The total number of unreleased trips at the end of the evening peak increases slightly from 8 per cent of the total demand to 9 per cent. The slight increase in unreleased trips is from zones entering the Warringah Freeway and surrounds study area at Military Road, Brook Street on approach to Merrenburn Avenue, and Walker Street on approach to the Berry Street / Walker Street intersection. On the other hand, there is a significant decrease in unreleased trips from the Gore Hill Freeway southbound entry zone (by approximately 1400 vehicles) under the refined 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario.

The general improvement to operating performance under the refined 2037 'Do something' scenario in both the morning and evening peaks is also reflective of the proposed project infrastructure which includes the addition of high-speed motorway sections (ie Beaches Link), as well as the upgrade of the existing motorway network (Warringah Freeway Upgrade).

3.2.2. General traffic travel times

The general traffic travel times for key corridors within the Warringah Freeway and surrounds study area under the 2037 'Do minimum' and refined 2037 'Do something' scenarios are presented in Table 3.3 and Table 3.4 for the morning and evening peak hours, respectively.

FUTURE ROAD PERFORMANCE WITH THE PROJECT

Table 3.3: Modelled ‘Do something’ morning peak hour (8am to 9am) general traffic travel times – Warringah Freeway and surrounds study area

Route	Direction	2037 ‘Do minimum’	2037 ‘Do something’
Sydney Harbour Bridge to Warringah Freeway / Falcon Street Interchange	Northbound	0:04:51	0:03:29
	Southbound	0:04:02	0:04:08
Sydney Harbour Tunnel to Warringah Freeway / Falcon Street Interchange	Northbound	0:04:08	0:12:19
	Southbound	0:04:02	0:04:16
Sydney Harbour Bridge to Gore Hill Freeway / Pacific Highway Interchange	Northbound	0:06:16	0:05:22
	Southbound	0:15:22	0:11:47
Sydney Harbour Tunnel to Gore Hill Freeway / Pacific Highway Interchange	Northbound	0:05:30	0:17:08
	Southbound	0:12:37	0:10:26
Berry Street to Amherst Street via Miller Street	Northbound	0:03:53	0:04:15
	Southbound	0:05:43	0:04:22

Table 3.4: Modelled ‘Do something’ evening peak hour (5pm to 6pm) general traffic travel times – Warringah Freeway and surrounds study area

Route	Direction	2037 ‘Do minimum’	2037 ‘Do something’
Sydney Harbour Bridge to Warringah Freeway / Falcon Street Interchange	Northbound	0:07:51	0:04:59
	Southbound	0:05:02	0:04:39
Sydney Harbour Tunnel to Warringah Freeway / Falcon Street Interchange	Northbound	0:07:36	0:03:36
	Southbound	0:14:59	0:07:41
Sydney Harbour Bridge to Gore Hill Freeway / Pacific Highway Interchange	Northbound	0:06:45	0:06:53
	Southbound	0:17:31	0:09:09
Sydney Harbour Tunnel to Gore Hill Freeway / Pacific Highway Interchange	Northbound	0:06:46	0:05:22
	Southbound	0:30:09	0:16:00
Berry Street to Amherst Street via Miller Street	Northbound	0:03:50	0:05:18
	Southbound	0:08:39	0:04:42

A summary of the key general traffic travel times outcomes under the refined 2037 ‘Do something’ morning and evening peak models compared to the 2037 ‘Do minimum’ scenario is as follows:

- Marginal changes to travel time are expected in the morning peak for major routes under the refined 2037 ‘Do something’ scenario compared to the 2037 ‘Do minimum’ scenario, with the following notable exceptions:
 - Travel time on the Sydney Harbour Tunnel to Warringah Freeway / Falcon Street Interchange northbound route is expected to increase by approximately 8 minutes
 - Travel time on the Sydney Harbour Tunnel to Gore Hill Freeway / Pacific Highway Interchange northbound route is expected to increase by approximately 12 minutes

- The abovementioned travel time increases are due to the increase in traffic demand from the Sydney Harbour Tunnel in the northbound direction in the refined 2037 'Do something' scenario, as well as the change in the freeway merging arrangement north of Falcon Street (ie lane reduction), noting that the change in freeway arrangement is part of the Warringah Freeway Upgrade scope to accommodate the Western Harbour Tunnel (although the Western Harbour Tunnel is assumed not to be operational in the 'Do something' scenario).
- During the evening peak, travel times are generally improved under the refined 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario, noting the following:
 - Significant improvements to evening peak travel times on the Sydney Harbour Bridge are observed, particularly in the southbound direction, including:
 - Travel time on the Sydney Harbour Tunnel to Warringah Freeway / Falcon Street Interchange southbound route is expected to decrease by approximately 7 minutes
 - Travel time on the Sydney Harbour Bridge to Gore Hill Freeway / Pacific Highway Interchange southbound route is expected to decrease by approximately 8 minutes
 - Travel time on the Sydney Harbour Tunnel to Gore Hill Freeway / Pacific Highway Interchange southbound route is expected to decrease by approximately 14 minutes
 - Travel time on the Miller Street southbound route from Amherst Street to Berry Street is expected to decrease by approximately 4 minutes
 - The abovementioned improvements to travel times are due to the changes to the Warringah Freeway configuration (as part of the Warringah Freeway Upgrade) in the southbound direction in the refined 2037 'Do something' scenario and the addition of Beaches Link which relieves some congestion on the Warringah Freeway mainline and surrounds
 - Improvements are also observed in the Warringah Freeway northbound direction particularly for routes ending at the Warringah Freeway / Falcon Street interchange. The changes to the northbound configuration of the Warringah Freeway (ie separation of the Sydney Harbour Bridge and Sydney Harbour Tunnel carriageways) has assisted to reduce merge and weave conflicts on the motorway.

3.2.3. Intersection performance

When reviewing the intersection performance results, it is imperative to clearly understand the nature of the network management and optimisation strategies adopted for the Warringah Freeway and surrounds modelling. Given the constraints of the network and the key strategic road corridors that exist within the Warringah Freeway and surrounds study area (e.g. Miller Street, Falcon Street, Military Road, Pacific Highway, etc.), emphasis is placed on preserving the function and operation of the network and/or corridors (as indicated by the network performance and travel time metrics) rather than isolated intersection performance.

A high quality, well connected network of key motorway corridors is essential in keeping other transport corridors moving, providing high levels of mobility and accessibility, and minimising impacts on local communities. This was considered a primary attribute to promote the viability of the Beaches Link and Gore Hill Freeway Connection project in the Warringah Freeway and surrounds study area, in addition to providing an appropriate motorway system to accommodate the movement of people, goods, and services through and within the network.

FUTURE ROAD PERFORMANCE WITH THE PROJECT

The intersection performance results within the Warringah Freeway and surrounds study area under the 2037 'Do minimum' and refined 2037 'Do something' scenario are presented in Table 3.5 and Table 3.6 for the morning and evening peak hours, respectively. The intersection performance results presented in Section 7.4.3 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement have some minor inconsistencies with the model outputs. As such, Table 3.5 and Table 3.6 presents the corrected and uncapped intersection performance results for the 2037 'Do minimum' scenario (this has been provided as a clarification within Section A5.1.5 of the submissions report) and the refined results for the 2037 'Do something' scenario.

Table 3.5: Modelled 'Do something' morning peak hour (8am to 9am) intersection performance – Warringah Freeway and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road / Gore Hill Freeway interchange	123	F	24	B
Brook Street / Warringah Freeway on ramp	177	F	7	A
Brook Street / Warringah Freeway off ramp	67	E	10	A
Brook Street / Merrenburn Avenue	117	F	26	B
Amherst Street / West Street	4	A	6	A
Amherst Street / Miller Street	20	B	36	C
Miller Street / Warringah Freeway on ramp	6	A	3	A
Miller Street / Warringah Freeway off ramp	13	A	5	A
Miller Street / Ernest Street	32	C	38	C
Miller Street / Falcon Street	38	C	34	C
Ernest Street / Warringah Freeway on ramp	5	A	9	A
Ernest Street / Warringah Freeway off ramp (off ramp in evening, on ramp in morning)	5	A	11	A
Falcon Street / Warringah Freeway ramps	15	B	38	C
Watson Street / Military Road	26	B	40	C
Military Road / Ben Boyd Road	23	B	58	E
Falcon Street / Merlin Street	32	C	48	D
Berry Street / Walker Street	39	C	46	D
Berry Street / Miller Street	69	E	42	C
Mount Street / Arthur Street	59	E	25	B
Pacific Highway / High Street / Arthur Street	38	C	24	B
Pacific Highway / Walker Street / Blue Street	65	E	29	C
Pacific Highway / Miller Street / Mount Street	41	C	55	D

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Intersection	2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Pacific Highway / Berry Street	52	D	11	A
Pacific Highway / Bay Road	77	F	25	B
Miller Street / McLaren Street	72	F	48	D
Miller Street / Ridge Street	53	D	46	D
Miller Street / Carlow Street	13	A	9	A
High Street / Clark Road	55	D	37	C
High Street / Alfred Street	33	C	17	B
Mount Street / Alfred Street	2	A	15	B
Ernest Street / Ben Boyd Road	12	A	13	A
Pedestrian crossing at Military Road	5	A	6	A

Table 3.6: Modelled 'Do something' evening peak hour (5pm to 6pm) intersection performance – Warringah Freeway and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road / Gore Hill Freeway interchange	76	F	9	A
Brook Street / Warringah Freeway on ramp	17	B	8	A
Brook Street / Warringah Freeway off ramp	20	B	18	B
Brook Street / Merrenburn Avenue	13	A	53	D
Amherst Street / West Street	10	A	5	A
Amherst Street / Miller Street	31	C	39	C
Miller Street / Warringah Freeway on ramp	6	A	7	A
Miller Street / Warringah Freeway off ramp	15	B	9	A
Miller Street / Ernest Street	43	D	36	C
Miller Street / Falcon Street	49	D	62	E
Ernest Street / Warringah Freeway on ramp	15	B	13	A
Ernest Street / Warringah Freeway off ramp (off ramp in evening, on ramp in morning)	17	B	14	A
Falcon Street / Warringah Freeway ramps	92	F	65	E
Watson Street / Military Road	59	E	47	D

FUTURE ROAD PERFORMANCE WITH THE PROJECT

Intersection	2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Military Road / Ben Boyd Road	70	E	103	F
Falcon Street / Merlin Street	136	F	102	F
Berry Street / Walker Street	73	F	76	F
Berry Street / Miller Street	70	F	58	E
Mount Street / Arthur Street	92	F	19	B
Pacific Highway / High Street / Arthur Street	61	E	20	B
Pacific Highway / Walker Street / Blue Street	80	F	72	F
Pacific Highway / Miller Street / Mount Street	58	E	69	E
Pacific Highway / Berry Street	56	E	20	B
Pacific Highway / Bay Road	41	C	29	C
Miller Street / McLaren Street	55	D	59	E
Miller Street / Ridge Street	91	F	19	B
Miller Street / Carlow Street	19	B	7	A
High Street / Clark Road	97	F	53	D
High Street / Alfred Street	66	E	16	B
Mount Street / Alfred Street	10	A	13	A
Ernest Street / Ben Boyd Road	94	F	36	C
Pedestrian crossing at Military Road	34	C	6	A

During the morning peak, key observations of intersection performance under the refined 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario are as follows:

- Intersection performance in the morning peak is expected to be generally comparable or better than the 2037 'Do minimum' scenario, with all intersections in the Warringah Freeway and surrounds area expected to operate at LoS D or better, except for Military Road / Ben Boyd Road which is expected to operate at LoS E
- Significant improvements to the performance of intersections along the Brook Street corridor are observed with LoS generally improving from F in the 2037 'Do minimum' scenario to A or B under the refined 2037 'Do something' scenario. This is a result of the upgrades to the Brook Street southbound on-ramp which has been lengthened, the Warringah Freeway merge located further south and redistribution of traffic demand in the area due to the Beaches Link and Gore Hill Freeway project.

During the evening peak, key observations of intersection performance under the refined 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario are as follows:

- Similar to the morning peak, most intersections under the refined 2037 'Do something' scenario operate at a similar or improved level of service to the 2037 'Do minimum' scenario

- The Falcon Street / Merlin Street and Berry Street / Walker Street intersections are expected to operate at LoS F under the refined 2037 'Do something' scenario similar to the 2037 'Do minimum' scenario. However, it is noted that average delays decrease by approximately 30 seconds at the Falcon Street / Merlin Street intersection and are generally unchanged at the Berry Street / Walker Street intersection
- Average delay at the Military Road / Ben Boyd Road intersection is expected to increase from 70 seconds (LoS E) to 103 seconds (LoS F) under the refined 2037 'Do something scenario' compared to the 2037 'Do minimum' scenario
- Performance of intersections along Amherst Street, Brook Street, Ernest Street and Miller Street corridors under the refined 2037 'Do something' scenario is generally comparable with (or better than) performance in the 2037 'Do minimum' scenario, with the exception of the Miller Street / Falcon Street and Pacific Highway / Miller Street / Mount Street intersections which record slight increases in average delay
- In addition, the Brook Street / Merrenburn Avenue intersection under the refined 2037 'Do something' scenario is expected to operate at LoS D as opposed to LoS A in the 2037 'Do minimum' scenario, which is considered to be an acceptable outcome given the constrained urban nature of the study area. The reduction in performance at this intersection is due to the continued traffic demand from Sydney Harbour Tunnel to Brook Street assumed in this scenario. Following the Warringah Freeway Upgrade, Sydney Harbour Tunnel trips to this area could travel via the Willoughby Road northbound off-ramp and Merrenburn Avenue eastbound to access Brook Street as a result of the Warringah Freeway northbound carriageway separation under the 2037 'Do something' scenario. This route differs from the 2037 'Do minimum' scenario which allows these trips to access the Brook Street northbound off-ramp directly (ie no northbound carriageway separation). It also differs from the 'Do something cumulative' scenario, where these trips are forecast to switch to the Sydney Harbour Bridge (following an improvement in traffic conditions due to the Western Harbour Tunnel) and access Brook Street directly from the Warringah Freeway. Notwithstanding this, in the refined 2037 'Do Something' scenario the corresponding potential increase in traffic demand on Merrenburn Avenue competes with demands on Brook Street resulting in a decrease in Level of Service at the Brook Street / Merrenburn Avenue intersection
- Average delay at Willoughby Road / Gore Hill Freeway Interchange is also expected to significantly improve under the refined 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario (from LoS F to LoS A). This is due to the Warringah Freeway southbound congestion no longer impeding traffic flow and performance at the intersection which is evident in the 2037 'Do minimum' scenario.

3.2.4. Public transport impacts

The bus travel times for key corridors within the Warringah Freeway and surrounds study area under the 2037 'Do minimum' and refined 2037 'Do something' scenarios are presented in Table 3.7 and Table 3.8 for the morning and evening peaks, respectively.

FUTURE ROAD PERFORMANCE WITH THE PROJECT

Table 3.7: Modelled ‘Do something’ morning peak hour (8am to 9am) bus travel times – Warringah Freeway and surrounds study area

Route	Direction	2037 ‘Do minimum’	2037 ‘Do something’
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:09:30	0:09:50
	Southbound	0:13:26	0:10:14
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:06:29	0:06:16
	Southbound	0:13:31	0:07:44
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:43	0:05:16
	Southbound	0:06:33	0:05:36
Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:42	0:05:37
	Southbound	0:28:17	0:10:04

Table 3.8: Modelled ‘Do something’ evening peak hour (5pm to 6pm) bus travel times – Warringah Freeway and surrounds study area

Route	Direction	2037 ‘Do minimum’	2037 ‘Do something’
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:13:34	0:15:46
	Southbound	0:19:09	0:16:07
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:09:52	0:09:40
	Southbound	0:13:59	0:11:51
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:08:36	0:06:08
	Southbound	0:06:51	0:05:44
Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:33	0:07:33
	Southbound	0:20:57	0:09:08

A summary of the key bus travel time outcomes under the refined 2037 ‘Do something’ morning and evening peak models compared to the 2037 ‘Do minimum’ scenario is as follows:

- Bus travel times under the refined 2037 ‘Do something’ morning peak scenario are generally comparable to the 2037 ‘Do minimum’ scenario, except for:
 - Bus travel time on the Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station) southbound route is expected to decrease by approximately 3 minutes
 - Bus travel time on the Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway) southbound route is expected to decrease by approximately 6 minutes
 - Bus travel time on the Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway) southbound route is expected to decrease by approximately 18 minutes
- In the evening peak, bus travel times under the refined 2037 ‘Do something’ scenario are also generally comparable to the 2037 ‘Do minimum’ scenario except for:
 - Bus travel time on the Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station) southbound route is expected to decrease by approximately 3 minutes

- Bus travel time on the Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway) southbound route is expected to decrease by approximately 11 minutes
- The significant improvements to bus travel time from Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway) southbound are a result of the changes to the southbound bus lane configuration which is further separated from the mainline under the refined 2037 'Do something' scenario, which includes the Warringah Freeway Upgrade.

3.3. Gore Hill Freeway and Artarmon

As mentioned in Section 2.2.2, the environmental impact statement models for the Gore Hill Freeway and Artarmon study area are considered acceptable to demonstrate the performance benefits on the local road network corridor of Reserve Road. As such, no further modelling was required for the Gore Hill Freeway and Artarmon study area.

The following sections provide some additional contextual discussion on performance metrics as it relates to the environmental impact statement results, as well as present the intersection performance results in further detail with additional supporting analysis to demonstrate the limited project impacts in the 2037 'Do something' scenario when compared to the 2037 'Do minimum' scenario during the evening peak.

3.3.1. Network performance

Network performance results are located in Section 7.5.1 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key network performance outcomes for the 2037 'Do something' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- Marginal changes to overall network performance are expected in the 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario during the evening peak
- The refined road network configuration following introduction of the Beaches Link and Gore Hill Freeway connection project is expected to satisfactorily accommodate the additional traffic demand generated in the 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario.

3.3.2. General traffic travel times

General traffic travel time results are located in Section 7.5.2 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key general travel time outcomes for the 2037 'Do something' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- Marginal changes to travel times are expected during the evening peak along all routes in the 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario.

3.3.3. Intersection performance

The intersection performance results presented in Section 7.5.3 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement have some minor inconsistencies with the model outputs. As such, Table 3.9 presents the corrected and uncapped intersection performance results for the 2037 'Do minimum' and 2037 'Do something' evening peak hour scenarios (this has been provided as a clarification within Section A5.1.6 of the submissions report).

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Table 3.9: Modelled ‘Do something’ evening peak hour (5pm to 6pm) intersection performance – Gore Hill Freeway and Artarmon study area

Intersection	2037 ‘Do minimum’		2037 ‘Do something’	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road / Longueville Road / Parklands Avenue	75	F	71	F
Longueville Road / Pacific Highway	44	D	42	D
Pacific Highway / Howarth Road / Norton Lane	8	A	6	A
Pacific Highway / Gore Hill Freeway interchange	30	C	38	C
Reserve Road / Gore Hill Freeway interchange	64	E	47	D
Reserve Road / Dickson Avenue	96	F	66	E
Reserve Road / Barton Road [1]	298	F	141	F

[1] Reserve Road / Barton Road is an unsignalised intersection (roundabout) and as such intersection performance is reported for the worst performing approach.

A summary of the key intersection performance outcomes for the 2037 ‘Do something’ evening peak model compared to the 2037 ‘Do minimum’ scenario is as follows (also refer to Section 3.3.5 for detailed analysis of the Reserve Road intersections):

- For all reported intersections, intersection performance improves in the 2037 ‘Do something’ scenario compared to the 2037 ‘Do minimum’ scenario during the evening peak hour
- Intersections along the critical Reserve Road corridor are expected to experience a reduction in average intersection delays
- While the Reserve Road / Barton Road intersection is still expected to operate at LoS F in the 2037 ‘Do something’ scenario, overall intersection delay is halved compared to the 2037 ‘Do minimum’ scenario indicating that the Beaches Link and Gore Hill Freeway project results in a significant improvement in traffic performance when compared to the future network without the project
- The above is also demonstrated at the Reserve Road / Gore Hill Freeway interchange and the Reserve Road / Dickson Avenue intersection whereby a reduction in average intersection delay in the order of 30 seconds can be expected.

3.3.4. Public transport impacts

Bus travel time results are located in Section 7.5.5 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key bus travel time outcomes for the 2037 ‘Do something’ evening peak model compared to the 2037 ‘Do minimum’ scenario is as follows:

- Bus travel time results for the 2037 ‘Do something’ scenario are comparable to the 2037 ‘Do minimum’ scenario indicating that the project is not expected to affect bus performance along the reported corridor.

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3.3.5. Supporting analysis

To provide some additional context on the road network performance and to better understand potential impacts on the local road network (e.g. Reserve Road corridor), the intersection performance results for individual turn movements at intersections and unreleased demands by zone have been presented in the following sections.

Reserve Road intersection performance for individual turn movements

Intersection performance for individual turn movements has been presented in Table 3.10 for the critical intersections along the Reserve Road corridor for the evening peak hour.

Table 3.10: Modelled ‘Do something’ evening peak hour (5pm to 6pm) detailed intersection performance – Gore Hill Freeway and Artarmon study area

Intersection	Approach	Movement	2037 ‘Do minimum’			2037 ‘Do something’		
			Volume	Average delay (sec)	LoS	Volume	Average delay (sec)	LoS
Reserve Road / Dickson Avenue	Reserve Road North	Left	123	11	A	-	-	-
		Through	425	14	B	433	6	A
		Right	115	25	B	162	31	C
	Dickson Avenue / Off-Ramp East	Left	22	174	F	200	33	C
		Through	57	204	F	76	25	B
		Right	187	264	F	-	-	-
	Reserve Road South	Left	14	136	F	65	47	D
		Through	744	138	F	1,154	42	C
		Right	1	100	F	-	-	-
	Dickson Avenue West	Left	290	53	D	358	246	F
		Through	48	21	B	-	-	-
		Right	14	17	B	53	170	F
	Intersection			2,040	96	F	2,501	66
Reserve Road / Gore Hill Freeway Interchange	Reserve Road North	Left	82	84	F	147	70	F
		Through	125	98	F	116	62	E
		Right	218	125	F	199	67	E
	Gore Hill Freeway East	Left	171	7	A	152	2	A
		Right	119	72	F	118	67	E
	Reserve Road South	Left	591	43	D	501	36	C
		Through	331	58	E	376	49	D
		Right – to BL	-	-	-	322	36	C
	Right – to GHF	298	74	F	303	45	D	

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Intersection	Approach	Movement	2037 'Do minimum'			2037 'Do something'		
			Volume	Average delay (sec)	LoS	Volume	Average delay (sec)	LoS
	Gore Hill Freeway West	Left	209	30	C	186	30	C
		Right	372	85	F	326	72	F
	Intersection		2,516	64	E	2,746	47	D
Reserve Road / Barton Road	Reserve Road North	Left	22	113	F	24	107	F
		Through	332	148	F	411	112	F
		Right	0	0	A	0	0	A
	Barton Road East	Left	94	299	F	146	146	F
		Through	1	660	F	2	72	F
		Right	8	239	F	45	130	F
	Reserve Road South	Left	0	0	A	0	0	A
		Through	569	3	A	575	4	A
		Right	96	5	A	104	4	A
	Barton Road West	Left	3	9	A	3	9	A
		Through	1	0	A	1	0	A
		Right	0	0	A	0	0	A
	Intersection [1]		1,126	75	F	1,311	60	E

[1] Reserve Road / Barton Road is an unsignalised intersection (roundabout) and as such intersection performance is reported for the worst performing approach.

The key outcomes of the intersection performance by movement are outlined below for the 2037 'Do something' evening peak model compared to the 2037 'Do minimum' scenario:

- At the Reserve Road / Dickson Avenue intersection, the Reserve Road south and Dickson Avenue west approaches generally indicate the highest recorded average delays. The 2037 'Do something' scenario can be expected to reduce delays on the Reserve Road south approach compared to the 2037 'Do minimum' scenario (from LoS F to LoS D). However, the Dickson Avenue west approach is shown to worsen to LoS F (from LoS D). Model observations indicate that queues on the Dickson Avenue west approach extend up to the model extents at times during the evening peak hour (approximately 220 metres from the intersection stop line) and this is largely due to the build-up of Reserve Road northbound queues at the interchange affecting the ability for Dickson Avenue traffic to enter Reserve Road. However, these queues dissipate relatively quickly at the end of the peak hour
- All approaches and movements at the Reserve Road / Gore Hill Freeway interchange can be expected to experience a reduction in average delay in the 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario
- At the Reserve Road / Barton Road intersection, the Reserve Road north and Barton Road east approaches are expected to experience high average delays in all future year scenarios. However, the 2037 'Do something' scenario is expected to result in significant improvements to average delay when compared to the 2037 'Do minimum' scenario – maximum recorded average delay reduces

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from 660 seconds to 146 seconds on these critical approaches. The efficiencies gained at the Reserve Road / Gore Hill Freeway interchange following the introduction of the project ultimately assists with throughput at the Reserve Road / Barton Road intersection, thus reducing average delays. Notwithstanding, model observations still indicate the build-up of queues at times during the evening peak on these critical approaches that extend beyond the model extent.

Unreleased demand

Unreleased demand by zone / location presented in Table 3.11 represent the number of vehicles that were not able to enter the network by the end of the reported evening peak period (6pm). Locations relevant to the Reserve Road corridor are shown in '**bold italics**'. The figures provided in Annexure B illustrate the geographical location of all zones for the 2037 'Do minimum', 2037 'Do something' and 2037 'Do something cumulative' scenarios.

Table 3.11: Modelled 'Do something' evening peak unreleased demand by zone recorded at the end of the evening peak (6pm) – Gore Hill Freeway and Artarmon study area

Zone	Location	2037 'Do minimum'	2037 'Do something'
1	Epping Road In	0	267
2	Parkland Avenue In	4	0
4	Howarth Road In	0	0
5	Pacific Highway North In	1	0
8	<i>Barton Road West In</i>	0	0
9	<i>Reserve Road North In</i>	140	74
10	<i>Barton Road East In</i>	263	57
12	Gore Hill Freeway In	2	1
13	Dickson Avenue East In [1]	41	0
14	<i>Reserve Road South In</i>	20	0
15	<i>Dickson Avenue West In</i>	0	0
16	Lane Cove Tunnel - Pacific Highway In	2	2
18	Pacific Highway South In	1	2
19	Longueville Road In	86	361
6	Beaches Link In	0	0
	Total	560	764

[1] Relevant for 'Do minimum' scenario only.

The key outcomes of the unreleased demand analysis are outlined below for the 2037 'Do something' evening peak scenario compared to the 2037 'Do minimum' scenario, focussing on the critical locations along the Reserve Road corridor:

- A reduction in unreleased demand is expected in the 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario for locations on Reserve Road and surrounds, suggesting that the project impacts are mitigated by the additional infrastructure proposed to complement / support the projects forecast demands.

3.4. Balgowlah and surrounds

As mentioned in Section 2.2.2, the environmental impact statement models for the Balgowlah and surrounds study area are considered acceptable to demonstrate the performance benefits on the local road network corridor of Sydney Road. As such, no further modelling was required for the Balgowlah and surrounds study area.

The following sections provide some additional contextual discussion on performance metrics as it relates to the environmental impact statement results, as well as presenting the intersection performance results in further detail with additional supporting analysis to demonstrate the project benefits in the 2037 'Do something' scenario when compared to the 2037 'Do minimum' scenario during the evening peak.

3.4.1. Network performance

Network performance results are located in Section 7.6.1 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key network performance outcomes for the 2037 'Do something' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- The 2037 'Do something' scenario demonstrates an improvement to overall network performance compared to the 2037 'Do minimum' scenario as indicated by the following key metrics:
 - The average vehicle trip time decreases by approximately 1.5 minutes
 - The network average trip speed increases to approximately 32 km/hr compared to 22 km/hr
 - An overall increase in vehicle kilometres travelled and decrease in vehicle hours travelled
 - A reduction in unreleased demand by approximately 600 vehicles
- The above generally indicates that the infrastructure proposed as part of the Beaches Link and Gore Hill Freeway Connection project in the 2037 'Do something' scenario would improve the operating performance of the overall Balgowlah and surrounds network when compared to a future year scenario without the project (ie 2037 'Do minimum' scenario). This also reflects the introduction of high-speed motorway sections in the 2037 'Do something' scenario.

3.4.2. General traffic travel times

General traffic travel time results are located in Section 7.6.2 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key general traffic travel time outcomes for the 2037 'Do something' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- The 2037 'Do something' scenario results show an improvement in travel time for each route compared to the 2037 'Do minimum' scenario during the evening peak hour
- The Spit Bridge to Burnt Bridge Creek Deviation / Condamine Street travel time reduces by up to 2 minutes in the northbound direction and up to 6 minutes in the southbound direction
- The Spit Bridge to Wakehurst Parkway / Judith Street travel time reduces by approximately 2 minutes in both directions. This route includes travel on Sydney Road through the intersections with Frenchs Forest Road and Burnt Bridge Creek Deviation (ie the western section of the corridor in question).

3.4.3. Intersection performance

The intersection performance results presented in Section 7.6.3 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement have been included in Table 3.12 for the 2037 'Do minimum' and 2037 'Do something' evening peak hour model scenarios but with the uncapped values for all intersections (ie no >100 second delay values).

Table 3.12: Modelled 'Do something' evening peak hour (5pm to 6pm) intersection performance – Balgowlah and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road / Manly Road / Burnt Bridge Creek Deviation	104	F	93	F
Frenchs Forest Road / Sydney Road [1]	151	F	163	F
Sydney Road / Wanganella Street	14	B	15	B
Sydney Road / Condamine Street	40	C	48	D
Condamine Street / Burnt Bridge Creek Deviation	16	B	38	C
Access Road / Sydney Road / Maretimo Street [2]	30	C	27	B
Access Road / Bridge Creek Deviation	-	-	12	A

[1] Frenchs Forest Road / Sydney Road is an unsignalised intersection (roundabout) and as such intersection performance is reported for the worst performing approach.

[2] The Do Minimum scenario does not include the Access Road approach and is an unsignalised intersection. As such intersection performance is reported for the worst performing approach.

The key outcomes of the intersection performance assessment are outlined below for the 2037 'Do something' evening peak model compared to the 2037 'Do minimum' scenario:

- The critical intersection of Sydney Road / Manly Road / Burnt Bridge Creek Deviation is expected to operate at LoS F in both the 2037 'Do something' and 2037 'Do minimum' scenarios during the evening peak hour. However, it is noted that the 2037 'Do something' scenario is expected to slightly improve intersection performance with a reduction in average intersection delay of 11 seconds compared to the 2037 'Do minimum' scenario. The performance benefits at this intersection are further illustrated through the supporting analysis (average speed plots) presented in Section 3.4.5
- The critical intersection of Frenchs Forest Road / Sydney Road is expected to perform at LoS F in both the 2037 'Do something' and 2037 'Do minimum' scenarios during the evening peak hour. Given that this is an unsignalised intersection (roundabout), the worst performing approach has been reported – Sydney Road west in the 2037 'Do minimum' scenario and Ethel Street south in the 2037 'Do something' scenario – resulting in a 12 second increase to the reported average intersection delay in the 2037 'Do something' scenario. Notwithstanding this, the performance benefits at this intersection are better illustrated through the supporting analysis (average speed plots) presented in Section 3.4.5. A further breakdown of the intersection performance by approach at this location is outlined below:

- Frenchs Forest Road north approach – approach delays reduce from 108 seconds in the 2037 'Do minimum' scenario to 83 seconds in the 2037 'Do something' scenario
- Sydney Road east approach – approach delays reduce from 25 seconds in the 2037 'Do minimum' scenario to 20 seconds in the 2037 'Do something' scenario
- Ethel Street south approach – approach delays increase from 137 seconds in the 2037 'Do minimum' scenario to 163 seconds in the 2037 'Do something' scenario
- Sydney Road west approach – approach delays reduce from 151 seconds in the 2037 'Do minimum' scenario to 147 seconds in the 2037 'Do something' scenario

In most cases, the intersection approach delays in the 2037 'Do something' scenario improve compared to the 2037 'Do minimum' scenario, with the exception of the Ethel Street south approach where a 25 second increase in delay can be expected. This is attributed to the increased throughput from the Sydney Road east approach which Ethel Street traffic give way to

- All other intersections in the 2037 'Do something' scenario can be expected to operate at a comparable level to the 2037 'Do minimum scenario' and/or at LoS D or better which is considered to be an acceptable outcome given the constrained suburban nature of the study area. This includes the intersections on the eastern section of the corridor in question – ie Sydney Road between Burnt Bridge Creek Deviation and Wanganella Street.

Limitations of isolated intersection performance results for the Balgowlah and surrounds study area

When reviewing the intersection performance results, it is important to consider the limitations in the way these performance metrics have been extracted from the model software package (VISSIM). These limitations are also relevant to other study area models but particularly pertinent to the Balgowlah and surrounds model.

Nodes (as a polygon shape) are drawn around an intersection to specify the evaluation area for intersections. The reported intersection Level of Service / delay results are extracted from VISSIM which records delays at each node by generating travel time segment lengths that begin either at a specified distance from the intersection node entrance (set at 100 metres in the Balgowlah and surrounds model) or immediately after the preceding (upstream) node, whichever comes first. The evaluation ends at the intersection node exit.

As such, the extent to which the delay is calculated is dependent on model user setup (ie 'shape' of the nodes and node evaluation parameter settings) as well as the general road network configuration. Given that the Balgowlah and surrounds study area models have a number of closely spaced intersections on Sydney Road between Frenchs Forest Road and Burnt Bridge Creek Deviation, there are limitations in this evaluation approach as the smaller segments may not capture the full extent of delay on the approaches that experience extended queuing beyond the adjacent node.

As an example, the north approach to the French Forest Road / Sydney Road roundabout and the west approach to the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection may not record the full delays on the approach due to the close proximity of adjacent intersections (or nodes). The modelling results and observations indicate that the north approach to the French Forest Road / Sydney Road roundabout experiences significant congestion, particularly in the 2037 'Do minimum' scenario with queues that extend beyond the northern adjacent intersection (or greater than 100 metres). Similarly, the west approach to the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection experiences congestion that extends beyond the western adjacent node. As such, the delays experienced beyond the adjacent intersection (or greater than 100 metres) would not be captured in the results for the relevant intersection.

Noting these limitations, it is important to re-iterate the importance of considering network and travel time performance via other model metrics and outputs to illustrate the project impacts.

3.4.4. Public transport impacts

Bus travel time results are located in Section 7.6.5 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key bus travel time outcomes for the 2037 'Do something' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- The Spit Bridge to Manly Road / Sydney Road northbound route in the 2037 'Do something' scenario can be expected to experience an improvement in bus travel time of approximately 40 seconds compared to the 2037 'Do minimum' scenario
- The Manly Road / Sydney Road to Wakehurst Parkway / Judith Street southbound route in the 2037 'Do something' scenario can be expected to experience an improvement in bus travel time of approximately 5 minutes compared to the 2037 'Do minimum' scenario (which includes the western section of Sydney Road between Frenchs Forest Road and Burnt Bridge Creek Deviation)
- Travel times for all other routes in the 2037 'Do something' scenario are within 15 seconds of the 2037 'Do minimum' scenario.

3.4.5. Supporting analysis – average speed plots

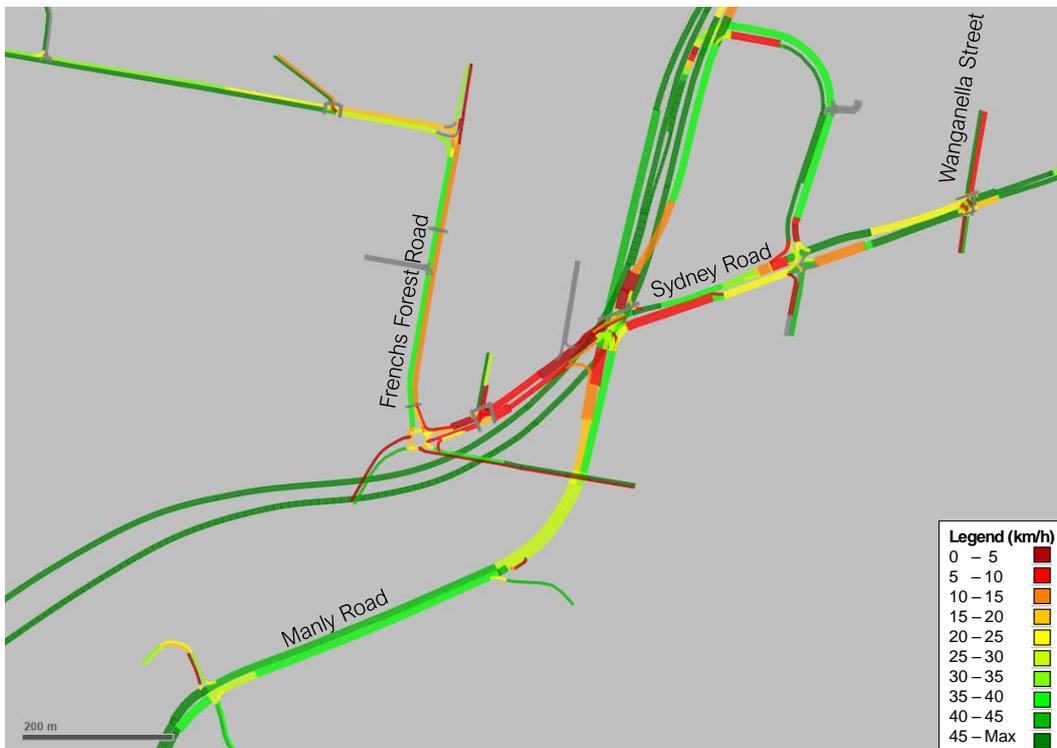
To provide some additional context on road network performance and to better understand any potential local road network impacts along the Sydney Road corridor, average speed plots of the environmental impact statement models have been presented in the following section to broadly illustrate the extent of congestion and queues expected in the respective scenarios in the evening peak. Presentation of these average speed plots also illustrates the need to consider the performance of the Balgowlah and surrounds study area from a broader network perspective noting the limitations in intersection performance results.

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Figure 3.1: Modelled 'Do minimum' evening peak (4pm to 6pm) average speed plot – Balgowlah and surrounds study area



Figure 3.2: Modelled 'Do something' evening peak (4pm to 6pm) average speed plot – Balgowlah and surrounds study area



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A summary of the key outcomes in the review of the average speed plots for the 2037 'Do something' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- The average speed plots indicate slight improvements on Sydney Road between Frenchs Forest Road and Burnt Bridge Creek Deviation in the 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario. This is also reflected on Frenchs Forest Road southbound which indicates average speed improvements in the 2037 'Do something' scenario
- On Sydney Road to the east of the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection, the performance of the corridor is generally comparable between the 2037 'Do something' scenario and the 2037 'Do minimum' scenario, including the effects of the new traffic signals in the 2037 'Do something' scenario at Access Road / Sydney Road / Maretimo Street
- Significant improvements to average speed can be expected on the north and south approaches to the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection.

3.5. Frenchs Forest and surrounds

As discussed in Section 2.2.4, the environmental impact statement models for the Frenchs Forest and surrounds study area have been reviewed and updated to reflect an assumed reduction in total traffic demand for the 2037 'Do something' scenario to align with the 2037 'Do minimum' scenario. This assumption has been made on the basis that the introduction of express bus services via the Beaches Link and opportunities for other public transport network enhancements and demand management initiatives created by Beaches Link would increase public transport demand and consequently reduce private vehicle demand.

The full suite of environmental impact statement modelling results have been replicated in the following sections. However, noting that these model performance metrics represent the refined 2037 'Do something' model runs based on the adopted approach outlined in Section 2.2.4, compared against the benchmark 2037 'Do minimum' scenario which is unchanged from the environmental impact statement (noting the following differences in the way the model outcomes are presented).

It is noted that there are some minor inconsistencies between the model outputs and results presented in Section 7.7 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement due to the way model outcomes are presented. The environmental impact statement network performance results included inconsistent calculations for specific metrics which have been corrected in the preferred infrastructure report. The environmental impact statement intersection level of service was calculated inclusive of traffic travelling through the grade separated section of Warringah Road, to demonstrate the benefit of the Northern Beaches Hospital Road Upgrade compared to pre-upgrade network conditions. However, for the preferred infrastructure report, intersection level of service has been presented excluding traffic travelling through the grade separated section, to provide a better understanding of the impacts of the project on network performance; potential project impacts are limited to the non-grade separated areas of the network. The updated results are not materially different to the environmental impact statement and do not change the overall outcomes of the environmental impact statement assessment.

3.5.1. Network performance

The network performance metrics in the Frenchs Forest and surrounds study area under the 2037 'Do minimum' and refined 2037 'Do something' scenarios are presented in Table 3.13 and Table 3.14 for the morning and evening peaks, respectively.

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Table 3.13: Modelled 'Do something' morning peak (7am to 9am) network performance – Frenchs Forest and surrounds study area

Network Measure	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles		
Total traffic demand (veh)	34,394	34,384
Total VKT through network	98,635	96,535
Total VHT through network	3,188	2,718
Total number of stops	101,630	79,865
Average vehicle statistics		
Average vehicle trip length through the network (km)	2.87	2.81
Average vehicle trip time through the network (hours)	0:05:36	0:04:35
Average number of stops per trip	2.98	2.34
Average trip speed (km/hr)	30.9	35.5
Unreleased traffic		
Total unreleased trips	315	251
% demand unreleased	1%	1%

Table 3.14: Modelled 'Do something' evening peak (4pm to 6pm) network performance – Frenchs Forest and surrounds study area

Network Measure	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles		
Total traffic demand (veh)	36,205	36,139
Total VKT through network	107,133	105,138
Total VHT through network	3,096	2,850
Total number of stops	89,506	81,735
Average vehicle statistics		
Average vehicle trip length through the network (km)	2.96	2.91
Average vehicle trip time through the network (hours)	0:05:11	0:04:33
Average number of stops per trip	2.50	2.28
Average trip speed (km/hr)	34.6	36.9
Unreleased traffic		
Total unreleased trips	369	246
% demand unreleased	1%	1%

A summary of the key network performance outcomes under the refined 2037 'Do something' morning and evening peak models compared to the 2037 'Do minimum' scenario is as follows:

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- The performance of the refined 2037 'Do something' scenario in the morning peak is improved overall compared to the 2037 'Do minimum' scenario, noting the following key metrics:
 - Total traffic demand is consistent between the refined 2037 'Do something' and 2037 'Do minimum' scenarios as intended by the preferred infrastructure report assumption
 - Total number of stops is expected to decrease by approximately 20 per cent
 - Average trip time through the network is expected to improve by approximately 1 minute
 - Average trip speed is expected to increase by approximately 5 km/hr (approximately 15 per cent improvement)
 - Marginal reduction in the number of unreleased trips at the end of the morning peak period
- The refined 2037 'Do something' scenario in the evening peak is also improved overall compared to the 2037 'Do minimum' scenario, noting the following key metrics:
 - Total traffic demand is consistent between the refined 2037 'Do something' and 2037 'Do minimum' scenarios as intended by the preferred infrastructure report assumption
 - Total number of stops is expected to decrease by approximately 10 per cent
 - Average trip time through the network is expected to improve by approximately 45 seconds
 - Average trip speed is expected to increase by approximately 2 km/hr (approximately 7 per cent improvement)
 - Marginal reduction in the number of unreleased trips at the end of the evening peak period.

The network performance results generally indicate that the refined 2037 'Do something' road network in the Frenchs Forest and surrounds study area would result in a relative improvement to road network performance in both the morning and evening peaks compared to the 2037 'Do minimum' scenario. As such, the proposed project infrastructure is considered appropriate to accommodate future year demand as compared to a future year scenario without the project. However, this is based on the assumption that total traffic demand under the refined 2037 'Do something' scenario would be equivalent to the 2037 'Do minimum' scenario as a result of a multi-modal mitigation strategy to manage private vehicle demand, leveraging the opportunities created by Beaches Link as well as the Northern Beaches Hospital Precinct Structure Plan.

3.5.2. General traffic travel times

The general travel times for key corridors within the Frenchs Forest and surrounds study area under the 2037 'Do minimum' and refined 2037 'Do something' scenarios are presented in Table 3.15 and Table 3.16 for the morning and evening peaks, respectively.

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Table 3.15: Modelled ‘Do something’ morning peak hour (8am to 9am) general traffic travel times – Frenchs Forest and surrounds study area

Route	Direction	2037 ‘Do minimum’	2037 ‘Do something’
Wakehurst Parkway / Judith Street to Wakehurst Parkway / Dreadnought Road	Northbound	0:06:58	0:04:00
	Southbound	0:05:03	0:03:34
Warringah Road / Forestville Avenue to Ellis Road / Warringah Road	Eastbound	0:05:25	0:05:25
	Westbound	0:06:12	0:05:24

Table 3.16: Modelled ‘Do something’ evening peak hour (5pm to 6pm) general traffic travel times – Frenchs Forest and surrounds study area

Route	Direction	2037 ‘Do minimum’	2037 ‘Do something’
Wakehurst Parkway / Judith Street to Wakehurst Parkway / Dreadnought Road	Northbound	0:06:59	0:03:24
	Southbound	0:04:02	0:02:47
Warringah Road / Forestville Avenue to Ellis Road / Warringah Road	Eastbound	0:06:23	0:05:50
	Westbound	0:05:36	0:05:17

A summary of the key general travel times outcomes under the refined 2037 ‘Do something’ morning and evening peak models compared to the 2037 ‘Do minimum’ scenario is as follows:

- All travel time routes under the refined 2037 ‘Do something’ scenario in the morning peak are expected to experience an improvement, noting the following:
 - Travel times on the Wakehurst Parkway / Judith Street to Wakehurst Parkway / Dreadnought Road northbound and southbound routes are expected to improve by up to 3 and 1.5 minutes, respectively
 - Travel times on the Warringah Road / Forestville Avenue to Ellis Road / Warringah Road routes are expected to experience improvements of less than 1 minute in the westbound direction
- During the evening peak, improvements to travel times are also expected under the refined 2037 ‘Do something’ scenario compared to the 2037 ‘Do minimum’ scenario, noting the following:
 - Travel times on the Wakehurst Parkway / Judith Street to Wakehurst Parkway / Dreadnought Road northbound and southbound routes are expected to improve by up to 3.5 and 1.5 minutes, respectively
 - Travel times on the Warringah Road / Forestville Avenue to Ellis Road / Warringah Road routes are expected to experience improvements of up to 30 seconds.

The above relative improvements to travel time in the refined 2037 ‘Do something’ scenario (morning and evening peaks) is a result of the traffic demand redistribution expected in the Frenchs Forest and surround study area following the introduction of the project, combined with the supporting minor infrastructure and operational changes assumed under the refined 2037 ‘Do something’ scenario. The effect of these changes balances the congestion on the Frenchs Forest and surrounds road network resulting in the observed net performance benefits from a network and corridor perspective.

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3.5.3. Intersection performance

The intersection performance results within the Frenchs Forest and surrounds study area under the 2037 'Do minimum' and refined 2037 'Do something' scenarios are presented in Table 3.17 and Table 3.18 for the morning and evening peaks, respectively.

Table 3.17: Modelled 'Do something' morning peak hour (8am to 9am) intersection performance – Frenchs Forest and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway / Frenchs Forest Road East	66	E	42	C
Warringah Road / Allambie Road	45	D	51	D
Wakehurst Parkway / Warringah Road	116	F	95	F
Warringah Road / Hilmer Street	87	F	32	C
Warringah Road / Forest Way	34	C	26	B
Forest Way / Naree Road	27	B	36	C
Warringah Road / Brown Street / Currie Road	23	B	17	B
Warringah Road / Starkey Street	26	B	19	B
Warringah Road / Darley Street	30	C	25	B
Warringah Road / Forestville Avenue	13	A	14	A

Table 3.18: Modelled 'Do something' evening peak hour (5pm to 6pm) intersection performance – Frenchs Forest and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway / Frenchs Forest Road East	46	D	37	C
Warringah Road / Allambie Road	49	D	46	D
Wakehurst Parkway / Warringah Road	65	E	55	D
Warringah Road / Hilmer Street	19	B	18	B
Warringah Road / Forest Way	42	C	31	C
Forest Way / Naree Road	27	B	25	B
Warringah Road / Brown Street / Currie Road	11	A	9	A
Warringah Road / Starkey Street	19	B	20	B

FUTURE ROAD PERFORMANCE WITH THE PROJECT

Intersection	2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Warringah Road / Darley Street	19	B	16	B
Warringah Road / Forestville Avenue	46	D	26	B

During the morning peak, key observations of intersection performance under the refined 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario are as follows:

- Intersection performance in the morning peak is expected to be generally comparable or better than the 2037 'Do minimum' scenario, with most intersections in the Frenchs Forest and surrounds area operating at LoS D or better which is considered to be an acceptable outcome given the constrained suburban nature of the study area. This includes the intersections along the Warringah Road and Frenchs Forest Road East corridors in question
- The Wakehurst Parkway / Warringah Road intersection is expected to operate at LoS F in both the 2037 'Do minimum' and 2037 'Do something' scenarios. However, an improvement in average intersection delay of approximately 20 seconds is expected under the refined 2037 'Do something' scenario illustrating the performance benefits as a result of the proposed minor infrastructure works at this intersection
- The Wakehurst Parkway / Frenchs Forest Road East intersection is also expected to experience an improvement in average intersection delay of approximately 20 seconds under the refined 2037 'Do something' scenario
- A marginal increase in average intersection delay is expected at the Warringah Road / Allambie Road and Forest Way / Naree Road intersections. However, the impacts are considered negligible with the intersection generally able to maintain operating performance when compared to the 2037 'Do minimum' scenario.

During the evening peak, key observations of intersection performance under the refined 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario are as follows:

- Similar to the morning peak, intersections under the refined 2037 'Do something' scenario are expected to operate better or comparable to the 2037 'Do minimum' scenario (and/or LoS D or better). This includes the intersections along the Warringah Road and Frenchs Forest Road East corridors
- Average intersection delays improvements are generally within 10 seconds of the 2037 'Do minimum' scenario across all intersections, with the exception of the Warringah Road / Forestville Avenue intersection which has the largest improvement in average delay of 20 seconds.

3.5.4. Public transport impacts

The bus travel times for key corridors within the Frenchs Forest and surrounds study area under the 2037 'Do minimum' and refined 2037 'Do something' scenarios are presented in Table 3.19 and Table 3.20 for the morning and evening peaks, respectively.

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Table 3.19: Modelled 'Do something' morning peak hour (8am to 9am) bus travel times – Frenchs Forest and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Northbound	0:10:44	0:10:05
	Southbound	0:08:16	0:07:11
Forestville Avenue to Ellis Road via Warringah Road and Frenchs Forest Road	Eastbound	0:16:49	0:16:33
	Westbound	0:15:35	0:13:38

Table 3.20: Modelled 'Do something' evening peak hour (5pm to 6pm) bus travel times – Frenchs Forest and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Northbound	0:11:09	0:11:18
	Southbound	0:07:16	0:07:41
Forestville Avenue to Ellis Road via Warringah Road and Frenchs Forest Road	Eastbound	0:17:06	0:17:06
	Westbound	0:13:15	0:11:21

A summary of the key bus travel time outcomes under the refined 2037 'Do something' morning and evening peak models compared to the 2037 'Do minimum' scenario is as follows:

- In the morning peak, bus travel times for the assessed corridors under the refined 2037 'Do something' scenario are generally improved when compared to the 2037 'Do minimum' scenario (up to 2 minutes improvement to bus travel times)
- In the evening peak, bus travel times for the assessed corridors under the refined 2037 'Do something' scenario are comparable to the 2037 'Do minimum' scenario. However, noting in one instance a marginal increase to bus travel times of less than 30 seconds, which is considered negligible
- The Forestville Avenue to Ellis Road via Warringah Road and Frenchs Forest Road westbound route reports the largest improvement to travel time in the order of 2 minutes in both the morning and evening peaks.

4. CUMULATIVE OPERATIONAL IMPACTS ASSESSMENT

4.1. Overview

This section provides a summary of future road network performance under the respective future year 2037 model scenarios with the full Western Harbour Tunnel and Beaches Link program – ie Western Harbour Tunnel and Warringah Freeway Upgrade project and Beaches Link and Gore Hill Freeway Connection project ('Do something cumulative'). This assessment is based on a comparison against the 2037 'Do minimum' scenario for the following performance measures (consistent with the environmental impact statement):

- Network performance metrics
- Intersection performance based on intersection Level of Service
- General traffic and bus travel times for key corridors.

Additional supplementary performance measures have been presented, where necessary, to further demonstrate the performance of the 2037 'Do something cumulative' scenarios in comparison to the 2037 'Do minimum' scenario.

It is noted that the environmental impact statement models and results for the Gore Hill Freeway and Artarmon and Balgowlah and surrounds study areas are considered appropriate to inform the preferred infrastructure report and as such no further modelling was required for the respective 2037 'Do something cumulative' scenarios. However, further detail and commentary has been provided for these study areas on the relevant performance metrics to contextualise the project benefits and impacts.

The 2037 'Do something cumulative' model results presented for the Warringah Freeway and surrounds and Frenchs Forest and surrounds study areas have been reviewed and refined as part of the preferred infrastructure report, as discussed in previous sections.

4.2. Warringah Freeway and surrounds

Intersection performance at key intersections on local road corridors is one indicator of operating performance. However, preserving the overall corridor and network performance is of primary importance to Transport for NSW, particularly for the Warringah Freeway and surrounds study area.

As such, in addition to intersection performance metrics, the full suite of performance metrics have been reviewed as part of the modelling process and presented in the following sections in order to enable consideration of the broader road network and corridor performance for users, not just individual intersection performance. These model performance metrics represent the refined 2037 'Do something cumulative' model outcomes based on the adopted approach outlined in Section 2.2.1 and compared against the benchmark 2037 'Do minimum' scenario which is unchanged from the environmental impact statement.

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4.2.1. Network performance

The network performance metrics in the Warringah Freeway and surrounds study area for the 2037 'Do minimum', refined 2037 'Do something' and refined 2037 'Do something cumulative' scenarios are presented in Table 4.1 and Table 4.2 for the morning and evening peaks, respectively.

Table 4.1: Modelled 'Do something cumulative' morning peak (6am to 9am) network performance – Warringah Freeway and surrounds study area

Network Measure	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles			
Total traffic demand (veh)	112,432	114,989	131,676
Total VKT through network	350,650	385,754	450,588
Total VHT through network	10,158	10,869	11,269
Total number of stops	746,104	672,526	457,955
Average vehicle statistics			
Average vehicle trip length through the network (km)	3.5	3.7	3.7
Average vehicle trip time through the network (hours)	0:06:01	0:06:12	0:05:31
Average number of stops per trip	7.4	6.4	3.7
Average trip speed (km/hr)	34.5	35.5	40.0
Unreleased traffic			
Total unreleased trips	11,269	9,834	9,199
% demand unreleased	10.0%	8.6%	7.0%

Table 4.2: Modelled 'Do something cumulative' evening peak (3pm to 6pm) network performance – Warringah Freeway and surrounds study area

Network Measure	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles			
Total traffic demand (veh)	118,121	120,706	129,744
Total VKT through network	348,965	387,823	408,357
Total VHT through network	12,368	10,997	10,840
Total number of stops	980,319	454,848	347,960
Average vehicle statistics			
Average vehicle trip length through the network (km)	3.2	3.5	3.5
Average vehicle trip time through the network (hours)	0:06:51	0:06:00	0:05:30

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Network Measure	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Average number of stops per trip	9.0	4.1	2.9
Average trip speed (km/hr)	28.2	35.3	37.7
Unreleased traffic			
Total unreleased trips	9,800	10,880	11,530
% demand unreleased	8.3%	9.0%	8.9%

A summary of the key network performance outcomes under the refined 2037 'Do something cumulative' morning and evening peak models compared to the 2037 'Do minimum' scenario is as follows:

- Consistent with the outcomes presented in the environmental impact statement, the refined 2037 'Do something cumulative' scenario in the morning peak indicates road network performance improvements compared to the 2037 'Do minimum' scenario, noting the following key metrics:
 - Total number of stops is expected to improve significantly by approximately 40 per cent
 - Average vehicle trip time through the network is expected to improve by approximately 30 seconds
 - Average trip speed is expected to increase by approximately 5 km/hr (approximately 16 per cent improvement)
 - Total number of unreleased trips at the end of the morning peak is expected to decrease from 10 per cent of the total demand to 7 per cent
- In the evening peak, the refined 2037 'Do something cumulative' scenario also indicates road network performance improvements compared to the 2037 'Do minimum' scenario, noting the following key metrics:
 - Total number of stops is expected to improve significantly by approximately 65 per cent
 - Average vehicle trip time through the network is expected to improve by approximately 1.5 minutes
 - Average trip speed is expected to increase by approximately 10 km/hr (approximately 34 per cent improvement)
 - The total number of unreleased trips at the end of the evening peak is expected to increase marginally from 8 per cent of the total demand to 9 per cent. The slight increase in unreleased trips is from zones on Military Road and Walker Street on approach to the Berry Street / Walker Street intersection. On the other hand, there is a significant decrease in unreleased trips from the Gore Hill Freeway southbound entry zone (by approximately 1700 vehicles) under the refined 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario.

The general improvement in network performance under the refined 2037 'Do something cumulative' scenario in both the morning and evening peaks is also reflective of the cumulative projects scenario network configuration which includes the addition of high-speed motorway sections (ie Western Harbour Tunnel and Beaches Link), as well as the upgrade of the existing motorway network (Warringah Freeway Upgrade).

4.2.2. General traffic travel times

The general traffic travel times for key corridors within the Warringah Freeway and surrounds study area under the 2037 'Do minimum', refined 2037 'Do something' and refined 2037 'Do something cumulative' scenarios are presented in Table 4.3 and Table 4.4 for the morning and evening peak hours, respectively.

Table 4.3: Modelled 'Do something cumulative' morning peak hour (8am to 9am) general traffic travel times – Warringah Freeway and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Warringah Freeway / Falcon Street Interchange	Northbound	0:04:51	0:03:29	0:04:03
	Southbound	0:04:02	0:04:08	0:04:01
Sydney Harbour Tunnel to Warringah Freeway / Falcon Street Interchange	Northbound	0:04:08	0:12:19	0:03:56
	Southbound	0:04:02	0:04:16	0:04:13
Sydney Harbour Bridge to Gore Hill Freeway / Pacific Highway Interchange	Northbound	0:06:16	0:05:22	0:05:30
	Southbound	0:15:22	0:11:47	0:08:02
Sydney Harbour Tunnel to Gore Hill Freeway / Pacific Highway Interchange	Northbound	0:05:30	0:17:08	0:05:23
	Southbound	0:12:37	0:10:26	0:08:04
Berry Street to Amherst Street via Miller Street	Northbound	0:03:53	0:04:15	0:04:54
	Southbound	0:05:43	0:04:22	0:08:00

Table 4.4: Modelled 'Do something cumulative' evening peak hour (5pm to 6pm) general traffic travel times – Warringah Freeway and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Warringah Freeway / Falcon Street Interchange	Northbound	0:07:51	0:04:59	0:04:28
	Southbound	0:05:02	0:04:39	0:04:15
Sydney Harbour Tunnel to Warringah Freeway / Falcon Street Interchange	Northbound	0:07:36	0:03:36	0:03:57
	Southbound	0:14:59	0:07:41	0:05:12
Sydney Harbour Bridge to Gore Hill Freeway / Pacific Highway Interchange	Northbound	0:06:45	0:06:53	0:05:59
	Southbound	0:17:31	0:09:09	0:06:11
Sydney Harbour Tunnel to Gore Hill Freeway / Pacific Highway Interchange	Northbound	0:06:46	0:05:22	0:05:13
	Southbound	0:30:09	0:16:00	0:07:03
Berry Street to Amherst Street via Miller Street	Northbound	0:03:50	0:05:18	0:05:04
	Southbound	0:08:39	0:04:42	0:07:39

A summary of the key general traffic travel times outcomes under the refined 2037 'Do something cumulative' scenario in the morning and evening peaks compared to the 2037 'Do minimum' scenario is as follows:

- Marginal changes to travel times are expected in the morning peak for major routes under the refined 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario, with the following notable exceptions:
 - Travel time on the Sydney Harbour Bridge to Gore Hill Freeway / Pacific Highway Interchange southbound route is expected to improve by approximately 7 minutes
 - Travel time on the Sydney Harbour Tunnel to Gore Hill Freeway / Pacific Highway Interchange southbound route is expected to improve by approximately 4 to 5 minutes
 - Travel time on the Berry Street to Amherst Street via Miller Street southbound route is expected to increase by approximately 2 minutes. This is a result of the traffic demand management strategy in this area which prioritised the management of congestion on higher order roads (e.g. Regional road corridors such as Miller Street) and reducing congestion on the local road network (e.g. Amherst Street)
- In the evening peak, travel times are comparable or improved under the refined 2037 'Do something cumulative' scenario compared to the 2037 'Do Minimum' scenario, noting the following significant improvements:
 - Travel time on the Sydney Harbour Tunnel to Warringah Freeway / Falcon Street Interchange southbound route is expected to improve by approximately 10 minutes
 - Travel time on the Sydney Harbour Bridge to Gore Hill Freeway / Pacific Highway Interchange southbound route is expected to improve by approximately 11 minutes
 - Travel time on the Sydney Harbour Tunnel to Gore Hill Freeway / Pacific Highway Interchange southbound route is expected to improve by approximately 23 minutes
- The improvements to travel times in both the morning and evening peaks are due to the changes to the Warringah Freeway configuration in the southbound direction under the refined 2037 'Do something cumulative' scenario and the addition of both Western Harbour Tunnel and Beaches Link which encourages a shift of traffic away from Sydney Harbour Bridge and Sydney Harbour Tunnel, thus relieving congestion on the Warringah Freeway and connecting routes
- Improvements are also observed in the Warringah Freeway northbound direction particularly for routes ending at the Warringah Freeway / Falcon Street interchange. The changes to the northbound configuration of the Warringah Freeway (ie separation of the Sydney Harbour Bridge and Sydney Harbour Tunnel carriageways as part of the Warringah Freeway Upgrade) has assisted in reducing merge and weave conflicts on the motorway.

4.2.3. Intersection performance

When reviewing the intersection performance results, it is imperative to clearly understand the nature of the network management and optimisation strategies adopted for the Warringah Freeway and surrounds modelling. Given the constraints of the network and the key strategic road corridors that exist within the Warringah Freeway and surrounds study area (e.g. Miller Street, Falcon Street, Military Road, Pacific Highway, etc.), emphasis is placed on preserving the function and operation of the network and/or corridors (as indicated by the network performance and travel time metrics) rather than isolated intersection performance.

A high quality, well connected network of key motorway corridors is essential in keeping other transport corridors moving, providing high levels of mobility and accessibility, and minimising impacts on local

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communities. This was considered a primary attribute to promote the viability of the Beaches Link and Gore Hill Freeway Connection project in the Warringah Freeway and surrounds study area, in addition to providing an appropriate motorway system to accommodate the movement of people, goods, and services through and within the network.

The intersection performance results for intersections within the Warringah Freeway and surrounds study area under the 2037 'Do minimum', refined 2037 'Do something' and refined 2037 'Do something cumulative' scenarios are presented in Table 4.5 and Table 4.6 for the morning and evening peak hours, respectively. The intersection performance results presented in Section 8.4.3 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement have some minor inconsistencies with the model outputs. As such, Table 3.5 and Table 4.6 presents the corrected and uncapped intersection performance results for the 2037 'Do minimum' scenario (this has been provided as a clarification within Section A5.1.5 of the submissions report) and the refined results for the 2037 'Do something' and 2037 'Do something cumulative' scenarios.

Table 4.5: Modelled 'Do something cumulative' morning peak hour (8am to 9am) intersection performance – Warringah Freeway and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road / Gore Hill Freeway interchange	123	F	24	B	9	A
Brook Street / Warringah Freeway on ramp	177	F	7	A	8	A
Brook Street / Warringah Freeway off ramp	67	E	10	A	11	A
Brook Street / Merrenburn Avenue	117	F	26	B	29	C
Amherst Street / West Street	4	A	6	A	18	B
Amherst Street / Miller Street	20	B	36	C	48	D
Miller Street / Warringah Freeway on ramp	6	A	3	A	4	A
Miller Street / Warringah Freeway off ramp	13	A	5	A	8	A
Miller Street / Ernest Street	32	C	38	C	45	D
Miller Street / Falcon Street	38	C	34	C	76	F
Ernest Street / Warringah Freeway on ramp	5	A	9	A	23	B
Ernest Street / Warringah Freeway off ramp (off ramp in evening, on ramp in morning)	5	A	11	A	23	B
Falcon Street / Warringah Freeway ramps	15	B	38	C	49	D

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Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Watson Street / Military Road	26	B	40	C	33	C
Military Road / Ben Boyd Road	23	B	58	E	61	E
Falcon Street / Merlin Street	32	C	48	D	72	F
Berry Street / Walker Street	39	C	46	D	51	D
Berry Street / Miller Street	69	E	42	C	60	E
Mount Street / Arthur Street	59	E	25	B	41	C
Pacific Highway / High Street / Arthur Street	38	C	24	B	21	B
Pacific Highway / Walker Street / Blue Street	65	E	29	C	30	C
Pacific Highway / Miller Street / Mount Street	41	C	55	D	45	D
Pacific Highway / Berry Street	52	D	11	A	54	D
Pacific Highway / Bay Road	77	F	25	B	87	F
Miller Street / McLaren Street	72	F	48	D	59	E
Miller Street / Ridge Street	53	D	46	D	68	E
Miller Street / Carlow Street	13	A	9	A	28	B
High Street / Clark Road	55	D	37	C	40	C
High Street / Alfred Street	33	C	17	B	17	B
Mount Street / Alfred Street	2	A	15	B	14	B
Ernest Street / Ben Boyd Road	12	A	13	A	28	C
Pedestrian crossing at Military Road	5	A	6	A	6	A

Table 4.6: Modelled 'Do something cumulative' evening peak hour (5pm to 6pm) intersection performance – Warringah Freeway and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road / Gore Hill Freeway interchange	76	F	9	A	11	A
Brook Street / Warringah Freeway on ramp	17	B	8	A	5	A

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Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Brook Street / Warringah Freeway off ramp	20	B	18	B	19	B
Brook Street / Merrenburn Avenue	13	A	53	D	23	B
Amherst Street / West Street	10	A	5	A	5	A
Amherst Street / Miller Street	31	C	39	C	33	C
Miller Street / Warringah Freeway on ramp	6	A	7	A	7	A
Miller Street / Warringah Freeway off ramp	15	B	9	A	8	A
Miller Street / Ernest Street	43	D	36	C	38	C
Miller Street / Falcon Street	49	D	62	E	49	D
Ernest Street / Warringah Freeway on ramp	15	B	13	A	14	A
Ernest Street / Warringah Freeway off ramp (off ramp in evening, on ramp in morning)	17	B	14	A	16	B
Falcon Street / Warringah Freeway ramps	92	F	65	E	81	F
Watson Street / Military Road	59	E	47	D	37	C
Military Road / Ben Boyd Road	70	E	103	F	92	F
Falcon Street / Merlin Street	136	F	102	F	103	F
Berry Street / Walker Street	73	F	76	F	73	F
Berry Street / Miller Street	70	F	58	E	58	E
Mount Street / Arthur Street	92	F	19	B	135	F
Pacific Highway / High Street / Arthur Street	61	E	20	B	51	D
Pacific Highway / Walker Street / Blue Street	80	F	72	F	68	E
Pacific Highway / Miller Street / Mount Street	58	E	69	E	63	E
Pacific Highway / Berry Street	56	E	20	B	75	F
Pacific Highway / Bay Road	41	C	29	C	30	C
Miller Street / McLaren Street	55	D	59	E	65	E

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Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Miller Street / Ridge Street	91	F	19	B	54	D
Miller Street / Carlow Street	19	B	7	A	7	A
High Street / Clark Road	97	F	53	D	121	F
High Street / Alfred Street	66	E	16	B	69	E
Mount Street / Alfred Street	10	A	13	A	13	A
Ernest Street / Ben Boyd Road	94	F	36	C	58	E
Pedestrian crossing at Military Road	34	C	6	A	6	A

During the morning peak, key observations of intersection performance under the refined 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario are as follows:

- Intersection performance under the refined 2037 'Do something cumulative' scenario along the Brook Street corridor is improved from the 2037 'Do minimum' scenario as congestion no longer extends back from the Warringah Freeway southbound mainline onto the Brook Street on-ramp, noting the following:
 - The Brook Street / Warringah Freeway on and off ramp intersections improves from LoS E / F to LoS A
 - The Brook Street / Merrenburn Avenue intersection improves from LoS F to LoS C
- Intersection performance along the Miller Street corridor under the refined 2037 'Do something cumulative' morning peak scenario is generally comparable to the 2037 'Do minimum' scenario and/or at LoS D or better which is considered an acceptable outcome given the constrained urban nature of the study area. However, it is noted that performance at the Miller Street / Falcon Street intersection is expected to decrease from LoS C to LoS F. The additional traffic demand arriving at this intersection following the introduction of the Western Harbour Tunnel to Falcon Street northbound off-ramp under the refined 2037 'Do something cumulative' scenario results in a higher level of competing movements, which was considered in the signal optimisation. In addition, the traffic demand management strategy implemented in this area of the network prioritised the management of congestion and queues on higher order roads (e.g. Regional road corridors such as Miller Street) thus resulting in instances like this where individual intersections may experience a decrease in Level of Service to avoid more significant upstream or downstream impacts
- Intersection performance for intersections along the Ernest Street corridor are expected to experience slight increases in delays (from LoS A to LoS B) due to the increase in demand travelling along this corridor under the refined 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario.

During the evening peak, key observations of intersection performance under the refined 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario are as follows:

- Intersection performance under the refined 2037 'Do something cumulative' scenario is generally expected to be similar to the 2037 'Do minimum' scenario, with the following notable exceptions:

- The Willoughby Road / Gore Hill Freeway Interchange improving from LoS F to LoS A
- The Miller Street / Ridge Street intersection improving from LoS F to LoS D
- The reduction in performance at the Brook Street / Merrenburn Avenue intersection observed under the refined 2037 'Do something' scenario is not evident under the refined 2037 'Do something cumulative' due to the strategic redistribution of traffic demand assumed in this scenario. The Sydney Harbour Tunnel to Brook Street northbound trips which contributed to the reduction in performance at the Brook Street / Merrenburn Avenue intersection under the refined 2037 'Do something' scenario have been forecast to originate from other zones (most notably Sydney Harbour Bridge, benefitting from the reduction in congestion created by Western Harbour Tunnel)) under the refined 2037 'Do something cumulative' scenario. These redistributed trips have better connectivity and are able to utilise the Brook Street northbound off-ramp directly, thus reducing the number of competing movements at the Brook Street / Merrenburn Avenue intersection.

4.2.4. Public transport impacts

The bus travel times for key corridors within the Warringah Freeway and surrounds study area under the 2037 'Do minimum', refined 2037 'Do something' and refined 2037 'Do something cumulative' scenarios are presented in Table 4.7 and Table 4.8 for the morning and evening peaks, respectively.

Table 4.7: Modelled 'Do something cumulative' morning peak hour (8am to 9am) bus travel times – Warringah Freeway and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:09:30	0:09:50	0:10:25
	Southbound	0:13:26	0:10:14	0:12:58
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:06:29	0:06:16	0:06:12
	Southbound	0:13:31	0:07:44	0:14:06
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:43	0:05:16	0:05:45
	Southbound	0:06:33	0:05:36	0:05:17
Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:42	0:05:37	0:05:45
	Southbound	0:28:17	0:10:04	0:07:38

Table 4.8: Modelled 'Do something cumulative' evening peak hour (5pm to 6pm) bus travel times – Warringah Freeway and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:13:34	0:15:46	0:14:10
	Southbound	0:19:09	0:16:07	0:24:53
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:09:52	0:09:40	0:08:59
	Southbound	0:13:59	0:11:51	0:17:55
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:08:36	0:06:08	0:05:49

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Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
	Southbound	0:06:51	0:05:44	0:05:50
Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:33	0:07:33	0:06:41
	Southbound	0:20:57	0:09:08	0:06:53

A summary of the key bus travel time results under the refined 2037 'Do something cumulative' morning and evening peak models compared to the 2037 'Do minimum' scenario is as follows:

- Bus travel times under the refined 2037 'Do something cumulative' morning peak scenario are generally comparable to the 2037 'Do minimum' scenario with the exception of:
 - Bus travel time on the Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway) southbound route is expected to improve by approximately 21 minutes
- In the evening peak, bus travel times under the refined 2037 'Do something cumulative' scenario are generally comparable to the 2037 'Do minimum' scenario with the exception of:
 - Bus travel time on the Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station) southbound route is expected to increase by approximately 5 minutes
 - Bus travel time on the Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway) southbound route is expected to increase by approximately 4 minutes
 - Bus travel time on the Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway) southbound route is expected to improve by approximately 13 minutes
- Significant improvements to bus travel times from Sydney Harbour Tunnel to Lane Cove Tunnel (via Gore Hill Freeway) southbound are due to the changes to the southbound bus lane configuration which is further separated from the mainline under the refined 2037 'Do something cumulative' scenario.

4.3. Gore Hill Freeway and Artarmon

As mentioned in Section 2.2.2, the environmental impact statement models for the Gore Hill Freeway and Artarmon study area are considered acceptable to demonstrate the performance benefits on the local road network corridor of Reserve Road. As such, no further modelling was required for the Gore Hill Freeway and Artarmon study area.

The following sections provide some additional contextual discussion on performance metrics as it relates to the environmental impact statement results, as well as present the intersection performance results in further detail with additional supporting analysis to demonstrate the limited project impacts in the 2037 'Do something cumulative' scenario when compared to the 2037 'Do minimum' scenario during the evening peak.

4.3.1. Network performance

Network performance results are located in Section 8.5.1 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key network performance outcomes for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- Generally, marginal changes to overall network performance are expected in the 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario during the evening peak
- A slight decrease in average speed (5 per cent) can be expected across the network, as well as increases to the number of stops and travel time. This is generally a result of increased congestion areas on Longueville Road westbound and Pacific Highway northbound in the 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario.

4.3.2. General traffic travel times

General traffic travel time results are located in Section 8.5.2 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key general travel time outcomes for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- Marginal changes to travel times are expected during the evening peak along all assessed routes in the 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario
- The notable exception being the Longueville Road to Gore Hill Freeway westbound travel time which is expected to increase by 39 seconds in the 2037 'Do something cumulative' scenario when compared to the 2037 'Do minimum' scenario.

4.3.3. Intersection performance

The intersection performance results presented in Section 8.5.3 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement have some minor inconsistencies with the model outputs. As such, Table 4.9 presents the corrected and uncapped intersection performance results for the 2037 'Do minimum', 2037 'Do something' and 2037 'Do something cumulative' evening peak hour model scenarios (this has been provided as a clarification within Section A5.1.6 of the submissions report).

Table 4.9: Modelled 'Do something cumulative' evening peak hour (5pm to 6pm) intersection performance – Gore Hill Freeway and Artarmon study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road / Longueville Road / Parklands Avenue	75	F	71	F	82	F
Longueville Road / Pacific Highway	44	D	42	D	70	F
Pacific Highway / Howarth Road / Norton Lane	8	A	6	A	5	A
Pacific Highway / Gore Hill Freeway interchange	30	C	38	C	41	C
Reserve Road / Gore Hill Freeway interchange	64	E	47	D	52	D
Reserve Road / Dickson Avenue	96	F	66	E	101	F

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Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Reserve Road / Barton Road [1]	298	F	141	F	203	F

[1] Reserve Road / Barton Road is an unsignalised intersection (roundabout) and as such intersection performance is reported for the worst performing approach.

A summary of the key intersection performance outcomes for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario is as follows (also refer to Section 4.3.5 for detailed analysis of the Reserve Road intersections):

- Similar to the 2037 'Do something' scenario, most intersections in the 2037 'Do something cumulative' scenario can be expected to maintain or improve intersection performance when compared to the 2037 'Do minimum' scenario during the evening peak hour
- The notable exceptions to the above are at the Epping Road / Longueville Road / Parklands Avenue and Longueville Road / Pacific Highway intersections due to the increase in westbound (outbound) traffic demand during the evening peak hour
- However, at the focus Reserve Road intersections, the 2037 'Do something cumulative' scenario can be expected to result in improvements at the Reserve Road / Gore Hill Freeway interchange (12 second average intersection delay reduction) and significant improvement at the Reserve Road / Barton Road intersection (95 second average intersection delay reduction) when compared to the 2037 'Do minimum' scenario. The performance of the Reserve Road / Dickson Avenue intersection is expected to be comparable to the 'Do minimum' scenario
- This also indicates that the cumulative projects (ie Western Harbour Tunnel and Warringah Freeway Upgrade, and Beaches Link and Gore Hill Freeway Connection) in the 2037 'Do something cumulative' scenario is expected to generally maintain or improve traffic performance in the Reserve Road area when compared to conditions without the project.

4.3.4. Public transport impacts

Bus travel time results are located in Section 8.5.5 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key bus travel time outcomes for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- Bus travel time results for the 2037 'Do something cumulative' are comparable to the 2037 'Do minimum' scenario indicating that the project is not expected to affect bus performance along the reported corridor.

4.3.5. Supporting analysis

To provide some additional context on the model performance results and to better understand the potential local road network performance along the Reserve Road corridor, the intersection performance results for individual turn movements at intersections and unreleased demands by zone have been presented in the following sections.

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Reserve Road intersection performance for individual turn movements

Intersection performance for individual turn movements has been presented in Table 4.10 for the critical intersections along the Reserve Road corridor for the evening peak hour.

Table 4.10: Modelled ‘Do something cumulative’ evening peak hour (5pm to 6pm) detailed intersection performance – Gore Hill Freeway and Artarmon study area

Intersection	Approach	Movement	2037 ‘Do minimum’			2037 ‘Do something’			2037 ‘Do something cumulative’			
			Volume	Average delay (sec)	LoS	Volume	Average delay (sec)	LoS	Volume	Average delay (sec)	LoS	
Reserve Road / Dickson Avenue	Reserve Road North	Left	123	11	A	-	-	-	-	-	-	
		Through	425	14	B	433	6	A	409	12	A	
		Right	115	25	B	162	31	C	176	32	C	
	Dickson Avenue / Off-Ramp East	Left	22	174	F	200	33	C	162	17	B	
		Through	57	204	F	76	25	B	76	20	B	
		Right	187	264	F	-	-	-	-	-	-	
	Reserve Road South	Left	14	136	F	65	47	D	49	85	F	
		Through	744	138	F	1,154	42	C	868	99	F	
		Right	1	100	F	-	-	-	-	-	-	
	Dickson Avenue West	Left	290	53	D	358	246	F	409	258	F	
		Through	48	21	B	-	-	-	-	-	-	
		Right	14	17	B	53	170	F	68	197	F	
	Intersection			2,040	96	F	2,501	66	E	2,217	101	F
	Reserve Road / Gore Hill Freeway Interchange	Reserve Road North	Left	82	84	F	147	70	F	136	111	F
Through			125	98	F	116	62	E	85	109	F	
Right			218	125	F	199	67	E	136	113	F	
Gore Hill Freeway East		Left	171	7	A	152	2	A	165	2	A	
		Right	119	72	F	118	67	E	136	68	E	
Reserve Road South		Left	591	43	D	501	36	C	389	36	C	
		Through	331	58	E	376	49	D	300	48	D	
		Right – to BL	-	-	-	322	36	C	260	37	C	
		Right – to GHF	298	74	F	303	45	D	322	43	D	
Gore Hill Freeway West		Left	209	30	C	186	30	C	188	26	B	
		Right	372	85	F	326	72	F	338	64	E	

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Intersection	Approach	Movement	2037 'Do minimum'			2037 'Do something'			2037 'Do something cumulative'			
			Volume	Average delay (sec)	LoS	Volume	Average delay (sec)	LoS	Volume	Average delay (sec)	LoS	
	Intersection		2,516	64	E	2,746	47	D	2,455	52	D	
Reserve Road / Barton Road	Reserve Road North	Left	22	113	F	24	107	F	18	149	F	
		Through	332	148	F	411	112	F	322	155	F	
		Right	0	0	A	0	0	A	0	0	A	
	Barton Road East	Left	94	299	F	146	146	F	105	207	F	
		Through	1	660	F	2	72	F	1	111	F	
		Right	8	239	F	45	130	F	31	192	F	
	Reserve Road South	Left	0	0	A	0	0	A	0	0	A	
		Through	569	3	A	575	4	A	534	4	A	
		Right	96	5	A	104	4	A	93	6	A	
	Barton Road West	Left	3	9	A	3	9	A	3	0	A	
		Through	1	0	A	1	0	A	1	8	A	
		Right	0	0	A	0	0	A	0	0	A	
	Intersection [1]			1,126	75	F	1,311	60	E	1,108	75	F

[1] Reserve Road / Barton Road is an unsignalised intersection (roundabout) and as such intersection performance is reported for the worst performing approach.

The key outcomes of the intersection performance by movement are outlined below for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario:

- At the Reserve Road / Dickson Avenue intersection, the Reserve Road south and Dickson Avenue west approaches experience the highest delays in the 2037 'Do something cumulative' scenario. The 2037 'Do something cumulative' scenario can be expected to reduce delays on the Reserve Road south approach by approximately 40 to 50 seconds compared to the 2037 'Do minimum' scenario (from LoS F to LoS D). However, the Dickson Avenue west approach is expected to worsen to LoS F (from LoS D). Visual model observations indicate that queues on the Dickson Avenue west approach can extend up to the model extents during the highest peak times and throughput on this approach is affected by the build-up of queues on Reserve Road, restricting intersection exit capacity
- The 2037 'Do something cumulative' scenario provides a net overall benefit to intersection performance at the Reserve Road / Gore Hill Freeway interchange when compared to the 2037 'Do minimum' scenario
- At the Reserve Road / Barton Road intersection the Reserve Road north and Barton Road east approaches are expected to experience high average delays in all future year scenarios. The 2037 'Do something cumulative' scenario is expected to result in significant improvements to average delay when compared to the 2037 'Do minimum' scenario – maximum recorded average delay reduces from 660 seconds to 207 seconds on these critical approaches. As per the 2037 'Do

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something' scenario, the efficiencies gained at the Reserve Road / Gore Hill Freeway interchange following the introduction of the project ultimately improves throughput at the Reserve Road / Barton Road intersection, thus reducing average delays. Notwithstanding, model observations still indicate the build-up of queues at times during the evening peak on approaches that extend beyond the model extent.

Unreleased demand

Unreleased demand by zone / location is presented in Table 4.11 representing the number of vehicles that were not able to enter the network by the end of the reported evening peak period (6pm). Locations relevant to the Reserve Road corridor are shown in '**bold italics**' with the Gore Hill Freeway and Artarmon model zones illustrated in Annexure B for reference.

Table 4.11: Modelled 'Do something cumulative' evening peak unreleased demand by zone recorded at the end of the evening peak (6pm) – Gore Hill Freeway and Artarmon study area

Zone	Location	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
1	Epping Road In	0	267	78
2	Parkland Avenue In	4	0	1
4	Howarth Road In	0	0	0
5	Pacific Highway North In	1	0	2
8	<i>Barton Road West In</i>	<i>0</i>	<i>0</i>	<i>0</i>
9	<i>Reserve Road North In</i>	<i>140</i>	<i>74</i>	<i>240</i>
10	<i>Barton Road East In</i>	<i>263</i>	<i>57</i>	<i>85</i>
12	Gore Hill Freeway In	2	1	1
13	Dickson Avenue East In [1]	41	0	0
14	<i>Reserve Road South In</i>	<i>20</i>	<i>0</i>	<i>242</i>
15	<i>Dickson Avenue West In</i>	<i>0</i>	<i>0</i>	<i>0</i>
16	Lane Cove Tunnel - Pacific Highway In	2	2	2
18	Pacific Highway South In	1	2	109
19	Longueville Road In	86	361	335
6	Beaches Link In	0	0	1
	Total	560	764	1,096

[1] Relevant for 'Do minimum' scenario only.

The key outcomes of the unreleased demand analysis are outlined below for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario, focussing on the relevant locations along the Reserve Road corridor:

- The 2037 'Do something cumulative' scenario can be expected to reduce the total unreleased demand originating from the Reserve Road / Barton Road intersection (Zones 8, 9 and 10)
- However, an increase in unreleased demand at the Reserve Road south zone (Zone 14) can be expected indicating there is excess demand that is unable to be accommodated on this approach to the Gore Hill Freeway and Artarmon study area extents.

4.4. Balgowlah and surrounds

As mentioned in Section 2.2.2, the environmental impact statement models for the Balgowlah and surrounds study area are considered acceptable to demonstrate the performance benefits on the local road network corridor of Sydney Road. As such, no further modelling was required for the Balgowlah and surrounds study area.

The following sections provide some additional contextual discussion on performance metrics as it relates to the environmental impact statement results, as well as presenting the intersection performance results in further detail with additional supporting analysis to demonstrate the project benefits in the 2037 'Do something cumulative' scenario when compared to the 2037 'Do minimum' scenario during the evening peak.

4.4.1. Network performance

Network performance results are located in Section 8.6.1 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key network performance outcomes for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- The 2037 'Do something cumulative' scenario demonstrates an improvement to overall network performance compared to the 2037 'Do minimum' scenario during the evening peak as indicated by the following key metrics:
 - The average vehicle trip time decreases by approximately 1.5 minutes
 - The network average trip speed increases to approximately 32 km/hr compared to 22 km/hr
 - An overall increase in vehicle kilometres travelled and decrease in vehicle hours travelled
 - A reduction in unreleased demand by 550 vehicles.
- The above generally indicates that the infrastructure proposed as part of the Beaches Link and Gore Hill Freeway Connection project in the 2037 'Do something cumulative' scenario would improve the operating performance of the overall Balgowlah and surrounds network when compared to a future year scenario without the project (ie 2037 'Do minimum' scenario). This also reflects the introduction of high-speed motorway connections in the 2037 'Do something cumulative' scenario.

4.4.2. General traffic travel times

General traffic travel time results are located in Section 8.6.2 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

A summary of the key general traffic travel time outcomes for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- The 2037 'Do something cumulative' scenario experiences an improvement in travel time for all routes compared to the 2037 'Do minimum' scenario during the evening peak
- The Spit Bridge to Burnt Bridge Creek Deviation / Condamine Street travel time improves by up to 2 minutes in the northbound direction and up to 6 minutes in the southbound direction
- The Spit Bridge to Wakehurst Parkway / Judith Street travel time improves by approximately 2 minutes in both directions. This route includes travel on Sydney Road through the intersections with Frenchs Forest Road and Burnt Bridge Creek Deviation (ie the western section of the corridor in focus).

4.4.3. Intersection performance

Section 3.4.3 of this report describes some limitations associated with the intersection performance results for the Balgowlah and surrounds model in the 'Do something' scenario. These limitations are also applicable in the review of intersection performance results for the 2037 'Do something cumulative' scenario.

The intersection performance results presented in Section 8.6.3 of Appendix F (Technical working paper: Traffic and transport) have been included in Table 4.12 for the 2037 'Do minimum', 2037 'Do something' and 2037 'Do something cumulative' evening peak hour scenarios but with the uncapped values for all intersections (ie no >100 second delay values).

Table 4.12: Modelled 'Do something cumulative' evening peak hour (5pm to 6pm) intersection performance – Balgowlah and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road / Manly Road / Burnt Bridge Creek Deviation	104	F	93	F	73	F
Frenchs Forest Road / Sydney Road [1]	151	F	163	F	172	F
Sydney Road / Wanganella Street	14	B	15	B	15	B
Sydney Road / Condamine Street	40	C	48	D	45	D
Condamine Street / Burnt Bridge Creek Deviation	16	B	38	C	41	C
Access Road / Sydney Road / Maretimo Street [2]	30	C	27	B	31	C
Access Road / Bridge Creek Deviation	-	-	12	A	11	A

[1] Frenchs Forest Road / Sydney Road is an unsignalised intersection (roundabout) and as such intersection performance is reported for the worst performing approach.

[2] The Do Minimum scenario does not include the Access Road approach and is an unsignalised intersection. As such intersection performance is reported for the worst performing approach.

The key outcomes of the intersection performance assessment are outlined below for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario:

- The critical intersection of Sydney Road / Manly Road / Burnt Bridge Creek Deviation is expected to perform at LoS F in both the 2037 'Do something cumulative' and 2037 'Do minimum' scenarios during the evening peak hour. However, it is noted that the 2037 'Do something cumulative' is expected to improve average intersection delay by 31 seconds compared to the 2037 'Do minimum' scenario
- The critical intersection of Frenchs Forest Road / Sydney Road is expected to perform at LoS F in both the 2037 'Do something cumulative' and 2037 'Do minimum' scenarios during the evening peak hour. A 21 second increase to average intersection delay on the worst performing approach is

expected in the 2037 'Do something cumulative' scenario. Notwithstanding this, the performance benefits at this intersection are better illustrated through the supporting analysis (average speed plots) presented in Section 4.4.5. Given that the Frenchs Forest Road Sydney Road intersection is an unsignalised intersection (roundabout), the worst performing approach has been reported in Table 4.12 above (and within the environmental impact statement) – Sydney Road west in the 2037 'Do minimum' scenario and Ethel Street south in the 2037 'Do something cumulative' scenario – resulting in a 21 second increase to the reported average intersection delay in the 2037 'Do something cumulative' scenario. A further breakdown of the intersection performance by approach is outlined below:

- Frenchs Forest Road north approach – approach delays reduce from 108 seconds in the 2037 'Do minimum' scenario to 80 seconds in the 2037 'Do something cumulative' scenario
- Sydney Road east approach – approach delays reduce from 25 seconds in the 2037 'Do minimum' scenario to 19 seconds in the 2037 'Do something cumulative' scenario
- Ethel Street south approach – approach delays increase from 137 seconds in the 2037 'Do minimum' scenario to 172 seconds in the 2037 'Do something cumulative' scenario
- Sydney Road west approach – approach delays increase from 151 seconds in the 2037 'Do minimum' scenario to 153 seconds in the 2037 'Do something cumulative' scenario

In most cases, the intersection approach delays in the 2037 'Do something cumulative' scenario improve compared to the 2037 'Do minimum' scenario, with the exception of the Ethel Street south approach where a 35 second increase in delay can be expected. Similar to the 2037 'Do something' scenario, this is attributed to the increased throughput from the Sydney Road east approach which Ethel Street traffic give way to

- The remaining intersections in the 2037 'Do something cumulative' scenario can be expected to operate at either a comparable level to the 2037 'Do minimum scenario' and/or at LoS D or better which is considered an acceptable outcome given the constrained suburban nature of the study area. This includes the intersections on the eastern section of the corridor in question – ie Sydney Road between Burnt Bridge Creek Deviation and Wanganella Street.

4.4.4. Public transport impacts

Bus travel time results are located in Section 8.6.5 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement.

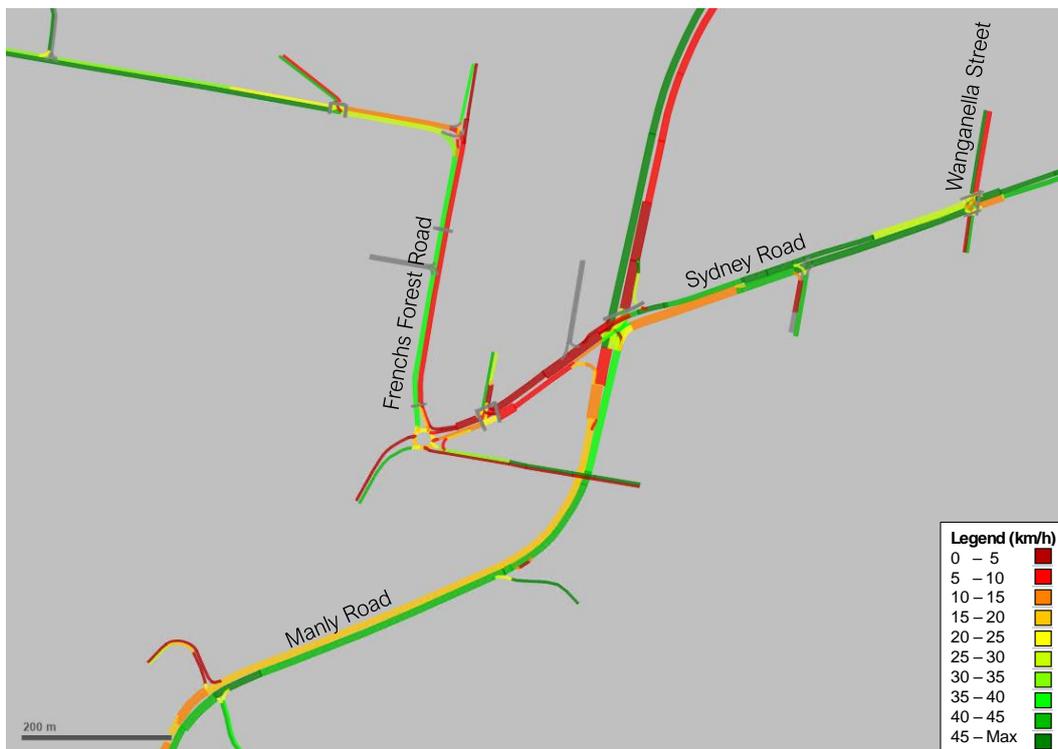
A summary of the key bus travel time outcomes for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- The Spit Bridge to Manly Road / Sydney Road northbound route in the 2037 'Do something cumulative' scenario can be expected to experience an improvement in bus travel times of approximately 2.5 minutes compared to the 2037 'Do minimum' scenario
- The Manly Road / Sydney Road to Wakehurst Parkway / Judith Street southbound route in the 2037 'Do something cumulative' scenario can be expected to experience an improvement in bus travel times of approximately 9 minutes compared to the 2037 'Do minimum' scenario (which includes the western section of Sydney Road between Frenchs Forest Road and Burnt Bridge Creek Deviation)
- The Manly Road / Sydney Road to Burnt Bridge Creek Deviation / Condamine Street southbound route in the 2037 'Do something cumulative' scenario can be expected to experience an increase in bus travel times of approximately 1.5 minutes compared to the 2037 'Do minimum' scenario.

4.4.5. Supporting analysis – average speed plots

To provide some additional context on road network performance and to better understand the potential local road network impact along the Sydney Road corridor, average speed plots of the environmental impact statement models have been presented in the following section to broadly illustrate the extent of congestion and queues expected in the respective scenarios in the evening peak. Presentation of these average speed plots also illustrates the need to consider the performance of the Balgowlah and surrounds study area from a broader network perspective noting the limitations in intersection performance results.

Figure 4.1: Modelled ‘Do minimum’ evening peak hour (4pm to 6pm) average speed plot – Balgowlah and surrounds study area



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Figure 4.2: Modelled 'Do something' evening peak hour (4pm to 6pm) average speed plot – Balgowlah and surrounds study area

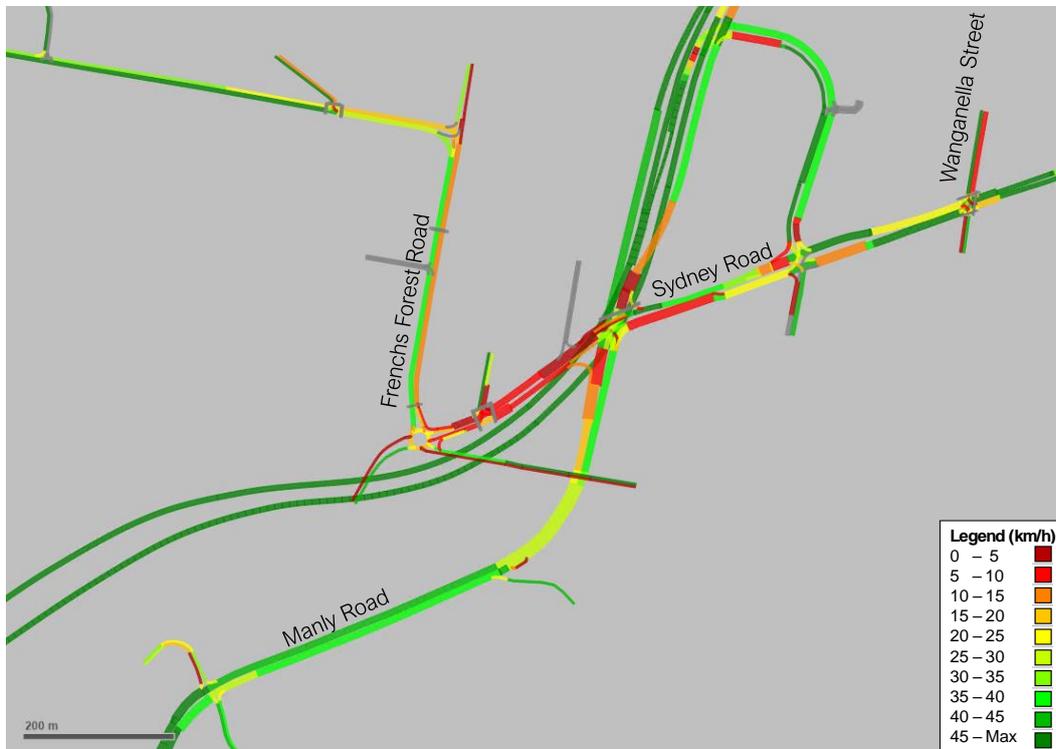
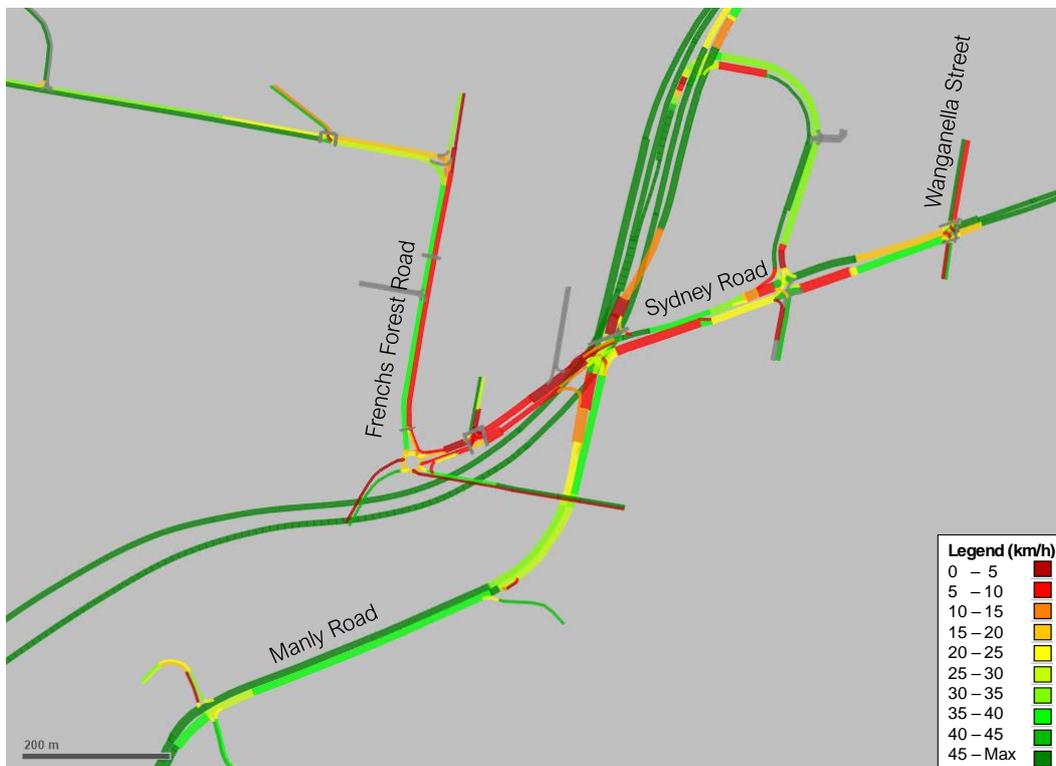


Figure 4.3: Modelled 'Do something cumulative' evening peak hour (4pm to 6pm) average speed plot – Balgowlah and surrounds study area



A summary of the key outcomes in the review of the average speed plots for the 2037 'Do something cumulative' evening peak model compared to the 2037 'Do minimum' scenario is as follows:

- The average speed plots indicate slight improvements on Sydney Road between Frenchs Forest Road and Burnt Bridge Creek Deviation in the 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario
- While not clearly visible in the average speed plots, model visual observations confirmed that the operation of Frenchs Forest Road southbound on approach to Sydney Road improves in the 2037 'Do something cumulative' scenario compared to 2037 'Do minimum' scenario with a reduction in the extent of queues
- On Sydney Road to the east of the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection, the performance of the corridor is slightly slower in the 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario due to the introduction of traffic signals at the Maretimo Street / Access Road intersection. Notwithstanding, the average speed plots illustrate that congestion (or queues) are not extensive on this section of the corridor, supported by the intersection performance results which show comparable levels of performance with the 2037 'Do minimum' scenario
- Significant improvements to average speed can be expected on the north and south approaches to the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection.

4.5. Frenchs Forest and surrounds

Similar to the 2037 'Do something' scenario presented in Section 3.5 of this report for the Frenchs Forest and surrounds study area, the 2037 'Do something cumulative' scenario also assumes a reduction in total traffic demand to align with the 2037 'Do minimum' scenario. This assumption has been made on the basis that the introduction of express bus services via the Beaches Link and opportunities for other public transport network enhancements and demand management initiatives created by Beaches Link would increase public transport demand and consequently reduce private vehicle demand.

The model performance metrics presented in the following sections represent the refined 2037 'Do something cumulative' model runs based on the adopted approach outlined in Section 2.2.4, compared against the benchmark 2037 'Do minimum' scenario which is unchanged from the environmental impact statement (noting the following differences in the way the model outcomes are presented).

It is noted that there are some minor inconsistencies between the model outputs and results presented in Section 8.7 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement due to the way model outcomes are presented. The environmental impact statement network performance results included inconsistent calculations for specific metrics which have been corrected in the preferred infrastructure report. The environmental impact statement intersection level of service was calculated inclusive of traffic travelling through the grade separated section of Warringah Road, to demonstrate the benefit of the Northern Beaches Hospital Road Upgrade compared to pre-upgrade network conditions. However, for the preferred infrastructure report, intersection level of service has been presented excluding traffic travelling through the grade separated section, to provide a better understanding of the impacts of the project on network performance; potential project impacts are limited to the non-grade separated areas of the network. The updated results are not materially different to the environmental impact statement and do not change the outcomes of the environmental impact statement assessment.

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4.5.1. Network performance

The network performance metrics in the Frenchs Forest and surrounds study area under the 2037 'Do minimum', refined 2037 'Do something' and refined 2037 'Do something cumulative' scenarios are presented in Table 4.13 and Table 4.14 for the morning and evening peaks, respectively.

Table 4.13: Modelled 'Do something cumulative' morning peak (7am to 9am) network performance – Frenchs Forest and surrounds study area

Network Measure	2037 'Do minimum'	2037 'Do something'	2037 'Do something' cumulative
Network statistics for all vehicles			
Total traffic demand (veh)	34,394	34,384	34,307
Total VKT through network	98,635	96,535	94,727
Total VHT through network	3,188	2,718	2,897
Total number of stops	101,630	79,865	90,691
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.87	2.81	2.76
Average vehicle trip time through the network (hours)	0:05:36	0:04:35	0:05:03
Average number of stops per trip	2.98	2.34	2.68
Average trip speed (km/hr)	30.9	35.5	32.7
Unreleased traffic			
Total unreleased trips	315	251	471
% demand unreleased	1%	1%	1%

Table 4.14: Modelled 'Do something cumulative' evening peak (4pm to 6pm) network performance – Frenchs Forest and surrounds study area

Network Measure	2037 'Do minimum'	2037 'Do something'	2037 'Do something' cumulative
Network statistics for all vehicles			
Total traffic demand (veh)	36,205	36,139	36,198
Total VKT through network	107,133	105,138	105,364
Total VHT through network	3,096	2,850	2,878
Total number of stops	89,506	81,735	83,359
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.96	2.91	2.91
Average vehicle trip time through the network (hours)	0:05:11	0:04:33	0:04:38

CUMULATIVE OPERATIONAL IMPACTS ASSESSMENT

Network Measure	2037 'Do minimum'	2037 'Do something'	2037 'Do something' cumulative
Average number of stops per trip	2.50	2.28	2.32
Average trip speed (km/hr)	34.6	36.9	36.6
Unreleased traffic			
Total unreleased trips	369	246	269
% demand unreleased	1%	1%	1%

A summary of the key network performance outcomes under the refined 2037 'Do something cumulative' morning and evening peak models compared to the 2037 'Do minimum' scenario is as follows:

- The performance of the refined 2037 'Do something cumulative' scenario in the morning peak is improved overall compared to the 2037 'Do minimum' scenario, noting the following key metrics:
 - Total traffic demand is consistent between the refined 2037 'Do something cumulative' and 2037 'Do minimum' scenarios as intended by the preferred infrastructure report assumption
 - Total number of stops is expected to decrease by approximately 11 per cent
 - Average trip time through the network is expected to decrease by approximately 30 seconds
 - Average trip speed is expected to increase by approximately 2 km/hr (or approximately 6 per cent improvement)
 - Marginal increase in the number of unreleased trips at the end of the morning peak period
- Network performance under the refined 2037 'Do something cumulative' scenario in the evening peak is also improved overall compared to the 2037 'Do minimum' scenario, noting the following key metrics:
 - Total traffic demand is consistent between the refined 2037 'Do something' and 2037 'Do minimum' scenarios as intended by the preferred infrastructure report assumption
 - Total number of stops is expected to decrease by approximately 7 per cent
 - Average trip time through the network is expected to decrease by approximately 30 seconds
 - Average trip speed is expected to increase by approximately 2 km/hr (or approximately 6 per cent improvement)
 - Marginal reduction in the number of unreleased trips at the end of the evening peak period.

Similar to the refined 2037 'Do something' scenario, the network performance results generally indicate that the refined 2037 'Do something cumulative' road network in the Frenchs Forest and surrounds study area would result in a relative improvement to road network performance in both the morning and evening peaks compared to the 2037 'Do minimum' scenario. As such, the proposed project infrastructure is considered appropriate to accommodate future year demand as compared to a future year scenario without the project. However, this is based on the assumption that total traffic demand under the refined 2037 'Do something cumulative' scenario would be equivalent to the 2037 'Do minimum' scenario as a result of a multi-modal mitigation strategy to manage private vehicle demand, leveraging the opportunities created by Beaches Link as well as the Northern Beaches Hospital Precinct Structure Plan.

4.5.2. General traffic travel times

The general traffic travel times for key corridors within the Frenchs Forest and surrounds study area under the 2037 'Do minimum', refined 2037 'Do something' and refined 2037 'Do something cumulative' scenarios are presented in Table 4.15 and Table 4.16 for the morning and evening peak hours, respectively.

Table 4.15: Modelled 'Do something cumulative' morning peak hour (8am to 9am) general traffic travel times – Frenchs Forest and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Wakehurst Parkway / Judith Street to Wakehurst Parkway / Dreadnought Road	Northbound	0:06:58	0:04:00	0:03:33
	Southbound	0:05:03	0:03:34	0:03:12
Warringah Road / Forestville Avenue to Ellis Road / Warringah Road	Eastbound	0:05:25	0:05:25	0:06:12
	Westbound	0:06:12	0:05:24	0:05:12

Table 4.16: Modelled 'Do something cumulative' evening peak hour (5pm to 6pm) general traffic travel times – Frenchs Forest and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Wakehurst Parkway / Judith Street to Wakehurst Parkway / Dreadnought Road	Northbound	0:06:59	0:03:24	0:03:50
	Southbound	0:04:02	0:02:47	0:02:58
Warringah Road / Forestville Avenue to Ellis Road / Warringah Road	Eastbound	0:06:23	0:05:50	0:05:49
	Westbound	0:05:36	0:05:17	0:05:16

A summary of the key general travel time outcomes under the refined 2037 'Do something cumulative' morning and evening peak models compared to the 2037 'Do minimum' scenario is as follows:

- All travel time routes under the refined 2037 'Do something cumulative' scenario in the morning peak are expected to experience an improvement to travel times, noting the following:
 - Travel times on the Wakehurst Parkway / Judith Street to Wakehurst Parkway / Dreadnought Road northbound and southbound routes are expected to improve by up to 3.5 minutes and 2 minutes, respectively
 - Travel times on the Warringah Road / Forestville Avenue to Ellis Road / Warringah Road westbound routes are expected to improve by approximately 1 minute. However, the eastbound route is expected to marginally increase (by less than 1 minute) as a result of balancing the increase to Wakehurst Parkway north-south demand with the Warringah Road east-west demands, particularly at the critical Wakehurst Parkway / Warringah Road and Wakehurst Parkway / Frenchs Forest Road East intersections

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- During the evening peak, an improvement to travel times is also expected under the refined 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario, noting the following:
 - Travel times on the Wakehurst Parkway / Judith Street to Wakehurst Parkway / Dreadnought Road northbound and southbound routes are expected to improve by approximately 3 minutes and 1 minute, respectively
 - Travel times on the Warringah Road / Forestville Avenue to Ellis Road / Warringah Road routes are expected to experience improvements of up to 30 seconds.

Similar to the refined 2037 'Do something' scenario, the above relative improvements to travel times under the refined 2037 'Do something cumulative' scenario (morning and evening peaks) reflects the traffic demand redistribution expected in the Frenchs Forest and surrounds study area following the introduction of the project, combined with the supporting minor infrastructure and operational changes assumed under the refined 2037 'Do something cumulative' scenario. This balances the congestion on the Frenchs Forest and surrounds road network resulting in the observed net performance benefits from a network and corridor perspective. However, it is noted that the refined 2037 'Do something cumulative' scenario in the morning peak experiences slight increases to congestion on Warringah Road eastbound resulting in a marginal increase to travel time on this route.

4.5.3. Intersection performance

The intersection performance results for the Frenchs Forest and surrounds study area under the 2037 'Do minimum', refined 2037 'Do something' and refined 2037 'Do something cumulative' scenarios are presented in Table 4.17 and Table 4.18 for the morning and evening peak hours, respectively.

Table 4.17: Modelled 'Do something cumulative' morning peak hour (8am to 9am) intersection performance – Frenchs Forest and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway / Frenchs Forest Road East	66	E	42	C	40	C
Warringah Road / Allambie Road	45	D	51	D	40	C
Wakehurst Parkway / Warringah Road	116	F	95	F	99	F
Warringah Road / Hilmer Street	87	F	32	C	67	E
Warringah Road / Forest Way	34	C	26	B	37	C
Forest Way / Naree Road	27	B	36	C	52	D
Warringah Road / Brown Street / Currie Road	23	B	17	B	14	A
Warringah Road / Starkey Street	26	B	19	B	18	B
Warringah Road / Darley Street	30	C	25	B	25	B

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Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Warringah Road / Forestville Avenue	13	A	14	A	14	A

Table 4.18: Modelled 'Do something cumulative' evening peak hour (5pm to 6pm) intersection performance – Frenchs Forest and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway / Frenchs Forest Road East	46	D	37	C	40	C
Warringah Road / Allambie Road	49	D	46	D	44	D
Wakehurst Parkway / Warringah Road	65	E	55	D	50	C
Warringah Road / Hilmer Street	19	B	18	B	17	B
Warringah Road / Forest Way	42	C	31	C	33	C
Forest Way / Naree Road	27	B	25	B	28	B
Warringah Road / Brown Street / Currie Road	11	A	9	A	8	A
Warringah Road / Starkey Street	19	B	20	B	19	B
Warringah Road / Darley Street	19	B	16	B	15	B
Warringah Road / Forestville Avenue	46	D	26	B	28	B

During the morning peak, key observations of intersection performance under the refined 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario are as follows:

- Intersection performance in the morning peak is expected to be generally comparable or better than the 2037 'Do minimum' scenario, with most intersections in the Frenchs Forest and surrounds area expected to operate at LoS D or better which is considered to be an acceptable outcome given the constrained suburban nature of the study area. This includes the intersections along the Warringah Road and Frenchs Forest Road East corridors in focus
- The Wakehurst Parkway / Warringah Road intersection is expected to operate at LoS F in both the 2037 'Do minimum' and 2037 'Do something cumulative' scenarios. However, similar to the refined 2037 'Do something' scenario an improvement in average intersection delay of approximately 20 seconds is expected under the refined 2037 'Do something cumulative' scenario illustrating the performance benefits as a result of the proposed minor infrastructure works at this intersection

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- The Wakehurst Parkway / Frenchs Forest Road East intersection is also expected to experience an improvement in average intersection delay of approximately 25 seconds under the refined 2037 'Do something cumulative' scenario
- It is noted that the Wakehurst Parkway / Hilmer Street intersection is expected to operate at LoS E under the refined 2037 'Do something cumulative' scenario but this represents an improvement compared to the 2037 'Do minimum' scenario which operates at LoS F, reflecting a 20 second improvement in average intersection delay
- The Forest Way / Naree Road intersection is expected to experience an increase of 25 seconds to average intersection delay, however, still operates at LoS D which is considered to be an acceptable outcome given the constrained suburban nature of the study area.

During the evening peak, key observations of intersection performance under the refined 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario are as follows:

- All intersections in the refined 2037 'Do something cumulative' scenario are expected to operate better or comparable to the 2037 'Do minimum' scenario (and/or LoS D or better). This includes the intersections along the Warringah Road and Frenchs Forest Road corridors
- Average intersection delay improvements are generally within 10 seconds of the 2037 'Do minimum' scenario across all intersections, with the exception of the Warringah Road / Forestville Avenue intersection which has the largest improvement in average delay of up to 20 seconds.

4.5.4. Public transport impacts

The bus travel times for key corridors within the Frenchs Forest and surrounds study area under the 2037 'Do minimum', refined 2037 'Do something' and refined 2037 'Do something cumulative' scenarios are presented in Table 4.19 and Table 4.20 for the morning and evening peak hours, respectively.

Table 4.19: Modelled 'Do something cumulative' morning peak hour (8am to 9am) bus travel times – Frenchs Forest and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Northbound	0:10:44	0:10:05	0:10:14
	Southbound	0:08:16	0:07:11	0:08:25
Forestville Avenue to Ellis Road via Warringah Road and Frenchs Forest Road	Eastbound	0:16:49	0:16:33	0:17:41
	Westbound	0:15:35	0:13:38	0:13:29

Table 4.20: Modelled 'Do something cumulative' evening peak hour (5pm to 6pm) bus travel times – Frenchs Forest and surrounds study area

Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
	Northbound	0:11:09	0:11:18	0:11:21

CUMULATIVE OPERATIONAL IMPACTS ASSESSMENT

Route	Direction	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Southbound	0:07:16	0:07:41	0:07:35
Forestville Avenue to Ellis Road via Warringah Road and Frenchs Forest Road	Eastbound	0:17:06	0:17:06	0:17:13
	Westbound	0:13:15	0:11:21	0:10:52

A summary of the key bus travel time outcomes under the refined 2037 'Do something cumulative' morning and evening peak models compared to the 2037 'Do minimum' scenario is as follows:

- In the morning peak, bus travel times for the assessed corridors under the refined 2037 'Do something cumulative' scenario are generally comparable to the 2037 'Do minimum' scenario. However, a marginal increase to bus travel time is expected on the Forestville Avenue to Ellis Road via Warringah Road and Frenchs Forest Road eastbound route of approximately 1 minute
- In the evening peak, bus travel times for the assessed corridors under the refined 2037 'Do something cumulative' scenario are also comparable to the 2037 'Do minimum' scenario. Marginal increases to bus travel times of less than 20 seconds can be expected for some routes which is considered negligible
- The Forestville Avenue to Ellis Road via Warringah Road and Frenchs Forest Road westbound route reports the largest improvement to travel time in the order of 2 minutes in both the morning and evening peaks.

5. SUMMARY

5.1. Warringah Freeway and surrounds

Based on the discussion and analysis presented in this report, refined operational traffic models for the Warringah Freeway and surrounds study area indicates the following key outcomes:

- Both the 2037 'Do something' and 2037 'Do something cumulative' scenarios in the morning peak generally result in an improvement to overall road network performance compared to the 2037 'Do minimum' scenario with higher average trip speeds and similar or improved average trip times recorded. The number of unreleased trips at the end of the morning peak also decreases from the 2037 'Do minimum' scenario to 2037 'Do something' scenario, and decreases further in the 2037 'Do something cumulative' scenario
- In the evening peak, both the 2037 'Do something' and 2037 'Do something cumulative' scenarios also show an improvement to overall road network performance with higher average trip speeds, significantly lower number of total stops and lower average trip times compared to the 2037 'Do minimum' scenario. However, a slight increase in the total number of unreleased trips at the end of the evening peak in the 2037 'Do something' and 2037 'Do something cumulative' scenarios was observed from Military Road, and Walker Street in North Sydney, which is balanced by a significant decrease in the total number of unreleased trips on Gore Hill Freeway southbound
- The changes to the Warringah Freeway configuration in the 2037 'Do something' and 2037 'Do something cumulative' scenarios contribute to significant improvements to travel times on the Warringah Freeway mainline in both the northbound and southbound directions compared to the 2037 'Do minimum' scenario in both the morning and evening peaks
- The review of intersection performance results for the nominated intersections within the Warringah Freeway and surrounds study area generally indicate net performance benefits across the majority of locations in the network in the 2037 'Do something' and 2037 'Do something cumulative' scenarios compared to the 2037 'Do minimum' scenario. However, it is noted that there are a small number of locations where residual impacts to isolated intersection delay are reported.

To address these residual issues Transport for NSW would continue to investigate further opportunities to provide additional benefits or mitigate residual impacts within the Warringah Freeway and surrounds study through the Western Harbour Tunnel and Beaches Link program and/or other relevant processes. Given the context of this complex and constrained urban area, additional mitigations would focus on multi-modal transport and demand management strategies to reduce private vehicle demand rather than seek to deliver further road capacity upgrades, consistent with the North Sydney Integrated Transport Program and cognisant of the need to balance movement and place outcomes in constrained urban areas such as North Sydney, Cammeray, and surrounds.

5.2. Gore Hill Freeway and Artarmon

Based on the discussion and analysis presented in this report, additional analysis of the environmental impact statement operational traffic models for the Gore Hill Freeway and Artarmon study area indicates the following key outcomes:

- The 2037 'Do something' scenario in the evening peak can generally be expected to operate at a comparable or improved performance level than the 2037 'Do minimum' scenario. In particular, the

modelling indicates that intersection performance along the Reserve Road corridor is expected to be at a satisfactory level and generally improved when compared to the 2037 'Do minimum' scenario

- While impacts are expected to be higher in the 2037 'Do something cumulative' scenario compared to the 2037 'Do something' scenario, the modelling also demonstrates net overall benefits can be expected along the Reserve Road corridor when compared to the 2037 'Do minimum' scenario. Average delays during the busiest peak periods can be expected to remain at a relatively high level in this scenario, however, the operational traffic modelling assessment has necessarily considered a balance between optimising localised corridor performance and broader network performance.

Overall, the additional information extracted and provided confirms the operational traffic modelling outcomes for the Gore Hill Freeway and Artarmon study area as presented in the environmental impact statement. Specifically, that the project (and broader Western Harbour Tunnel and Beaches Link program of works) would not adversely impact the performance of the local road network (specifically Reserve Road).

In addition, sensitivity testing of the Gore Hill Freeway and Artarmon study area models indicates that further localised performance improvements could potentially be gained through signal optimisation. However, the model results also highlight the complexity of the Gore Hill Freeway and Artarmon study area network, whereby the broader (or downstream) impacts on the network negates the benefits achieved in the local area, thus resulting in limited or no change to the overall performance of the network.

5.3. Balgowlah and surrounds

Based on the discussion and analysis presented in this report, additional analysis of the environmental impact statement operational traffic models for the Balgowlah and surrounds study area indicates the following key outcomes:

- The environmental impact statement model scenarios generally demonstrate significant improvements to the overall network and corridor performance following the introduction of the project in the 2037 'Do something' and 2037 'Do something cumulative' model scenarios when compared to the 'Do minimum' scenario
- However, for all scenarios congestion is evident at the west approach of the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection with queues extending beyond the Frenchs Forest Road / Sydney Road roundabout, limiting the overall network performance
- The noted limitations of isolated intersection performance evaluation places further emphasis on the need to consider network performance and travel time metrics (and other model outputs) to demonstrate the benefits of the Beaches Link and Gore Hill Freeway Connection project. In this regard, the modelling indicates that the 2037 'Do something' and 2037 'Do something cumulative' scenarios are expected to result in improved performance compared to the 2037 'Do minimum' scenario.

Overall, the additional information extracted and provided confirms the operational traffic modelling outcomes for the Balgowlah and surrounds study area as presented in the environmental impact statement. Specifically, that the project (and broader Western Harbour Tunnel and Beaches Link program of works) would not adversely impact the performance of the local road network, in particular Sydney Road.

In addition, sensitivity testing of the Balgowlah and surrounds study area models indicates that localised performance improvements could potentially be gained – and the traffic performance benefits of the

Beaches Link project amplified – through signal optimisation at the Sydney Road / Manly Road / Burnt Bridge Creek Deviation intersection in combination with potential capacity improvement works at the Frenchs Forest Road / Sydney Road roundabout.

5.4. Frenchs Forest and surrounds

Based on the above discussion and analysis, the refined operational traffic models for the Frenchs Forest and surrounds study area indicate the following key outcomes:

- The approach to target total traffic demand in the 2037 'Do something' and 2037 'Do something cumulative' scenarios to be consistent with the 2037 'Do minimum' scenario results in a general improvement to road network performance compared to the 2037 'Do minimum' scenario across all performance metrics, in both the morning and evening peaks
- This includes the key road corridors in focus – ie Frenchs Forest Road and Warringah Road – whereby intersections along these corridors generally operate similar to or better than the 2037 'Do minimum' scenario
- As such, the proposed infrastructure and operational upgrades proposed by the project are considered appropriate to accommodate the expected level of future traffic demand growth in the Frenchs Forest and surrounds study area (on the assumption that traffic demand can be managed to an equivalent level to the 2037 'Do minimum' scenario). In particular, the network improvements on the northbound approach to the Wakehurst Parkway / Warringah Road intersection and access to the Warringah Road underpass offers a suitable package of mitigation works to accommodate the changes to traffic distribution expected in the 2037 'Do something' and 2037 'Do something cumulative' scenarios when compared with the 2037 'Do minimum' scenario.

The introduction of express bus services via the Beaches Link and opportunities for other public transport network enhancements and demand management initiatives created by Beaches Link would increase public transport demand and consequently reduce private vehicle demand. Noting this and given the context of this complex and constrained urban area, additional mitigations would focus on multi-modal strategies to reduce private vehicle demand rather than seek to deliver further road capacity upgrades, consistent with ongoing strategic planning for the Northern Beaches Hospital Precinct Structure Plan and overarching transport strategies.

6. REFERENCES

Northern Beaches Council (2017) *Northern Beaches Hospital Precinct Structure Plan*

NSW Government (2018) *Future Transport Strategy 2056*, Transport for NSW, Chippendale NSW

Transport for NSW (2020a) *Beaches Link and Gore Hill Freeway Connection, Chapter 9: Operational traffic and transport*, Transport for NSW

Transport for NSW (2020b) *Beaches Link and Gore Hill Freeway Connection, Appendix F: Traffic and transport*, Transport for NSW (prepared by Jacobs Group (Australia) Pty Ltd)

ANNEXURE A: WARRINGAH FREEWAY AND SURROUNDS SIGNAL OPTIMISATION

ANNEXURE A: WARRINGAH FREEWAY AND SURROUNDS SIGNAL OPTIMISATION

A.1. Warringah Freeway and surrounds signal optimisation

Table A.1: Warringah Freeway and surrounds – signal optimisation strategies

Intersection	2037 'Do something'		2037 'Do something cumulative'	
	Morning Peak	Evening Peak	Morning Peak	Evening Peak
Amherst Street / Miller Street	<ul style="list-style-type: none"> Signal phasing changed from split east and west approach phases to a leading west approach phase into an east-west phase. 	<ul style="list-style-type: none"> Signal phasing changed from split east and west approach phases to a leading west approach phase into an east-west phase. 	<ul style="list-style-type: none"> Signal phasing changed from split east and west approach phases to a leading west approach phase into an east-west phase. 	<ul style="list-style-type: none"> Signal phasing changed from split east and west approach phases to a leading west approach phase into an east-west phase.
Ernest Street / Warringah Freeway on / off ramp	<ul style="list-style-type: none"> Green time redistribution from the Warringah Freeway off-ramp phase to the Ernest Street phase. 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
Falcon Street and M1 / Warringah Freeway Northbound off-ramps	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Green time redistribution from the Falcon Street west approach phase to the Warringah Freeway off-ramp phase. 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
Falcon Street and M1 / Warringah Freeway Northbound on-ramps	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Improved coordination with adjacent signals. 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
Falcon Street and M1 / Warringah Freeway Southbound on-ramp	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Improved coordination with adjacent signals. 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
Falcon Street and M1 / Warringah Freeway Southbound off-ramps	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Improved coordination with adjacent signals. 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
Miller Street / Ernest Street	<ul style="list-style-type: none"> Green time redistribution from the Miller Street north and south approach phases to the Ernest Street east and west approach phases. 	<ul style="list-style-type: none"> Green time redistribution from the Miller Street north and south approach phases to the Ernest Street east approach phase. 	<ul style="list-style-type: none"> Green time redistribution from the Miller Street north and south approach phases to the Ernest Street east approach phase. 	<ul style="list-style-type: none"> N/A
Miller Street / Falcon Street	<ul style="list-style-type: none"> Refer to Item 1 in Section A.2 other assumptions. 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Refer to Item 1 in Section A.2 other assumptions. 	<ul style="list-style-type: none"> N/A

ANNEXURE A: WARRINGAH FREEWAY AND SURROUNDS SIGNAL OPTIMISATION

Intersection	2037 'Do something'		2037 'Do something cumulative'	
	Morning Peak	Evening Peak	Morning Peak	Evening Peak
Miller Street / Carlow Street	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Improved coordination with adjacent signals. Green time redistribution from the Carlow Street phase to the Miller Street north and south phase. 	<ul style="list-style-type: none"> N/A
Miller Street / Ridge Street	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Improved coordination with adjacent signals. Green time redistribution from the Ridge Street east and west approach phase to the Miller Street north and south phase. 	<ul style="list-style-type: none"> N/A
Miller Street / McLaren Street	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Improved coordination with adjacent signals. 	<ul style="list-style-type: none"> N/A
Berry Street / Miller Street	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Improved coordination with adjacent signals. 	<ul style="list-style-type: none"> N/A
Berry Street / Walker Street	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Green time redistribution from the Walker Street south approach right turn phase to the Walker Street north and south approach phase 	<ul style="list-style-type: none"> Improved coordination with adjacent signals. 	<ul style="list-style-type: none"> N/A
Pacific Highway / Walker Street	<ul style="list-style-type: none"> Improved coordination with adjacent signals. 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
Pacific Highway / Miller Street / Mount Street	<ul style="list-style-type: none"> Green time redistribution from the Miller Street south approach phase to the Pacific Highway east approach phase. Green time redistribution from the Miller Street north and south approach phase to the Pacific Highway east-west diamond right turn phase. Improved coordination with adjacent signals. Refer to Item 2 in Section A.2 other assumptions. 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Green time redistribution from the Miller Street south approach phase to the Pacific Highway east approach phase. Green time redistribution from the Miller Street north and south approach phase to the Pacific Highway east-west diamond right turn phase. Improved coordination with adjacent signals. Refer to Item 2 in Section A.2 other assumptions. 	<ul style="list-style-type: none"> N/A

ANNEXURE A: WARRINGAH FREEWAY AND SURROUNDS SIGNAL OPTIMISATION

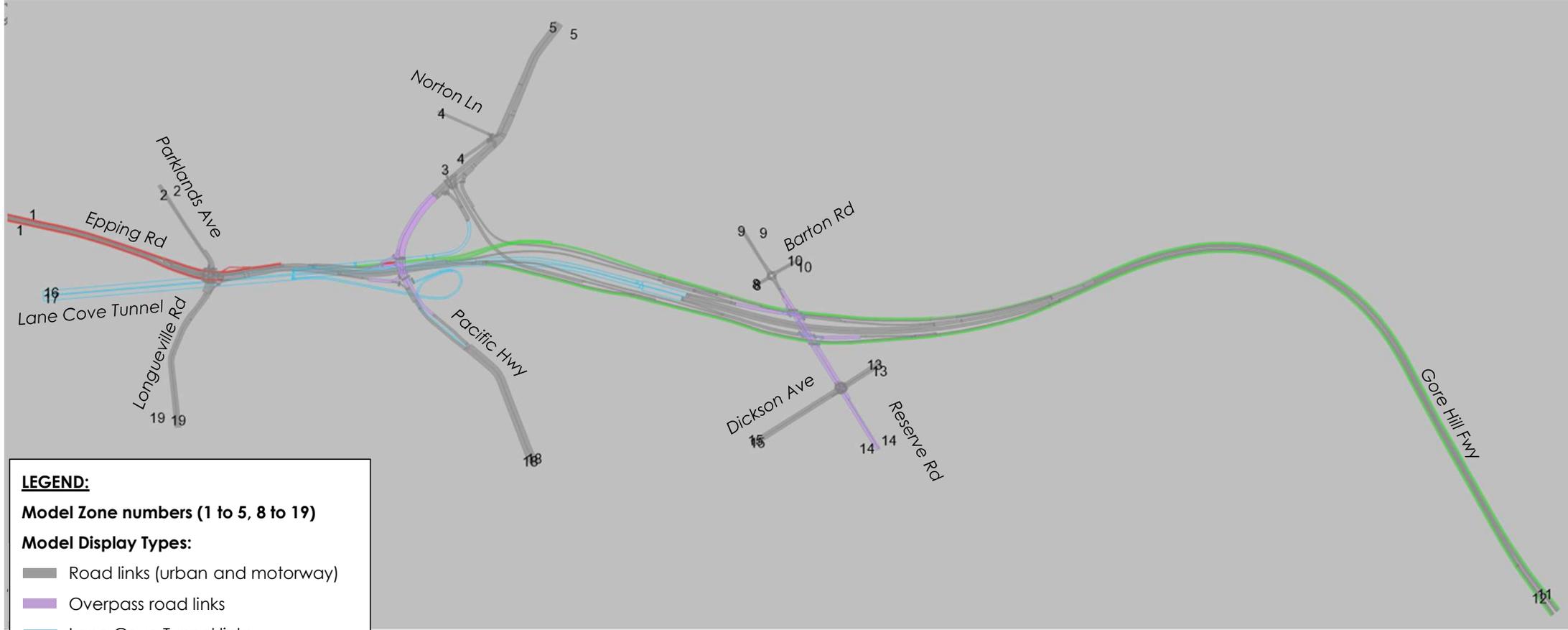
Intersection	2037 'Do something'		2037 'Do something cumulative'	
	Morning Peak	Evening Peak	Morning Peak	Evening Peak
Brook Street / Merrenburn Avenue	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Increased cycle time to be consistent with other scenarios. 	<ul style="list-style-type: none"> Green time redistribution from the Brook Street north and south approach phase to the Merrenburn Avenue phase. 	<ul style="list-style-type: none"> N/A

A.2. Other assumptions

1. In the 2037 'Do something' and 2037 'Do something cumulative' morning peak models, the right turn from the Falcon Street east approach of the Falcon Street / Miller Street intersection was reassigned to the correct signal head to ensure this movement was in operation during permitted phases only. The impacts of this amendment were addressed during the signal optimisation process such that the performance outcomes in this area was consistent (as a minimum) with results reported in the environmental impact statement.
2. In the 2037 'Do something' and 2037 'Do something cumulative' morning peak scenarios, the green time for the Miller Street north approach through movements at the Pacific Highway / Miller Street / Mount Street intersection was extended to appropriately run for the entire duration of its relevant phase.

ANNEXURE B: GORE HILL FREEWAY AND ARTARMON OPERATIONAL TRAFFIC MODEL ZONES

Gore Hill Freeway and Artarmon model zones 2037 'Do minimum' network



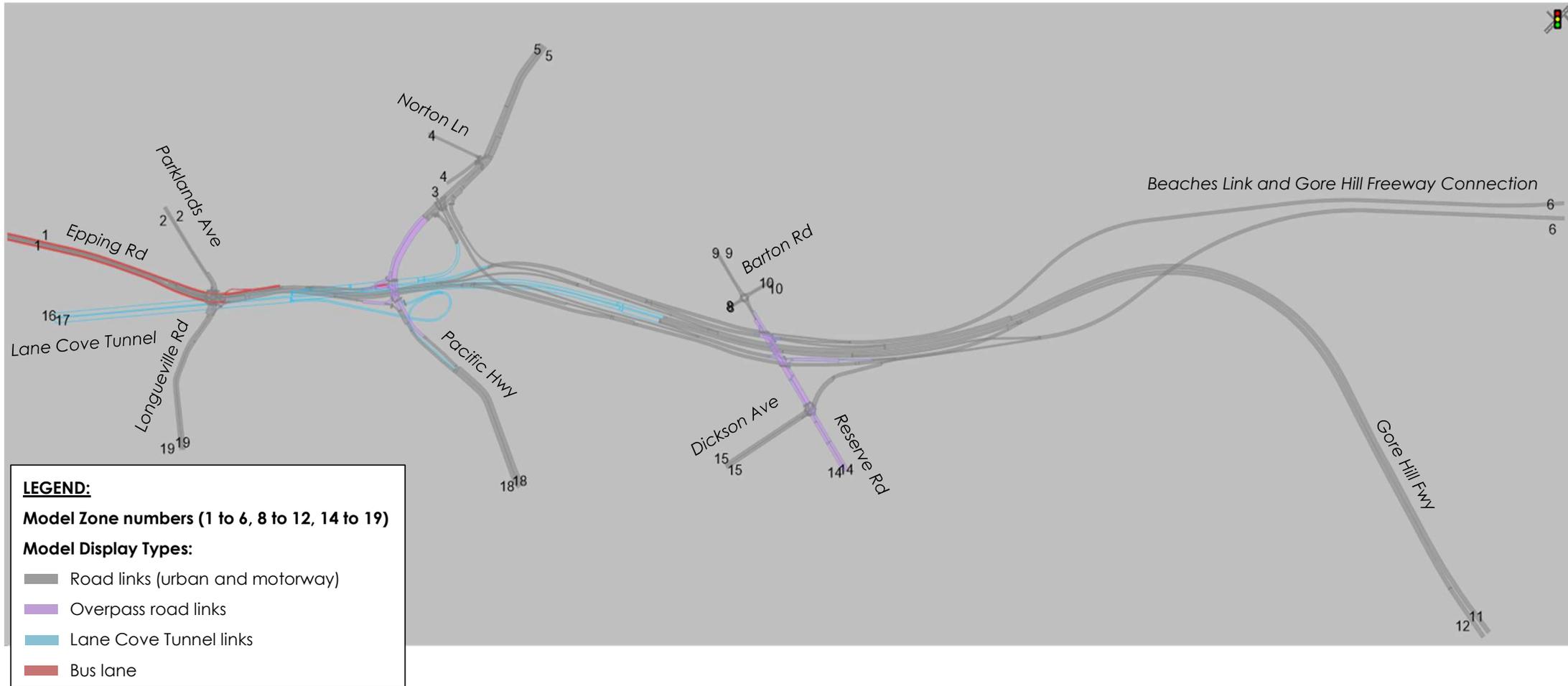
LEGEND:

Model Zone numbers (1 to 5, 8 to 19)

Model Display Types:

- Road links (urban and motorway)
- Overpass road links
- Lane Cove Tunnel links
- Bus lane
- T2 lane

Gore Hill Freeway and Artarmon model zones 2037 'Do something' / 2037 'Do something cumulative' network





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