Traffic Impact Assessment Route 5: Bent Street to Rangers Road

Traffic Impact Assessment

North Sydney Council

13 January 2025

→ **The Power of Commitment**

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1. Introduction

1.1 Project background

Route 5: Bent Street to Rangers Raod, as identified as part of the North Sydney Council Integrated Cycling Strategy 2014, represents one of the five major 'arterial routes' of the bicycle network in North Sydney. The route between North Sydney and Mosman via Yeo Street is an established route, however it currently includes missing links. A suite of upgrades, including dedicated cycle lanes, are proposed to transform this route into a safe and accessible connection that will provide for commuters to the North Sydney CBD and the Sydney Harbour Bridge cycleway.

The route has been partially completed, with an off-road bi-directional cycleway along Ridge Street, mixed traffic along Winter Avenue and an uphill cycleway on Bent Street. Route 5: Bent Street to Rangers Road (the Study) is proposed to undertake a variety of infrastructure upgrades, including pedestrian crossings, traffic signal changes and a bi-directional cycleway. GHD was commissioned by North Sydney Council (the Council) to carry out a Traffic Impact Assessment for the proposed pedestrian and cycling upgrades for the study. The project area (Figure 1-1), including Yeo Street, Wycombe Road, Harrison Street, Rangers Road and Spofforth Street is currently on-road, mixed traffic conditions. It was noted that Ben Boyed Road is a popular bike routes connecting with Military Road.

The list of intersections on this route includes:

– Ben Boyd Road and Yeo Street, Neutral Bay (signalised)
– Wycombe Road and Yeo Street, Neutral Bay (signalised)
– Murdoch Street and Rangers Road, Cremorne (signalised)
– Rangers Road and Spofforth Street, Cremorne (priority)
– Barry Street and Yeo Street, Neutral Bay (priority)

The Traffic Impact Assessment includes the development of intersection modelling (SIDRA) at five intersections of interest along the route as shown in Figure 1-1 to assess the existing traffic conditions and the impact of proposed designs on network performance.

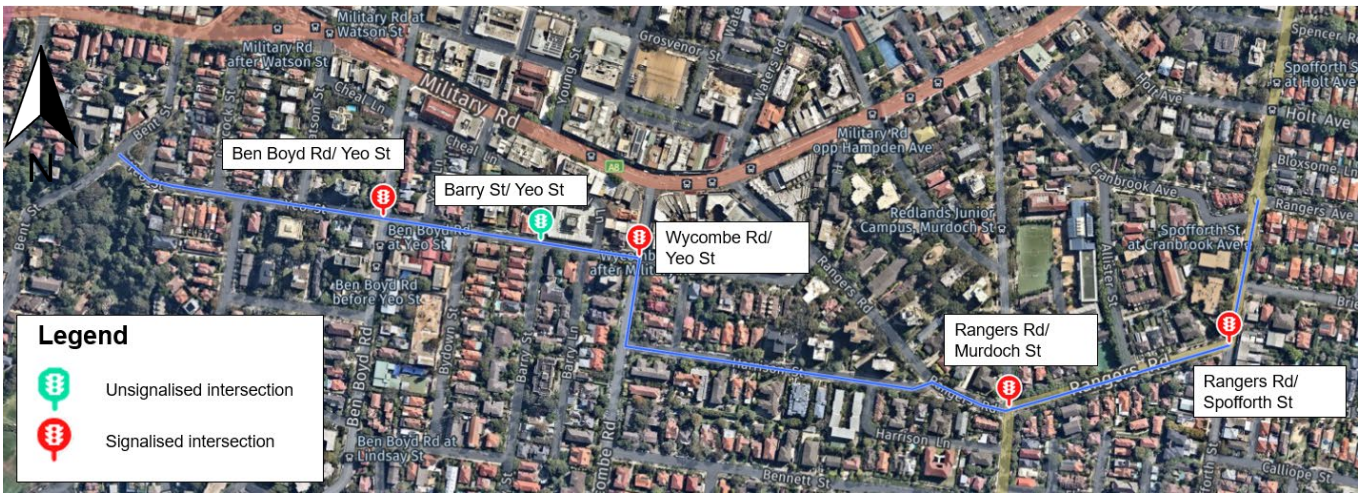


Figure 1-1 Study area map for Route 5 and intersections of interest

1.2 Purpose of this report

The purpose of this Transport Assessment is to document the process and outcomes of the study, including the following key items:

– Review of existing conditions, including cycling, walking, parking, public transport and vehicular traffic.
– Crash data analysis.

– Intersection modelling (SIDRA) to assess the performance of existing intersection arrangements under current and future traffic demands and identify potential site constraints.
– Assessment of impact of proposed upgrades (based on the concept design drawing provided by the Council) onto the road network performance.
– Assessment of impact of proposed designs on parking.
– Recommendations of road treatments to address any potential adverse impacts from the proposed design to maintain safe conditions for all modes in alignment with cycling network.

1.3 Project objectives

The objective of this study is to develop a comprehensive transport and infrastructure review that supports the future planning direction. The assessment involves intersection modelling using the SIDRA 9 traffic modelling software for the 2023 existing condition, future base case (no cycleway), and the proposed cycleway upgrade based on a concept design drawing provided by the Council in November 2023. The assessment involves modelling scenarios of typical weekdays, and weekends. The main purpose of the SIDRA modelling analysis is to inform decision making in identifying transport performance deficiencies and potential travel impacts of the proposed cycleway design scheme, and to propose solutions accordingly.

1.4 Glossary of key terminology

A glossary of technical terms for traffic modelling is set out in Table 1-1 to assist in the interpretation of this document.

Table 1-1 Key terminology

Technical Terms	Definition
Base Case Traffic Model	A model calibrated and validated with respect to observed traffic data.
Calibration	A process of modifying model parameter values until model outputs replicate observed data to within a specified tolerance level.
Level of Service	A qualitative measure for ranking operating conditions or service quality based on service measures, such as speed, travel time, delay, density, freedom to manoeuvre, interruptions, comfort, and convenience (Austroads, 2017).
Modelling Methodology	Also called Modelling Type. It is the type of analysis that a model undertakes, either Strategic, Mesoscopic, Hybrid or Microscopic.
Traffic Demand	The volume of traffic assigned to a traffic zone, rather than completing a journey.
Validation	An evaluation of the model's ability to predict behaviour through comparisons of information not used in the calibration process.
Vehicle Class	The categorisation of a set of vehicles based on a common attribute.

1.5 Assumptions and limitations

The Traffic Impact Assessment methodology for this study has been reviewed and approved by North Sydney Council. All source data employed in the preparation of the traffic and transport assessment has been diligently collated and reviewed by GHD. However, given the level of details of the assessment and the reliance on assumptions, the accuracy of modelling predictions will be influenced by unknown or unexpected changes to what has been assumed to occur in the future.

GHD has applied the appropriate effort and attention to ensure the completeness and accuracy of the analysis included in this report. The traffic assessment documented within this report has been undertaken based on the following assumptions:

- Nearmap (existing intersection geometry also verified by site inspection) was utilised for SIDRA base model geometry coding, which is assumed to be reflective of the current traffic network.
- Supplied traffic data adequately reflects existing conditions and forecasts, including the following:
  - Intersection turning count data
  - SCATS signal data

  It should be noted that the Saturday peak period adopted similar phasing arrangements and timings from Weekday peaks given the lack of SCATS data for weekend peak period.
- GHD conducted site inspections of the study areas to record the operation, queueing and congestion for calibration and validation process.
- Typical Google live traffic has also been utilised to validate queue length for 2023 base year SIDRA model.
- The NSW average population growth per annum as published by New South Wales (NSW) Department of Planning and Environment (DPE) is deemed as a reflection of future year traffic demand sources within the study area.
- No major land use changes or committed developments were informed in proximity to the study area for future horizon planning 2033 and 2043. As such, the forecast traffic volume for the study only applied the background traffic growth for assessment, as agreed with the Council.

1.6 Disclaimer

This report: has been prepared by GHD for North Sydney Council and may only be used and relied on by North Sydney Council for the purpose agreed between GHD and North Sydney Council as set out in Section 1.2 and Section – of this report.

GHD otherwise disclaims responsibility to any person other than North Sydney Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Existing context

This section describes the local traffic and transport conditions in the study area.

2.1 Local land uses

2.1.1 Land use zones

Existing land uses in the study area are identified in the North Sydney Local Environmental Plan 2015 (LEP). The following land use zones are present within the study area:

– B4 Mixed Use
– R2 Low Density Residential
– R3 Medium Density Residential
– R4 High Density Residential
– SP1 Special Activities

Figure 2-1 presents the land use zones surrounding the Route 5 (Bent Street to Rangers Road) based on the North Sydney Local Environmental Plan 2015.

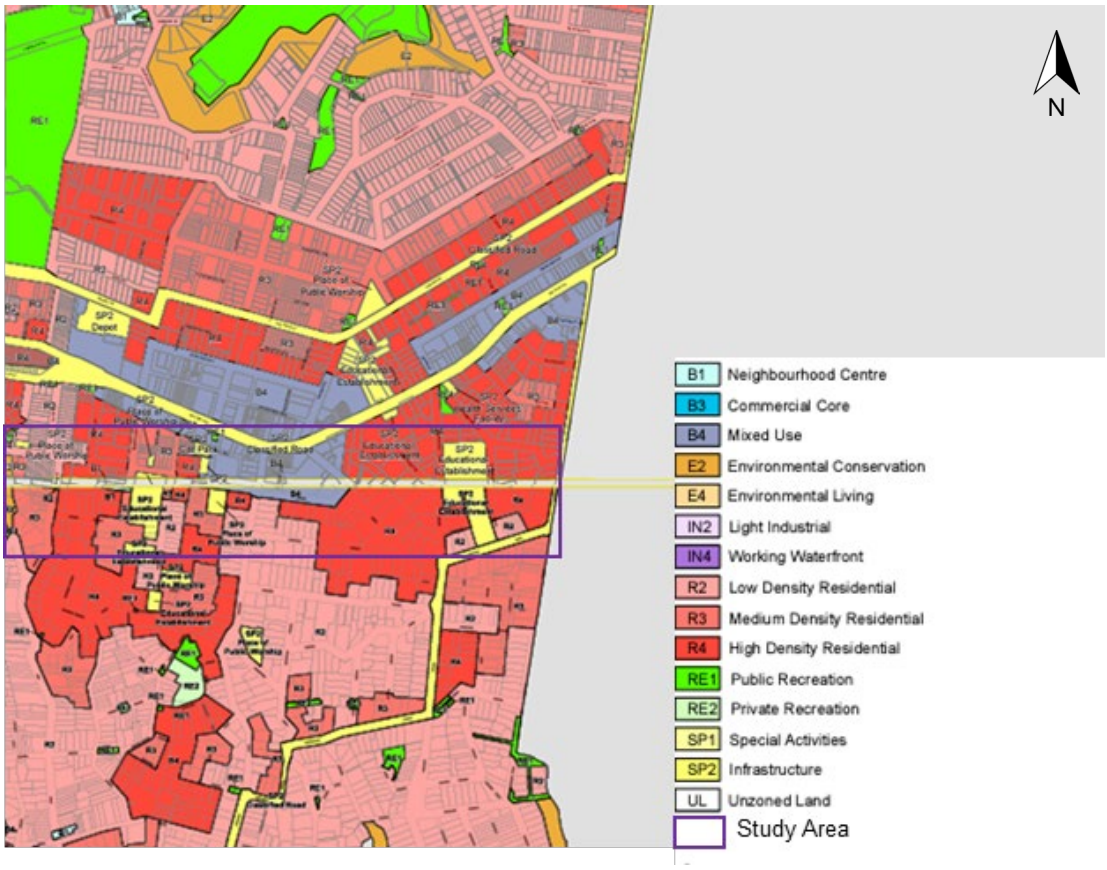


Figure 2-1 Land Use surrounding the Route 5 (Bent Street to Rangers Road)
Source: North Sydney Local Environmental Plan 2013 (modified by GHD)

2.2 Road network hierarchy

Roads within New South Wales are categorised in the following two ways:

1. By classification (ownership).
2. By the function that they perform.

2.2.1 Road classification

Roads are classified (as defined by the Roads Act 1993) based on their importance to the movement of people and goods within NSW (as a primary means of communication). The classification of a road allows Transport for New South Wales (TfNSW) to exercise authority of all or part of the road. Classified roads include Main Roads, State Highways, Tourist Roads, Secondary Roads, Tollways, Freeways and Transitways. For management purposes, RMS has three administrative classes of roads:

– **State Roads** – Major arterial links through NSW and within major urban areas. They are the principal traffic carrying roads and fully controlled and maintained by RMS. State Roads include all Tollways, Freeways and Transitways; and all or part of a Main Road, Tourist Road or State Highway.
– **Regional Roads** – Roads of secondary importance between State Roads and Local Roads which, along with State Roads, provide the main connections to and between smaller towns and perform a sub arterial function in major urban areas. Regional roads are the responsibility of councils for maintenance funding, though RMS funds some maintenance based on traffic and infrastructure. Traffic management on Regional Roads is controlled under the delegations to local government from RMS. Regional Roads may own all or part of a Main Road, Secondary Road, Tourist Road or State Highway; or other roads as determined by RMS.
– **Local Roads** – The remainder of the council-controlled roads, Local Roads are the responsibility of councils for maintenance funding. RMS may fund some maintenance and improvements based on specific programs (e.g., urban bus routes, road safety programs). Traffic management on Local Roads is controlled under the delegations to local government from RMS.

2.2.2 Functional hierarchy

Functional road classification involves the relative balance of mobility and access functions. TfNSW define four levels in a typical functional road hierarchy, ranking from high mobility and low accessibility to high accessibility and low mobility. These road classes are:

– **Arterial Roads** – generally controlled by TfNSW, typically no limit in flow and designed to carry vehicles long distance between regional centres.
– **Sub-Arterial Roads** – can be managed by either TfNSW or local council. Typically, their operating capacity ranges between 10,000 and 20,000 vehicles per day, and their aim is to carry through traffic between specific areas in a subregion or provide connectivity from arterial road routes (regional links).
– **Collector Roads** – provide connectivity between local roads and the arterial road network and typically carry between 2,000 and 10,000 vehicles per day.
– **Local Roads** – provide direct access to properties and the collector road system and typically carry between 500 and 4,000 vehicles per day.

2.2.3 Road Classification Summary

Figure 2-2 illustrates the different road types within the study area. The majority of the roads within the study area are classified as local roads with signposted speed limits of 50 km/h, except Spofforth Street classified as a regional road with same speed limit of 50 km/h.

Figure 2-2 Functional hierarchy of road network in study area
Source: TfNSW Open Data: https://maps.transport.nsw.gov.au/egeomaps/road-network-classification/

2.3 Existing road network

Table 2-1 describes the characteristics of key roads (refer Figure 1-1) in the vicinity of the study area, including walking and cycling infrastructure and parking facilities.

Table 2-1 Road characteristics

Road Name	Description
Yeo Street	– Two-way undivided road with one lane of traffic in each direction – Posted speed of 50km/h. East of Bydown St, the speed is reduced to 40km/h during school hours (8:00 am – 9:30 am & 2:30 pm – 4:00 pm) a result of a school zone. – Restricted 2P kerbside parallel parking from 8:00 am to 6:00 pm Monday to Friday (authorised residents vehicle excepted) in both directions west of Ben Boyd Rd – Restricted 1P kerbside parallel parking from 8:00 am to 6:00 pm Monday to Friday (authorised residents vehicle excepted) in both directions east of Barry Street – Pedestrian crossings at signalized intersections, and at priority intersections where intersecting Watson St, Bydown St and Rangers Rd. Paved footpaths on both sides of the road. – Mixed traffic lane allowing cycling movements in both directions with dedicated on-road cycling lane (eastbound only) west of Ben Boyd Rd
Rangers Road	– Two-way road with one lane of traffic in each direction – Posted speed of 50km/h. East of Murdoch St, the speed is reduced to 40km/h during school hours (8:00 am – 9:30 am & 2:30 pm – 4:00 pm) as a result of a school zone. – Restricted 1P kerbside parallel parking in both directions from 8:30 am to 6:00 pm Monday to Friday, and 8:30 am to 12:00 pm on Saturday (authorised residents vehicle excepted) – Pedestrian crossings at signalized intersections. Paved footpaths on both sides of the road – Mixed traffic lane allowing cycling movements in both directions
Spofforth Street	– Two-way road with one lane of traffic in each direction – Posted speed of 50km/h – Restricted ½ P kerbside parallel parking in both directions from 9:00 am to 5:00 pm Monday to Friday, and 9:00 am to 12:30 pm on Saturday (authorised residents vehicle excepted) – Pedestrian crossings with zig zag lines approaching Cranbrook Ave to increase visibility. Paved footpaths on both sides of the road – Mixed traffic lane allowing cycling movements in both directions
Murdoch Street	– Two-way road with one lane of traffic in each direction

Road Name	Description
	– Posted speed of 50km/h. North of Bunnett St, the speed is reduced to 40km/h during school hours (8:00 am – 9:30 am & 2:30 pm – 4:00 pm) as a result of a school zone. – Restricted 1P kerbside parallel parking in both directions from 8:30 am to 6:00 pm Monday to Friday (authorised residents vehicle excepted) – Pedestrian crossings at signalized intersections, and mid – block pedestrian crossing between Rangers Rd and Military Rd. Paved footpaths on both sides of the road – Mixed traffic lane allowing cycling movements in both directions
Wycombe Road	– Two-way road with one lane of traffic in each direction – Posted speed of 50km/h – Restricted 2P kerbside parallel parking from 8:00 am to 6:00 pm Monday to Friday (authorised residents vehicle excepted) – Pedestrian crossings at signalized intersections. Paved footpaths on both sides of the road – Mixed traffic lane allowing cycling movements in both directions
Barry Street	– Two-way undivided road with one lane of traffic in each direction – Posted speed of 50km/h – Restricted 2P kerbside parallel parking from 8:00 am to 6:00 pm Monday to Friday (authorised residents vehicle excepted) in northbound direction only – No formal pedestrian crossings. Paved footpaths on both sides of the road – Mixed traffic lane allowing cycling movements in both directions
Ben Boyd Rd	– A key bike route connecting Military Road – Two-way road with one lane of traffic in each direction – Posted speed of 50km/h. North of Lindsay St, the speed is reduced to 40km/h during school hours (8:00 am – 9:30 am & 2:30 pm – 4:00 pm) as a result of a school zone. – No parking allowed from 6:30 am to 9:30 pm, and 3:30 pm to 6:30 pm Monday to Friday on both sides of the road north of Hardie Street – Pedestrian crossings with zig zag lines approaching Hardie St to increase visibility. Paved footpaths on both sides of the road – Mixed traffic lane allowing cycling movements in both directions

2.4 Public transport

The road network contained in the study area supports public and school bus service operations. Table 2-2 summarises the bus routes and its frequencies which operate within the study area, mainly along Ben Boyd Road, Wycombe Road and Spofforth Street. Figure 2-3 presents the surrounding bus network map in a broader context.

Table 2-2 Bus frequency

Bus Number	Bus Direction	Frequency on/off peak
225	Cremorne Point Wharf to Neutral Bay Wharf	20 mins/ 30 mins
263	Crows Nest to city Bridge St via Cremorne	15 mins / 30 mins

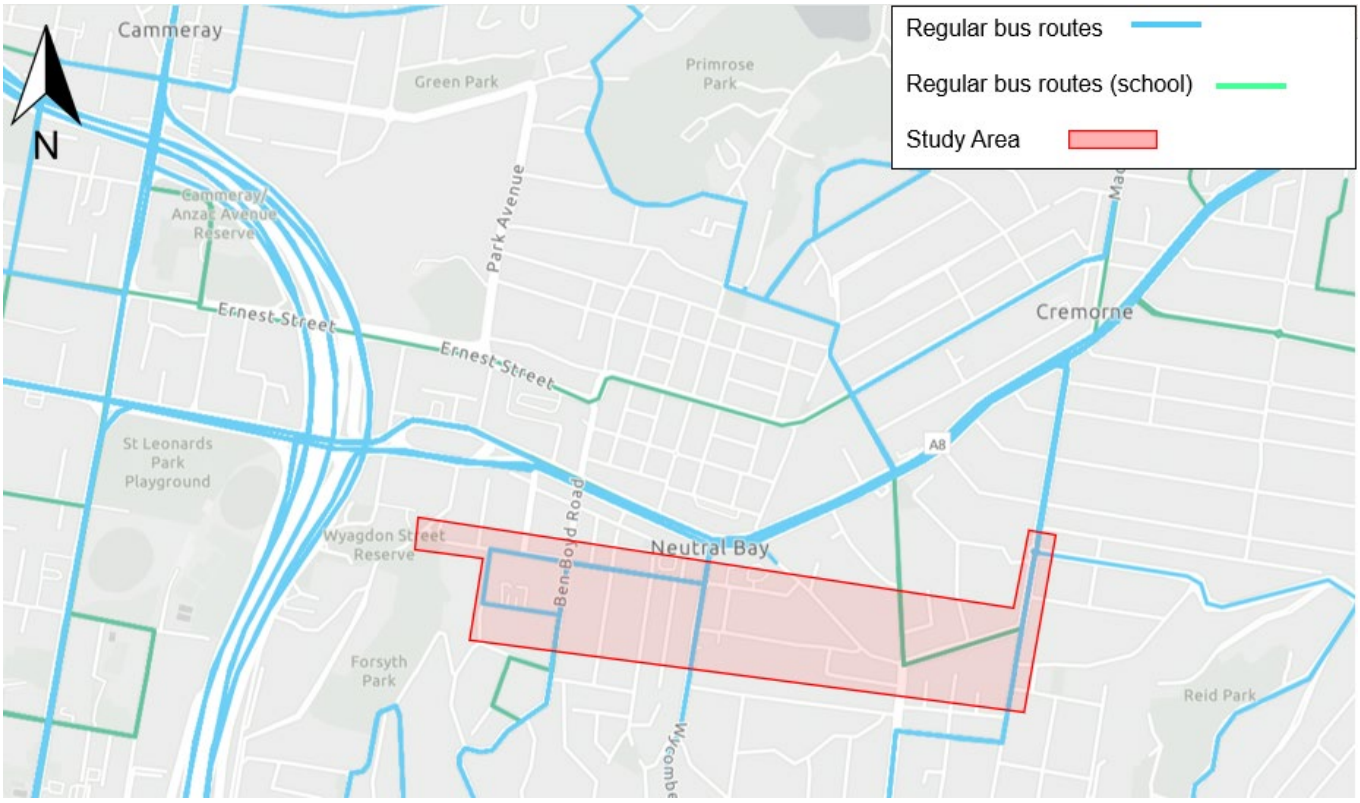


Figure 2-3 Surrounding bus network map
Source: https://www.transport.nsw.gov.au/operations/roads-and-waterways/committees-communities-and-groups/committees-and-groups-0, Modified by GHD

2.4.1 Opal Card Data Analysis

A high-level review of opal card data for the period from 8th January 2023 to 31st October 2023, provided by the Council was undertaken at bus stops on the Spofforth Street within the study area. There are 6 bus stops with opal card data being analysed as shown in Table 2-3.

Table 2-3 Bus stops information

Bus stop ID	Direction	Location
209055	Northbound	Spofforth St at Holt Ave
209054	Northbound	Spofforth St at Brierley St
209053	Northbound	Spofforth St at Reginald St
208814	Southbound	Spofforth St at Holt Ave
208815	Southbound	Spofforth St at Brierley St
208816	Southbound	Spofforth St at Reginald St

The opal card data includes tap on and off time and location and tapped on and off activities have been analysed by daily and monthly average as summarised in Table 2-4.

Table 2-4 Opal card data summary

Bus stop ID	208814	208815	208816	209053	209054	209055
Tap On Day	5	5	4	6	4	1
Tap On Month	140	147	130	172	106	16
Tap Off Day	1	2	2	8	7	10
Tap Off Month	18	64	67	228	196	294
Tap On/Off Day	5	7	7	13	10	10
Tap On/Off Month	158	211	197	399	303	310

Analysis of the opal card data indicates the following:

– Average daily tap on activities range from 4 to 6 times for majority of stops along Spofforth St, with the exception of bus stop 209055
– Bus stop (209055) in Spofforth St northbound direction at Holt Ave shows lowest tap on activities (1 time/day; 16 times/ month), whereas the daily tap off activities are recorded as the highest (10 times/day)
– Tap off activities are generally low at all bus stops in Spofforth St southbound direction, with average tap off daily activities no more than two times
– Average daily tap off activities are relatively high (more than 6 times) at all bus stops in Spofforth St northbound direction

2.5 Site inspection

GHD conducted site inspections of the study area during midday peak period (11:00 -12:00), on Saturday, 16th December 2023. The site inspection involved observation of operation, queueing and congestion along Yeo Street and Rangers Road. Based upon the review on the traffic survey, Saturday peak was deemed as the busiest peak period along the project corridor, in terms of the traffic volumes.

The following is a summary of roads and intersections that were driven and inspected during the site inspection:

– Ben Boyd Road and Yeo Street, Neutral Bay (signalised)
– Barry Street and Yeo Street, Neutral Bay (priority
– Wycombe Road and Yeo Street, Neutral Bay (signalised)
– Murdoch Street and Rangers Road, Cremorne (signalised)
– Rangers Road and Spofforth Street, Cremorne (priority)

The following information was identified from the site inspection:

– Intersection controls and speed zones
– Traffic management devices and signage
– Parking controls, type and orientation
– Existing land uses and building form and infrastructure
– Traffic flow and circulation patterns
– Road network constraints
– Pedestrian crossing and cycling facilities.

The site visit photos for the intersections of interest along Yeo Street and Rangers Road are shown in Table 2-5. It was noted that no major congestion, queuing or delay were observed for the majority of intersections during the site inspection. However, noticeable queues were observed at the intersection Murdoch Street and Rangers Road, details of queuing conditions are provided in the following table.

Table 2-5 Site Viste of study area

No.	Location	Detail
1	Ben Boyd Road and Yeo Street	**Ben Boyd Rd looking northbound**  No noticeable queuing or delay were observed at this intersection.
2	Barry Street and Yeo Street	**Yeo Street looking eastbound**  No noticeable queuing or delay were observed at this intersection.

No.	Location	Detail
3	Wycombe Road and Yeo Street	**Wycombe Road looking northbound**  Slow moving queue were noticed for right turners from Wycombe Road northbound to Military Road eastbound, spilling back to Yeo Street at worst. The rolling queue was able to clear up within each cycle, without impacting the operation of the intersection of Wycombe Road and Yeo Street.
4	Murdoch Street and Rangers Road	**Murdoch Road looking northbound**  Long right turn queue from Murdoch Street to Rangers Road eastbound were observed, occasionally spilling back to Bennette Street at worst.

No.	Location	Detail
		Rangers Road looking westbound  Long westbound queue along Rangers Road was observed, occasionally spilling back to Allister Street at worst, mainly associated with the filter right turn blocking the through movement behind.
5	Rangers Road and Spofforth Street	 No noticeable queuing or delay were observed at this intersection

2.6 Crash data analysis

A crash data analysis for the study area has been undertaken using the NSW crash data (sourced from Open Data Hub) for the most recent period between 2018 and 2022. The data coverage mainly includes the following streets surrounding the Route 5:

- Yeo Street
- Rangers Road
- Spofforth Street
- Murdoch Street
- Wycombe Road
- Barry Street
- Ben Boyd Road

The locations of recorded crashes surrounding the Route 5 are shown in Figure 2-4.

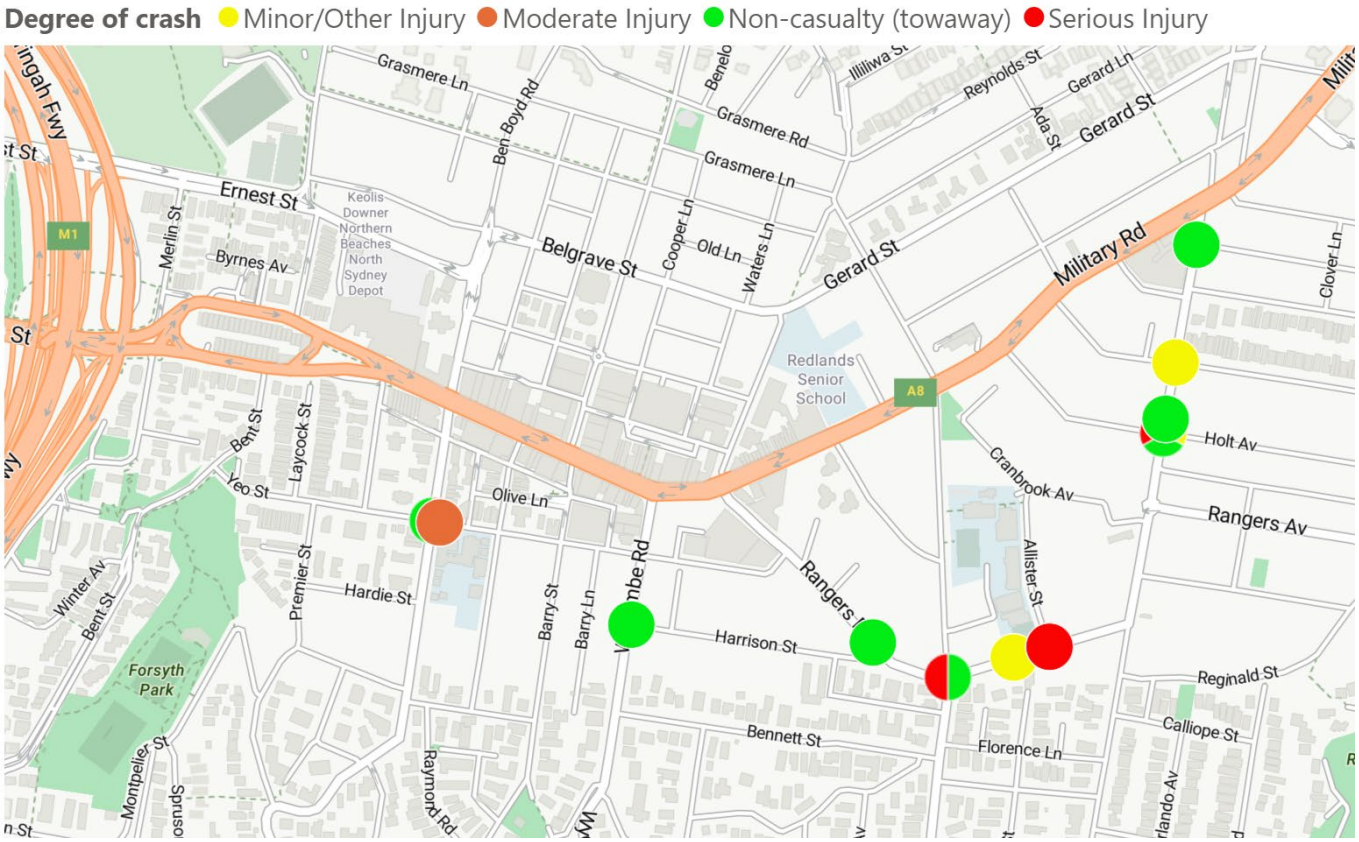


Figure 2-4 Route 5 (study area) crash locations (2018-2022)
Source: Transport for NSW, Modified by GHD

Analysis of the crash data indicates that the majority of recorded incidents are minor injury or non-casualty crashes, while serious injury and moderate injury crashes along Rangers Road and Spofforth Street were recorded during the last 5 years.

Though there are no reported crashes involving cyclists, however, an Urban Area Road Crash Matching Study in Carins [1]indicated that the accidents involving cyclists are typically underreported, by comparing hospital records with the published crash data.

[1] undertook by Queensland University of Technology and sponsored by the Main Roads QLD (2011)

2.6.1 Summary of crash severity

The severity of crashes identified was analysed with incidents graded using the following severities:

– Non-casualty (towaway)
– Minor/ Other injury
– Moderate injury
– Serious injury
– Fatal

Table 2-6 summarises crash statistics, classified by severity, including a summary of number of fatalities, injuries and non-casualty crashes for both study areas. Five serious incidents were recorded, including:

– Three serious injury crashes on Rangers Road, including one incident with a pedestrian involved near Allister Street
– Two serious injury crashes on Spofforth Street, and both of which were cross traffic related

Table 2-6 Route 5 (study area) crashes by severity

Severity	Crashes	% of Total
Non-casualty (towaway)	8	44%
Minor/ Other injury	3	17%
Moderate injury	2	11%
Serious injury	5	28%
Fatal	0	0%
Total	**18**	**100%**

2.6.2 Summary of crash type

Of the total 18 crashes reported within the study area, Figure 2-5 indicates that the most prevalent collision type was collisions involving vehicles from adjacent approaches, accounting for 41 percent of the total crashes, followed by incidents caused by vehicles off bend onto object (12 percent). There was one serious crash with pedestrians involved recorded at the intersection Rangers Road / Allister Street.

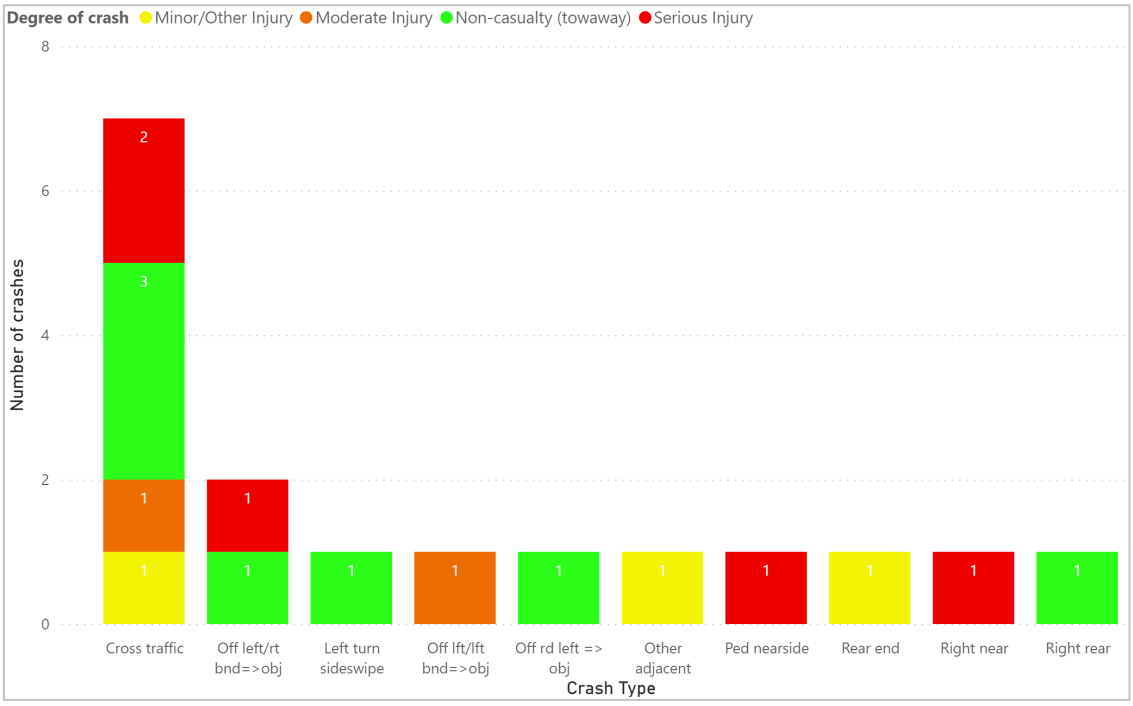


Figure 2-5 Route 5 (study area) crash counts by crash type

3. Traffic assessment – existing condition

The scope for the data collection and traffic surveys was discussed and agreed upon with the Council during the inception meeting. This section details the data provided by primary sources to inform the development of the base model. The Project Team completed data analysis based on the available surveyed data.

The following traffic surveys have been used as part of this assessment:

– Classified intersection counts
– SCATS signal data

3.1 Traffic demand inputs

Classified intersection turning movements (including light vehicles, heavy vehicles, and cyclists) were collected at five intersections of interest (refer Figure 1-1) within the study area by Matrix on Thursday 19 Oct 2023 and on Saturday 21 Oct 2023. Table 3-1 lists the surveyed intersections and surveyed time periods.

Table 3-1 Intersection count data

ID	Location	Control Type	Weekday Survey Date and Time	Saturday Survey Date and Time
1	Ben Boyd Road and Yeo Street	Signal	Thu 19 Oct 2023 6-10 am & 3-7 pm	Sat 21 Oct 2023 9 am 7 pm
2	Wycombe Road and Yeo Street	Signal	Thu 19 Oct 2023 6-10 am & 3-7 pm	Sat 21 Oct 2023 9 am 7 pm
3	Murdoch Street and Rangers Road	Signal	Thu 19 Oct 2023 6-10 am & 3-7 pm	Sat 21 Oct 2023 9 am 7 pm
4	Rangers Road and Spofforth Street	Priority	Thu 19 Oct 2023 6-10 am & 3-7 pm	Sat 21 Oct 2023 9 am 7 pm
5	Barry Street and Yeo Street	Priority	Thu 19 Oct 2023 6-10 am & 3-7 pm	Sat 21 Oct 2023 9 am 7 pm

The surveyed captured light vehicles, heavy vehicles and cyclists. The intersection traffic counts were used as the classified traffic demand inputs in SIDRA.

3.2 Peak period identification

Figure 3-1 to Figure 3-3 show the total hourly traffic volumes across all the assessed intersections to facilitate identification of the peak hour for both typical weekday and Saturday.

Analysis of the survey data identified the following peak hours:

– Weekday AM peak hour between 8:15 am to 9:15 am
– Weekday PM peak hour between 15:30 pm to 16:30 pm
– Saturday peak hour between 11:00 pm to 12:00 pm

It was noted that the Saturday peak hour is the critical peak hour for the traffic assessment, having approximately 400 and 700 more vehicles within the study area than AM and PM peak hour respectively. The higher trips on Saturday are associated with trips to surrounding beach areas (i.e. Manly beach) for recreational activities.

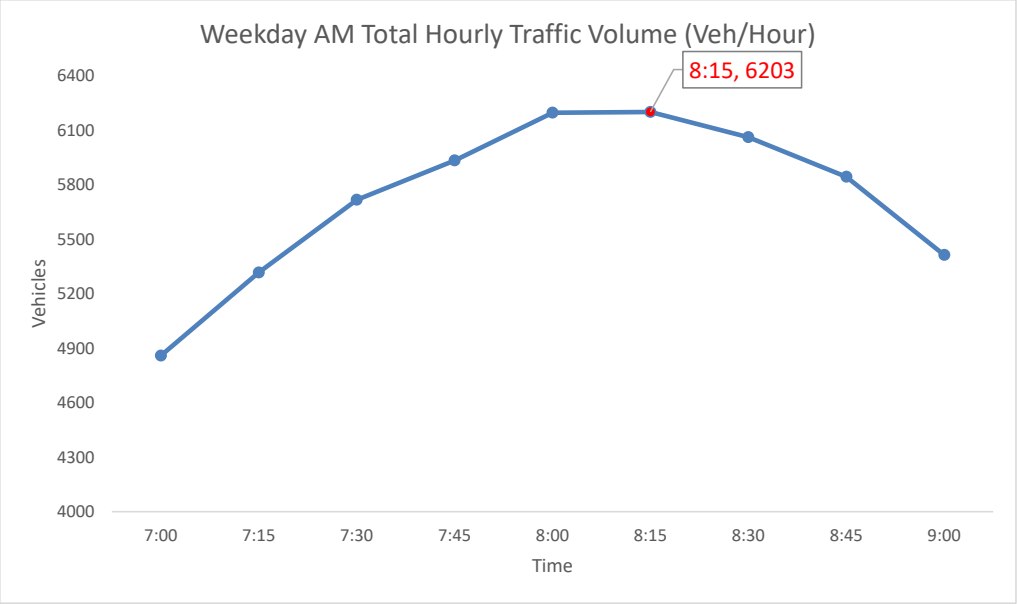


Figure 3-1 Weekday AM Total Hourly Traffic Volume

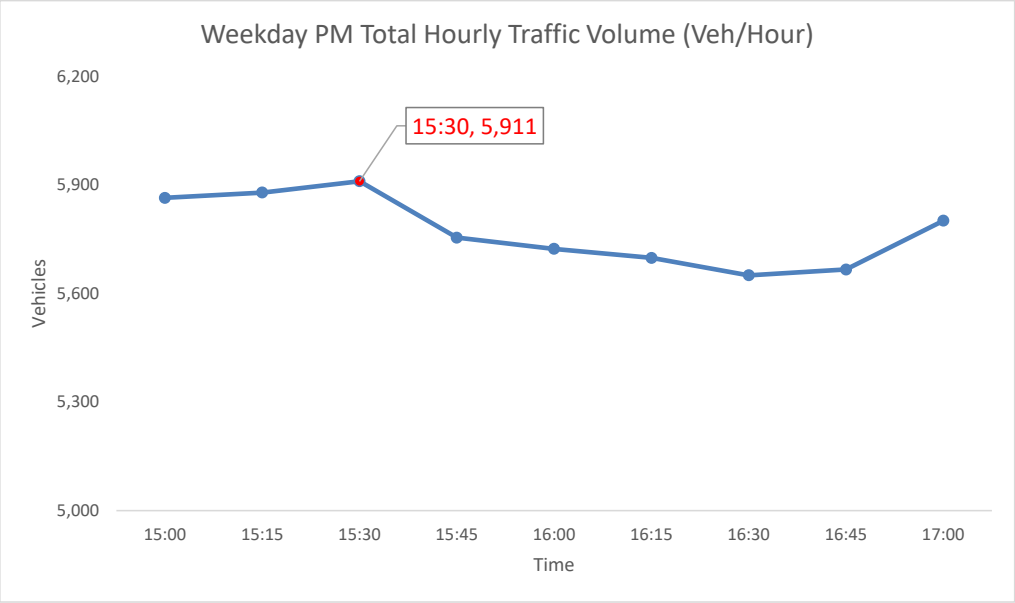


Figure 3-2 Weekday PM Total Hourly Traffic Volume

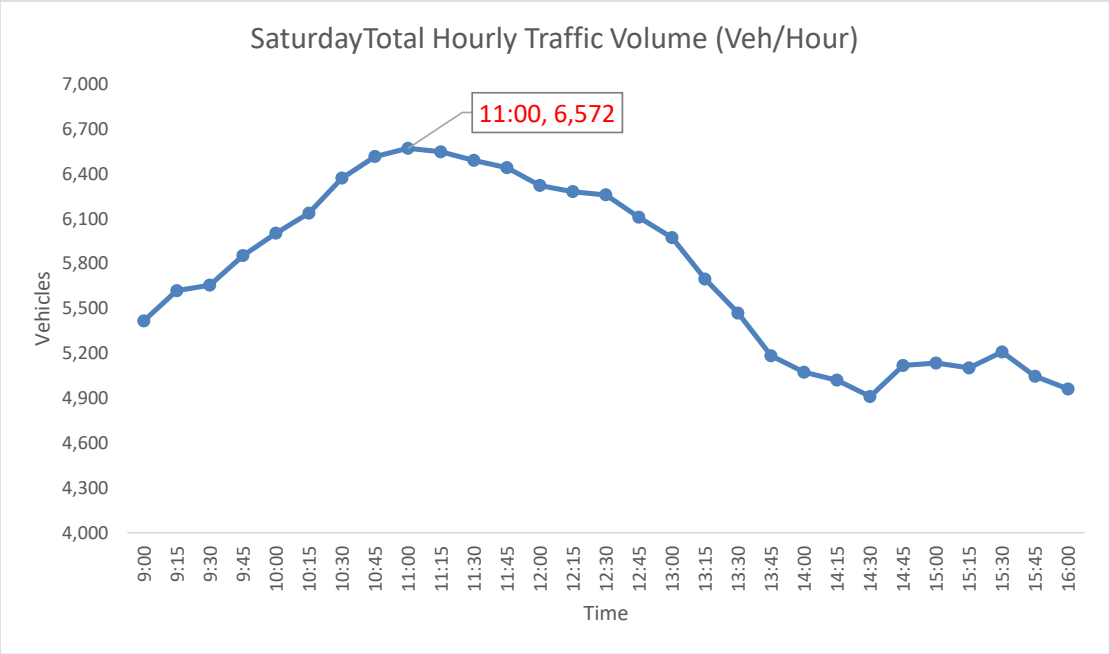


Figure 3-3 Saturday Total Hourly Traffic Volume

Traffic counts data has also been analysed by westbound and eastbound direction for identified peak periods as summarized in Table 3-2. Key findings are summarized as follows:

– Both AM and PM peaks are observed to have a higher number of trips in the westbound direction, being approx.500 trips more than that of the eastbound direction
– A higher number of trips are observed in the eastbound direction, being approx. 300 trips more than that of the westbound direction on Saturday peak.

Table 3-2 Peak Hourly Traffic Volume by Direction

West	Westbound traffic volume (veh)	Eastbound traffic volume (veh)
AM peak (8:15 – 9:15)	2388	1908
PM peak (15:30 – 16:30)	2339	1834
Saturday peak (11:00 – 12:00)	2102	2428

3.3 SCATS signal data

All signal phases were coded in the SIDRA models according to the signal phasing plan for each intersection. Signal phasing was applied based upon average hourly phase time from the SCATS data by TfNSW for Thursday 19 Oct 2023

It should be noted that the Saturday peak period adopted similar phasing arrangements and timings from weekday peaks given the lack of SCATS data for weekend peak period. The phasing operations adopted are also consistent with the observations from the site visit, and therefore, deemed to accurately reflect the existing condition.

3.4 Base year SIDRA model development

The SIDRA model was coded based on aerial images from the latest Nearmap (2023) and site visit, then calibrated and validated based on traffic count surveys, and queue length with reference to Google's typical peak hour traffic and site visit queuing conditions. Network models were developed in SIDRA (version 9.1) for closely spaced intersections along Yeo Street. Intersections on Rangers Road are modelled as isolated intersections for this traffic assessment.

Figure 3-4 and Figure 3-5 show the SIDRA intersection layout for the existing base year (2023) of both Yeo Street and Rangers Road intersections respectively

Yeo Street Network Layout

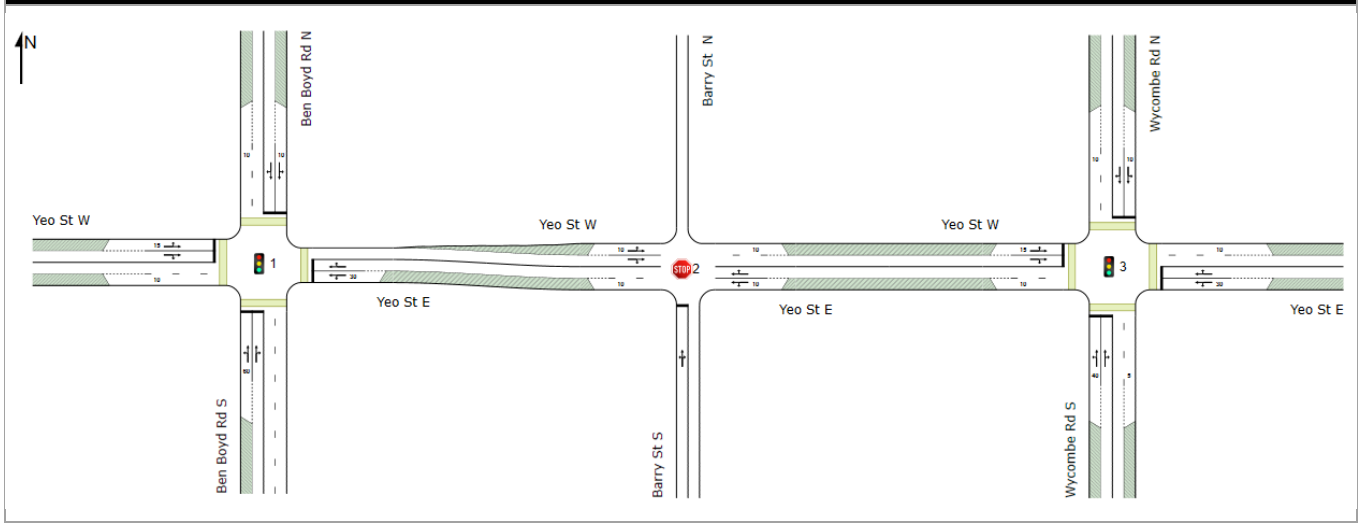
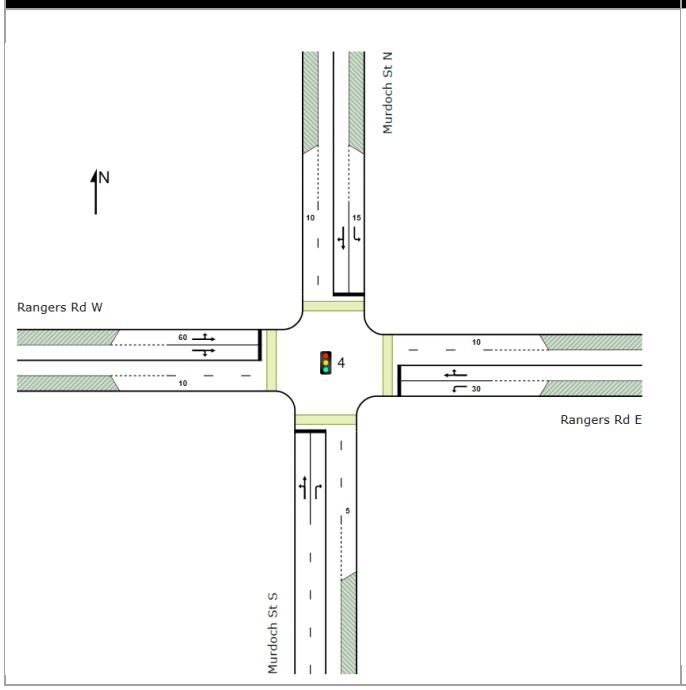


Figure 3-4 Yeo Street SIDRA Network Model Layout (2023)

Source: SIDRA Model Screenshot

Rangers Rd / Murdoch St



Rangers Road / Spofforth St

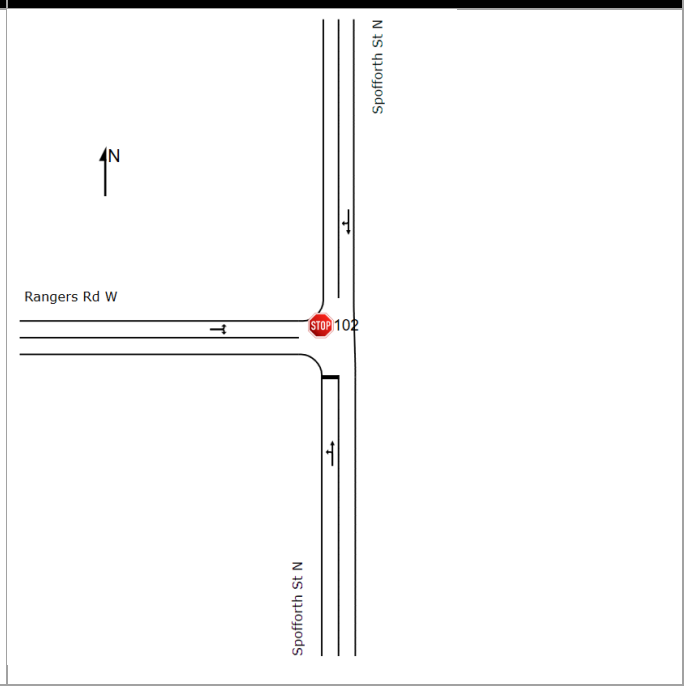


Figure 3-5 Rangers Road SIDRA Intersection Layout (2023)

Source: SIDRA Model Screenshot

The base models were coded and developed utilising the existing intersection layouts including:

– The classified peak hour flows identified for the corridor based on the traffic counts.
– The length of approaches or the distance between intersections based on detailed measurement from the satellite imagery.
– The cruise speed in accordance with the posted speed limit at each approach.
– The number and length of lanes at each intersection are based on publicly available satellite imagery.
– The following vehicle movement classes were adopted. It should be noted that rigid and articulated trucks and buses were categorised as heavy vehicles.
    - Light Vehicles
    - Heavy Vehicles
    - Cyclists

Traffic signal data have been coded for signalized intersections according to the Intersection Diagnostic Monitor (IDM) data from SCATS which were provided for the date of 19th Oct 2023. Interpretation of this data provides signal information including typical cycle times, inter-green and green splits of individual signal phases at each signalised intersection in the study area during peak periods. The following signalised intersections were modelled:

– Ben Boyd Road and Yeo Street, Neutral Bay (TCS 1399)
– Wycombe Road and Yeo Street, Neutral Bay (TCS 3115)
– Murdoch Street and Rangers Road, Cremorne (TCS 1354)

3.5 Level of Service criteria

Level of Service (LoS) is a basic performance parameter used to describe the operation of an intersection. The LoS range from A to F is based on the operational performance primarily determined by the average traffic delay at the signalised intersection, as indicated in Table 3-3.

The results of the degree of saturation and the 95th percentile queue length were also assessed at each approach. The *Roads and Maritime Services Guide to Traffic Generating Developments* (2002) provides a guideline for the LoS assessment for different intersection control types. The outputs produced by SIDRA were used to assess the intersection performance.

Table 3-3 Level of Service Criteria

Level of Service	Average Delay (seconds)	Control types	
		Traffic signal	Priority control
A	< 14	Good operation	Good operation
B	15 – 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 – 42	Satisfactory operation	Satisfactory, but accident study required
D	43 – 56	Near capacity	Near capacity and accident study required
E	57 – 70	At capacity. At signals incidents will cause excessive delays.	At capacity, require other control model
F	> 70	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing; requires other control model

3.6 Summary of existing (2023) intersection performance results

Table 3-4 summarise the base year (2023) SIDRA intersection performance of surveyed intersections along Route 5 (study area).

Table 3-4 Existing base peak hour intersection performance

Intersection		Weekday AM Peak					Weekday PM Peak				Saturday Peak			
Location		Control Type	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)
1	Ben Boyd Rd / Yeo St	Signalized	0.53	20	B	52 (east)	0.46	16	B	47 (east)	0.61	14	A	43 (west)
2	Barry St / Yeo St	Priority	0.22	20	B	<10	0.19	17	B	<10	0.20	14	B	<10
3	Wycombe Rd / Yeo St	Signalized	0.45	19	B	57 (east)	0.40	17	B	42 (east)	0.73	15	B	51 (west)
4	Rangers Rd / Murdoch St	Signalized	0.75	45	D	130 (east)	0.86	48	D	160 (east)	0.89	47	D	180 (south)
5	Rangers Rd / Spofforth St	Priority	0.57	7	C	18 (south)	0.43	25	B	<10	0.53	34	C	15 (south)

The SIDRA results in Table 3-4 indicate that there is currently no congestion during the weekday and weekend peak periods, with all key intersections within the study area operating within the capacity and at a satisfactory LOS (LOS D at worst). Key findings are summarized as the following:

– The intersection Rangers Road and Murdoch Street was estimated to experience relatively long rolling queues (approximately 160 m) on Rangers Road eastern approach for both weekday and weekend peak periods. This is mainly due to the westbound filtered right turn occasionally blocking the through movement behind.

– During the weekend peak period, noticeable queues (approximately 180m) were estimated for Murdoch Street northbound right turn movement, associated with relatively high right turn volumes (460 veh/ hr).

– The SIDRA results also correlate with the observed traffic conditions during the site inspections and typical Google live traffic.

4. Traffic assessment: without cycleway

4.1 Future traffic growth

The *NSW Population Projections | Planning Portal - Department of Planning and Environment* website indicates an average annual growth rate of one (1.0) percent for NSW, which has been adopted as the background traffic growth to estimate future year traffic volume for the study, as agreed with the Council. Considering the planned bi-directional cycleway along the Route 5 is likely to attract more cyclists, an additional 1.50 percent background growth has also been applied to estimate future cyclist volume for relatively conservative forecast, consistent with the projected cyclist growth adopted by the Council for other traffic studies within the LGA.

It was advised by the Council that there will be no major land use changes or committed development in proximity to the Route 5 to generate additional development-related traffic for the purpose of this traffic study. Therefore, only background traffic growth factors were applied to the existing 2023 traffic volume to estimate future year demand for planning horizon 2033 and 2043.

4.2 Future scenario: without cycleway

4.2.1 Overview

The future base case models (without cycleway) were developed for the following scenarios:

– Future horizon (forecast years) 2033 and 2043.
– Typical weekday and weekend peak periods, based on the base year (2023) calibrated and validated models.

The scenario retains the existing intersection layout and includes the background traffic growth set out in section 4.1. The BAU scenario does not include the implementation of a bidirectional cycleway along the Route 5. A summary of LOS outputs for each intersection during all the assessed peak periods is provided for Route 5 study area in Table 4-1.

Table 4-1 Without cycleway: peak hour intersection performance

Location		Control Type	2023			2033			2043		
			AM	PM	Saturday	AM	PM	Saturday	AM	PM	Saturday
1	Ben Boyd Rd / Yeo St	Signalized	B	B	A	C	B	B	C	B	B
2	Barry St / Yeo St	Priority	B	B	B	B	B	B	B	B	B
3	Wycombe Rd / Yeo St	Signalized	B	B	B	F	B	B	F	B	B
4	Rangers Rd / Murdoch St	Signalized	D	D	D	D	E	E	E	F	F
5	Rangers Rd / Spofforth St	Priority	C	B	C	C	C	D	F	D	F

The results in the above table demonstrate that majority of intersections operating within capacity in 2033, except for Wycombe Road and Yeo Street intersection. The performance of these intersections are predicted to deteriorate from year 2033 to 2043 as the future traffic volumes increase. Key findings based on the LOS outputs are summarised as follows:

– Intersection Wycombe Rd / Yeo St is predicted to operate at LOS F during AM peak from 2033, associated with increase of overall intersection volume (approx.120 veh/hr of increase)

– Intersection Rangers Rd / Murdoch St is predicted to operate at LOS F by 2043, associated with increase of Rangers Road westbound filter right turns, potentially block the through movement.
– Intersection Rangers Rd / Spofforth St is predicted to operate at LOS F by 2043, associated with long waiting time required for Spofforth Street northbound vehicles to find the gap in the major traffic flow as the traffic demand increases.

In summary, The LOS outputs demonstrate a continued trend from the existing year 2023 base case model, with intersection performance expected to slightly deteriorate from year 2033 to 2043 as the traffic demand increases.

For simplicity, forecast year 2033 has been used to discuss the details of intersection modelling results in the following section.

4.2.2 Details of 2033 intersection performance without cycleway

Table 4-2 summarises the intersection performance of surveyed intersections along Route 5 (study area) in 2033.

Table 4-2 2033 BAU peak hour intersection performance

Intersection		Weekday AM Peak					Weekday PM Peak				Saturday Peak			
Location		Control Type	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)
1	Ben Boyd Rd / Yeo St	Signalized	0.62	22	B	60 (east)	0.51	17	B	53 (east)	0.61	16	B	49 (west)
2	Barry St / Yeo St	Priority	0.24	24	B	<10	0.21	20	B	<10	0.22	21	B	<10
3	Wycombe Rd / Yeo St	Signalized	1.40	91	F	125 (east)	0.45	18	B	48 (east)	0.68	15	B	55 (west)
4	Rangers Rd / Murdoch St	Signalized	0.85	50	D	157 (east)	0.97	60	E	244 (east)	0.98	59	E	264 (south)
5	Rangers Rd / Spofforth St	Priority	0.80	48	C	32 (south)	0.47	33	C	<10	0.78	56	D	28 (south)

The SIDRA results in Table 4-2 indicate that majority of intersections are expected to operate within capacity with satisfactory LOS during the weekday and weekend peak periods by 2033. The intersection Wycombe Rd / Yeo St and intersection Rangers Rd / Murdoch St would experience capacity issues as demand increases. Key findings are summarized as the following:

– The eastbound filter right turn at intersection Wycombe Road and Yeo Street would experience long delays, leading to the intersection operating at LOS F during 2033 AM peak period. Figure 4-1 shows the modelled average queue length for Yeo Street network intersections are all expected within the approach distance.

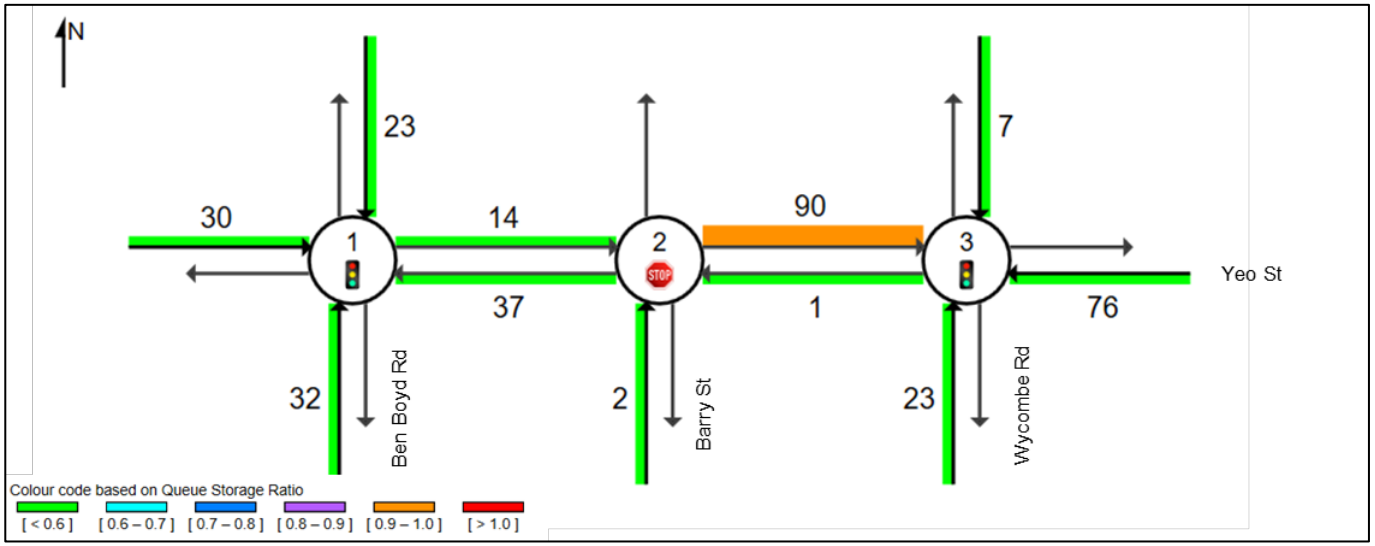


Figure 4-1 Yeo St predicted average queue length, 2033 AM pek
Source: SIDRA outputs extract

– During the weekend peak period, noticeable queues (approximately 250m at max) were observed for right turn movements on both eastern and southern approach, associated with relatively high right turn volumes.

5. Future model: with proposed cycleway

5.1 Overview

The concept design drawing provided by the council indicates the proposed bidirectional cycleway has the following key features in regards to the traffic capacity:

– Implemented on the southern side of the Yeo Street and Rangers Road along the kerb in both directions.
– The cycleway will be converted from the existing carriageway of vehicle lane, whilst the traffic lane reduction and removal of kerbside parking is proposed
– Implement right turn ban for peak times (buses excepted) at the Wycombe Road and Yeo Street intersection for eastbound and southbound traffic as a result of the new cycleway and the lane reduction (e.g. removal of the right turn lane). The detour movements and volumes resulted from the assumed right turn ban from the design are reviewed as part of the assessment.
– Refer to the below figure for the proposed cross-section of Yeo Street.

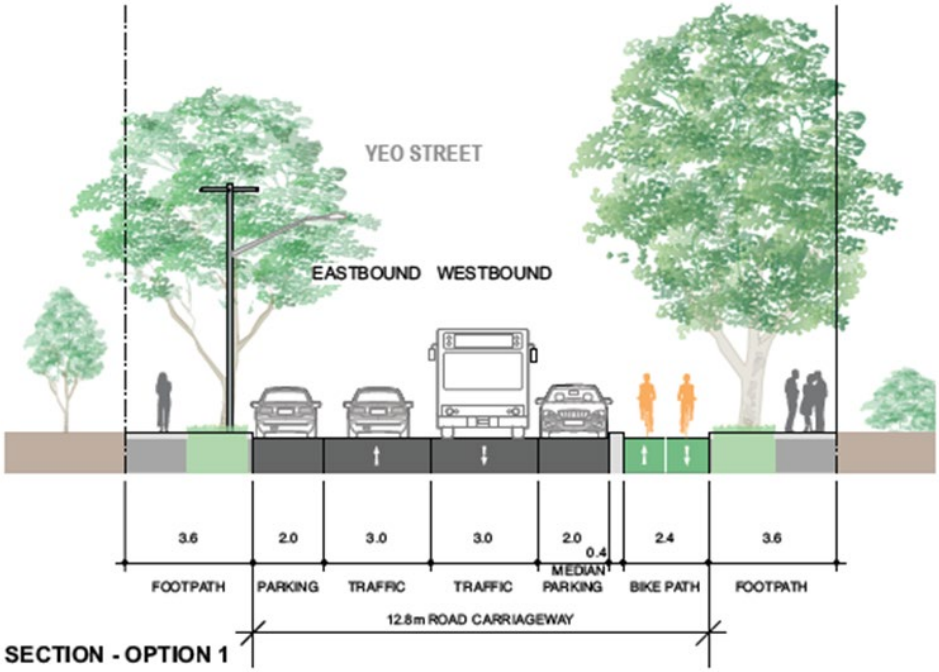


Figure 5-1 Proposed cross section of Yeo Street
Source: North Sydney Council Cycleway, Route 5 Bike Path, Concept Design Upgrade, Final Draft

Table 5-1 shows the proposed SIDRA intersection layout, supplemented by Figure 5-2 presenting the potential detour routes with the proposed right turn ban as part of the supplied design.

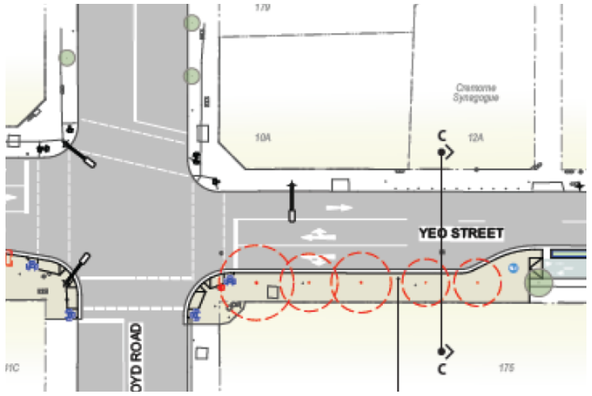
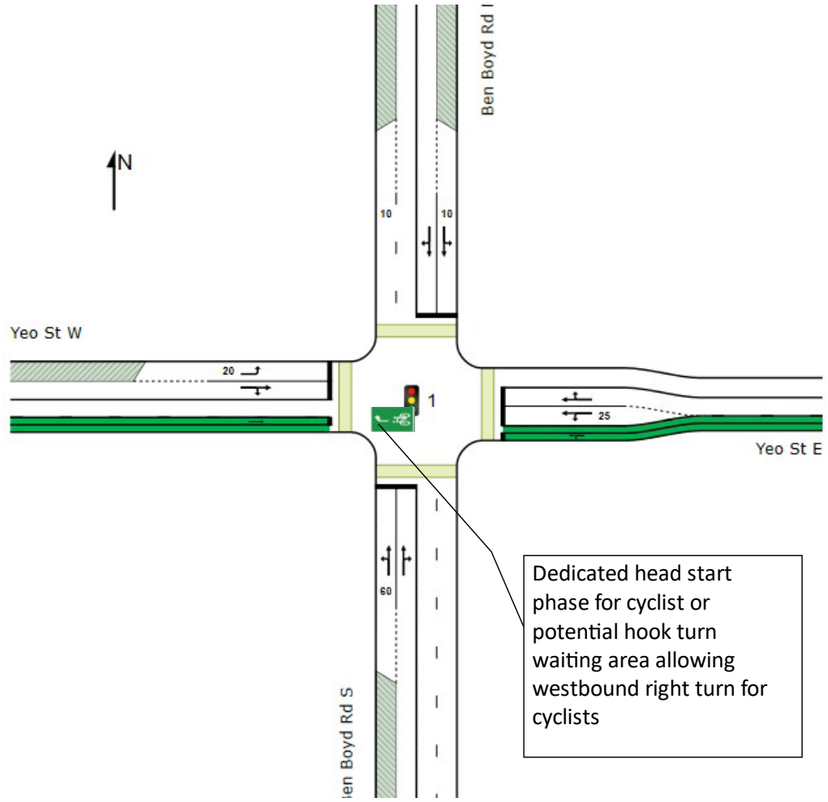
The following assumptions regarding the cyclist movements were made for the purpose of traffic impact assessment:

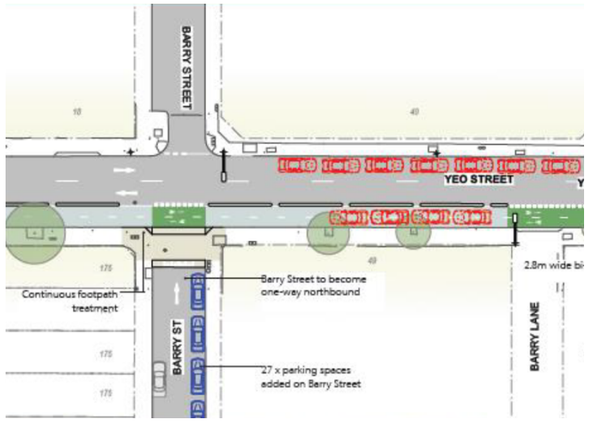
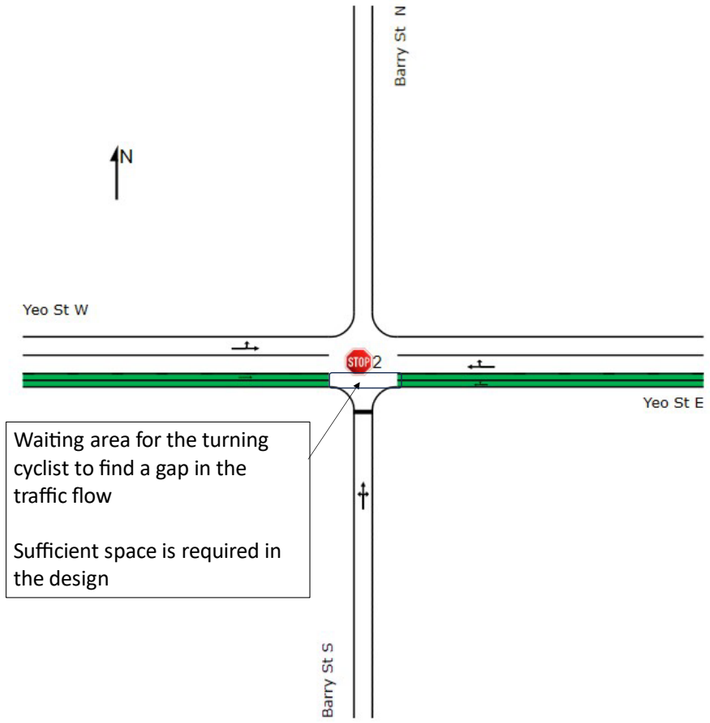
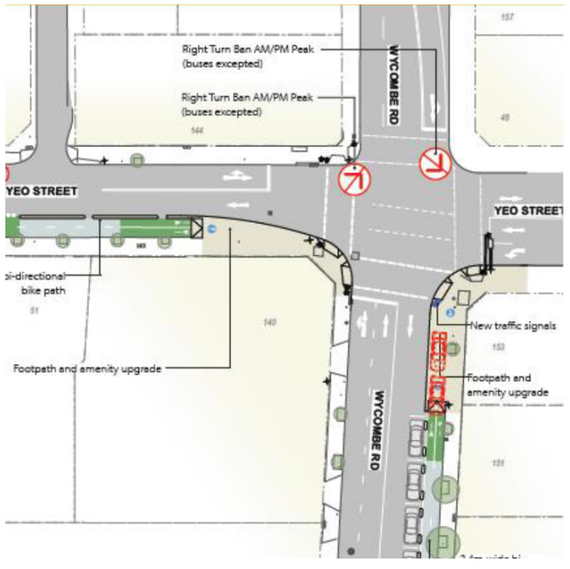
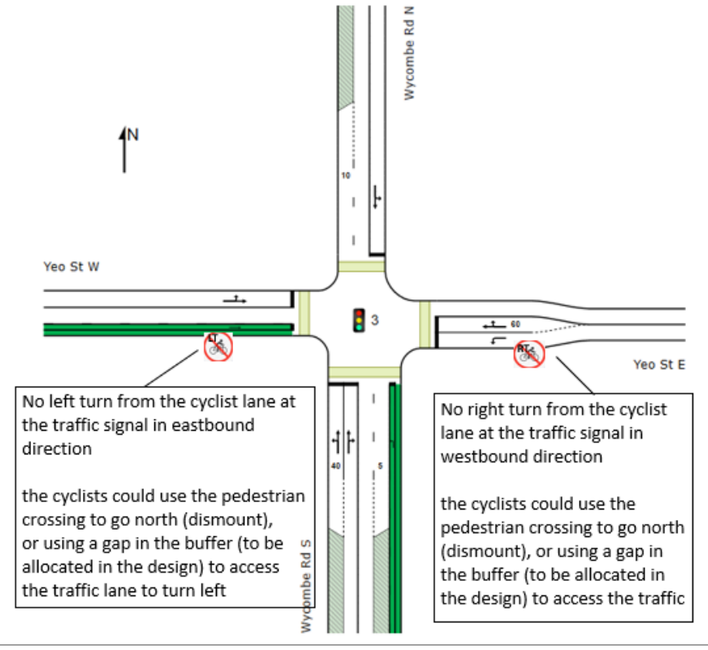
– Except at Ben Boyd Road, right turn cyclist movement is excluded in both directions along Yeo Street from the proposed cycling lane, with the predicted low volume (up to approx. 5 cyclists/ hr). The treatment of right turn cyclist movement from Yeo Street to Ben Boyd Road (crossing all the traffic lanes) is discussed as part of the assessment.
– Except at Ben Boyd Road, left turn cyclist movement is excluded in eastbound along Yeo Street, with the predicted low volume (up to 5 cyclists/ hr). The treatment of left turn cyclist movement from Yeo Street to Ben Boyd Road (crossing all the traffic lanes) is discussed as part of the assessment.

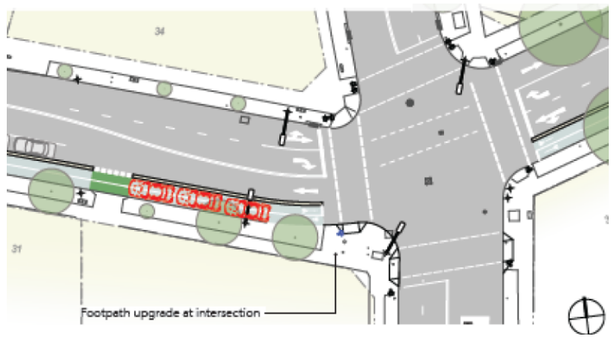
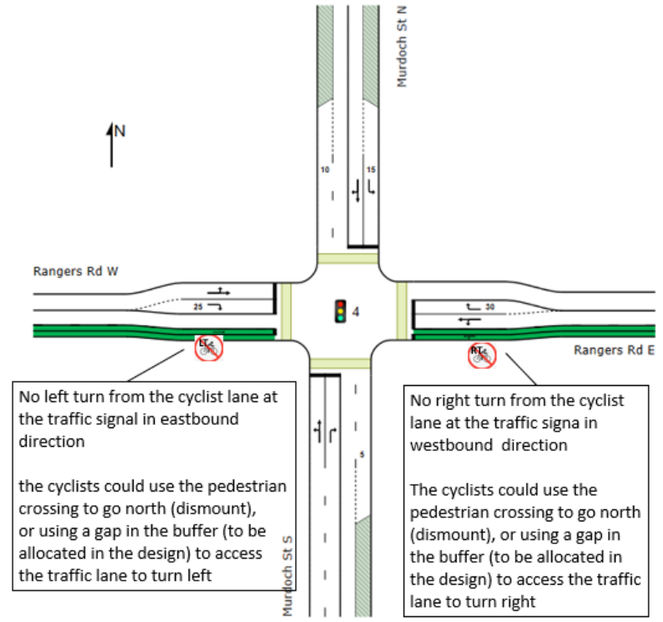
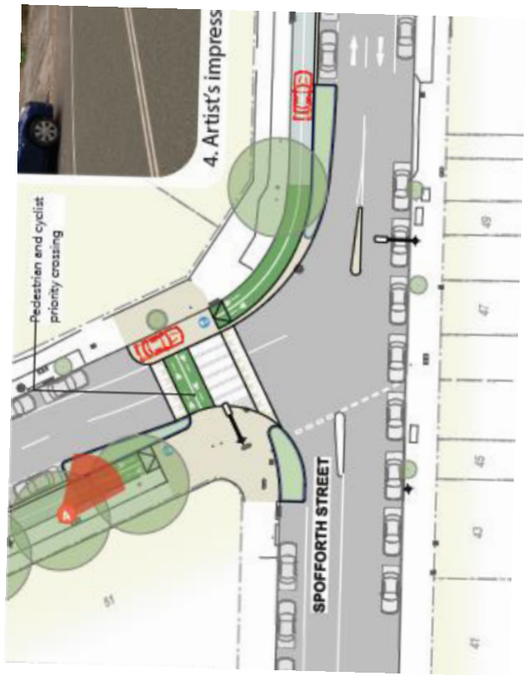
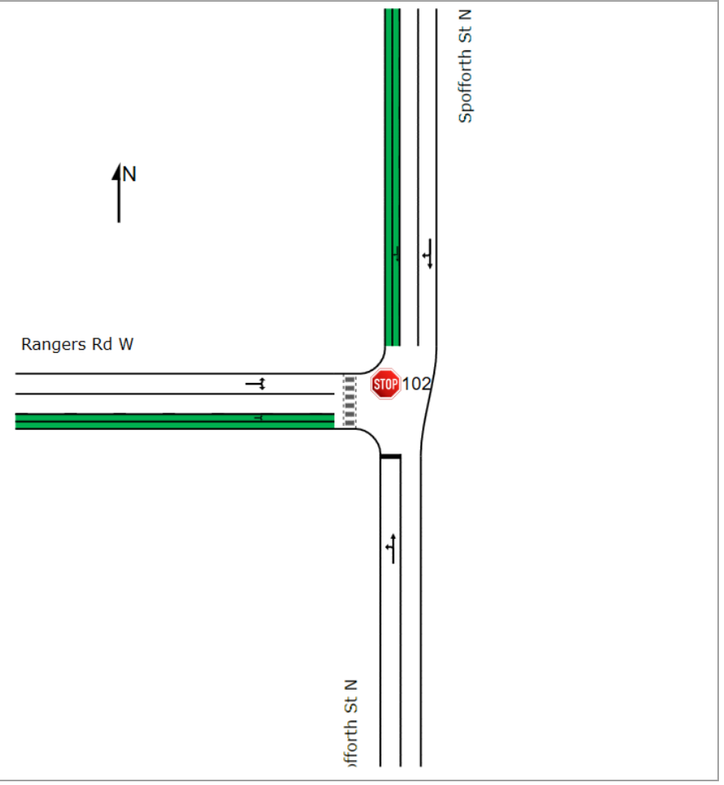
– At intersection Rangers Road / Murdoch Street, eastbound left turn cyclist movement and right turn cyclist movement in both directions of Rangers Road are excluded with the predicted low volumes.

It should be noted that the cyclists turning movement would require the crossing of dual directional vehicle lanes of Yeo Street and Rangers Road. Safety assessment (e.g. road safety audit) is recommended to advise whether such movement could be undertaken in a safe manner, with the appropriate traffic signal design associated with the proposed design. However, the impact of excluding such turning movement to the intersection performance is predicted to be minimal given the low cyclist volumes.

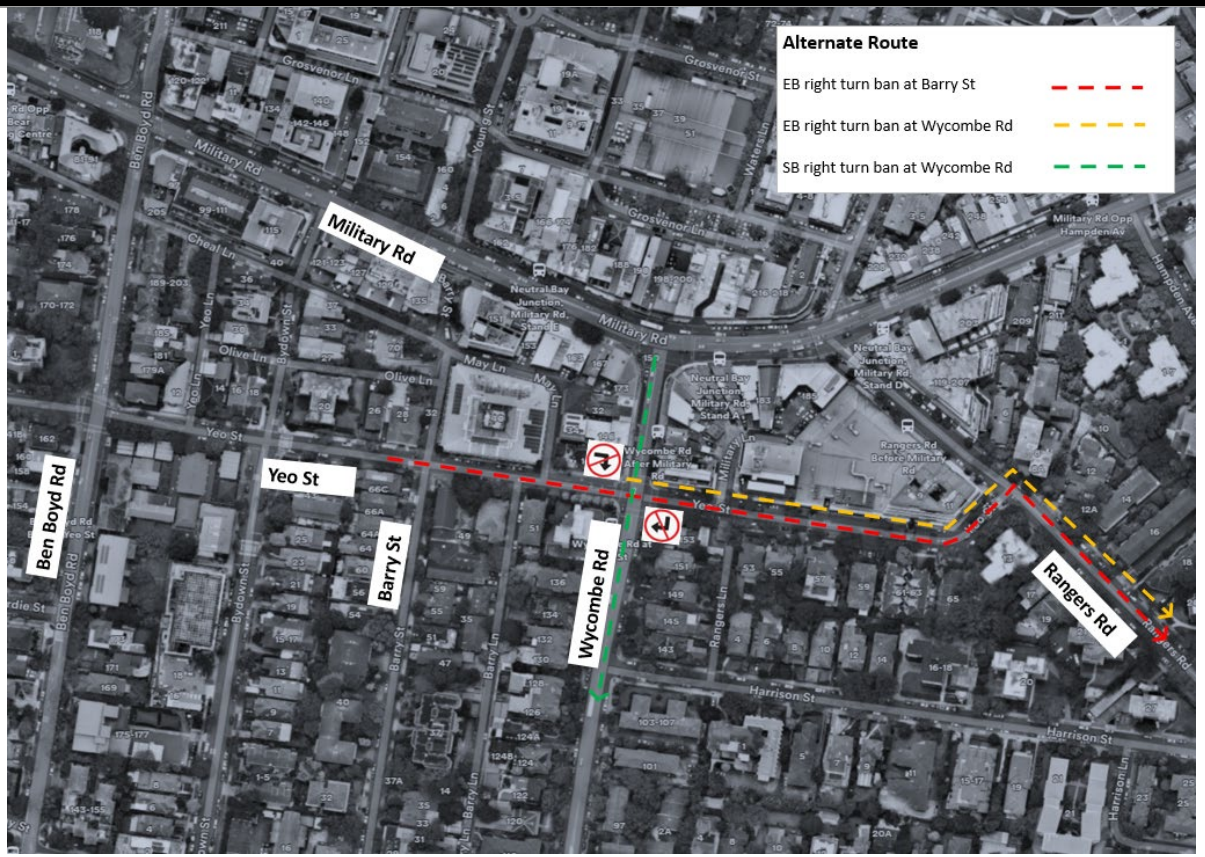
Table 5-1 Proposed intersection layout and trip redistribution assumption

ID	Intersection	Control Type	Proposed intersection layout changes compared with the 2023 existing base case	Design layout	Proposed intersection layout (SIDRA snapshot)
1	Ben Boyd Road and Yeo Street	Signal	– A bidirectional cycleway is being implemented on the southern side of Yeo Street – Ben Boyd Road is popular with cyclist movements and a strategic route (south to CBD and north to Northern Beaches). Therefore, all the movements from the proposed cycleway would be accommodated at this location		

ID	Intersection	Control Type	Proposed intersection layout changes compared with the 2023 existing base case	Design layout	Proposed intersection layout (SIDRA snapshot)
2	Barry Street and Yeo Street	Priority	– Yeo Street right turn ban on the west approach as Barry Street south is one-way out. – Barry Street being converted into a one-way northbound street – Bidirectional cycleway implemented on the southern side of Yeo Street		
3	Wycombe Road and Yeo Street	Signal	– Yeo Street eastbound right turn ban for vehicles – Wycombe Road southbound right turn ban for vehicles – The right turn in westbound and northbound are maintained. – A bidirectional cycleway implemented on the southern side of Yeo Street		

ID	Intersection	Control Type	Proposed intersection layout changes compared with the 2023 existing base case	Design layout	Proposed intersection layout (SIDRA snapshot)
4	Murdoch Street and Rangers Road	Signal	– A bidirectional cycleway implemented on the southern side of Rangers Road		
5	Rangers Road and Spofforth Street	Priority	– Pedestrian crossing implemented to cross Rangers Road – Bidirectional cycleway being implemented on the southern side of Rangers Road – Bidirectional cycleway being implemented on the western side of Spofforth Street		

Yeo Street right turn ban alternate route



- **Eastbound right turn ban on Yeo Street at Barry St - alternate route (red line):** assuming all the right turn movements redistributed onto Rangers Road for a right turn
- **Eastbound right turn ban on Yeo Street at Wycombe Road - alternate route (yellow line):** right turn movements redistributed onto Rangers Road for a right turn
- **Southbound right turn ban on Wycombe Road at Yeo Street - alternate route (Green line):** right turn movements redistributed to through movements onto Wycombe Road south

The impact of right turn redistribution to intersection Yeo Street/ Rangers Rd and the additional traffic on the south of Wycombe Road may need further investigation on the traffic impact.

Figure 5-2 Alternate route for proposed right turn ban

The future models with proposed upgrades incorporate the proposed intersection layout and trip redistribution assumptions as set out in Table 5-1 and Figure 5-2, with the traffic growth set out in section 4.1. A summary of LOS outputs for each intersection during all the assessed peak periods is provided for Route 5 study area in Table 5-2.

Table 5-2 Intersection performance with proposed upgrades

Location		Control Type	2033			2043		
			AM	PM	Saturday	AM	PM	Saturday
1	Ben Boyd Rd / Yeo St	Signalized	B	B	B	B	B	B
2	Barry St / Yeo St	Priority	B	A	B	B	A	B
3	Wycombe Rd / Yeo St	Signalized	A	A	A	A	A	A
4	Rangers Rd / Murdoch St	Signalized	C	D	D	D	E	E
5	Rangers Rd / Spofforth St	Priority	C	B	C	F	C	F

The key findings are:

– Provided the proposed cycleway is implemented by 2028, all the intersections are predicted to operate within capacity, with LOS D or better, by 2033 or 5 years after the proposed cycleway is implemented)

– The majority of intersections are predicted to still operate within capacity, with LOS D or better, except for the following intersections:

  - Intersection Rangers Road and Murdoch Street, by 2043 or 15 years after the proposed cycleway is implmeneted
  - intersection Rangers Road and Spofforth Street, by 2043 or 15 years after the proposed cycleway is implemented

– In 2043, intersection Rangers Road and Murdoch Street is expected to operate at capacity (LOS E) with the forecasted traffic volumes. The intersection performance (i.e. LOS and queues) at this intersection improved when compared to the future scenario without a cycleway. This is due to the signal time optimisation undertaken in the traffic modelling at this location.

– Intersection Rangers Road and Spofforth Street is expected to operate at LOS F, due to the capacity constraint on Spofforth Street with the existing configuration (e.g. long delay for Spofforth Street northbound to find the gap in the major traffic flow)

5.2 Summary of 2033 intersection performance with proposed upgrades

Table 5-3 summarises the 2033 SIDRA intersection performance with proposed upgrades along Route 5 (study area).

Table 5-3 2033 peak hour intersection performance with proposed upgrades

Intersection		Control Type	Weekday AM Peak				Weekday PM Peak				Saturday Peak			
Location			DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)
1	Ben Boyd Rd / Yeo St	Signalized	0.51	21	B	61 (west)	0.42	17	B	50 (west)	0.61	23	B	77 (west)
2	Barry St / Yeo St	Priority	0.29	19	B	<10	0.25	8	A	<10	0.26	15	B	<10
3	Wycombe Rd / Yeo St	Signalized	0.45	14	A	61 (east)	0.38	12	A	47 (east)	0.39	14	A	46 (west)
4	Rangers Rd / Murdoch St	Signalized	0.85	40	C	129 (east)	0.92	51	D	204 (east)	0.88	52	D	177 (south)
5	Rangers Rd / Spofforth St	Priority	0.74	36	C	28 (south)	0.53	27	B	27 (west)	0.70	37	C	42 (west)

5.3 Summary of 2043 intersection performance with proposed upgrades

Table 5-4 summarises 2043 SIDRA intersection performance with proposed upgrades along Route 5 (study area).

Table 5-4 2043 peak hour intersection performance with proposed upgrades

Intersection		Control Type	Weekday AM Peak				Weekday PM Peak				Saturday Peak			
Location			DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)	DoS	Average Delay (s)	LOS	95th Percentile Queue Length (m)
1	Ben Boyd Rd / Yeo St	Signalized	0.71	27	B	82 (West)	0.47	19	B	58 (west)	0.66	23	B	80 (west)
2	Barry St / Yeo St	Priority	0.32	21	B	<10	0.27	9	A	<10	0.28	17	B	<10
3	Wycombe Rd / Yeo St	Signalized	0.50	14	A	69 (east)	0.41	12	A	52 (east)	0.43	14	A	52 (west)
4	Rangers Rd / Murdoch St	Signalized	0.90	47	D	164 (east)	0.98	70	E	307 (east)	0.92	63	E	220 (south)
5	Rangers Rd / Spofforth St	Priority	1.03	148	F	124 (south)	0.58	36	C	33 (west)	1.03	159	F	105 (south)

6. Parking assessment

During the site inspection conducted during a weekend in December 2023, it was observed that the on-street parking within the study area was well utilized with some spare capacity. Due to the short-term parking limitations during the peak periods, the frequent parking manoeuvres are likely to slow down the general traffic circulation.

The proposed concept design provided by the Council indicates that over thirty (30) parking spaces would be removed on both sides of Yeo Street between Ben Boyd Road and Wycombe Road due to the implementation of a bidirectional cycleway. The majority of existing parking spaces would be retained on Rangers Road, with 5 parking spaces removed close to Murdoch Street.

However, Barry Street south approach would be converted into a one-way northbound street with an additional 27 parking spaces added to offset the parking removal along Yeo Street. The total loss and parking gain of the study area are provided in Table 6-1.

Table 6-1 Total Parking Gain and Loss

Parking Loss	Parking Gain	Total
60 parking spaces	37 parking spaces	-23 parking spaces

High level review was also conducted on the surrounding area to identify additional parking capacity. Potential capacity was identified, if converting parallel parking to 45-degree parking on Cranbrook Avenue, between Cranbrook Lane and Spofforth Street as illustrated in Figure 6-1.

Further, existing on-street parking on Harrison Street was noted to typically have spare capacity.

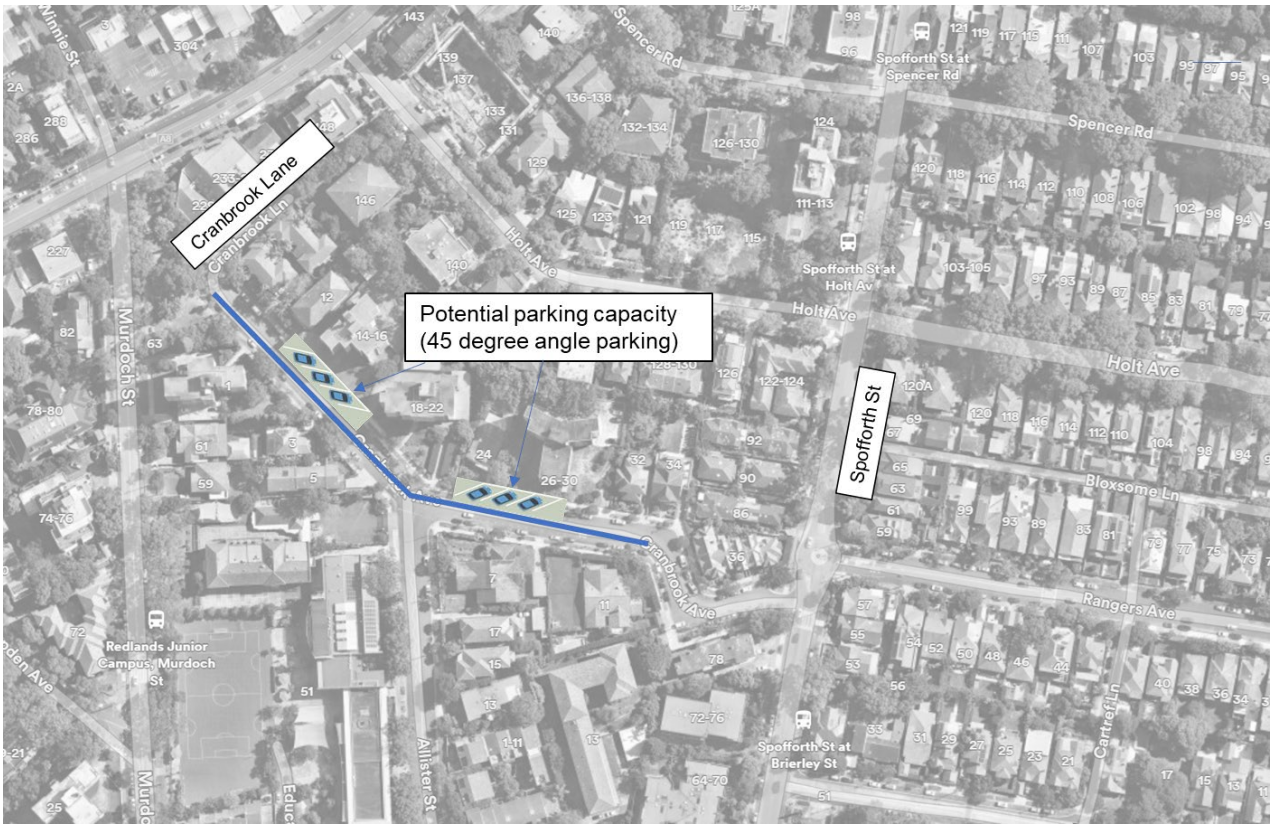
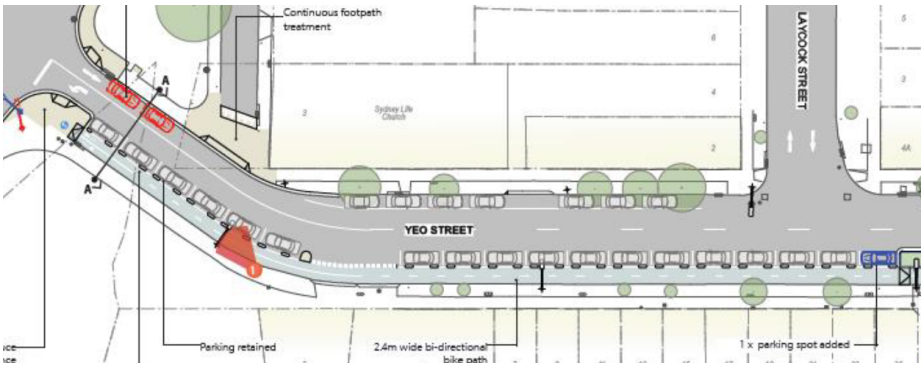
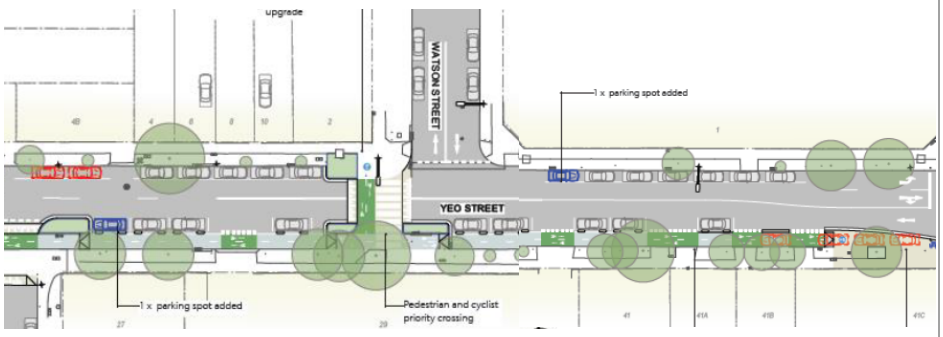
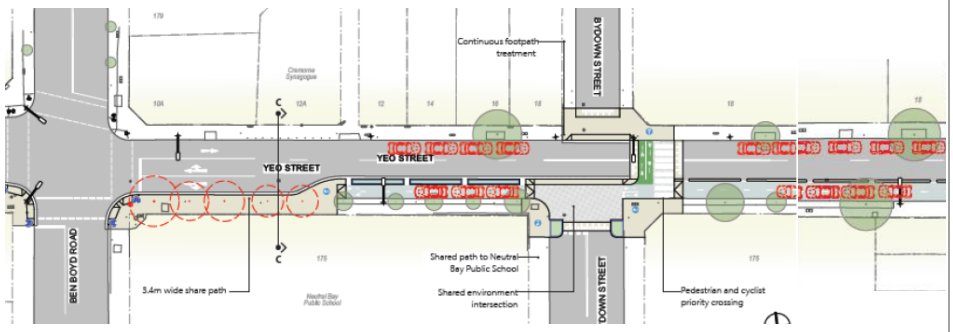
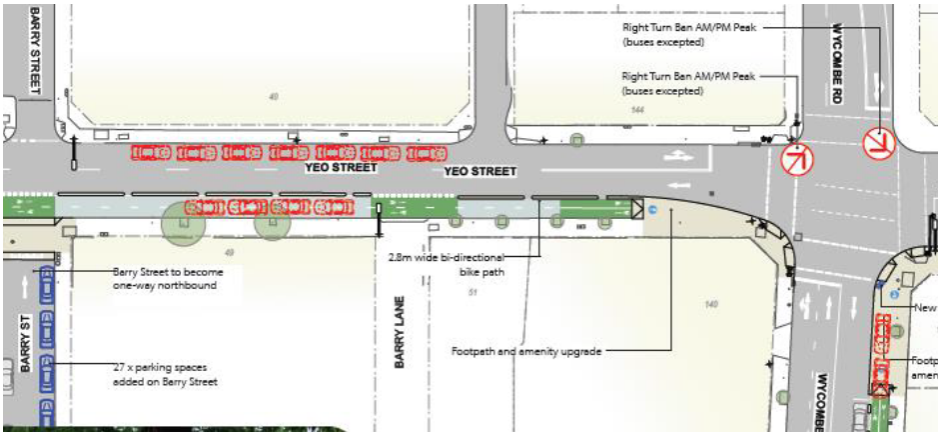


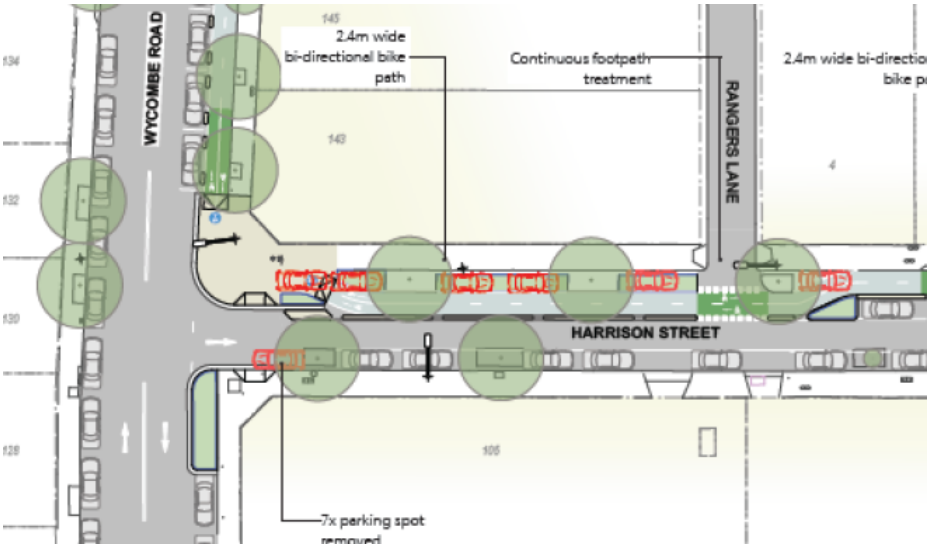
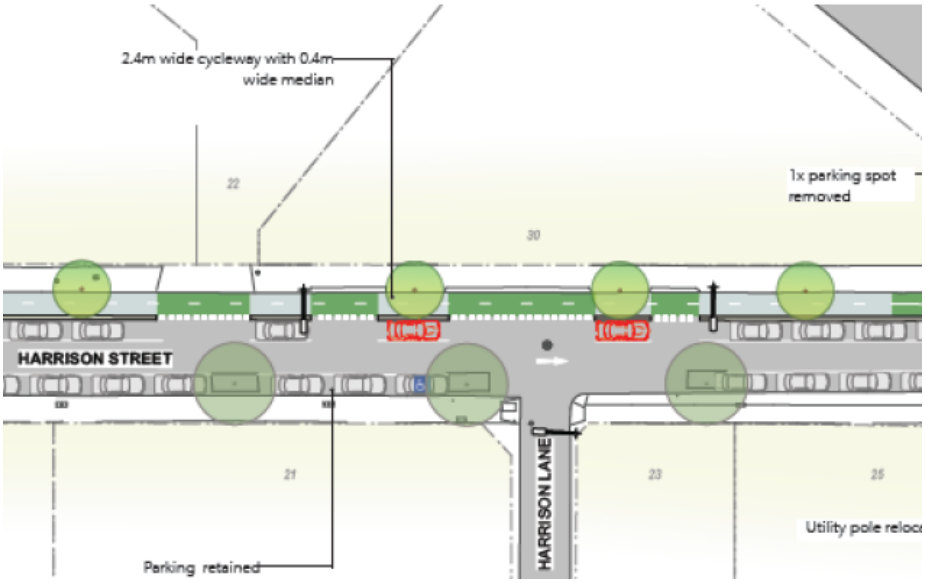
Figure 6-1 Potential parking capacity

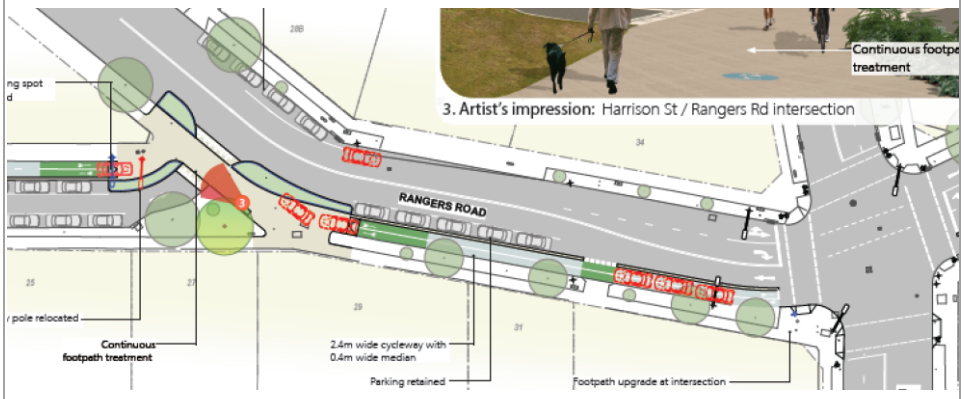
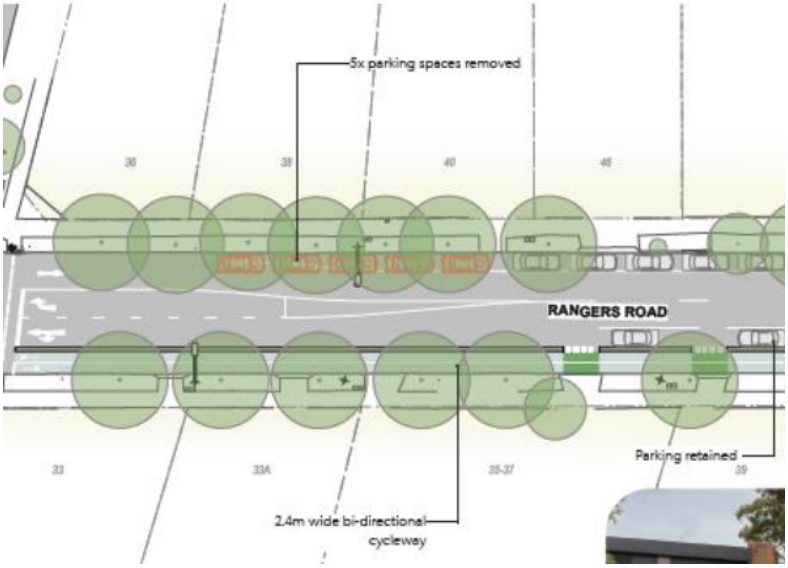
Therefore, the impact on the parking within the vicinity is predicted to be limited. A detailed future parking arrangement is illustrated in Table 6-2.

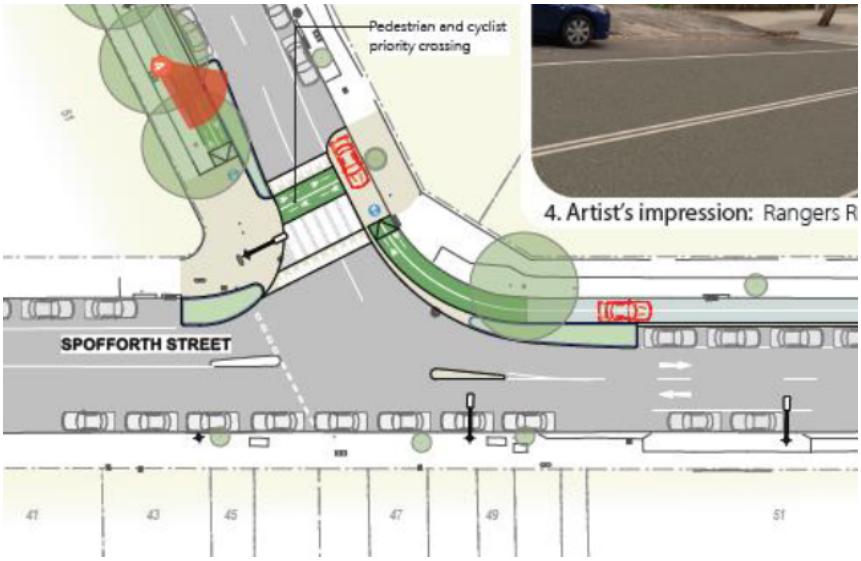
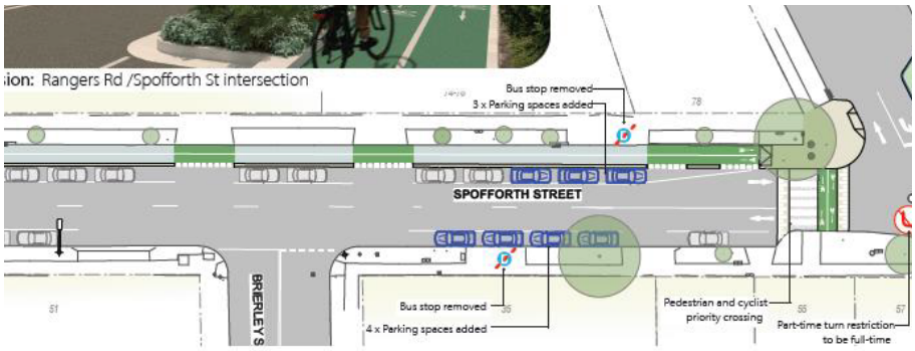
Table 6-2 Future Parking Arrangement

No.	Location	Detail
1	Yeo Street between Bent Road and Laycock Street (loss of 2 parking, gain of 1 parking)	
2	Yeo Street between Premier Street and Ben Boyd Road (loss of 6 parking, gain of 2 parking)	

No.	Location	Detail
3	Yeo Street between Ben Boyd Road and Barry Street (loss of 16 parking)	 *Source: North Sydney Council Cycleway: Route 5 Bike Path Concept Design Final Draft*
4	Yeo Street between Barry Street and Wycombe Road (loss of 13 parking) *Barry Street gain 27 parking spaces, converted to one-way*	 *Source: North Sydney Council Cycleway: Route 5 Bike Path Concept Design Final Draft*

No.	Location	Detail
5	Wycombe Road and Harrison Street (loss of 7 parking) (Part 1 out of 2)	 *Source: North Sydney Council Cycleway: Route 5 Bike Path Concept Design Final Draft*
6	Along Harrison Street (loss of 2 parking) (Part 2 out of 2)	

No.	Location	Detail
7	Harrison Street and Rangers Road & West side of Rangers Road and Murdoch Street (loss of 7 parking)	
8	East side of Rangers Road and Murdoch Street (loss of 5 parking)	

No.	Location	Detail
9	Rangers Road and Spofforth Street (loss of 2 parking)	 *Source: North Sydney Council Cycleway: Route 5 Bike Path Concept Design Final Draft*
10	Spofforth Street between Brierley Street and Rangers Avenue (gain of 7 parking)	 *Source: North Sydney Council Cycleway: Route 5 Bike Path Concept Design Final Draft*

7. Conclusion

GHD was commissioned by North Sydney Council to assess the traffic impacts of the proposed design of a bidirectional cycleway on Route 5 from Bent Street to Rangers Road. The traffic modelling was undertaken at five intersections of interest along Route 5 to assess the potential traffic impact of the proposed cycleway.

7.1 Summary of findings

Traffic modelling was undertaken to assess existing traffic conditions and provide a basis for the assessment of future scenarios with the proposed cycleway. The key findings are:

All intersections of interest operate within capacity and at a satisfactory LOS D or better during the weekday and weekend peak periods, however,

– Slow moving queues were observed on the south approach of the intersection Rangers Road and Murdoch Street during the weekend peak period, associated with high northbound right turn volume (460 veh/hr).
– Slow moving queues were observed on the eastern approach of the intersection Rangers Road and Murdoch Street during weekday peak periods, this is associated with the westbound filter right turn phasing arrangement.

The predicted future traffic growth (1% growth p.a.) along Route 5 would slightly worsen the traffic performance:

– Intersection Wycombe Rd / Yeo St is predicted to operate at LOS F during AM peak from 2033, associated with an increase of westbound right turn volumes along Yeo Street.
– Both intersections Rangers Rd / Murdoch St and Rangers Rd / Spofforth St are predicted to operate at LOS F by 2043, with the Rangers Road westbound right turn and Spofforth Street northbound through being critical movements.

7.2 Other considerations

Figure 7-1 indicates the proposed bus stop consolidation (bus stops ID209054 and ID208815 removal) on Spofforth Street for providing a bicycle facility is a practical approach to improving the overall flow of the bus route 225. According to *State Transit Bus Infrastructure Guide (TfNSW, 2012),* bus stops are generally to be spaced at 200m to 400m intervals. Following the removal, a distance of 340m between existing Holt Avenue and Rangers Rd bus stops is practical to improve efficiency and to reduce travel times.

Further consultation with TfNSW is required to carry out the potential bus stop consolidation.

Figure 7-1 Consolidation of bus stops on spofforth st plan
Source: North Sydney Council Cycleway, Route 5 Bike Path, Concept Design Upgrade, Final Draft

7.3 Recommendations

7.3.1 Proposed right turn ban at Wycombe Street and Yeo Street intersection

With the proposed cycleway design, a right turn ban for peak times (buses excepted) at the Wycombe Road and Yeo Street intersection for eastbound and southbound traffic would be implemented due to safety considerations and site constraints (e.g. converting a traffic lane to a cycleway). With the anticipated detour and changes in traffic distribution resolving the conflicting movement (e.g. typically associated with the right turn if retained), the intersection is predicted to operate within capacity.

7.3.2 Pedestrian crossing opportunities

The bus stops on Spofforth Street indicate high interactions between general traffic and pedestrians. The existing observation of the pedestrian activities indicated that pedestrians tend to cross outside the formalised zebra crossings provided at Cranbrook Avenue, suggesting that additional crossing facilities may be beneficial, particularly at the intersection Rangers Rd/ Spofforth St.

It is anticipated that the additional pedestrian crossing facilities over Ranges Road will:

– Provide better connections for pedestrians to access bus stops
– Provide a safer crossing environment and more crossing opportunities
– Improve connection to existing and proposed infrastructure (e.g. bidirectional cycleway)

7.3.3 Turning movements from the proposed cycling lane

Cyclists turning movements are reviewed as part of the assessment and the key findings are:

– The proposed bi-directional cycling lane will be positioned at the south of the carriageway and requires the eastbound left turn and westbound right turn cyclists to cross at least four traffic lanes (in both directions) on Yeo Street and Rangers Road

- It is recommended such cyclist turning movements be discouraged using the relevant signages, due to safety considerations (such as in Figure 7-2).
  - Provided that the cyclists will make such movements, they would use the pedestrian crossing (after dismounting) to move onto the general traffic lane, before making the turn
- The exception is made for the cyclist movements turning from Yeo Street to Ben Boyd Road, due to it is strategic alignment and connection, by
  - Providing hook turns and a waiting area for cyclists at the intersection Yeo Street and Ben Boyd Road for allowing westbound right turn movements (such as in Figure 7-3), subject to design requirements and outcome of relevant safety assessment. However, it is noted that such an arrangement is typically appropriate at locations with larger intersection footprint.
  - Alternatively, implementing a dedicated 'head start' signal phase for all the cyclist and pedestrian movements, whilst all the general vehicles are stopped (such as in Figure 7-4).

– It is recommended that a late start (e.g. left turn arrow with red light) is considered at all the signalised intersections for the left turning vehicles to protect cyclists on the cycling lane and pedestrians crossing on the southern side of the carriageway.
– At the Barry Street and Yeo Street intersection (priority control), it is recommended that an additional waiting area between the cycling lane and the traffic lane should be allocated for those making the northbound turn to Barry Street from the cycling lane
– Road safety audit is recommended to advise whether the proposed design accounts for the safe cyclist movement.

Figure 7-2 signage 'no right turn from bicycle lane' – Willliam Street and College Street, Sydney

Figure 7-3 Hook turn with cyclist stopping area – Willliam Street and College Street, Sydney

Source: Google Map

Figure 7-4 Head start for cycling movements with the dedicated traffic signal for cyclists – Kent Street and Margaret Street

7.3.4 Parking removal and reallocation for the proposed cycling lane

With the implementation of a bidirectional cycleway, the proposed design indicates that approximately 60 parking spaces would be removed on both sides of Yeo Street between Ben Boyd Road and Wycombe Road, whilst additional 37 parking spaces would be provided mainly on Barry Street and other surrounding locations, resulting in a net loss of (23) parking spaces. The impact on parking is predicted to be limited, and potentially be accommodated by other streets in proximity where spare on-street parking is available (e.g. Harrison Street, Cranbrook Avenue e.g. converting paralell parking to 45-degree parking between Cranbrook Lane and Spofforth Street).